HARTCROWSER

Earth and Environmental Technologies

Remediation Plan
Portac Log Sort Yard
Port of Tacoma, Washington

Volume I

Prepared for
Port of Tacoma

June 17, 1988
J-1773-04

J-1773-04

SEPTEMBER 14, 1988-ADDENDUM 1 TO EXHIBIT B
VOLUME I, REMEDIATION PLAN JUNE 17, 1988
PORTAC LOG SORT YARD
PORT OF TACOMA, WASHINGTON

This document amends and adds to Volume I of the June 17, 1988 Remediation Plan for the Portac Log Sort Yard. This addendum together with Volume I and Volume II of the Remediation Plan constitute Exhibit B. Additional material is divided into the following areas:

- Engineering
- Geohydrology
- Cleanup Goals and Performance Standards
- Text Revisions

ENGINEERING

Pavement Thickness

In our preliminary analysis of pavement thickness, we estimated the required concrete thickness to be 14 to 19 inches thick. Final design pavement thickness is within this range of estimated thickness.

Settling and Bearing Capacity

The organic content of the surficial material (upper 1 to four feet) is 50% or greater. As of September 1987, the on-site quantity of organic material was estimated at 20,000 tons. Organic material provides marginal support for the pavement. Design is based on the actual elastic properties of organic material as measured by field results. The pavement is of sufficient strength to compensate for marginal support.

Methane Gas

One result of decomposition of the wood waste may be generation of methane gas. Methane gas of itself is not a potential hazard unless it is generated faster than it dissipates and accumulates in an area accessible to people. If methane does accumulate, it may then present an explosion or confined space entry hazard for personnel. The concern is not the generation of methane gas, but the accumulation of the gas.

The design of the Portac paving presents several possible zones of accumulation:

- beneath the pavement slab
- within the sewer pipe
- within catch basins
- within the spill containment vessel

Accumulation of methane gas beneath the pavement slab or in the sewer pipe is not a hazard because these areas are inaccessible to people. In addition, the sewer pipe will be installed below the gas generating wood waste so will not likely collect methane (which is lighter than air and thus tends to rise). For similar reasons, the catch basins do not present a significant methane gas hazard.

It is not expected that methane gas will accumulate in the spill containment vessels. However, the spill containment vessels are closed containers below ground. Oxygen content may be low or hazardous vapors may be present within the vessel. Therefore, only personnel trained in confined space entry and properly equipped will enter the vessel.

Storm Drain System Design

The surface water collection system was designed for a 25-year, 24-hour storm event. The system is designed to address potential for water quality impacts from operations and must meet requirements of the pending NPDES permit application.

Coordination with Pentachlorophenol Contamination

To coordinate with the cleanup of the pentachlorophenol contamination, paving construction will be set back 25 feet from the centerline of the central drainage ditch as indicated on Sheet 3 of the construction drawings (Exhibit C of the Consent Order). The drainage line from the area of current wood treatment activities will not be hooked up to the new drainage system until establishment of suitable effluent guidelines for the current wood treatment discharges.

GEOHYDROLOGY

The geohydrology of the PORTAC site is presented in a report dated April 24, 1987 entitled Groundwater Assessment PORTAC Log Yard (Appendix E, Remediation Plan, Volume II) and in a follow-up summary presented as Appendix G are Volume II of the Remediation Plan. Some of the data and analyses is rediscussed below to provide additional back-up information and clarify some of the evaluations presented in those reports. Data sources referenced below are included in the Remediation Plan for the PORTAC Log Yard dated June 17, 1988. A timetable for the site sampling is attached as Table 2.

Also discussed below is the groundwater monitoring program that will be conducted following the site paving. This monitoring plan will be supplemental to the plan presented in Appendix H, Section 3.0.

Groundwater occurs as a shallow unconfined system at the Portac site. The water table is encountered in the native and dredge silts which underlie the site, at depths of roughly 6 to 13 feet. The occurrence and depth to groundwater was determined from test pits excavated in July 1986 (Appendix B, Figures 5 through 7) and from borings drilled in March 1987 (Appendix E, A-2 through A-7). In the 1986 test pits some interstitial water was observed within the bark and slag fill layer in 2 of the 11 test pits. An additional 23 test pits were excavated in April 1988 to observe the nature and thickness of the slag and bark fill. Of these, 8 were observed to have small amounts of water in the slag fill layer at depths of 1 to 3 feet.

Groundwater versus Surface Water

Surface water is defined as overland flow and shallow subsurface storm flow. Groundwater is considered to be saturated soils below the water table. Groundwater flow and surface water flow are the two potential pathways for metals migration from the site to Wapato Creek. Our observations from the site investigations indicate that precipitation falling on the Portac site either runs off the site and discharges to surface water or slowly infiltrates to the water table. See Figure 1 attached.

Surface water runoff is discussed in Appendix E, pg. 5 and in the Site Remediation Plan, Volume I, pg. 30. Because of the thick bark mat which occurs over much of the site, all runoff does not directly flow overland. Some of it flows to shallow subsurface drains located throughout the log yard area that collect water released from the bark and discharge this water to storm drains and the central ditch. Our studies have considered this very shallow water to be surface water as it is well above the saturated zone, and occurs only intermittently as shallow underground pipes drain and direct it to surface water discharge points. No monitoring wells have been constructed to date in the shallow bark/slag fill material (at interface with the underlying silts) because these wells would have generally been dry. Paving of the site will cut off precipitation infiltration, eliminating the shallow subsurface runoff. Within a short period of time any residual water occurring in small, isolated pockets within this shallow fill zone will be gone.

Groundwater flow is discussed in the Appendix E report, pg. 8. The groundwater flows predominately westward as shown in Appendix E, Figure 3. The groundwater flow direction is based on water level data collected from 6 on-site monitoring wells. To date, over 9 months of water level data have been collected. These data are presented in the attached Table 1. The water level monitoring data indicates only minor changes in the flow pattern with seasonal fluctuations. The attached Figure 2 presents the April 1987 data from Appendix E Figure 3, the high groundwater level (April 6, 1988), and the low water level (August 1, 1988) obtained during the 9-month monitoring period.

Groundwater Fluctuations

The monitoring data collected to date in the PORTAC wells are used with other data in the area to assess the groundwater fluctuations. Seasonal and tidal fluctuations indicate the range in groundwater conditions which could occur at the site. Of particular interest is whether water levels could rise into the slag layer, and if so, how often and for how long. We have made a reasonable estimate of expected fluctuations under normal conditions based on existing information. This is presented in Appendix E, pgs. 7 and 8 based on data collected through the April 1987, and in Appendix G based on data collected through May 1988. We now have data collected through September 1988 as shown in Table 1. A summary of the expected fluctuations and clarification of data sources for previous estimates is discussed below.

A study of the tidal fluctuation was accomplished on April 15th and 16th 1988. The data indicate that only well B-5 responds to tidal fluctuations which occur in Wapato Creek. The other wells do not respond to the tides presumably due to the low soil permeability and/or distance from Wapato Creek. Well B-5 showed a maximum tidal fluctuation of 1.5 feet. The data are presented in Appendix G, pg. G-5 and in Figure G-5.

Seasonal fluctuations are estimated to be a maximum of 4 to 5 feet with the low occurring during late summer/early fall and the high occurring in early spring. This estimate is based on the following data:

o Table 1 which presents actual site data for the Spring of 1987 and Spring through Fall of 1988. The maximum observed fluctuation in the wells unaffected by tides is 2 feet. The highest water level is in March or April and the lowest is in August and September. Precipitation data are not yet available for Tacoma but data from the SeaTac weather station indicate that March and April of 1987 were +1.94 and +0.21 inches, respectively, above the normal rainfall for these months, while April 1988 was +0.8 inches above normal. July and August

1988 are -0.23 and -0.99 inches below normal. A comparison of the precipitation data with the monitoring data indicates the water level data collected to date can be used to reasonably estimate seasonal fluctuations.

- Hart Crowser has performed or reviewed water level monitoring in wells which tap the water table aquifer in similar silty soils in the Port of Tacoma area. At the Pennwalt Tacoma Plant monitoring data collected in the summer and fall of 1981 and again from January through September 1986 indicated a maximum fluctuation in the shallowmost wells (unaffected by tides) of 3.5 feet. The highest water levels were observed in the winter and the lowest in the late summer/early fall. At the Reichold plant in Tacoma, 12-month data collected in 1987 indicate the seasonal water table fluctuation is 3 feet with a similar high and low level period.

- In general, seasonal water level fluctuations are moderated in a hydrologic environment such as the Port area because it lies in a groundwater discharge area and is surrounded by surface water bodies largely unaffected by seasonal variations.

The water level fluctuations were used to assess whether the water levels will rise into the slag. Because the ground surface, slag occurrence, and groundwater levels vary across the site it was necessary to compare elevation data at various points across the site. Our analyses of the base of slag elevation and the water level elevation are presented in detail in Appendix F. Figure 3 (attached) presents a plan of the site showing the thickness of the unsaturated soil between the bottom of the slag and the water table using 4/87 data which is close to the high water level.

Based on our estimated maximum fluctuation of 4 to 5 feet and the reasonable assumption that the April 1987 data are close to the high level, it still appears unlikely that the groundwater level will rise into the slag. Even a 2-foot higher water level than the highest recorded to date will leave at least 1 foot of unsaturated conditions between the bottom of the slag and the water table (as can be seen from Figure 3).

Metals Discharge to Wapato Creek

Metal loadings from groundwater were compared to metal loadings from surface water because Wapato Creek acts as the common receptor. These data were compared to determine if it was appropriate for the remedial action to focus predominantly on surface water. There was no intention of directly relating (in time and space) the surface water and groundwater samplings. We have no data to assess whether the metals leaching has decreased since the study conducted by Ecology (Appendix A). It is conservative to assume that it has not.

The analysis of the discharge rates and metal loading to the Creek from the groundwater system was referred to as conservative for the reasons presented with the analysis discussion on pg. 11 of Appendix E. Specifically, these are:

- The hydraulic conductivity value used was for a silty sand (5×10^{-3} cm/sec) when the more common soil at the site is a sandy to clayey silt (10^{-4} to 10^{-6} cm/sec); and
- The average and highest metal concentrations were used when the majority of the wells had levels below detection limits.

Groundwater discharge and metal loading calculations are attached for a matter of record (Attachment A). These calculations present the average conditions and the extreme deviations from average. These calculations are based on the updated permeability estimates and additional water quality sampling presented in Appendix G. The average conditions presented in these calculations indicate a discharge to the creek of 56 gals/day and an arsenic loading of 8×10^{-5} lbs/day. The difference between this estimate and the original estimate of 100 gals/day and 10^{-4} to 10^{-5} lbs/day is within the variability of the data.

Groundwater Monitoring Plan

This groundwater monitoring plan is supplemental to the plan presented in Appendix H, Section 3.0. Paving the site is designed to keep water out of the slag thus controlling the source and protecting the groundwater from any additional metal leaching. Water level monitoring and water quality sampling will be conducted following paving to verify that metal concentrations in the groundwater do not worsen as a result of paving.

As discussed in Appendix H, groundwater monitoring will be conducted in 6 wells at the site. If the existing wells are damaged during construction, a new well will be installed in approximately the same location.

In addition to the existing wells we will install two shallow wells to the bottom of the slag layer (just above the interface of the slag and underlying silt) to verify our assessment that groundwater does not occur within this layer. These wells will be located in the vicinity of the existing B-1 and B-3.

Groundwater quality sampling will be conducted biannually for two additional years beyond the planned first year of monitoring to verify that the metal concentrations in the groundwater do not worsen. The groundwater will be sampled for arsenic, copper, zinc, and lead during the high water level period (February or March) and low water level period (September) for three successive years. This amounts to a total of six sampling events following the site paving.

The new shallow wells will be sampled if water can be measured in the well. The well will be purged once prior to sampling. If the purging drys the well we will return monthly to determine if additional water has entered the well. A sample will be obtained without purging, the next time water can be measured in the well. An assessment of the water source will be conducted when any water is indicated in the well.

Monthly water level monitoring will continue through March 1989 so that a complete water year of data is obtained. Following that the well water levels will be measured at the time of the sampling. This will provide useful information to compare the high and low water levels with the previous years.

The methods, analysis, and QA/QC will be as presented in Appendix H.

CLEANUP GOALS AND PERFORMANCE STANDARDS

The proposed remedial action is to mitigate surface water metals contamination at the site. The remedial action will also serve as a source control protecting groundwater by preventing surface water infiltration and associated mobilization of metals. Post-construction monitoring of both surface and groundwater are proposed.

Following paving of the site, surface water quality will be monitored and will meet conditions of the required NPDES permit. The NPDES permit will cover two aspects of the project: 1. The effectiveness of the remedial action in abating release of metals to surface waters; and 2. The quality of surface water runoff as impacted by future operation of the log storage sort yard following paving of the project. An NPDES permit application has been made.

Groundwater monitoring must show no increase in metals contaminations following paving. Groundwater will be monitored for three years following paving. The performance goal is that no statistically significant increase in metals (As, Pb, Zn, Cu) will occur. Groundwater quality is expected to improve over time

TEXT REVISIONS

1. Section 2.1 should read "Site Setting" instead of "Site Settling".

2. Change the first sentence of Section 2.3 to read: "In our opinion, the Hart Crowser studies showed that the major contamination migration pathway for metals was through surface runoff."

3. Section 2.3, Introduction, should be amended to read "Refer to expanded discussion of environmental concerns in Section 4.2".

