COST AND PERFORMANCE REPORT

Pump and Treat of Contaminated Groundwater at the
Western Processing Superfund Site
Kent, Washington

September 1998

Prepared by:

EPA

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office

SITE INFORMATION

Identifying Information:

Western Processing Superfund Site
Kent, Washington

CERCLIS #: WAD009487514

ROD Date: September 1985
Amended September 1986
Explanation of Significant Differences (ESD)
December 1995

Treatment Application:

Type of Action: Remedial

Period of operation: 10/88 - Ongoing
(Performance data collected through December 1996)

Quantity of groundwater treated during application: 974 million gallons

Background

Historical Activity that Generated Contamination at the Site: Waste processing

Corresponding SIC Code: 4953W
(Miscellaneous waste processing)

Waste Management Practice That Contributed to Contamination: Unauthorized dumping, spills, and leaks from surface impoundments

Location: Kent, Washington

Facility Operations: [3, 7]

- The 13-acre site operated as a waste processing facility from 1961 to 1983. Over 400 businesses transported industrial wastes to the site to be stored, reclaimed, or buried. Processes at the site included the recovery of metals from sludges and liquid wastes; spent solvent recovery; reclamation of caustics, flue ash, and ferrous sulfide; reprocessing pickle liquor; electrolytic destruction of cyanides; chemical recombination to produce zinc chloride and lead chromate; and waste oil reclamation. Operations ceased in 1983 by order of the EPA.
- In March 1981, during a RCRA audit, EPA first discovered violations of regulations governing waste storage, drum management, surface impoundments, and waste piles.
- In 1983, EPA performed an emergency waste removal operation to stabilize the site. Over 460,000 gallons and 127 drums of waste liquids were removed.
- Remedial investigations were conducted between 1983 and 1985.
- Site cleanup activities were divided into two phases. Phase I involved removing tanks, buildings, impoundments, and waste piles from the site. Phase II involved subsurface cleanup.
- The initial ROD was issued in September 1985. It was amended in 1986 to reflect the requirements to be included in the Consent Decree.
- In April 1987, a Consent Decree was entered to begin Phase II cleanup activities. In the summer of 1987, construction activities began, which included installing two extraction and treatment systems and a slurry wall, enclosing the site. Extraction and treatment began in October 1988.
- After eight years of remediation that focused on groundwater and soil restoration, the objective was changed to contain the contamination on site and prevent further off-site migration. An ESD was issued in December 1995 to reflect a Technical Impracticability (TI) Waiver.
- A new extraction system was installed in 1996 to provide more automated operation during the period of containment. A new treatment system was constructed for all groundwater extracted during containment operations and became operational in June 1997.

SITE INFORMATION (CONT.)

Background (Cont.)

Regulatory Context:

- Site activities are conducted under provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, and the National Contingency Plan (NCP), 40 CFR 300.
- The ROD for the site was signed in September 1985 and amended in September 1986. A Consent Decree was issued in 1987. An ESD was issued in December 1995.

Groundwater Remedy Selection:

- Originally, the selected remedy was extraction and treatment of groundwater in conjunction with a passive containment system (slurry wall) and an aggressive effort to restore groundwater quality to acceptable levels within five to seven years. In the ESD, the remedy was changed to containment of the on-site and off-site plumes.

Site Logistics/Contacts

Site Lead: PRP

Oversight: EPA/State of Washington (Joint Oversight)

Remedial Project Manager:
Lee Marshall
U.S. EPA Region 10
1200 Sixth Avenue (ECL-116)
Seattle, WA 98010
(206) 553-2723

State Contact:
Christopher Maurer, P.E.
Washington Department of Ecology

Contractors:
OHM Remediation Services, Corp. (Formerly CWM)
Landau Associates, Inc.

PRP - Lead:
Paul Johansen*
Western Processing
20015 72nd Avenue South
Kent, Washington 98032
(425) 393-2565

*Indicates primary contact

MATRIX DESCRIPTION

Matrix Identification

Type of Matrix Processed Through the Treatment System: Groundwater

MATRIX DESCRIPTION (CONT.)

Contaminant Characterization [1, 2, 13, 17]

Primary Contaminant Groups: Halogenated volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), phenolic compounds, and metals

- The primary organic contaminants of concern are trichloroethene (TCE), *cis*- and *trans*-1,2-dichloroethene (DCE), methylene chloride, toluene, and vinyl chloride.
- The metal contaminants of concern are cadmium, zinc, chromium, nickel, copper, and lead.
- Figures 1 and 2 show plume maps from 1988, 1991, and 1995 for TCE and vinyl chloride.
- Investigations conducted during the remedial investigation identified more than 90 of EPA's priority pollutants at the site, mostly volatile and semivolatile organic compounds and metals.
- The maximum initial concentrations of contaminants detected were 390 mg/L (*trans*-1,2-DCE), 250 mg/L (TCE), 510 mg/L (zinc), 280 mg/L (nickel), and 2.5 mg/L (cadmium).
- In 1989, an EPA toxicologist suggested that the organic compound oxazolidinone present in the site groundwater might be genotoxic. As a result, an activated carbon system was added to remove this compound from the treated groundwater. The compound was later found to be non-hazardous and the carbon treatment system was removed [13].
- An immiscible liquid has been visually observed floating in samples taken from several on-site wells, confirming the presence of light nonaqueous phase liquid (LNAPL). The levels of DCE found in groundwater samples were also greater than 6% of solubility. Although this concentration indicates the likely presence of a dense nonaqueous phase liquid (DNAPL), DNAPLs were never found.
- The volume of the plume was estimated for this report to be approximately 500 million gallons, based on monitoring data collected in 1987 [17].
- The majority of contaminants are found on site within the upper unconfined aquifer. The on-site plume contains many contaminants and primarily impacts Mill Creek to the west of the site.
- A separate, deeper plume containing primarily *cis*-1,2-DCE is also present off site. This plume originates on site in the southern portion of the site.

