HARTCROWSER

Earth and Environmental Technologies

Feasibility Study Report
PACCAR Site
Renton, Washington

Prepared for
PACCAR Inc.

February 23, 1990
J-1639-09

Seattle, Tacoma, Richland, Anchorage, Portland, San Francisco

CONTENTS

TABLES

Page

TABLES (Continued)

FIGURES

DRAFT FEASIBILITY STUDY REPORT
PACCAR SITE
RENTON, WASHINGTON

1.0 INTRODUCTION

1.1 Purpose

This report presents the results of our Feasibility Study (FS) for the former PACCAR Defense Systems site (PACCAR site) located in Renton, Washington. The purpose of the work is to meet three general objectives:

- o Complete a Remedial Investigation/Feasibility Study (RI/FS) using Washington State Department of Ecology (Ecology) and EPA guidelines

This RI/FS was completed as a voluntary effort being coordinated by Ecology under the Model Toxics Control Act. The plan developed to guide the work is incorporated into a consent decree which was entered into Superior Court in February 1989, after approval by Ecology and a public review comment period.

The PACCAR site was proposed for listing as a National Priority List (NPL) site on June 24, 1988 and was officially listed as a NPL site on February 15, 1990. If a site is placed on the NPL, then a Remedial Investigation (RI) and Feasibility Study (FS) needs to be completed. PACCAR is completing the RI/FS process.

This report presents the results of the Feasibility Study which identifies and evaluates remedial alternatives designed to meet a set of Remedial Action Objectives (RAOs). The RAOs were developed using data collected during the Remedial Investigation (Hart Crowser, 1989) which are described in Section 3.0 of this report. The objectives were developed based on available Applicable or Relevant and Appropriate Requirements (ARARs) and the results of the baseline risk assessment documented in the RI report.

- o Complete necessary site remediation

PACCAR Inc. is using the RI/FS process to assess soil and groundwater quality conditions beneath the site to develop a remedial action plan to achieve the RAOs. This process is being used so that remedial actions can be approved by the regulatory agencies as a voluntary effort.

o Redevelop the site

In addition to addressing issues about soil and groundwater quality, PACCAR will use information generated in the RI/FS process to plan construction of its proposed Kenworth truck manufacturing facility. Current plans include construction of a large plant building and offices (75,700 square yards) within the central area of the site. Demolition of most existing structures was completed during the Fall of 1989.

Construction of the building will result in a substantial portion of the site being permanently covered. Some soils will necessarily be disturbed to remove old foundations and pavement and construct new building, equipment foundations, utility conduits, etc. The purpose of this part of the study is to assess soil quality so that the disposition of soils which will be removed and those soils which will remain beneath the building can be resolved prior to construction.

Site remediation within the construction area will be implemented as part of the remedial action plan covering site preparation and construction activities. Soil handling procedures, erosion and runoff controls, and monitoring requirements developed as part of the site remedial action plan will be implemented during plant construction to mitigate any adverse impacts.

Remedial alternatives which do not include construction of a Kenworth manufacturing facility were also included in this FS. This approach was taken to allow flexibility in preparing the cleanup action plan (CAP) if the facility is not built.

PACCAR anticipates that development, approval, and implementation of a soils remedial action plan may be completed independently of a remedial action plan for groundwater.

1.2 How the Report is Organized

Our Feasibility Study report is organized into sections using the recommended FS report outline in the most recent guidance document (EPA, 1988a) as a guide.

- o The remaining portion of Section 1.0 **INTRODUCTION** presents a description of the site and site history, a summary of the results of the RI and a description of the Kenworth redevelopment plans.

- o Section 2.0 presents a **SUMMARY OF FINDINGS** which provides an overview of our report. The remaining report sections should be consulted for supporting details and technical analyses.

- o Section 3.0 **REMEDIAL ACTION OBJECTIVES** presents the objectives and discusses how the objectives were developed.

- o Section 4.0 **IDENTIFICATION AND SCREENING OF TECHNOLOGIES** lists and screens possible remedial action technologies. General response actions and remedial technologies are discussed for each media which may require remediation (soil, groundwater, and sediments).

- o Section 5.0 **DEVELOPMENT AND SCREENING OF ALTERNATIVES** discusses how the applicable and representative remedial technologies were grouped to form various alternatives and how the alternatives were screened to decide which alternatives to evaluate in detail.

- o Section 6.0 **DETAILED ANALYSES OF ALTERNATIVES** presents the results of the detailed analyses of representative remedial alternatives for soil, groundwater, and sediments.

- o Section 7.0 **REFERENCES** concludes the main body of the report.

Figures for each section are given at the end of their respective sections.

Our report is supported by five appendices. These are:

- o Appendix A - Basis for Volume Estimates of Groundwater, Soil, and Sediment
- o Appendix B - Remedial Technology Descriptions
- o Appendix C - Cost Estimate Breakdowns

- Appendix D - Listing of Potential Location-Specific ARARs
- Appendix E - Development of Remediation Criteria for Proposed Utility Trenches

This report has been prepared by Hart Crowser, Inc., for the exclusive use of PACCAR, Inc. for the specific application to this project and site. This work was performed and this report prepared in accordance with generally accepted professional practices for the nature of the work completed in the same or similar localities, at the time the work was performed. No other warranty, express or implied, is made. Assistance in this report preparation was provided by Mr. Matt Dalton of Dalton, Olmsted, and Fuglevand, Inc.

1.3 Summary of Remedial Investigation Report

1.3.1 Site Description

The PACCAR site is located within the City of Renton, about 1/2 mile northeast of the downtown area (Figure 1-1) and is about 82 acres in size. The site is within the Cedar River Valley, with city land surface elevations ranging between 25 and 40 feet. Upland areas of Renton with land surface elevations greater than 200 to 300 feet bound the valley to the east, west, and south.

The Cedar River is located about 2,000 to 3,300 feet to the southwest and west while Johns Creek and Lake Washington lie about 2,500 to 3,000 feet to the north and northwest. Both Johns Creek and the Cedar River flow into Lake Washington.

Previous facilities included a foundry, forge shop, machine shops, fabrication, storage, assembly and painting buildings, railway spurs, and other support facilities (Figure 1-2). All production equipment has been sold and has been removed. Demolition of most site structures was completed during the spring and summer of 1989 under a permit issued by the City of Renton. All waste production and demolition materials were disposed of according to applicable laws and regulations. Most of the southern portion of the site is paved while the northwest and northeast portions are mostly unpaved. Unpaved areas are covered with a layer of clean sand and gravel.

Three drainage ditches are present within the northern site area, termed west, middle, and east ditches. The site is also drained (to the north and west) by a culvert, connected to a storm drainage system, which lies beneath the site. The west drainage channel is equipped with an oil/water separator.

1.3.2 How the Site was Used

The facility opened in 1907 as a foundry and rail car manufacturing plant. At its peak, the Pacific Car and Foundry (predecessor of PACCAR Defense Systems) plant built rail cars, Sherman tanks, and other military vehicles and employed up to about 2,100 workers. It stopped making rail cars in 1984. From 1984 to 1988, military vehicles, castings, forgings, and other industrial products were produced at the site. Manufacturing activities have ceased and the plant was closed during the spring and summer of 1988.

Initially, the site was about 40 acres in size with the activities being conducted on the southern part of the existing site. The site expanded northward and east with the last property acquisition occurring in the late 1960s.

A variety of activities occurred at the site with the potential to have adversely affected soil and/or groundwater quality:

o Industrial fill containing heavy metals and other materials was deposited mostly on the northern half of the site. This practice was discontinued in 1962.

o Diesel fuel was stored in an above-ground tank facility within the southwestern portion of the plant (monitoring well LW-11 area).

o The plant was powered by diesel until a natural gas system was installed in 1955. A buried pipeline feeder network (now unused) was used to distribute the fuel generally within the southern half of the existing site.

o Fuels and solvents were used at the plant which were stored in above-ground or underground tanks. All of these tanks have been removed.

- Paint spraying operations were conducted throughout the plant.

- Sand and shot blasting operations were conducted on the site.

- Galvanizing was conducted in the 1940s and 1950s.

- Transformers and other electrical equipment containing PCBs were used on the site. A program is currently underway to remove transformers and other electrical equipment containing PCBs. As of December 1988 the concentration of PCBs was below the federal EPA-regulated limit of 50 ppm in all equipment containing PCBs. Most electrical equipment containing PCBs had been removed from the site by the summer of 1989.

1.3.3 Possible Sources of Contaminants

Potential sources of contamination were identified based on past history. Many of these sources are no longer present on the site because of changing site operations and waste handling practices and programs implemented by PACCAR to remove possible sources such as tanks. The identified possible sources include:

- Fill materials.

- Underground and above-ground tanks (now removed).

- Leakage prior to 1955 from abandoned buried diesel distribution lines within the southern part of the plant.

- Transformers and other electrical equipment.

- Painting and galvanizing operations.

- Residues from sand blasting and shot blasting.

- Solvents, degreasing agents, lubrication oils, and cutting oils used in the machine shop and other operations.

1.3.4 Results of Soil and Fill Analysis

Soils and fill materials on the site have been screened and tested for a variety of potential contaminants including metals, volatile and semivolatile organic chemicals, and PCBs.

- o At a few locations on-site metal concentrations exceed background levels but, except for lead, nearly all values fall within the reported background range. Lead concentrations exceeding background levels were detected in a greater number of locations at the site. Concentrations of metals in soils are generally highest in the top several feet and decline with increasing depth. Highest metal concentrations are associated with industrial fill materials. Table 1-1 presents a summary of total metal concentration data.

Table 1-1 - **Summary** of Target **Metal** and Organic Concentrations in **Soil**

Parameter	Typical Concentration Range in mg/kg (ppm)	Highest Concentration in mg/kg (ppm)	Regional Background Concentration in mg/kg (ppm)
Arsenic	ND to 10	180	5 to 30
Cadmium	ND	9.7	<1 to 1.4
Chromium	10 to 100	1,600	10 to 70
Copper	10 to 100	1,600	5 to 20
Lead	ND to 100	19,000	10 to 60
Nickel	10 to 100	330	10 to 70
Zinc	10 to 100	6,400	20 to 80
BTEX	ND	7.3	<0.01
Vinyl Chloride	ND	0.01	<0.01
HPAHs	0.1 to 10	1,085	<0.01 to 0.1
PCBs	ND	24	<0.01

ND = not detected

The large majority of soils on the site would not be designated as dangerous wastes. However, a small number of samples indicate that some soil has the potential to be designated as a dangerous waste if excavated based on total arsenic concentration and EP Tox results for lead.

280 samples were tested for total arsenic. 274 of the samples would not be classified as a dangerous waste (WAC 173-303) based on total arsenic concentrations below 100 ppm. Six of the 280 samples exceeded 100 ppm (*in situ*) which indicates that some of the soil on the site could be designated as a dangerous waste. However, it is unlikely that excavated soil concentrations would exceed 100 ppm arsenic because the number of samples exceeding 100 ppm was small and most of the samples were of relatively low concentration (maximum 180 ppm).

200 samples were tested for Extraction Procedure Toxicity (EP Tox) metals. Two samples exceeded EP Tox dangerous waste criteria for lead. Soil from one of these locations was removed from the site in 1987 with Ecology approval. It is unlikely that any excavated soil would exceed the EP Tox criteria because of the small number of samples which exceeded the criteria.

- Most of the volatile organic chemicals detected in soils were in the range of less than detection to 0.1 mg/kg (ppm), with a few samples ranging up to 7.3 mg/kg. The compounds detected include constituents associated with fuels (benzene, toluene, ethylbenzene, and xylenes) and solvents (tetrachloroethene, trichloroethene, and 1,2-Dichloroethane). Table 1-1 presents a summary of organics concentration data in soils.

- Semivolatile organic chemicals were detected in most samples in the range of below detection limits to about 10 mg/kg (ppm) with a few of the samples ranging up to 1,300 mg/kg. We have divided this class of chemical compounds into petroleum hydrocarbons and polynuclear aromatic hydrocarbons (PAHs). Petroleum hydrocarbons are measured by two methods; TPH (418.1) and GC/FID (8015-extended). PAHs are broken into two subgroups; low molecular weight (LPAHs) and high molecular weight (HPAHs).

  Petroleum hydrocarbons concentrations range between less than the detection limit to

58,000 ppm as measured by TPH (418.1) and 10,000 ppm as measured by GC/FID (8015-extended). The highest concentrations were measured in near-surface soils and the concentrations generally declined with increasing depth. The highest concentrations were also measured within the southern part of the site where the buried diesel distribution lines are present. GC/FID screening analyses indicate that the high petroleum hydrocarbon concentrations are predominantly the result of the presence of diesel fuel although the presence of gasoline and heavier oils (e.g., lubricating and cutting oils) are also indicated.

Low and high molecular weight polynuclear aromatic hydrocarbons (LPAH and HPAH) concentrations range between not detected to 222 mg/kg and not detected to 1,085 mg/kg, respectively. These compounds are associated with fuel and with fill materials containing cinders, coal, and other rubble. Concentrations decline with increasing depth.

- Generally low concentrations of PCBs were detected in site soils. Concentrations range from not detected over most of site to about 5 ppm although one sample detected a concentration of 24 ppm. The presence of PCBs is localized to areas where small spills likely occurred.

1.3.5 Results of Groundwater Analyses

Groundwater samples were obtained from over 70 monitoring wells and were analyzed for volatile and semivolatile organic chemicals, pesticides and PCBs, and metals. Samples were obtained from both on-site and off-site wells. Table 1-2 presents a summary of groundwater data for organics and Table 1-3 presents a summary of groundwater data for metals.

- Volatile organic chemicals were detected in the range of not detected to about 3 mg/L (ppm) for shallow on-site monitoring wells (less than about 25 feet deep) to not detected to about 1 ppm for deeper on-site monitoring wells. Samples from two off-site monitoring wells detected volatile chemicals. The constituents detected are indicative of fuels and solvents. Vinyl chloride was the only significant detection at 0.045 ppm (LMW-2D) and 0.004 to 0.005 ppm (OSP-5D) in two monitoring wells west of the site. These monitoring wells are located within the Cedar River catchment area. Well OSP-5D is downgradient of well LMW-2D which indicates that a significant reduction in vinyl chloride concentrations occurs within a relatively short distance from the site.

The vinyl chloride likely is a breakdown product of chlorinated solvents which entered groundwater. Vinyl chloride was not used on the site but is a typical degradation product of solvents such as tetrachloroethene and trichloroethene, both of which were used. However, the source of the vinyl chloride is no longer present on the site based on the available data. The data includes over 100 soil samples obtained from locations distributed over the entire site and at various depths including within the probable source area, upgradient of the wells in which this compound was detected. Out of 108 soil samples analyzed for volatile organic chemicals (VOCs), only 4 samples detected solvents above the reported detection limits (see Appendix G of the remedial investigation report) and only one of these samples detected vinyl chloride. The detected concentrations are very low and ranged between 0.002 and 0.01 mg/kg (ppm).

The available monitoring data indicate that VOC concentrations in several wells are declining as a results of previous actions taken by PACCAR. For example, in well LW-12S, benzene, toluene, ethylbenzene, and xylene concentrations have declined from 0.040 to 0.006 mg/L (ppm) from July 1986 to February 1989; a reduction of about 85 percent. Similarly vinyl chloride concentrations in LW-6D have declined from 0.080 to 0.038 mg/L during the same period; a reduction of over 50 percent.

- Semivolatile organic chemicals were not detected in groundwater beneath most of the site. The highest concentrations were detected in samples adjacent to previous tank (underground or above-ground) locations. The presence of high semivolatile concentrations in site soils, especially within the southern portion of the site, has not had a discernible influence on groundwater quality. No semivolatile organic chemicals were detected in off-site monitoring wells.

The concentrations of semivolatile chemicals in several wells are also declining. In well LW-12D the sum of the semivolatile compounds has declined from 0.029 to 0.004 ppm from July 1986 to February 1989; a reduction of over 85 percent. Concentrations in well LW-3S are also showing a declining trend during the same period (0.357 to 0.194 ppm; a reduction of about 45 percent).

Table 1-2 - Summary of Groundwater Data for Organic Compounds

Parameter		On-Site Concentration Range in mg/L (ppm)	Off-Site Concentration Range in mg/L (ppm)
Volatile Organic Compounds	S	ND to 3.0 (4/22)	ND (0/12)
	D	ND to 1.0 (5/19)	ND to 0.045 (2/9)
Semi-volatile Organic Compounds	S	ND to 0.36 (4/22)	ND (0/5)
	D	ND to 0.062 (3/15)	ND (0/7)
PCBs	S	ND to 0.010 (0/13)	No shallow wells sampled
	D	ND (0/6)	ND (0/2)

NOTES:
* Detected in one well in 1984. Not detected in subsequent sampling round.
ND - Not detected above detection limit.
S = shallow wells less than 25 feet deep.
D = deep wells greater than 25 feet deep.
Concentrations of Volatile Organic Compounds and Semivolatile Organic Compounds represent the sum of concentrations of individual constituents.
(3/18) = 3 of 18 wells sampled had significant detectable concentrations, based on most recent sampling of each well.

- o Pesticides or PCBs were not detected in groundwater beneath the site, except during an early sampling round where a single low level PCB and several pesticides were reported to have been detected. Later sampling rounds did not confirm the presence of PCBs or the pesticides.

- o Metals: Dissolved lead, zinc, and arsenic were the only metals consistently detected in groundwater samples from shallow and deep monitoring wells. Copper, nickel, chromium, cadmium, mercury, selenium, barium, and silver were generally not detected. The range of concentrations for lead, zinc, and arsenic in groundwater are listed in Table 1-3. The presence of lead in soils has not had a substantive influence on groundwater quality.

Table 1-3 - Summary of Groundwater Data for Metals

Parameter		On-Site Concentration Range in mg/L (ppm)	Off-Site Concentration Range in mg/L (ppm)	Standards CMCL/PMCL in mg/L (ppm)
Arsenic*	S	<0.005 to 0.073 (6/18>0.010 ppm)	<5 to 0.027 (1/8>0.010 ppm)	0.050/ 0.030
	D	<0.005 to 0.070 (3/15>0.010 ppm)	<5 to 0.045 (1/7>0.010 ppm)	50/30
Lead	S	<0.005 to 0.040 (3/23>0.010 ppm)	<5 to 11 (1/8>0.010 ppm)	0.050/ 0.005
	D	<0.005 to 0.012 (2/15>0.010 ppm)	<5 to 5 (0/8>0.010 ppm)	0.050/ 0.005
Zinc	S	0.010 to 0.052 (3/23>0.030 ppm)	0.004 to 0.050 (1/8>0.030 ppm)	5.0/np
	D	0.003 to 0.110 (3/14>0.030 ppm)	0.008 to 0.028 (0/7>0.030 ppm)	5.0/np

NOTES:
S = shallow wells less than 25 feet deep.
D = deep wells greater than 25 feet deep.
CMCL = drinking water current maximum contaminant level.
PMCL = drinking water proposed maximum contaminant level.
np = none proposed.
* = 1988/89 data used because of improved analytical laboratory quality assurance techniques
6/18 = 6 samples of 18 total samples

- o Most samples were analyzed to be within two times the lower limit of detection (0.010 ppm for arsenic and lead) or within two times background (0.030 ppm for zinc) as shown in Table 1-3. Samples above these concentrations are considered to have been potentially affected by the fill. These limits were chosen based on analysis of the data set to account for data variability inherent in analysis of relatively large number of samples with metals concentrations at such a low concentration level. For example, the concentration of lead in a duplicate sample from well LW-12D obtained during February 1989 ranged between <0.005 and 0.007 ppm.

Relatively few samples (24 of 153 or 15 percent) exceed two times the detection (for arsenic and lead) or two times the background (for zinc). An even fewer number exceed existing or proposed drinking water standards (9 of 153 or 6 percent).

The metals groundwater quality data indicate that the on-site industrial fill has had little impact on overall groundwater quality. A consistent pattern of where arsenic, lead, or zinc concentrations exceed the indicated "variability" levels is not evident in the data. The exceedences are localized in extent and are not indicative of the quality of most of the groundwater beneath or downgradient of the site.

1.3.6 Results of Surface Water and Sediment Analyses

Surface water samples have been collected and analyzed from two locations where runoff is collected and leaves the site. The quality of runoff from the site is similar to runoff from local urban areas (Hart Crowser 1989, Remedial Investigation Report, Table 6.13). Volatiles and pesticides/PCBs were not detected in these samples and only very low concentrations (0.002 to 0.021 ppm) of two phthalate compounds were detected. Copper, nickel, lead, and zinc were detected in surface water samples.

Sediments obtained from the bottom of two ditches which collect surface water flow have also been analyzed. Xylene was the only volatile chemical detected (at 0.02 mg/kg) and several semivolatile compounds were detected at concentrations less than about 10 to 11 mg/kg (ppm). The PCB Aroclor 1254 was detected at 3.1 ppm in one sample. Total lead, chromium, nickel, and zinc were detected at concentrations within a similar range as for site soils.

1.3.7 Contaminant Transport Pathways

Air. Migration via air can occur through volatilization and generation of dust. Volatilization of volatile organic chemicals is not considered significant because of the low concentrations of these chemicals in site soils. Generation of dust is a potential migration pathway which is currently limited by the presence of building foundations and site paving which cover about 50 percent of the site. Migration via this pathway is further limited by clean granular fill materials which cover most of the remaining portions of the site. However, because of the presence of metals in soil, this possible pathway was evaluated in the baseline risk assessment.

Surface Water. Surface water as stormwater flow leaves the site via several ditches and a culvert most of which flows into Johns Creek. Migration of particulates, which contain metals, into the ditches probably occurs during periods of high runoff. However, available data indicate that the runoff is similar to typical urban runoff. This pathway was considered in the baseline risk assessment.

Groundwater. Groundwater beneath the site flows to the west and southwest. Most of the site is upgradient of the Cedar River (termed Cedar River catchment) while a portion of the southeast corner of the site is upgradient of the Renton well field (termed Renton Well catchment). The two catchment areas are separated by a groundwater divide which has been defined based on extensive groundwater monitoring. The northern extent of this divide delineates the northern portion of Zone 2 of the Renton Aquifer Protection Area (APA) as shown on Figure 2-1. Because the Cedar River and the Renton well field are downgradient of the site, migration to these receptors was considered in the baseline risk assessment.

Most of the groundwater beneath the site flows in two zones designated upper and lower sand zones (see Section 4 of the Remedial Investigation report). Groundwater flow rates are variable within each zone depending on variability in hydraulic conductivity and hydraulic gradient. Table 1-4 summarizes the flow rate estimates based on the available data. These estimates were made using hydraulic conductivity data summarized in Table 5.1 and hydraulic gradient data summarized in Table 8.2 of the Remedial Investigation report.

Table 1-4 - Summary of Groundwater Flow Rates

	Estimated Flow Rate in Feet per Year		
	Low	Best Estimate	High
Upper Sand			
Cedar River Catchment	1.7	20 to 50	640
Renton Catchment	0.9	10 to 30	362
Lower Sand			
Cedar River Catchment	287	300 to 600	651
Renton Catchment	159	175 to 350	369

Notes:

- o Similar gradients were used for upper and lower sand zones, although the variation in gradients between the Cedar River and Renton Catchment is accounted for in the velocity estimates.
- o A porosity of 0.3 was used for the upper sand and 0.2 was used for the lower sand.

The variability in flow rate estimates is higher in the upper sand than in the lower sand because of the larger variability in hydraulic conductivity estimates. This variability is consistent with variation in material types observed during soil sampling activities and is reflected in the geologic logs.

1.3.8 Results of Baseline Risk Assessment

We took a conservative "probabilistic worst case" approach to the risk assessment consistent with recent EPA and Ecology guidance and comment. This is what we found:

- o The site poses little public health or environmental risk. Most risk is associated with disturbing soils within a portion of the site in an uncontrolled manner. Because the site is controlled and any soil disturbance would be according to an approved health and safety plan, the risks are actually lower than those indicated using the assumptions incorporated into the risk assessment.

- Both carcinogenic and non-carcinogenic risks posed by the site are within general guidance provided by the regulatory agencies. Non-carcinogenic risks, expressed as a hazard index, were below 1.0 and the cumulative upper-bound lifetime carcinogenic risks were smaller than 1 additional case in 10,000. To provide perspective in evaluating cancer risk, consumption of charcoal broiled steak (two servings per week) is associated with an estimated upper-bound cancer risk of 1 in 14,000.

- Potential risks to the Renton well field are very small because few off-site chemical detections have occurred and are beyond the catchment area of the well field even under pumping conditions. In addition flow from the PACCAR site to the well field is only a small percentage of the volume of water which is pumped from the well field. Other than the Renton wells no other water supply wells are present in the area and the possibility that future wells will be installed in this area is remote.

Our assessment indicates that the other constituents of concern and possible exposure routes pose lower risks to human health. Potential environmental risks appear limited to stormwater discharges into Johns Creek, although such risks are likely minor and not substantially different from those in residential areas typical of the site vicinity.

1.3.9 Proposed Site Redevelopment Plans

PACCAR Facility. As noted in Section 1.1, PACCAR is proposing to redevelop the site into a Kenworth Truck plant. The plant will consist of a large manufacturing building, office building, small auxiliary buildings, roadways, parking lots, two storm water settling basins, and utilities. The currently proposed facility layout is shown on Figure 6-6.

Our Feasibility Study evaluates alternatives which assume the plant will and will not be built. If the plant is built, a substantial portion of the site will be covered by structures and paving which will assist in meeting the remedial action objectives. However, some soil will be disturbed which will have to be handled in an appropriate fashion. If the plant is not built, smaller volumes of soil will be disturbed but other means of covering portions of the site may have to be used.

Realignment of Garden Avenue. The City of Renton has proposed that Garden Avenue be realigned to cross a portion of the northwest corner of the PACCAR site as shown on Figure 1-3. This portion of the site is underlain by industrial fill materials which contain metals above the RAOs as discussed in Section 3. In addition to the realigned roadway, buried utilities, such as water and electric, would be buried adjacent to the road. Construction of the realigned road/utilities and future upgrade and repairs need to consider the impacts of the metals in soil on site workers.

Realignment of Existing Storm Sewer. A storm sewer which receives off-site flow is located beneath the central portion of the site (Figure 1-3). The existing location of the drainage impacts future site redevelopment so PACCAR is proposing that the storm sewer be realigned to the east within the Houser Way North right-of-way. PACCAR only proposes to realign this storm sewer if it redevelops the site. Realignment of storm sewer will require some soil disturbance when it leaves Houser Way and crosses the northern portion of the site which will need to be considered because of the presence of metals, high molecular weight PAHs, and diesel fuel residuals in soil.

Vicinity Map

Base map prepared from USGS 7.5-minute quadrangles of Mercer Island and Renton, Washington

(crosshatch)	Regional Study Area
(diagonal hatch)	PACCAR Site

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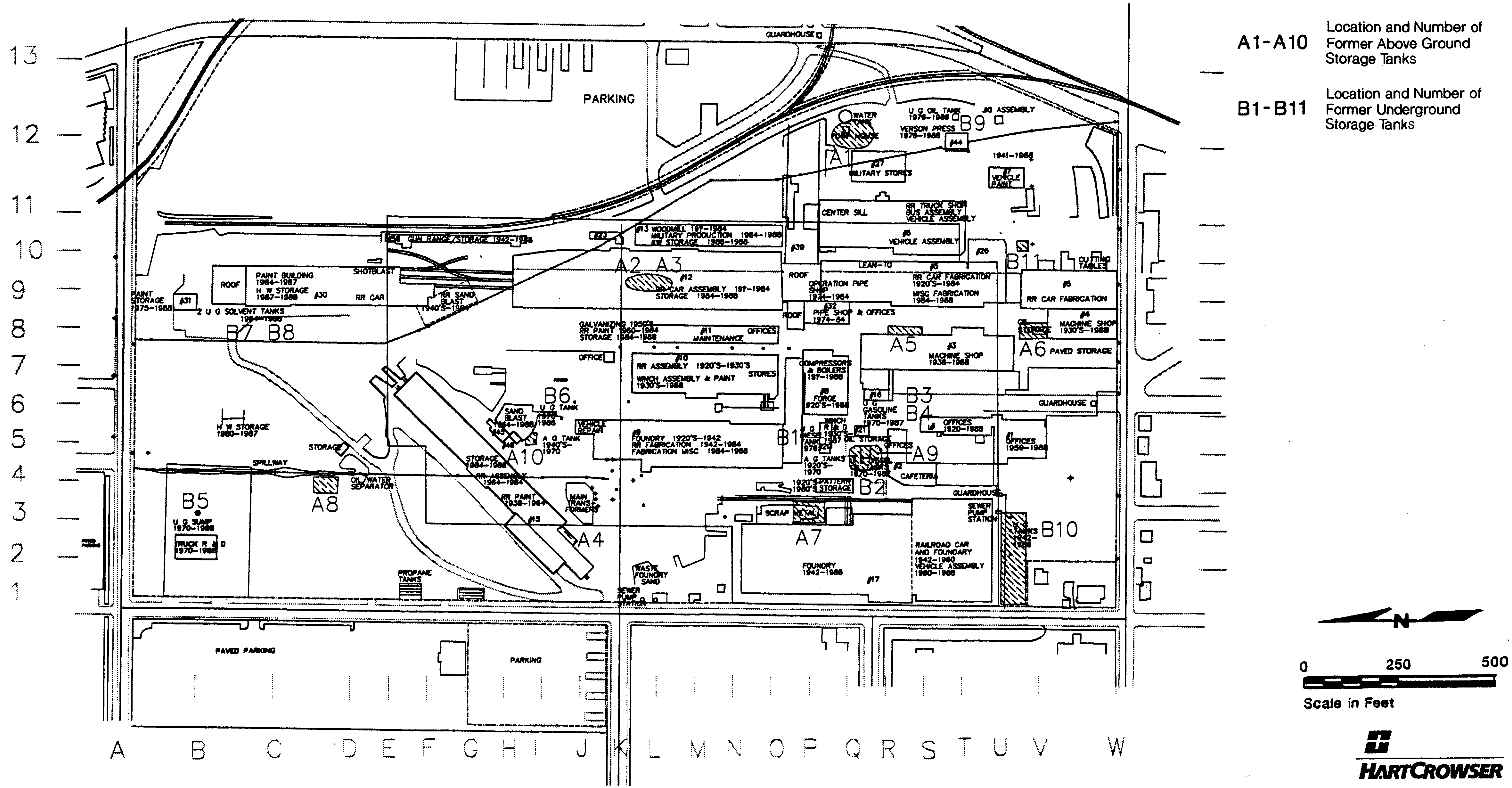
J-1639-09 5/89

Figure 1-1

Site Features Map



A1-A10 Location and Number of Former Above Ground Storage Tanks

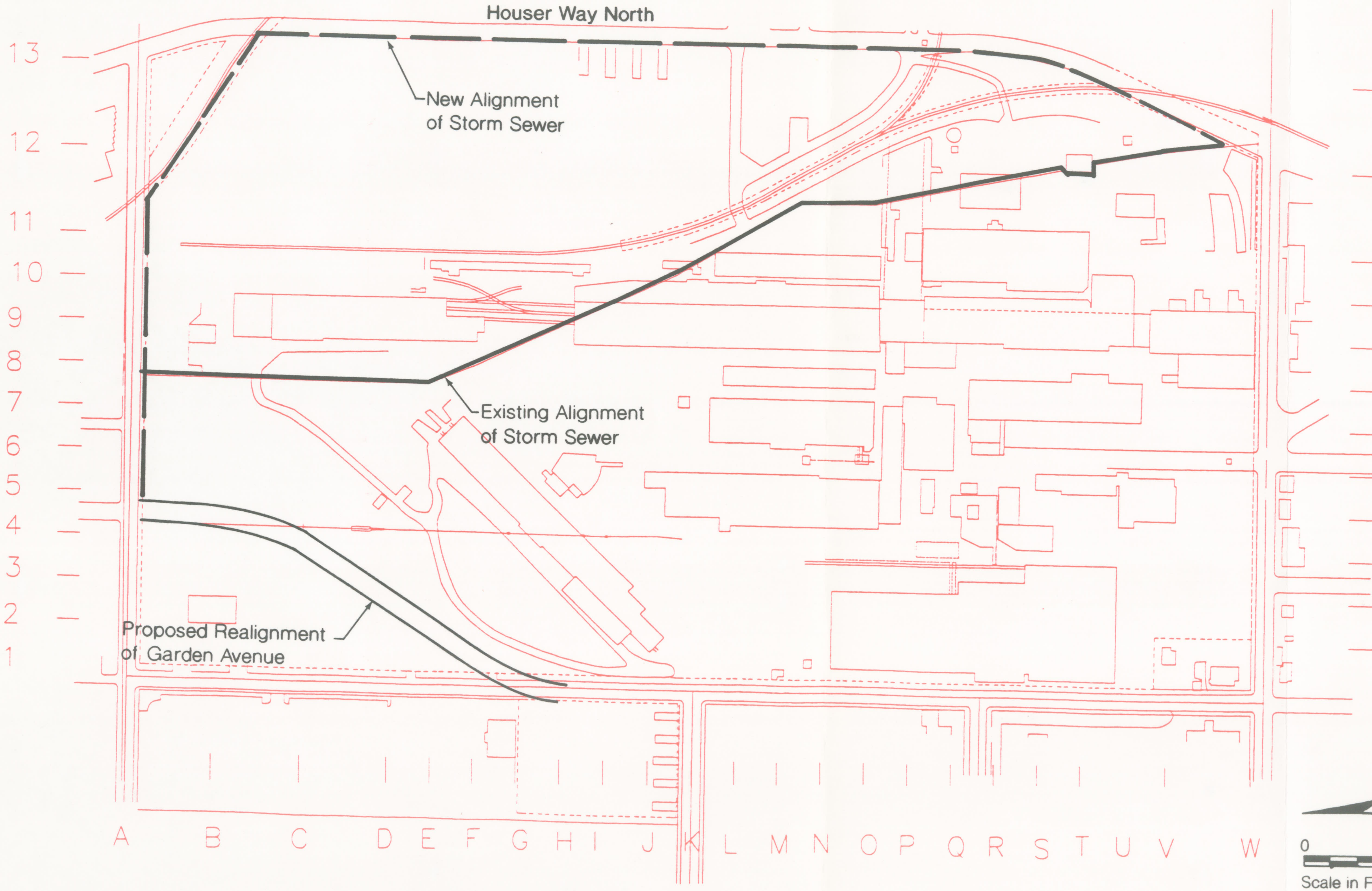
B1-B11 Location and Number of Former Underground Storage Tanks

HARTCROWSER

J-1639-09 5/89

Figure 1-2

Proposed Realignment of Storm Sewer and Garden Avenue



HARTCROWSER
J-1639-09 7/89
Figure 1-3

2.0 SUMMARY OF FINDINGS-FEASIBILITY STUDY

2.1 Remedial Action Objectives

Although the baseline risk assessment prepared as part of the Remedial Investigation indicates that the site poses little public health or environmental risk, a set of preliminary remedial action objectives were developed. This approach was used so that remedial alternatives could be developed to reduce the already low site risk and meet the general remedial objective of reducing the mobility, toxicity, or volume of site contaminants.

Development of the preliminary objectives considered Applicable or Relevant and Appropriate Requirements (ARARs) where available. Where ARARs are not available other policies and guidance were used as To-Be-Considered (TBCs). The results of the baseline risk assessment were considered to fall within this category. The risk targets outlined in the proposed (December 1988 draft) National Contingency Plan (NCP - EPA, 1988d) were compared against the results of the baseline risk assessment to formulate specific preliminary objectives where ARARs were not available.

The preliminary remedial action objectives are listed in Table 3-7 of this FS report. Section 3.0 **REMEDIAL ACTION OBJECTIVES** should be consulted for supporting detail.

2.2 Identification of Remedial Technologies and Development of Remedial Alternatives

Remedial alternatives selected for detailed analysis were developed using recommended procedures in the RI/FS guidance documents published by EPA. General response actions to remediate the various media (soils, groundwater, and sediments) were assessed and available technologies applicable to the site conditions were screened and selected to form preliminary alternatives. We assembled and screened 6 alternatives for groundwater, 11 alternatives for soil, and 5 alternatives for sediments. Of these alternatives the following were selected for detailed analysis:

- o Groundwater
  - Monitor
  - Restrict groundwater use
  - Pump and treat

- o Soils
  - Monitor
  - Restrict access
  - Slow biological treatment with stabilization
  - Cover
  - Excavate and dispose of a limited amount of soil containing PCBs
  - Cover with biological treatment and stabilization of "hot spots"

- o Sediment
  - Line/fill ditches
  - Excavate and dispose of contaminated sediment in ditches.

2.3 Detailed Analysis and Discussion of Preferred Alternatives

The 11 alternatives selected for detailed analysis were evaluated using the criteria in the latest EPA guidance document. These include:

- o Overall protection of human health and the environment;
- o Compliance with the Remedial Action Objectives (RAOs) and Applicable or Relevant and Appropriate Requirements (ARARs);
- o Short- and Long-term effectiveness;
- o Reduction of toxicity, mobility, and volume;
- o Implementability; and
- o Cost.

(In this draft document state and community acceptance has not been addressed. These areas will be addressed after state review and public comment.)

Based on the detailed analysis the preferred alternatives for the site are:

- o Groundwater - Continued baseline monitoring. The effects of the other remedial actions would be assessed and based on the monitoring data the need for other groundwater remedial actions would be evaluated.

- o Soil - Biologically treat or stabilize soil in hot spots and source areas and place a cover. This alternative is described in more detail in Section 6 of this report.

The approximate extent of the cover is shown on Figure 6-5. The selected alternative would treat or stabilize soil representing about 50 percent of the mass of contaminants.

