

Case Study Abstract

Pump & Treatment System at Commencement Bay, South Tacoma Channel (Well 12A) Phase 2, Tacoma, Washington

<p>Site Name: Commencement Bay, South Tacoma Channel (Well 12A) Superfund Site</p>	<p>Contaminants: Chlorinated Aliphatics</p> <ul style="list-style-type: none"> - trans-1,2-Dichloroethene (DCE), 1,1,2,2-Tetrachloroethane (PCA), 1,1,2,2-Tetrachloroethane (PCE), Trichloroethene (TCE) - PCA contamination plume measured at levels greater than 10,000 µg/L in July 1983 - Free phase estimates of contamination are PCE - 3734 lbs, TCE - 126,112 lbs, and PCA - 209,115 lbs - Remedial investigation showed DCE up to 100 ppb; PCA up to 300 ppb; PCE up to 5.4 ppb; and TCE up to 130 ppb in Well 12A 	<p>Period of Operation: Status: Ongoing Report covers - 1988 to 2/94</p>
<p>Location: Tacoma, Washington</p>		<p>Cleanup Type: Full-scale cleanup (interim results)</p>
<p>Vendor: Not Available</p>	<p>Technology: Groundwater Extraction followed by Granular Activated Carbon (GAC)</p> <ul style="list-style-type: none"> - 7 groundwater extraction wells with a 500 gpm design flow rate - Designed to have drawn-down sufficient to create a cone of depression and to reduce further migration of contaminants out of the source area - 2 liquid-phase GAC containers operated in parallel - Treated water discharged to a storm drain system - Soil vapor extraction used in a related application to remove volatile contaminants from the soil matrix 	<p>Cleanup Authority: CERCLA; Local Requirements - ROD Date: 3/85</p>
<p>SIC Code: 2851 (Paints, Varnishes, Lacquers, Enamels, and Allied Products)</p>		<p>Point of Contact: Kevin Rochlin Remedial Project Manager U.S. EPA Region 10 Seattle, Washington</p>
<p>Waste Source: Storage - Drums; Other: Pour off from Processing Tanks</p>	<p>Type/Quantity of Media Treated: Groundwater</p> <ul style="list-style-type: none"> - Upper aquifer (50 ft thickness) consists of unconfined sand and gravel - Depth to water table approximately 36 feet - Lower aquifer not contaminated - Separate liquid phases of VOCs in soil and groundwater suspected - Area suspected of groundwater contamination covers approximately 100 acres 	
<p>Purpose/Significance of Application: Application of groundwater extraction followed by granular activated carbon treatment of extracted groundwater. Project completed in conjunction with an ongoing soil vapor extraction system.</p>		

Case Study Abstract

Pump & Treatment System at Commencement Bay South Tacoma Channel (Well 12A), Phase 2, Tacoma, Washington

Regulatory Requirements/Cleanup Goals:

- Cleanup goals identified for Well 12A (City of Tacoma production well) based on ARARs for RCRA, CAA, and CWA:
 - if Well 12A is used for drinking water - 10^{-6} risk level for contaminants present
 - if not, groundwater corrective action required until the concentration of hazardous constituents meets one of the following: MCLs, ACLs, or background
- Prior to discharge to storm sewer, extracted water required to meet EPA standards for "Fish Consumption Only", including DCE at 1.85 $\mu\text{g/L}$; PCA at 10.7 $\mu\text{g/L}$; PCE at 8.85 $\mu\text{g/L}$; TCE at 80.7 $\mu\text{g/L}$; discharge rate of 500 gallons per minute; pH of 6 to 9; TSS < 500 mg/L, and total VOAs of < 1mg/L

Results:

As of February 1994:

- 281,700,000 gallons of groundwater have been pumped and treated
- An estimated 10,361 pounds of VOCs have been removed by the GAC system
- Specific VOCs in GAC system influent ranged from 13 $\mu\text{g/L}$ to 2,000 $\mu\text{g/L}$
- Specific VOCs in GAC system effluent ranged from <1 $\mu\text{g/L}$ to 13 $\mu\text{g/L}$