MATRIX DESCRIPTION (CONT.)

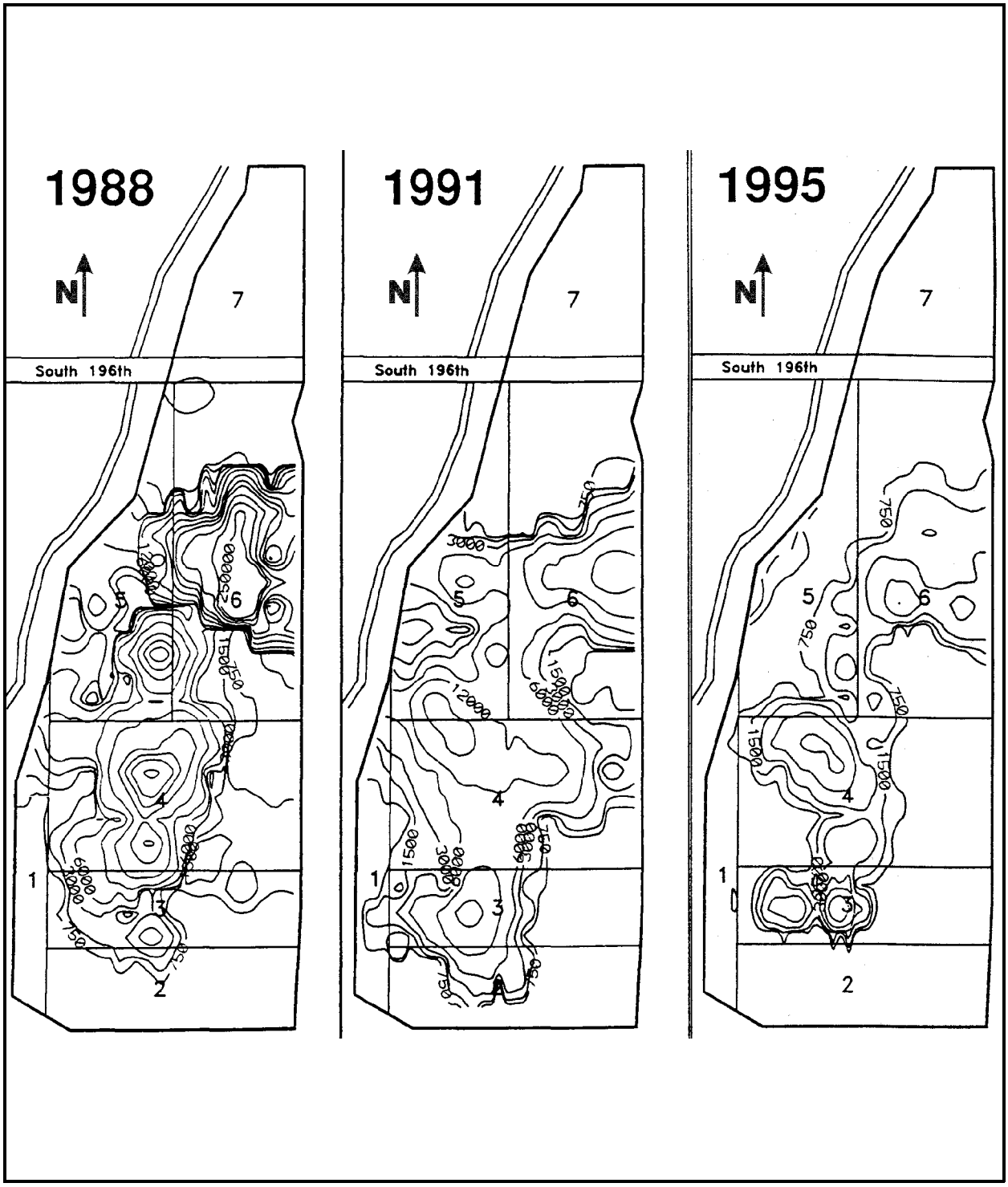

Figure 1. Trichloroethene (TCE) Contour Maps (Concentrations in µg/L) [10]

MATRIX DESCRIPTION (CONT.)