TABLE 1 - GROUNDWATER AND SURFACE WATER ELEVATIONS

Water Elevation in Feet (Port of Tacoma Datum: Mean Low Low Water)

STATION :	B-1 (B-1R)	B-2	B-3 (B-3R)	B-4	B-5	B-6 (B-6R)	DDW	DDC	DDE	WAPATO
MEASURE PT ELEV. (*) :	21.43 (21.12)	21.44	23.93 (24.32)	23.51	24.35	22.39 (22.13)	15.55	16.60	18.75	10.94
DATE OF MEASUREMENT:										
3/20/87 :	13.63	13.74	15.63	14.81	9.15	12.89	--	--	--	--
3/24/87 :	13.23	13.74	15.43	14.51	9.85	12.79	14.90	14.90	--	--
4/02/87 :	13.23	13.64	15.73	14.21	8.85	12.69	--	--	--	--
4/07/87 :	13.13	13.64	15.43	14.21	8.85	12.59	14.70	14.90	--	--
3/01/88 :	13.09	13.53	15.25	13.87	10.03	12.31	--	--	--	--
4/06/88 :	13.23	13.98	15.51	15.16	10.83	12.59	--	--	--	--
4/11/88 :	12.92	13.94	15.47	14.76	9.05	12.53	--	--	--	--
4/15/88 :	12.83	13.81	15.41	14.46	9.18	12.50	15.01	15.69	15.68	5.84
5/11/88 :	12.45	13.40	15.29	14.20	8.86	12.31	14.60	15.25	16.89	5.37
6/23/88 :	12.34	13.68	15.54	13.73	8.50	12.21	14.60	15.25	16.82	5.85
7/06/88 :	12.34	13.34	15.00	13.51	8.61	12.12	14.60	15.25	16.63	5.22
8/01/88 :	12.22	13.62	14.85	13.23	9.07	12.12	DRY	13.70	DRY	5.22
9/06/88 :	11.99	13.26	14.61	13.10	10.47	12.61	DRY	15.04	DRY	--

(*) Elevation reference point is top of PVC casing in monitoring wells and survey markers at surface water stations.

(21.34) Elevations for replacement wells 1R, 3R, and 6R installed near the original wells on 5/4/88.

Original wells were abandoned by pressure grouting due to poor condition.

DDW - Drainage Ditch West

DDC - Drainage Ditch Central

DDE - Drainage Ditch East

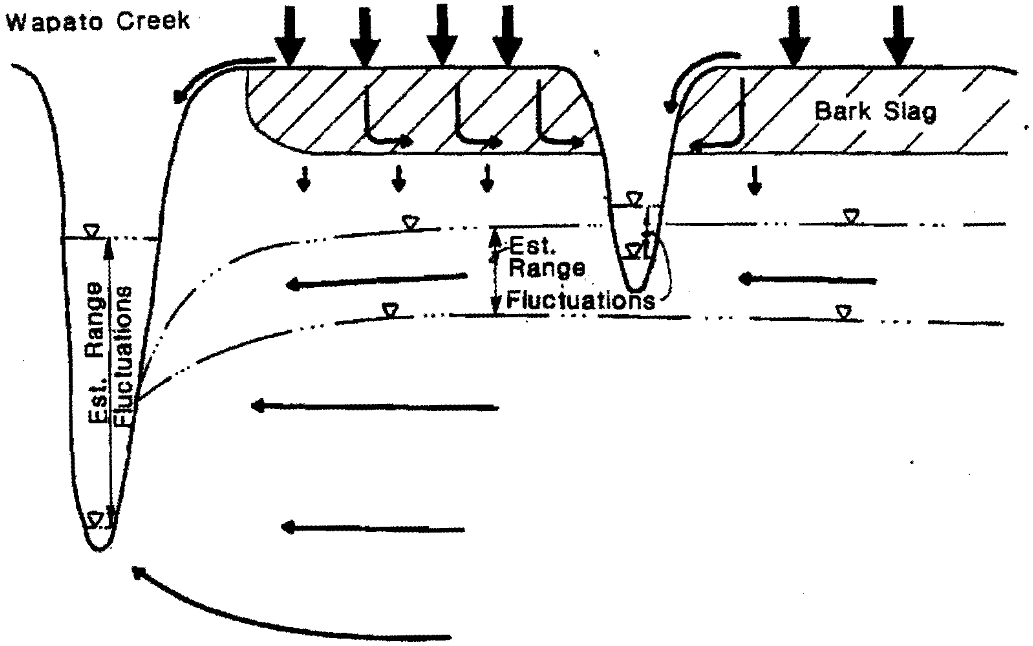
WAPATO - Wapato Creek, northwest of site

Table 2 - Time Table of Site Sampling

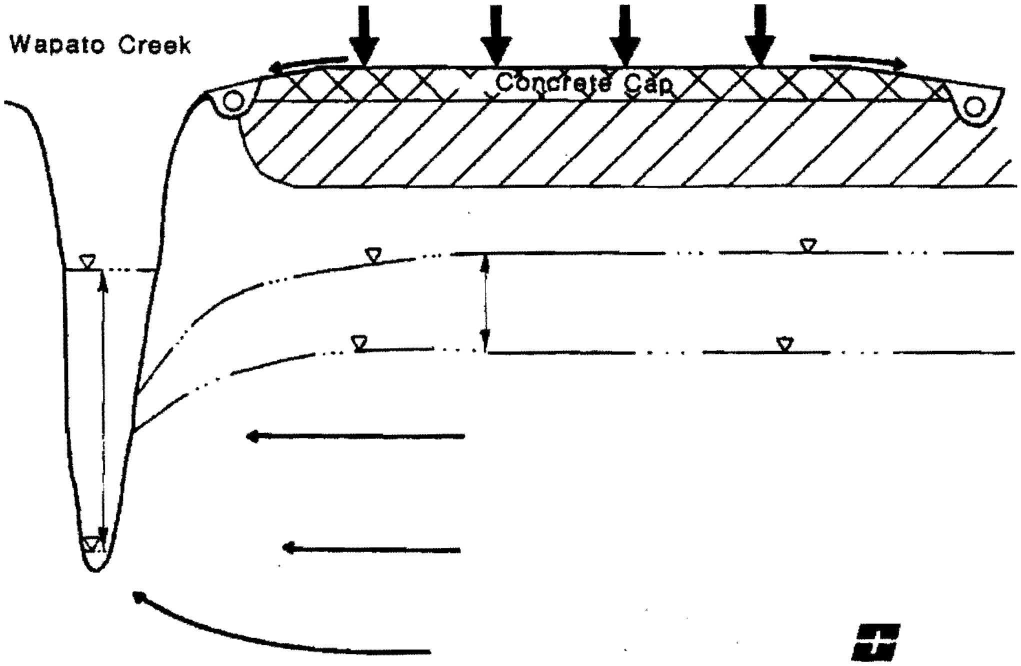
Sample Date	Sampling Party	Sample Type	Type of Chemical Tests for Metals
11/83	Ecology	Surface Water Runoff	Total Metals (As, Zn, Cu, Pb, Ni, Sb, Cd)
12/83	Ecology	Surface Water Runoff	Total Metals (As, Zn, Cu, Pb, Ni, Sb, Cd)
3/84	Ecology	Surface Water Runoff	Total Metals (As, Zn, Cu, Pb, Ni, Sb, Cd)
4/84	Ecology	Surface Water Runoff	Total Metals (As, Zn, Cu, Pb, Ni, Sb, Cd)
5/84	Ecology	Surface Water Runoff	Total Metals (As, Zn, Cu, Pb, Ni, Sb, Cd)
5/84	Ecology	Wapato Creek Water	Total Metals (As, Zn, Cu, Pb, Ni, Sb, Cd)
6/84	Ecology	Wapato Creek Water	Total Metals (As, Zn, Cu, Pb, Ni, Sb, Cd)
7/86	Hart Crowser	Portac Site Slag, Bark, and Soil	E.P. Toxicity (As, Zn, Cu, Pb)
3/87	Hart Crowser	Portac Site Slag, Bark, and Soil	E.P. Toxicity (As, Zn, Cu, Pb)
3/87	Hart Crowser	Portac Site Groundwater	Dissolved Metals (As, Zn, Cu, Pb)
9/87	Hart Crowser	Portac Site Slag & Bark	E.P. Toxicity (As, Zn, Cu, Pb)
2/88	Hart Crowser	Portac Site Slag & Bark	Total Metals (As, Zn, Cu, Pb)
5/88	Hart Crowser	Portac Site Groundwater	Dissolved Metals (As, Zn, Cu, Pb)

Conceptual Diagram of Hydrologic System

Before Paving



After Paving



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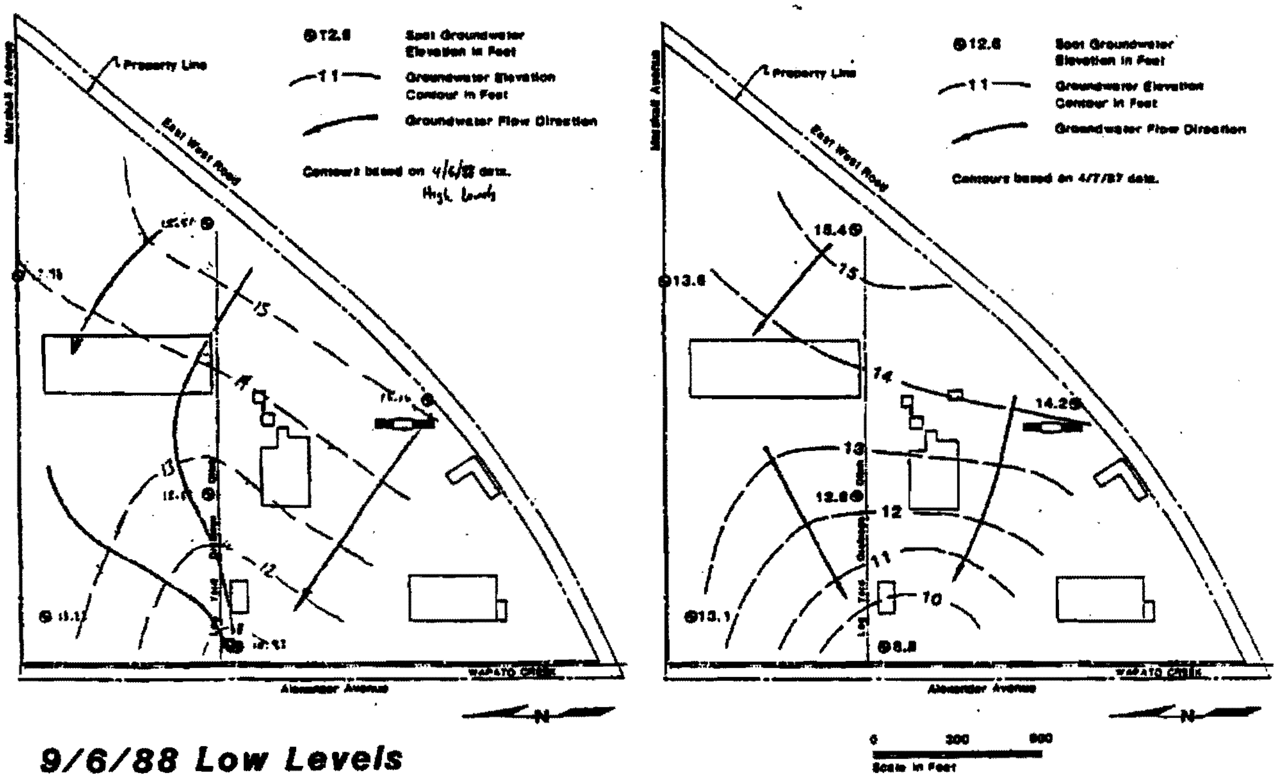
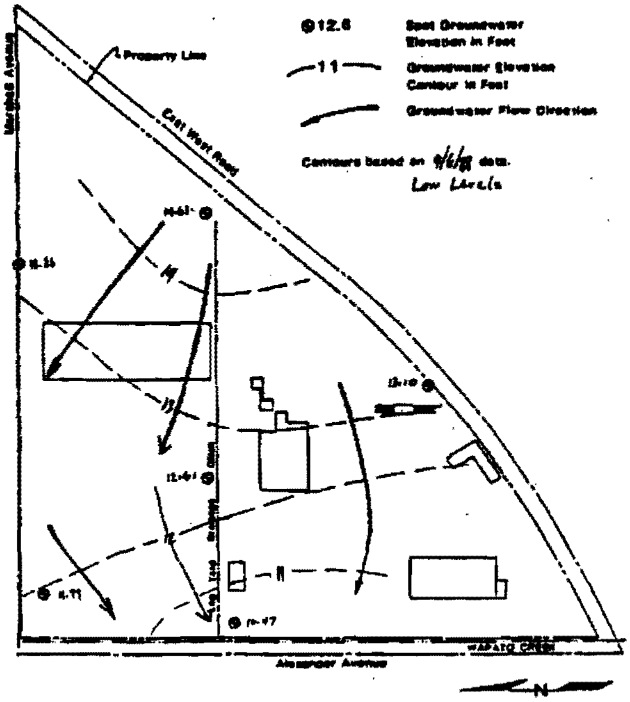
J-1773-04 9/88
Figure 1