Cost Factors:

- Total Capital Costs (contract amount) - \$1,343,701 (as of 7/25/88)
- No information provided on operating costs, cost sensitivities, or breakdown of capital costs

Description:

The Commencement Bay site was used from 1927 to 1964 for waste oil recycling, paint and lacquer thinner manufacturing, and solvent reclamation. Hundreds of drums of material were stored at this site. Leaks from these drums, as well as the dumping of wastes directly on the ground and overflows from the solvent and waste oil recycling tanks, resulted in contamination of the soil and groundwater at the site. The primary contaminants of concern at the site included DCE (trans-1,2-dichloroethene), PCA (1,1,2,2-tetrachloroethane), PCE (1,1,2,2-tetrachloroethene), and TCE (trichloroethene). A PCA groundwater contamination plume was measured at levels greater than 10,000 $\mu\text{g/L}$ and a separate liquid phase of contamination was suspected in both the soil and groundwater. In addition, chlorinated hydrocarbons were detected in a City of Tacoma production well (Well 12A) in 1981. The site was placed on the National Priorities List (NPL) and a Record of Decision was signed in 1985.

A groundwater extraction system using granular activated carbon (GAC) for treatment of extracted groundwater was installed and began operating at the site in 1988. This system includes 7 groundwater extraction wells and a 500 gpm design flow rate, and was designed to have a draw-down sufficient to create a cone of depression and to reduce further migration of contaminants out of the source area. Treated water is discharged into a storm drain system. The groundwater remediation was ongoing at the time of this report.

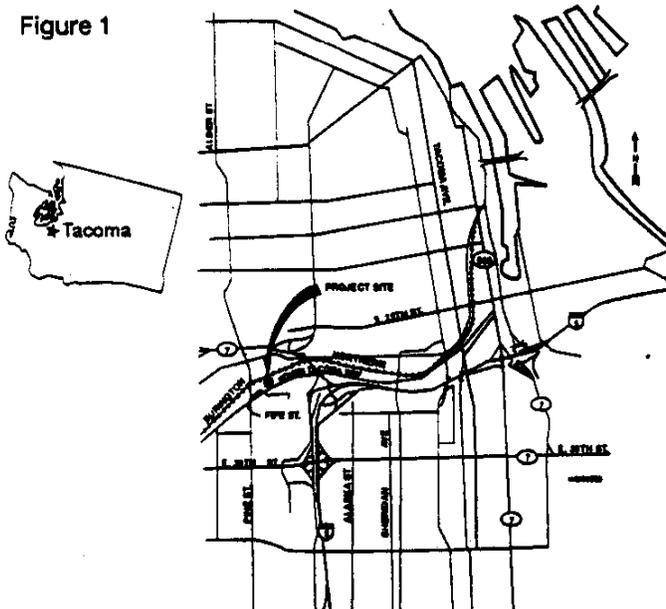
As of February 1994, approximately 282,000,000 gallons of groundwater had been extracted, and an estimated 10,631 pounds of VOCs removed by the GAC. Specific VOCs in the GAC system influent ranged from 13 $\mu\text{g/L}$ to 2,000 $\mu\text{g/L}$, and, in the effluent, from <1 $\mu\text{g/L}$ to 13 $\mu\text{g/L}$. The contract amount for total capital cost was identified as \$1,343,701, as of July, 1988.

TECHNOLOGY APPLICATION ANALYSIS

SITE

TECHNOLOGY APPLICATION

Figure 1



This analysis covers the field application of system to pump & treat the groundwater in a carbon adsorption system in an above ground plant. This began in late 1988 and Phase II is ongoing.

The contaminated soil matrix at this site is being remediated through *in situ* soil vapor extraction (SVE) which is not included in this analysis.

SITE CHARACTERISTICS

Site History/Release Characteristics

During the period from 1927 to 1964 this site was used by National Oil and Paint for waste oil recycling, paint and lacquer thinner manufacturing, and solvent reclamation. The site was purchased by the Time Oil Company in 1964.