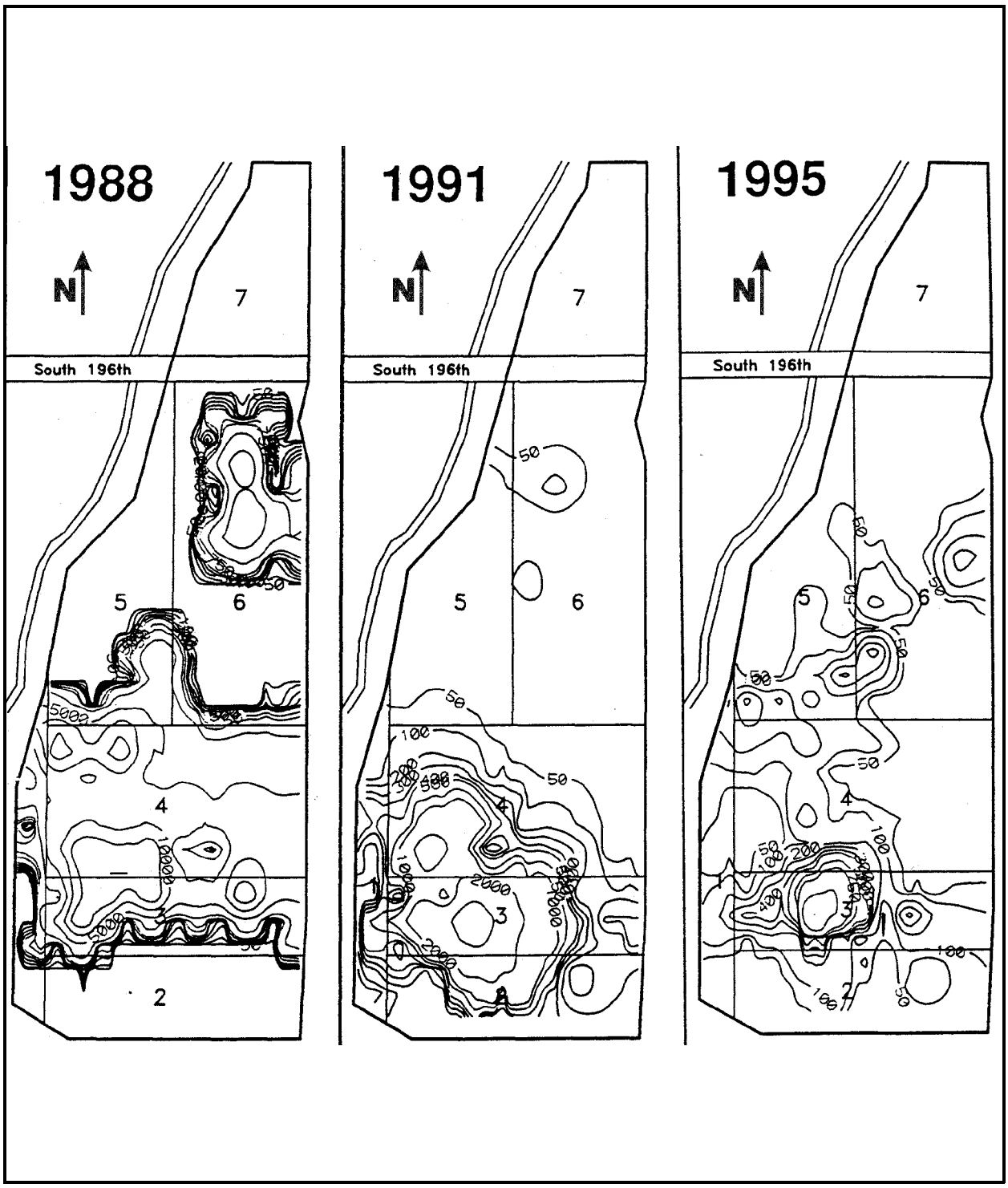

Figure 2. Vinyl Chloride Contour Maps (Concentrations in µg/L) [10]

MATRIX DESCRIPTION (CONT.)

Matrix Characteristics Affecting Treatment Costs or Performance

Hydrogeology [1]:

Three major geologic units comprise the hydrogeologic system in the vicinity of the site. These units comprise the White River Alluvium, the valley fill deposits that occur throughout the Kent Valley and beneath the Western Processing site. The alluvial fill consists primarily of sand, silt, and clay with occasional layers of sandy gravel. The White River Alluvium is not considered to be a major drinking water source due to naturally occurring poor water quality. Groundwater is encountered at 5 to 10 feet below ground surface. Shallow groundwater (Unit 1) flows northwest from the site and discharges into Mill Creek. The deeper aquifer (Unit 2) begins approximately 40 feet below ground surface. Groundwater in this unit flows northwest also, but passes below Mill Creek. Contaminants in Unit 2 were transported downgradient of the site and Mill Creek; contaminants in Unit 1 migrated to Mill Creek prior to the installation of a slurry wall around the site.

Unit 1 (Shallow Aquifer)	A complex sequence of discontinuous interbedded silt, sand, and clay lenses to a depth of 40 feet below ground surface.
Unit 2 (Deep Aquifer)	A fairly continuous fine to medium sand with intermittent silty zones existing below 40 feet. This sand unit extends to a depth of 150 feet below ground surface.

Tables 1 and 2 present technical aquifer information and technical well data, respectively.

Table 1. Technical Aquifer Information

Unit Name	Thickness (ft)	Conductivity (ft/day)	Velocity (ft/day)	Flow Direction
1	35 - 40	1 - 10	.27	Northwest
2	75 - 100	10 - 100	0.02 - 0.2	Northwest

Source: [1]

TREATMENT SYSTEM DESCRIPTION

Primary Treatment Technology

Pump and treat (P&T) with air stripping and metals precipitation
In situ soil flushing (1988 - 1996)

Supplemental Treatment Technology

Passive containment system (slurry wall)
Carbon polishing (1990-1991)
Peroxide oxidation (1988 - 1989)
Chromium reduction (1988 - 1989)

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation

Table 2. Extraction Well Data

Well Name	Unit Name	Depth (ft)	Design Yield (gal/min)
Wellpoints 1 - 210	Unit 1	30	100 - 200[1]
U-wells 1 - 6	Unit 1	40	15 each
T2 - T4	Unit 2	70	15 each

[1]Cumulative extraction yield

Source: [2]

System Description [2, 4, 14]