Groundwater Elevation Contour Maps

4/6/88 High Levels　　　　4/7/87



9/6/88 Low Levels



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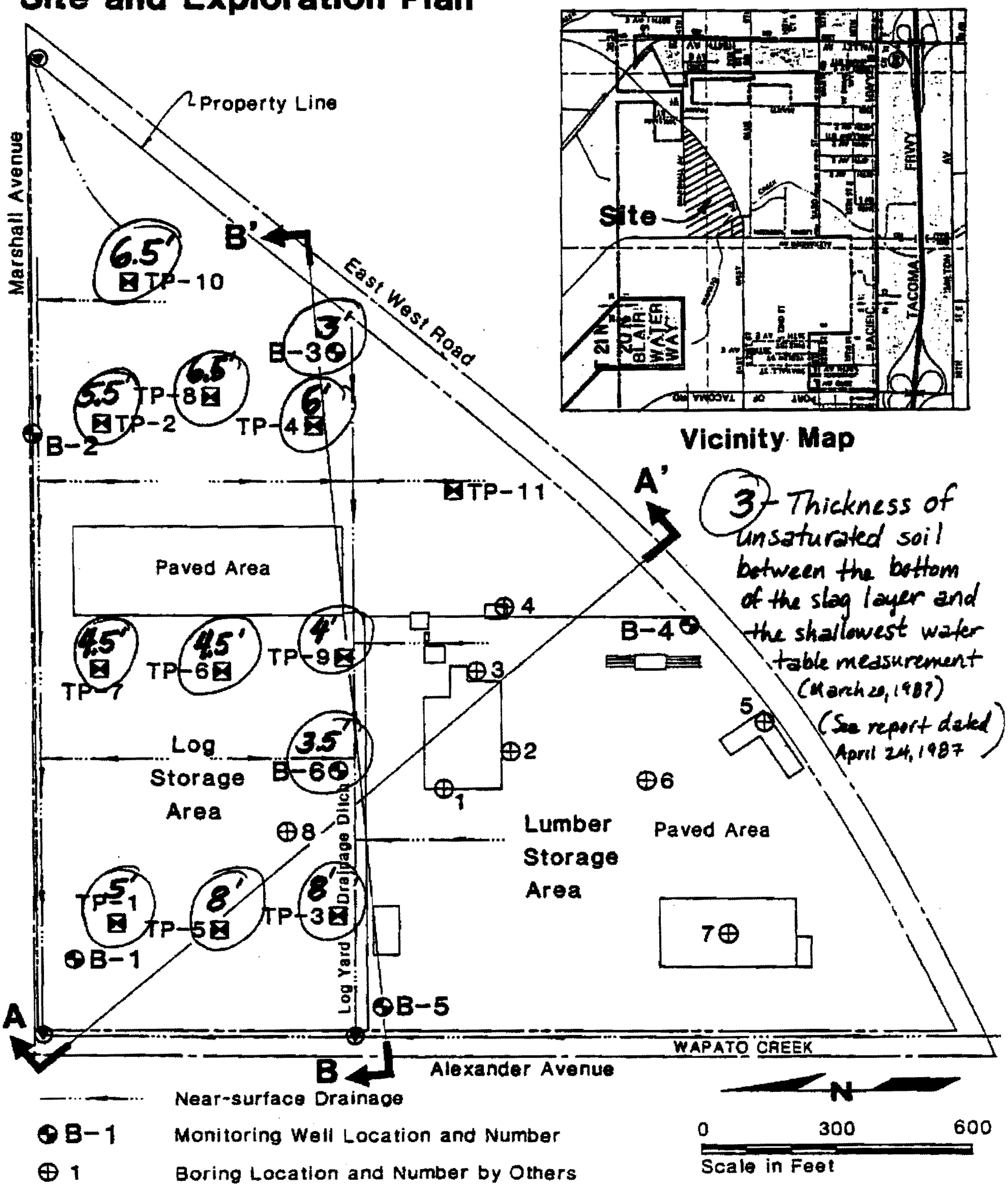
J-1773-04　9/88
Figure 2

Site and Exploration Plan



3 - Thickness of unsaturated soil between the bottom of the slag layer and the shallowest water table measurement (March 20, 1987) (See report dated April 24, 1987)

‐‐‐··‐‐‐	Near-surface Drainage
● B-1	Monitoring Well Location and Number
⊕ 1	Boring Location and Number by Others
◉	Ecology Sampling Location
☒ TP-1	Test Pit Location and Number

Hart Crowser, Inc.
J-1773-04 9/88
Figure 3

ATTACHMENT A

HARTCROWSER

Memorandum

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699
206.324-9530

To
From
Project PORTAC
Subject Groundwater Flux and Metals Loading

Page 1 of 3
Date 9/13/88
Job Number 1773-04

I) Groundwater Flow From Site

Use Darcy's Law: $Q = KIA = KI(w \cdot b)$

Where: Q = GW flux
K = Hydraulic Conductivity
I = Hydraulic Gradient
w = Aquifer width ⎤
b = Aquifer thickness ⎦ — Cross Sectional Area

Hydraulic Conductivity

Assume flow is through uniform silty sands which could range in conductivity from 10^{-3} to 10^{-5} cm/sec.

Avg = 10^{-4} cm/sec
= 3.3×10^{-6} ft/sec

High = 10^{-3} cm/sec
= 3.3×10^{-5} ft/sec

Low = 10^{-5} cm/sec
= 3.3×10^{-7} ft/sec

Hydraulic Gradient

Water level elevations recorded in B-4 and B-5 during wet, dry, and intermediate periods were used to calculate a range of hydraulic gradients accross the site.

Avg = 0.004 High = 0.005 Low = 0.003

Average Linear Velocity (assume porosity = 0.25)

Avg = 0.005 ft/day High = 0.06 ft/day Low = 0.0003 ft/day

HARTCROWSER

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Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699
206.324-9530

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Subject Groundwater Flux and Metals Loading

Page 2 of 3
Date 9/13/88
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Cross Sectional Area

Groundwater discharge from the site is focused through a zone approximately 600 ft wide, located near well B-5 (See Groundwater Elevation Contour Maps).

Avg = 600 ft High = 900 ft Low = 400 ft

The portion of the shallow aquifer discharging to Wapato Creek is assumed to be from the water table surface to approximately sea level (elevation = 0). From wells B-1 and B-5, which are located nearest Wapato Creek, the saturated thickness ranges from 8.5 to 13.6 ft.

Avg = 11 ft High = 14 ft Low = 8 ft

Groundwater Discharge from Site

Avg: $Q = \frac{3.3 \times 10^{-6}\ \text{ft}}{\text{sec}} \bigg| 0.004 \bigg| 600 \cdot 11\ \text{ft}^2 = 8.7 \times 10^{-5}\ \text{ft}^3/\text{sec}$
$= 56$ gal/day

High: $Q = \frac{3.3 \times 10^{-5}\ \text{ft}}{\text{sec}} \bigg| 0.005 \bigg| 900 \cdot 14\ \text{ft}^2 = 2.1 \times 10^{-3}\ \text{ft}^3/\text{sec}$
$= 1343$ gal/day

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Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699
206.324-9530

Memorandum

To
From
Project PORTAC
Subject Groundwater Flux and Metals Loading

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Groundwater Discharge from Site -(Con't)

Low: $Q = \frac{3.3 \times 10^{-7}\ \text{ft}}{\text{sec}} \Big| 0.003 \Big| 400.8\ \text{ft}^2 = 3.2 \times 10^{-6}\ \text{ft}^3/\text{sec}$
$= 2\ \text{gal}/\text{day}$

II) Metals Loading

Chemical data collected in May 1988 is used to calculate an average As concentration in the 6 site wells. It is then assumed that this average value represents a conservative estimate (because it is weighted by the two largest detections) of the As concentration in the groundwater being discharged from the site.

As Concentration: 0.18 mg/l

Avg: $\frac{56\ \text{gal}}{\text{day}} \Big| \frac{0.18\ \text{mg}}{\ell} \Big| \frac{3.785\ \ell}{\text{gal}} \Big| \frac{\text{lb}}{453600\ \text{mg}} = 8.4 \times 10^{-5}\ \text{lb}/\text{day}$

High: $\frac{1343\ \text{gal}}{\text{day}} \Big| \frac{0.18\ \text{mg}}{\ell} \Big| \frac{3.785\ \ell}{\text{gal}} \Big| \frac{\text{lb}}{453600\ \text{mg}} = 2.0 \times 10^{-3}\ \text{lb}/\text{day}$

Low: $\frac{2\ \text{gal}}{\text{day}} \Big| \frac{0.13\ \text{mg}}{\ell} \Big| \frac{3.785\ \ell}{\text{gal}} \Big| \frac{\text{lb}}{453600\ \text{mg}} = 3.0 \times 10^{-6}\ \text{lb}/\text{day}$

CONTENTS

TABLES

REMEDIATION PLAN
PORTAC LOG SORT YARD
PORT OF TACOMA, WASHINGTON

1.0 INTRODUCTION

1.1 Purpose of This Study

We have conducted this site assessment and conceptual design at the request of the Port of Tacoma, in Tacoma, Washington. Recognizing there is a potential metals contamination problem at the Portac site, the Port together with Portac has decided to enter into a voluntary cleanup of the site. Hart Crowser, Inc. completed this study as the initial phase of design for this cleanup.

This study addresses remediation of the Portac site as a source of metals contamination only.

1.2 Purpose of This Report

This report has three purposes:

- Consolidate and summarize existing information on the Portac site;
- Present our assessment of the contamination levels, sources, and threats; and
- Document our engineering analysis for site remediation.

Intended audiences for this report include the general public, the Washington State Department of Ecology (Ecology), the Port of Tacoma, and Portac, Inc.

1.3 Perspective: Slag Use on Log Sort Yards

Portac, Inc. operates a log sort yard on property leased from the Port of Tacoma. In the past, slag was used to stabilize the site for log yard activities. At the time the log yard was constructed, slag from the ASARCO copper smelter was being processed and marketed as a construction ballast material. Because quarried ballast material is relatively expensive, slag was an attractive alternative ballast source. Use of slag was viewed as a good recycling alternative by the agencies. Recent studies by Ecology have shown metals are being released from the slag on the log yards into nearby surface waters (primarily arsenic, copper, and lead).

In addition to the use of slag presented here, slag has been used as mineral wool home insulation, composition roofing, an additive in concrete, sandblasting shot, and riprap. Most of the slag produced at ASARCO remains at that site.

In recent years, use of the slag in log yards has come under close scrutiny by the environmental agencies. The high release of metals from slag is apparently unique to its use on log yards. One hypothesis is that tannic acid reacts with the slag to release metals. The slag used on the log yards is now perceived to pose an unacceptable hazard to the surrounding environment. Portac, Inc. and the Port of Tacoma want to provide a permanent solution to the problems at the site.

1.4 Glossary

Because this report is a technical document, it necessarily uses some technical terms. Below, we have defined some terms that may be unfamiliar to some readers. We have also included all acronyms and abbreviations used in this report.

- AC - Asphalt Concrete.
- ACGIH - American Conference of Governmental Industrial Hygienists.
- As - Arsenic.
- Aquifer - A water bearing soil layer, typically composed of sand.
- ARARs - Applicable or Relevant and Appropriate Requirements; and local restrictions derived from federal, state, and local regulations that may apply to contaminated sites.
- CERCLA - Comprehensive Environmental and Response, Compensation, and Liability Act.
- cm/sec - centimeters per second.
- Cu - Copper.
- Ecology - Washington State Department of Ecology.
- EPA - Environmental Protection Agency.
- Fill - Imported material of unspecific origin, generally sand, silt, slag, and bark.
- Flow-weighted average concentration - A level of contaminant determined by taking into account the size of flow associated with the measured level; this results in an emphasis on larger flows.
- Hydraulic gradient - The slope of the groundwater surface.
- kip - 1,000 pounds.

o mg/L - Milligrams per liter.

o mg/m^3 - Milligrams per cubic meter.

o NPDES - National Pollutant Discharge Elimination System

o NTU - Nephelometric turbidity units.

o Overconsolidated - Term describing a soil that has experienced heavy loads (e.g., from ice) in the past.

o Pb - Lead.

o PCC - Portland Cement Concrete.

o Penta - Pentachlorophenol; a contaminant generally associated with wood preservative.

o Permeability - A measure of the ability of soil to allow the flow of groundwater; higher permeability indicates larger potential flows.

o pH - A measure of the relative acid or base content of a substance; pure water has pH of 7; acids have pH less than 7; bases have pH greater than 7.

o ppm - Parts per million.

o Prograding river delta - Delta at the mouth of a river that is building seaward due to a high sediment load in the river.

o RCC - Roller Compacted Concrete.

- QA/QC - Quality Assurance/Quality Control.
- RAO - Remedial Action Objective; Statement of the goal of the proposed remedial action.
- Slag - Rock-like waste material produced during smelting operations.
- Specific Conductivity - A measure of the ability of a substance to conduct electricity.
- um - Micrometer, 10^{-6} meter.
- WAC - Washington Administrative Code.
- Zn - Zinc.

2.0 SUMMARY OF PRINCIPAL FINDINGS

2.1 Site Settling

The project site is located in the Port of Tacoma industrial area between Interstate 5 and Commencement Bay. The site remained undeveloped until 1974 when the present sawmill and log sort yard were constructed. The operation is currently owned by Portac, Inc. which leases the property from the Port of Tacoma.

The site is situated on the Puyallup River-mouth delta. The upper 10 feet of the soil profile consists of bark/slag and fill overlying dredged sediment fill. Groundwater is about 6 to 9 feet below the ground surface. Wapato Creek borders the west edge of the property and empties into Blair Waterway about 1,000 feet downstream from the site.

2.2 Investigative Studies

Studies conducted by the Environmental Protection Agency (EPA) and Ecology in the early 1980s indicated high metals concentrations coming from log sort yards in the Commencement Bay area. The source was associated with slag from the ASARCO copper smelter placed on the sites as ballast material. The release of metals from slag was apparently unique to its use on log yards.

Hart Crowser conducted several studies at the site. They found that the metals contamination coming from the site was restricted essentially to the surface runoff. Little contamination was found in the soil or groundwater underlying the site.

2.3 Environmental Assessment

The Hart Crowser studies showed that the major contamination migration pathway for metals was through surface runoff.

The major existing and potential environmental concerns include:

- Copper concentrations in Wapato Creek (downstream from Portac) and Blair Waterway exceed the acute marine toxicity standard (Portac is not the sole source of metals to these waters)
- Arsenic concentrations in Wapato Creek equal the acute marine toxicity standard
- Concentrations of arsenic and lead in the uppermost shallow aquifer directly beneath the site exceed (by two to three times) drinking water standards, this thin aquifer is not used for drinking water or other domestic purposes.

Based on these environmental concerns, we have developed a statement of the goal of remedial action at the site:

> Reduce the metals concentrations in runoff from the Portac site (as measured at the point of discharge) to the acute marine toxicity standards.

The chosen remedial action should essentially limit vertical migration of metals to the aquifer by intercepting rainfall and preventing percolation to the groundwater.