The pre-1964 operations appear to have contributed to the site VOC contamination in several ways. First, the site was used to store hundreds of drum of potentially "useful" materials. Some of the stored drums leaked. Non-useable materials were dumped directly onto the ground. Second, during the recycling process for waste oil, solvents contained in the oil floated to the top of the processing tank and were poured off. Periodically, the tank holding the solvents overflowed onto the site.

In 1981 chlorinated hydrocarbons were detected in groundwater samples from the City of Tacoma production well 12A.

This site is in the City of Tacoma, Washington, and includes industrial, commercial, and residential areas that surround the site. Well 12A is one of 13 wells used by the city to meet peak summer and emergency water demands.

In 1983 a five tower air stripping system was built to treat well 12A water. In 1988 a pump and treatment system was installed near the contamination source to intercept and treat the groundwater plume.

In accordance with the Record of Decision (ROD), signed in 1985, soils and solid waste materials were disposed of in an offsite Resource Conservation and Recovery Act (RCRA) approved facility. This waste material was contaminated with heavy metals (primarily lead).



Contaminants of Concern

The VOCs of greatest concern in the soil and groundwater are the following chlorinated hydrocarbons:

DCE (trans-1,2-dichloroethylene)

PCA (1,1,2,2-tetrachloroethane)

PCE (1,1,2,2-tetrachloroethylene)

TCE (trichloroethylene)

Contaminant Properties

Properties of contaminants focused upon during remediation are:

Property at 1 atm	Units	DCE	PCA	PCE	TCE
Empirical Formula		$C_2H_2Cl_2$	$C_2H_2Cl_4$	C_2Cl_4	C_2HCl_3
Density	g/cm ³	1.257	1.586	1.6311	1.462
Melting Point	°C	-50	-43.8	-22.4	-84.8
Vapor Pressure @ 25°C	mm Hg	331	419	77	
Henry's Law Constant	$\frac{(atm)(m^3)}{mole}$	5.32×10^{-3} @ 25 °C	3.81×10^{-4} @ 20 °C	2.87×10^{-2} @ 25 °C	1.17×10^{-2} @ 25 °C
Water Solubility	mg/l	600 @ 20 °C	2,900 @ 20 °C	150 @ 25 °C	1,100 @ 25 °C
Log Octanol-Water Partition Coefficient;	log Kow	1.48	2.39	2.53	2.53
Organic Carbon Partition Coefficient; Koc,	L/kg	118	364	126	
Site Specific Extraction Efficiency, %		7	2	2	

Nature & Extent of Contamination

- About 20% of the contamination is in the top 32.5 feet, and the remaining 80% is in the 32.5 to 40 feet depth interval.
- The volume of contaminated soil is (66,287 ft² X 40 ft deep =) 2,651,480 ft³.
- For the VOCs, there may be separate liquid phases of these compounds or miscible solutions between them in both the soil and groundwater.
- Free phase estimates are 3,734 pounds of PCE; 126,112 pounds of TCE; and 209, 115 pounds of PCA.
- Total semi-volatile organic compounds (SVOCs) for the site is roughly 420 pounds.
- Gas chromatography limitations resulted in the PCA concentrations reported actually being PCA and/or PCE.