- Remedial systems at the site originally included an on-site extraction and treatment system, an off-site extraction and treatment system, and a slurry wall that enclosed the 13-acre site.
- The on-site extraction system, which operated from 1988 until 1997, consisted of 210 vacuum-operated recovery well points. These were divided into seven well-point groups, all of which were connected to three 30-horsepower centrifugal-vacuum pumps. Each of the well point installations was sand packed continuously from 5 to 30 feet below ground surface. Well points were installed over the entire site, with a greater density of well points in the areas known to have higher concentrations of contaminants.
- The objective of the on-site extraction system was to create and sustain a net inward flow of groundwater at the site perimeter and a net upward flow of groundwater within the area surrounded by the slurry wall. An infiltration system (soil flushing) was placed in the shallow on-site soils within the slurry wall to flush contaminants out. The soil-flushing system was designed to expedite leaching of contaminants from the shallow soils.
- The well-point system was designed to offer flexibility and "variable" pumped volume. Header pipes and valves at the top of each well could be used to select specific flow rates from each section of the system.
- The extraction system was modified in late 1996 and early 1997. Use of the shallow vacuum-operated well points (on site) was discontinued and a set of 15 deeper recovery wells were installed in 1996 to replace the vacuum-operated well point system.
- The original treatment system for groundwater extracted included stripping of VOCs, followed by oxidation of phenolic compounds with hydrogen peroxide, reduction of hexavalent chromium to the trivalent form, pH adjustment, metals precipitation, and carbon polishing. The carbon polishing step was removed in 1991. Treated water was reinjected into the ground through the infiltration system or discharged to the POTW.
- Because of severe fouling of the on-site stripping tower by inorganic precipitates, the treatment sequence was modified in September 1989 to provide metals precipitation before stripping of VOCs [10.]
- After 1989, the treatment system was modified to provide metals removal before air stripping, and phenol oxidation and hexavalent chromium reduction were discontinued. The treatment system was replaced in 1997 with a new automated system for VOCs only.
- Liquid-phase carbon filters were used to remove oxazolidinone from treated water before discharge to the POTW. EPA eventually determined that this compound

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation (Cont.)

had no detrimental health effects and the carbon polishing was discontinued.

- The slurry wall, which is 40 feet deep and laterally confines the on-site contaminants to the site boundaries, enhances the recovery process. The soil/bentonite wall was installed using a backhoe and bucket excavator.

- The off-site extraction system consisted of three deep wells (trans wells) screened between 40 and 70 feet below ground surface. The purpose of the trans wells was to extract groundwater from an off-site plume of *cis*-1,2-DCE. The Consent Decree required overlapping zones of influence for these extraction wells. Each well was fitted with a submersible electric pump and designed to produce up to 15 gpm which was determined to provide sufficient overlapping zones.

- Water extracted from the off-site trans wells was directed to a separate treatment system consisting of a sand filter bed and an air stripper. Effluent from this system was reinjected to the infiltration gallery or discharged to the POTW.

- Contaminant concentrations in groundwater and water levels are monitored using a system of 51 monitoring wells and 28 piezometers located on and off the site in both Units 1 and 2.

System Operation [2, 4, 6, 7, 10, 13, 14]

- Construction and installation of the on-site and off-site extraction and treatment systems was completed in 1988. The slurry wall installation was completed in 1989 [2].

- Six new extraction wells (U-wells) were installed in the spring of 1993. Four of these were placed within the slurry wall and two were placed off site adjacent to the slurry wall, where high concentrations of organic contaminants were detected. These wells were equipped with dedicated down-well pumps and were connected directly to the existing treatment system. Well depths were approximately 40 feet [7].

- The average extraction rate for the site has been approximately 230 gpm based on annual averages from 1988 to 1997. The annual rate was reduced to 140 gpm in 1996 and 40 gpm in 1997 [10]. The extraction rate was reduced in conjunction with the change to a containment focus from a restoration focus, and because the infiltration of about 100 gpm of treated water was discontinued at the end of 1996.

Groundwater Pumped From Aquifer in gallons per minute (gpm):

Average GPM Pumped

Year	On-Site System	Off-Site System
1989	225	40
1990	225	40
1991	225	40
1992	225	40
1993	225	40
1994	225	40
1995	200	40
1996	100	40
1997	40	40

- The original on-site treatment system included a phenol oxidation and a chromium reduction process, which were discontinued by December 1988 because it was found that the concentrations of phenol and chromium in the influent were below effluent permit limits [14].

- Effluent from both treatment systems continue to be combined and discharged to the local POTW under a Waste Discharge Permit. The limitations in the permit have not been exceeded since operations began [10].

- The Western Processing facility also has a permit from the Puget Sound Air Pollution Control Agency for the emissions from the air stripper [6].

- The site is operational seven days per week, 24 hours per day. From 1988 until 1996, the system has operated 97% of the time for

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation (Cont.)

a total of approximately 70,000 hours [13]. The new extraction and treatment systems that became operational in 1997 have experienced similar operational efficiency.

- Air stripping media for the off-site treatment system was changed once in the first year of operation because of fouling caused by scale buildup. Acid washing of the stripping tower was conducted once every three weeks to minimize scale buildup. This procedure required four hours of down time [13].
- The carbon system used to remove oxazolidinone from the treated groundwater required carbon changeouts approximately once per month in 1990 and early 1991. The air phase carbon system associated with the air stripping process required carbon changeouts approximately once per month at first, but has averaged about once every eight months due to declining contaminant concentrations and the use of more efficient activated carbon.

Operating Parameters Affecting Treatment Cost or Performance

Table 3 presents operating parameters affecting cost and performance at this site.