2.4 Development of Conceptual Design

For the conceptual design phase of the project, we assessed the potentially applicable technologies for site cleanup. We screened these technologies on the basis of their applicability to the cleanup goals, the specific contaminant, and cost.

Following technology screening, we formulated potential remedial alternatives. We screened these alternatives on the basis of the following criteria:

- Compliance with ARARs
- Protection of Public Health
- Implementability
- Short-Term Effectiveness
- Long-Term Effectiveness
- Reduction of Toxicity, Mobility, or Volume
- Cost
- Adverse Environmental Effects

Based on these criteria, the best remedial alternative is:

> Cap -- The site will be capped with pavement to inhibit infiltration of surface water and rainfall into slag and groundwater.

2.5 Preliminary Remedial Action Design

We evaluated preliminary pavement sections for asphalt concrete, Portland cement concrete, and roller compacted concrete. The results are:

- Asphalt Concrete -- 24 to 30 inches thick
- Portland Cement Concrete -- 14 to 19 inches thick
- Roller Compacted Concrete -- 14 to 19 inches thick

These sections are full depth equivalent thicknesses. Actual pavement thickness will be less if imported fill subbase or base is used.

Surface drainage at the site will be accomplished by sloping the pavement to drain to catch basins. Underground piping or lined ditches will carry storm water to discharge in Wapato Creek. The catch basins will be designed to collect bark, dirt, and other floatables before discharging to Wapato Creek. An NPDES permit will be applied for concurrently with this action.

2.6 Water Quality Monitoring

We have included a work plan for post-construction sampling of surface water and groundwater. The purpose of the monitoring will be to verify the effectiveness of the remedial action.

3.0 SITE ASSESSMENT

The site assessment consists of a synthesis of relevant information about the Portac site and nearby lands. Our basis for this assessment includes:

- A study conducted by Ecology (Appendix A)
- Studies conducted by Hart Crowser (Appendices B through G)
- Studies conducted by other consultants
- Historical records of the area

The reports are referenced where appropriate.

3.1 Location

The Portac, Inc. facility is located in the Tacoma tideflats industrial area near the head of Blair Waterway. Figure 1 shows a site plan and vicinity map.

3.2 Existing Site Conditions

The log sort yard, approximately 30 acres in size, is part of the 50-acre Portac, Inc. facility. The remainder of the property holds a sawmill complex and lumber storage. The facility is roughly triangular and bounded by the Marshall Avenue right-of-way, Alexander Avenue, and East West Road. The log sort yard occupies the northern portion of the facility. The site surface is essentially level with only a few feet of total relief.

Prior to site development (circa 1974), ground cover consisted of wild grasses and blackberry bushes. During site development and continuing operations, slag was placed on the log sort yard (above the water table) as ballast material to stabilize the yard surface. The slag was produced as a byproduct material by ASARCO and marketed by them as construction material.

The surface material at the site consists of bark, slag, sand, and silt.

The site surface water drainage is controlled through a system of surface ditches and subsurface drain lines. Figure 2 presents a sketch of the drainage system in the yard. A central, open ditch (closed only where it goes under roadways) runs through the middle of the site. This ditch discharges to Wapato Creek. The unpaved log storage area lies north of the ditch and the paved lumber storage area lies south of the ditch. The central ditch drains about two-thirds of the site including the south half of the log storage area and most of the lumber storage area. Shallow perforated pipe assist drainage in the south half of the log storage area. Runoff from the lumber storage area is collected in subsurface piping and routed to the central ditch.

The north portion of the log storage area drains to three catch basins along the north property line. These catch basins discharge to Wapato Creek. In addition, a sump and pipe drains water from the northwest portion of the site directly to Wapato Creek.

Wapato Creek flows into Blair Waterway approximately 1,000 feet from the site. Wapato Creek is tidally influenced as it passes this site.

3.3 Historical Development of the Area

Although historical development of the Tacoma tideflat began in the late 1880s, the site and surrounding area was undeveloped tidelands at the turn of the century. Waterway development was not substantial until World War I when marine and wood products industries were established on Wapato Creek and the Hylebos Waterway. World War II stimulated further growth, but the site was still in tidelands. Then, between 1959 and 1965, the site and surrounding area received several million tons of fill, setting the stage for commercial and industrial development of Port of Tacoma lands.

Except for a small farm in the northeast corner, the site remained commercially undeveloped until the early 1970s. In the 1960s, road development was not extensive--East-West Road had not been built and Alexander Avenue did not extend to the site. In addition, Wapato Creek originally ran through the northeast corner of the site, but was rerouted parallel to Alexander Avenue in the late 1960s or early 1970s.

The first known industrial development on-site was the West Coast Orient Lumber Mill (ownership changed to West Coast Lumber Operations, Inc. in 1978 and to Portac, Inc. in 1983). The mill was constructed in the fall of 1974 and spring of 1975. The major activities of the company are storage of logs on thirty acres on the north half of the site, and sawmilling on twenty-two acres on the southern half of the site. There are also open storage areas on the southern half of the site for finished lumber. Mr. Pittman of Portac, Inc. says their primary function is to process logs for shipment to Japan. Operational facilities on-site include log storage, sawmill, planing mill, office, dry kiln, dry lumber storage, and a maintenance shop.

Property south and east of the site has remained undeveloped. Foot and vehicular trails criss-cross the vacant land. Port of Tacoma, corporate, and private lands north and west of the site, have supported a wide range of commercial and industrial activities since the turn of the century. Over the last thirty years those industries have been typified by freight and transfer services, marine supply and maintenance yards, wood processing and products manufacturers, and petroleum distributors.

3.4 Geology

The Portac site is located on the Puyallup River-mouth delta. This delta is located in the central Puget Sound part of the Puget Lowland. The Puget Lowland is a complex basin formed during the past 2 million years. The lowland has been repeatedly glaciated, resulting in the accumulation of a thick sequence of glacial and nonglacial sediments. The depth to bedrock in the vicinity of the Puyallup River-mouth delta is estimated to be about 2,000 feet.

The Puyallup River-mouth delta complex has been constructed seaward into Commencement Bay. The post-glacial delta has been built with sediment supplied by the Puyallup River. The upland bluffs that fringe the delta consist primarily of overconsolidated glacial sediments.

The thickness of these normally consolidated post-glacial deltaic sediments below the site is on the order of 600 feet. Loose to medium stiff sand to clayey silt are present in the near subsurface beneath the site. These deposits have estimated permeabilities that range from 1×10^{-2} to 1×10^{-6} centimeters per second (cm/sec).

3.5 Current Subsurface Conditions

For classification purposes, we have divided the soils at the Portac site into two distinct units:

- Fill - Near-surface material consisting of a mixture of sand, silt, slag, and bark.
- Silt - Soil lying beneath the fill unit consisting of silt, sand, and clay either natural or deposited as dredge fill.

Figure 3 presents a generalized subsurface cross section of the site.

The fill unit is associated with the development of the site as a log sort yard. This material is described in detail in Section 4.1. The organic content (due to bark) is generally 50 percent or greater. This unit contains the slag material which is the source of the metals contamination. Total slag thickness within this unit averages slightly under 1 foot. Total thickness of the unit is typically between 1 and 6 feet.

The silt unit lies below the fill unit. The top of this layer is typically between elevation 16 to 20 feet (Port of Tacoma datum). The soils in this unit are generally silty in nature although zones of locally cleaner sands exist. The soils consist of deltaic sediments deposited either naturally or as dredge spoils during construction of Blair Waterway.

We have estimated the permeability of the soils in the silt unit based on rising head slug tests and correlations to grain size. The permeabilities range from about 10^{-2} cm/sec in the clean sands to 10^{-6} cm/sec in the clayey soils. The overall average permeability of the silt unit is probably near 10^{-4} cm/sec (see Appendix G).

3.6 Groundwater

Hart Crowser assessed the groundwater conditions at the Portac site in April 1987. That report is included in this report as Appendix E. Appendix G of this report includes data gathered since that time as well as additional analyses of the groundwater data.

Briefly, the results of these analyses are:

- Groundwater at highest level is typically between elevation 11 to 16 feet.
- Groundwater is typically deeper than 3 feet below the slag.
- Seasonal fluctuations of groundwater are on the order of 2 to 4 feet.
- Tidal influence on groundwater is limited to within about 100 feet of Wapato Creek. These fluctuations are less than 2 feet.
- Groundwater is not generally connected to water in the log yard ditch.
- Groundwater flows toward the west to Wapato Creek (see Figure 3 of Appendix E).

Groundwater usage around the Portac site and in the tideflats area is minimal. Some water is extracted from very deep aquifers (approximately 400 to 600 feet below ground surface) for manufacturing or processing use. No drinking water is supplied by groundwater in the shallow sediments in the Tacoma tideflats area although the City of Fife does extract drinking water from very deep wells in the nearby lowland areas.

3.7 Surface Water

Local surface waters in the Portac area include Blair Waterway and Wapato Creek (see Figure 1). Wapato Creek borders the west edge of the site. It empties into Blair Waterway about 1,000 feet from the site. These surface waters receive permitted discharges of effluent (from manufacturing and processing industries) and storm water. Industrial development in the tideflat area has occurred since the late 1800s, and until recently, little was done to protect the receiving waters.

3.8 Pentachlorophenol Contamination

In the past, Portac has used wood preservatives containing pentachlorophenol (Penta). The treated lumber was stored in the paved lumber storage area. This area drains through piping to the central drainage ditch. Penta contamination has resulted in this ditch from runoff from the treatment/storage area.

The remediation efforts for the Penta contamination are being pursued separately by Portac, Inc. While the studies are being pursued separately, the remedial actions must be coordinated. Section 7.3 addresses this issue further.

4.0 SITE CHARACTERIZATION

This section presents a review of work done at the Portac site to characterize the contaminants and affected media. Hart Crowser, Inc., (under contract to the Port of Tacoma) and Ecology have conducted investigations at the site. Ecology investigations focused on identifying the source and magnitude of metals contamination of the local waterways and sediments. Hart Crowser investigations focused primarily on characterization of surface material and exploration of soil and groundwater conditions.

4.1 Source of Metals Contamination

4.1.1 Log Sort Yard Runoff

In November 1980, the EPA released a report showing high concentrations of arsenic and zinc were present in a sample of surface runoff collected from a log sort yard (not Portac) on the Blair Waterway. Inspectors from Ecology sought to verify this finding by collecting and analyzing additional runoff samples from that yard and other log sort yards on the Tacoma tideflats. These samples also contained high concentrations of arsenic and zinc. Other metals detected included copper, lead, nickel, and antimony. As a result of these preliminary investigations (winter 1980/81), Ecology inspectors theorized that slag constituents were being mobilized into the environment. Sort yard operators, including Portac, agreed to stop using slag until additional information could be obtained regarding metals in sort yard runoff.

Ecology launched a more detailed runoff study from November 1983 to June 1984. Results were made available in a February 1985 report (Norton and Johnson). A complete copy of this report is presented in Appendix A. They concluded that:

> The common occurrence of high concentrations of arsenic, zinc, copper, and lead in ASARCO slag and in log sort yard runoff, the relatively

> constant metals ratio in runoff from different yards, and the fact that sort yard runoff is unique among discharges to Commencement Bay waterways in its high metals content, indicate the use of slag as ballast is the source of the problem. The impacts of sort yard runoff on metals distributions in Blair and Hylebos Waterways are evidenced by strong concentration gradients in both surface waters and sediment which point to sort yards as sources.

Specific results from the 1985 report., as they apply to the Portac site, are as follows.

Table 1 presents the data collected between November 1983 and May 1984 characterizing runoff. Specific conductivity and pH are reported as simple averages. Solids and metals are flow-weighted average concentrations.

Total suspended solids concentrations were relatively low at the Portac site. This is probably due to the fact that most of the runoff flows through the near-surface soil to the ditch. These near-surface soils act as a filter to screen out much of the solids. Additional suspended solids analyses showed that solids coming off the yard were composed of approximately equal amounts of organic and inorganic materials.

Data on individual discharges at the Portac yard (3 separate discharges were sampled) shetals concentrations to be highly variable. In general, they found the greatest metals concentrations in discharges draining heavy traffic areas.

The report includes daily average annual metals load in runoff. It shows that loadings from throm the sort yard are greatest during storm events. Po
rtac
was noted as being one of two major arsenic sources to Blair Waterway during storm events. Portac consistently ranked in the top three of the twelve log sort yards examined for estimated average annual daily metals loads for arsenic, zinc, copper, and lead.

Table 1 Coventional Water Quality Parameters and Metals Concentrations in Portac Log Sort Yard Runoff to Blair Waterway; Ecology Data Collected November 1983 through May 1984 (From Table 8, Appendix A)

	Date	Time	Total Yard Flow (MGD)	pH (S.U.)	Specific Conductivity in umhos/cm	Total Susp. Solids in mg/L	Flow Weighted Concentration, ug/L Total Metal						
							Arsenic	Zinc	Copper	Lead	Nickel	Antimony	Cadmium
Napato Creek/ Blair Waterway	11/04/83	1000-1030	0.36	5.7	910	110	2900	5000	1400	290	270	140	10
	12/29/83	2030-2045	1.8	5.8	230	28	1100	790	310	9	30	---	1.0
	3/12/84	1535-1555	0.11	6.1	600	130	7100	2600	1600	570	130	380	3.5
	4/10/84	1440-1500	0.095	6.3	690	64	5800	1700	720	270	87	150	2.9
	5/03/84	1535-1550	0.058	6.4	930	88	9500	2100	1000	380	120	120	2.0
		Average	0.48	6.1	670	84	5300	2400	1000	300	130	200	3.9

4.1.2 Slag Bearing Surface Material at Portac

To characterize the source of metals contamination coming from the log sort yard, Hart Crowser performed investigations on three occasions. These included test pits, bulk sampling, and test separation sampling (see Appendices B, C, and D). For analysis purposes, the components of the surface material (the surface material is defined as that material lying above the competant slag layer) on the Portac site were grouped into three units. These units were dictated by the currently available technology for separation of bark from rock/slag. The units include:

- Fines - Sand, silt, fine bark, and slag chips. The particles range in size up to about 1 inch. Most are smaller. Looks like garden quality topsoil.
- Rock - Slag, rock, and bark fragments. The slag fragments are typically heavy, shiney, and gray although some are very light due to gas pockets. Particle size is typically 1 to 5 inches.
- Bark - Tree-bark, wood fragments, and some fines and rock. Some bark and wood fragments are longer than 1 foot.