Contaminant Locations and Geologic Profiles

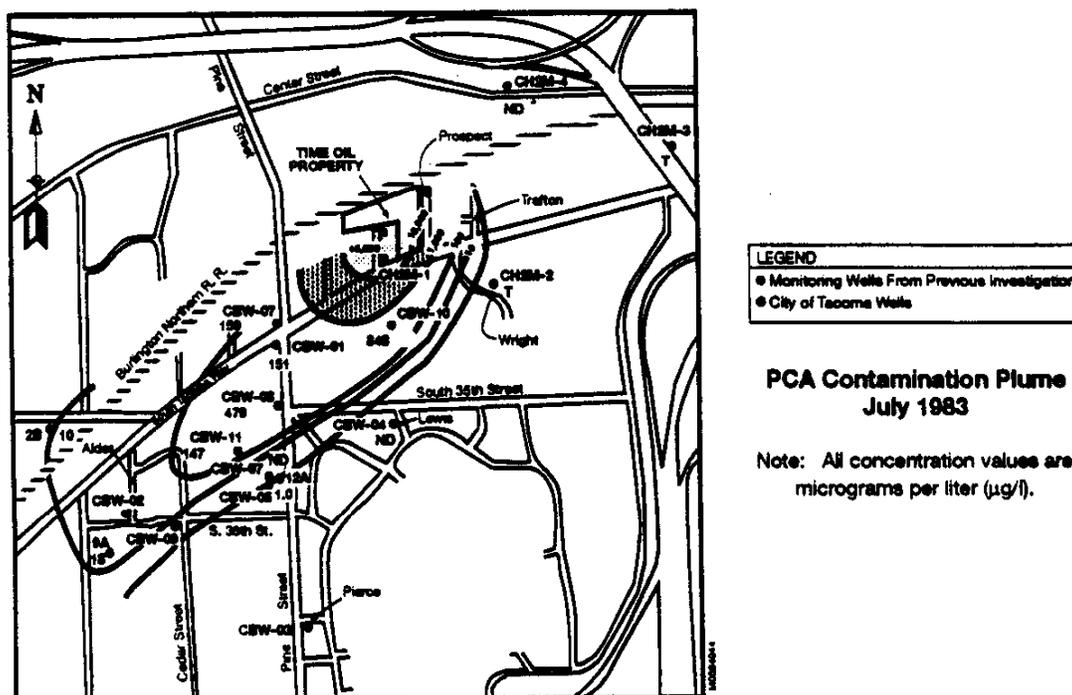
Remedial investigation (RI) field activities at the site found the following concentrations:

Contaminant	Water from Well 12A Concentration, ppb	Railroad Spur Fill soil Concentration, mg/kg
DCE	30 to 100	3.92
PCA	17 to 300	*1,030
PCE	1.6 to 5.4	*1,030
TCE	54 to 130	160

* PCA and/or PCE

Spatial Distribution of the Contaminants of Concern

Figure 2



- All of the contaminants of concern have a solubility in water of 150 mg/l (PCE) or more (up to 2,900 mg/l for PCA).
- Groundwater underlying the Time Oil Company property and adjacent properties to the south appears to be the most contaminated.

Hydrogeologic Units

- The upper aquifer (unconfined sand and gravel) is 50 feet thick (depth to the water table is about 36 feet).
- The upper aquifer is separated from the lower aquifer by a 40 foot thick dense glacial till aquitard.
- The lower aquifer is not contaminated.
- The area suspected of groundwater contamination is in the upper aquifer and covers about 100 acres and is bounded by the city water well field on the south, the Burlington Northern Railroad on the north, and Interstate 5 on the East.
- Figure 2 shows the contamination plume for PCA which is typical for the VOC groundwater contamination at this site.



Site Conditions

- Average Air Temperature 38°F (Jan.) to 65°F (July)
- Precipitation
 - Annual Average 38. in.
 - December Average 6.3 in.
 - July Average 0.8 in.
- Snowfall, Annual Average 14. in.
- Relative Humidity, Average 65% to 85%
- Wind Speed, Average 10 mph
- Project site elevation is 270 feet.
- The vadose zone thickness (depth to groundwater) varies from 33 to 40 feet.
- The groundwater gradient is about 0.05%, falling to the north-northeast.

Key Soil or Key Aquifer Characteristics

Property	Units	Range or value
Porosity	%	30
Particle density	g/cm ³	2.65
Soil bulk density	g/cm ³	1.86
Surface soil permeability	cm/sec	2.8 to 3.6 X 10 ⁻³
Depth to groundwater	ft	36
Aquifer thickness	feet	50
Water Saturated thickness	feet	10 to 17