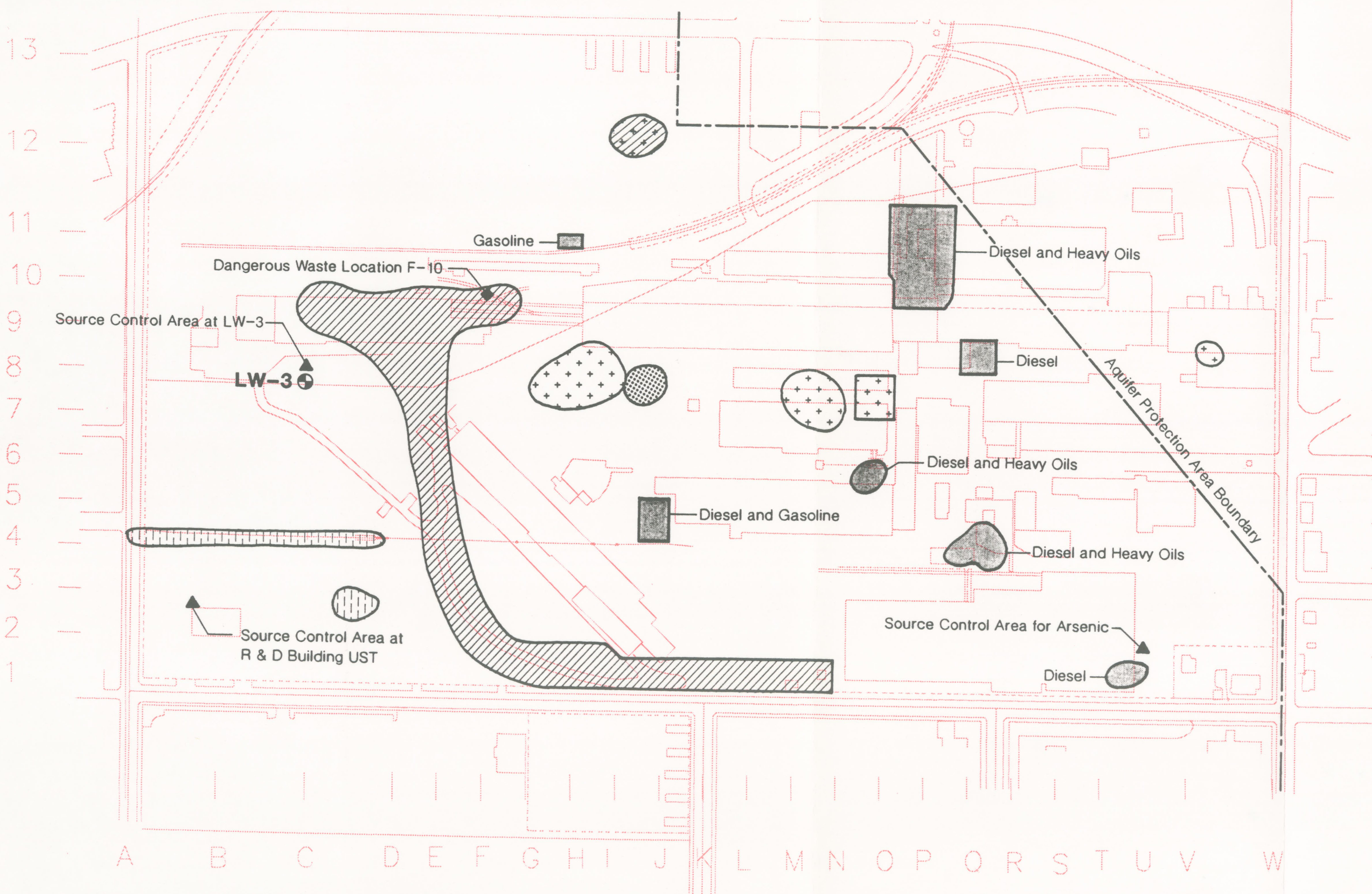
- Excavate and dispose of roughly 700 cubic yards of soil containing PCBs and about 10 cubic yards of soil containing lead exceeding dangerous waste limits. The areas with these soils are two isolated locations in the northern portion of the site. The excavation will be filled with clean soil.

- Sediment - Excavate/dispose of sediments containing PCBs and fill the ditch with clean fill.

The areas of soil or sediment excavation, treatment, stabilization, or disposal are shown on Figure 2-1. The boundary of the Renton Aquifer Protection Area is also shown on Figure 2-1.

Our evaluation indicates that these alternatives will be protective of human health and the environment, will meet the RAOs, and will reduce the already low risks that the site potentially poses to site workers and the surrounding environment.

Approximate Extent of Contaminated Soil to be Excavated[1] Under Soil Alternatives 8 and 9/10 and Sediment Alternative 5



[1] Arsenic, Lead, Chromium, and HPAH Soils will be excavated and stabilized under soil alternative 9/10.

Petroleum Hydrocarbons Soils will be excavated and biotreated under soil alternative 9/10.

PCB Soils and Dangerous Waste Soils will be excavated and disposed of off-site under soils alternative 8.

PCB Sediments will be excavated and disposed of off-site under sediment alternative 5.

[2] Phenanthrene Response Used to Quantify Petroleum Hydrocarbon Concentrations

Arsenic > 100 ppm

Lead > 8,000 ppm and Chromium > 600 ppm

Diesel - Tentative Characterization Based on GC/FID Signatures

Petroleum Hydrocarbons > 2,500 ppm (GC/FID, 8015-ext.)[2]

HPAH > 800 ppm

PCBs

LW-3 Monitoring Well Location and Number

N

0 250 500

Scale in Feet

HARTCROWSER

J-1639-09 1/90

Figure 2-1

3.0 REMEDIAL ACTION OBJECTIVES

3.1 Development of Remedial Action Objectives

EPA's proposed revisions to the National Contingency Plan (NCP) (53 Fed. Reg. 51394) and a draft EPA Guidance Document entitled "CERCLA Compliance with Other Laws Manual" (August 8, 1988 draft -- EPA, 1988c) include procedures for establishing remedial action objectives (RAOs) in Feasibility Studies of Superfund sites. According to the proposed NCP revisions, the remedial action objectives should specify the contaminants and media of concern, potential exposure pathways, and preliminary remediation goals. Final remediation goals are not determined until the remedy is selected.

In this section the remedial action objectives were identified or developed for chemicals identified as being of concern in the baseline risk assessment conducted as part of the remedial investigation (RI). Applicable or Relevant and Appropriate Requirements (ARARs) formed the basis for a specific remedial action objective when available. The risk assessment formed the basis to develop a specific objective when ARARs were not available, and when available ARARs were clearly not adequate to protect human health or the environment. To-be-considered (TBCs) policies and guidance were evaluated along with the risk based analyses.

3.1.1 Identifying Chemicals of Concern

Figure 3-1 shows the process used to select the chemicals of concern used to develop RAOs.

Of the 163 parameters tested, 23 chemicals were initially identified to be of concern based on the preliminary screening (listed in Table 7.3 of the Remedial Investigation Report). These are summarized, along with the media of concern in Table 3-1. As shown, the media of concern include both soil and water.

A detailed analysis of potential risks conducted during the remedial investigation reduced the number of chemicals of concern to those listed in Table 3-2. Inclusion in Table 3-2 was based upon whether a chemical's concentration exceeded the reference dose (for non-carcinogens) or exceeded an upper-bound lifetime cancer risk of 1 in 1,000,000 for carcinogens.

Table 3-1 - Summary of Constituents of Concern (Based on Preliminary Risk Assessment Screening)

	Soil	Groundwater	Surface Water
METALS			
Arsenic	X	Xa	
Chromium (VI)	X		X
Copper			X
Lead	X	Xa	X
Nickel			X
Silver	X		
Zinc			X
VOLATILES			
Benzene		X	
1,2-Dichloroethane		X	
Ethylbenzene		Xb	
Toluene		Xb	
Vinyl Chloride		X	
Xylenes		Xb	
SEMIVOLATILES			
Benzo (a) anthracene	X		
Benzo (a) pyrene	X		
Benzo (b) fluoranthene	X		
Benzo (k) fluoranthene	X		
Dibenzo (a,h) anthracene	X		
1,2-Dichlorobenzene		Xb	
Hexachlorobenzene	X		
Indeno (1,2,3-cd)pyrene	X		
PCB Aroclor 1254	X		
PCB Aroclor 1260	X		

Notes: a) Based on exceedence of proposed primary drinking water standard. Does not exceed current standard.
b) Based on exceedence of proposed secondary drinking water standard. Does not exceed current standard.

Table 3-2 - Summary of Constituents of Concern
(Based on Detailed Risk Assessment)

	Soil	Groundwater
METALS		
Arsenic	X	X
Chromium	X	
Lead	X	
VOLATILES		
Vinyl Chloride		X
Benzene		X
SEMIVOLATILES		
Total PAHs	X	
Hexachlorobenzene	X	
Total PCBs	X	

The application of ARARs and the results of the baseline risk assessment were used to develop remedial action objectives which are discussed in a following section. Background information concerning ARARs is presented below.

3.2 What are ARARs?

Section 121 (d) of the Superfund Amendments and Reauthorization Act of 1986 (SARA) requires remedial actions at Superfund sites to attain the "applicable or relevant and appropriate" requirements of federal and state environmental laws. The recently adopted State Model Toxics Control Act (Initiative 97) requires that remedial actions meet remediation standards at least as stringent as those under Section 121 (d) of SARA. EPA's proposed revisions to the National Contingency Plan and EPA's draft guidance document entitled "CERCLA Compliance with Other Laws Manual" (August 8, 1988 draft - EPA, 1988c) provide information regarding ARARs.

According to the proposed NCP, applicable requirements are those promulgated under federal or state law that specifically address a hazardous substance, contaminant, remedial action, location, or other situation on a Superfund site. Relevant and appropriate requirements are those promulgated under federal and state law that are not directly applicable, but still address problems or situations sufficiently similar to those encountered at a

Superfund site, that their use is well suited to the particular site. For these requirements to apply, they must be both relevant and appropriate which is determined on a case by case basis.

According to EPA's proposed Compliance with Other Laws Guidance Document other non-promulgated policies, guidance, and directives may also be incorporated into the evaluation of remedial actions. These are termed To-be-Considered (TBC) materials which should only be used when ARARs are not adequate to achieve a protective remedy. In our evaluation, TBCs are considered as part of the site risk assessment to assess the necessary level of remediation for protection of health and the environment.

3.2.1 Three Types of ARARs

EPA's draft guidance discusses three types of potential ARARs:

- o Chemical-specific ARARs;
- o Location-specific ARARs; and
- o Action-specific ARARs.

Chemical-specific ARARs include those requirements that regulate the acceptable amount or concentration of a chemical that may be found in or released to the environment. These ARARs are discussed in detail below.

Location-specific ARARs are those requirements that restrict the concentration of hazardous substances or the conduct of activities solely because they occur in special locations. Our evaluation found no location-specific ARARs that are potentially applicable, or relevant and appropriate to the site. These ARARs will not be discussed any further but the sources of location-specific ARARs we considered are summarized in Appendix D.

Action-specific ARARs are those requirements that define acceptable treatment and disposal procedures for hazardous substances being handled or created during the implementation of the remedial action. EPA's draft guidance states that these ARARs should be evaluated later during the development and screening of remedial action alternatives portion of the feasibility study (FS). These are discussed as part of the alternative screening and analysis sections.

3.2.2 Chemical-specific ARARs

Sources for potential ARARs considered include drinking water and aquatic criteria and air quality standards.

Drinking Water Criteria. The regulations listed in the EPA guidance document for chemical-specific ARARs, include the Safe Drinking Water Act (SDWA) regulations. These regulations present water quality standards (contaminant levels) for water used for drinking, cooking, bathing, etc. Maximum contaminant levels (MCLs) are enforceable for public water systems, usually at the point of water usage. Secondary Maximum Contaminant Levels (SMCLs) may be ARARs if they have been adopted by the state as additional drinking water standards; which is the case in Washington State.

Based on the water quality testing completed as part of the remedial investigation and the SDWA drinking water quality standards, the potential ARARs for groundwater listed in Table 3-3 were identified.

Table 3-3 - Applicable Drinking Water Standards

Chemical	Concentration Standard in mg/L	Exceeded On-Site	Exceeded Off-Site
Arsenic	0.050 (a)	Yes	No
Chromium (VI)	0.050 (a)	No	No
Copper	1.0 (b)	No	No
Lead	0.050 (a)	No	No
Zinc	5.0 (b)	No	No
Benzene	0.005	Yes	No
1,2 dichloroethane	0.005	Yes	No
Vinyl chloride	0.002	Yes	Yes

(a) Dissolved Concentration
(b) Secondary MCL

Reference: WAC 173-290 (DRAFT)

Environmental Aquatic Criteria. Several metals were identified as being of concern because they exceed existing aquatic criteria for fresh water. The risk assessment found that the primary risk (although low) to surface water was via metals migration to Johns Creek by stormwater discharge. Table 3-4 lists the metals of concern with their environmental criteria.

Table 3-4 - Summary of Environmental Aquatic Criteria

METALS	Fresh Water Chronic Toxicity in mg/L	Exceeded in Stormwater
Chromium	0.011	No
Copper	0.007	Yes
Lead	0.001	Yes
Nickel	0.088	No
Zinc	0.059	Yes

Note: Concentrations derived using a hardness of 50 mg/L $CaCO_3$.
Reference: 173-201 WAC

Air Quality Standards. Potential ARARs pertaining to atmospheric releases are limited to EPA's air quality standards (40 CFR 50). These standards are relevant and appropriate to the PACCAR site, but have not been promulgated for any of the identified site contaminants except lead. The standard for lead is an airborne concentration not to exceed 1.5 ug/m^3 averaged over a three-month period.

3.3 Application of TBCs to PACCAR Site

In our analysis we considered proposed drinking water standards and various environmental aquatic criteria as TBCs.

Proposed Drinking Water Standards. Standards for various chemicals in drinking water have been proposed but have not been adopted. Both primary and secondary standards are proposed. Primary standards are those which are set to protect human health while secondary standards are those which are set for purposes such as taste, odor, etc. Table 3-5 summarizes existing proposed criteria for chemicals identified to be of concern at the PACCAR site. Guidance for the use of proposed standards for groundwater is contained in the preamble to the proposed NCP Amendment dated December 21, 1988 (EPA, 1988d). This proposed guidance indicates that proposed MCLs should be used when MCLs or state standards do not exist. Because these standards may be adopted in the future they are considered in our evaluation.

Table 3-5 - Summary of Proposed Primary and Secondary Drinking Water Standards

	Proposed Concentration		Exceeded	
	Primary Standards in ppm	Secondary Standards in ppm	On-Site	Off-Site
METALS				
Arsenic	0.030	NPS	Yes	Yes
Lead	0.005	NPS	Yes	Yes
VOLATILES				
Ethylbenzene	0.700	0.030	Yes/ Secondary	No
Toluene	2.0	0.040	Yes/ Secondary	No
Xylene	10.0	0.020	Yes/ Secondary	No
SEMIVOLATILES				
1,2-Dichlorobenzene	0.600	0.010	Yes/ Secondary	No

NPS - No Proposed Standard
Reference: 40 CFR 141, 142, 143:22061-22160

PCBs. A cleanup level of 10 ppm PCBs in soil may be a TBC at the PACCAR site, based on EPA's PCB Spill Cleanup Policy (EPA, 1985b). The policy also recommends a PCB cleanup level of 1 ppm for materials with considerable water contact, such as stream sediments. No other potential TBCs or ARARs for PCB in soil or sediment were identified.

3.4 Remedial Action Objectives Based on Risk Assessment

As discussed above, ARARs are not available for all contaminants and possible exposure pathways of concern at the PACCAR site. In these situations, EPA's draft guidance document recommends that the results of the baseline risk assessment be used to formulate preliminary site remediation goals. These preliminary risk-based objectives are generally referred to by EPA as "points of departure" to be used as a basis to evaluate alternative remedial actions during the feasibility study (FS). These points of departure are calculated using methodologies recognized as TBCs. However, the specific remediation levels for actual remediation activities at the site are determined following consideration of findings from the entire RI/FS. Along with assessments of potential human health and environmental risks, issues such as cost and implementation are often addressed in the final agency determination. Ecology generally follows a similar procedure.

The baseline risk assessment indicates that the PACCAR site poses little public health or environmental risk based on very conservative exposure assumptions. However, to formulate a set of preliminary objectives, the results of the risk assessment were evaluated with respect to guidance in the proposed NCP as discussed below.

Preliminary soil remediation objectives for the PACCAR site were based on the baseline risk assessment. For contaminants such as lead which EPA regulates based on non-carcinogenic effects, the preliminary remediation goal was calculated by comparing upper-bound exposure assumptions with the published reference dose or other appropriate toxicity criteria to derive a Hazard Index. These are detailed in the RI report procedures. If the Hazard Index does not exceed 1.0, then non-carcinogenic adverse health effects are not expected.

Potential carcinogens are evaluated differently. In this case both average and upper-bound exposure conditions are compared against a range of "acceptable risks" generally considered by EPA. Although the risk range considered by EPA may span values for 1 in 10,000 to 1 in 10,000,000, a reasonable target for formulating remedial action objectives can be derived based on the proposed NCP.

The preamble to the proposed NCP specifies that, in evaluating risks associated with remedial alternatives, cumulative site risk to an individual under the "reasonable maximum exposure scenario" should be compared to the 10^{-7} to 10^{-4} lifetime carcinogenic risk range and to the non-carcinogenic Hazard Index of 1.0. The "reasonable maximum exposure" scenario (RME) was excluded prior to formal EPA definition of the RME. However, the RME used in this RI/FS is generally consistent with current EPA and Ecology guidelines. Based on available RI/FS guidance and a review of past EPA Records of Decision at similar sites, the reasonable maximum exposure scenario may generally consider such factors as: 1) potential future land use; 2) the range of potential exposures among the population at risk (e.g., the Most Exposed Individual [MEI]); and 3) statistical variability in the exposure and risk estimates (e.g., probabilistic upper-bound exposures to the MEI). These three issues were addressed in the development of remedial action objectives for the PACCAR site, as discussed below.

Remediation criteria were calculated using two probabilistic definitions of "realistic maximum exposure" of chemicals at the PACCAR site. The first condition evaluated considered the average potential lifetime exposure of the MEI. Use of the MEI scenario, as defined in the risk assessment, represents a common definition of future realistic maximum conditions likely to be encountered at the site. Based on an assessment of current and projected land use within the area, and considering that potential site development plans call for the construction of a major new industrial facility, only future industrial use of the site (with potential off-site residential exposures) was considered realistic in this assessment. These potential exposure conditions are detailed in the RI report. Conservative points of departure were developed for this exposure condition using a target lifetime cancer risk of 10^{-6}, a Hazard Index of 1.0, or other appropriate toxicological criteria (e.g., a soil lead concentration of 1,000 ppm; CDC, 1985).

The second point of departure considered the probabilistic upper-bound (upper 95th percentile) exposure of the MEI, given the range of all exposure factors which formed the basis of the risk assessment. For this upper-bound exposure condition, remediation criteria were developed to achieve an upper-bound target lifetime cancer risk of 10^{-4} and a Hazard

Index of 1.0. In all cases, however, post-remediation chemical concentrations based on an average lifetime cancer risk of 10^{-6} resulted in achievement of the probabilistic upper-bound risk criterion of 10^{-4}. Similarly, all upper-bound Hazard Index values were less than 1.0. The only non-carcinogen to exceed the toxicological criteria was lead (based on the 1,000 ppm soil criterion).

Risk-Based Soil Remediation Criteria

The concentrations of indicator chemicals in potentially exposed (i.e., near-surface) soil media which are required to achieve the specified risk objectives are listed in Table 3-6. Only those exposures which are calculated directly from the soil concentration (i.e., soil ingestion, dermal contact, and inhalation of dusts) were addressed in this analysis. Potential water pathways are considered separately below.

The risk-based soil remediation concentrations are also compared with available chemical-specific TBC criteria for lead (1,000 ppm; CDC, 1985) and PCBs (10 ppm; 40 CFR 761). Existing on-site concentrations and regional background levels are also included for comparison (Table 3-6). These summaries allow for a ready identification of chemicals which currently exceed various alternative criterion concentrations in soil as derived from risk assessment, TBCs, and background comparisons. As discussed in Section 3.2, no ARARs have been identified for the constituents of concern in soil.

As discussed in the RI report, the risk from soil exposure routes at the PACCAR site under conservative, pre-remediation baseline exposure conditions is predominantly attributable to potentially carcinogenic PAHs (CPAHs). Based on achieving an average lifetime MEI cancer risk of 10^{-6} under these conditions, the average CPAH concentration in potentially exposed, on-site, near-surface soils would need to be reduced to 3.5 ppm (Table 3-6). Using the observed on-site correlation ($r^2 = 0.99$) between CPAH and total HPAH, and considering the statistical distribution of HPAH concentrations in surficial soils, remediation of soils above approximately

Table 3-6 - Summary of Risk-Based Remedial Action Objectives for Soil Media

Soil Concentration in mg/kg (ppm) (dry weight)

PARAMETER	Risk-Based Soil Criteria: Average Concentration to Achieve 10-6 Lifetime Cancer Risk	Risk-Based Soil Criteria: Remediation Criterion Resulting in Stated Average (a)	PACCAR Site Near-Surface Soils (Existing Uncovered Areas): Average	PACCAR: Upper 95%	PACCAR: Detection Frequency	Puget Sound Background (b): Average	Puget Sound Background: Upper 95%	Puget Sound Background: Detection Frequency	TBC Criteria	Preliminary Remedial Action Objective
METALS:										
Total Arsenic	6.6	-	18	65	48/48	13	32	88/89	-	32 (c)
Total Chromium	8.3	-	76	279	67/67	43	68	106/106	-	68 (c)
Total Lead	-	-	737	4,811	62/69	32	58	101/101	1,000 (d)	1,000 (d)
ORGANICS:										
CPAHs (e)	3.5	22	19	142	33/38	0.0 J	0.1 J	2/7	-	22 (f)
Total HPAHs (g)	6.7	35	35	239	35/38	0.1 J	0.2 J	5/7	-	35 (f)
Hexachlorobenzene (i)	25	400	< 0.01	< 1.0	0/38	< 0.01	< 0.10	0/7	-	400 (f)
Total PCBs	5.5	92	0.3	2.0	7/30	0.002 J	0.005 J	3/7	10 (h)	10 (h)

NOTES:

a) If soils exceeding this concentration are remediated to approximate background levels, then the target (10-6) site-wide average concentration will be met; calculations performed based on the worst-case assumption that the statistical distribution of soil concentrations are equivalent to existing potentially exposed near-surface soils; see Appendix A.

b) Based on data collected by Seattle METRO and the University of Washington at Pilchuck Tree Farm (Snohomish County), Pack Forest (Pierce County), and Section 24 Site (King County). Data from Harper-Owes, 1985 and METRO, unpublished data.

c) Soil remediation criterion to achieve parity with regional background soil quality.

d) TBC criterion based on a 1,000 ppm total lead concentration in soils which may result in increased blood lead levels in semi-residential and industrial land use areas; CDC (1985), EPA and DSHS, personal communication, 1989.

e) CPAHs denote potentially carcinogenic PAHs (EPA B2 status and above), which include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

f) Soil remediation criterion resulting in achievement of the stated risk-based average concentration.

g) HPAHs refer to total high molecular weight PAHs; risk-based criteria are based on the observed correlation between CPAHs and HPAHs.

h) TBC criterion based on EPA's PCB Spill Cleanup Policy (40 CFR 761) for sites without access restrictions; the 10 ppm PCB criterion for soils is more restrictive than the risk-based criterion.

i) Hexachlorobenzene was not detected in near-surface soils.

35 ppm HPAH would achieve the stated risk target. Additional discussion of the calculation procedure is presented in Appendix A.

Under the pre-remediation baseline exposure assumptions, all Hazard Indices are on-target below 1.0, and not indicative of non-carcinogenic adverse human health effects. In the case of lead, however, the existing probabilistic upper-bound soil concentration of 4,800 ppm exceeds the general TBC criterion of 1,000 ppm for industrial sites (DSHS, 1989; EPA Region 10, 1989; based on CDC, 1985 study of residential sites). Accordingly, some reduction in the on-site lead concentration may be necessary to achieve the TBC risk criteria. The 1,000 ppm criterion was selected as the remedial action objective for this FS.

The risk-based average target concentrations for arsenic and chromium in on-site soils are approximately 7 to 8 ppm (Table 3-6). These calculated targets, however, are below typical background soil concentrations within the Puget Sound region (Harper-Owes, 1985; METRO, 1989). The risk calculations conservatively assume that **all** of the total metal concentration in soil is present in its most toxic form (e.g., hexavalent chromium), since detailed on-site chemical speciation data are generally lacking (see RI report for additional discussion). As a conservative point of departure for this FS, soil remediation objectives for both arsenic and chromium were based on the upper 95th percentile **background** soil concentration. Although these point of departure concentrations are conservative, the location and quantity of soil which exceeds the background arsenic and chromium criteria are generally similar to those exceeding the 1,000 ppm lead target. The on-site concentrations of arsenic and chromium are highly correlated ($r^2 > 0.80$) with lead.

The risk-based remedial action objective for hexachlorobenzene in soil is calculated at approximately 400 ppm (Table 3-6). However, this compound has not been detected in near-surface soils at the PACCAR site. Furthermore, out of 188 samples analyzed for hexachlorobenzene, only two subsurface soil samples exhibited detectable concentrations of this chemical. The maximum concentration in these samples was 16 ppm. The upper-bound risk associated with lifetime exposure to this maximum concentration under the baseline MEI exposure condition is within the general target range of 10^{-7} to 10^{-4}. Based on the infrequent detections and relatively low baseline risk estimates under existing conditions, specific remediation targets for hexachlorobenzene were not considered further in this FS.

The point of departure for PCB remediation of soils at the PACCAR site is 10 ppm PCBs. This value is based on EPA's Spill Cleanup Policy (40 CFR 761), and may be an appropriate TBC criterion for PCB remediation at sites where access may not be controlled. The 10 ppm PCB criterion was developed by EPA using a general risk assessment methodology, although some of the exposure assumptions differed from the site-specific factors developed in the RI report. Although the two criteria are similar, the 10 ppm TBC criterion is somewhat more restrictive than the risk-based value, and was conservatively selected for this FS analysis.

Water Remediation Criteria

Like the above evaluation of soil pathways, existing concentrations of indicator chemicals in on-site waters were compared with both risk-based criteria (targeted goals) and regulatory criteria. For water constituents, regulatory criteria consist of both ARARs and TBCs, as discussed previously. The risk assessment model was used to determine which indicator chemicals individually currently achieve (or do not achieve) the targeted lifetime cancer risk range of 10^{-7} to 10^{-4}, and a Hazard Index of less than 1.0, for water exposure routes only (water ingestion and fish consumption).

The assumptions made regarding the appropriate point of compliance for the risk-based and regulatory criteria should be clearly understood. As presented in detail in the RI report, potential site discharges to the Renton water supply well network and to the Cedar River represent the potential pathways of concern in the baseline MEI scenario for drinking water and fish consumption exposures, respectively. Considerable dilution of waters discharging off-site occurs prior to these receptor locations. The calculated baseline risks to these off-site receptors is well within the risk guideline range. Accordingly, existing conditions meet the risk-based water remediation criteria.

Although the possibility is considered very remote that a future domestic well would be located immediately downgradient of the PACCAR facility, Ecology has requested that all off-site locations be considered potential points of compliance for drinking water quality criteria and standards (e.g., MCLs; Ecology, 1989). Evaluation of groundwater quality data collected at off-site monitoring wells with ARARs and TBCs would form a principal basis for this evaluation. These criteria comparisons were discussed above in Sections 3.2 and 3.3.

3.5 Remedial Action Objectives

Remedial action objectives (RAOs) are proposed for both soil and water. As discussed above they are based on ARARs, TBCs, and the results of the risk assessment. The objectives are summarized in Table 3-7. The basis of including or not including specific constituents are discussed below.

Metals in Soil. Arsenic, lead, and chromium presently exceed risk based criteria in soil (Table 3-6). Concentrations of 30 ppm arsenic and 70 ppm chromium is proposed which are within background concentrations for soil in the Puget Sound area. Remediation of soils exceeding 1,000 ppm lead will generally also achieve the arsenic and chromium objectives.

PCBs in Soil. As discussed above, a TBC of 10 ppm exists for PCBs with a lower target concentration of 1 ppm PCBs for sediments which are in contact with surface water.

Table 3-7 - Preliminary Remedial Action Objectives

Environmental Media	Remedial Action Objective
Groundwater	For Human Health Prevent ingestion of water having arsenic in excess of 0.030 ppm, and lead in excess of 0.005 ppm. Prevent ingestion of water having benzene in excess of 0.005 ppm and vinyl chloride in excess of 0.002 ppm, and a total probabilistic (95th percentile) upper-bound cancer risk for organic chemicals of 1 in 10,000.
Soil	For Human Health Prevent ingestion/direct contact with soil having lead in excess of 1,000 ppm, chromium in excess of 70 ppm, and arsenic in excess of 30 ppm. Prevent ingestion/direct contact with soil having PCBs in excess of 10 ppm, and a total probabilistic (95th percentile) upper-bound cancer risk of greater than 1 in 10,000. Prevent ingestion/direct contact with soil having an average total HPAHs site concentration in excess of 3.5 ppm and a total probabilistic (95th percentile) upper-bound cancer risk of 1 in 10,000. For Environmental Protection Remediate soils containing significant levels of petroleum hydrocarbons. We propose an action level for petroleum hydrocarbons of 5,000 ppm TPHs (as measured by Method 418.1) or 1,000 ppm GC/FID (as measured by Method 8015-extended quantified by phenanthrene response). Soils which exceed 5,000 ppm TPH or 1,000 ppm GC/FID represent about 70 percent of the total mass of petroleum hydrocarbons.
Surface Water	For Environmental Protection Control off-site migration of contaminants in stormwater runoff. Prevent hydraulic contact of surface waters with soils and sediments having a PCB concentration in excess of 1 ppm.

HPAHs in Soil. Under the conservative baseline exposure conditions described in the RI Report, near-surface soil concentrations of CPAHs may exceed the target lifetime risk of 1 in 1,000,000. In order to attain this risk target, a site-wide average concentration of 3.5 ppm CPAHs is proposed. Because of the nature of the previous and proposed industrial facility at the site, workers who could be exposed to site soils (e.g., during maintenance operations) would encounter soils from many different areas of the site. Therefore, the site average criteria is an appropriate risk objective for use in the PACCAR Renton Feasibility Study. Based on a statistical analysis of the data, remediation of soils above approximately 35 ppm HPAH would achieve the stated lifetime cancer risk target.

Petroleum Hydrocarbons in Soil. The risk assessment did not identify petroleum hydrocarbons as posing a risk to those who might be exposed to soils. Most of the soils containing petroleum hydrocarbons consist of low molecular weight PAHs (LPAHs) which do not pose the same risks as the high molecular weight PAHs (HPAHs). In addition, the high concentrations of petroleum hydrocarbons in most of the site soils have not adversely affected site groundwater quality. Where groundwater has been adversely affected by fuel constituents, above-ground or underground tanks were present. However, because of the relatively high concentrations of petroleum hydrocarbons in soils, means to remediate these soils were considered in the Feasibility Study. A remedial action objective of 5,000 ppm TPH (Method 418.1) or 1,000 ppm GC/FID (Method 8015-extended quantified as phenanthrene) were considered. Soil containing the above or greater TPH or GC/FID concentrations represent about 70 percent of the mass of petroleum hydrocarbons on site. For the remainder of this FS, petroleum hydrocarbons concentrations are expressed as GC/FID.

BETX and Other Volatiles in Soil. BETX and other volatile compounds were not detected in most of the soils which lie beneath the PACCAR site (see Figures 6.46 through 6.50 of the Remedial Investigation Report). Of the 150 samples tested during the latest sampling round (summer 1988) BETX compounds were either not detected (84 percent or 126 samples) or were detected at low concentrations of less than 0.17 ppm (10 percent or 15 samples). Only 9 samples (or 6 percent of those tested) had concentrations above 1 ppm total BETX. The concentrations of these samples ranged between 2.4 and 7.3 ppm. Similarly, other volatile compounds such as chlorinated solvents were not detected. Because of the isolated site occurrences of these constituents, an overall remedial action objective is not being proposed. A contingency plan to treat soils disturbed during construction which may contain these and other volatile compounds will be prepared as part of the cleanup action plan.

Metals in Groundwater. Groundwater quality data collected during the latest sampling rounds indicate that arsenic and lead concentrations in groundwater meet existing drinking water standards. However, concentrations exceed the proposed standards for these two metals.

Volatile Organics in Groundwater. Concentrations of benzene and vinyl chloride exceed existing ARARs in monitoring wells located on the site boundary within the Cedar River catchment area for these compounds. Concentrations of vinyl chloride exceed existing ARARs in monitoring wells located just beyond the site boundary. Because ARARs are exceeded, remedial action objectives are proposed for these compounds.

Ethylbenzene, toluene, and total xylenes meet proposed primary drinking water standards but proposed secondary standards are exceeded in on-site groundwater. Specific objectives for these constituents are not proposed because no water supply wells have the potential to be impacted by these constituents. The concentrations are below proposed standards to protect public health, and remediation for benzene will also reduce the concentrations of these associated constituents.

A specific remedial action objective for 1,2-dichloroethane is not being proposed because the existing standard of 0.005 ppm is exceeded in only one monitoring well in the interior of the property (LW-3S). Monitoring wells downgradient of LW-3S have not detected this compound.

Semivolatile Organics in Groundwater. The concentration of only one semivolatile organic chemical was found to exceed an existing or proposed water quality standard. 1,2-dichlorobenzene concentrations meet the proposed primary standard of 0.600 ppm but the concentration of 0.014 ppm exceeds the proposed secondary standard of 0.010 ppm. A remedial action objective for this compound is not being proposed because it was detected in a monitoring well in the interior of the property (LW-3S). Monitoring wells downgradient of LW-3S have not detected this compound and a later sampling indicates a concentration of 0.006 ppm which is below the proposed secondary standard.

Metals in Stormwater Runoff. Stormwater runoff from the site is similar to runoff from urban areas in western Washington. The major potential for off-site migration of metals from the site is via erosion and particulate transport of site soils containing metals by runoff. Specific concentrations are not proposed because of the similarity of the runoff to urban areas. However, a general objective is proposed because it is desirable to improve the quality of runoff from the site.

Process for Identifying Chemicals of Concern

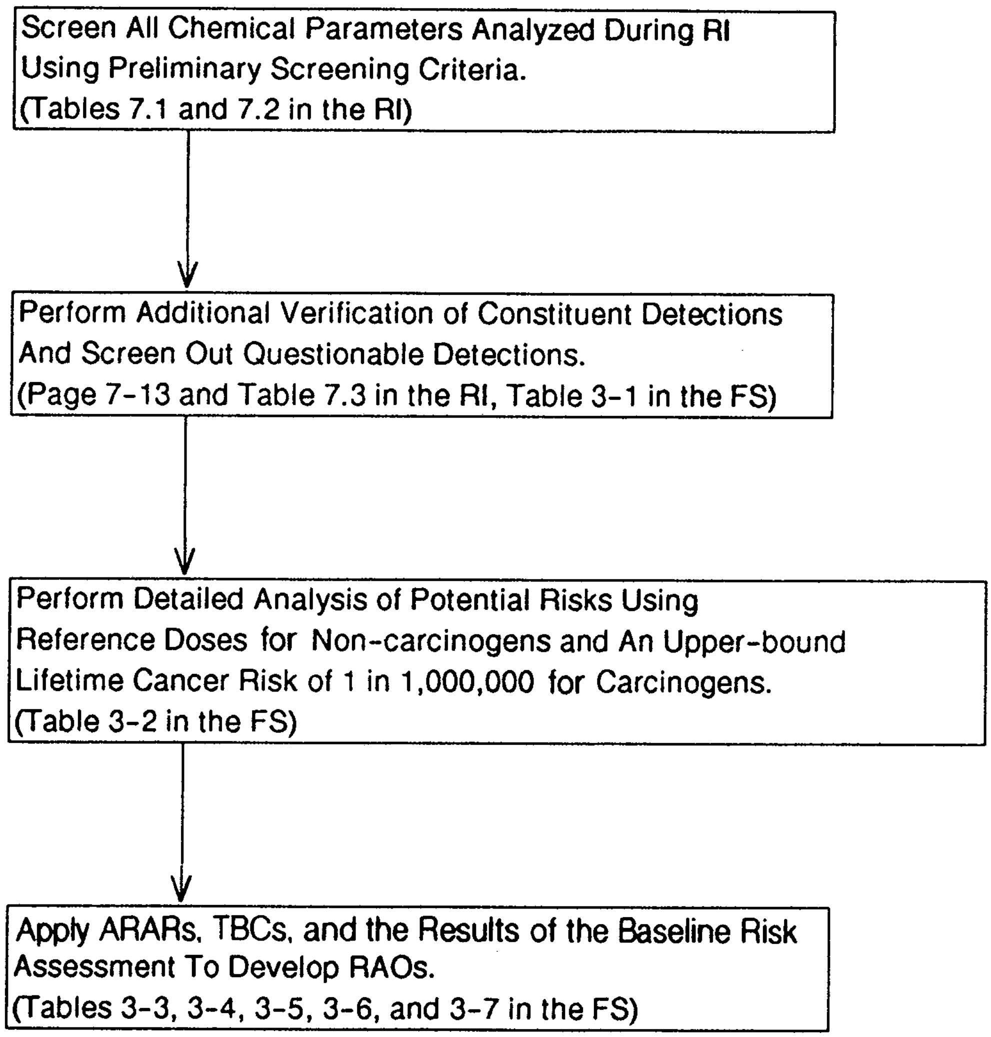


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Figure 3-1

4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

4.1 Outline of Approach

4.1.1 Identify and Evaluate Technologies by Media/Contaminants

We approached the development of remedial alternatives by first identifying general response actions and available technologies applicable to the types of media in which the contaminants exist. The available technologies were then evaluated with respect to the types of contaminants within each media to form alternatives, which were in turn, evaluated with respect to selected criteria (as discussed in following report sections). Table 4-1 lists the media and contaminants we considered in completing the FS. A flow chart showing this step and subsequent steps in the FS process is shown on Figure 4-1.