Table 2 summarizes the make-up and quantity of the surface material. The Total Organics column gives the amount of bark or wood in each component. The quantities are as of September 1987.

Table 2 - Material Quantities

Material	Total Organics by Weight in Percent	Estimated Volume in Cubic Yards	Estimated Weight in Tons
Fines	55	47,000	25,000
Rock	1	12,000	21,000
Bark	70	19,000	9,000

Based on our most recent test pits, there may be as much as 40,000 tons of slag below the surface material. In addition, it is likely that several thousand tons of bark have been deposited since September 1987.

4.1.3 Metals Levels in Surface Material

Table 3 summarizes our estimate of metals levels in the surface material components. The estimates are averages based on the chemical test data from the test pits, bulk sampling, and test separation sampling. Appendices B, C, and D contain the reports that detail these three sampling and analytical efforts. The EP Toxicity method is designed to simulate leaching of contaminants from a waste material within a sanitary landfill.

Efforts were focused on four metals (arsenic, lead, copper, and zinc). These metals are the predominant contaminants of ASARCO slag. One set of testing included other metals. Other than arsenic, lead, copper, and zinc none were detected.

No chemical data are given for the Rock material. The Rock is predominantly slag. Numerous other studies have been conducted on metals leachability from slag (Crecelius, 1986; Johnson, et al., 1982).

Table 3 - Surface Material Component Contamination Levels

	EP Toxicity in ppm				Total Metals in ppm			
Material	As	Pb	Cu	Zn	As	Pb	Cu	Zn
Fines	1.2	nd[*]	nd	0.1	490	260	450	650
Bark	1.0	nd	nd	0.1	200	110	190	350
Regulatory[**] Limit	5.0	5.0	100	500				
Detection Limit	0.2	0.1	0.1	0.1				

[*] nd - Not detected.

[**] Primary drinking water standards

The EP Toxicity test results indicate the material is not considered hazardous waste, for the parameters analyzed, in accordance with state and federal criteria (WAC 173-303-091 and 40 CFR 261.24).

4.2 Extent of Metals Contamination

Based on the information currently available, we assessed the extent of contamination for five media:

- Surface water
- Sediment (below surface water)
- Groundwater
- Air
- Soil

We obtained data on surface water and sediments from the Ecology report presented in Appendix A. Data on soil and groundwater were obtained from Hart Crowser reports presented in Appendices B through G.

4.2.1. Surface Water

Table 4 presents surface water (Wapato Creek and Blair Waterway) sampling data from the Ecology investigation. It should be noted that the Portac site is not the sole contributor of metals to Blair Waterway. Observing the distribution of arsenic, zinc, and copper along Blair Waterway and Wapato Creek, peaks were noted near log yards at the middle of the waterway and the mouth of the creek. Substantial increases in arsenic, zinc, and copper concentrations (also lead and suspended solids) occurred between sampling locations above and below Portac discharges. This was especially true for arsenic which increased by a factor of 35 in Wapato Creek after passing Portac.

It is important to note that these contamination levels vary considerably with the flow. The metals concentrations are highest during storm events. Most of the time, the concentrations in site runoff are less than the values in the table. In addition, dilution effects are greater during storm events when the concentrations are highest.

Table 4 Coventional Parameters and Metals Concentrations in Water Samples Collected by Ecology from Blair Waterway and Wapato Creek May 3, 1984 (From Table 17 of Appendix A)

Sample Number	Station Number	Time Sampled	pH (S.U.)	Specific Conductivity in umhos/cm	Salinity (0/00)	Total Susp. Solids in mg/L	Flow Weighted Concentration in ug/L Total Metal						
							Arsenic	Zinc	Copper	Lead	Nickel	Antimony	Cadmium
Blair Waterway													
14-1940	B-1	0930	7.3	---	15	24	16	23	24	12	1u	1u	0.6
14-1941	B-2	0935	7.7	---	25	18	13	17	12	6	---	---	---
14-1942	B-3	0940	7.8	---	26	23	1u	1u	18	13	---	---	---
14-1943	B-4	0945	7.8	---	25	20	13	10	15	8	1u	1u	0.6
14-1944	B-5	0950	7.7	---	26	20	40	15	21	11	1u	1u	0.3
14-1945	B-6	1000	7.6	---	23	24	88	35	31	9	1u	1u	0.4
14-1946	B-7	1005	7.8	---	25	19	8	14	22	7	---	---	---
14-1947	B-8	1010	7.4	---	20	21	59	87	54	8	---	---	---
14-1948	B-9	1020	7.3	---	16	34	120	72	30	12	1u	5	0.4
14-1949	B-10	1030	7.4	---	22	18	34	33	27	12	---	---	---
14-1950	B-11	1040	7.8	---	25	18	6	12	17	6	---	---	---
14-1951	B-12	1100	7.8	---	15	27	3	8	31	9	---	---	---
Wapato Creek													
14-1965	W-1	1445	7.4	220	---	32	2	8	14	4	1u	1u	0.4
14-1966	W-2	1130	7.1	2720	---	58	70	65	34	11	1u	1u	0.2
EPA Criteria - Saltwater Aquatic Life (1)													
24-hour average (chronic)							---	58	4	25	7.1	---	4.5
Maximum (acute)							508	170	23	668	140	---	5.9

u = Not detected at detection limit shown
--- = Not analysed
(1) = EPA water quality criteria documents; availabilty, "Federal Register, 1980.

Compare the metals levels in the surface waters with the EPA criteria listed at the bottom of Table 4. Zinc levels exceed the chronic criterion at two locations in Blair Waterway and at one location in Wapato Creek. Copper levels exceed the chronic criterion at all sampling locations and the acute criterion at many sampling locations. Note that even the copper level in the station upstream from the Portac site (W-1) exceeds the chronic criterion.

Based on these data, the metals contamination in Blair Waterway and Wapato Creek pose potential threats to marine life. The major metals of concern are arsenic, zinc, and copper.

4.2.2 Sediments

Table 5 presents the results of sediment sample analyses at two locations on Wapato Creek (above and below the Portac site). The Wapato Creek sediment data show a three-fold increase in arsenic concentrations between samples collected above and below Portac's discharges to the creek. All other metals tested remained essentially unchanged between sampling locations.

4.2.3 Soils

Soils from the Portac site have been sampled on two occasions to evaluate the degree and types of metals leaching from the bark and slag mixtures. Eleven test pits were excavated in June 1986 and chemical analyses performed on soil samples obtained from the pits (Appendix B). Soil samples were also retrieved for analyses during monitoring well installation in March 1987 (Appendix E).

There were no detectable metal concentrations in the natural soil underlying the bark and slag stratum in the test pit sample analyzed.

Table 5 Coventional Parameters and Metals Concentrations in Sediment Samples Collected by Ecology from Wapato Creek near Portac Log Sort Yard
June 11, 1984 (From Table 1B, Appendix A)

Sample Number	Station Number	Position	Depth at MLLW in Feet	Moisture in Percent	Total Organic Carbon in Percent	Nitrogen in Percent	Grain Size in Percent				Metals in mg/Kg Dry Weight						
							Sand	Silt	Clay	Total	Arsenic	Zinc	Copper	Lead	Nickel	Antimony	Cadmium
Wapato Creek																	
14-2710	W-8	above	---	69	0.68	0.04(J)	81.1	16.3	0.89	98.3	14	70	23	14	7.3	0.1	0.04
14-2711	W-10	below	---	76	0.32	0.02(J)	91.7	7.2	---	98.9	45	78	23	10	6.2	0.1u	0.16

(J) = Estimated Concentration
u = Not detected at detection limit shown

The chemical testing done on the well soil samples indicated the soils do not appreciably leach metals or act as receptors for metals leached from the bark/slag mixture. Analytical data for the March 1987 sampling are presented in Table 6.

Table 6 - Concentration of Metals in Underlying Silt and Sand

Metal	Concentration in mg/L (EP Toxicity Test)
Arsenic	0.01
Zinc	0.01 to 0.03
Copper	0.01
Lead	0.1 to 0.2

These data suggest that in situ leaching into the underlying soils is limited at the site. Additional supporting information can be found in the August 18, 1986 report and the April 24, 1987 report in Appendices B and E, respectively.

4.2.4 Groundwater

The Ecology study did not investigate the potential impacts on groundwater from the use of slag at the log sort yards.

During March 1987, Hart Crowser installed six monitoring wells to depths of approximately 20 feet and initiated a groundwater monitoring program. The hydrogeologic assessment of the data collected during this program is presented in Appendices E, F, and G. Table 7 presents results from chemical tests conducted on samples obtained from the monitoring wells.

Table 7 - Concentration of Metals in Groundwater

	Groundwater Concentration in mg/L		
	Average	Range	Background
Arsenic	0.14	<0.005 to 0.56	<0.005
Zinc	0.07	<0.01 to 0.31	0.01
Copper	0.02	0.005 to 0.08	<0.002
Lead	0.1	0.01 to 0.4	<0.01

The data indicate the groundwater metal concentrations are one to two orders of magnitude less than the surface water discharge concentrations.

Based on the water levels observed in the wells, B-4 is essentially upgradient from the site (with respect to the uppermost aquifer). The metals levels in this well represent the background values listed in Table 7.

4.2.5 Air

Air quality has not been specifically addressed at the Portac site. In general, we do not expect that the site has a significant effect on existing air quality: metals do not volatilize into the air. The major potential problem is contaminated dust raised by the action of heavy equipment on site during construction. Current practice is to water spray heavily traveled areas to reduce dust. Dust is generally only a problem during extended dry periods. Construction is expected to last only two to three months.

Other studies have shown that all Commencement Bay is blanketed with elevated levels of arsenic due to ASARCO emissions.

4.3 Contamination Migration Pathway

There are three potential pathways for migration of metals from the Portac site to the surface waters:

- Air
- Groundwater
- Site Runoff

We have identified site runoff as the only significant pathway of migration from the Portac site. In addition, there is always the possibility of contamination from off-site sources. We have not addressed this possibility further.

4.3.1 Air

The possible mechanism for migration through the air is contaminated dust carried by the wind. We discussed air contamination in Section 4.2.5. Air monitoring has not been conducted at the Portac site. Observations of the site indicate dust levels are significant only during periods of heavy equipment use during dry weather, such as during construction. In addition, very little dust generated actually leaves the site. Therefore, we conclude that air is not a significant pathway for metals migration.

4.3.2 Groundwater

4.3.2.1. Mechanism for Groundwater Contamination

We have identified two potential mechanisms for metals transport from the site slag to the groundwater:

- Precipitation leaching metals and carrying them down to groundwater

- Groundwater rising up into the slag and leaching metals directly

Although precipitation does infiltrate to groundwater, the relatively low permeability of the soils beneath the slag layer restricts the amount of water infiltrating. This conclusion is further supported by:

- The relatively low value of metals detected in groundwater
- The almost complete absence of metals in soil samples obtained from beneath the slag

We have monitored groundwater levels at the Portac site in March and April of 1987, and March, April, and May of 1988 (see Appendix G). These data indicate the highest groundwater levels are at least 3 feet below the base of the slag layer. As the March and April groundwater levels are likely near the peak for the year, it is unlikely groundwater rises into the slag layer.

4.3.2.2 Metals Flux through Groundwater

Recognizing that small amounts of contamination exist in the groundwater, we have estimated the flux (flow of material) of contaminants to Wapato Creek. The flux is a function of several factors including:

- Soil Permeability
- Groundwater Hydraulic Gradient

Both of these factors are quite small. The hydraulic gradient slopes toward Wapato Creek at an average value of about 4 feet per 1,000 feet. The soil permeability averages about 10^{-4} cm/sec (See Section 3.5 and Appendix G).

Using these values, we estimate the total flux of arsenic to Wapato Creek is about 0.0006 pounds per day. This value amounts to 0.01 percent of Ecology's estimate of the amount being discharged to Wapato Creek from the Portac site. Other metals give similar results. Therefore, groundwater is not considered to be a significant pathway for metals transport.

This conclusion is contrary to that implied in the Ecology report (see Appendix A). Their conclusion is based on admittedly little evidence. The major factor supporting their conclusion is their assumption of the value for the runoff coefficient of 0.4. The runoff coefficient is an empirical factor used for design of storm drains. It is generally only accurate for moderate storms in urban areas (areas with a high percentage of pavement and buildings). Because of other possible losses such as evaporation, it is not intended to be used to estimate infiltration.

4.3.3 Site Runoff

Site runoff includes water collected by catch basins or the central drainage ditch. Most rainfall infiltrates through the bark and slag materials and flows along the silt 1 to 3 feet below the surface. This water either collects in shallow, perforated pipe drains beneath the log yard or discharges directly into the drainage ditch. Surface water on the north portion of the site is collected by catch basins along the north property line. Both the catch basins and the central drainage ditch discharge to Wapato Creek. These were the discharges sampled by Ecology.

The site runoff is responsible for most of the metals flux to Wapato Creek. The infiltrating rainfall flows through the near surface slag/bark fill picking up metals. This water then flows to Wapato Creek through the surface water collection system. Based on this analysis, we have concluded the metals loading to Wapato Creek is essentially a surface runoff problem.

5.0 ENVIRONMENTAL ASSESSMENT

The environmental assessment looks at

- Existing Environmental Concerns
- Future Environmental Concerns
- Future Site Use
- ARARs

From these, we have developed cleanup goals for the log sort yard.