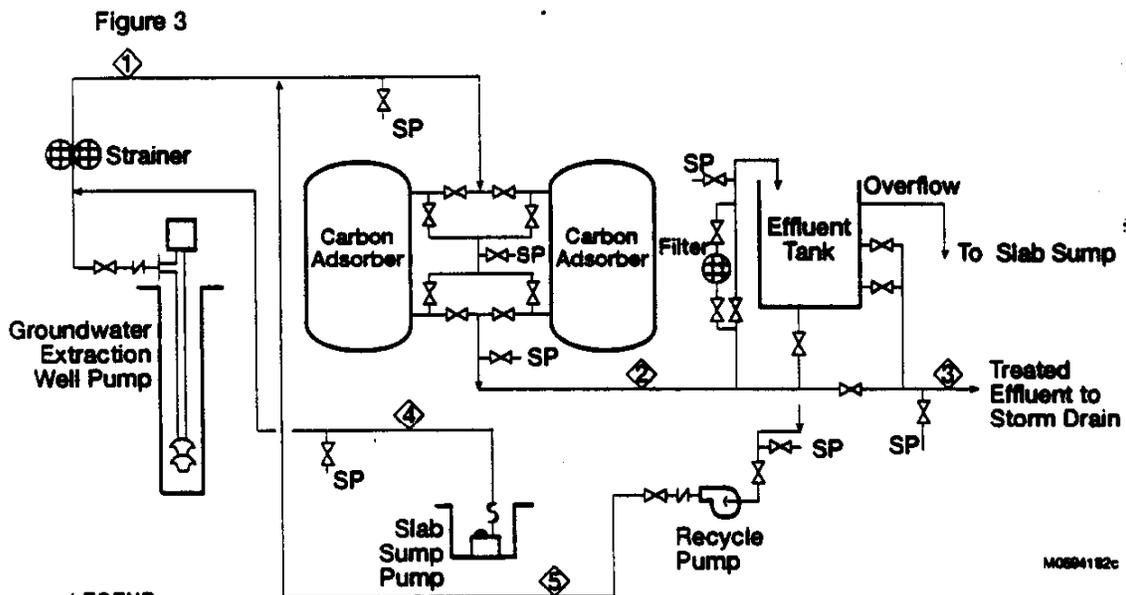


TREATMENT SYSTEM

The selected remedial action includes:

- Groundwater treatment by a liquid phase granulated activated carbon (GAC) adsorption system (predicted >98% removal), discussed in this report.
- Treated water is disposed of in the storm drain system .
- Monitor groundwater for VOCs and, after 2 years of operation, evaluate the effectiveness of the groundwater extraction and treatment system.
- Prohibit withdrawal of groundwater by private parties where the hazard > 10⁻⁶.
- Use soil vapor extraction (vacuum applied via extraction wells that extend to the groundwater), described in a separate report to remove volatile contaminants in the soil matrix.

Overall Process Schematic



- LEGEND**
- SP Sampling Port
 - ∨ One-way Valve
 - ⋈ Valve
 - ◇ Stream Flow

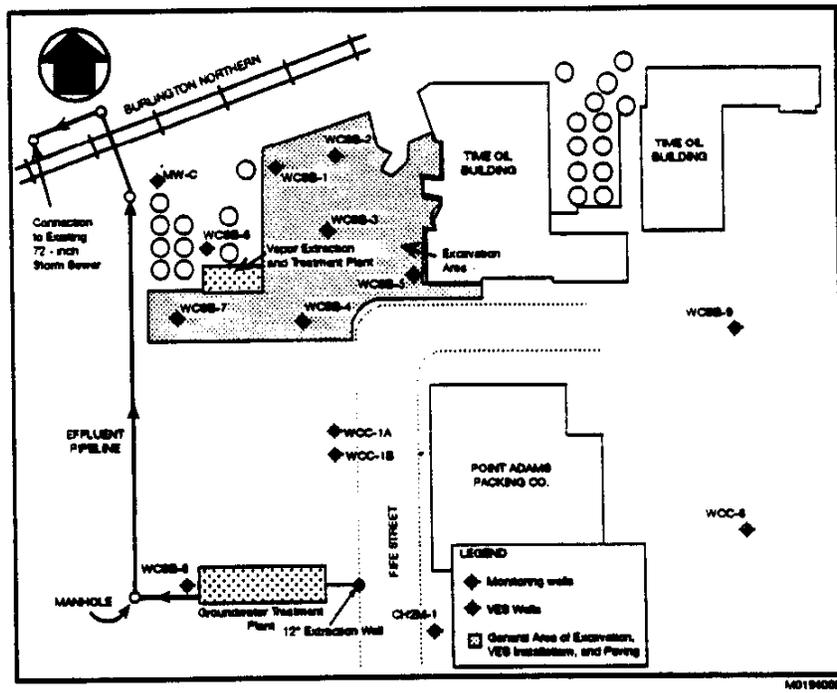
Process Flow Diagram for Groundwater Extraction and Treatment System