Table 4-1 - Media and Contaminants Considered in FS

Media	Contaminants
o Soil	Metals (Pb, As, Cr); Petroleum Hydrocarbons; HPAHs; PCBs
o Groundwater	Metals (Pb, As); vinyl chloride; benzene
o Surface Water	Metals (Cu, Zn)
o Sediments	PCBs

Note: HPAHs - High Molecular Weight Polycyclic Aromatic Hydrocarbons
PCBs - Polychlorinated Biphenyls

4.1.2 Interrelationship between Media

With the exception of surface water, the media were evaluated independently of each other based on the results of the risk assessment which identified media, contaminants, and exposure pathways of concern. For example the risk assessment indicates that the greatest risk from soil contaminants is from ingestion or inhalation (of dust) so alternatives were developed to reduce this potential exposure. The available data indicates that additional soil remediation has the potential to provide an overall beneficial impact on groundwater quality. As discussed in Section 1, concentrations of volatile and semivolatile chemicals have declined in several wells as a result of past site remediation such as removing underground storage tanks. Additional soil remediation, such as in the LW-3 area, will remove, stabilize or contain primary potential sources of contamination to groundwater which should result in improved groundwater quality. Groundwater monitoring which will be conducted, in part, to assess changes in groundwater quality will be part of the selected remedial alternative.

Specific remedial alternatives were not developed for surface water because remediation of soil and sediments will have a desirable impact on surface water quality. The proposed remedial alternatives consider methods to remove contaminated sediments from water contact and prevent erosion of site soils.

4.2 General Response Actions

In the first step of the feasibility study process we identified general response actions which will meet the remedial action objectives.

General response actions are broad categories of remedial measures used to reduce the exposure of humans and the environment to contaminants. These include measures used to reduce the mobility, toxicity, or volume of contaminants.

We identified separate sets of general response actions for soil, groundwater, and sediments. General response actions pertaining to surface water were included in the response actions for soil.

Each general response action includes one or more remediation technologies, each of which includes one or more process options.

The general response actions for soil, groundwater, and sediments are discussed below.

4.2.1 Soil Response Actions

We addressed the following general response actions for soil:

- **Baseline Condition with Monitoring.** This action would include monitoring fugitive dust emissions. Potential exposure would be reduced by providing a health and safety plan for excavation activities on site.

- **Institutional Controls.** This action would reduce potential exposure by restricting use and access to the site.

- **Containment/Isolation.** This action would reduce potential exposure by covering and protecting soil. Containment/isolation action would be taken at specific areas of the site with contaminant concentrations above the remedial action objectives. Grading and vegetation would be components of covering.

- **Surface Water Collection and Control.** This action would use grading and ditches to reduce migration of soil contaminants via surface water. It would be taken at specific areas where soil contaminant concentrations are above the remedial action objectives.

- **Excavation and Disposal.** This action would remove contaminated soils to an appropriate landfill. It would be taken at specific areas where soil contaminant concentrations are above the remedial action objectives and on-site treatment is not practical or feasible.

- **Excavation and Treatment.** This action would reduce the toxicity of contaminated soils. It would be taken at specific areas where soil contaminant concentrations are above the remedial action objectives. Specific treatment technologies are discussed in Subsection 4.4.

- **Excavation and Stabilization.** This action would reduce mobility of contaminants in soil. It would be taken at specific areas where soil contaminant concentrations are above the remedial action objectives.

- ***In Situ* Stabilization.** This action would reduce mobility of contaminants in soil. It would be taken at specific areas where soil contaminant concentrations are above the remedial action objectives.

4.2.2 Groundwater Response Actions

We addressed the following general response actions for groundwater:

- **Baseline Condition with Monitoring.** This action would include monitoring groundwater quality. This action would encompass off-site and on-site areas. Monitoring would include shallow and deep water-bearing zones.

- **Institutional Controls.** This action would reduce potential exposure by restricting use of groundwater at the site and within the Cedar River catchment area.

- **Diversion/Containment.** This action would reduce potential migration of contaminants in groundwater by diverting clean groundwater away from contaminated areas, and containing contaminated groundwater. This action would be taken at specific areas determined by the hydrogeologic system and the distribution of contaminants in groundwater.

- **Pumping** and **Treatment.** This action would reduce potential exposure by removing contaminated groundwater from the water-bearing zones and treating, if required, prior to discharge to a permitted source. It would be taken at specific areas on site where contaminant concentrations are above the remedial action objectives.

- ***In Situ*** **Treatment.** This action would reduce the toxicity of contaminants in groundwater. It would be taken at specific areas on site where contaminant concentrations are above the remedial action objectives.

4.2.3 Sediment Response Actions

We addressed the following general response actions for sediments:

- **Baseline Condition with Monitoring.** This action would include monitoring the quality of surface water migrating off site. Potential exposure would be reduced by providing a health and safety plan for excavation activities in areas with contaminated sediments.

- **Institutional Controls.** This action would reduce potential exposure by restricting use and access to the area containing contaminated sediments.

- **Containment/Isolation.** This action would reduce potential exposure by covering and protecting sediment. Containment/isolation action would be taken at specific areas where sediment contaminant concentrations above the remedial action objectives.

  Grading and vegetation would be components of covering.

- **Excavation and Disposal.** This action would remove contaminated sediments to an appropriate landfill. It would be taken at specific areas where sediment contaminant concentrations are above the remedial action objectives.

4.3 Identification of Volumes

We identified the volumes of groundwater, soil, and sediments to which remedial actions might be applied. These volume estimates were used as a common basis to evaluate the applicability, implementability, and cost of technologies and alternatives. Table 4-2 shows volume estimates for groundwater, soil, and sediment which may exceed the remedial action objectives. Table 4-3 shows volume estimates for soil representing 50 percent of the mass of contaminants and for source control areas. We used data and contour maps from the remedial investigation to estimate these volumes. The contour maps were based on continuous first derivative interpolation of spot concentration data. This computer contouring technique was judged to be a consistent approach yielding representative contours.

Volume estimates for soil assume remediation of only the fill soil above the silt layer. In general, it is the fill soils that contain chemical concentrations greater than the RAOs or other action levels. Therefore, in order to protect the silt layer as much as possible, remediation would generally only include the fill soils above the silt layer. The depth of the silt layer (where it exists) ranges from about 1 to 8 feet below existing ground surface.

Table 4-2 - Estimated Groundwater, Soil, and Sediment Volumes Exceeding Remedial Action Objectives

Groundwater	Pumping Volumes in Gallons per Minute
Shallow Zone (30 to 40 feet) along Garden Avenue (Cedar River Catchment)	50
Deep Zone (130 feet) along Garden Avenue (Cedar River Catchment)	150
TOTAL	200

Soil	In-place Volume in Cubic Yards
Petroleum Hydrocarbons: GC/FID (8015-ext.) > 1,000	20,000
HPAH > 35 ppm*	19,000
Lead > 1,000 ppm AND Chromium > 70 ppm	91,000
Arsenic > 30 ppm	21,000
Mixed Petroleum Hydrocarbons, HPAH, Lead, Chromium, and Arsenic	23,000
PCB > 10 ppm	700
TOTAL	175,000

Sediment	In-place Volume in Cubic Yards
PCB > 1 ppm	700**

*Remedial action for soil with HPAH concentrations greater than 35 ppm results in meeting the RAO of a site-wide average carcinogenic PAH concentration of 3.5 ppm. See Appendix A.
**Based on one sample.

Table 4-3 - Estimated Soil Volumes Representing Source Control Areas and 50 Percent of the Mass of Contaminants

	In-place Volume in Cubic Yards
Petroleum Hydrocarbons: GC/FID (8015-ext.) >2,500 ppm and source control areas at well LW-3 and R&D UST	7,800
HPAH > 800 ppm	300
Lead > 8,000 ppm AND Chromium > 600 ppm	14,700
Arsenic > 100 ppm and source area at U-2**	5,700
Subtotal	28,500
Dangerous Waste (lead) Area	10
PCB > 10 ppm*	700
TOTAL	29,210

*Soil with PCBs greater than 10 ppm is located in one area on site. Therefore, all of this soil is considered a hot spot and all of the PCB soil volume exceeding the RAO is included.
**U-2 refers to grid location as shown on various site plans.

Appendix A describes the methods used for estimating these volumes. Actual volumes will depend on the actual distribution of contaminants. As a result, actual volumes will likely vary from the estimates presented herein.

4.4 Identification and Screening of Technologies

4.4.1 Identification of Remedial Technologies

We identified remedial technologies for the general response actions from a variety of sources such as Superfund guidance documents (EPA, 1985a; EPA, 1988b), standard engineering practices, current literature on innovative technologies, technology vendors, and our experience. Table 4-4 lists the technologies we have identified. These technologies are categorized by the general response action.

Table 4-4 - Identification and Screening of General Response Actions, Technologies, and Process Options (Sheet 1 of 8)

FORMAT
GENERAL RESPONSE ACTION

x.x Technology
Process Option

GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS	APPLICABILITY TO PACCAR SITE
1. BASELINE CONDITION WITH MONITORING	Potentially applicable.
2. INSTITUTIONAL CONTROLS	All technologies potentially applicable.
2.1 Fencing	
2.2 Deed Restrictions	
2.3 Zoning Restrictions	
2.4 Water Well Use Restrictions	
3. CONTAINMENT/ISOLATION	
3.1 Capping (Soil, sediment, water) Synthetic Membranes Structural Fill Clay Asphalt Concrete Chemical Sealants	All technologies potentially applicable.
3.2 Grading Scarification Contour Furrowing Slope Modification	Not applicable except as necessary for other technologies. Grading is applicable at sites where erosion from steep slopes is a problem. The PACCAR site does not have steep slopes.

Table 4-4 (continued) (Sheet 2 of 8)

GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS	APPLICABILITY TO PACCAR SITE
3.3 Revegetation (Soil, sediment, water) Grasses Legumes Shrubs with shallow root systems	Potentially applicable.
Shrubs with deep root systems Trees	Not applicable for shallow soil cover.
3.4 Retaining Dikes and Berms (Sediment)	Not applicable except as necessary for other technologies.
4. SURFACE WATER COLLECTION AND CONTROL 4.1 Dikes and Berms 4.2 Channels 4.3 Terraces 4.4 Sedimentation Ponds 4.5 Storm Drainage System	Not applicable except as necessary for other technologies.
5. GROUNDWATER DIVERSION/CONTAINMENT	
5.1 Groundwater Pumping Well Point System Deep Well System	All technologies potentially applicable.
5.2 Subsurface Drains French Drains Tile Drains	Questionable applicability due to site topography. The PACCAR site may be too flat for drainage to be effective.

Table 4-4 (continued) (Sheet 3 of 8)

GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS	APPLICABILITY TO PACCAR SITE
5.3 Subsurface Barriers	Potentially applicable.
Slurry Walls	
Grouting	
Sheet Piling	Not applicable because of depth limitations.
Bottom Sealing	
6. EXCAVATION AND REMOVAL FROM SITE (SOIL, SEDIMENT)	
6.1 Excavation of Waste and Soil	
Backhoe	Potentially applicable.
Crane and Clamshell	
Front-end Loader	
Pump	Not applicable. These process options apply to sludges, drums, and solids, and are not applicable to the soils or sediments at the PACCAR site.
Industrial Vacuums	
Drum Grapplers	
Forklift	
6.2 Dredging of Sediment	
Mechanical Dredging	Potentially applicable.
Hydraulic Dredging	Not applicable. Volume of sediment too small.
Pneumatic Dredging	Not applicable. Volume of sediment too small.
6.3 Off-Site Disposal	Potentially applicable.
Hazardous Waste Landfill	
Sanitary Landfill	
Special Use Landfill	
Debris Landfill	
Land Application	
6.4 Off-Site Treatment	Potentially applicable.

Table 4-4 (continued) (Sheet 4 of 8)

GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS	APPLICABILITY TO PACCAR SITE
7. EXCAVATION AND ON-SITE STORAGE OR DISPOSAL	
7.1 On-Site Land Disposal Temporary Storage Permanent Placement	Potentially applicable. May be able to use certain treated and untreated soils as structural fill.
Surface Impoundments Waste Piles Deep-Well Injection Land Application of Liquid Wastes	Not applicable because of site use and shallow groundwater.
8. IN SITU TREATMENT (Soil and Groundwater)	
8.1 Physical treatment Soil venting (ambient and heated)	Potentially applicable.
8.2 Bioreclamation Aerobic biological treatment	Potentially applicable.
8.3 Chemical Treatment Soil Flushing	Not applicable. Site topography and geology not suited for soil flushing and drainage. No free product on-site.
8.4 Solidification/Stabilization	Potentially applicable.
8.5 Thermal Treatment Vitrification	Not applicable because high strength of vitrified soil not compatible with site use. Also not applicable because of shallow groundwater. Process used for recalcitrant contaminants such as PCBs and dioxins.
9. ABOVE-GROUND TREATMENT OF SOLIDS (Excavate and Treat Soils)	
9.1 Physical Treatment Separation Magnetic Screening Crushing Drying	Potentially applicable.

Table 4-4 (continued) (Sheet 5 of 8)

GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS	APPLICABILITY TO PACCAR SITE
Solvent Extraction Soil Washing (Water, acid or other solutions) Leaching Dewatering	
9.2 Chemical Treatment Neutralization Precipitation Oxidation Reduction	Potentially applicable.
Photolysis Gamma Irridation De-chlorination	Not applicable for constituents in soil and sediment on-site.
9.3 Stabilization/Solidification Cement-Based Solidification Silicate-Based Solidification (Pozzolanic) Thermoplastic Solidification Surface Microencapsulation	Potentially applicable.
Sorbents	Not applicable. Sorbents used for liquids. No liquids on-site.
9.4 Thermal Treatment Low Temperature Volatilization Incineration: Rotary Kiln Multiple Hearth Fluidized Bed Cement Kiln	Potentially applicable.
Molten Glass Plasma Systems	Not applicable. These processes used for PCB and dioxin destruction, concentrated wastes.

Table 4-4 (continued) (Sheet 6 of 8)

GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS	APPLICABILITY TO PACCAR SITE
Wet-Air Oxidation Liquid Injection Lime Kiln Aggregate Kiln Industrial Boiler	Not applicable. These processes used for liquids and concentrated wastes.
9.5 Biological Treatment Land Treatment (Spreading in Lifts) Composting (Piles) Slurry Treatment (Above-ground Bioreactor)	Potentially applicable.
10. ABOVE-GROUND TREATMENT OF WATER	
10.1 Groundwater Pumping Wells Well Points Trenches	Potentially applicable.
10.2 Physical Treatment Air Stripping Flocculation Sedimentation Filtration Membrane Filtration (Reverse Osmosis) Adsorption Ion Exchange	Potentially applicable.
Phase Separation of Surface Waters	Phase separation may be applicable to surface waters which contact TPH-contaminated soil during remediation activities.
Evaporation Electrolytic Refining Solvent Extraction Steam Stripping	Not applicable. Evaporation, Electrolytic Refining, and Solvent Extraction not applicable because of the low concentrations of contaminants in groundwater at the site. Steam

Table 4-4 (continued) (Sheet 7 of 8)

GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS	APPLICABILITY TO PACCAR SITE
Phase Separation of Groundwater	Stripping not applicable for contaminants on-site. Phase Separation not applicable to groundwater because no free-floating product has been observed in groundwater.
10.3 Chemical Treatment Precipitation (coagulation) Neutralization Oxidation Reduction Photolysis (ultraviolet treatment) Irradiation Electrolysis	Potentially applicable.
10.4 Biological Treatment Aerobic Treatment Activated Sludge (CSTR) Fixed-Film Treatment	Potentially applicable.
Anaerobic Treatment	Not applicable for contaminants in groundwater at the PACCAR site.
11. AIR POLLUTION CONTROLS AND MONITORING	
11.1 Site Perimeter Monitoring for Air and Dust Quality	Potentially applicable.
11.2 Control of Gaseous Emissions to the Atmosphere Covers Active Interior Gas Collection/Recovery System Active Perimeter Gas Control Systems Passive Perimeter Gas Control Systems	Not applicable because only negligible gas emissions from soils on-site.
11.3 Fugitive Dusts Dust Suppressant Wind Fences/Screens	Potentially applicable only as related to technologies or response actions for soil and sediment.

Table 4-4 (continued) (Sheet 8 of 8)

GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS	APPLICABILITY TO PACCAR SITE
12. ABOVE-GROUND TREATMENT OF GASES	
12.1 Physical Treatment Carbon Adsorption Wet Scrubbing	Potentially applicable only as related to technologies or response actions for groundwater.
12.2 Chemical Treatment Oxidation Reduction Internal Combustion Catalytic Conversion Photolysis (ultraviolet treatment)	Potentially applicable only as related to technologies or response actions for groundwater.
12.3 Biological Treatment Biological Wet Scrubbing Fixed-Film Treatment	Potentially applicable only as related to technologies or response actions for groundwater.

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Under each technology we have listed some process options. The final column in the table provides comments on the applicability to the PACCAR site of the technologies and process options.

Refer to Appendix B for more detailed descriptions of remedial technologies.

It is important to understand that many process options within a technology type can be combined. For example, Above-Ground Physical Treatment of Water may combine a filtration process followed by an air stripping process.

4.4.2 Screening of Remedial Technologies

The applicable technologies from Table 4-4 were refined to better fit the PACCAR site conditions and screened using three criteria:

- o Effectiveness;
- o Implementability; and
- o Cost-Effectiveness.

Effectiveness. We evaluated process options based on their effectiveness relative to other process options within a technology type. This procedure eliminated the less effective processes while retaining a wide range of remedial technologies.

Our effectiveness evaluation focused on four areas:

- o The ability of the process option to handle the area and volume of contaminated material;
- o The ability of the process option to meet the remedial action objectives;
- o Protection of human health and the environment during the construction and implementation phase; and
- o How proven and reliable the process option is.

Implementability. The implementability criterion addresses the question: can the process option be built/used? Specific issues included in this criterion are:

- o Ability to obtain permits for off-site activities;

- o Availability of treatment, storage, and disposal services; and

- o Availability of equipment and skilled workers.

Cost-Effectiveness. We used cost-effectiveness in a general way only during this phase of the feasibility study. We evaluated each process option as to whether its capital and operation/maintenance costs, relative to other process options within a technology type, are high, medium, or low.

Screening of Remedial Technologies. Table 4-5 presents a summary of our screening of the applicable process options from Table 4-4. Table 4-5 discusses how well each process option meets the three criteria. Table 4-5 is based on the detailed discussions of the technologies in Appendix B. Technologies or process options retained for alternative development are indicated in Table 4-5. To simplify the subsequent development of alternatives, one representative process was selected, if possible, for each technology type. These representative processes provided a basis for evaluating alternatives, but do not limit flexibility during remedial design. The specific process used to implement a remedial action may not be selected until the remedial design phase.

Groundwater Diversion. A slurry wall was retained over pumping wells since pumping wells would require continued operation and associated higher operating and maintenance costs.

Groundwater Containment. A deep slurry wall was retained as the process option for the perimeter subsurface wall. It was judged to have good effectiveness, while grouting -- the other process option -- was judged to have only fair effectiveness. Implementability and cost of these process options were similar.

Groundwater Treatment. For treatment of arsenic and lead, all six process options were retained because these process options can be combined during optimization of the treatment process. We have completed a treatability study for arsenic and lead in groundwater. The results of this study indicated that these process options are applicable for treatment of

Table 4-5 - Screened List of Technologies (Sheet 1 of 9)

(A) GROUNDWATER

REMEDIAL ACTION OBJECTIVES: ARSENIC AND LEAD

Note: * indicates technology or process option retained for alternative development

General Response Actions	Technologies	Process Options	Effectiveness	Implementability	Cost Capital/O&M
Monitoring (FS-No Action Alternative)	Monitoring	*Groundwater Wells	Does not achieve remedial action objectives (RAOs)	Readily implementable	Low/Low
Institutional Controls	Restrict Use	*Deed or Zoning Restrictions	Effective at reducing exposure. Does not reduce contamination.	Readily implementable on site; more difficult off site.	Low/Low
Diversion	Subsurface Barriers	*Slurry Walls with Upgradient Interceptor trenches or wells	Effective at diverting groundwater if deep; less effective if shallow. May not meet all RAOs.	Readily implementable conventional methods available.	High/Low
Diversion	Groundwater Pumping	Well Point System Deep Well System	Effective at diverting groundwater. May not meet all RAOs.	Readily implementable conventional methods available. Treatment may be required.	High/High
Containment	Perimeter subsurface wall	*Deep Slurry wall (Approx. 120 feet deep)	Effective at containment. Meets all groundwater RAOs.	Readily implementable using conventional methods. May require other technologies such as capping.	High/Low
Containment	Perimeter subsurface wall	Grouting (Curtain wall)	Fair at containment. Meets most groundwater RAOs.	Readily implementable using conventional methods available. May require other technologies such as capping.	High/Low
Groundwater Treatment	Groundwater Pumping	*Wells, well points, trenches	Meets remedial action objectives if coupled with groundwater treatment.	Uses conventional methods.	Medium/Low

Table 4-5 (cont'd) (Sheet 2 of 9)

General Response Actions	Technologies	Process Options	Effectiveness	Implementability	Cost Capital/O&M
(A) GROUNDWATER					
REMEDIAL ACTION OBJECTIVES: ARSENIC AND LEAD					
Groundwater Treatment	Physical Treatment	*Ion Exchange	May be effective for low levels of metals. Yields concentrate requiring further treatment.	Commercially available, but must be bench tested for effectiveness.	Medium/Medium
Groundwater Treatment	Physical Treatment	*Filtration	May be effective for removal of metals associated with suspended solids.	Uses conventional methods.	Low/Medium
Groundwater Treatment	Physical Treatment	*Membrane Filtration	Membrane filtration may be effective for low levels of metals. Yields concentrate requiring further treatment.	Commercially available, but must be bench tested for effectiveness.	Medium/Low
Groundwater Treatment	Physical Treatment	*Adsorption	May be effective for low levels of metals. Yields solid waste.	Commercially available, but must be bench tested for effectiveness.	Low/High
Groundwater Treatment	Chemical Treatment	*Oxidation - reduction	May not be effective for very low levels of metals. Effective for treatment of concentrate. Yields sludge.	Commercially available, but must be bench tested for effectiveness.	Medium/Medium
Groundwater Treatment	Chemical Treatment	*Precipitation/ Electro-refining	May not be effective for very low levels of metals. Effective for treatment of concentrate. Possible recycling of lead. Yields sludge.	Commercially available, but must be bench tested for effectiveness.	Medium/Medium

Table 4-5 (cont'd) (Sheet 3 of 9)

General Response Actions	Technologies	Process Options	Effectiveness	Implementability	Cost Capital/O&M
(A) GROUNDWATER					
REMEDIAL ACTION OBJECTIVES: **VINYL CHLORIDE, BENZENE** Same as arsenic and lead except as below					
Groundwater Treatment	Physical Treatment	Adsorption	Used alone may not be effective for removal of vinyl chloride.	Uses conventional methods.	Low/High
Groundwater Treatment	Chemical Treatment	Chemical Oxidation	Effective.	Commercially available, requires bench-scale testing.	Medium/High
Groundwater Treatment	Chemical Treatment	Photolysis	May be effective if turbidity is low.	Commercially available, requires bench-scale testing for design.	Medium/High
Groundwater Treatment	Physical Treatment	*Air Stripping	Effective.	Uses conventional methods. May require air pollution control.	Low/Medium
Groundwater Treatment	Biological Treatment	Aerobic Treatment	May not be effective for very low levels.	Commercially available, requires bench-scale testing for effectiveness.	Medium/Medium
In situ Treatment	Bioreclamation	*Aerobic Biological Treatment	May not be effective for very low levels. In situ control of process is difficult. Not effective for metals.	Not commercially available. Requires on-site testing site specific process development.	Medium/Low
(B) SOIL					
REMEDIAL ACTION OBJECTIVES: **ARSENIC, LEAD, AND CHROMIUM**					
No action	Monitoring	*Fugitive Dust Instrumentation	Does not achieve RAOs.	Readily implementable.	Low/Low

Table 4-5 (cont'd) (Sheet 4 of 9)

General Response Actions	Technologies	Process Options	Effectiveness	Implementability	Cost Capital/O&M
(B) SOIL					
REMEDIAL ACTION OBJECTIVES: ARSENIC, LEAD, AND CHROMIUM					
Institutional Controls	Restrict Use	*Deed or zoning restrictions Fencing On-site Health and Safety Programs	Effective at reducing exposure. Does not reduce contamination.	Readily implementable.	Low/Low
Containment	Capping	*Geomembrane (and protective cover soils)	Effective at reducing exposure. Does not reduce contamination. Must integrate with future site use.	Readily implementable. Conventional methods available.	Medium/Medium
Containment	Capping	Clay (and protective cover soils)	Effective at reducing exposure. Does not reduce contamination. Must integrate with future site use.	Readily implementable. Conventional methods available.	Medium/Medium
Containment	Capping	*Structural Fill (with and without landscaping cover)	Effective at reducing exposure. Does not reduce contamination. Must integrate with future site use. Does not prevent infiltration of rainwater.	Readily implementable. Conventional methods available.	Medium/Low
Containment	Capping	*Paving (concrete or asphalt)	Effective at reducing exposure. Does not reduce contamination. Meets future site use.	Readily implementable. Conventional methods available.	Medium/Low

Table 4-5 (cont'd) (Sheet 5 of 9)

General Response Actions	Technologies	Process Options	Effectiveness	Implementability	Cost Capital/O&M
(B) SOIL					
REMEDIAL ACTION OBJECTIVES: ARSENIC, LEAD, AND CHROMIUM					
Containment	Capping	Chemical Sealants	Fair at reducing exposure. Does not reduce contamination. May need other components to integrate with future site use.	Readily implementable. Conventional methods available.	Medium/Medium
Containment	Grading	*Additional on-site fill	Effective at reducing erosion. Does not reduce contamination.	Readily implementable.	Low/Low
Containment	Vegetation	*Grasses/Legumes	Effective at reducing erosion. Does not reduce contamination.	Readily implementable.	Low/Low
Surface Water collection/ control	Dikes and berms, channels, terraces, sedimentation ponds, storm drainage system	*	Effective at reducing infiltration. Does not reduce contamination.	Readily implementable.	Low/Low
Excavate and dispose	Mechanical equipment	*Contain on-site or dispose at suitable off-site landfill	Effective at reducing exposure. Reduces contamination on-site. Does not reduce overall contamination.	Readily implementable. May carry future liability of off-site disposal.	High/Low
Excavate and Treat	Physical Treatment	Magnetic Separation Screening Crushing Dewatering	Effective for preparing soil prior to treatment. Significant volume reductions can be achieved by removing clean fractions.	Readily implementable. Methods commercially available.	High/High

Table 4-5 (cont'd) (Sheet 6 of 9)

General Response Actions	Technologies	Process Options	Effectiveness	Implementability	Cost Capital/O&M
(B) SOIL					
REMEDIAL ACTION OBJECTIVES: ARSENIC, LEAD, AND CHROMIUM					
Excavate and Treat	Physcial Treatment, chemical treatment - (reuse soil on-site)	*Soil washing (solvent extraction)	Prototype studies have been effective for removing contaminants. Sludge produced.	Methods not commercially available. Requires additional testing and process development.	High/High
		*Soil leaching	Prototype studies have been effective for removing contaminants. Slow process. Limited effectiveness in fine-grained soils. Sludge produced.	Methods not commercially available. Requires additional testing and process development.	Medium/Medium
Excavate and Stabilize	Mechanical equipment, physical solidification/ stabilization	*Cement or chemical encapsulation	Effective at reducing exposure and mobility. May not reduce contamination.	Readily implementable. Uses conventional methods.	High/Low
In situ Treatment	Solidification/ Stabilization	*Cement or chemical encapsulation by pressure grouting	Effective at reducing exposure and mobility. May not reduce contamination.	Would require new techniques available from limited sources.	High/Low

REMEDIAL ACTION OBJECTIVES: PCBs
Same as lead and chromium (presented above) except:

No excavation and treatment considered because volume too small.

Table 4-5 (cont'd) (Sheet 7 of 9)

General Response Actions	Technologies	Process Options	Effectiveness	Implementability	Cost Capital/O&M
(B) SOIL					
REMEDIAL ACTION OBJECTIVES: HPAH and TPH Same as arsenic, lead, and chromium except as below					
Excavate and treat	Physical Treatment	Soil washing	Prototype studies have been effective for removing contaminants. Materials handling difficult.	Methods not commercially available. Requires further testing and process development.	High/High
Excavate and Treat	Biological Treatment	*Land bio-treatment	Effective for treatment of TPH. Effectiveness may be limited for HPAH. Metals may interfere with process.	Uses conventional land treatment technology. Further testing for metals interference required.	Low/Medium
Excavate and Treat	Biological Treatment	*Slurry bio-treatment	Effective for rapid treatment of TPH. Effectiveness may be limited for HPAH. Metals may interfere with process.	Uses conventional biological treatment technology. Further testing for metals interference required.	Medium/Medium
Excavate and Treat	Thermal Treatment	Incineration	Effective in destroying organic contaminants. Off-gasses may require treatment for metals.	Uses conventional methods. Mobile units are available.	High/High
Excavate and Treat	Thermal Treatment	*Low-temperature volatization	Effective for removal of organic contaminants.	Commercially available. Requires additional testing for HPAH effectiveness. Difficult to implement for wet soil.	High/High

Table 4-5 (cont'd) (Sheet 8 of 9)

General Response Actions	Technologies	Process Options	Effectiveness	Implementability	Cost Capital/O&M
(B) SOIL					
REMEDIAL ACTION OBJECTIVES: HPAH and TPH					
In situ treatment	Bio-remediation	*Land treatment and deep tilling	Effective in removing TPH. Possibly less effective for removing HPAH.	Special equipment required. Access may be a problem due to utilities and pavement.	Low/High
In situ Treatment	Physical Treatment	*Heated Soil Venting	Prototype studies have been effective for removing organic contaminants. Not yet shown effective for HPAHs.	Methods not commercially available. Requires additional testing and process development.	High/Low
(C) SEDIMENTS					
REMEDIAL ACTION OBJECTIVES: PCBs					
No action	Monitoring	*Monitor sediment quality at property line.	Does not meet RAOs.	Readily implementable.	Low/Low
Containment	Vegetation	*Establish grass-lined ditches	Effective at limiting sediment transport.	Readily implementable.	Low/Low
Surface water collection and control	Fill or line existing ditches	Concrete	Effective at limiting sediment transport.	Readily implementable.	Low/Low
		Asphalt	Effective at limiting sediment transport.	Readily implementable.	Low/Low
		Clay (with protective soils)	Effective at limiting sediment transport.	Readily implementable.	Low/Low

Table 4-5 (cont'd) (Sheet 9 of 9)

General Response Actions	Technologies	Process Options	Effectiveness	Implementability	Cost Capital/O&M
(C) SEDIMENTS					
REMEDIAL ACTION OBJECTIVES: PCB					
		Geomembrane (with protective soils)	Effective at limiting sediment transport.	Readily implementable.	Low/Low
		*Granular fill with geotextile	Effective at limiting sediment transport.	Readily implementable.	Low/Low
Excavate and contain/ dispose	Contain on-site	*Contained pile	Meets RAOs.	Readily implementable.	Medium/Low
Excavated and Dispose	Off-site disposal	*Suitable landfill	Meets RAOs.	Readily implementable. May carry future liability.	High/N.A.

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NOTE: * indicates technology or process option retained for alternative development.

arsenic and lead in groundwater. The results of this study will be reported in a separate document. For treatment of vinyl chloride and benzene, air stripping was retained as a representative process option because of its proven effectiveness, implementability, and lower costs.

Soil Containment. Capping options of structural fill, geomembrane, and paving were retained because we judged them to be equally effective as clay with superior ease of implementation. Imported structural fill (sand and gravel) would be effective in reducing dust and exposure to soil with contaminants.

Soil Stabilization. Excavation and stabilization using cement or chemical encapsulation was retained. We have completed a treatability study using cement stabilization. The results of this study indicate this technology is applicable eee.

Soil Treatment: HPAH and Petroleum Hydrocarbons. Land biotreatment, slurry biotreatment, and low temperature thermal treatment were retained.

Land biotreatment was tested in a treatability study. The results of this study indicated that this technology is applicable. The results of this study will be reported in a separate document.

Slurry biotreatment was retained as a process option which is also representative of soil washing for these organic contaminants. Low temperature thermal treatment was retained as a process option which is also representative of incineration.

Soil Treatment: Lead, Chromium, and Arsenic. Soil treatment by soil washing was <u>not</u> retained primarily because it would require more significant process development than other remediation technologies which address these metals.

Soil washing for metals is not commercially available, and would require significant process development. Soil washing faces significant materials handling problems which are complex and expensive to solve.

The chemical and mechanical parameters of soil washing are unique to each soil type and mix of contaminants. Because much of the contaminated soil at PACCAR contains mixtures of hydrocarbons, lead, chromium, and arsenic in several chemical forms, considerable process development would be required prior to implementing soil washing.

Soil washing also produces wash water to be treated and sludge to be disposed of. Treatment of wash water and dewatering of sludge would require additional process development prior to full-scale implementation.

Sediment Control. Granular fill with geotextile was retained as the representative process option because we judged it to be slightly more effective and implementable than other comparable options.

Process for Selecting Technologies and Alternatives

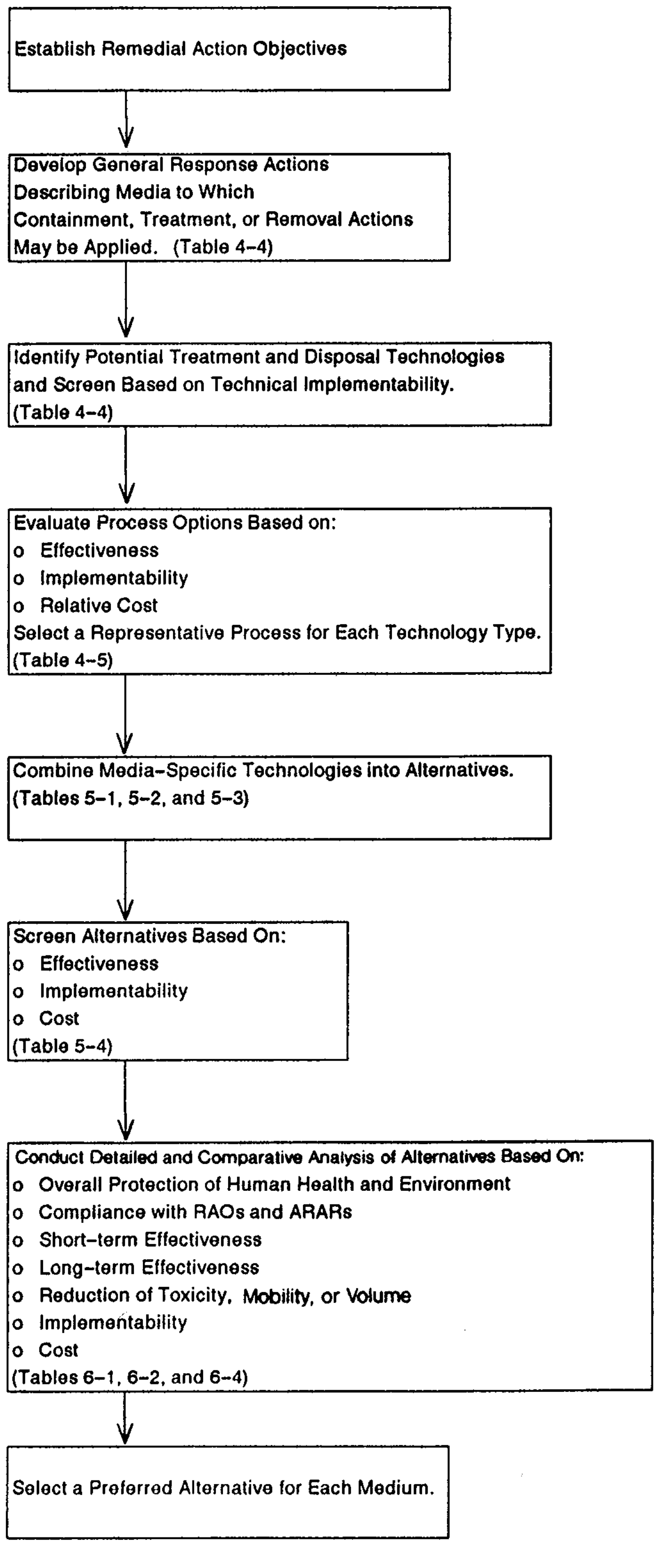

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Figure 4-1

5.0 DEVELOPMENT AND PRELIMINARY SCREENING OF ALTERNATIVES

5.1 Overview of Alternative Development and Screening Process

In this step we assembled the selected technologies and process options into alternatives representing a range of treatment and containment combinations. These alternatives were then screened on the same three criteria used to evaluate technologies - effectiveness, implementability, and cost.