5.1 Existing Environmental Concerns

This section presents the level of environmental hazard posed by the metals runoff to nearby aquatic plants and animals and public health.

The EPA Office of Water Regulations and Standards, Criteria and Standards Division, publishes a document, "Quality Criteria for Water 1986" that we have used to assess the impact of the metals contamination. Table 8 compares the developed criteria for arsenic, lead, copper, and zinc against the levels observed in nearby surface waters and groundwater. The values for Blair Waterway and Wapato Creek in Table 8 were obtained from the Ecology report (see Appendix A). The groundwater values are average values from Hart Crowser studies (see Appendix G).

Table 8 - Comparison of Criteria Levels for Metals against Metal Concentrations in Nearby Surface Waters

CRITERIA	Metal Concentration in mg/L			
	As (III)	Pb	Cu	Zn
Fresh Water Animal Toxicity				
Acute *	0.36	0.082	0.018	0.12
Chronic**	0.19	0.0032	0.012	0.11
Marine Animal Toxicity				
Acute	0.069	0.14	0.0029	0.095
Chronic	0.036	0.0056	0.0029	0.086
Human Health				
Drinking Water	0.05	0.05	--	--
Carcinogen	YES	NO	NO	NO
MEASURED VALUES				
Wapato Creek Upstream	0.002	0.004	0.014	0.008
Wapato Creek Downstream	0.07	0.011	0.034	0.065
Blair Waterway (Mouth Wapato Creek)	0.015	--	0.012	0.025
Groundwater at Portac	0.14	0.1	0.02	0.07

* Acute - Short-Term

** Chronic - Long-Term

When observing Table 8, keep in mind the following points:

- Wapato Creek adjacent to Portac is a tidally influenced urban stream. Fresh water animals probably do not live in this portion of the creek. Therefore, the marine standards are probably the most appropriate (with the exception of lead, the marine standards are stricter than the fresh water standards).

- Because the metals loadings are related to storm events, acute criteria are probably most appropriate.

- Neither the site groundwater nor Wapato Creek are used for drinking water. Nevertheless, we will assess the groundwater contamination levels against the drinking water standards.

With these three points in mind, note the following from Table 8:

- Arsenic
  - Concentrations in Wapato Creek equal the acute marine standard.
  - Concentrations in Blair Waterway are below all standards.
  - Groundwater concentrations exceed drinking water standards by a factor of 3.

- Lead
  - Concentrations in Wapato Creek are below the acute marine standard.
  - Groundwater concentrations exceed drinking water standards by a factor of 2.

- Copper
  - Concentrations in Wapato Creek below the Portac site exceed the acute marine standard by a factor of 11.
  - Background concentrations (above Portac) in Wapato Creek exceed the acute marine standard by a factor of 5.
  - Concentrations in Blair Waterway exceed the acute marine standard by a factor of 4.

- Zinc
  - All concentrations are below all standards.

The 1985 Ecology report evaluated environmental concerns as follows. Locally toxic conditions for aquatic organisms could exist in nearshore receiving waters until sort yard runoff is completely mixed in the receiving waters. These adverse conditions result from the metals concentrations (both particulate and dissolved) and from high solids concentrations (siltation may have an adverse effect on organisms).

Based on the above concerns, we've drawn the following conclusions regarding existing environmental concerns:

- For marine organisms, potentially toxic concentrations of arsenic and copper are being discharged via surface water from the Portac site

- There is little risk to general public health

- There is marginal risk to workers on the site breathing contaminated dust

5.2 Future Environmental Concerns

If no action is taken at the Portac site, we expect the future environmental concerns will be similar to the existing concerns. It is likely the slag will continue to leach metals at a relatively constant rate. Metals concentration in site runoff should not change significantly.

Risks to human health will not likely change.

5.3 Future Site Use

The site is located in an industrial area. Although future use of the site may not include log yard or sawmill activities, the area is likely to remain an industrial area.

5.4 Applicable or Relevant and Appropriate Requirements (ARARs)

ARARs are contaminant, location, or action specific restrictions that may apply to contaminated sites. They are derived from federal, state, or local regulations or ordinances that may govern the site.

We have developed a list of ARARs for the Portac site. These include:

1) EPA Quality Criteria for Fresh and Marine Water (1986 and updates) as well as Drinking Water

These criteria are listed in Table 8.

2) Water Quality Standards, Chapter 173-201 WAC

We assessed these potential ARARs on the assumption that Wapato Creek is a Class A receiving water. With respect to discharges from the Portac site, standards for fecal coliform, dissolved oxygen, total dissolved gas, and temperature are not relevant. For pH and turbidity we have assumed marine standards. These are:

- pH -- Range of 7.0 to 8.5 with not more than 0.5 difference from ambient surface water pH.

- Turbidity -- If background less than or equal to 50 NTU, then less than background +5 NTU; otherwise less than 110 percent of background.

3) Dangerous Waste Standards, Chapter 173-303 WAC

These standards include the State's Dangerous Waste Regulations. The relevant designation limits for the four major metal contaminants are:

	EP Toxicity in mg/L	Acute Toxicity in ppm	
Arsenic	5.0	Aquatic*	LT**0.1
		Oral	5 - 50
Copper	-	Aquatic	LT 0.1
		Oral	50 - 500
Lead	5.0	Aquatic	LT 0.1
Zinc	-	Aquatic	LT 0.1
		Oral	5 - 50

* Aquatic toxicity based on EPA Spill Table (302.4); oral toxicity based on lowest reported Oral Rat LD50 for inorganic compound, RTECS.

** LT = Less than

4) Standards, Threshhold Limit Values, ACGIH

These standards are based on occupational exposures. The values provided below are Time Weighted Averages (mg/m^3) for air levels.

Arsenic	0.2
Copper	1.0
Lead (dust)	0.15
Lead Arsenate	0.15
Zinc Oxide (dust)	10.0

5) Standards, Ambient Air Quality Guidelines, Puget Sound Air Pollution Control Agency

Standards given below are in micrograms per cubic meter.

Arsenic	0.00022
Copper	2.4
Zinc Oxide	11.4
Zinc Chromate	0.12

There is some question whether the arsenic standard is appropriate. Background levels of arsenic in the Commencement Bay area may be such as to make this standard impossible to meet.

5.5 Cleanup Goals

Based on our remedial study (Section 4) and Environmental Assessment (Section 5), we have developed a Remedial Action Objective (RAO). The RAO is a statement of the goal of the proposed remedial action at the Portac site.

Portac RAO: Reduce metals concentrations in runoff from the Portac site (at the point of discharge) to the acute marine standards (Table 8).

The RAO appears to be realistic for all metals except copper. Background levels of copper may exceed the acute marine standard. A significant source of copper contamination is highway runoff.

Because contamination of the uppermost aquifer is not a significant problem, the RAO does not specifically address this contamination. Note, however, the remedial action chosen for satisfying the RAO should inhibit metals migration to the uppermost aquifer as well.

6.0 DEVELOPMENT OF CONCEPTUAL DESIGN

We developed the conceptual design for this project in four stages:

- Screening of available remedial technologies to determine those potentially applicable
- Formulation and initial screening of remedial alternatives
- Development of screening criteria
- Screening of potential remedial alternatives

Below, we have summarized this process.

6.1 Remedial Technologies

The EPA has grouped remedial technologies into nine categories which correspond to general site problems. The categories include:

1) Surface water controls
2) Air pollution controls
3) Groundwater controls
4) Gas migration controls
5) On-site and off-site disposal of wastes and soil
6) Contaminated sediments
7) In situ treatment measures
8) Direct waste treatment
9) Contaminated water and water and sewer liners

We have evaluated the site problems at the Portac site. These site problems are listed below together with the remedial technology (category number from above) designed to treat that problem.

- Dust generation by heavy construction or other site activities (2)
- Contaminated site runoff (1)
- Surface seepage of leachate (1)
- Precipitation infiltrating into site to form leachate (1)
- On-site waste piles (5),(7),(8)
- Contaminated surface water (5),(7),(8)

The technologies applicable to the site problems include numbers (1), (2), (5), (7), and (8). These are discussed in some detail below.

6.1.1 Surface Water Controls

Surface water controls include containment, diversion, and collection methods. They are designed to perform one of six basic functions:

- Prevent run-on or intercept runoff
- Prevent infiltration
- Control erosion
- Collect and transfer water
- Store and discharge water
- Protect from flooding

For typical surface water control problems, several technologies will be combined.

Potentially applicable technologies in the surface water control category are:

- Low permeability cap -- This consists of some form of horizontal membrane or barrier that prevents or reduces infiltration
- Site grading -- This includes excavating, filling, placing riprap, and sloping the site to drain
- Revegetation -- Used to prevent erosion of surface soils

- Surface water channels -- These are used to intercept runoff, reduce runoff slope lengths, or collect and carry water to a specific location
- Sedimentation basin -- This is intended to reduce the load of suspended solids in runoff; water is slowed as it enters the basin allowing the particles to settle out

6.1.2 Air Pollution Controls

Air pollution controls are associated with either gaseous emissions or dusts. Gaseous emissions are not a problem at the Portac site. Dusts generally arise from wind, construction traffic, or excavation.

Potentially applicable technologies to control dusts include:

- Pavement -- Paving essentially permenently binds particles to the surface

- Dust suppressants -- Usually consists of some form of coating (resin, bitumen, or polymer) that binds the surface particles and prevents them from becoming airborne

- Wind fence -- Temporary barrier to deflect the wind away from waste piles

- Water spraying -- Water is sprayed every few hours on exposed surfaces to reduce dusts

6.1.3 On-site and Off-site Disposal of Wastes and Soil

Wastes are often excavated and disposed of in a landfill. A landfill may be on or off the site. The type or level of contamination affects where the wastes may go.

Potentially applicable technologies in this category include:

- Landfilling -- Wastes disposed of on-site usually require some form of isolation such as capping. Wastes disposed of off-site will be placed in a regulated landfill.
- Incineration -- This is used to reduce the amount of waste prior to landfilling.

6.1.4 In Situ Groundwater Treatment Measures

In situ treatments consist of some form of chemical, biological, or physical treatment in the ground which breakdown, remove, or lock in the contaminant. Treatment measures in this category are specifically aimed at treating groundwater problems. In situ treatment of soils such as solidification is included in Section 6.1.5. Since groundwater is not the remediation objective at the Portac site, in situ treatment technologies will not be addressed further.

6.1.5 Direct Waste Treatment

Direct waste treatments include methods for treating liquid, gas, and solid wastes. There are no gas wastes at the Portac site. Many of these technologies are widely used in industrial waste treatments.

6.1.5.1 Liquid Waste Treatments

Potentially applicable liquid waste treatments include:

- Filtration -- Suspended solids are removed from a liquid by forcing the fluid though a porous medium
- Precipitation/Flocculation -- Inorganic wastes are forced out of solution (by altering the chemical equilibrium) with the addition of chemicals to the waste stream

- Ion Exchange -- Toxic ions in solution are removed from the waste stream by being exchanged with harmless ions in an exchange material

- Reverse Osmosis -- This is a sophisticated form of filtration where the porous medium is a semipermeable membrane

6.1.5.2 Solid Waste Treatments

Potentially applicable solid waste treatments include:

- Gravity Thickening -- A sludge is allowed to settle under its own weight, forcing water out of the sludge

- Dewatering Lagoons -- Water is removed from the bottom of a large pond either by gravity or with vacuum assist

- Centrifuge -- Sludge is spun at high speed to force out excess water

- Filtration -- This is a similar process to that described earlier in that the waste material is forced through a porous medium. In this case, however, the object is to remove water from the solid instead of the other way around

- Separation -- This is a mechanical process whereby a solid material is separated into its constituent materials by mechanical screening

- Solidification -- Wastes are solidified to improve handling, decrease surface area, or limit solubility or toxicity; this term is typically associated with the creation of a monolithic block of material by some form of physical treatment

- Stabilization -- This is similar to solidification except with stabilization the handling characteristics are typically not improved; the benefit is typically achieved by some form of chemical treatment of the contaminant

6.1.6 Additional Technologies

In addition, there are some technologies that do not fit into any of these categories. These additional technologies include:

- Monitoring Wells -- These are used to monitor the effectiveness of cleanup efforts on groundwater

- Institutional Controls -- These are used to restrict use of possibly contaminated areas, food, or water

6.1.7 Remedial Technology Screening

We created the initial list of technologies given above based on potential applicability. We then screened this list using three basic criteria:

- Applicability to the specific contaminant and RAO

- Cost

- Continued use of site as log yard

Using these criteria, we screened out the following technologies:

- Institutional Controls -- these are inconsistent with our RAO

- Dust suppressants -- these do not work well under construction traffic

- Wind fence -- the major source of dust at the site will be due to moving construction traffic not wind

- Precipitation/Flocculation -- This technology generally requires uniform flow rates and contamination concentrations. Flows and contamination levels of surface water from the Portac site are highly irregular

- Reverse osmosis -- This is an expensive technology that is generally only appropriate for low flows and very toxic wastes
- Dewatering lagoons -- Space limitations restrict the use of large lagoons
- Revegetation -- Incompatible with intended use of the site

6.2 Formulation of Remedial Alternatives

Our next step in the screening process was to formulate the alternatives that potentially meet the RAO. Fundamentally, this process consists of combining all of the applicable technologies in all possible variations. In practice, however, the process is not that simple. We have 15 applicable technologies. There are thousands of possible ways that these may be combined. To simplify things, we have grouped the technologies into logically similar categories. These groupings are shown below.

Universal	Primary	Secondary
Monitoring wells	Cap	Incineration
Site grading	Landfilling	Filtration
Surface water channels	Ion exchange	Gravity thickening
Sedimentation basin	Solidification	Centrifuge
Water spraying		Separation
		Stabilization

The group headings are defined as follows:

Universal - Technologies in this group must be used with all alternatives. For example, site grading is part of almost any construction job, so it essentially will always be used.