Table 3. Performance Parameters

Parameter	Value	
Average Extraction Rate (for both on- and off-site systems)	230 gpm	
Air Discharge Requirements	Hydrochloric gas Methylene Chloride	100 mg/l 100 mg/l
Treated Groundwater Discharge Permit Requirements (daily averages)	Arsenic Cadmium Chromium Copper Lead Mercury Nickel Silver Zinc Cyanide Organics[1]	1.0 mg/l 0.5 mg/l 2.75 mg/l 3.0 mg/l 2.0 mg/l 0.1 mg/l 2.5 mg/l 1.0 mg/l 5.0 mg/l 2.0 mg/l Monitoring only
Remedial Goal (Surface Water Requirements)[2]	Cadmium Chromium Copper Nickel Lead Zinc Mercury Silver Cyanide For Hardness	1.1 µg/L 207 µg/L 11.8 µg/L 158 µg/L 3.2 µg/L 120 µg/L .012 µg/L .12 µg/L 5.2 µg/L 100 µg/L
Remedial Goal (Off-site Aquifer)	*trans*-1,2-DCE *cis*-1,2-DCE	70 µg/L 70 µg/L
Note: Average system yield over eight years of operation was 230 gpm for both systems based on annual data.		

Source: [3, 10]

[1]Organics include: Acrolein, Acrylonitrile, Benzene, Carbon Tetrachloride, Chlorinated Benzene, Chloroform, Dichlorobenzene, 1,2-Dichloroethane, Dichloroethylenes, Dichloropropane, Dichloropropene, Ethylbenzene, 1,1,2,2-Tetrachloroethane, Toluene, 1,1,2-Trichloroethane, Trichloroethene

[2]At the time of the Consent Decree, the organic compounds detected in Mill Creek did not have associated Ambient Water Quality Criteria values.

TREATMENT SYSTEM PERFORMANCE (CONT.)

Timeline

Table 4 presents a timeline for major events performed during this remedial project.

Table 4. Project Timeline

Start Date	End Date	Activity
9/85	---	Record of Decision issued
9/86	---	Amended Record of Decision issued
4/87	---	Consent Decree issued
4/87	---	Subsurface remediation begun
10/88	---	Operations for both P&T systems begun
5/88	10/89	Slurry wall constructed around the site
3/90	---	Three-year performance standards achieved for Mill Creek (surface water goals)
12/92	5/93	Five deep wells added to the collection system
10/86	8/93	Mill Creek restoration goals achieved
9/95	---	TI Waiver Petition submitted
6/96	---	Containment wells installed
12/95	---	ESD issued in response to TI Waiver (restoration goal changed to containment goal)
1/97	---	Containment pumping phased into operation
6/97	---	New treatment system started

Source: [3, 7, 10]

TREATMENT SYSTEM PERFORMANCE

Cleanup Goals/Standards [11, 14]

As determined by the Consent Decree and the amended ROD, the following cleanup goals were established:

- Surface water quality goals for Mill Creek (adjacent to site) are Federal Ambient Water Quality Criteria (AWQC). The Consent Decree required that these goals be met within three years. Attachment A includes the Consent Decree text which pertains to surface water goals.
- Off-site groundwater goals were established by the Consent Decree for *cis*- and *trans*-1,2-DCE.

Additional Information on Goals [11]

- Shallow groundwater from the site discharges to Mill Creek. The surface water requirements were a means of measuring cleanup within shallow groundwater beneath the site. There were no other on-site cleanup goals set for the shallow groundwater.
- The ESD, issued in 1995, did not change the surface water or off-site groundwater cleanup or treatment performance goals from the amended ROD. The focus of remediation was changed from site restoration to containment.

TREATMENT SYSTEM PERFORMANCE (CONT.)

Treatment Performance Goals [11]

As determined by the Consent Decree and the amended ROD, the following treatment performance goals have been established:

- Achievement of an inward flow of shallow groundwater (<40 ft bgs) within a specified area of the site. This area is approximately defined by the property boundaries (see Figure 1 of this report).
- Achievement of either: 1) a reversal of groundwater flow for Unit 2 at a depth of 40 to 70 feet at the western boundary of the site; or 2) establishment of a hydraulic barrier to regional groundwater flow at the 40- to 70-foot depth at the western boundary of the site.
- Combined wastewater effluent from the treatment systems must meet discharge criteria included in the POTW discharge permit. Specific criteria are included in Table 3.
- All air emissions must comply with a discharge permit issued from the Puget Sound Air Pollution Control Agency. Specific criteria are included in Table 3.

Performance Data Assessment [10, 14, 15]

For this report, total metals includes zinc, nickel, chromium, copper, and cadmium. Total VOCs includes TCE, DCE, vinyl chloride, methylene chloride, and chloroform.

- According to monthly surface water monitoring data, surface water criteria in Mill Creek were achieved by mid-1990. Figure 3 shows concentrations of zinc in the downstream monitoring point of Mill Creek. Zinc concentrations were the highest of any metal contaminant. By mid-1990, concentrations were below 100 µg/L.
- The P&T system achieved the cleanup goal of 70 µg/L of DCE in all three of the extraction wells in the off-site trans plume.
- Concentrations of DCE in the off-site plume have decreased since operations began in 1988. As shown in Figure 4, concentrations of DCE have decreased in all three trans wells from above 2,000 µg/L in 1988 to less than 100 µg/L in January 1996, a 95% reduction.
- Contaminants have not increased in downgradient monitoring wells as noted in the 1996 Quarterly Report. On the basis of this information, plume containment for the off-site plume has been achieved [17].
- Monitoring well data from on-site wells (N-wells, U-wells, and monitoring wells) show contaminant concentrations for TCE, vinyl chloride, and zinc decreased by two orders of magnitude from 1988 to 1995.
- The maximum concentrations of contaminants detected in on-site well points (extraction wells) during the June 1995 sampling event were zinc (117,000 µg/L), cadmium (1,360 µg/L), DCE (14,600 µg/L), vinyl chloride (5,490 µg/L), and TCE (55,200 µg/L).
- Figure 5 shows the contaminant removal rate in pounds per day for the P&T systems from 1988 through 1996. This figure includes combined removal rates for total metals and total VOCs from both treatment systems. The extraction rate decreased to less than 20 lbs/day within 3 years. It has remained below 20 lbs/day since then. A total of 102,000 lbs of contaminants was removed during eight years of operation.