5.2 Assembly of Alternatives

We assembled six alternatives for groundwater, eleven alternatives for soil, and five alternatives for sediments. Tables 5-1, 5-2, and 5-3 present the potentially applicable remedial alternatives for each medium that we assembled from the screened technologies. These tables do not include all possible combinations of these technologies. Instead, they present alternatives which represent a range of treatment and exposure control options.

Table 5-1 - Development of Groundwater Alternatives

	Groundwater Alternative					
Technology	1	2	3	4	5	6
Monitoring	x	x	x	x	x	x
Institutional Controls		x				
Diversion			x			
Containment				x		
Groundwater Pumping					x	
On-site Treatment					x	
In situ Treatment						x

x Technologies included in Alternative

Table 5-2 - Development of Soil Alternatives

Technology	Soil Alternative 1	2	3	4	5	6	7	8	9	10	11
Monitoring	x	x									
Institutional Controls		x									
Excavate and Dispose			x					x (Hot Spots)			x (Hot Spots)
Excavate and Treat On-site				x					x (Hot Spots)		
Excavate and Stabilize/ On-site					x					x (Hot Spots)	
In situ Treatment						x					
Cover							x	x	x	x	
Vegetation	x	x	x	x	x	x	x	x	x	x	x
Surface Water Collection	x	x	x	x	x	x	x	x	x	x	x

x - Technologies included in Alternative

Table 5-3 - Development of Sediment Alternatives

Technology	Sediment Alternative 1	2	3	4	5
Monitoring	x				
Vegetation in Ditches		x			
Protect or Line Existing Ditches			x		
Excavation and On-site Containment				x	
Excavation and Off-site Disposal					x

x - Technologies included in Alternative

The subsections which follow describe each potentially applicable alternative, including the process options chosen to represent each technology.

5.2.1 Groundwater Alternatives

Groundwater Alternative 1 - Monitoring

Groundwater monitoring would include semiannual and annual sampling and chemical analysis of selected monitoring wells. Both the deep and shallow water-bearing zones would be included.

This alternative would also include a health and safety plan to be implemented during future excavation activities which involve contacting groundwater. The monitoring and health and safety plans would be reviewed after 5 years.

Groundwater Alternative 2 - Institutional Controls: Restrict Use

This alternative includes all provisions of the monitoring alternative. Future installation of groundwater production wells in the Cedar River catchment area downgradient of the site would be restricted.

Groundwater Alternative 3 - Diversion

Groundwater flow through the contaminated shallow zone would be diverted by constructing a slurry wall to the middle aquitard (or its elevation). The slurry wall would extend around the perimeter of the site. Monitoring would be included in this alternative. The duration of construction would be several months.

Groundwater Alternative 4 - Containment

Contaminated groundwater in both shallow and deeper zones would be contained by a slurry wall constructed to the lower aquitard (a depth of about 120 feet). The slurry wall would extend around the perimeter of the site. Monitoring would be included in this alternative. The duration of construction would be several months.

Groundwater Alternative 5 - Pumping and Treatment

Groundwater with contaminant concentrations above the remedial action objectives would be pumped from both shallow and deeper zones and treated on site. Treated water would be discharged to either the municipal sewage treatment system or to surface water. The representative process options would be designed to meet discharge limits and would include filtration of suspended solids followed by air stripping.

Monitoring would be included in this alternative. The duration of construction would be several months. The duration of operation would be several years.

Groundwater Alternative 6 - *In Situ* Treatment

Groundwater with organic contaminant concentrations above the remedial action objectives would be treated *in situ* in both shallow and deeper zones. The representative process option would be biological treatment by subsurface injection of nutrient and oxygen sources. Only the organic constituents -- benzene and vinyl chloride -- would be treated.

Monitoring for both inorganics and organics would be included in this alternative. The duration of construction would be several months. The duration of operation would be several years.

5.2.2 Soil Alternatives

Soil Alternative 1 - Monitoring

This alternative includes monitoring fugitive dust emissions. Potential exposure is reduced by providing a health and safety plan for excavation activities on site. This alternative encompasses the entire site. The monitoring and health and safety plans would be reviewed after five years.

Soil Alternative 2 - Institutional Controls: Restrict Access

This alternative includes Alternative 1. Access would be restricted by maintaining a fence around the perimeter of the site. Warning signs would be posted on the fence to discourage trespassing.

Soil Alternative 3 - Excavation and Disposal

All soil with contaminant concentrations above the remedial action objectives would be excavated and transported to a licensed disposal facility. This alternative includes surface water control and vegetation. The duration of operation would be several months.

Soil Alternative 4 - Treatment

4a - Rapid Treatment. Soil with contaminant concentrations above the remedial action objectives would be excavated and rapidly treated on site. Rapid treatment would accommodate current site development plans. The representative process options for rapid treatment for soil with metals contamination would be soil washing. Low temperature thermal treatment would be used for unsaturated (dry) soil with HPAH and petroleum hydrocarbon contamination. Slurry biotreatment would be used for saturated (wet) soil with HPAH and petroleum hydrocarbon contamination. Soils with both metals and HPAH or petroleum hydrocarbon contamination would require sequential treatment.

This alternative includes surface water control and vegetation. The duration of construction and operation would be several months.

4b - Slow Treatment. All soil with contaminant concentrations above the remedial action objectives would be excavated and slowly treated on site. Slow treatment could accommodate current site development plan if sufficient space is available to slow treat soils when proposed site development occurs. The representative process option for slow treatment of soil with metals contamination would be soil leaching. Soil biotreatment would be used for soil with HPAH and petroleum hydrocarbon contamination. Soils with both metals and HPAH or petroleum hydrocarbon contamination would require sequential treatment.

This alternative includes surface water control and vegetation. The duration of construction and operation would be several years.

Soil Alternative 5 - Excavation and Stabilization

All soil with contaminant concentrations above the remedial action objectives would be excavated and stabilized on site. The representative process option would be cement stabilization.

This alternative includes surface water control and vegetation. The duration of construction and operation would be several months.

Soil Alternative 6 - *In Situ* Stabilization/Treatment

All soil with contaminant concentrations above the remedial action objectives would be stabilized or treated *in situ*. This alternative would not accommodate current site development plans and assumes that no immediate site development will take place.

Pressure grouting would be the representative process option for soil contaminated with metals only and metals and HPAH. Contaminated soils beneath building foundations would be pressure grouted where accessible by the grouting rig.

In-place soil biotreatment and volatilization would be used for soil with petroleum hydrocarbon contamination. Soils with both metals and HPAH or petroleum hydrocarbon contamination would require sequential treatment.

This alternative includes surface water control and vegetation. The duration of construction and operation would be several years.

Soil Alternative 7 - Cover

All soil with contaminant concentrations above the remedial action objectives would be contained by a protective cover. The representative process option for areas which would be paved according to the current development plan would be concrete and asphaltic pavement. Areas which would not be paved would be contained by a structural fill cover with and without landscaping.

This alternative includes surface water control and vegetation. The duration of construction would be several months.

The soil alternatives 8, 9, 10, and 11 -- discussed below -- refer to areas of relatively high concentrations of soil contaminants (hot spots) as defined in Section 4.2.

Soil Alternative 8 - Excavation and Disposal of Hot Spots, Cover

Hot spot soils would be excavated and transported to a licensed disposal facility. Remediation of these hot spots would result in a 50 percent overall decrease in the mass of contaminants in contaminated areas. All other soil with contaminant concentrations above the remedial action objectives would be contained by a protective cover.

This alternative includes surface water control and vegetation. The duration of construction would be several months.

This alternative was further defined during detailed analysis to include only the PCB-contaminated soil and Dangerous Waste (lead) soil (see Table 5-4) and will be accomplished regardless of what other alternative is selected.

Soil Alternative 9 - Excavation and Treatment of Hot Spots and Source Areas, Cover

Hot spot soils would be excavated and treated. Remediation of these hot spots would result in a 50 percent overall decrease in the mass of contaminants in contaminated areas. Soils in selected potential source areas would also be treated. Other soil with contaminant concentrations above the remedial action objectives would be contained by a protective cover. Representative process options for treatment would be those described in Soil Alternative 4b.

This alternative includes surface water control and vegetation. The duration of construction and operation would be several months.

Soil Alternative 10 - Excavation and Stabilization of Hot Spots, Cover

Hot spot soils would be excavated and stabilized. Remediation of these hot spots would result in a 50 percent overall decrease in the mass of contaminants in contaminated areas. Soils in selected potential source areas would also be stabilized. Other soil with contaminant concentrations above the remedial action objectives would be contained by a protective cover. Representative process options would be those described in Soil Alternative 5.

This alternative includes surface water control and vegetation. The duration of construction and operation would be several months.

Soil Alternative 11 - Access Restriction, Excavation and Disposal of Hot Spots

Hot spot soils would be excavated and transported to a licensed disposal facility. Remediation of these hot spots would result in a 50 percent overall decrease in the mass of contaminants in contaminated areas. Access would be restricted as in Soil Alternative 2.

This alternative includes surface water control and vegetation. The duration of construction and operation would be several months.

5.2.3 Sediment Alternatives

Sediment Alternative 1 - Monitoring

This alternative includes monitoring water quality. Potential exposure is reduced by providing a health and safety plan for excavation activities in the sediment areas. This alternative would be limited to the areas containing sediments. The monitoring and health and safety plans would be reviewed after five years. This alternative is not compatible with proposed redevelopment of the property.

Sediment Alternative 2 - Vegetation

Ditches containing contaminated sediments would be vegetated to reduce migration by wind and surface water. The duration of construction would be several weeks. This alternative is not compatible with proposed redevelopment of the property.

Sediment Alternative 3 - Cover

Contaminated sediments in ditches would be contained by a geotextile and protective sand and gravel cover. The duration of construction would be several weeks.

Sediment Alternative 4 - Excavation and On-site Containment

Contaminated sediments in ditches would be excavated and contained on site by a geotextile liner and cover. The duration of construction would be several weeks.

Sediment Alternative 5 - Excavation and Off-site Disposal

All sediment with contaminant concentrations above the remedial action objectives would be excavated and transported to a licensed disposal facility. The duration of operation would be several weeks.

5.3 Screening of Alternatives

This section presents our initial screening of the remedial alternatives. The first subsection describes the criteria we used for the initial screening. The second subsection summarizes the results of the screening.

5.3.1 Screening Evaluation: Effectiveness, Implementability, and Cost

Our evaluation of the alternatives at this stage was general, but sufficiently detailed to be able to distinguish between the alternatives.

The basic screening criteria are those that we used for the technology screening:

- Effectiveness;
- Implementability; and
- Cost.

Specific issues under each of these main criteria are listed below.

Effectiveness. The effectiveness of each alternative is based on how well it addresses the following issues:

- Long-term toxicity reduction;
- Long-term mobility reduction;
- Long-term volume reduction;
- Long-term exposure reduction; and
- Short-term effectiveness.

Implementability. The degree to which an alternative is implementable is indicated by the following criteria:

- o Ability to construct;
- o Reliability of operation;
- o Ability to meet short-term regulatory requirements;
- o Long-term operation, maintenance, and monitoring;
- o Ability to obtain permits and approvals;
- o Availability of treatment, storage, and disposal services;
- o Availability of equipment and personnel; and
- o Compatibility with site development.

Cost. The cost estimates made during preliminary screening are for comparison purposes only. As such, absolute costs are not important as long as the relative costs are considered. More refined cost estimates are provided for retained alternatives in Section 6.0 DETAILED ANALYSES.

Our cost estimates for this phase consist of two contributions -- capital costs and operation and maintenance (O&M) costs.

The costs do not include items which would not affect the relative cost comparison between alternatives. This would include general site work engineering, administration, and taxes.

5.3.2 Results of Screening Evaluation

Table 5-4 presents a summary of our alternative screening. In the table, we qualitatively rate the alternatives on a three point scale: 1 (poor), 2 (moderate), and 3 (good). For example, Soil Alternative 1 - Monitoring has a 3 (good) rating for implementability. We used the scoring as a guide to screen the alternatives. The results of our screening are shown in the "keep" and "discard" columns of Table 5-4.

Table 5-4 - Alternative Screening

Alternative Number	Description	Qualification	Scoring Effect.	Implem.	Cost	Keep	Discard
GROUNDWATER							
1	Monitoring		1	3	3	x	
2	Institutional Controls		1	2	3	x	
3	Diversion		1	2	2		x
4	Containment		2	2	1		x
5	Pumping and treatment		2	3	2	x	
6	In situ treatment		1	2	2		x
SOIL							
1	Monitoring		1	3	3	x	
2	Institutional Controls		1	3	3	x	
3	Excavation/disposal		2	2	1		x
4a	Rapid treatment	With and without site development	3	1	1		x
4b	Slow treatment	With and without site development	3	2-1	2-1	x*	
5	Stabilization	With and without site development	3	2	1	x*	
6	In situ stabilization/ treatment		2-1	2-1	2		x
7	Cover		2	3	3-1	x	
8	Cover/disposal of hot spots	Site development as planned	2	3	2-1	x***	
9	Cover/treatment of hot spots	Site development as planned	3	3	2-1	x**	
10	Cover/stabilization of hot spots	Site development as planned	3	3	2-1	x**	
11	Restrict access/disposal of hot spots		2	3	1		x
SEDIMENT							
1	Monitoring		1	3	3		x
2	Vegetation of ditch		1	2	3		x
3	Line/fill ditch		2	3	3	x	
4	Excavation/on-site containment		2	2	3	x	
5	Excavation/off-site disposal		2	3	3	x	

* Refined by combining into one alternative 4b/5.
** Refined by combining into one alternative 9/10.
*** Refined to include only soils with PCBs and Dangerous Waste (lead) soil.
Alternative Ranking: 1 = poor; 2 = moderate; 3 = good

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Eleven Alternatives Retained for Screening

The refined alternatives passing the initial screen and retained for the detailed analyses are:

Groundwater

1	- Monitoring
2	- Restriction of use
5	- Pumping and treatment

Soil

1	- Monitoring
2	- Restriction of access
4b/5	- Slow treatment/stabilization
7	- Cover
8	- Excavation and disposal of a limited amount of soil with PCBs and Dangerous Waste (lead) soil
9/10	- Cover with treatment and stabilization of hot spots

Sediment

3	- Line/fill ditch
5	- Excavation and disposal

Two sets of soil alternatives -- (4b and 5) and (9 and 10) -- were combined into alternatives 4b/5 and 9/10. These combinations make it possible to use a mix of technologies suited to the various contaminants and concentrations present in soil.

In Section 6.0, **DETAILED ANALYSES**, we describe the retained alternatives in greater detail.

Nine Alternatives Discarded after Screening

Groundwater. We discarded three groundwater alternatives -- diversion, containment, and *in situ* treatment. In comparison to other groundwater alternatives, these would offer only poor to moderate effectiveness or implementability and in the case of containment, much greater cost. The effectiveness of diversion depends on sealing the bottom of the vertical wall to the middle aquitard. However, the middle aquitard is not continuous across the site. The effectiveness of *in situ* groundwater treatment is limited because it will not treat arsenic or lead. The containment option (deep slurry wall) would be very expensive due to the depth and size of the site.

Soil. We discarded four soil alternatives -- excavate and dispose, rapid treatment, *in situ* treatment, and restrict access/dispose hot spots.

Disposal is a very expensive alternative and its effectiveness is limited because the toxicity and mobility of the soil is not reduced.

Rapid treatment would potentially be effective but difficult and costly to implement because of the process development and custom design involved. However, new rapid treatment technologies are emerging which may render this alternative feasible in the future.

In situ soil treatment is only moderately effective because process control is difficult. It would be difficult and costly to implement because of the process development and custom design involved.

We discarded the restrict access/disposal alternative because it would be only moderately effective (affording some exposure reduction) while having high cost.

Sediment. We discarded two sediment alternatives -- monitor and vegetate ditch -- because they lacked effectiveness. Other alternatives were more effective and had similar implementability and cost.

6.0 DETAILED ANALYSES OF ALTERNATIVES

6.1 Overview of Detailed Analyses Process

This section presents the results of detailed analyses of the 11 alternatives retained from the alternative evaluation. The 11 alternatives are given below and in Table 6-1.

- Groundwater
  1. Baseline condition with monitoring (No Action)
  2. Baseline condition with monitoring and institutional controls
  5. Pumping and treatment with monitoring

- Soil
  1. Baseline condition with monitoring (No Action)
  2. Baseline condition with monitoring and institutional controls
  4b./5. Biotreatment and stabilization
  7. Construct cover
  8. Disposal of specified PCB-contaminated soil and Dangerous Waste (lead) soil
  9./10. Construct cover with biotreatment and stabilization of hot spots.

- Sediment
  3. Fill ditch
  5. Excavation and disposal of sediments, fill ditch

For the detailed analysis the alternatives passing the screen were further refined and evaluated. For each alternative, we developed a conceptual design sufficient for completing a preliminary cost estimate. We then evaluated these alternatives following guidelines published by EPA for feasibility studies under CERCLA (EPA, 1988a). The alternatives were analyzed using criteria given in that reference. The criteria are given in Table 6-2.

A treatability study has been completed for the land biotreatment of soils, cement stabilization of soils, and treatment of lead and arsenic in groundwater technologies. That study has indicated that the above technologies are potentially applicable and effective for soil and groundwater treatment at this site. The treatability study results will be published separately from this document.

Table 6-1 - Description of Alternatives Retained for Detailed Analysis

Alternative	Description
Groundwater	
1 - No Action	Monitor selected existing groundwater wells. Health and safety programs for site activities encountering groundwater.
2 - Institutional Controls	Monitor selected existing groundwater wells. Prohibit groundwater use on site. Health and safety programs for site activities encountering groundwater.
5 - Pumping and Treatment	Monitor selected existing groundwater wells. Pump 15 wells in shallow aquifer. Pump 5 wells in deep aquifer. Use air stripping treatment for vinyl chloride and benzene; use oxidation/reduction and filtration for arsenic and lead.
Soil	
1 - No Action	Monitor for fugitive dust quality. Require health and safety programs for subsurface work.
2 - Institutional Controls	Monitor for fugitive dust quality. Require health and safety programs for subsurface work. Restrict access for property (maintain existing fence).
4b/5 - Treatment and Stabilization	Use land treatment for soils with petroleum hydrocarbons and possibly HPAH. Use cement stabilization for metals and HPAH.
7 - Containment	Use a combination of pavement and structural fill if PACCAR facility is constructed. Use a combination of structural fill and geomembrane if PACCAR facility is not constructed.
8 - Excavation and Disposal of PCB-Contaminated Soil and Dangerous Waste Soil	Off-site disposal of specified PCB-contaminated soil and Dangerous Waste (lead) soil.
9/10 - Containment with treatment, stabilization, and disposal of hot spots	Use pavement and structural fill cover in conjunction with: - Biotreatment of soils with petroleum hydrocarbons (and possibly HPAH) hot spots. - Stabilization of metals and HPAH hot spots.
Sediment	
3 - Fill Ditch	Place geotextile and granular import fill in ditches. Reconstruct site surface drainage.
5 - Disposal contaminated sediments	Excavate contaminated sediments in ditches and dispose of off-site.

TABLE6-1

Table 6-2 - Criteria for Detailed Analysis of Alternatives

Overall Protection of Human Health and Environment

- How Alternative Provides Human Health and Environmental Protection

Compliance with RAOs and ARARs

- How Does Alternative Meet Site RAOs and Action-specific ARARs

Short-Term Effectiveness

- Protection of Community during Remedial Actions
- Protection of Workers during Remedial Actions
- Time Until Remedial Action Objectives are Achieved

Long-Term Effectiveness

- Magnitude of Residual Risk
- Adequacy of Controls
- Reliability of Controls

Reduction of Toxicity, Mobility, and Volume

- Treatment Process Used and Materials Treated
- Amount of Hazardous Materials Destroyed or Treated
- Degree of Expected Reductions in Toxicity, Mobility, and Volume
- Degree to Which Treatment is Irreversible
- Type and Quantity of Residuals Remaining after Treatment

Implementability

- Ability to Construct and Operate the Technology
- Reliability of the Technology
- Ease of Undertaking Additional Remedial Actions, if Necessary
- Ability to Monitor Effectiveness of Remedy
- Ability to Obtain Approval from Other Agencies
- Coordination with Other Agencies
- Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity
- Availability of Necessary Equipment, and Specialists

Cost

- Capital Costs
- Operating and Maintenance Cost
- Present Worth

Community Acceptance*

State Acceptance*

*These criteria will be assessed following comment on the RI/FS report and the proposed plan.

The cost estimates shown have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. Unless indicated otherwise, these "study estimate" costs provide an accuracy of +50 percent to -30 percent in accordance with EPA guidelines. The actual costs of remediation depend on many variables, including quantity of contaminated material disturbed by site redevelopment, process development costs, disposal fees, health and safety regulations, labor and equipment costs, and the final project scope. As a result, the final project costs will vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper evaluation and adequate funding.

The capital cost estimates include design of the selected remediation alternative, construction management, and the cost for actual remediation work. The capital costs do not include costs for negotiating the alternative selection or community relations.

The operation and maintenance costs include long-term monitoring and long-term operation, if needed, of those items directly attributable to the remediation of site contamination.

The present worth amounts are based on a net five percent discount rate and a maximum 30 years of operation. This is consistent with EPA guidelines (EPA, 1988a).

Appendix C presents cost breakdowns and assumptions for each alternative.

The remainder of this section is organized as follows:

- Elements common to all or some alternatives (Section 6.2)
- Alternative analyses (Section 6.3)
- Comparison among alternatives (Section 6.4)

6.2 Elements Common to Alternatives

Certain features of site development, alternative development, and responses to detailed analysis criteria (in Table 6-1) are common to all or some alternatives. Rather than include discussion of these features in each detailed analysis, the discussion is presented here.

6.2.1 Common Site Development Features

Proposed PACCAR Facility

As discussed in Subsection 1.2.6, the proposed PACCAR facility will include a new manufacturing building, and associated concrete slabs (100-foot-wide apron around the building) and asphalt roadways. All alternatives will have to accommodate the design of the facility. The facility design is conceptual at this time; therefore, details of alternatives will be developed later to accommodate final facility design. All alternatives (except those noted) appear conceptually to integrate well with facility development.

Procedures to handle soil and groundwater, including monitoring will be developed as part of the site remediation plan. These same procedures would also be used in the event of site remediation with no site development. These same procedures will be used during facility construction to mitigate any potential adverse impacts. These procedures will also incorporate normal City of Renton requirements for construction projects such as approval of a temporary erosion control plan.

The construction of the facility will also require that utility corridors be established. Methods such as constructing low permeability barriers in the trench will be used to mitigate the potential for contaminants to migrate along the trenches.

Proposed Storm Sewer

A storm sewer line is proposed along Houser Way during the development of the new facility. Based on RI sample results, the storm sewer line is not expected to contact soils with constituents above the general action levels, and thus does not impact the alternative analysis. Health and safety programs during sewer construction may be required if contamination is detected during construction. Monitoring for contaminants will be conducted during excavation.

Proposed Garden Avenue Realignment

Realignment of Garden Avenue has been proposed by the City of Renton. The realignment does encompass areas of soil with constituents above the general action levels. The realignment of Garden Avenue is not certain; however, the presence of Garden Avenue on-site should not result in significant impacts to any alternative. The design and construction of Garden Avenue should consider means to limit worker exposure to soils. Cost of added remediation associated with realigned Garden Avenue has not been estimated and is not included in this document.

6.2.2 Common Alternative Features

Fencing

An existing fence surrounds the site. This fence will be maintained or replaced for any alternative. The costs of a replacement fence have been included in the baseline soil alternatives but excluded elsewhere.

Surface Water Control

All soil and sediment alternatives, with the exception of baseline condition alternatives, will include surface water control. Surface water control is a function of future site development and thus is difficult to define until site development is defined. Therefore, detailed descriptions of surface water control or the associated costs has not been included with the alternatives.

Utility Trench Construction (during New Facility Development)

Several underground utility systems will be constructed during the new facility development including water, wastewater, natural gas, surface water, drainage, fire protection, and electrical utilities. These utilities will typically require shallow trenches on the order of 2 to 4 feet deep. However, some drainage trenches may be up to 10 feet deep. Soils excavated during utility construction will be sampled and tested. A separate criteria for soils that can be replaced in the trench has been established as noted in Table 6-3 and as discussed in Appendix E. Appendix E also has supporting discussions for the trench soil criteria.

The trench soil criteria are primarily based on human health risks for utility maintenance workers. Some concern has been noted regarding the transport of contaminants through pipe joints or walls. Plastic or metal pipes under pressure would be used for water and fire protection utilities. Metal pipes would be used for the natural gas utilities. Concrete pipes with gasket joints would be used for wastewater and stormwater utilities. All pipes would have leak-proof joints. Given the proposed pipe materials and construction, migration of soil or contaminants into the pipes is not a concern. In addition, barriers will be constructed in the trenches to prevent migration of soil particles within the backfill.

Placement of Excavated Soils

The placement of excavated soils after sampling and testing (and treatment under soil alternatives 4b/5 and 9/10) is shown in Table 6-3. A matrix of allowable excavated soil placement is given in that table with reference to buildings, groundwater, and utility trenches.

Soils at Location F-10

A small amount of soil at grid location F-10 had concentrations of lead exceeding the EP Tox Dangerous Waste criteria. This volume of soil (estimated as 10 cubic yards) will be excavated and disposed of at a hazardous waste landfill in Oregon or Idaho. The location of this soil is shown on Figures 6-3 and 6-8.

Soil at well LB-24 exceeding the EP Tox criteria was similarly excavated and removed with Ecology approval in 1987.

Existing Diesel Pipelines

A system of diesel pipelines exists at this site and was previously used for heating and other purposes. These pipelines will be removed as encountered in site excavations. Remaining product will be collected and disposed of in accordance with applicable regulations. Contaminated soils at the pipelines will be handled in a manner consistent with the selected alternatives.

Table 6-3 - Summary of Soil Remedial Action Levels and Matrix of On-Site Placement of Excavated Soils

(a) SUMMARY OF SOIL REMEDIAL ACTION LEVELS
All Values in mg/kg (ppm)

Parameter	Site RAO	Trench Action Level	Hot Spot Action Level
Arsenic	30	100	100
Chromium	70	600	600
Lead	1000	4500	8000
HPAHs	35	350	800
PCBs (soil)	10	10	10
PCBs (sediment)	1	Not Applicable	Not Applicable
Petroleum Hydrocarbons (GC/FID)	1000	2500	2500

(b) ON-SITE PLACEMENT OF EXCAVATED SOILS

Materials	May be Placed under Buildings	May be Placed below Groundwater	May be Placed in Utility Trenches
Excavated Soils with Contaminant Concentrations below RAOs	YES	YES	YES
Excavated Soils with Contaminant Concentrations above RAOs and below Hot Spot Action Levels	YES	YES	Refer to Utility Trench Action Levels
Biotreated Soils Which Meet Approved Criteria	YES	YES	YES
Stabilized Soils	YES	NO	NO
Excavated Utility Trench Soils with Contaminant Concentrations above Trench Action Levels and below Hot Spot Action Levels	YES	YES	NO
Excavated Utility Trench Soils with Contaminant Concetrations below Trench Action Levels but above RAOs	YES	YES	YES

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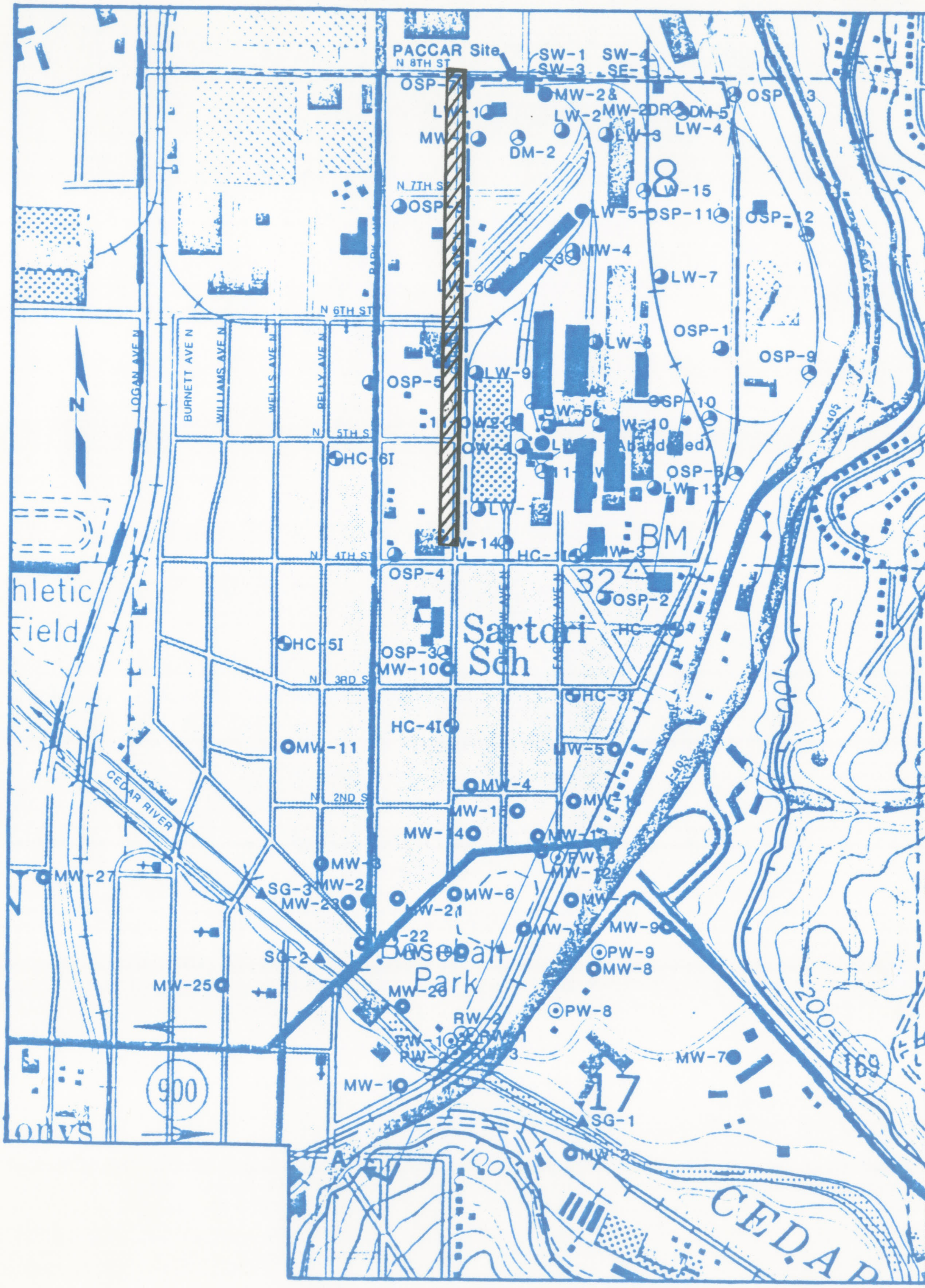
Location of Pumping Wells for Groundwater Alternative 5



Note: Base map prepared from USGS 7.5 minute quadrangles of Mercer Island and Renton, Washington.

0 800 1600

Location of Pumping Well for Both Shallow and Deep Zones

HARTCROWSER
J-1639-09 5/89
Figure 6-1

6.2.3 Common Responses to Alternative Criteria Evaluation

Responses to two criteria, state and community acceptance, are common to all alternatives. Both state and community acceptance will not be known until comments are received on this draft Feasibility Study.

6.3 Alternative Analysis

6.3.1 Groundwater Baseline Condition with Monitoring (Groundwater Alternative No. 1)

Description

This alternative will consist of continued monitoring of groundwater quality at existing on-site and off-site monitoring wells. Monitoring will consist of semiannual and annual sampling and testing. Testing parameters during the first year will include volatiles, semivolatiles, and dissolved arsenic and lead. The monitoring program will be evaluated after the results of the first year have been received and analyzed.

Monitoring wells affected by possible facility construction will be abandoned in accordance with state regulations and replaced if required by the approved monitoring plan.

This alternative also includes a Health and Safety Plan to be implemented when groundwater is encountered during future excavation activities on-site.

Overall Protection of Human Health and Environment and Compliance with RAOs and ARARs

This alternative, in and of itself, will not contribute further protection of health and environment or meet the remedial action objectives (RAOs) based on ARARs, TBCs, and the risk assessment.

However, monitoring will provide information on contamination levels so decisions can be made regarding the potential need for additional remedial action.

This alternative also provides an early warning system for protection of City of Renton wells.

The Health and Safety Plan will effectively reduce exposure of on-site construction workers to contaminated groundwater.

Action-specific ARARs include monitoring well construction (if new wells are required) and abandonment requirements of WAC-173-160. This alternative would be able to meet those action-specific ARARs.

ARARs associated with drinking water standards may, in the future, be met for vinyl chloride and benzene. Previous actions by PACCAR have removed the sources of these contaminants and natural processes will reduce contaminant concentrations. However, if the current standards for lead and arsenic are lowered, than this alternative will not meet these lowered standards, depending on final adopted standards and the point of compliance.

Short- and Long-Term Effectiveness

This alternative will not be effective in, and of itself, in the short-term or long-term in that no remedial action is planned. It will be effective in determining any contaminant migration so additional remedial actions can be implemented if necessary.

Reduction of Toxicity, Mobility, or Volume

This alternative does not reduce the toxicity, mobility, or volume of contaminants, other than that which occurs through natural biodegradation and attenuation.

Implementability

This alternative uses standard techniques, wells already exist. No permits are required. The present worth amount is based on 30 years of monitoring.

Costs	No Site Development	Site Development
Capital Cost	$ 0	$ 20,000
Annual Monitoring Costs (30 years)	$ 60,000	$ 60,000
PRESENT WORTH	$920,000	$940,000

6.3.2 Groundwater-Baseline Condition with Monitoring and Institutional Controls (Groundwater Alternative No. 2)

Description

This alternative includes all provisions of groundwater monitoring and adds restriction of groundwater use on-site and monitoring of groundwater use/education of groundwater users within the Cedar River Catchment Area downgradient of the site. Restriction of use shall include advisory notification of no drinking water or irrigation use of groundwater on-site or within the Cedar River Catchment Area. Health and safety programs and discharge procedures would be required for any dewatering activities.

Overall Protection of Human Health and Environment

Restrictions and monitoring should prevent human exposure to groundwater. Increased protection to the environment should also be provided by limiting use and discharge.

Compliance with RAOs and ARARs

The restrictions should meet the RAOs. Action-specific ARARs include monitoring well construction (if new wells are required) and abandonment requirements of WAC-173-160. This alternative would be able to meet those action-specific ARARs.

ARARs associated with drinking water standards may, in the future, be met for vinyl chloride and benzene. Previous actions by PACCAR have removed the sources of these contaminants and natural processes will reduce contaminant concentrations. However, if the current standards for lead and arsenic are lowered, than this alternative will not meet these lowered standards, depending on final adopted standards and the point of compliance.

Short- and Long-Term Effectiveness

This alternative may not provide reduction in contaminant levels but would be effective in the short-term and long-term for the protection of the community and workers. The restrictions on use would be reliable.

Reduction of Toxicity, Mobility, or Volume

This alternative does not reduce the toxicity, mobility, or volume of contaminants in groundwater, other than that which occurs through natural biodegradation and attenuation.

Implementability

This alternative is easily implemented on-site. Monitoring of potential off-site use and testing within the Cedar River catchment area would be conducted. Monitoring wells exist now. No permits are required (other than necessary for discharge during construction dewatering activities). The present worth amount is based on 30 years of monitoring.

Costs

Costs are summarized below. Appendix C provides additional detail.

Costs	No Site Development	Site Development
Capital Costs	$ 0	20,000
Annual Costs (30 years)	$ 72,000	72,000
PRESENT WORTH	$1,110,000	$1,130,000

6.3.3 Groundwater - Pumping and Treatment (Groundwater Alternative No. 5)

Pump from Shallow and Deep Zones

This alternative includes the monitoring program described in groundwater alternative No. 1 along with groundwater pumping and treatment for selected areas. Groundwater would be pumped from both the shallow and deep water-bearing zones using approximately 15 and 5 wells, respectively. The general vicinity of pumping well locations is shown on Figure 6-1. The shallow wells would be about 40 feet deep and the deep wells would be about 130 feet deep. Flow from each well system would be about 50 gallons per minute (gpm) and 150 gpm for the shallow and deep system, respectively. The estimated radius of influence for the pumping wells range from 20 to 300 feet for shallow wells and 100 to 600 feet for deep wells.

Treat Using Filtration and Air Stripping

The pumped groundwater would be treated for organics (vinyl chloride and benzene) and metals (lead and arsenic) using filtration for metals and air stripping for organics. The filtration would be accomplished prior to air stripping and would be effective in removing metals attached to suspended solids. Discharge after air stripping would go to surface waters or the publicly-owned sewage treatment works (METRO Sewage Treatment Facility). The duration of pumping and treatment is estimated to be 5 years. The exact duration may be shortened or lengthened based on groundwater monitoring. A schematic diagram of this alternative is given on Figure 6-2.

Overall Protection of Human Health and Environment

This alternative would be effective in providing protection to humans and the environment. Discharge from treatment system would not result in additional risks to humans or the environment.

Compliance with RAOs and ARARs

This alternative would meet the RAOs for groundwater. Action-specific ARARs would include treated water discharge. Preliminary estimates show that discharge criteria can be readily met for surface water or discharge to POTW.

Short- and Long-Term Effectiveness

Short-Term. This alternative may require restrictions on groundwater use until treatment results in significant reductions in contaminants. Given these restrictions and on-site health and safety programs, this alternative would be effective in the short-term in protecting the community and workers.

Long-Term. This alternative would be effective in the long-term in meeting the RAOs. The residual risk would be below target levels. Control on the effectiveness would be obtained through monitoring wells and discharge monitoring. The alternative is reliable; additional wells can be easily installed, if necessary.