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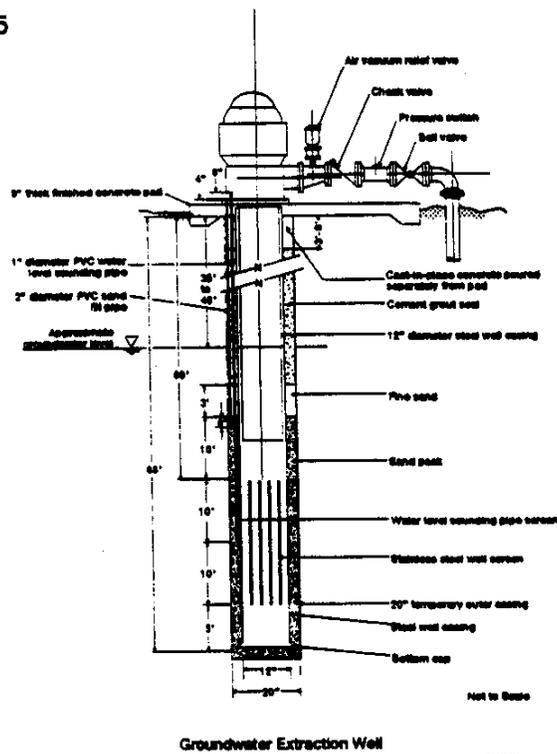
System Closeup

Figure 4



LOCATION OF EXCAVATION AREA AND TREATMENT SYSTEMS

Figure 5



Key Design Criteria

- The extraction system is designed to have sufficient draw-down to create a cone of depression to reduce further migration of contaminants out of the source area.
- A pumping rate of 200 gpm is estimated to induce a 0.75 foot draw down at a radius of influence of 200 feet, and a pumping rate of 500 gpm is estimated to induce 1.9 feet of draw down at a radius of influence of 200 feet. 500 gpm was selected as the design flow rate.
- A radius of influence of 200 feet is expected to largely prevent further contamination from leaving the source area.
- The adsorption capacity of granular activated carbon for PCA is given by the equation

$$\text{mg PCA adsorbed/g GAC} = 12.8(\text{mg/L of PCA in water})^{0.613}$$

EXPECTED FLOWRATES AND CONCENTRATIONS OF CONTAMINANTS FOR THE TREATMENT SYSTEM

Stream Number*	1	2	3	4	5
Maximum Flowrate (gpm)	500	500	500	20	200
<u>Concentration of Volatile Organic Compounds, mg/l</u>					
1,1,2,2-Tetrachloroethane (PCA)	2-35	0.3	0.3	—	—
Trans-1,2-Dichloroethylene (DCE)	0.2-3.5	0.03	0.03	—	—
Trichloroethylene (TCE)	0.4-6.5	0.06	0.06	—	—
Tetrachloroethylene (PCE)	0.4-0.7	.01	.01	—	—

*Stream number explanation (see also figure 3):

1. Groundwater from extraction well.
2. Treated groundwater leaving GAC adsorbers.
3. Effluent to storm drain.
4. Slab sump pump to strainer and GAC adsorbers.
5. recirculating water to GAC adsorbers.