TREATMENT SYSTEM PERFORMANCE (CONT.)

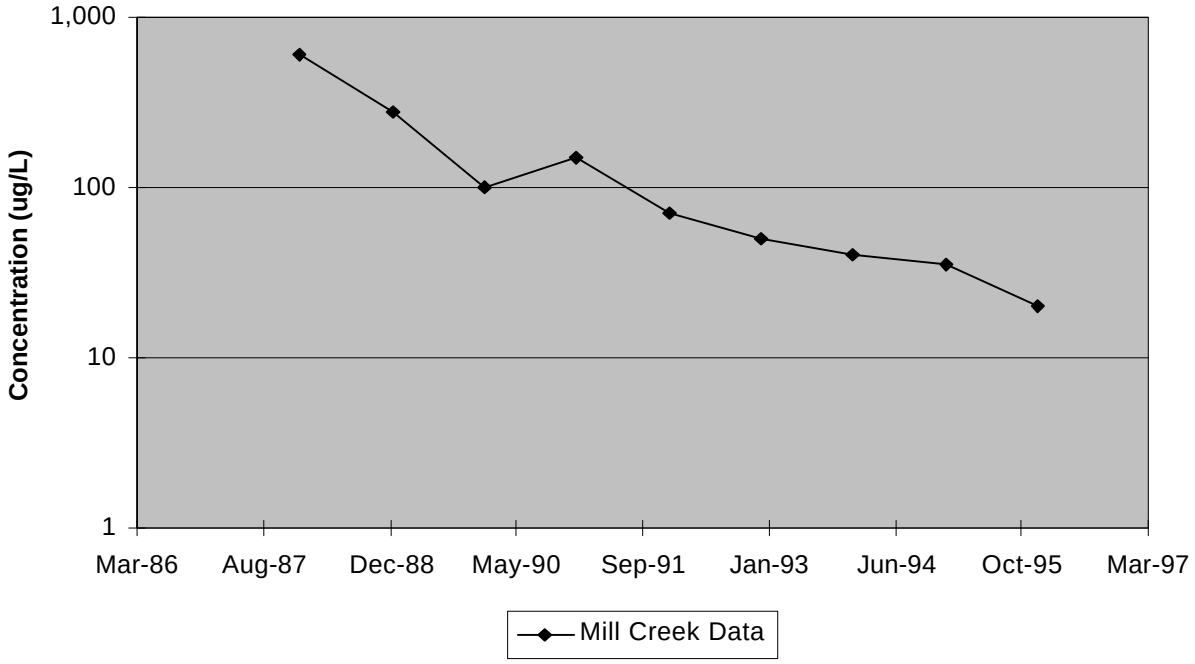

Figure 3. Zinc Concentration at Downstream Monitoring Point of Mill Creek (1988-1996) [10]

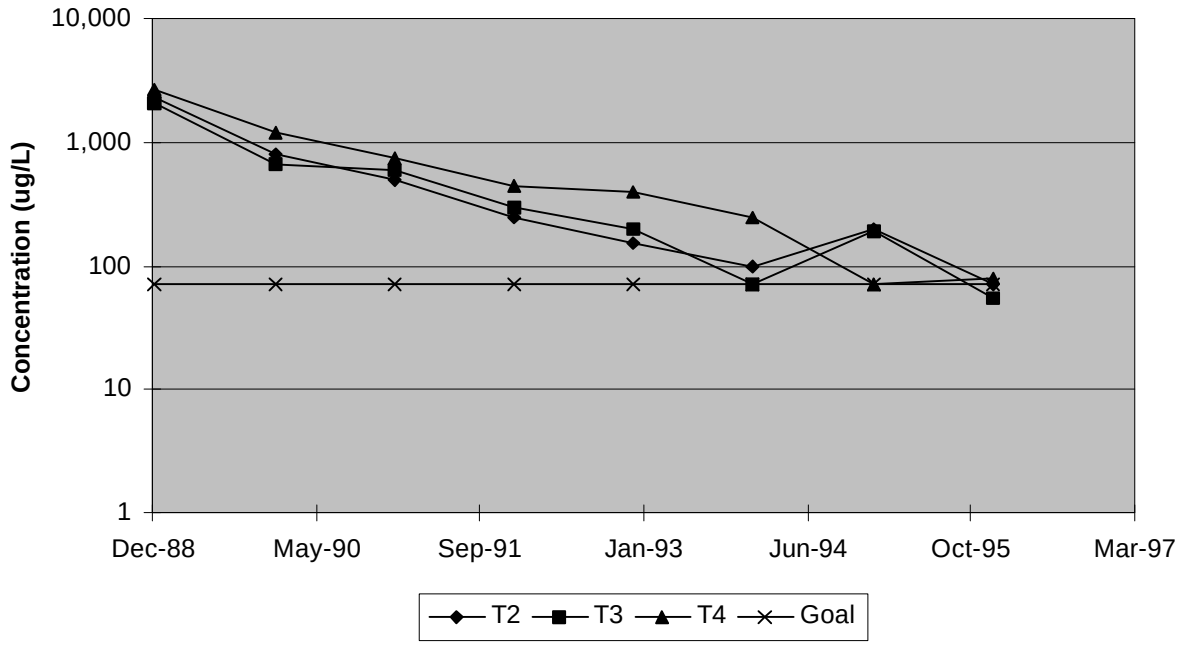

Figure 4. Total DCE Concentrations in 3 Trans Wells (1988-1996) [10,15]

TREATMENT SYSTEM PERFORMANCE (CONT.)