Reduction of Toxicity, Mobility, or Volume

Through treatment, this alternative reduces the toxicity and volume of contaminants in groundwater. The groundwater pumping also reverses gradients and further reduces contaminant mobility during the treatment process. The alternative effectively results in groundwater levels below the RAOs.

Implementability

The pumping and treatment schemes use conventional technologies readily available and proven to be reliable. Additional remedial actions are not precluded by this alternative.

Past projects using similar schemes have been approved by state and federal agencies. Permits will be required for treated water discharge and the installation of pumping wells. A permit for discharge is not anticipated to be difficult to obtain.

Costs

Costs are summarized below. Appendix C provides additional detail.

Costs	No Site Development	Site Development
Capital Costs	$ 470,000	$ 500,000
Annual O&M Costs (5 yrs)	340,000	340,000
Annual Monitoring Cost (30 yrs)	60,000	60,000
PRESENT WORTH	$2,870,000	$2,900,000

6.3.4 - Soil - Baseline Condition with Monitoring (Soil Alternative No. 1)

Description

This alternative will consist of monitoring of fugitive dust for contaminants of concern (primarily metals). Specific health and safety plans will be required for on-site work involving disturbance or excavation of soils.

Six air quality monitoring stations would be installed on the perimeter of the site. Each station would have two air pumps. Monitoring would include quarterly sampling for HPAH, arsenic, lead, chromium, and total dust.

Overall Protection of Human Health and Environment

This alternative will protect on-site workers as a result of health and safety plans. Exposure from dust generation would be monitored.

Compliance with RAOs and ARARs

This alternative does not meet the RAOs. No action-specific ARARs were identified.

Short- and Long-Term Effectiveness

This alternative will serve to protect on-site personnel working with soil.

Reduction of Toxicity, Mobility, or Volume

No reduction of toxicity, mobility, or volume is provided.

Implementability

This alternative would use standard dust collection and analyses techniques. No permits are required.

Costs

Costs are summarized below. Costs for this alternative with site development are substantially higher than costs with no site development. Additional items associated with site development include groundwater and surface water control during construction, testing, and treatment of exposed soils, construction work pad, and health and safety management. Appendix C provides additional detail.

Costs	No Site Development	Site Development
Capital Costs	$ 20,000	$5,770,000
Annual Monitoring Costs (30 yrs)	60,000	60,000
PRESENT WORTH	$940,000	$6,690,000

6.3.5 Baseline Condition with Monitoring and Institutional Controls (Soil Alternative No. 2)

Description

This alternative is identical to the above alternative (Soil Alternative No. 1) with addition of institutional controls which would include maintenance of the existing fence (or construction of a new fence), placement of warning signs, and deed restrictions. Deed restrictions will limit site use to industrial purposes rather than residential, recreation, or agricultural purposes. Health and safety programs and dust monitoring will be required as in Soil Alternative No. 1.

Overall Protection of Human Health and Environment

This alternative will protect on-site workers (health and safety plan); limit public access and use; and monitor exposure from dust generation.

Compliance with RAOs and ARARs

This alternative does not meet the RAOs. No action-specific ARARs were identified.

Short- and Long-Term Effectiveness

This alternative will serve to protect on-site personnel working with soil. Public protection will be limited. No other protection is provided.

Reduction of Toxicity, Mobility, or Volume

No reduction of toxicity, mobility, or volume is provided.

Implementability

This alternative would use standard fence construction and dust collection/analyses techniques. No permits are required.

Costs

Costs are summarized below. Costs for this alternative with site development are substantially higher than costs with no site development. Additional items associated with site development include groundwater and surface water control during construction, testing, and treatment of exposed soils, construction work pad, and health and safety management. Appendix C provides additional detail.

Costs	No Site Development	Site Development
Capital Costs	$ 130,000	$5,880,000
Annual O&M Costs with Monitoring (30 years)	61,200	61,200
PRESENT WORTH	$1,070,000	$6,820,000

6.3.6 Soil - Slow Biotreatment and Stabilization) (Soil Alternative No. 4b/5)

Description

This alternative consists of excavation followed by biotreatment of soils with petroleum hydrocarbons and stabilization of soils with metals (arsenic, lead, and chromium) and HPAH. Soils to be treated or stabilized are based on RAO concentrations as follows (note that for the purposes of the detailed analyses, remediation of soils with petroleum hydrocarbons is addressed by GC/FID method 8015 - extended):

Biotreatment:	
Soil with Petroleum Hydrocarbon GC/FID (8015-extended)	>1,000 ppm
Stabilization:	
Soil with HPAHs	> 35 ppm (achieves site average concentration less than 3.5 ppm CPAH)
Soil with Lead	>1,000 ppm
Soil with Chromium	>70 ppm
Soil with Arsenic	>30 ppm

The extent of these soils is shown on Figure 6-3. Approximately 20,000 cubic yards would be biotreated and 160,000 cubic yards would be stabilized. Placement of treated soils was addressed in Table 6-3.

Three shallow monitoring wells would be constructed at both the final placement areas of biotreated and stabilized soils.

Biotreatment. The biotreatment is termed slow in that the treatment would require a 15-month time frame. This time frame included two six-month treatment periods and a three-month dormant winter period. An area which would not interfere with potential site redevelopment would need to be provided. The biotreatment in this alternative involves excavation of soil, placement in lined area, the addition of nutrients, water, and lime (for pH control), and periodic tilling. The biotreatment will use thin lifts (about 1 foot) of soil over a relatively large area. In order to treat 20,000 cubic yards in the available area, two sequential biotreatment periods would be required. The treatment area would be about 300 feet wide and 1,000 feet long. It would be located in the northeast portion of the site.

An alternative to spreading the soil in thin lifts would be to treat the soil in aerated heaps. Area and time constraints may necessitate the use of the aerated heap method. Soil would be piled into windrows about five feet high. Perforated piping placed in the soil would be attached to a vacuum blower to aerate the soil.

It is assumed that biotreatment will result in petroleum hydrocarbons (GC/FID) concentrations less than 200 ppm.

Stabilization. Stabilization would consist of the addition of Portland cement and other materials (based on treatability testing) to soil containing arsenic, lead, chromium, or HPAHs. Soil containing petroleum hydrocarbons and metals or HPAH above RAO concentrations would also be stabilized. Cement would be added in the range of 3 to 12 percent in order to create a compacted soil-cement. The soil would probably require screening and crushing of large particles; the crushed particles would be added back to the soil mix. The processed mix of soil and cement would be designed to provide relatively low permeability, good strength, compactibility, and adequate pH control. Additives may be added, if necessary, to reduce shrinkage upon curing.

Soil to be stabilized would be excavated, processed, mixed, and placed in lifts in an on-site excavation. Compaction of each lift would be performed. Stabilized soil would be placed above seasonally high groundwater levels (which vary on-site from 2 to 6 feet below existing site grades). Stabilized soil would be covered with a minimum of 12 inches of protective soil. Greater soil cover may be necessary beneath slabs or pavement. The duration of stabilization activities would be about 9 months.

A schematic process diagram of biotreatment and stabilization is given on Figure 6-4.

Overall Protection of Human Health and Environment

This alternative would be effective in providing protection to human health and the environment by significant destruction of petroleum hydrocarbons in soils and significantly limiting exposure to metals and HPAH in soil by direct human, surface water, or groundwater contact. The mobility of metals and HPAH would also be decreased by stabilization.

Compliance with RAOs and ARARs

This alternative would meet the RAOs. No action-specific ARARs have been identified.

Short- and Long-Term Effectiveness

Short-Term. Given the duration of these activities, health and safety programs would be required to protect on-site personnel. No increase in risk to the community is anticipated because appropriate action would be taken to control dust.

Long-Term. The residual risk of HPAH, lead, arsenic, and chromium would be below RAO levels. Residual petroleum hydrocarbons (GC/FID) would be below 1,000 ppm and on the average much lower.

Activities in this alternative can be readily monitored for effectiveness during construction. Visual observation of ground surface would identify significant change to stabilized material. Such controls during and after activities should be reliable.

Reduction of Toxicity, Mobility, or Volume

Biotreatment would reduce the toxicity and volume of petroleum hydrocarbons in soils through destruction of contaminants. Stabilization would reduce the mobility of HPAH and metals in soil. Stabilization may reduce the toxicity of HPAH or metals, though that effect is not certain. Stabilization would not reduce the volume of soil but would only result in volume increases of about 10 percent or less.

Implementability

Both biotreatment and stabilization would utilize readily available and reliable construction techniques. Neither alternative would preclude the use of further remedial actions. Effectiveness of activities is readily monitored during construction and after construction. After construction, monitoring would include monitoring wells and visual inspection of ground surface. Exposure and observation of stabilized material is possible if necessary. Both biotreatment and stabilization have been used on other projects and thus approval and coordination with other agencies is not expected to be a problem.

Costs

Costs are summarized below. Appendix C provides additional detail.

Costs	No Site Development	Site Development
Capital Costs		
General	$ 870,000	$ 5,820,000
Biotreatment	960,000	960,000
Stabilization	12,250,000	12,250,000
Annual O&M (30 years)	12,000	12,000
PRESENT WORTH	$14,260,000	$19,240,000

6.3.7 Soil - Construct Cover (Soil Alternative No. 7)

Description

This alternative includes the construction of a cover over soils containing contaminant concentrations greater than the soil RAOs (as shown on Figure 6-5). Two schemes of cover construction are discussed:

1. Cover with PACCAR facility development; or
2. Cover without site development.

Cover with PACCAR Facility Development. The proposed PACCAR Facility Development would include a significant area of concrete slabs and asphalt paved parking areas and access roadway. The concrete slabs would be reinforced and exist beneath buildings (as a ground floor slabs) and as a 100-foot-wide apron outside of the manufacturing building. Both the concrete slab and asphalt paving would be effective covers for soils. Some areas may be covered solely with structural fill. The proposed future site development is shown on Figure 6-6.

The minimum extent of the cover for soils with contaminants exceeding the RAOs is shown on Figure 6-5. This area represents about 270,000 square yards.

A portion of this minimum cover is outside of the concrete slab or asphalt. In those areas, a structural fill cover will be constructed.

Typical cross sections of concrete, asphalt, and structural fill covers are given on Figure 6-7. These thicknesses are typical of past remediation projects and were used primarily for cost estimating purposes. Exact thickness and nature of layers may change during final PACCAR Facility and remedial action design.

We estimate that the cover areas will be as follows:

Concrete Building Slabs	72,000 square yards
Concrete Apron	48,000 square yards
Asphalt Parking and Roads	17,000 square yards
Structural Fill (Finished with Vegetative Cover)	133,000 square yards
Total Minimum Cover Area	270,000 square yards

Design details would be necessary to provide continuity between cover systems.

Cover without Site Development. In the event the PACCAR Facility is not constructed, this alternative would consist of placing a geomembrane and structural fill cover.

Approximately 133,000 square yards would be covered by the structural fill and approximately 137,000 square yards would be covered by the geomembrane (equivalent to building and parking areas for development). This cover may be revised to suit interim or other site use. For example, given the site location, the area to be covered could be utilized as vehicle parking or storage. For those site uses, asphalt paving cover could be utilized.

Final ground elevations after cover construction will not be available until after site development decisions.

The duration of cover construction is anticipated to be about 6 months.

Overall Protection of Human Health and Environment

This alternative will provide protection to human health and the environment by limiting human exposure from direct contact or direct inhalation and preventing rainwater from contacting certain contaminated soils.

Compliance with RAOs and ARARs

This alternative would meet all soil RAOs. No action-specific ARARs have been identified.

Short- and Long-Term Effectiveness

Short-Term. Short-term protection of the community and on-site workers is provided by this alternative. Though the cover construction may take 6 months, short-term protection is affected by the initial soil layers which can be rapidly placed.

Long-Term. This alternative should be effective in meeting the RAOs, i.e., by limiting exposure to and migration of contaminants in soil. Maintenance of cover systems is easily accomplished.

A Health and Safety program would be effective for protection of workers during future excavation below the cover.

Reduction of Toxicity, Mobility, or Volume

This alternative does not reduce the toxicity, mobility, or volume of contaminants in soil.

Implementability

The cover systems use conventional techniques readily available and proven to be reliable. These cover systems should, with proper maintenance/repair, last 30 to 50 years or longer.

The presence of the cover systems do not preclude additional remedial actions. Similar cover systems have been used for other sites, thus agency approval and coordination is not anticipated to be a problem.

Costs

A range of costs is given below for covers reflecting development of the PACCAR Facility or no development. Site preparation and demolition is not included in these costs. Appendix C provides additional detail.

Costs	No Site Development	Site Development
Capital Costs	$4,710,000	$5,710,000
Annual O&M Costs (30 years)	6,000	0
PRESENT WORTH	$4,800,000	$5,740,000

It should be noted that a substantial portion of the costs of the cover with PACCAR Facility Development will be a part of the costs of that development. The costs of the cover, as concrete slab and asphalt parking required for the development, are not included in this estimate.

6.3.8 Soil - Excavate and Dispose of PCB-Contaminated Soils and Dangerous Waste (Lead) Soils (Soil Alternative No. 8)

A small volume (up to roughly 700 cubic yards) of soil with PCBs exists in the northwest corner of the site. The level of PCBs in the soil is 24 mg/kg based on one sample. A small volume (about 10 cubic yards) of soil with EP Tox lead concentrations exceeding Washington State Dangerous Waste regulations exists at location F-10. Excavation and disposal of these soils is planned for all alternatives. Disposal of these soils will be at a hazardous waste landfill in Oregon or Idaho.

Clean fill would be placed in the excavations.

The duration of construction would be a few weeks.

This alternative will be accomplished. This alternative does not depend on the selection of other soil alternatives.

Overall Protection of Human Health and Environment

By removing this soil, the local environment and community would be protected by this alternative.

Compliance with RAOs and ARARs

This alternative would meet all sediment RAOs. No action-specific ARARs were identified.

Short- and Long-Term Effectiveness

Given the short duration to remove soil, this alternative would provide protection to workers and the community in both the short-term and long-term. Some liability may result from disposal of soil in a hazardous waste landfill.

Reduction of Toxicity, Mobility, or Volume

This alternative does not reduce the toxicity, mobility, or volume of the PCBs.

Implementability

Common and reliable earthwork, transportation, and disposal techniques would be used for this alternative. This alternative does not preclude additional remedial actions.

Similar work has been accomplished at numerous sites; agency approval and coordination is not expected to be a problem.

Costs

Costs are summarized below. Appendix C provides additional detail.

Costs	No Site Development	Site Development
Capital Costs	$260,000	$240,000
Annual O&M Costs and Monitoring Costs	0	0
PRESENT WORTH	$260,000	$240,000

6.3.9 Soil - Construct Cover and Biotreat or Stabilize Hot Spot and Source Control Areas (Soil Alternative No. 9/10

Description

This alternative combines the cover alternative described above (Soil Alternative No. 7) with biotreatment and stabilization of soil containing hot spot levels of contaminants (as described in Section 4.3), specifically:

Biotreatment:
- Soils with GC/FID (8015-extended) > 2,500 ppm

Stabilization:
- Soils with HPAHs > 800 ppm
- Soils with lead > 8,000 ppm
- Soils with chromium > 600 ppm
- Soils with arsenic > 100 ppm

The extent of these soils is shown on Figure 6-8.

Also shown on Figure 6-8 and included in the soils to be treated in this alternative are three "source control areas", specifically in the LW-3 area (assumed to be 150 cubic yards of soil for bioremediation), the R&D UST area (assumed to be 150 cubic yards of soil for bioremediation), and arsenic in soil area at grid location U-2 (assumed to be 100 cubic yards of soil for stabilization).

The cover system, as part of this alternative, meets the RAOs for protection of human health. The addition of biotreatment and stabilization of hot spots provides additional protection to human health and the environment. By treating soils containing about 50 percent of the mass of chemicals of concern and three "source control" areas, the character of the site will be improved significantly. Further, the use of GC/FID extended (quantified as phenanthrene response) in identifying soils to be biotreated and evaluating the success of biotreatment will result in the treatment of the most mobile hydrocarbons that could potentially affect site groundwater quality.

The biotreatment and stabilization process are identical to those described in Subsection 6.3.6. Approximately 7,800 cubic yards of soil would be biotreated, and 20,700 cubic yards of soil would be stabilized. Placement of treated soils was addressed in Table 6-3.

Three shallow monitoring wells would be constructed at both of the final placement areas of biotreated and stabilized soils.

Total duration of this alternative is about 8 months. The duration of excavation is about 2 months and the duration of treatment is about 6 months.

Overall Protection of Human Health and Environment

This alternative will provide protection to human health and the environment by limiting human exposure from direct contact or dust inhalation, preventing rainwater from contacting contaminated soils, and reducing toxicity or mobility of soil contaminants.

Compliance with RAOs and ARARs

This alternative would meet all soil RAOs. No action-specific ARARs have been identified.

Short- and Long-Term Effectiveness

Short-Term. Short-term protection of the community and on-site workers is provided by this alternative. Though the alternative completion may take 8 months, short-term protection is affected by the initial soil layers which can be rapidly placed.

Long-Term. This alternative should be effective in meeting the RAOs, i.e., by limiting exposure to and migration of contaminants in soil and reducing toxicity of petroleum hydrocarbons in soil and mobility of metals and HPAH in soil. The biotreatment, stabilization, and cover is expected to be reliable. Monitoring of reliability can be accomplished by surface observation. Maintenance of cover systems is easily accomplished.

Reduction of Toxicity, Mobility, or Volume

This alternative reduces the toxicity of petroleum hydrocarbons and mobility of metals and HPAH in soil.

Implementability

The cover systems use conventional techniques readily available and proven to be reliable. These cover systems should, with proper maintenance, last 30 to 50 years or longer. Biotreatment and stabilization also use readily available and reliable techniques.

This alternative does not preclude additional remedial actions. Similar measures have been used for other sites, thus agency approval and coordination is not anticipated to be a problem.

Costs

A range of costs is given below for covers reflecting development of the PACCAR Facility or no development. Site preparation and demobilization are not included in these costs. Appendix C provides additional detail.

Costs	No Site Development	Site Development
Capital Costs		
General	$ 870,000	$5,350,000
Construct Cover	1,620,000	0
Bioremediation	570,000	570,000
Stabilization	1,800,000	1,590,000
Annual O&M Costs (30 years)	14,400	8,400
PRESENT WORTH	$5,080,000	$7,670,000

6.3.10 Sediment - Fill Placement in Ditch (Sediment Alternative No. 3)

Description

This alternative consists of filling the ditch (containing sediments with PCBs) and the pond area with imported sand and gravel. A geotextile would be placed prior to sand and gravel placement to further limit migration of sediments. Depending on eventual site use, the various concrete walls and structures may or may not be demolished. The duration of construction is a few weeks. The location of the ditch and a schematic cross section of ditch filling is shown on Figure 6-9.

Overall Protection of Human Health and Environment

By limiting sediment migration, this alternative would protect human health and environment.

Compliance with RAOs and ARARs

This alternative would meet all sediment RAOs. No action-specific ARARs have been identified.

Short- and Long-Term Effectiveness

Given the short duration of construction and the immobile nature of the sediments, this alternative would provide protection to workers and the community in both the short-term and long-term. The alternative would be reliable in retaining sediments with PCBs.

Reduction of Toxicity, Mobility, or Volume

This alternative does not reduce the toxicity, mobility, or volume of the PCBs.

Implementability

The work required for this alternative uses common earthwork techniques and does not preclude additional remedial actions.

Effectiveness could be monitored using shallow monitoring wells or by analyzing soil or water quality at the downstream end of the filled ditch.

Costs

Costs are summarized below. Appendix C provides additional detail.

Capital Costs	$30,000
Annual O&M and Monitoring Costs	0
PRESENT WORTH	$30,000

6.3.11 Sediment - Excavation and Off-site Disposal (Sediment Alternative No. 5)

Description

This alternative consists of excavating all sediment with PCB concentrations greater than RAO of 1 ppm and disposing of that soil in a hazardous waste landfill. The ditch would be filled similarly to Sediment Alternative No. 3 above except no geotextile would be used. In the event that the new facility is not constructed, the ditch would be filled in a manner allowing surface water drainage. An estimated 700 cubic yards of sediment with PCBs will be excavated and disposed of. This is a conservatively high estimate based on one ditch sample analyzed for PCBs.

The duration of construction would be a few weeks.

Overall Protection of Human Health and Environment

By removing sediment, the local environment and community would be protected by this alternative.

Compliance with RAOs and ARARs

This alternative would meet all sediment RAOs. No action-specific ARARs were identified.

Short- and Long-Term Effectiveness

Given the short duration to remove sediments, this alternative would provide protection to workers and the community in both the short-term and long-term. Some liability may result from disposal of sediments in a hazardous waste landfill.

Reduction of Toxicity, Mobility, or Volume

This alternative does not reduce the toxicity, mobility, or volume of the PCBs.

Implementability

Common and reliable earthwork, transportation, and disposal techniques would be used for this alternative. This alternative does not preclude additional remedial actions.

Similar work has been accomplished at numerous sites; agency approval and coordination is not expected to be a problem.

Costs

Costs are summarized below. Appendix C provides additional detail.

Capital Costs	$270,000
Annual O&M and Monitoring Costs	0
PRESENT WORTH	$270,000

6.4 Comparative Analysis of Alternatives

This section presents a comparative analysis of the alternatives in which the alternatives are reviewed with respect to one another.

The results of the comparative analyses are shown in Table 6-4. Relative rankings have been given to alternatives for groundwater, soil, and sediment. Discussions of those rankings are given below for each medium. Comparative costs for each alternative are given in Table 6-5.

6.4.1 Groundwater Comparative Analysis

The pumping and treatment alternative has an advantage over the other alternatives with respect to meeting RAOs and effectiveness. However, the baseline condition with monitoring and institutional controls does offer effective environmental protection at a much reduced cost and allows the effects of other remedial activities to be assessed.

6.4.2 Soil Comparative Analysis

The soil alternatives 4b/5, 7, and 9/10 all rank well with respect to overall environmental protection, compliance with RAOs, and effectiveness. Alternative 7 (cover) does not rank as well in terms of reducing toxicity, mobility, or volume (compared to 4b/5 and 9/10); however, the cover offers better ranking in terms of implementability and cost by being able to accommodate site development and using aspects of that development to provide environmental protection or by using quick and simple construction techniques in the event of no site development.

The two baseline alternatives offer reduced environmental protection (as compared to the other three alternatives) with lower costs.

6.4.3 Sediment Comparative Analysis

Both alternatives rank similarly with greater costs expected for excavation and disposal.

Table 6-4(a) Comparative Analysis of Groundwater Alternatives

	Baseline Condition with Monitoring (No. 1)	Baseline Condition with Monitoring and Institutional Controls (No. 2)	Pump and Treat (No. 3)
Overall Protection of Human Health and the Environment	-	-	+
Compliance with RAOs and ARARs	-	o	+
Short-term Effectiveness	o	o	o
Long-term Effectiveness	o	o	+
Reduction of Toxicity, Mobility, or Volume	-	-	+
Implementability	+	+	o
Cost	+	+	-
Overall Analysis	o	o	+

+ = Positive
o = Neutral
- = Negative

Table 6-4(b) **Comparative Analysis of Soil Alternatives**

	Baseline Condition with Monitoring (No. 1)	Baseline Condition with Monitoring and Institutional Controls (No. 2)	Treatment and Stabilization (No. 4b/5)	Cover (No. 7)	Cover with Treatment and Stabilization of Hot Spots (No. 9/10)
Overall Protection of of Human Health and the Environment	-	-	+	o	+
Compliance with RAOs and ARARs	-	o	+	o	+
Short-term Effectiveness	-	o	o	+	+
Long-term Effectiveness	-	o	+	+	+
Reduction of Toxicity, Mobility, or Volume	-	-	+	-	+
Implementability	+	o	o	+	o
Cost	+	+	-	o	-
Overall Analysis	-	o	o+	o+	+

\+ = Positive
o = Neutral
\- = Negative

Note: No comparative analysis was performed in Soil Alternative No. 8 (excavate/dispose of soils with PCBs) as this alternative would be accomplished for any selected site remediation plan.

Table 6-4(c) Comparative Analysis of Sediment Alternatives

	Place Fill in Ditch (No. 3)	Excavate/Dispose of Sediments/Fill Ditch (No. 5)
Overall Protection of Human Health and the Environment	+	+
Compliance with RAOs and ARARs	+	+
Short-term Effectiveness	+	+
Long-term Effectiveness	+	+
Reduction of Toxicity, Mobility, or Volume	-	-
Implementability	+	+
Cost	+	-
Overall Analysis	+	+

+ = Positive
o = Neutral
- = Negative

Table 6-5 - Comparison of Present Worth Amounts

Alternative	Description	Present Worth: Without Site Development	Present Worth: With Site Development
Groundwater 1	Baseline/Monitoring	$ 920,000	$ 940,000
Groundwater 2	Baseline/Monitoring/ Institutional Controls	$ 1,110,000	$ 1,130,000
Groundwater 5	Pumping and Treatment	$ 2,870,000	$ 2,900,000
Soil 1	Baseline/Monitoring	$ 940,000	$ 6,690,000
Soil 2	Baseline/Monitoring/ Institutional Controls	$ 1,070,000	$ 6,820,000
Soil 4b/5	Biotreatment and Stabilization	$14,260,000	$19,240,000
Soil 7	Cover	$ 4,800,000	$ 5,740,000
Soil 9/10	Cover with Biotreatment and Stabilization of Hot Spots	$ 5,080,000	$ 7,670,000
Sediment 3	Fill Ditch	$ 30,000	$ 30,000
Sediment 5	Excavation and Off-site Disposal Fill Ditch	$ 270,000	$ 270,000
Common to all Alternatives:			
Soil 8	Excavation and Disposal of PCB and Dangerous Waste Soils	$ 260,000	$ 240,000

Note:
1. Present Worth Amounts are based on 5 percent discount rate before taxes and after inflation.
2. Cost differences between the with and without soil development scenarios are a result of additional remediation potential during development, development budgets which may include certain remediation components (e.g., pavement), and other detailed factors. Please refer to cost tables in Appendix C.

6.4.4 Preferred Alternatives

The preferred alternatives for this site are:

- o Groundwater - Baseline monitoring (No. 1).
- o Soil - Cover with treatment and stabilization of hot spots (No. 9/10).
- o Excavate/dispose of specified soils with PCBs and dangerous waste (lead) soils (No. 8).
- o Sediment - Excavate/dispose of sediments/fill ditch (No. 5).

The comparative and detailed analyses indicate that these selected alternatives represent the best combination of alternatives in meeting effectiveness, implementability, and cost. While groundwater alternatives No. 2 and No. 3 (pump and treat) ranked higher than No. 1, the combined effect of all of these alternatives should improve groundwater quality. The necessity of pump and treat is not, therefore, certain as groundwater quality is expected to improve as the remediation is accomplished.

Monitoring will be conducted to assess the effects of the soil and sediment remediation.

Groundwater Treatment Process Diagram
Groundwater Alternative 5

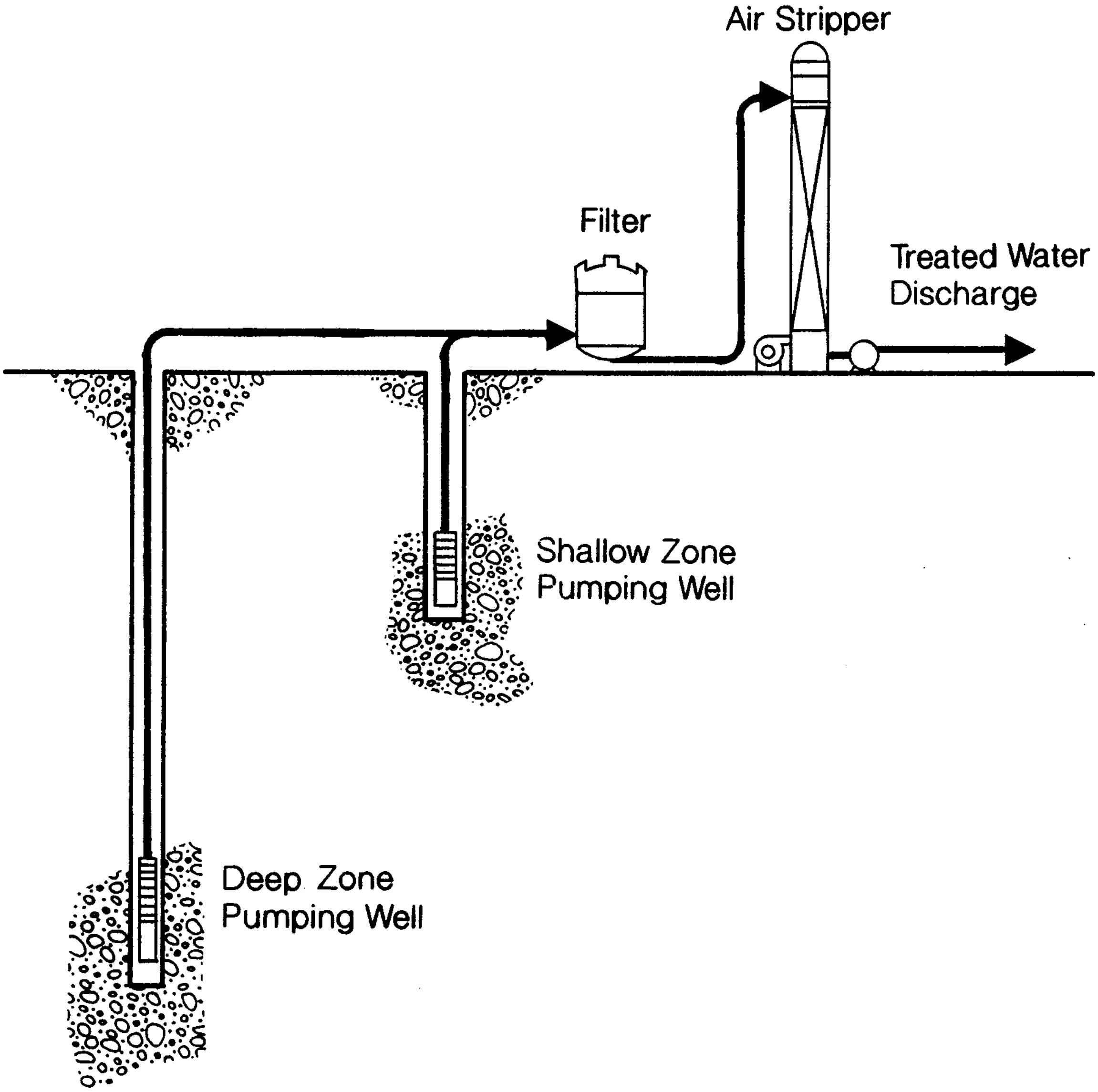


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Figure 6-2

Extent of Soil Contamination above Remedial Action Objectives

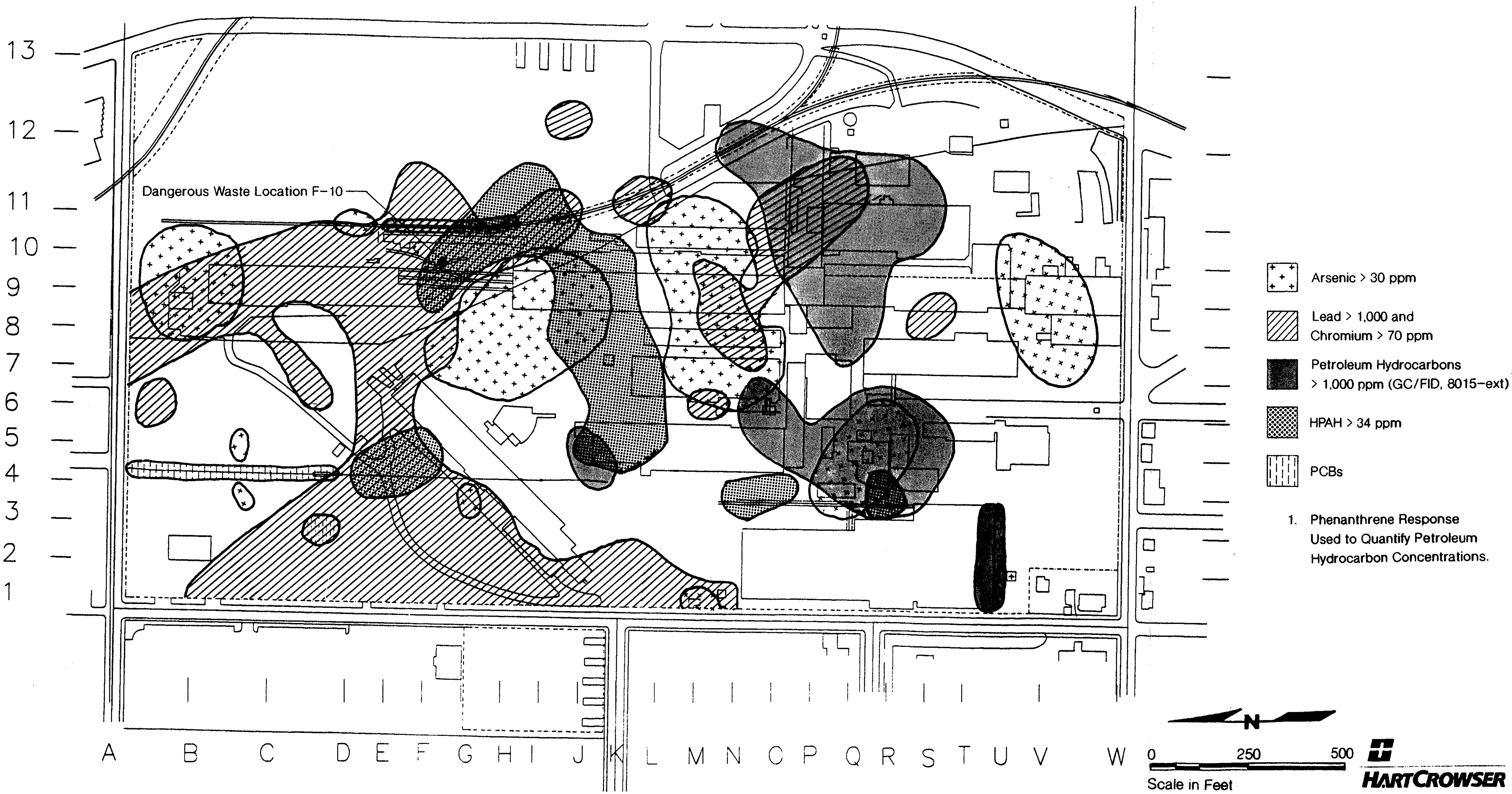

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Figure 6-3

Process Diagram of Biotreatment and Stabilization

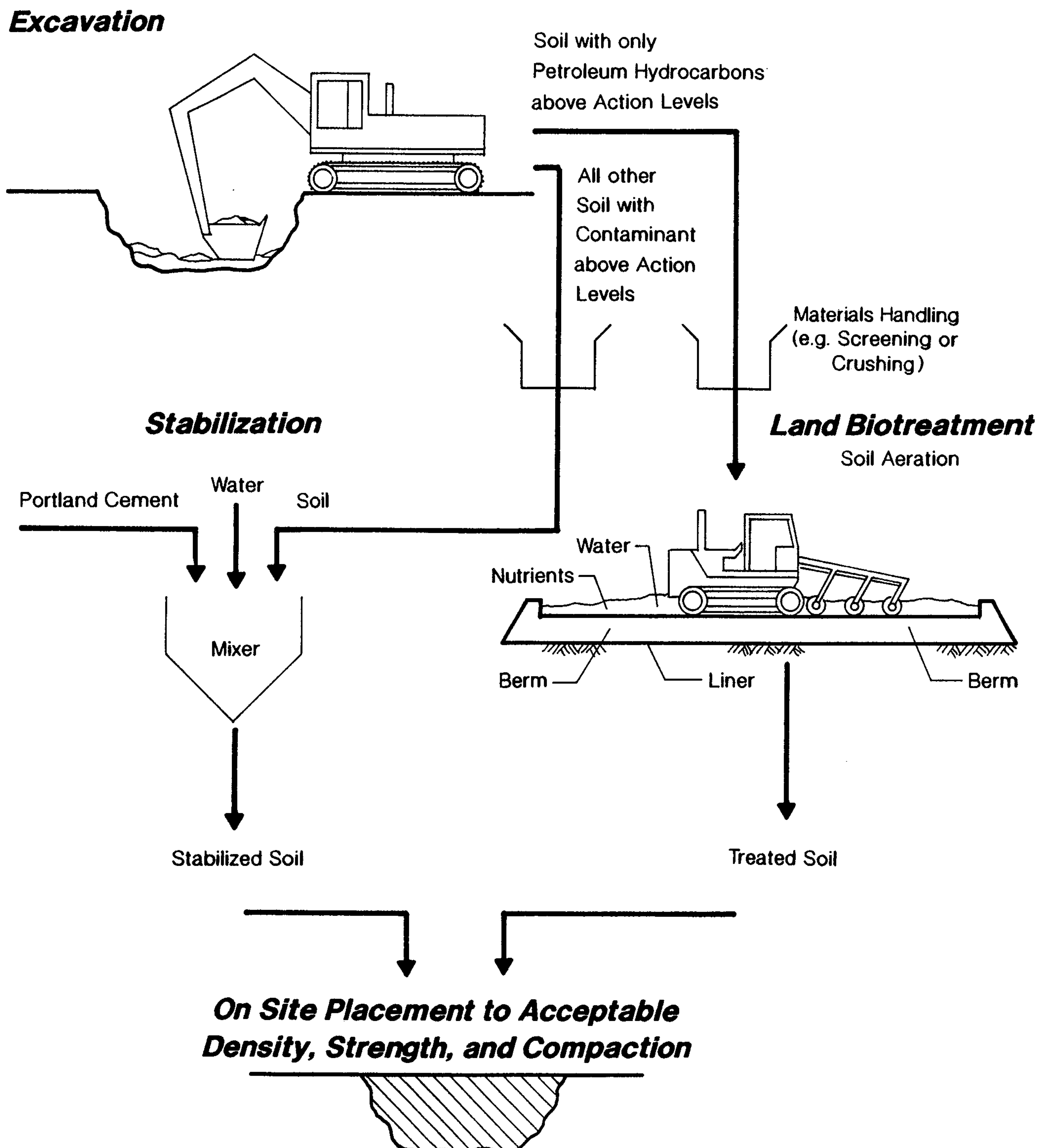

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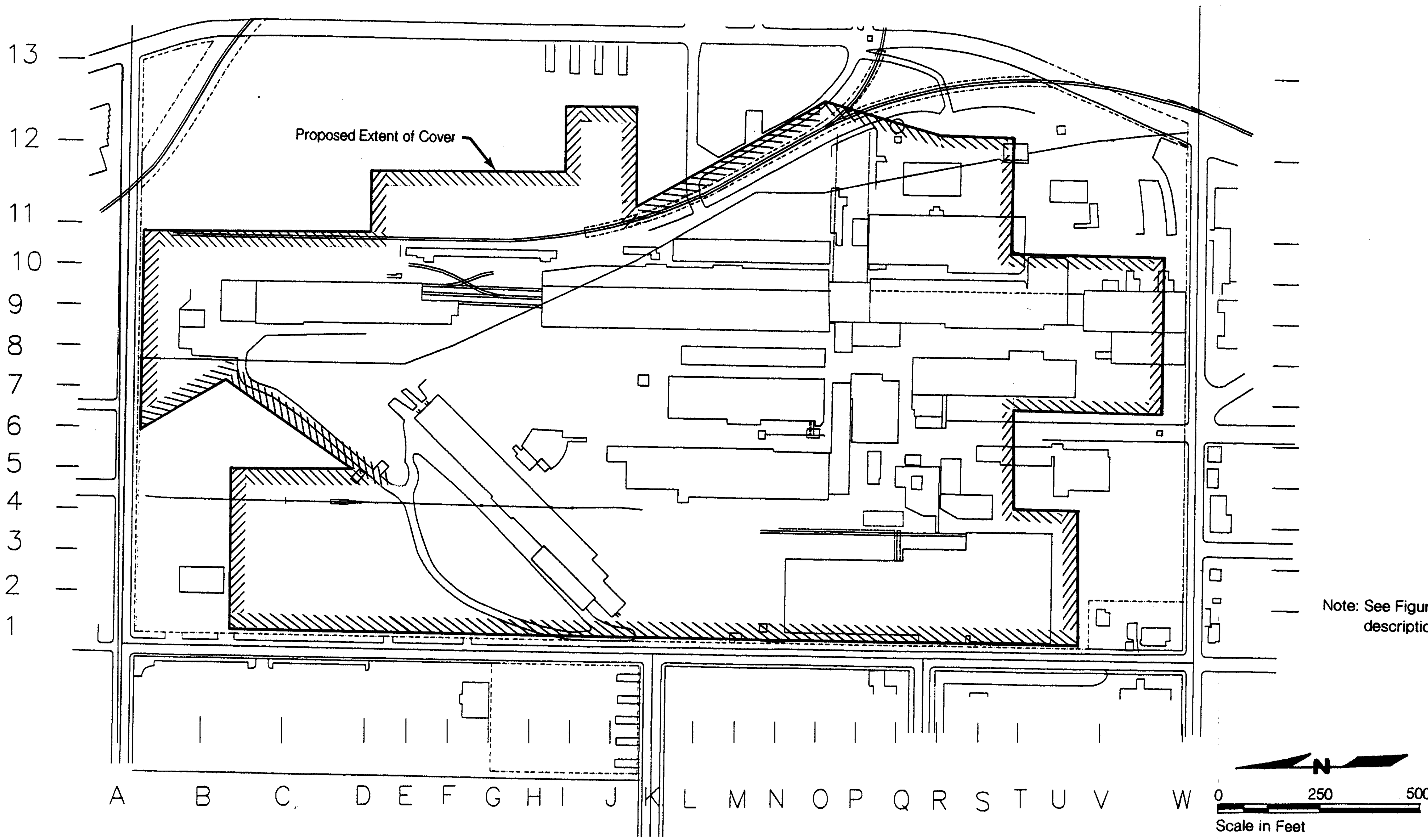
Figure 6-4

Extent of Cover System



Note: See Figure 6-7 and text for description of Cover Systems.