Key Monitored Operating Parameters

- Groundwater monitoring wells located in the vicinity of the Time Oil Company will be used to observe the effectiveness of the extraction system in creating a capture zone that will effectively reduce contaminant concentration outside the source area.
- The groundwater treatment plant discharge shall meet the EPA standards for the storm water discharge, maximum permitted concentrations (for "Fish Consumption Only"):

Compound	Permitted Concentration, µg/L
DCE	1.85
PCA	10.7
PCE	8.85
TCE	80.7

Other limitations include:

maximum discharge rate	500 gallons/minute,
pH	6 to 9,
total suspended solids	< 500 mg/L
total VOAs	<1 mg/L



PERFORMANCE

Performance Objectives

- Create a cone of depression that would reduce further migration of contaminants out of the source area.
- Treat the contaminated groundwater to reduce volatile organic compounds to meet the EPA standards for the storm water discharge.

Treatment Plan

- Contaminated groundwater is being treated to remove VOCs by pumping contaminated groundwater out of the source area through a GAC adsorption system.
- The groundwater treatment plant discharge is meeting water quality criteria for protection of human health at a 10^{-4} cancer risk for human ingestion of aquatic organisms (45 FR 79318, November 28, 1980), as follows:

Compound	Permitted Concentration, $\mu\text{g/L}$
Vinyl chloride	525
PCA	10.7
TCE	80.7
Other permit limitations include:	
pH	6 to 9

Operational Performance

Volume of Water Pumped

- As of 23 Feb. 1994, 281,700,000 gallon of groundwater have been pumped and treated by the GAC treatment system.

System Downtime

- No down time was reported for the period January 1994 through February 1994.
- The EPA has provided no other Activities Reports for this project. (Figure 6 suggests a period of downtime from early to middle 1990.)

Treatment Performance

Effects on Plume

- A pumping rate of 500 gpm was estimated to induce 1.9 feet of draw down at a radius of influence of 200 feet.
- The EPA has provided no documents or data relative to the cone of influence resulting from pumping of the groundwater.

Contaminants versus Time at the Treatment Plant Influent

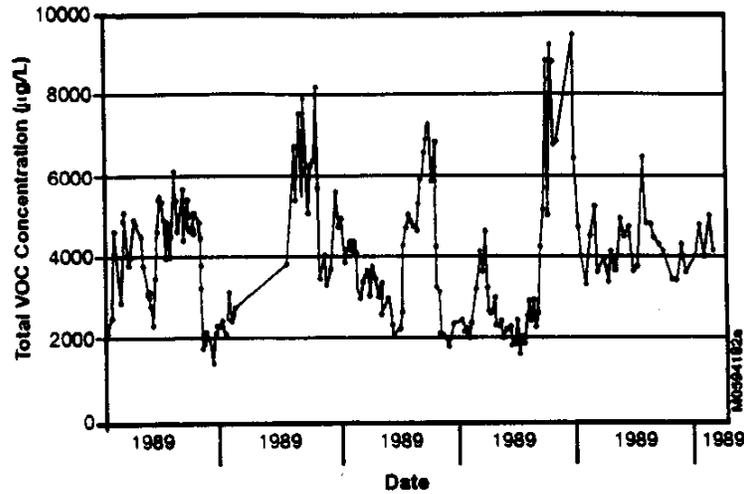
- Figure 6 shows the total VOC concentration for the period 1989 through February 1994.

Influent versus Effluent

- The following table gives the results of the groundwater GAC treatment for the period 11 January 1994 through 23 February 1994



Figure 6
Total VOC Influent Concentrations, 1989 Through Current



VOCs IN GAC TREATMENT SYSTEM INFLUENT AND EFFLUENT

<u>Concentration of VOCs, µg/l</u>	<u>Date</u>			
<u>GAC System Influent</u>	<u>1/11/94</u>	<u>1/26/94</u>	<u>2/8/94</u>	<u>2/23/94</u>
Vinyl Chloride	21	16	32	29
Trans-1,2-Dichloroethylene	290	270	280	270
Cis-1,2-Dichloroethylene	240	210	200	200
Trichloroethylene	1,200	1,000	1,200	920
1,1,2-Trichloroethylene	15	10	15	13
Tetrachloroethylene	46	43	57	45
1,1,2,2-Tetrachloroethane	3,000	2,400	3,300	2,000
<u>GAC System Effluent</u>				
Vinyl Chloride	3.2	5.9	9.6	13
Trans-1,2-Dichloroethylene	<1	<1	<1	<1
Cis-1,2-Dichloroethylene	<1	<1	<1	<1
Trichloroethylene	8.4	8.1	11	6.9
1,1,2-Trichloroethylene	<1	<1	<1	<1
Tetrachloroethylene	<1	<1	<1	<1
1,1,2,2-Tetrachloroethane	<1	3.9	8.5	2.2