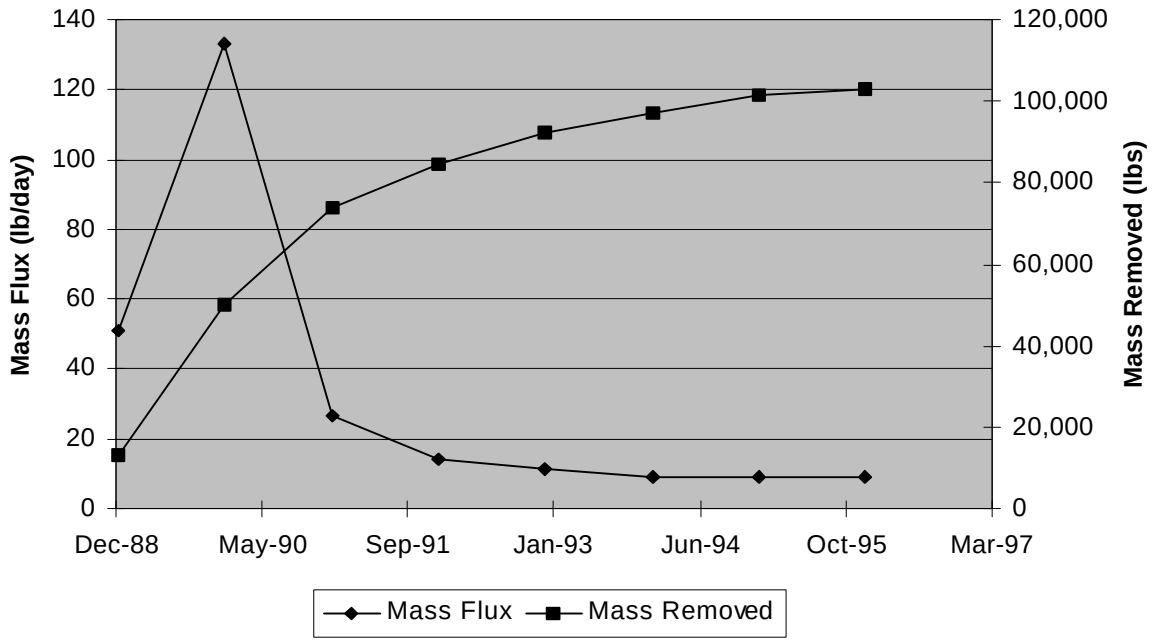

Figure 5. Mass Flux and Cumulative Contaminant Removal (1988-1996) [10,15]

Performance Data Assessment (Cont.)

- Data from annual reports indicate that inward flow gradients have been achieved in all but two deep (45 ft) piezometer pairs, which are both located in the northwest portion of the site. These two piezometer pairs, each composed of one piezometer located inside and one outside of the slurry wall, have historically displayed neutral or outward gradients [10].
- Discharge requirements established by the wastewater discharge and air emission permits have been met consistently by treatments systems on site [10].

Performance Data Completeness

- Data are available in annual reports for concentrations of contaminants in the groundwater and surface water according to the following schedule [10]:

Monitoring wells	Quarterly
N-Wells	Bimonthly
Trans Wells	Monthly
U-Wells	Bimonthly
Well Points	Annually
Stream Sampling Points	Quarterly

TREATMENT SYSTEM PERFORMANCE (CONT.)

Performance Data Completeness (Cont.)

- Data are available for influent and effluent concentrations to both treatment plants on a monthly basis.
- Contaminant mass removal data for the on-site system was provided by the site engineer.
- Contaminant mass removal for the off-site system was calculated from annual well concentration data and pumping rates from each well.
- Figures 2 and 3 were generated from data provided in annual reports. Figure 4 was generated from data provided by the primary contact for this site. Annual data were used to generate the graph.
- Data are available from 1988 through 1996 for this report. The 1995 Annual Report includes data from 1988 through 1995. Quarterly reports were used for data through the first quarter of 1996.

Performance Data Quality

The QA/QC program used throughout the remedial action met the EPA and the State of Washington requirements. All monitoring was performed using EPA-approved SW-846 methods, and the vendor did not note any exceptions to the QA/QC protocols.

TREATMENT SYSTEM COST

Procurement Process

The Western Processing Trust Fund contracted with Chemical Waste Management (now OHM) to construct and operate the initial P&T system at the site. Landau Associates is the primary technical consultant to Western Processing Trust Fund. Tacoma Pump and Drilling Company has been contracted to provide parts of the installation.

Cost Analysis

- All costs for investigation, design, construction and operation of the treatment system at this site were borne by the PRPs. The following costs are for the remediation systems operating at this site through 1995 and exclude excavation and disposal [17].

Capital Costs [13, 16, 17]

Remedial Construction	
Administration and Mobilization	$2,827,998
On-Site Laboratory and Monitoring Wells	$1,051,610
Site Work	$3,282,631
Slurry Wall	$1,382,744
Extraction/Reinjection Wells and Infiltration System	$2,977,339
Original Treatment System	$1,895,740
Original Air Stripping System	$2,311,988
Oversight	$302,579
Total Construction	**$16,032,629**

Operating Costs [13, 16]

Operations and Maintenance	$18,866,923
Administration and Taxes	$4,057,576
Operational and Environmental Monitoring	$7,657,272
Wastewater Treatment Discharge Fees	$2,115,712
Total Operating Expenses (1988 - 1995)	**$32,697,483**

TREATMENT SYSTEM COST (CONT.)