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Figure 6-5

Proposed Future Site Development

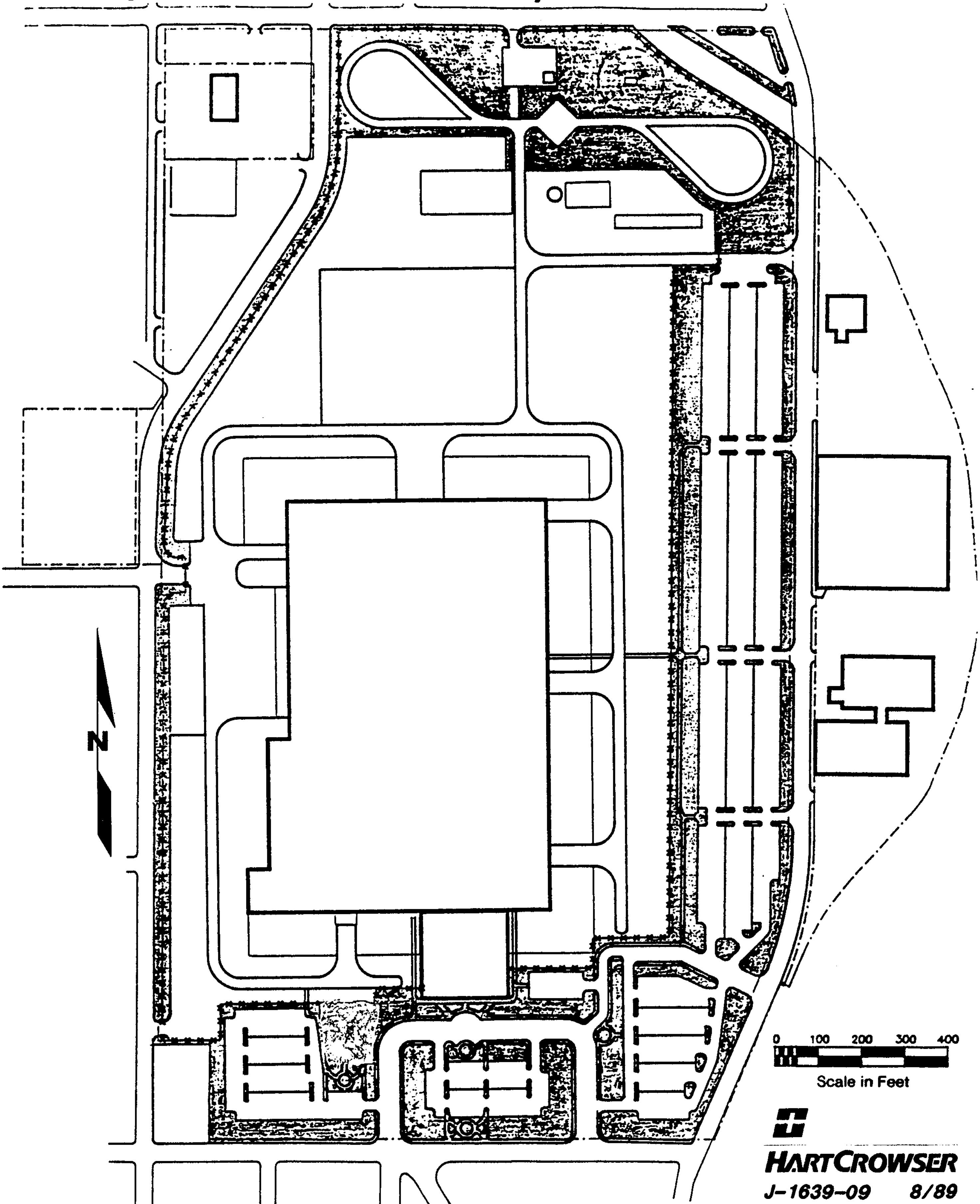

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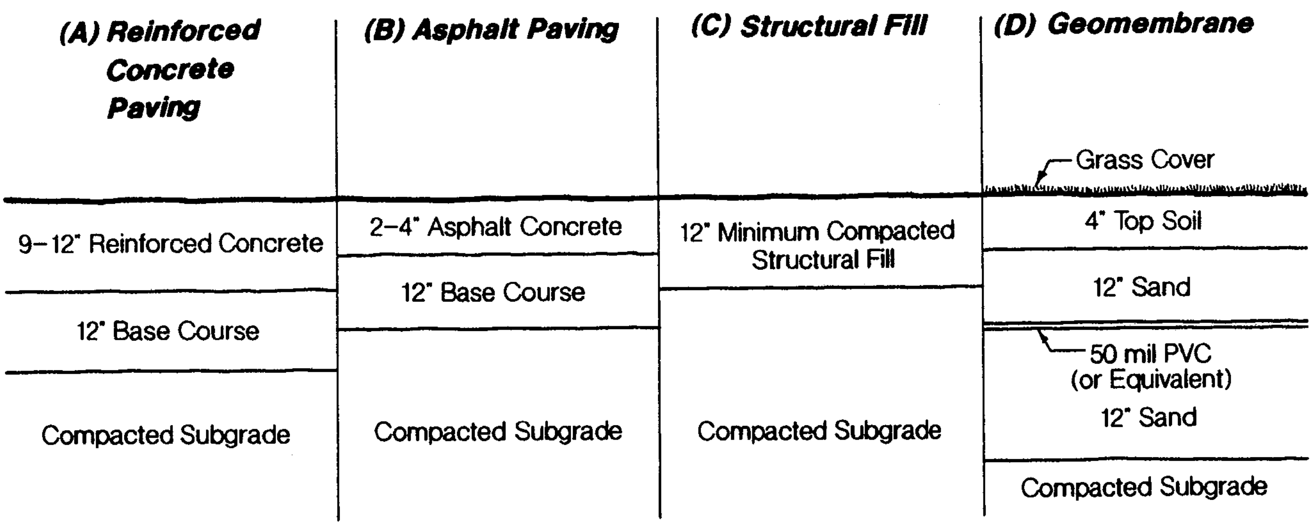
Figure 6-6

Typical Cover Systems Cross Sections



Note: Refer to text for applicability of each Cover System.

Dimensions of Cover Systems (A) or (B) may vary with details of future site development plans.

Preliminary, for cost estimation purposes only.

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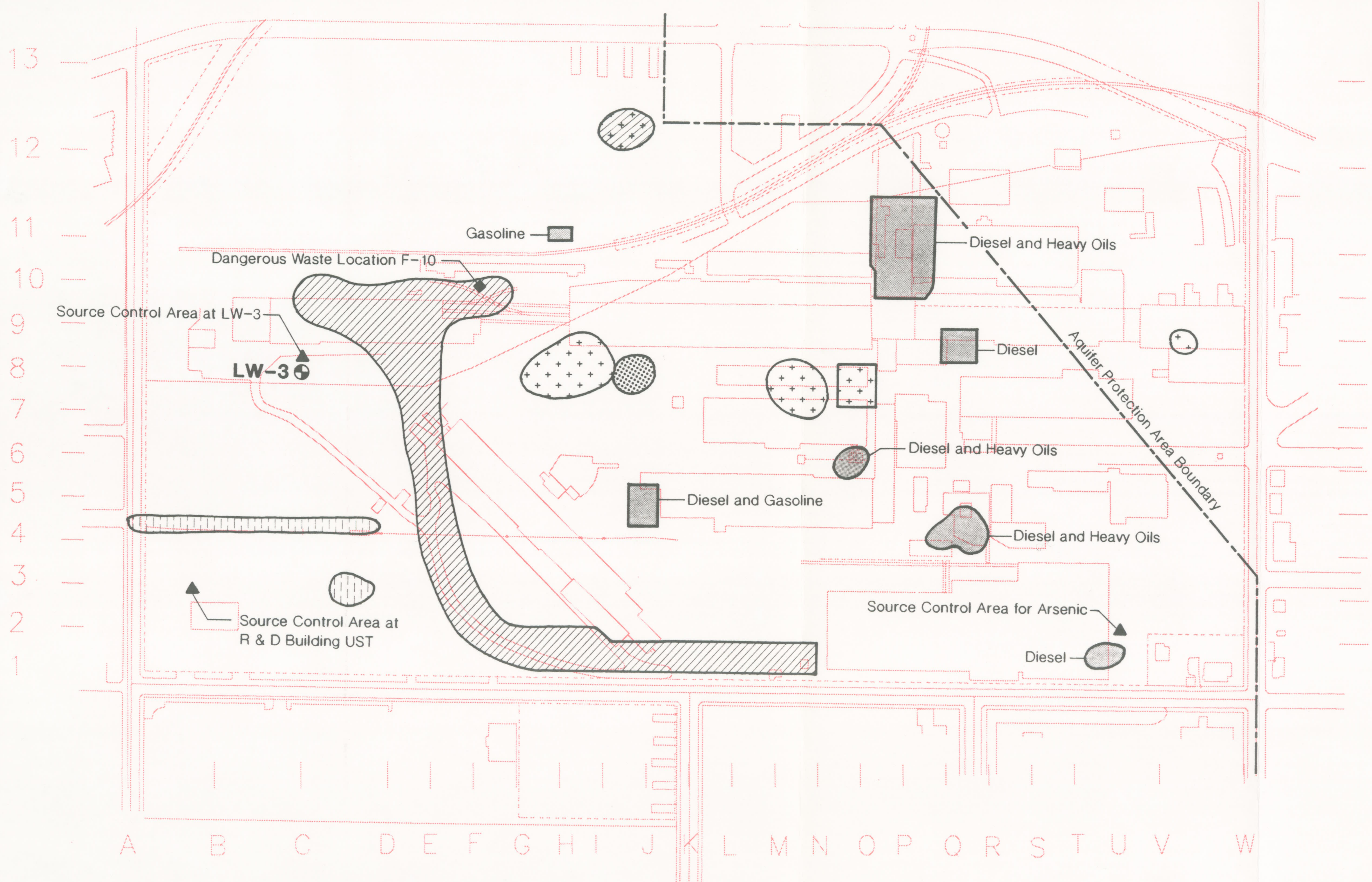
Figure 6-7

Approximate Extent of Contaminated Soil to be Excavated[1] *Under Soil Alternatives 8 and 9/10 and Sediment Alternative 5*



[1] Arsenic, Lead, Chromium, and HPAH Soils will be excavated and stabilized under soil alternative 9/10.

Petroleum Hydrocarbons Soils will be excavated and biotreated under soil alternative 9/10.

PCB Soils and Dangerous Waste Soils will be excavated and disposed of off-site under soils alternative 8.

PCB Sediments will be excavated and disposed of off-site under sediment alternative 5.

[2] Phenanthrene Response Used to Quantify Petroleum Hydrocarbon Concentrations

Arsenic > 100 ppm

Lead > 8,000 ppm and Chromium > 600 ppm

Diesel - Tentative Characterization Based on GC/FID Signatures

Petroleum Hydrocarbons > 2,500 ppm (GC/FID, 8015-ext.)[2]

HPAH > 800 ppm

PCBs

LW-3 Monitoring Well Location and Number

N

0 250 500

Scale in Feet

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J-1639-09 1/90

Figure 6-8

Location of Ditch with PCBs in Sediments

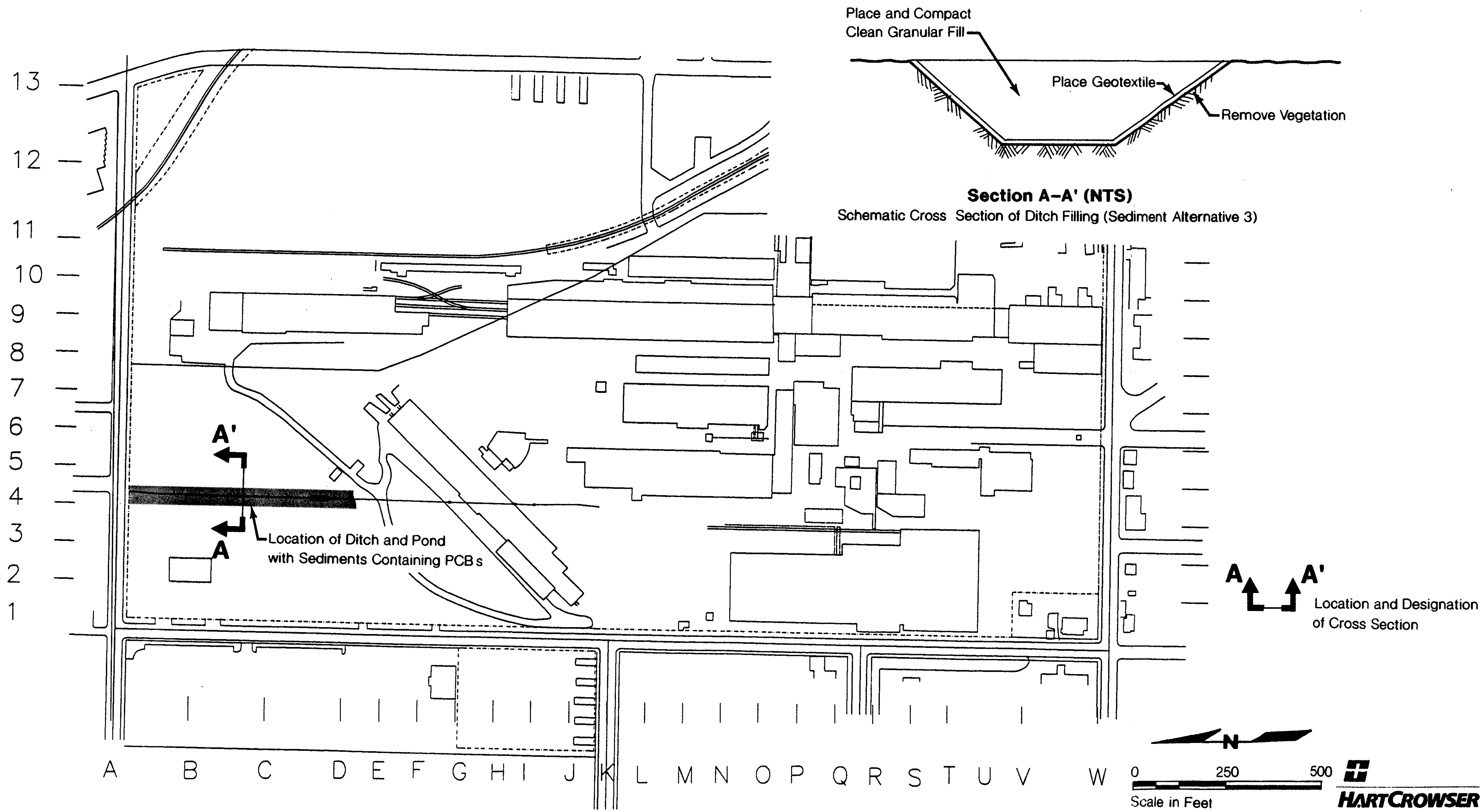

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Figure 6-9

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APPENDIX A
VOLUME ESTIMATES

APPENDIX A
VOLUME ESTIMATES

Volume estimates were used in the feasibility study to judge the applicability of technologies and to estimate the costs of remedial action alternatives.

This appendix presents the procedures used to estimate volumes of groundwater, soil and sediment at the PACCAR site. The appendix is organized by media as follows:

- Groundwater Volume Estimates - provides the key assumptions and methods used to estimate the pumping flow rate achievable from wells in the shallow and deep groundwater-bearing zones.
- Soil Volume Estimates - provides the key assumptions and methods used to estimate the volume of soil with contaminant concentrations above the RAOs and the volume of soil in hot spot locations.
- Sediment Volume Estimates - provides the key assumptions and methods used to estimate the volume of sediments with contaminant concentrations above the RAOs.

GROUNDWATER VOLUME ESTIMATES

Analysis of the pump and treat groundwater alternative -- groundwater alternative no. 5 -- required estimates of achievable flow rates. The pump and treat system would pump groundwater from the shallow and deeper water-bearing zones.

Results. We estimated the flow rate from the shallow zone to be 30 to 50 gallons per minute (gpm), and the flow rate from the deeper zone to be 100 to 200 gpm. We used a combined flow rate of 200 gpm in the screening and evaluation of the pump and treat alternative.

Groundwater Pumping System

The general assumptions regarding the well system design are as follows:

- o No hydraulic connection between upper and lower sand units. Separate wells needed in each unit.

- o Transmissivities with each sand unit are constant.

- o Range of conductivities in Table 5-1 of the Remedial Investigation Report (RI) apply.

- o Well system must generate enough drawdown to capture all flow below site and draw some flow from area west of site.

- o Well system must withdraw at least twice the calculated flux. At least one-half of the water pumped will be derived from the eastern side, below the site. Radial flow to the well will also generate some flow from the western side, but based on the gradient (Figure 5.9 in RI), most flow will be from the eastern side.

The assumptions regarding shallow zone pumping are as follows:

- o Average well depth is 30 to 40 feet below ground surface.

- o Depth to groundwater is 5 feet below ground surface.

- o Alignment of wells is along Garden Avenue, western boundary of the property, downgradient of the property.

- o Number of wells is 7 to 15.

The assumptions regarding deeper zone pumping are as follows:

- o Average well depth is 130 feet below ground surface.

- o Depth to groundwater is 5 feet below ground surface.

- o Alignment of wells is along Garden Avenue, western boundary of the property, downgradient of the property.

- o Number of wells is 4 to 6.

Flux Calculations

Groundwater fluxes were estimated using the equation Q = K i A where:

Q is the flux in cubic feet per second (cfs)
K is the hydraulic conductivity in feet per second.
i is the groundwater surface gradient.
A is the cross-sectional area in square feet.

A range of fluxes was calculated by assuming a range of K values from Table 5-1 of the RI. The assumptions which apply to these calculations are as follows:

- Vinyl chloride used to define extent of contamination (Figures 6.70 and 6.71 from RI).
- Flow direction and average horizontal gradients for upper sand, upper aquitard, and lower sand from RI.
- Vertical flow not included in calculations.
- Cross-sectional areas for each unit along Garden Avenue were estimated from stratigraphy presented in the RI.

SOIL VOLUME ESTIMATES

Results. Two sets of soil volume estimates were used in the Feasibility Study. The first volume estimates, presented in Table 4-2, are based on the RAOs for each constituent. For example, removing all soil above the RAO concentrations would require removing the volumes indicated in Table 4-2.

The second set of volume estimates represent the quantity of soil containing about 50 percent of the mass of contaminants. For example, removing all soil with lead above the "50 percent decrease level" would result in about 50 percent less mass of lead in the contaminated areas.

RAO Volume Estimates

The procedure used was as follows:

- o The concentration contour maps presented in the RI were used to delineate the areas exceeding the RAOs.
- o Areas were computed. The areas represented each contaminant and mixtures of contaminants.
- o Volumes were computed by multiplying areas by the appropriate depth. These are in-place volumes because swelling upon excavation was not included. Increased volumes due to swelling were used as appropriate in cost estimates.

The assumptions which apply are as follows:

- o The contour maps were drawn assuming linear trend distribution of contaminants between data points.
- o Maximum soil depth for remediation was the depth of the silt layer. This assumption minimizes excavation and disturbance of the silt layer. In general, the majority of samples with concentrations exceeding RAOs were above the silt layer. Therefore, we chose to protect the silt layer.
- o Remediation of soil exceeding a total HPAH concentration of 35 ppm results in meeting the RAO of an overall site average carcinogenic PAH (CPAH) concentration of 3.5 ppm.

HPAH Remediation Concentration Resulting in an Overall Site Average CPAH Concentration of 3.5 ppm

The overall site average for HPAH concentration was calculated according to the following assumptions:

- o Only data values from 0 to 2.5 feet were used. Most HPAH contamination and potential exposure occurs in the 0- to 2.5-foot-depth interval.
- o Each data point was assumed to represent an equal volume of soil.

- o The entire volume of soil was assumed to be adequately sampled and represented. Samples were collected on 100-foot and 200-foot sampling grids. Over 600 samples were visually classified and screened in the field for volatile compounds. Over 200 samples were analyzed for petroleum hydrocarbons and priority pollutant metals.

Procedure

- o The 119 data points taken from 0 to 2.5 feet were ranked from least to greatest HPAH concentration.

- o The overall site average was computed as the arithmetic average of the concentrations weighting each data point equally.

- o Using correlation analysis, the risk-based remedial action objective of 3.5 ppm CPAH is equivalent to an HPAH concentration of 6.7 ppm.

- o The effective remediation value was selected by an iterative process to determine the value which brings the site average below 6.7 ppm HPAH.

- o To simulate remediation, values above a certain arbitrary value were replaced with zero and new use average calculated.

- o 35 ppm was determined to be the effective remediation value which when implemented would result in an overall site average concentration below 6.7 ppm HPAH.

Soil Volumes Representing 50 Percent Contaminant Mass Decrease

Results. Table 4-3 presents the volumes which represent a 50 percent contaminant mass decrease. Figures A-1 through A-6 show the relationship between the volume of soil remediated and the corresponding decrease in contaminant mass. These figures were used to determine the concentrations which would result in a cost-effective mass decrease. As shown on the figures, at about 50 percent mass decrease the volume begins to increase with a corresponding decrease in the mass of contaminant being treated. The volumes shown in these figures are relative volumes only. Final volumes for alternative detailed analyses were computed using contour maps, as above.

Procedure. The procedure used was as follows:

- o The soil volume exceeding the RAOs for each contaminant was divided by the number of concentration data points exceeding the RAOs.
- o The mass of soil representing each data point multiplied by the concentration of that data point resulting in the mass of contaminant for each data point.
- o The masses for each data point were summed, resulting in a total contaminant mass.
- o Figures A-1 through A-6 were constructed by sequentially changing to zero the concentrations of ranked data points.
- o The concentration corresponding to a 50 percent contaminant mass reduction was used to estimate volumes. The volume computation procedure used the contour maps and was identical to the procedure used to estimate soil volumes corresponding to the RAOs.

The assumptions which apply are as follows:

- o In-place density of the soil is 3,000 pounds per cubic yard.
- o The contour maps were drawn based on continuous first derivative interpolation of spot concentration data. This contouring technique was judged to be consistent and representative.
- o Each data point was assumed to represent an equal volume of soil.
- o The entire volume of soil was assumed to be adequately sampled and represented. Samples were taken at 100-foot and 200-foot grid points. Over 600 samples were visually classified and field screened for volatile contaminants. Over 200 samples were analyzed in the laboratory.

SEDIMENT VOLUME ESTIMATES

Sediments with contaminant concentrations exceeding the RAOs occur only in one ditch and pond area in the northwest portion of the site. Only one sample had contaminant levels (PCBs) above the RAOs. For a conservative estimate we considered the entire length of the ditch (from N. 8th St. to the pond) for remediation. The volume of "contaminated sediments" was estimated by multiplying the bottom and sidewall areas of the ditch and pond by a one-foot assumed depth.