Primary - This includes technologies that are mainly responsible for the effectiveness of the alternative.

Secondary - This includes technologies that may only be used in conjuction with other technologies.

These groupings greatly reduce the number of possible alternatives: all alternatives that do not include all of the Universal technologies are eliminated.

To further simplify the formulation of alternatives, we grouped the possible alternatives into processes. These process groups are based on the four primary technologies. They are:

- Site cap
- Solidification/Stabilization
- Treat surface water
- Landfill

Staying within the restrictions governed by the technology and process groups, we formulated all the possible alternatives. Some of the resulting alternatives were illogical and eliminated by inspection: for example, an alternative that included water treatment but did not include water collection. This procedure resulted in 23 possibly applicable alternatives.

Because of the large number of alternatives, we decided to do an initial screening prior to the final, detailed screening. We used the same criteria for the initial screening that we will use in the final screening (see Section 6.3 for a discussion of the criteria). For the initial screening, we rated the performance of each alternative against each criterion on a subjective scale as follows:

Performance:	Good	+1
	Neutral	0
	Poor	-1

The scores were summed for each alternative and the 10 highest scoring alternatives were selected for final screening. The 10 highest scoring alternatives included 7 capping and 3 water treatment alternatives.

Because the initial screening was subjective, we felt it was important that the list for final screening include at least one alternative from each process group. Therefore, we chose to include one landfill and one site stabilization option in the final screening.

The 12 alternatives chosen for final screening were:

- Cap - Leave all surface material on site and cap with pavement.

- Stabilize and Cap - Raise pH of surface material (to reduce metals solubility) with lime treatment and cap with pavement.

- Solidify and Cap - Solidify surface material with a cementing agent and cap with pavement.

- Landfill Bark and Cap - Dispose of bark in an off-site landfill and cap with pavement.

- Landfill Bark, Solidify remaining and Cap - Separate and dispose of bark in an off-site landfill, solidify remaining surface material with a cementing agent, and cap with pavement.

- Landfill Bark, Stabilize remaining and Cap - Separate and dispose of bark in an off-site landfill, raise pH of remaining material with lime treatment, and cap with pavement.

- Incinerate Surface Material and Cap - Incinerate surface material, return ash to the site, and cap with pavement.

- Treat Surface Water - Collect surface water and remove metal contaminants with ion exchange.

- Solidify and Treat Surface Water - Solidify surface material with a cementing agent, collect surface water, and remove metal contaminants with ion exchange.
- Stabilize and Treat Surface Water - Raise pH of surface material with lime treatment, collect surface water, and remove metal contaminants with ion exchange.
- Landfill - Dispose of all surface material in an off-site landfill.
- Solidify Surface Material - Solidify surface material with a cementing agent.

6.3 Screening Criteria for Alternatives

We developed the criteria for screening based on the EPA's guidance for conducting feasibility studies under CERCLA. We slightly modified these criteria because we are not dealing with a hazardous waste. Our final list includes 8 criteria. They are:

1. Compliance with ARARs
2. Protection of Public Health
3. Implementability
4. Short-term Effectiveness
5. Long-term Effectiveness
6. Reduction of Toxicity, Mobility, or Volume
7. Cost
8. Adverse Environmental Effects

The following sections discuss each of these criteria in detail. Included in the discussion is what specific factors affect the rating of each alternative against each criterion.

6.3.1 Compliance with ARARs

The remedial alternatives were rated against this criterion based on the following questions:

- o Are the requirements appropriate?
- o Can all of the requirements be met?
- o If not, then how close are they to being met?

6.3.2 Protection of Public Health

The remedial alternatives were rated against this criterion based on the following questions:

- o To what extent are risks to people reduced?
- o Are there possible unknown sources of risk?
- o Are future exposures from this source possible or likely?
- o Are the objectives of the health and safety plan met?
- o Is the remedy protective of society as a whole rather than just locally?

6.3.3 Implementability

Four categories make up this criterion and are listed below. Under each category, we have listed appropriate questions that we addressed in evaluating the alternatives.

- Technical Feasibility
    - o Difficulties or unknowns associated with construction?
    - o Will additional work be required in the future, and if so, will this work be difficult?
    - o Can all potential significant contaminant migration pathways be monitored?
    - o What are the risks associated with monitoring failure?

- Administrative Feasibility

  - o What agency approvals are required?
  - o Can they be obtained?
  - o How long will it take?
  - o Is any coordination required with other agencies?

- Availability of Services and Materials

  - o Are adequate treatment, storage, or disposal services available?
  - o Are the necessary equipment and specialists available?
  - o Are the technologies generally available and proven?

- Schedule

  - o Will the remedy be in place by the end of the 1988 dry weather construction period?

6.3.4 Short-term Effectiveness

We used the following questions to rate alternatives under this criterion.

o What are the risks to the community during construction?
o What are the risks to the workers?
o How long until the protection is achieved?
o How long until construction can begin and finish?
o What are the risks until construction is complete?

6.3.5 Long-term Effectiveness

We used the following questions to rate alternatives under this criterion.

o What is the significance of the remaining risk?
o Are there any treatment residuals?
o Are there any untreated residuals?

- Are there any potential sources of risk not accounted for?
- What is the likelihood the technologies will work as well as required?
- What long-term management is required?
- What long-term monitoring is required?
- What level of operation and maintenance is required?
- What is the potential for failure of the system?
- What is the magnitude of the risk associated with failure?
- What are the uncertainties associated with land disposal?

6.3.6 Reduction of Toxicity, Mobility, or Volume

This criterion was applied depending upon how the alternative addresses the three parts: toxicity, mobility, or volume. We applied the following list of questions to each alternative.

- Toxicity
    - Does the treatment address the principal threat?
    - Is toxicity reduced without a corresponding increase in volume?
- Mobility
    - To what extent is the mobility irreversibly reduced?
- Volume
    - What portion of the contaminated material is treated?
    - How much of the contaminant is reduced or destroyed?
    - How much is the total volume decreased?

6.3.7 Cost

We assessed each alternative for its total cost. We used a present worth analysis for operation and maintenance costs. The assumed discount rate was 5 percent after inflation. For estimating operation and maintenance costs, we assumed a log yard operation life of 12 years (length of current lease with the Port) and an overall life of 20 years. The actual protection provided by the paving will last as long as the Port owns and maintains the property. Maintenance costs beyond 20 years are relatively unimportant after discounting to today's dollars.

Our resources for the cost estimates included published construction costs, quotes from contractors, and our experience with construction projects.

We divided the costs into two categories consistent with current pracitce: capital costs and operation and maintenance costs. Items contributing to these costs are listed below.

- Capital Costs
  - Construction
  - Remediation Equipment
  - Services
  - Disposal
  - Engineering
  - Legal Fees/Licenses
  - Contingency

- Operation and Maintenance Costs
  - Labor for Post-construction Operations
  - Maintenance Labor and Materials
  - Material and Energy Costs
  - Disposal of Residues
  - Lab or Consultant Fees
  - Administration
  - Insurance, Taxes, and Licensing
  - Rehabilitation Costs

6.3.8 Adverse Environmental Effects

We rated the alternatives against this criterion using the following questions.

- How and to what extent are risks to the environment reduced?
- Is it possible there are unknown sources of risk?
- Will the implementation of this alternative increase the risk to the environment in any way?
- Does the remedy prevent future exposure to residual contaminants?
- Are the environmental cleanup goals met?

6.4 Screening of Remedial Alternatives

Using the criteria developed in the previous section, we screened the 12 alternatives listed in Section 6.2.

The screening process consisted of rating each alternative against each criterion. We used a 10-point scale for this rating.

For each criterion, we assessed the alternative with respect to the specific questions listed in Section 6.3. If the alternative satisfactorily answered all questions, it was assigned a score of 10. If it addressed none of the questions, it was assigned a score of 0. We assigned scores between these values in proportion to the number of questions adequately addressed.

For the cost criterion, we assigned points as follows:

- Less than $2 million - 10 points
- Greater than $12 million - 0 points
- Between $2 million and $12 million - Linear variation from 10 to 0 points

For example, consider the following three cases:

Case 1 -- Alternative: Landfill
Criterion: Compliance with ARARs

For this case, the contaminant has been fully removed from the site. To the maximum extent possible, the ARARs have been met. This alternative for this criterion has been assigned a value of 10 points.

Case 2 -- Alternative: Landfill
Criterion: Cost

We estimated the landfill alternative would cost in excess of $20 million. Therefore, it was assigned a value of 0 points.

Case 3 -- Alternative: Landfill
Criterion: Short-term Effectiveness

For this criterion, there are five specific questions to be addressed. Each question was assigned a point value of 2 for a total of 10. For this alternative, we rated the questions as follows:

Question	Does the Alt. Meet?	Score
Risks to community?	Partial	1
Risks to workers?	Partial	1
How long until protection achieved?	Yes	2
How long until construction begins?	Yes	2
What are risks until complete?	Partial	1
		7

We used a process similar to that outlined in these examples to rate each of the alternatives.

We considered weighting some of the screening criteria more heavily than others. After careful consideration, we chose not to weight the criteria for the following reasons.

- The weighting process is simply a means of incorporating bias into the screening. Since each individual reading this report is likely to have different biases, none will agree on what is the best way to weight the alternatives. And each is likely to be right to some extent.

- The process by which we rated the alternatives is subjective. Our confidence in the alternative selected by the screening process is dependent to a large degree on the belief that the combination of many small decisions will cancel out subjective variations. On this basis, we believe that unless a few criteria are very heavily and unreasonably weighted, the results of the screening process will remain unchanged.

Table 9 presents the results of our screening in matrix form. Each alternative is listed along the side. Along the top are listed the criteria. The Total column presents the summed score for each alternative. Beside this, we have listed the rank of the alternative.

The Cap and Stabilize & Cap alternatives have the highest score. From an environmental health standpoint, the alternatives are equally good. We have chosen the Cap alternative because it has a lower estimated cost.

Table 9 - Primary Alternative Screening Matrix

	Compliance with ARARs	Protect. of Public Health	Implementability	Short Term Effectiveness	Long Term Effectiveness	Reduct. of Tox., Mob., or Vol.	Cost	Adverse Env. Effects	Total	Rank
1) Cap	9	6	9	7	8	2	7	7	55	1
2) Stabilize & Cap	9	7	8	7	8	3	7	6	55	1
3) Solidify & Cap	9	7	6	5	9	3	6	8	53	4
4) Landfill Bark & Cap	9	6	5	6	7	2	6	6	47	11
5) Landfill Bark, Solidy fines, & Cap	9	7	4	5	8	3	6	6	48	9
6) Landfill Bark, Treat Fines, & Cap	9	7	5	5	8	3	6	6	49	8
7) Treat Surface Water	8	6	9	7	6	1	8	8	53	4
8) Solidify Surface & Treat Water	9	8	7	6	7	2	8	7	54	3
9) Treat Surface & Treat Water	8	7	9	6	7	2	7	6	52	6
10) Landfill All	10	7	8	7	8	1	0	7	48	9
11) Incinerate Bark/Fines & Cap	8	5	6	6	7	4	7	7	50	7
12) Solidify Surface	8	3	6	5	6	1	8	6	43	12

7.0 PRELIMINARY ENGINEERING

For preliminary design, we have looked at pavement sections and surface drainage. In addition, we address the issue of coordination of construction activities between the metals remediation and the Penta remediation.

7.1 Pavement Section

The required thickness of pavement is a function of 3 factors:

- Magnitude of applied wheel loads
- Number of applications of the wheel loads
- Quality of support provided by the soil beneath the pavement

The pavement for the Portac site, however, has an additional function beyond that required of traditional pavements. The pavement must also serve as a relatively impermeable cap. We will accomplish this through control (proper joints) and treatment (fill cracks) of pavement cracking.

7.1.1 Design Assumptions

For preliminary estimates of pavement thickness, we have looked at two scenarios for subgrade conditions. These include:

- The existing surface material graded and compacted
- The existing surface material solidified into a competent subgrade

At this time, we have not addressed whether or not it is feasible to solidify the surface material.

Other design assumptions include:

- Design life of 12 years (for log sort yard operations)
- Single wheel load of 80 kips for the log carriers

The design life is used to estimate the number of applications of the wheel loads. We obtained additional data on forecast production volumes from Portac personnel. We used these data to estimate the total number of load repetitions experienced by the pavement. Because many of these forecasts were uncertain, we conducted a sensitivity analysis of the effect of changing the number of load applications on the pavement thickness. We looked at increasing the design life to 15 years. This results in a 25 percent increase in the number of load applications. The effect of this change is to increase the pavement thickness by less than 5 percent.

We have assessed the relative merits of various forms of pavement. These include:

- Asphalt Concrete (AC)
- Portland Cement Concrete (PCC)
- Roller Compacted Concrete (RCC)

7.1.2 Asphalt Concrete

Material costs for AC are generally the lowest of the three forms. For the same thickness of pavement, however, AC requires a more competent subgrade than either of the others. Hence, for soft subgrades, AC will require greater thicknesses of imported subgrade fill. This may offset any material cost savings.

The results of our preliminary analysis of an AC pavement section are shown in Table 10. The value for AC thickness is for a full depth AC section placed directly on the subgrade. For the actual section, much of the AC would be replaced by an equivalent thickness of fill. For example, the final design might consist of 15 inches AC over 6 inches crushed rock over 36 inches of fill.

Of the three forms of pavement, AC probably has the highest permeability. Standard AC generally has many open pores which may allow water to pass through. With special mix designs and careful compaction during construction, the permeability of AC can be reduced substantially.

AC is the least attractive option for operation of the log sort yard. Both PCC and RCC better withstand the wear and tear from the log yard equipment.

Table 10 - Preliminary Pavement Sections

	Pavement Thickness in Inches		
Subgrade	AC	PCC	RCC
Compacted Bark	30	19	19
Solidified Bark	24	14	14

7.1.3 Portland Cement Concrete

Table 10 shows preliminary thicknesses for PCC pavement on the two assumed subgrades. The PCC requirements are substantially less than the AC. The only fill required under a PCC pavement is a leveling and working course. The large structural capacity of the PCC layer precludes the need for large amounts of fill.