Other Costs

Remedial Investigation	
Remedial Investigation/ Feasibility Study	$2,366,654
Oversight	$13,191
Total Investigation	**$2,379,845**
Remedial Design	
Remedial Design	$1,382,919
Oversight	$22,644
Total Design	**$1,405,563**

Cost Data Quality

Actual capital and operations and maintenance cost data are available from Landau Associates, Inc..

OBSERVATIONS AND LESSONS LEARNED

- The cost for groundwater remediation between 1988 and 1995 was approximately $48,730,000 ($16,032,629 in capital costs, including the slurry wall, and $32,697,483 in operating costs), corresponding to a unit cost of $50 per 1,000 gallons of groundwater treated and $478 per pound of contaminant removed.
- The average annual operating expenses estimated using the above information are about $4,500,000.
- The original approach to this site was an aggressive effort to fully restore the site to original conditions within seven years. Restoration was a priority and high costs were incurred to achieve this goal. For example, the on-site extraction system consisted of over 200 thirty-foot well points each connected to a vacuum extraction system. This system was very costly to install and operate, but was expected to restore the site. After eight years of P&T, the goal of restoration was changed to containment based on technical impracticability of achieving full restoration.
- Goals set for surface water (Mill Creek) were time-specific. Mill Creek goals were set to be achieved within three years of the Consent Decree. The PRPs made the decision to install a slurry wall around the site at a cost of approximately $1.4 million to achieve this goal.
- More detailed study of the interactions of the broad range of contaminants found at the site was started in 1990. This effort included studies relating to contaminant transport and partitioning coefficients, as well as additional testing on the LNAPL layer and recovery system. These studies added an additional $600,000 in overall costs.
- The use of a slurry wall and a groundwater extraction system was successful at meeting the surface water criteria for Mill Creek. The surface water goals were achieved within the three-year window granted by the Consent Decree.
- Cleanup efforts at this site were very complicated from an engineering perspective. Organic and inorganic compounds were located in the saturated zone to depths of 40 feet and below. Many source areas were spread over the 13-acre site and subsurface source zones were likely present in several areas. The chemical and hydrogeologic complexity of this site led to increased costs and ultimately a change in approach from restoration to containment.

OBSERVATIONS AND LESSONS LEARNED (CONT.)

- The most rapid reductions in contaminant concentrations occurred between 1988 and 1991 (see Figure 3). Contaminant concentrations level out from 1991 through 1996. This trend has been observed at several other P&T sites.

REFERENCES

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2. Remedial Action Plan Phase II: Subsurface Cleanup, Landau Associates, Inc., September 1984.
3. Record of Decision, U.S. Environmental Protection Agency, September 1985.
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8. Technical Impracticably Waiver Petition, Western Processing, Landau Associates, Inc., September 12, 1995. (Referenced as T.I. Petition.)
9. Technical Impracticably Waiver Petition, Western Processing (Appendices), Landau Associates, Inc., September 12, 1995. (Referenced as T.I. Petition.)
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11. Copy of Western Processing Consent Decree. Filed April 10, 1987.
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13. Correspondence with Paul Johansen and Bill Enkeboll, July 8, 1997.
14. 1991 Annual Evaluation, Landau Associates, Inc., August 5, 1992.
15. Quarterly Interpretive Report, 3rd Quarter 1996, Landau Associates, Inc., April 2, 1997.
16. Groundwater Remedial Cost Analysis, U.S. Environmental Protection Agency Unpublished.
17. Comments on draft report provided by Lee Marshall, Region 10 Project Manager, and Bill Enkeboll, Landau Associates.

Analysis Preparation

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Attachment A

Consent Decree Text Pertaining to Mill Creek Standards

Allowable Concentrations in Mill Creek.

a. If the concentration of a Mill Creek indicator chemical (as listed in Table 1) or other priority pollutant at the upstream (background) monitoring point in Mill Creek is less than two-thirds of the applicable upstream Federal Ambient Water Quality Criterion for Aquatic Organisms (Water Quality Criterion)[1], the maximum allowable concentration at the downstream compliance point[2] shall be the downstream Water Quality Criterion[3].

b. If a Water Quality Criterion is not achievable because the upstream (background) concentration of a chemical is near or above the Water Quality Criterion, the maximum allowable concentration at the downstream compliance point shall be the level described below:

   i. If the concentration of a Mill creek indicator chemical or other priority pollutant at the upstream (background) monitoring point in Mill Creek is at or above two-thirds of the upstream Water Quality Criterion but less than the upstream Water Quality Criterion, the maximum allowable concentration at the downstream compliance point shall be no more than the background concentration plus fifty (50) percent of the background concentration; or

   ii. If the concentration of a Mill Creek indicator chemical or other priority pollutant at the upstream (background) monitoring point in Mill Creek is at or above the upstream Water Quality Criterion, the maximum allowable concentration at the downstream compliance point shall be no greater than background plus eighty (80) percent of the upstream Water Quality Criterion.

c. Meeting the above performance standards shall not require responsibility for any contaminated water entering Mill Creek between the upstream monitoring and downstream compliance points that is contaminated by a source other than the Site or Western Processing activities. Upon demonstration by the Consenting Defendants that water contaminated by a source other than the Site or Western Processing activities is entering Mill Creek between the upstream monitoring and downstream compliance points and quantification of such contamination by the Consenting Defendants, an appropriate adjustment will be made by the Governments for the Contaminants attributable to such other source.

[1]The applicable Water Quality Criteria shall be those final criteria published in the Federal Register as of the date of entry of this Consent Decree.

[2]The upstream monitoring point and the downstream compliance point are those described in subparagraph IV.D.7.b. below.

[3]Designation of upstream and downstream is necessary because the applicable Water Quality Criterion varies depending on the hardness of the water.