Total Pounds Contaminants Removed

- As of 23 Feb. 1994, an estimated 10,361 pounds of VOCs have been removed by treatment by the GAC treatment system. This estimates is based on the average loading rate of the GAC as calculated by periodic sampling.



COST

The U.S. EPA Region 10, Hazardous Waste Division declined to provide a breakdown of the capital estimate or the operating cost estimate. It also declined to provide cost data for the period since the remediation phase of the project started and access to the remediation contractor.

Capital Costs

	<u>Original (4/5/88)</u>	<u>Current (7/25/88)</u>
Contract Amount (reference 7)	\$987,789	\$1,343,701

Operating Costs

NONE PROVIDED.

Cost Sensitivities

NONE PROVIDED.



REGULATORY/INSTITUTIONAL ISSUES

- Highly contaminated surface soils were transported to a RCRA approved landfill facility for treatment/disposal
- ARARs include RCRA, Clean Air Act regulations (for emissions of VOCs), the Clean Water Act, and the Safe Drinking Water Act (there are no drinking water standards for the contaminants present in Well 12A).
- If groundwater from Well 12A is to be used for drinking water, then it must be treated to the 10⁻⁶ risk level for the contaminants present. Otherwise, in order to be consistent with 40 CFR 264, Subpart F, groundwater corrective action is required until the concentration of hazardous constituents complies with one of the following: MCLs (where designated for particular substances), ACLs (that provide adequate protection of public health and the environment), or background.
- NPL site.
- The EPA standard for "Fish Consumption Only" was used for the storm water discharge maximum permitted concentrations:

Compound	Permitted Concentration, µg/L
DCE	1.85
PCA	10.7
PCE	8.85
TCE	80.7

Other limitations include:

maximum discharge rate	500 gallons/minute,
pH	6 to 9,
total suspended solids	< 500 mg/L
total VOAs	<1 mg/L

SCHEDULE

None provided.

LESSONS LEARNED

- The project is not complete as yet.
- An operational analysis from which Lessons Learned could be derived has not been provided by the Region 10 of the U.S. EPA



SOURCES

Major Sources For Each Section

Site Characteristics:	2 and 9
Treatment System:	2 and 3
Performance:	4
Cost:	4 and 7
Regulatory/Institutional Issues:	1, 2, 5 and 6
Schedule:	None
Lessons Learned:	None

Chronological List of Sources and Additional References

1. EPA Superfund Record of Decision: South Tacoma Channel-Well 12A, WA, EPA/ROD/R10-85/004, May, 1985.
2. Revised Remedial Design Report, South Tacoma Channel Well 12A, by Woodward-Clyde Consultants for U.S. Army Corps of Engineers, Superfund Branch, Kansas City, Missouri District, April 17, 1987.
3. Letter from Philip N. Stoa, EPA Coordinator, Construction Division, Construction Services Branch, Seattle District, Corps of Engineers, December 15, 1993.
4. Fax from Kevin Rochlin, Region 10 U.S. EPA, Hazardous Waste Division, dated 18 May 1994.
5. RREL Treatability Data Base, Version 4.0, EPA, November 15, 1991.
6. Climates of the States, by the National Oceanic and Atmospheric Administration, US Department of Commerce, published by the Water Information Center, 1974.
7. Fax from Bill Brooker, Fort Lewis Area Office, Corps of Engineers, 10 May 1994.

ANALYSIS PREPARATION

This analysis was prepared by:
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REVIEW

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