ARSENIC MASS DECREASE

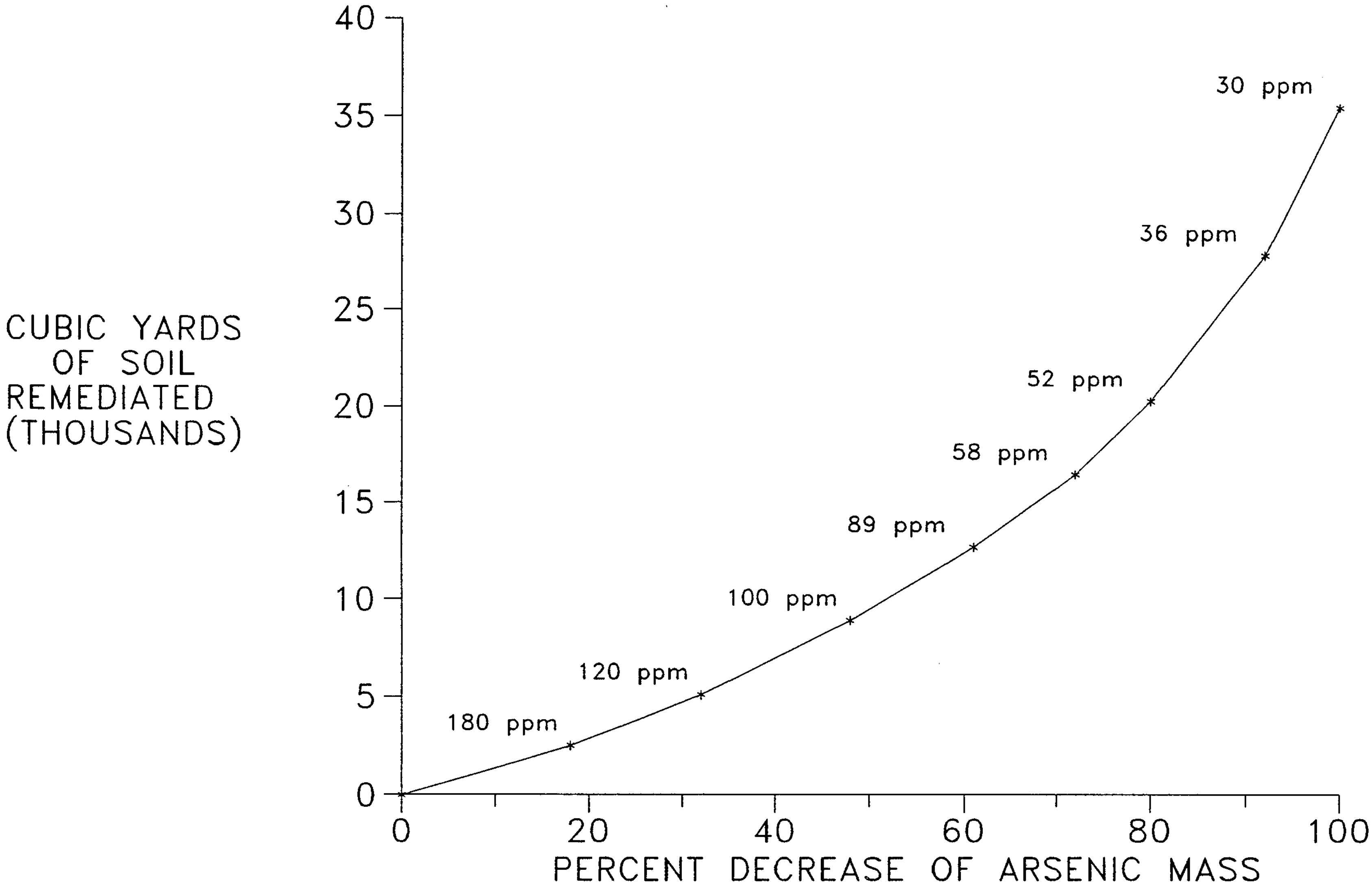

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FIGURE A-1

HPAH MASS DECREASE

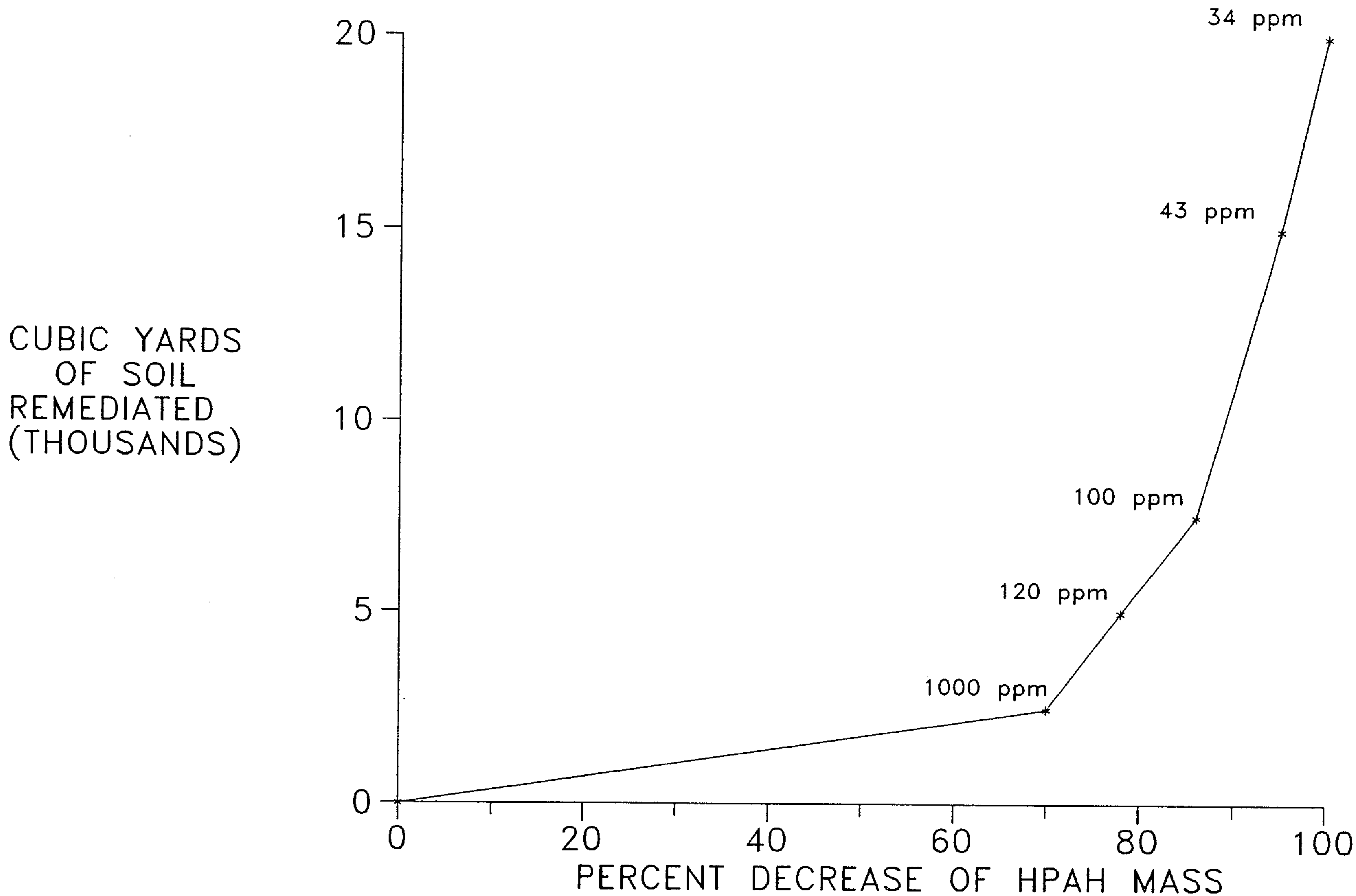

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FIGURE A-2

LEAD MASS DECREASE

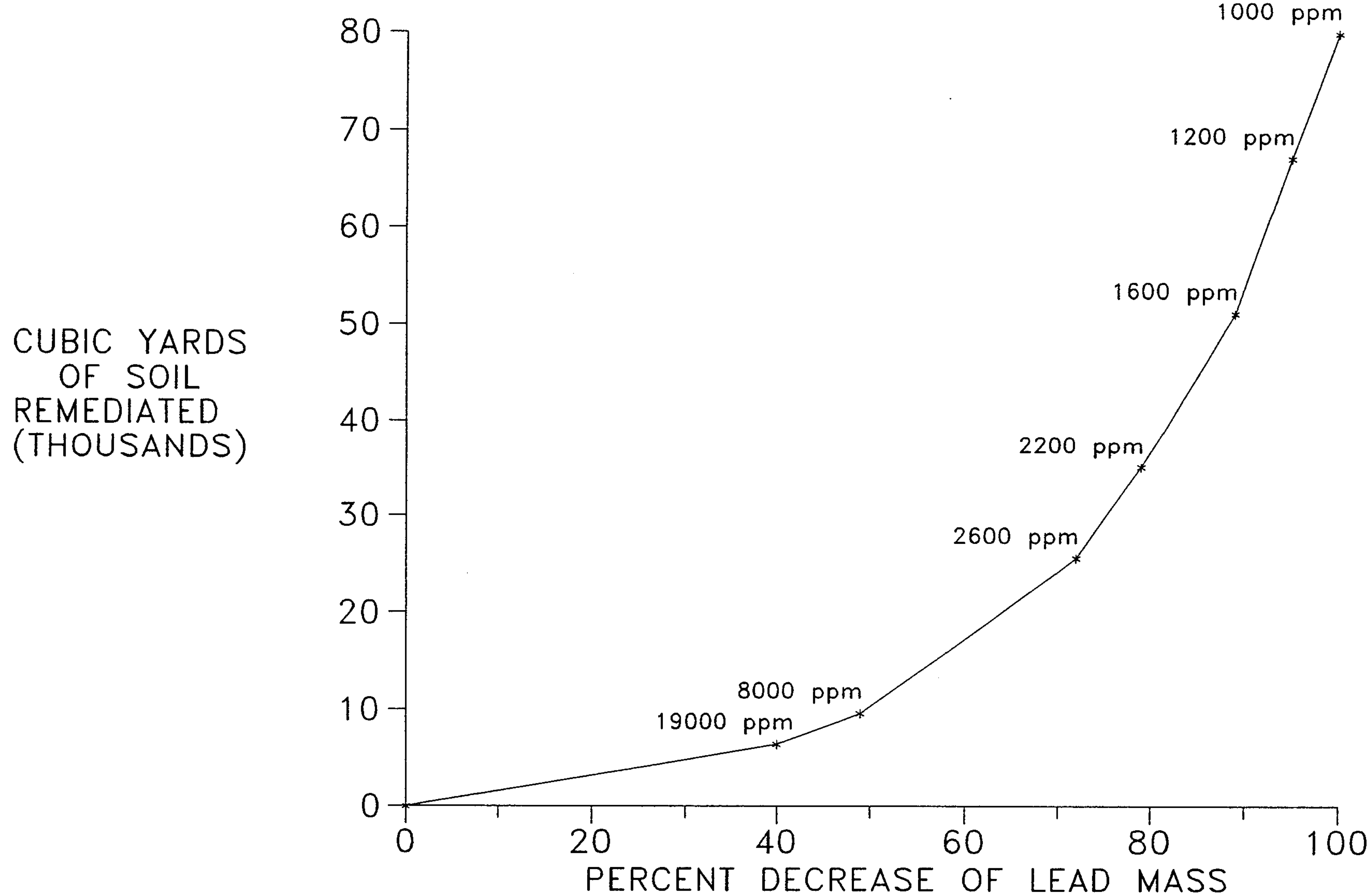

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FIGURE A-3

CHROMIUM MASS DECREASE

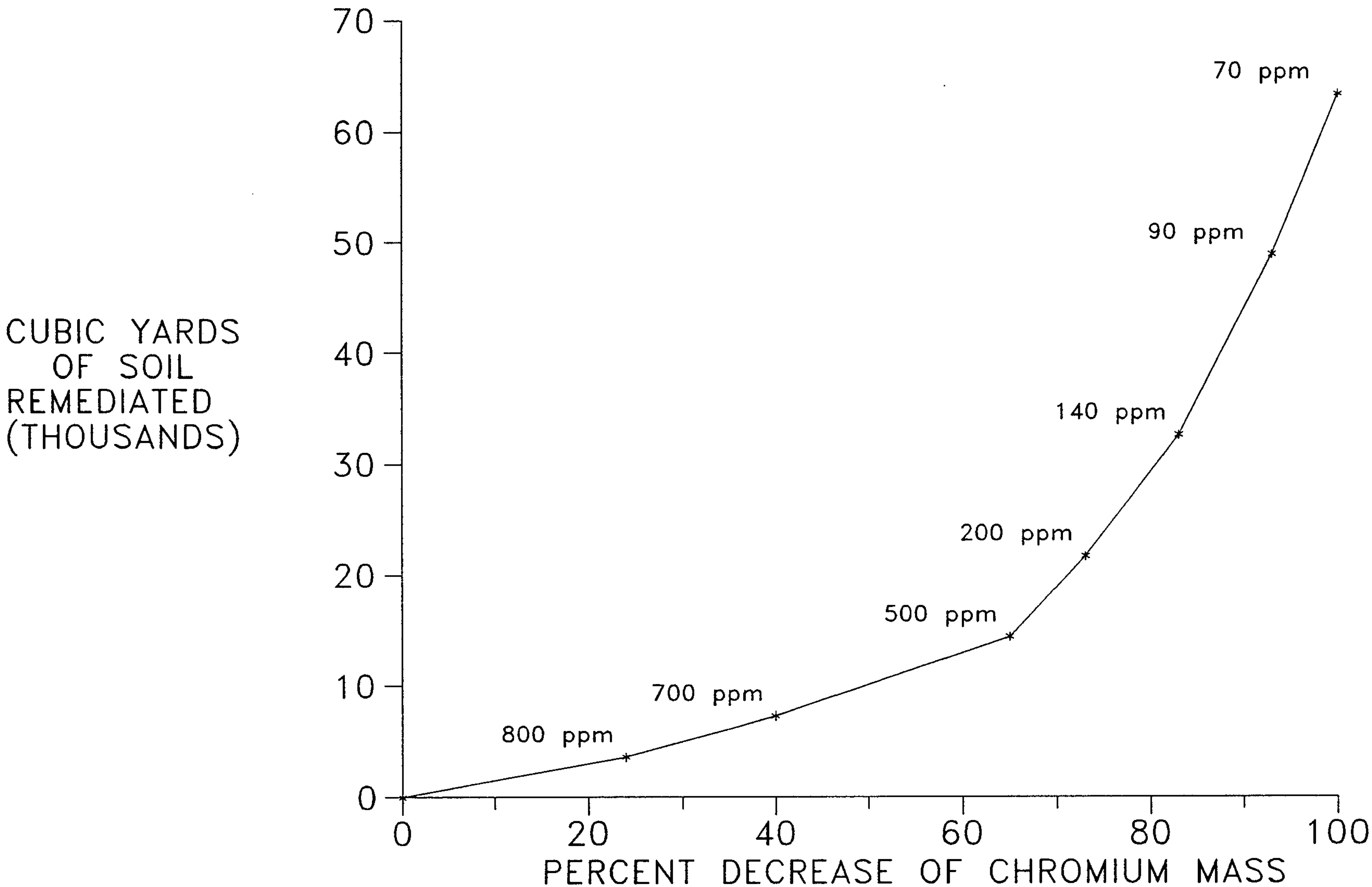

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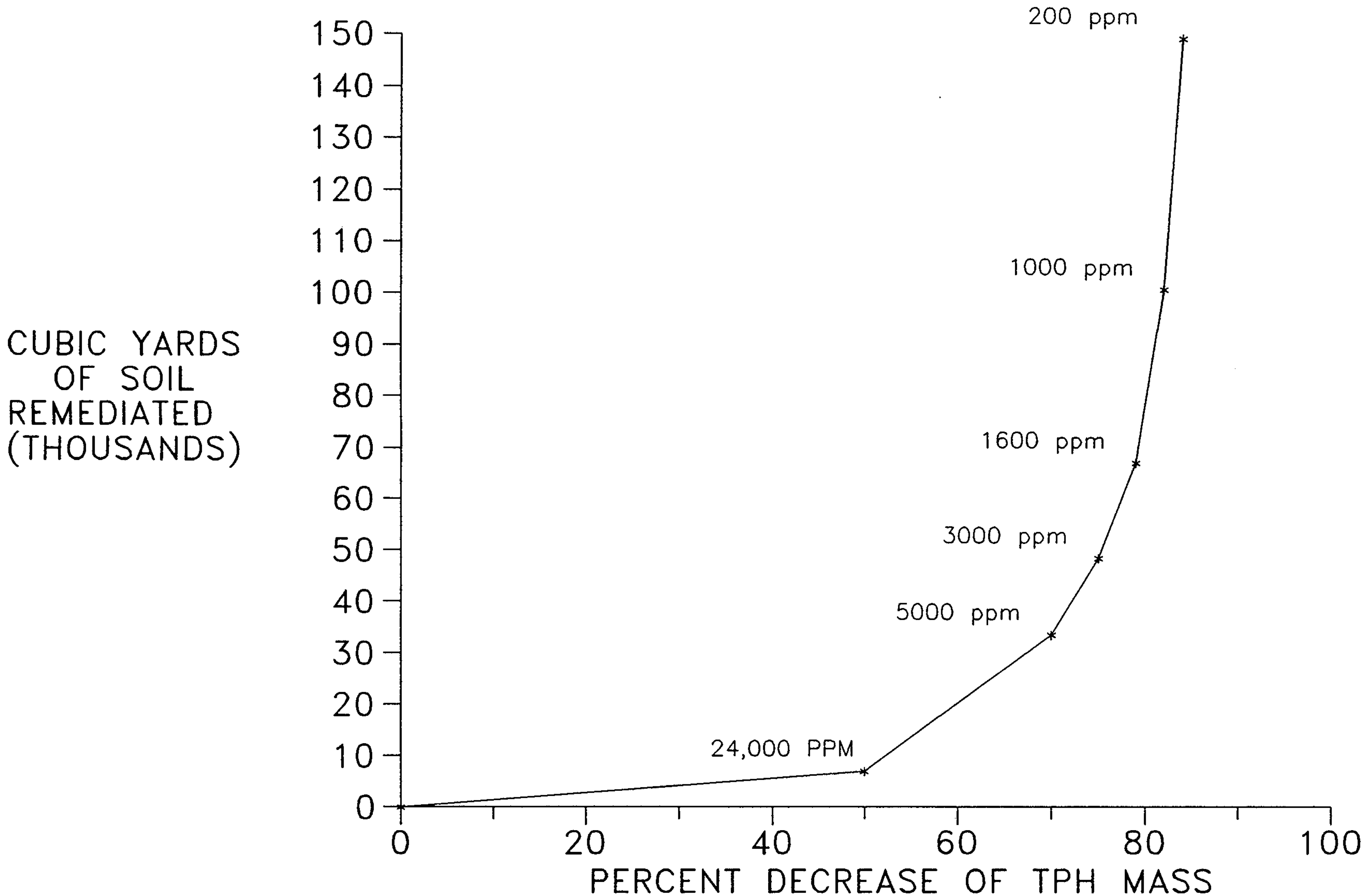
FIGURE A-4

TPH MASS DECREASE



Cubic yards of soil for 200 ppm and 24,000 ppm were estimated using contour maps.

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FIGURE A-5

GC/FID Mass Decrease

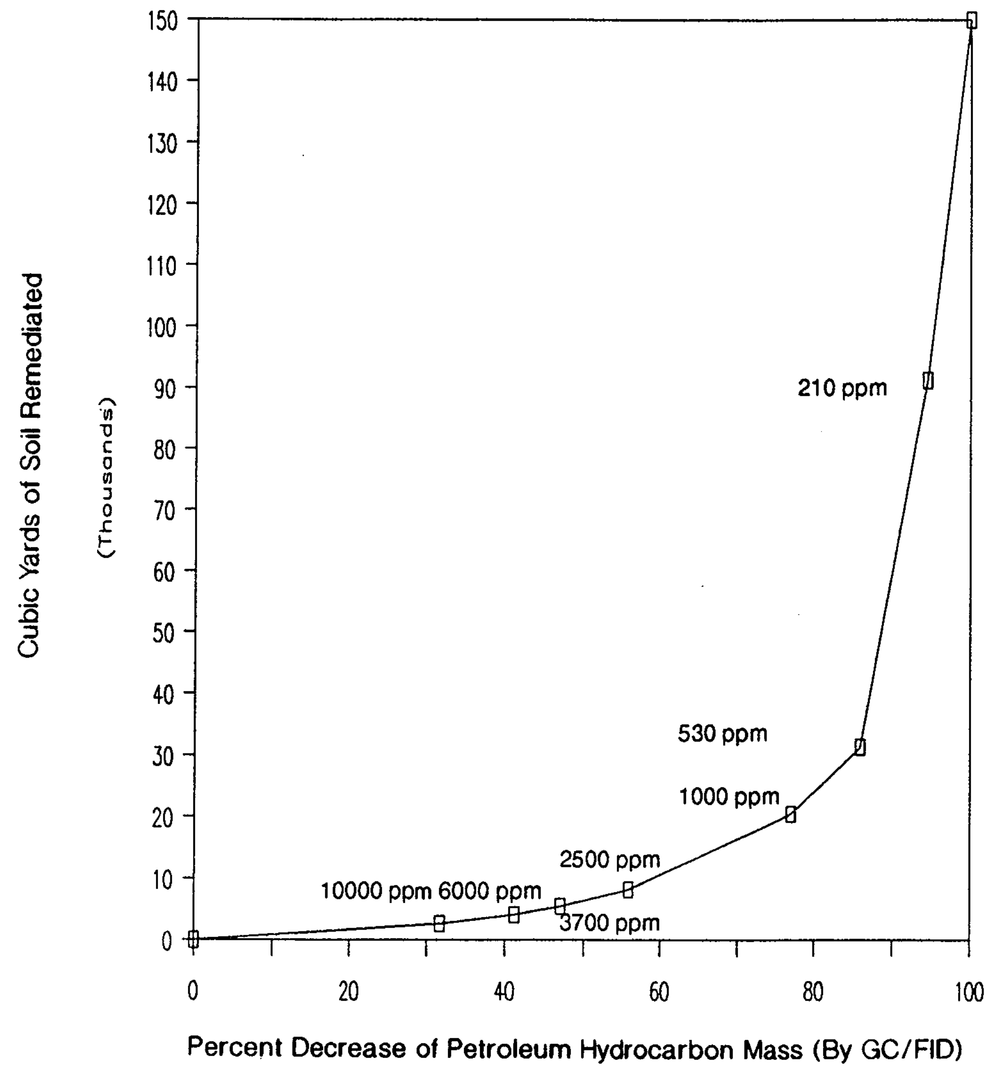

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Figure A-6

APPENDIX B
REMEDIAL TECHNOLOGIES

APPENDIX B
REMEDIAL TECHNOLOGIES

This appendix discusses the potentially applicable remedial technologies listed in Section 4. The technologies are grouped according to general response action categories in the same order as Tables 4-4 and 4-5.

MONITORING FOR GROUNDWATER, SOIL, AND SEDIMENT

Monitoring is used for two main purposes:

- To check the effectiveness of remedial actions; and

- To check for worker and public safety as part of a health and safety plan.

Monitoring is conducted on any medium that can become contaminated -- air, groundwater, surface water, or soil.

For all of these media, the procedure is essentially the same: the medium is sampled at a representative point and tested for the contaminant of concern.

Groundwater is sampled using monitoring wells. Soil monitoring is accomplished by sampling airborne dust.

Health and Safety Plan

Under this response, only people who are trained and equipped with appropriate safety gear are permitted to excavate on the site. This reduces direct soil and groundwater contact pathways and therefore reduces risk.

INSTITUTIONAL CONTROLS FOR GROUNDWATER, SOIL, AND SEDIMENT

Institutional controls such as access restrictions and use restrictions reduce risk by reducing public exposure.

Use Restriction

Use of groundwater may be restricted to reduce public exposure.

Access Restriction

Access restriction includes physical barriers such as fences and signs as well as legal barriers such as deed restrictions and zoning laws.

Fence. A fence can be used as both a physical barrier preventing entry and as a marker for a boundary. A tall fence is used to prevent access by animals such as deer. A fence using barbed wire may prevent access by people. On the other hand, a simple fence can be used to mark the boundary where protective gear is required.

Fencing is rarely used alone. But most remedial alternatives including fencing.

Fences require very little maintenance. They may require rehabilitation or replacement every 10 to 30 years.

CONTAINMENT OF GROUNDWATER

Containment uses physical barriers to prevent migration of the contaminants into the environment. Elements of containment include one or more layers of a cap over the material, a vertical barrier around the material, or a horizontal barrier under the material.

At the PACCAR site, the natural silt unit at a depth of about 1 to 8 feet appears to be limiting migration of contaminants from unsaturated soils to groundwater. Therefore, the cap element is not applicable for containment of groundwater.

CONTAINMENT OF SOIL AND SEDIMENT

For contaminated soil at the PACCAR site, only the cap element is applicable.

Cap elements can be further distinguished by the transport mechanism they are designed to prevent. These include:

- o Cover to prevent transport by rainfall directly on the site;
- o Dust control to prevent transport by wind; and

- o Surface water control to prevent transport by off-site run-on.

Cover

A cover could include compacted soil, structural fill, or clay, a geomembrane (plastic liner), asphalt, asphalt concrete, Portland cement concrete, or a combination of these materials. In addition to prevention of infiltration of rainwater, where required, the cover would also prevent direct contact with the soil and emission of dust.

Dust Control

Dust control typically consists of a simple form of cover designed only to prevent the wind from generating dust. Several forms are available including vegetation, dust suppressants, water spraying, and wind fences.

Vegetation. Exposed areas of soil are planted with vegetation -- usually grass -- to bind surface particles. This alternative has the advantage that it also helps prevent erosion. The grass does require maintenance in the form of periodic mowing and fertilizing. Vegetation can be used to prevent erosion of a protective cover.

Dust Suppressants. Some form of non-volatile liquid (such as liquid asphalt) is sprayed on the soil to bind the particles to the surface. This method has the advantage over water in that the liquid does not require frequent reapplication. However, the "membrane" formed by the suppressant is subject to damage and the liquid used may contribute contaminants to the soil.

Water Spraying. Water spraying is often used in standard construction practice. It is most commonly used on construction haul roads and other temporary activity areas. Dust is kept down simply by spraying it with water on a regular basis. During the summer time, application rates of once every 15 to 30 minutes are common.

Wind Fence. Wind fences are vertical barriers that deflect the wind from the area of exposed soil. They can be constructed from trees or artificial materials. In construction, wind fences are most commonly associated with stockpiles and take the form of plastic sheeting placed over the pile.

Surface Water Collection and Control

Surface water control features include ditches and site grading. These are designed to enhance runoff and to prevent run-on of surface water. Rapid runoff of water from a contaminated site prevents ponding and thereby reduces the time available for water to infiltrate into the soil. Collection of run-on prevents water from entering the contaminated site from other areas. The appropriate surface water controls will be part of other general response actions at the PACCAR site.

SOIL DISPOSAL

This response action includes excavation and off-site landfilling. The type of landfill used will depend on the level of contamination but may include licensed PCB or hazardous waste landfills, solid waste landfills with leachate collection and treatment, or unlined landfills.

Off-site disposal in a licensed hazardous waste landfill is a proven remedial technology. This method has the advantage that contaminated material is quickly removed from the site.

Off-site disposal in a solid waste landfill with proper leachate collection and treatment may be appropriate for soil with low levels (less than 25 ppm) of PCB or for lead.

Direct disposal of contaminated soils in an unlined landfill is not appropriate. It may be appropriate to dispose of stabilized or treated soils.

For any of the removal technologies, the main disadvantage is that the owner runs the risk of future liability for cleanup at the disposal site. This is true even at licensed hazardous waste disposal facilities.

EXCAVATION AND ON-SITE STORAGE OR DISPOSAL

Permanent on-site storage or disposal of excavated material is limited by site use and the shallow groundwater zone at the PACCAR site.

Temporary storage of excavated material may be required as prior to subsequent treatment or removal to off-site disposal.

IN SITU TREATMENT

In situ treatment involves treatment of soil or groundwater in place without excavation or pumping. In general, effectiveness is lessened because process control is more difficult *in situ* than above-ground. Costs, however, have generally been lower than for above-ground treatment. Potentially applicable *in situ* treatment technologies include:

- Physical Treatment by Soil Venting
- Bioreclamation by Aerobic Biological Treatment
- Solidification/Stabilization

Physical Treatment by Soil Venting

This process option is usually applied to sites with volatile organic compounds in soil. However, semivolatile compounds, such as some of the petroleum hydrocarbons at the PACCAR site may be volatilized *in situ* by heating the soil (Cosmos, 1989). This is an experimental process still in development. Soil is heated by steam or radio-frequency energy. Contaminants are volatilized and are incinerated, filtered, or condensed in an above-ground treatment unit.

Bioreclamation by Aerobic Biological Treatment

Groundwater. *In situ* groundwater biotreatment has been used for treatment of readily biodegradable compounds such as those found in petroleum hydrocarbons. Benzene and vinyl chloride are the organic contaminants of concern in groundwater at the PACCAR site. They are both readily biodegradable. However, *in situ* process control would be difficult and *in situ* treatment would not treat inorganics (lead and arsenic).

Solidification/Stabilization

In situ solidification/stabilization uses the same technologies as above-ground solidification/stabilization. Mixing of shallow soils with solidification agents is possible.

In-place stabilization can be accomplished by adding a solidification agent such as grout to the soil through a series of drill holes.

SOIL TREATMENT

Soil treatment includes the following remedial technologies:

- o Physical Treatment
- o Chemical Treatment by Soil Washing
- o Thermal Treatment
- o Stabilization/Solidification
- o Biological Treatment

Physical Treatment

Physical treatment changes the volume of the contaminated material by either removing the contaminant or removing clean material. Some physical treatment technologies reduce the size of contaminated debris.

Potentially applicable physical treatment process options include:

- o Magnetic Separation
- o Classification
- o Crushing
- o Drying
- o Dewatering

Magnetic Separation. Pieces of ferrous metals can be removed using magnetic separation. This is most applicable if metal pieces are abundant and would interfere with subsequent treatment.

Classification. Classification by grain size is a widely used physical treatment. It is a standard pretreatment for most other treatment processes. Many of these processes have limitations on the particle size that can be treated.

In general, coarse sand and gravel in contaminated soils are relatively clean. This is because contaminants are attached to the surfaces of soil particles. Since volume (length cubed) decreases much faster than surface area (length squared) as particle size decreases, there is relatively more surface area per unit weight in the fine-grained soil than in the coarse-grained soil. This phenomenon has been documented for lead contamination at Superfund sites (Freeman, 1989).

Consequently, removing the coarse sand and gravel is an economical method of reducing the volume of the contaminated soil.

Classification methods include grizzlies, sieves, screens, hydraulic and spiral classifiers, froth flotation, settling basins, and clarifiers.

Crushing. Crushing and shredding are pretreatment options which reduce the size of debris. They are important process options for industrial fill material.

Drying. Soil drying is used as a pretreatment option to reduce moisture content and improve handling characteristics.

Dewatering. After treatment of soil in slurry form, dewatering is used to return the soil to a solid form prior to stabilization, landfilling, or backfilling.

Chemical Treatment by Soil Washing

The soil chemical treatment technology which is potentially applicable at the PACCAR site involves first removing contaminants from the soil matrix, then treating them in the aqueous phase. Contaminant removal is accomplished by soil washing or soil leaching.

Soil Washing. In this process option, soil is mixed in tanks with solvent solutions, acidic solutions, or basic solutions.

Metals are removed as follows:

- o Excavated soils are fed into mixing tanks with the washing solution.
- o The solution is removed and the metals are precipitated out of the solution, usually by

increasing the pH. The washing solution is typically recycled.

- o The precipitate forms a sludge which must be disposed of off-site.

- o The washed soil can be backfilled on the site.

This process has had only limited use for soil remediation. It would require site-specific process development before actual use on this site. It is also relatively expensive.

The process is most efficient for treating soils with very high concentrations of very leachable metals.

Current studies for removal of metals in soils are focusing on chelating agents. These compounds preferentially bind to the metals in the soil. The agent is then drawn off and the metals removed by other chemical means. The effectiveness of chelating agents have been demonstrated only in the laboratory (Anonymous, 1987).

Dewatering yields treated soil and contaminated wash water. The wash water is treated using the aqueous treatment processes described below. The sludge produced by water treatment may be a hazardous waste and disposal of this sludge may be difficult.

Materials handling of the soil before and after treatment is required. This involves classification of the soil prior to treatment so that particle sizes are small enough to be handled in the soil washing equipment. After washing, soil must be dewatered so that it can be reused.

Soil Leaching. In this process option, soil contained in lined piles is leached using solvent solutions, acidic solutions, or basic solutions. It is slower and possibly less effective than soil washing, yet it is easier to implement and less costly. Similar processes have been used in the mining industry to extract gold, silver, and copper (Freeman, 1989). Leaching has not been used on large remediation projects.

Aqueous Treatment. Process options are conventional wastewater treatment for metals and include neutralization, precipitation, oxidation, and reduction. These processes are usually used in combination. Wash water or leachate is usually treated prior to re-use in the washing or leaching process.

Thermal Treatment

Thermal treatment destroys the organic contaminants in the soil, but does not destroy the inorganic contaminants such as lead and chromium.

Incineration

Incineration involves combustion under controlled conditions to convert wastes containing hazardous materials to inert residues and gases. It can be performed either off or on the site. The cost of incineration is high.

In the incineration process, soils are combined with fuel in the incinerator to create temperatures sufficiently high to ensure contaminant destruction. All incinerators include a secondary gas treatment system to meet air quality discharge criteria, particularly important for mixed organic/inorganic soils at the PACCAR site because lead will volatilize in the incinerator and contaminate the off-gas.

Off-site Incineration is a Proven Remedial Technology. Several commercial incinerators around the United States are licensed to burn PCB and/or hazardous waste.

This technology, however, would be difficult and costly to implement. The nearest licensed incinerator is thousands of miles away. Also, priority is given to extremely hazardous waste.

On-site Incineration Applicable. On-site incineration could be accomplished in either a rotary kiln or fluidized bed type incinerator. Either type could be assembled on-site. Mobile incinerators have been designed and tested by several manufacturers (Diot, 1989; Freeman, 1989).

Low Temperature Thermal Treatment

Another type of thermal treatment is low temperature thermal treatment. In this process, soil is heated to approximately 600°F, using a hollow, oil-filled auger. Organic contaminants and water are vaporized. Contaminant product may be condensed and collected for recovery and reuse. Residual off-gas and water may require treatment, although off-gas treatment for lead may not be required.

This technology is potentially applicable for PACCAR soils with petroleum hydrocarbon and HPAH contamination. However, high moisture contents of saturated soils will slow the process (Cosmos, 1989). Treatment of fill material would require physical pretreatment (separation of debris from soil). Implementation would therefore be costly.

Solidification/Stabilization

Solidification/stabilization (S/S) involves excavation of contaminated soils and mixing with solidifying agents. Typical agents include Portland cement and fly ash. These agents form physical or chemical bonds between soil particles and contaminants. The contaminants are bound up inside the cementitious matrix. The solidified material would be returned to the site for disposal.

The S/S process improves the characteristics of the contaminated soil. Wet soils become easier to handle. The soil particles are cemented together, decreasing the surface area available for leaching of contaminants. The permeability of cement treated soils is typically on the order of 1×10^{-6} centimeter per second. Thus, the amount of water passing through the soil is decreased (EPA, 1986).

EPA-sponsored studies are now underway to verify the long-term effectiveness of solidification in the field (EPA, 1989).

In summary, S/S results in a material that encapsulates the contaminated soil and may create different chemical bonds. The effectiveness of S/S will be evaluated in the basis of physical and leaching properties. For the purposes of this FS, the S/S process will be referred to as stabilization.

Pepper's Steel Site to Use Stabilization. The Pepper's Steel site, listed on the EPA's Superfund National Priorities List, is planned to use a combination of solidification of PCB and stabilization of heavy metals. The contaminated soil will be dug up and mixed with fly ash, cement, and other chemicals to form a solid material. The hardened material will be buried on the site.

The EPA and Florida Power and Light completed an extensive testing program on the stabilized material. They found a good fixing agent to be a mixture of 40 percent Portland cement and 60 percent fly ash.

Biological Treatment

Biological treatment uses microorganism which occur naturally in the soil. The microorganisms can be stimulated to degrade petroleum hydrocarbons (and more slowly, HPAHs) into carbon dioxide, water, and microbial cells (API, 1984). Biological treatment in general does not work on inorganic contaminants. This process option uses well established technology developed from land treatment in the petroleum refining industry.

A concern regarding the effectiveness of this technology is possible interference of heavy metals in the soil. However, data from the petroleum refining industry indicate that active landfarms having soil containing 277 ppm of chromium and 718 ppm of lead (average of 30 operations) were biologically treatable (API, 1984).

GROUNDWATER TREATMENT

Potentially applicable groundwater treatment technologies include:

- o Physical Treatment
- o Chemical Treatment
- o Biological Treatment

Physical Treatment

Process options for organics include air stripping and carbon adsorption. Air stripping of benzene and vinyl chloride is very feasible because of their high Henry's Law constants.

Carbon adsorption of vinyl chloride is not very efficient because of the compound's poor adsorption characteristics.

Process options for physical treatment of inorganics are conventional processes used for metals wastewater treatment and industrial water conditioning. These include fluctuation, sedimentation, filtration, membrane filtration, adsorption, and ion exchange (Freeman, 1989; Nalco, 1987). These processes are usually used in combination to achieve the required effluent quality.

Chemical Treatment

Applicable process options for chemical treatment of organics in groundwater include ultraviolet treatment (UV) and oxidation. These processes are commercially available in combination for destruction of benzene and vinyl chloride in water. Turbidity and inorganics can interfere with UV/oxidation processes.

Process options for inorganics are conventional processes used for metals, wastewater treatment, and industrial water conditioning. These include precipitation, neutralization, oxidation, reduction, and electrolysis (Freeman, 1989; Nalco, 1987). These processes are usually used in combination with physical processes to achieve the required effluent quality.

Biological Treatment

Biological treatment includes fixed-film and activated sludge-type processes. Biological treatment of groundwater would be effective for removing benzene and vinyl chloride. However, biological treatment alone would not remove metals and would probably require final polishing by activated carbon in order to achieve low discharge limits.

REFERENCES

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APPENDIX C
COST ESTIMATES FOR DETAILED ANALYSES

APPENDIX C
COST ESTIMATES FOR DETAILED ANALYSES

This appendix includes the capital, operation and maintenance (O&M), and present worth amounts for the alternatives described in Section 6 of the FS.

Cost estimate breakdowns are presented in Table C-1.

The cost estimates shown have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The actual costs of remediation depend on many variables, including quantity of contaminated material, disposal fees, health and safety regulations, labor and equipment costs, and the final project scope. As a result, the final project costs will vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper evaluation and adequate funding.

The capital cost estimates include design of the selected remediation alternative, construction management, and the cost for actual remediation work. The capital costs do not include costs for negotiating the alternative selection or community relations.

The operation and maintenance costs include long-term monitoring and long-term operation, if needed, of those items directly attributable to the remediation of site contamination. For example, there are no O&M costs for the alternatives that treat or remove the soil from the site.

To account for unforeseen costs, a 20 percent contingency was added to capital and O&M costs.

A single factor of 30 percent was added to capital costs to account for engineering permits, administration, and taxes. Engineering costs for these remediation projects were estimated at about 15 percent of total capital. Sales tax is 8 percent. The remaining 7 percent accounts for PACCAR's administrative costs, including contract management.

The calculations of present worth are based on a net five percent discount rate and 30 years of duration. This is consistent with EPA guidelines (EPA, 1988). Total capital costs, O&M costs, and present worth amounts were rounded to the nearest $10,000.

For each alternative, Table C-1 presents costs estimates for two scenarios: With No Site Development, and With Site Development. The cost estimates for these scenarios are different because development of the site involves activities which directly affect the cost of remediation. The major activities which affect remediation costs are as follows:

- Groundwater and surface water control during construction.
- Testing and treatment (as needed) of soil disturbed during construction.
- Storm drain relocation and plugging.
- Foundation demolition.
- Cover Types (see Soil Alternative 7, below).

In order to make cost estimates at the FS stage, it is necessary to make a number of assumptions on design details. The key assumptions for each alternative are summarized below.

Groundwater 1 - Monitoring

- Health & Safety Plan for construction activities which contact groundwater.
- Monitor selected existing wells.
- Selected semiannual and annual sampling for water level, lead, arsenic, volatiles and semivolatiles. Include sampling, analyses, and disposal of purge water.
- Semiannual letter report.
- 30 years duration.

Groundwater 2 - Monitoring and Institutional Controls

- Groundwater use restriction plan.

- o Health and Safety Plan for construction activities which contact groundwater.
- o Monitor selected existing wells.
- o Selected semiannual and annual sampling for water level, lead, arsenic, volatiles and semivolatiles. Include sampling, analyses, and disposal of purge water.
- o Semiannual letter report.
- o 30 years duration.

Groundwater 5 - Pump and Treat

- o Install 15, 4-inch PVC production wells, each 40 ft. deep.
- o Install 5, 4-inch PVC production wells, each 130 ft. deep.
- o Install submersible pumps in each well, with total 200 gpm capacity.
- o Install double-containment piping.
- o Install a central suspended solids filtration system to serve as metals pretreatment for discharge to METRO sewage treatment works.
- o Install a central air stripper system to serve as organics pretreatment for discharge to METRO sewage treatment works.
- o Operate for five years.
- o Fixed costs include labor, maintenance, insurance, taxes, and lab costs. Fixed costs were estimated using the EPA Process Design Manual for Stripping of Organics (EPA, 1984).
- o Sewage utility fees include METRO fees and City of Renton fees.
- o Monitor selected existing wells.
- o Selected semiannual and annual sampling for water level, lead, arsenic, volatiles and semivolatiles. Include sampling, analyses, and disposal of purge water.

- o Semiannual letter report.
- o 30 years duration.

Soil Alternative 1 - Baseline/Monitoring

- o Health and Safety Plan
- o Install six air quality stations on perimeter of site, two air pumps per station.
- o Quarterly sampling for HPAH, Arsenic, Lead, Chromium, Total Dust.
- o Monitor selected existing wells.
- o Selected semiannual and annual sampling for water level, chromium, copper, nickel, zinc, lead, arsenic, volatiles and semivolatiles. Include sampling, analyses, and disposal of purge water.
- o Semiannual letter report.
- o Monitor for 30 years.

Soil Alternative 2 - Baseline/Monitoring with Institutional Controls

- o Health and Safety Plan
- o Site Use Plan
- o Install fencing on perimeter of site.
- o Install six air quality stations on perimeter of site; two air pumps per station.
- o Quarterly sampling for HPAH, Lead, Chromium, Total Dust.
- o Annual inspection and repair of fence for 30 years.
- o Monitor for 30 years.

Soil Alternative 4B/5 - Treat and Stabilize

- o Earthwork costs estimated using Means (1987).
- o In-place volume increases by 20 percent upon excavation.

Biotreatment

- Biotreatment soil depth of the treatment plot is 1 ft.

- Biotreatment area is 300 ft. X 1,000 ft. located in northeast portion of site. Treatment area is lined with and covered with with plastic such as visqueen or T-55 Griffolyn. Construction costs include regrading and compaction after treatment.

- Average GC/FID concentration to be biotreated is 1,000 ppm, treatment is complete at 200 ppm.

- Biodegradation rate follows first-order kinetics with a half-life of 20 days.

- Biotreatment occurs in two, 10,000 CY batches, sequentially, in lifts in the same treatment area.

- Duration of biotreatment is 15 months.

- Monitor placed soils using three shallow groundwater monitoring wells. Sample and test annually for petroleum hydrocarbons (GC/FID).

Cement Stabilization

- Stabilize using Portland cement. Costs estimated using Means (1987), based on 6 percent to 12 percent cement.

- Protective soil cover includes grass cover with 12 inches of sand.

- Monitor placed soils using three shallow groundwater monitoring wells. Sample and test annually for dissolved arsenic, chromium, and lead.

Soil Alternative 7 - Cover

With No Site Development

- Cover some of the contaminated area shown on Figure 6-5 with structural fill. Place 12 inches of sand and gravel or topsoil above compacted subgrade.

- o Cover the remainder of the contaminated area shown on Figure 6-5 with geomembrane. Place 12 inches of sand base, 50 mil PVC geomembrane, 12 inches of sand cover, and 4 inches of topsoil.

With Site Development

The Capital and O & M costs for the cover not included because they will be part of the site development are:

- o Cover some of contaminated area with structural fill. Place 12 inches of sand and gravel or topsoil above compacted grade.
- o Cover some of contaminated area with asphalt. Place 12-inch base course and 4 inches of asphaltic concrete.
- o Cover the remainder of contaminated area with concrete. Place 12-inch ballast and 13 inches of Roller Compacted Concrete.

Soil Alternative 8 - Excavate and Dispose of PCB Soils

- o Dispose of soil in an off-site hazardous waste landfill.

Soil Alternative 9/10 - Cover/Treat & Stabilize Hot Spots

- o Cover design relates to site development as in Alternative 7 with the exception of the geomembrane.
- o Biotreatment assumptions as in alternative 4B/5, with initial GC/FID concentration of 2,500 ppm or greater.
- o Biotreatment area is same as in 4B/5. Treatment would occur in one batch during the summer. Monitor placed soils as in 4B/5.
- o Cement stabilization as in 4B/5, except sand and gravel subbase above stabilized soils in pavement areas. Monitor placed soils as in 4B/5.

Sediment Alternative 3 - Fill Ditch

- o Geotextile area from assumed ditch dimensions of 3 ft. bottom width, 6 ft. height, side slopes 2:1, 600 ft. length.

- o Concrete structures in ditch remain.

Sediment Alternative 5 - Excavate and Dispose/ Fill

- o Excavate bottom and sides of trench and pond south of trench.
- o Dispose of sediment in an off-site hazardous waste landfill.
- o Concrete structure in ditch remain.
- o If no plant development, fill ditch in a manner allowing surface water drainage.

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Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 1 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth		Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With No Site Development						**With Site Development**						
Groundwater Alternative 1. Baseline/Monitoring						Groundwater Alternative 1. Baseline/Monitoring						
Capital Costs						Capital Costs						
No Capital Costs						Replace Destroyed Wells	3	ea	$7,000	$20,000		
Annual Monitoring Costs						Annual Monitoring Costs						
Monitoring Groundwater	1	ea	$50,000	$50,000		Monitoring Groundwater	1	ea	$50,000	$50,000		
Contingency (20%)				$10,000		Contingency (20%)				$10,000		
Subtotal				$60,000		Subtotal				$60,000		
Present Worth of Capital + O&M (P/A,5%,30 yrs)					$920,000	Present Worth of Capital + O&M (P/A,5%,30 yrs)					$940,000	

ABREVIATIONS

CYE Cubic Yards, Excavated (CYE = 1.2 x CYI)

CYI Cubic Yards, In Place

ea Each

ft feet

Mgal Million Gallons

SY Square Yards

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 2 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth		Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With No Site Development						**With Site Development**						
Groundwater Alternative 2. Baseline/Monitoring with Institutional Controls						Groundwater Alternative 2. Baseline/Monitoring with Institutional Controls						
Capital Costs						Capital Costs						
No Capital Costs				$0		Replace Destroyed Wells	3	ea	$7,000	$20,000		
Annual O&M Costs						Annual O&M Costs						
Monitoring Groundwater	1	ea	$50,000	$50,000		Monitoring Groundwater	1	ea	$50,000	$50,000		
Admin. of Use Restriction	1	ea	$10,000	$10,000		Admin. of Use Restriction	1	ea	$10,000	$10,000		
Contingency (20%)				$12,000		Contingency (20%)				$12,000		
Subtotal				$72,000		Subtotal				$72,000		
Present Worth of Capital + O&M (P/A,5%,30 yrs)					$1,110,000	Present Worth of Capital + O&M (P/A,5%,30 yrs)					$1,130,000	

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 3 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth		Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With No Site Development						**With Site Development**						
Groundwater Alternative 5. Pump and Treat						Groundwater Alternative 5. Pump and Treat						
Capital Costs						Capital Costs						
Shallow Wells	15	ea	$2,000	$30,000		Shallow Wells	15	ea	$2,000	$30,000		
Deep Wells	5	ea	$7,000	$35,000		Deep Wells & Rplcmnt Wells	8	ea	$7,000	$56,000		
Shallow Pumps	15	ea	$1,300	$19,500		Shallow Pumps	15	ea	$1,300	$19,500		
Deep Pumps	5	ea	$2,000	$10,000		Deep Pumps	5	ea	$2,000	$10,000		
Piping & Trenching	1	ea	$100,000	$100,000		Piping & Trenching	1	ea	$100,000	$100,000		
Filtration Unit, Installed	1	ea	$20,000	$20,000		Filtration Unit, Installed	1	ea	$20,000	$20,000		
Air Stripper, Installed	1	ea	$100,000	$100,000		Air Stripper, Installed	1	ea	$100,000	$100,000		
Subtotal				$314,500		Subtotal				$335,500		
Contingency (20%)				$62,900		Contingency (20%)				$67,100		
Eng'g., Admin, Tax (30%)				$94,350		Eng'g., Admin, Tax (30%)				$100,650		
Subtotal				$470,000		Subtotal				$500,000		
Annual Monitoring Costs (30yrs)						Annual Monitoring Costs (30yrs)						
Monitoring Groundwater	1	ea	$50,000	$50,000		Monitoring Groundwater	1	ea	$50,000	$50,000		
Contingency (20%)				$10,000		Contingency (20%)				$10,000		
Subtotal				$60,000		Subtotal				$60,000		
Annual O&M Costs (5yrs)						Annual O&M Costs (5yrs)						
Fixed Costs	1	ea	$34,000	$34,000		Fixed Costs	1	ea	$34,000	$34,000		
Power Costs	1	ea	$12,000	$12,000		Power Costs	1	ea	$12,000	$12,000		
Metro and Renton Fees	105	Mgal	$2,280	$239,400		Metro and Renton Fees	105	mgal	$2,280	$239,400		
Contingency (20%)				$57,000		Contingency (20%)				$57,000		
Subtotal				$340,000		Subtotal				$340,000		
Present Worth of Monitoring for 30 Years (P/A,5%,30 yrs)					$920,000	Present Worth of Monitoring for 30 Years (P/A,5%,30 yrs)					$920,000	
Present Worth of O & M Costs (P/A,5%,5 yrs)					$1,480,000	Present Worth of O & M Costs (P/A,5%,5 yrs)					$1,480,000	
Present Worth of Capital + Monitoring + O&M					$2,870,000	Present Worth of Capital + Monitoring + O&M					$2,900,000	

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 4 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth
With No Site Development					
Soil Alternative 1.					
Baseline/Monitoring					
Capital Costs					
Air Monitoring					
Pumps for 6 Air Monitoring Stations	12	ea	$900	$10,800	
Contingency (20%)				$2,160	
Eng'g., Admin, Tax (30%)				$3,240	
Subtotal				$20,000	
Annual O&M Costs					
Monitoring Dust	1	ea	$50,000	$50,000	
Contingency (20%)				$10,000	
Subtotal				$60,000	
Present Worth of O&M (P/A,5%,30 yrs)					$920,000
Present Worth of Capital + O&M (P/A,5%,30 yrs)					$940,000

	Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With Site Development						
Soil Alternative 1.						
Baseline/Monitoring						
Capital Costs						
General						
GW & Surface Water Control	12	Mgal	$2,280	$27,360		
Testing and Treatment of Soil (as needed from site grading)	150,000	CYE	$15	$2,250,000		
Testing and Treatment of Soil (as needed from constructn excavation, and piling)	65,285	CYE	$15	$979,275		
Construction Work Pad	125,000	SY	$4	$500,000		
Testing, H&S Program	1	ea	$75,000	$75,000		
Subtotal				$3,831,635		
Contingency (20%)				$766,327		
Eng'g., Admin, Tax (30%)				$1,149,491		
Subtotal				$5,750,000		
Air Monitoring						
Pumps for 6 Air Monitoring Stations	12	ea	$900	$10,800		
Contingency (20%)				$2,160		
Eng'g., Admin, Tax (30%)				$3,240		
Subtotal				$20,000		
Annual O&M Costs						
Monitoring Dust	1	ea	$50,000	$50,000		
Contingency (20%)				$10,000		
Subtotal				$60,000		
Present Worth of O&M (P/A,5%,30 yrs)					$920,000	
Present Worth of Capital + O&M (P/A,5%,30 yrs)					$6,690,000	

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 5 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth
With No Site Development					
Soil Alternative 2. Baseline/Monitoring with Institutional Controls					
Capital Costs					
Fencing & Air Monitoring					
Fencing	8,000	ft	$10	$80,000	
Pumps for 6 Air Stations	12	ea	$800	$9,600	
Subtotal				$89,600	
Contingency (20%)				$17,920	
Eng'g., Admin, Tax (30%)				$26,880	
Subtotal				$130,000	
Annual O&M Costs					
Fence Repair	1	ea	$1,000	$1,000	
Monitoring	1	ea	$50,000	$50,000	
Contingency (20%)				$10,200	
Subtotal				$61,200	
Present Worth of O&M (P/A,5%,30 yrs)					$940,000
Present Worth of Capital + O&M (P/A,5%,30 yrs)					$1,070,000

	Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With Site Development						
Soil Alternative 2. Baseline/Monitoring with Institutional Controls						
Capital Costs						
General						
GW & Surface Water Control	12	Mgal	$2,280	$27,360		
Testing and Treatment of Soil (as needed from site grading)	150,000	CYE	$15	$2,250,000		
Testing and Treatment of Soil (as needed from constructn excavation, and piling)	65,285	CYE	$15	$979,275		
Construction Work Pad	125,000	SY	$4	$500,000		
Testing, H&S Program	1	ea	$75,000	$75,000		
Subtotal				$3,831,635		
Contingency (20%)				$766,327		
Eng'g., Admin, Tax (30%)				$1,149,491		
Subtotal				$5,750,000		
Fencing & Air Monitoring						
Fencing	8,000	ft	$10	$80,000		
Pumps for 6 Air Stations	12	ea	$800	$9,600		
Subtotal				$89,600		
Contingency (20%)				$17,920		
Eng'g., Admin, Tax (30%)				$26,880		
Subtotal				$130,000		
Annual O&M Costs						
Fence Repair	1	ea	$1,000	$1,000		
Monitoring	1	ea	$50,000	$50,000		
Contingency (20%)				$10,200		
Subtotal				$61,200		
Present Worth of O&M (P/A,5%,30 yrs)					$940,000	
Present Worth of Capital + O&M (P/A,5%,30 yrs)					$6,820,000	

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 6 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth
With No Site Development					
Soil Alternative 4B/ 5.					
Treat and Stabilize					
Capital Costs					
General					
Foundation Demolition	1	ea	$500,000	$500,000	
GW & Surface Water Control	12	Mgal	$2,280	$27,360	
Testing, H&S Program	1	ea	$50,000	$50,000	
Subtotal				$577,360	
Contingency (20%)				$115,472	
Eng'g., Admin, Tax (30%)				$173,208	
Subtotal				$870,000	
Biotreatment					
Excavation	20,000	CY	$10	$200,000	
Hauling & Spreading	24,000	CY	$3	$72,000	
Const. Treatment Area	1	ea	$185,000	$185,000	
Tilling 10 days per month	90	days	$400	$36,000	
Maintenance	20	days	$400	$8,000	
Placement	24,000	CY	$3	$72,000	
Monitoring Wells	3	ea	$5,000	$15,000	
Testing, H&S Program	1	ea	$50,000	$50,000	
Subtotal				$638,000	
Contingency (20%)				$127,600	
Eng'g., Admin, Tax (30%)				$191,400	
Subtotal				$960,000	

	Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With Site Development						
Soil Alternative 4B/ 5.						
Treat and Stabilize						
Capital Costs						
General						
Plug Existing Storm Drain	1	ea	$50,000	$50,000		
GW & Surface Water Control	12	Mgal	$2,280	$27,360		
Testing and Treatment of Soil (as needed from site grading)	150,000	CYE	$15	$2,250,000		
Testing and Treatment of Soil (as needed from constructn excavation, and piling)	65,285	CYE	$15	$979,275		
Construction Work Pad	125,000	SY	$4	$500,000		
Testing, H&S Program	1	ea	$75,000	$75,000		
Subtotal				$3,881,635		
Contingency (20%)				$776,327		
Eng'g., Admin, Tax (30%)				$1,164,491		
Subtotal				$5,820,000		
Biotreatment						
Excavation	20,000	CY	$10	$200,000		
Hauling & Spreading	24,000	CY	$3	$72,000		
Const. Treatment Area	1	ea	$185,000	$185,000		
Tilling 10 days per month	90	days	$400	$36,000		
Maintenance	20	days	$400	$8,000		
Placement	24,000	CY	$3	$72,000		
Monitoring Wells	3	ea	$5,000	$15,000		
Testing, H&S Program	1	ea	$50,000	$50,000		
Subtotal				$638,000		
Contingency (20%)				$127,600		
Eng'g., Admin, Tax (30%)				$191,400		
Subtotal				$960,000		

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 7 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth		Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
Cement Stabilization						Cement Stabilization						
Exc'tion, Mix, Place, Comp.	174,000	CY	$40	$6,960,000		Exc'tion, Mix, Place, Comp.	174,000	CY	$40	$6,960,000		
Protective Soil Cover	261,000	SY	$4	$1,044,000		Protective Soil Cover	261,000	SY	$4	$1,044,000		
Monitoring Wells	3	ea	$5,000	$15,000		Monitoring Wells	3	ea	$5,000	$15,000		
Testing, H&S Program	1	ea	$150,000	$150,000		Testing, H&S Program	1	ea	$150,000	$150,000		
Subtotal				$8,169,000		Subtotal				$8,169,000		
Contingency (20%)				$1,633,800		Contingency (20%)				$1,633,800		
Eng'g., Admin, Tax (30%)				$2,450,700		Eng'g., Admin, Tax (30%)				$2,450,700		
Subtotal				$12,250,000		Subtotal				$12,250,000		
Annual O&M Costs						Annual O&M Costs						
Monitoring Placement Areas	1	ea	$5,000	$5,000		Monitoring Placement Areas	1	ea	$5,000	$5,000		
Cement Stabilization						Cement Stabilization						
Maintenance of Surface	1	ea	$5,000	$5,000		Mainteneance of Surface	1	ea	$5,000	$5,000		
Contingency (20%)				$2,000		Contingency (20%)				$2,000		
Subtotal				$12,000		Subtotal				$12,000		
Present Worth of O&M (P/A,5%,30 yrs)					$180,000	Present Worth of O&M (P/A,5%,30 yrs)					$180,000	
Present Worth of Capital + O&M					$14,260,000	Present Worth of Capital + O&M					$19,210,000	

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 8 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth		Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With No Site Development						**With Site Development**						
Soil Alternative 7.						Soil Alternative 7.						
Cover						Cover						
Capital Costs						Capital Costs						
General						General						
						Plug Existing Storm Drain	1	ea	$50,000	$50,000		
Foundation Demolition	1	ea	$500,000	$500,000		GW & Surface Water Control	12	Mgal	$2,280	$27,360		
Testing, H&S Program	1	ea	$50,000	$50,000		Testing and Treatment of Soil						
Subtotal				$550,000		(as needed from Site Grading)	150,000	CYE	$15	$2,250,000		
Contingency (20%)				$110,000		Testing and Treatment of Soil						
Eng'g., Admin, Tax (30%)				$165,000		(as needed from constructn	65,285	CYE	$15	$979,275		
Subtotal				$830,000		excavation, and piling)						
						Construction Work Pad	125,000	SY	$4	$500,000		
Cover						Subtotal				$3,806,635		
Geomembrane	137,000	SY	$15	$2,055,000		Contingency (20%)				$761,327		
Structural Fill Cover	133,000	SY	$4	$532,000		Eng'g., Admin, Tax (30%)				$1,141,991		
Subtotal				$2,587,000		Subtotal				$5,710,000		
Contingency (20%)				$517,400								
Eng'g., Admin, Tax (30%)				$776,100		Capital and O&M						
Subtotal				$3,880,000		Costs for Asphalt,						
						Concrete and						
Annual O&M Costs						Structural Fill Cover						
Cover Maintenance	1	ea	$5,000	$5,000		Are Part of Site						
Contingency (20%)				$1,000		Development						
Subtotal				$6,000								
Present Worth of												
O&M (P/A,5%,30 yrs)					$90,000							
Present Worth of						Present Worth of						
Capital + O&M (P/A,5%,30 yrs)					$4,800,000	Capital					$5,710,000	

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 9 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth
With No Site Development					
Soil Alternative 8. – Common to All Other Alternatives					
Excavate and Dispose pf PCB Soils					
and Dangerous Waste (lead) Soils					
Capital Costs					
Excavation & Disposal	710	CYI	$225	$159,750	
Fill	710	CYI	$15	$10,650	
Subtotal				$170,400	
Contingency (20%)				$34,080	
Eng'g., Admin, Tax (30%)				$51,120	
Subtotal				$260,000	
Annual O&M Costs					
No Costs				$0	
Present Worth of					
Capital + O&M					$260,000

	Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With Site Development						
Soil Alternative 8. – Common to All Other Alternatives						
Excavate and Dispose pf PCB Soils						
and Dangerous Waste (lead) Soils						
Capital Costs						
Excavation & Disposal	710	CYI	$225	$159,750		
Contingency (20%)				$31,950		
Eng'g., Admin, Tax (30%)				$47,925		
Subtotal				$240,000		
Annual O&M Costs						
No Costs				$0		
Present Worth of						
Capital + O&M					$240,000	

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 10 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth
With No Site Development					
Soil Alternative 9/10.					
Cover/Treat & Stablz					
50 percent Mass Decrease					
and Source Areas					
Capital Costs					
Foundation Demolition	1	ea	$500,000	$500,000	
GW & Surface Water Control	12	Mgal	$2,280	$27,360	
Testing, H&S Program	1	ea	$50,000	$50,000	
Subtotal				$577,360	
Contingency (20%)				$115,472	
Eng'g., Admin, Tax (30%)				$173,208	
Subtotal				$870,000	
Cover					
Structural Fill Cover	270,000	SY	$4	$1,080,000	
Contingency (20%)				$216,000	
Eng'g., Admin, Tax (30%)				$324,000	
Subtotal				$1,620,000	
Biotreatment of TPH Hot Spots					
Excavation	7,800	CYI	$10	$78,000	
Hauling & Spreading	9,360	CYE	$3	$28,080	
Const. Treatment Area	1	ea	$185,000	$185,000	
Tilling 10 days per month	50	days	$400	$20,000	
Maintenance	10	days	$400	$4,000	
Placement	9,360	CYE	$3	$28,080	
Monitoring Wells	3	ea	$5,000	$15,000	
Testing, H&S Program	1	ea	$25,000	$25,000	
Subtotal				$383,160	
Contingency (20%)				$76,632	
Eng'g., Admin, Tax (30%)				$114,948	
Subtotal				$570,000	

	Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With Site Development						
Soil Alternative 9/10.						
Cover/Treat & Stablz						
50 Percent Mass Decrease.						
and Source Areas						
Capital Costs						
General						
Plug Existing Storm Drain	1	ea	$50,000	$50,000		
GW & Surface Water Control	12	Mgal	$2,280	$27,360		
Testing and Treatment of						
Soil from Site Grading	150,000	CYE	$15	$2,250,000		
Testing, H&S Program	1	ea	$100,000	$100,000		
Construction Work Pad	125,000	SY	$4	$500,000		
Subtotal				$2,927,360		
Contingency (20%)				$585,472		
Eng'g., Admin, Tax (30%)				$878,208		
Subtotal				$4,390,000		
Costs for Asphalt,						
Concrete and						
Structural Fill Cover						
Are Part of Site						
Development						
Biotreatment of TPH Hot Spots						
Excavation	7,800	CYI	$10	$78,000		
Hauling & Spreading	9,360	CYE	$3	$28,080		
Const. Treatment Area	1	ea	$185,000	$185,000		
Tilling 10 days per month	50	days	$400	$20,000		
Maintenance	10	days	$400	$4,000		
Placement	9,360	CYE	$3	$28,080		
Monitoring Wells	3	ea	$5,000	$15,000		
Testing, H&S Program	1	ea	$25,000	$25,000		
Subtotal				$383,160		
Contingency (20%)				$76,632		
Eng'g., Admin, Tax (30%)				$114,948		
Subtotal				$570,000		

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 11 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth
Cement Stabiliztn. of HotSpots					
Exc'tion, Mix, Place, Comp.	24,840	CYE	$40	$993,600	
Protective Soil Cover	28,300	SY	$5	$141,500	
Monitoring Wells	3	ea	$5,000	$15,000	
Testing, H&S Program	1	ea	$50,000	$50,000	
Subtotal				$1,200,100	
Contingency (20%)				$240,020	
Eng'g., Admin, Tax (30%)				$360,030	
Subtotal				$1,800,000	
Annual O&M Costs					
Cover Maintenance	1	ea	$5,000	$5,000	
Monitoring Placement Areas	1	ea	$5,000	$5,000	
Cement Stabilization					
Maintenance of Surface	1	ea	$2,000	$2,000	
Contingency (20%)				$2,400	
Subtotal				$14,400	
Present Worth of O&M (P/A,5%,30 yrs)					$220,000
Present Worth of Capital + O&M					$5,080,000

	Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
Cement Stabiliztn. of HotSpots						
Exc'tion, Mix, Place, Comp.	24,840	CYE	$40	$993,600		
Testing, H&S Program	1	ea	$50,000	$50,000		
Monitoring Wells	3	ea	$5,000	$15,000		
Subtotal				$1,058,600		
Contingency (20%)				$211,720		
Eng'g., Admin, Tax (30%)				$317,580		
Subtotal				$1,590,000		
Handling and Testing of Soil From Construction Excavation And Pilings						
Hauling, Storing & Loading	39,300	CYE	$15	$589,500		
Testing, H&S Program	1	ea	$50,000	$50,000		
Subtotal				$639,500		
Contingency (20%)				$127,900		
Eng'g., Admin, Tax (30%)				$191,850		
Subtotal				$960,000		
Annual O&M Costs						
Cover Maintenance	1	ea	$0	$0		Part of Site Development
Monitoring Placement Areas	1	ea	$5,000	$5,000		
Cement Stabilization						
Maintenance of Surface	1	ea	$2,000	$2,000		
Contingency (20%)				$1,400		
Subtotal				$8,400		
Present Worth of O&M (P/A,5%,30 yrs)					$130,000	
Present Worth of Capital + O&M					$7,640,000	

Table C–1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 12 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth		Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With No Site Development						**With Site Development**						
Sediment Alternative 3.						Sediment Alternative 3.						
Fill Ditch						Fill Ditch						
Capital Costs						Capital Costs						
Geotextile	1,111	SY	$2	$2,222		Geotextile	1,111	SY	$2	$2,222		
Fill	1,240	CYE	$15	$18,600		Fill	1,240	CYE	$15	$18,600		
Subtotal				$20,822		Subtotal				$20,822		
Contingency (20%)				$4,164		Contingency (20%)				$4,164		
Eng'g., Admin, Tax (30%)				$6,247		Eng'g., Admin, Tax (30%)				$6,247		
Subtotal				$30,000		Subtotal				$30,000		
Annual O&M Costs						Annual O&M Costs						
No Costs				$0		No Costs				$0		
Present Worth of						Present Worth of						
Capital + O&M					$30,000	Capital + O&M					$30,000	

Table C-1 – Cost Estimate Breakdowns for Detailed Analyses (Sheet 13 of 13)

	Quantity	Unit	Unit Cost	Cost	Present Worth		Quantity	Unit	Unit Cost	Cost	Present Worth	Comments
With No Site Development						**With Site Development**						
Sediment Alternative 5. Excavate and Dispose/Fill						Sediment Alternative 5. Excavate and Dispose/Fill						
Capital Costs						Capital Costs						
Excavation & Disposal	723	CYE	$225	$162,675		Excavation & Disposal	723	CYE	$225	$162,675		
Fill	1,240	CYE	$15	$18,600		Fill	1,240	CYE	$15	$18,600		
Subtotal				$181,275		Subtotal				$181,275		
Contingency (20%)				$36,255		Contingency (20%)				$36,255		
Eng'g., Admin, Tax (30%)				$54,383		Eng'g., Admin, Tax (30%)				$54,383		
Subtotal				$270,000		Subtotal				$270,000		
Annual O&M Costs						Annual O&M Costs						
No Costs				0		No Costs				0		
Present Worth of Capital + O&M					$270,000	Present Worth of Capital + O&M					$270,000	

APPENDIX D
LISTING OF POTENTIAL LOCATION-SPECIFIC ARARs

Table D-1 - Potential Location-Specific ARARs (Sheet 1 of 4)

Location	Requirement	Prerequisite	Citation	ARAR
GEOLOGICAL				
Within 200 feet of a fault displaced in Holocene time	New treatment, storage or disposal of hazardous waste prohibited	Hazardous waste management near Holocene fault	40 CFR 264.18; WAC 173-303-420	Not ARAR
Holocene faults and subsidence areas	New solid waste disposal facilities prohibited over faults with displacement in Holocene time, and in subsidence areas	New solid waste management activities near Holocene fault	WAC 173-304-130	Not ARAR
Unstable slopes	New solid waste disposal areas prohibited from hills with unstable slopes	New solid waste disposal on an unstable slope	WAC 173-304-130	Not ARAR
100-year floodplains	Solid and hazardous waste disposal facilities must be designed, built, operated, and maintained to prevent washout	Solid or hazardous waste disposal in a 100-year floodplain	40 CFR 264.18; WAC 173-303-420; WAC 173-304-460	Not ARAR
	Avoid adverse effects, minimize potential harm, restore/preserve natural and beneficial values in floodplains	Actions occurring in a floodplain	40 CFR Part 6 Subpart A; 16 USC 661 *et seq*; 40 CFR 6.302	Not ARAR
Salt dome and salt bed formations, underground mines, and caves	Placement of non-containerized or bulk liquid hazardous wastes is prohibited	Hazardous waste placement in salt dome, salt bed, mine or cave	40 CFR 264.18	Not ARAR
SURFACE WATER				
Wetlands	New hazardous waste disposal facilities prohibited in wetlands (including within 200 feet of shoreline)	Hazardous waste disposal in a wetland (200 feet of shoreline)	WAC 173-303-420	Not ARAR
	New solid waste disposal facilities prohibited within 200 feet of surface water (stream, lake, pond, river, salt water body)	Solid waste disposal within 200 feet of surface water	WAC 173-304-130	Not ARAR
	New solid waste disposal facilities prohibited in wetlands (swamps, marshes, bogs, estuaries, and similar areas)	Solid waste disposal in a wetland (swamp, marsh, bog, estuary, etc.)	WAC 173-304-130	Not ARAR
	Discharge of dredged or fill materials into wetlands prohibited without a permit	Discharges to wetlands	40 CFR Part 230; 33 CFR Parts 320 to 330	Not ARAR
	Minimize potential harm, avoid adverse effects, preserve and enhance wetlands	Construction or management of property in wetlands	40 CFR Part 6 Appendix A	Not ARAR

Table D-1 - (Continued) (Sheet 2 of 4)

Location	Requirement	Prerequisite	Citation	ARAR
Forest lands	Activities restricted within state forest lands to minimize fire hazards and other adverse impacts	Activities within state forest lands	Chapter 76.04 RCW; Chapter 332-24 WAC	Not ARAR
	Restrictions on activities in state and federal forest lands	Activities within state and federal forest lands	16 USC 1601; Chapter 76.09 RCW	Not ARAR
Public lands	Activities on public lands are restricted, regulated or proscribed	Activities on state-owned lands	Chapter 79.01 RCW	Not ARAR
Scenic vistas	Restrictions on activities that can occur in designated scenic areas	Activities in designated scenic vista areas	Chapter 47.42 RCW	Not ARAR
Historic areas	Actions must be taken to preserve and recover significant artifacts, preserve historic and archaeologic properties and resources, and minimize harm to national landmarks	Activities that could affect historic or archaeologic sites or artifacts	16 USC 469, 470 et seq; 36 CFR Parts 65 and 800; Chapters 27.34, 27.53, and 27.58 RCW	Not ARAR
LAND USE				
Neighboring properties	No new solid waste disposal areas within 100 feet of the facility's property line	New solid waste disposal within 100 feet of facility's property line	WAC 173-304-130	Not ARAR
	No new solid waste disposal areas within 250 feet of property line of residential zone properties	New solid waste disposal within 250 feet of property line of residential property	WAC 173-304-130	Not ARAR
Proximity to airports	Disposal of garbage that could attract birds prohibited within 10,000 feet (turbojet aircraft)/5,000 feet (piston-type aircraft) of airport runways	Garbage disposal near airport	WAC 173-304-130	Not ARAR

Table D-1 - (Continued) (Sheet 3 of 4)

Location	Requirement	Prerequisite	Citation	ARAR
AIR				
Non-attainment areas	Restrictions on air emissions in areas designated as non-attainment areas under state and federal air quality programs	Activities in a designated non-attainment area	Chapter 70.94 RCW; Chapters 173-400 and 173-403 WAC	Not ARAR
SENSITIVE ENVIRONMENTS				
Endangered/threatened species habitats	New solid waste disposal prohibited from from areas designated by US Fish and Wildlife Service as critical habitats for endangered/threatened species	New solid waste disposal in critical habitats	WAC 173-304-130	Not ARAR
	Actions within critical habitats must conserve endangered/threatened species	Activities where endangered or threatened species exist	50 CFR Parts 200 and 402	Not ARAR
Parks	No new solid waste disposal areas within 1,000 feet of state or national park	New solid waste disposal near state/national park	WAC 173-304-130	Not ARAR
	Restrictions on activities in areas that are designated state parks, or recreation/conservation areas	Activities in state parks or recreation/conservation areas	Chapter 43.51 RCW; Chapter 352-32 WAC	Not ARAR
Wilderness areas	Actions within designated wilderness areas must ensure area is preserved and not impaired	Activities within designated wilderness areas	16 USC 1131 et seq; 50 CFR 35.1 et seq	Not ARAR
Wildlife refuge	Restrictions on actions in areas that are part of the National Wildlife Refuge System	Activities within designated wildlife refuges	16 USC 668dd et seq; 50 CFR Part 27	Not ARAR
Natural areas preserves	Activities restricted in areas designated as having special habitat value (Natural Heritage Resources)	Activities within identified Natural Area Preserves	Chapter 79.70 RCW; Chapter 332-60 WAC	Not ARAR
Wild, scenic, or recreational rivers	Avoid actions that would have adverse effects on designated wild, scenic, or recreational rivers	Activities near wild, scenic, and recreational rivers	16 USC 1271 et seq; 40 CFR 6.302; Chapter 79.72 RCW	Not ARAR
Columbia River Gorge	Restrictions on activities that could affect resources in the Columbia River Gorge	Activities within the Columbia River Gorge	Chapter 43.97 RCW	Not ARAR
UNIQUE LANDS AND PROPERTIES				
Natural resource conservation areas	Restrictions on activities within designated Conservation Areas	Activities within designated Conservation Areas	Chapter 79.71 RCW	Not ARAR

Table D-1 - (Continued) (Sheet 4 of 4)

Location	Requirement	Prerequisite	Citation	ARAR
Shorelines	Actions prohibited within 200 feet of shorelines of statewide significance unless permitted	Actions near shorelines	Chapter 90.58 RCW; Chapter 173-14 WAC	Not ARAR
Rivers and streams	Avoid diversion, channeling or other actions that modify streams or rivers, or adversely affect fish or wildlife habitats and water resources	Actions modifying a stream or river and affecting fish or wildlife	40 CFR 6.302	Not ARAR
COASTAL AREAS				
Coastal zone	Conduct activities in a manner protective of coastal zones and adjacent areas	Activities affecting the coastal zone	16 USC 1451 et seq	Not ARAR
Coastal barrier	Conduct activities in a manner protective of designated coastal barriers	Activities within the Coastal Barrier Resource System	16 USC 3501 et seq	Not ARAR
GROUNDWATER				
Sole source aquifer	New solid and hazardous waste land disposal facilities prohibited over a sole source aquifer	Disposal over a sole source aquifer	WAC 173-303-420; WAC 173-304-130	Not ARAR
Uppermost aquifer	Bottom of lowest liner of new solid waste disposal facility must be at least 10 feet above seasonal high water in uppermost aquifer (5 feet if hydraulic gradient controls installed)	New solid waste disposal	WAC 173-304-130	Not ARAR
Aquifer Protection Areas	Activities restricted within designated Aquifer Protection Areas	Activities within an Aquifer Protection Area	Chapter 36.36 RCW	ARAR
Groundwater Management Areas	Activities restricted within Groundwater Management Areas	Activities within a Ground Water Management Area	Chapter 90.44 RCW; Chapter 173-100 WAC	Not ARAR
DRINKING WATER SUPPLY				
Drinking water supply well	New solid waste disposal areas prohibited within 1,000 feet upgradient, or 90 days travel time, of drinking water supply well	New solid waste disposal within 1,000 feet of drinking water supply well	WAC 173-304-130	Not ARAR
Watershed	New solid waste disposal areas prohibited within a watershed used by a public water supply system for municipal drinking water	New solid waste disposal in a public watershed	WAC 173-304-130	Not ARAR

APPENDIX E
DEVELOPMENT OF REMEDIATION CRITERIA FOR PROPOSED UTILITY TRENCHES

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DEVELOPMENT OF REMEDIATION CRITERIA FOR PROPOSED UTILITY TRENCHES

One of the first elements of the upcoming plant construction is the excavation of utility trenches. Since many of these trenches may be oriented through soil areas which presently exceed the general site-wide soil remedial action objectives (RAOs), as defined in the draft FS report, an excavation and handling plan is necessary to facilitate remediation of these areas. Critical to this plan is the development of soil RAOs specific to the trenches.

This appendix presents proposed RAOs for soils in the trench excavations, based on an assessment of potential chemical exposures and risks in these locations. The methodology used to develop these risk-based RAOs is equivalent to procedures described in the baseline risk assessment presented in the RI report. The proposed action-specific cleanup levels are more restrictive than the preferred alternative ("hot spot") action levels, but less restrictive than the site-wide RAOs. The rationale and development of the proposed action-specific RAOs are discussed below.

As discussed in detail in the baseline risk assessment and in the draft FS reports, preliminary site-wide soil RAOs were developed based on a consideration of potential risks to a hypothetical most exposed adult individual (MEI). The MEI was assumed for that analysis to regularly contact site soils at an average frequency of approximately 6 hours per day without any protection from contaminant exposure through the use of health and safety gear or related procedures. Although this MEI scenario serves as a conservative general point of departure for the development of site-wide RAOs under a maximum exposure condition, the assumptions may not apply to specific site activity locations. Trench environments are one such location.

In consideration of a variety of health and safety and employer liability issues throughout the plant, PACCAR has determined that it is appropriate to require any plant worker who gains access into a utility trench to utilize appropriate health and safety procedures. The requirement for health and safety in this situation can be readily enforced by PACCAR. In such a case, the MEI scenario would not be a valid estimate of realistic maximum exposures, and the site-wide RAOs would be overly restrictive.

In order to develop preliminary RAOs specific to the trench locations, it is necessary to develop a realistic maximum exposure scenario specific to the trench conditions. For this analysis, it is considered reasonable to assume that even an individual trained in health and safety procedures may occasionally either have a breach in his or her protective gear, or may otherwise determine that conditions (e.g., a plant fire) dictate that normal health and safety considerations be waived. Such a condition is expected to occur no more often than two to four weeks per year, which is roughly ten percent of working hours of the MEI. If exposure frequency and/or duration is reduced to ten percent of the MEI condition, and if all other exposure factors (e.g., soil contact rate) remained constant, then the corresponding risk-based soil RAOs for chronic exposure effects (e.g., carcinogenesis) would be increased approximately 10-fold over the MEI condition.

Short-term exposures such as those discussed above must also consider potential subchronic (e.g., acute toxicity) risks associated with infrequent shorter-duration exposure conditions. For subchronic exposure periods ranging from two weeks to seven years, EPA has developed reference dose for only one of the PACCAR site indicator chemicals -- chromium. A tentative subchronic reference dose can also be ascribed to lead based on previously published EPA assessments of lead toxicity.

The development of risk-based soil cleanup concentrations specific to the PACCAR trenches therefore considered the following risk scenarios:

o Lifetime Cancer Risk: Assuming that worker contact with trench soils in the absence of health and safety precautions occurs at a frequency of one-tenth that described in the baseline risk assessment, the probabilistic upper-bound lifetime cancer risk for soil exposure pathways must not exceed 1E-6 (one-in-one million). Specific exposure and cancer potency assumptions used in this calculation are described in detail in the baseline risk assessment.

- **Long-Term Toxicity (non-cancer) Risk:** This chronic toxicity evaluation (for exposure periods greater than 7 years) again assumed that overall soil contact would occur at a frequency of **one-tenth** that described in the baseline risk assessment. The probabilistic upper-bound Hazard Index for soil exposure pathways must not exceed 1.0. Specific exposure and reference dose assumptions used in this calculation are described in detail in the baseline risk assessment.

- **Short-Term Toxicity Risk:** The probabilistic upper-bound Hazard Index for exposure pathways under subchronic (2 week to 7 year) soil contact conditions must not exceed 1.0. Specific exposure assumptions used in this calculation were identical to those described in the baseline risk assessment, except that exposure duration was not averaged (i.e., daily exposure was assumed). The subchronic reference dose values available from EPA are summarized in Table E-1.

Overall, the consideration of lifetime cancer risk associated with infrequent soil contact exposures in the PACCAR trenches resulted in the most restrictive soil remediation limits (Table E-1). The cumulative long-term cancer risk evaluation generated more restrictive RAOs than those based on either chronic or subchronic exposures, at least for the four site indicator chemicals which are regulated as carcinogens.

Table E-1 - Summary of Risk-Based Soil Cleanup Concentrations in PACCAR Trenches

Chemical	Cancer Risk-Based Cleanup Conc. in ppm (a)	EPA (IRIS) Chronic Tox. Reference Dose in mg/kg-day	Chronic Risk-Based Cleanup Conc. in ppm (a)	EPA (IRIS) Subchronic Reference Dose in mg/kg-day	Subchronic Risk-Based Cleanup Conc. in ppm (b)	Most Restrictive Risk-Based Cleanup Conc. in ppm
METALS:						
Arsenic (Inorg)	300	1.0E-03	10,000	NA	-	300
Chromium (VI)	600	5.0E-03	50,000	2.5E-02	60,000	600
Lead	-	NA	1,000 - 8,000 (c)	1.4E-03 (d)	15,000	1,000 - 8,000 (c)
ORGANICS:						
HPAHs (B[a]P)	350	NA	-	NA	-	350
PCBs	10	NA	-	NA	-	10

NOTES:

a) Based on a ten percent exposure frequency as applied to the MEI evaluation presented in the RI/FS Report; see text.

b) Based on the MEI scenario as described in the RI/FS report, but without consideration of exposure duration. This subchronic evaluation addresses potential short-term toxicity of the MEI in a short-term trench exposure condition. Subchronic EPA risk evaluations are based on an exposure duration of two weeks to seven years.

c) Risk-based cleanup concentrations for lead are based on CDC (1985) and on "hot-spot" volume considerations; see text.

d) Value presented is the previous Acceptable Intake Concentration for chronic exposure to lead as reported by EPA.

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For lead, however, there currently exists a considerable uncertainty regarding the mechanism of toxicity to subchronic and chronic exposures to this metal. Because of this uncertainty, it is not possible at this time to evaluate quantitatively the risks associated with lead exposures in a standard chronic or subchronic format. Accordingly, the toxicity associated with subchronic exposures to lead was approximated as a value intermediate between the general chronic toxicity criteria (i.e., 1,000 ppm soil lead in an industrial setting) and the preferred alternative action level (8,000 ppm). The resulting trench cleanup concentration is thus 4,500 ppm.

Proposed soil cleanup limits specific to the PACCAR trench scenario are presented in Table E-2. In some cases requirements such as the PCB Spill Cleanup Policy are more restrictive than the risk-based concentrations, and in these cases the risk-based values may not be appropriate cleanup criteria. Soils exceeding these criteria are currently proposed to be remediated along with "hot spot" soils from the rest of the site, as appropriate.

Because of a general lack of suitable toxicity data, risk-based soil cleanup levels for petroleum hydrocarbons can not be developed at the PACCAR site. Cleanup of these constituents -- beyond those considered by the HPAH and PCB criteria -- are addressed relative to overall site protection of groundwater quality. RAOs and "hot-spot" cleanup limits for petroleum hydrocarbons are discussed in the main body of this FS Report.

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Table E-2 - Summary of Trench Soil Remediation Objectives

	Soil Concentration in ppm		
Chemical	Site-wide RAO	Preferred Alternative Action Level	Trench Cleanup Limit
METALS:			
Arsenic	30.	100.	100. (a)
Chromium	70.	600.	600.
Lead	1,000.	8,000.	4,500.
ORGANICS:			
HPAHs	35.	800.	350.
PCBs	10. (b)	10. (b)	10. (b)

Notes:

a) Since the calculated risk-based cleanup limit for arsenic (300 ppm) is higher than the action level, the 100 ppm value is proposed for trench locations.

b) A PCB cleanup concentration of 10 ppm is proposed based on a consideration of Applicable or Relevant and Appropriate Requirements.