PCC is for practical purposes impermeable. The pavement structure as a whole may be somewhat more permeable due to shrinkage cracks. This can be alleviated by filling joints with liquid asphalt at planned intervals. The resulting pavement structure forms a tight cap with very low permeability.

7.1.4 Roller Compacted Concrete

RCC is a form of PCC that has only recently come into widespread use. It consists of very dry PCC that is placed and compacted similar to conventional fill. The major attractions of RCC are its reduced construction costs and speed of placement. Some of its disadvantages include lower compressive strengths and a rough surface finish. Neither of these are a great disadvantage for use on a log sort yard.

The properties of RCC are comparable to normal strength PCC. The values for PCC pavement thickness are also appropriate for RCC. The discussion for PCC given above is applicable to RCC as well.

Because of the very dry nature of RCC, joints are generally not constructed during placement. Joints are placed after construction by saw cutting. The joints may then be filled with liquid asphalt. This results in a low permeability cap as for PCC.

7.2 Surface Drainage

7.2.1 Design Philosophy

In general, we propose to accomplish surface drainage by sloping the pavement to drain to catch basins. Underground piping or lined ditches would carry the water to discharge in Wapato Creek. Our basic design philosophy includes:

- o Avoid the use of open ditches within the log yard. These tend to fill with debris, especially where they enter culverts.
- o Avoid placement of catch basins in the log yard itself. They interfere with sorting activities and more easily clog with debris.
- o Use flat surface slopes to minimize flow velocities and decrease suspended solids in runoff.

7.2.2 Design Assumptions

We designed the surface drainage system using the following assumptions:

- 10-year storm event
- 0.9 runoff coefficient

We believe the 10-year design storm is appropriate for design of a log sort yard. The nature of the business is such that an occasional backup of water will not interfere with normal operations. In addition, we did analyze a 25-year storm event. This resulted in about a 20 percent increase in the flow. Because pipe comes in standard sizes, most of the pipes have some extra capacity. In many cases, this extra capacity is sufficient to accommodate the 25-year storm. Open ditches could easily be designed to accommodate a 25-year storm.

We assumed a runoff coefficient of 0.9. This value is appropriate for a clean paved surface. For much of the time, various amounts of bark and obstructions will impede the flow of water. The actual value of the runoff coefficient will probably be less due to evaporation.

7.2.3 Site Drainage Plan: Alternative 1

Figure 4 shows Alternative 1 for surface water drainage. The entire log yard will drain toward the center of the site. We have shown the option with underground pipe. Final design may include lined ditches instead. Four catch basins will collect the water and carry it to Wapato Creek. The final stretch of pipe is designed to carry the flows coming off the existing paved area.

This design will result in about 3.5 feet of relief across the site. One drawback of this design is that it may require a substantial amount of regrading.

7.2.4 Site Drainage Plan: Alternative 2

Figure 5 shows Alternative 2 for surface water drainage. The site will drain to discharge lines situated on either side of the log sort yard. As with Alternative 1, the piping may be replaced with lined ditches. Four catch basins on the north and three catch basins on the south will collect the water and carry it to Wapato Creek. The final stretch of pipe in the south drain line is designed to carry the water draining the existing paved area.

This design results in half the total relief of Alternative 1. This could result in substantially less site grading. On the other hand, this alternative requires about twice the total length of pipe. It also almost doubles the number of catch basins. Depending upon the design of these catch basins, they could be quite expensive.

7.2.5 Catch Basin Design

Figure 6 presents a proposed catch basin design. This design is based on an approved design for the Plum Creek log sort yard. The basic philosophy of the design is as follows:

- The flat slopes of the log yard inhibit the uptake of suspended solids in runoff.
- The stop blocks catch large chunks of debris.
- Smaller debris and suspended particles are filtered out by the fabric covered grate.
- The turned-down-elbow outlet inhibits floating particles or oil and grease from escaping the catch basin.

The overall success of this design is dependent upon careful maintenance of the system. The catch basin will be inspected on a regular basis and after major storm events. The maintenance personnel will remove any accumulated debris. The filter cloth will be changed as required. The inspector will remove the grate to check the catch basin for oil and grease. Any observed material will be removed. We will produce a more detailed maintenance schedule as part of final design.

7.3 Coordination with Penta Cleanup

Based on current information, the cleanup of the Penta contamination will not be complete this year. Our goal is to complete the remediation efforts for the metals cleanup this year. To achieve this goal, we will coordinate closely with the Penta cleanup efforts.

The Penta contamination is confined to the central drainage ditch within about 200 feet of Wapato Creek.

We will set back our paving construction from the ditch about 50 feet in this area. In addition, we will install the drainage pipe or ditch lining in a new trench parallel to the existing ditch. Water currently flowing through the ditch will be rerouted into the new facility. The reduction of water in the ditch should aid the Penta cleanup effort.

Following flushing of the storm drain in the existing paved area, it can be connected to the new drain pipe. This should further aid the Penta cleanup effort.

The portion of the log yard left unpaved can be paved following completion of the Penta cleanup.

8.0 WATER QUALITY MONITORING

After completion of log yard paving, the elevation and quality of both groundwater and surface water will be monitored. Monitoring will assess the effectiveness of the paving with regard to metals discharge into Wapato Creek from the Portac site. Data will be evaluated relative to earlier sampling events conducted by Ecology and Hart Crowser.

Appendix H outlines the objectives, sampling locations, and procedures for the surface water and groundwater monitoring program. To assure consistency in results, methods previously used by Ecology and Hart Crowser will be applied whenever possible.

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10.0 ACKNOWLEDGEMENT

This report was put together with the help of several individuals at Hart Crowser, Inc. We would like to acknowledge their contribution. They include Craig Holland, Kristen Darnell, Lori Herman, Doug Hillman, Dale Stirling, David Chawes, Lorraine Brazelton, and Jean Risser.

HART CROWSER, INC.

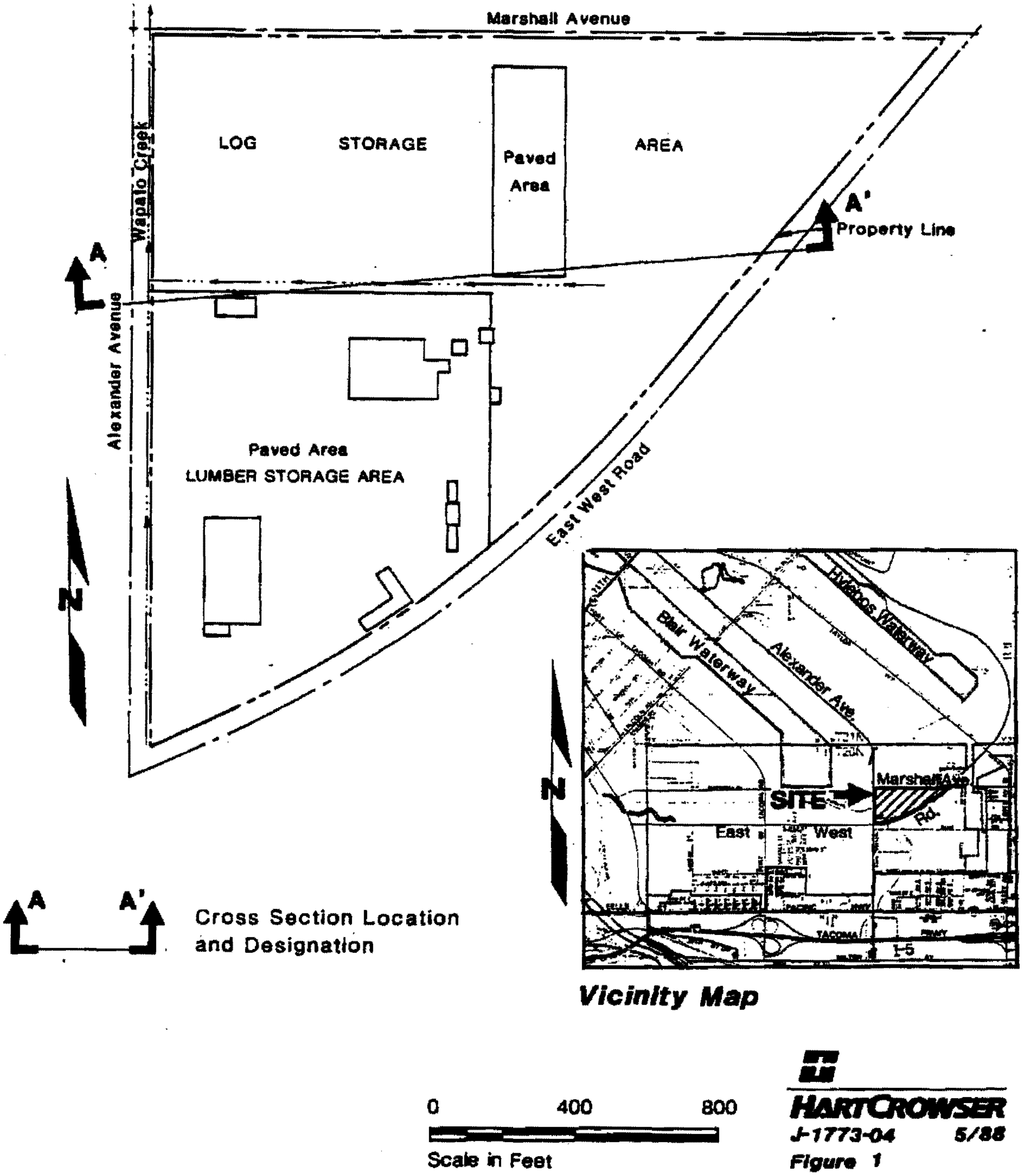
HERBERT F. CLOUGH, Project Manager
Project Engineer

RICHARD D. PIERCE
Associate

GARRY E. HORVITZ, P.E.
Principal

HFC/RDP/GEH:clb/sek
R177304B/JOBS

Site Plan



Vicinity Map

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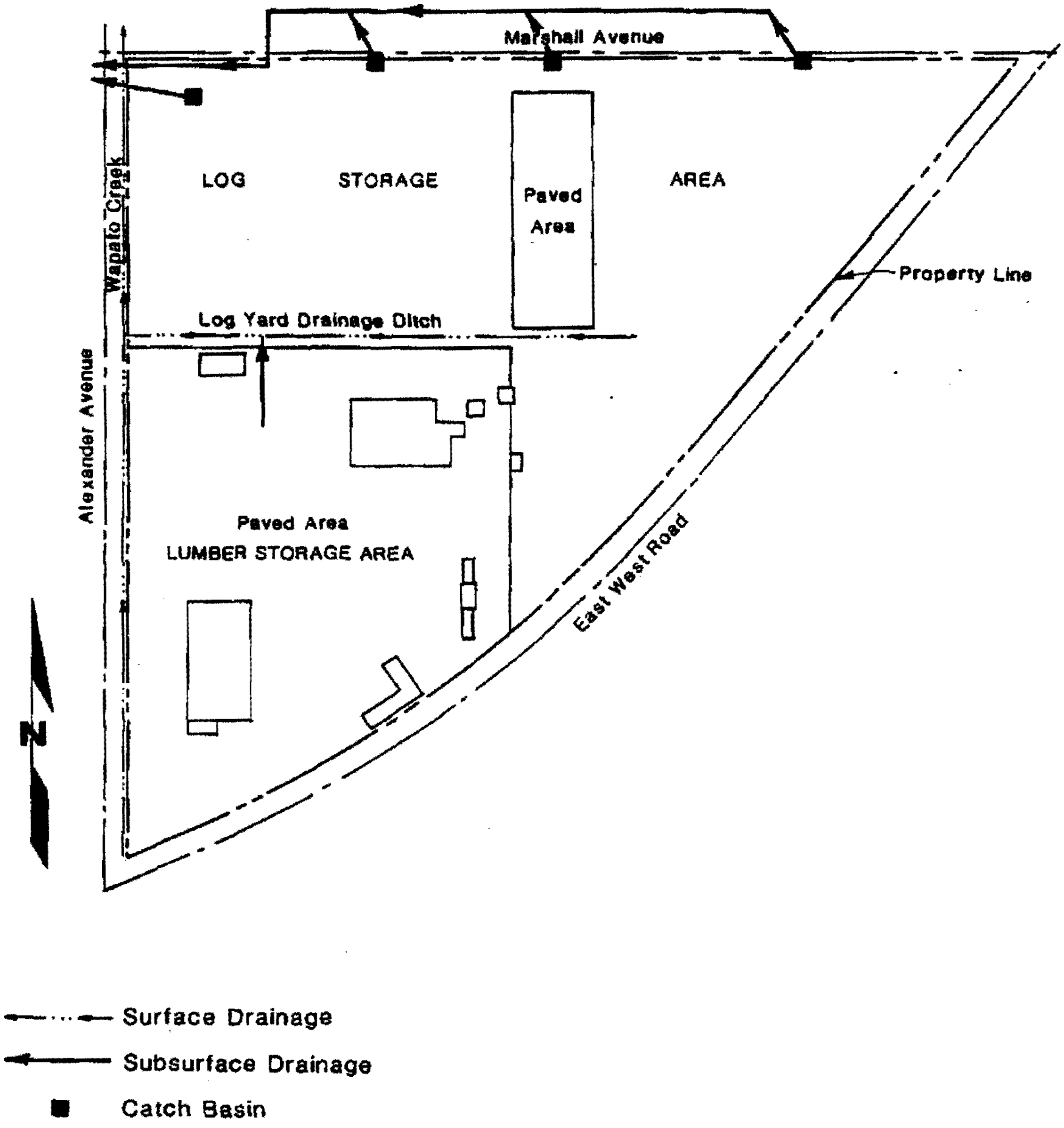
Figure 1

Existing Site Drainage Plan



0 400 800

Scale in Feet

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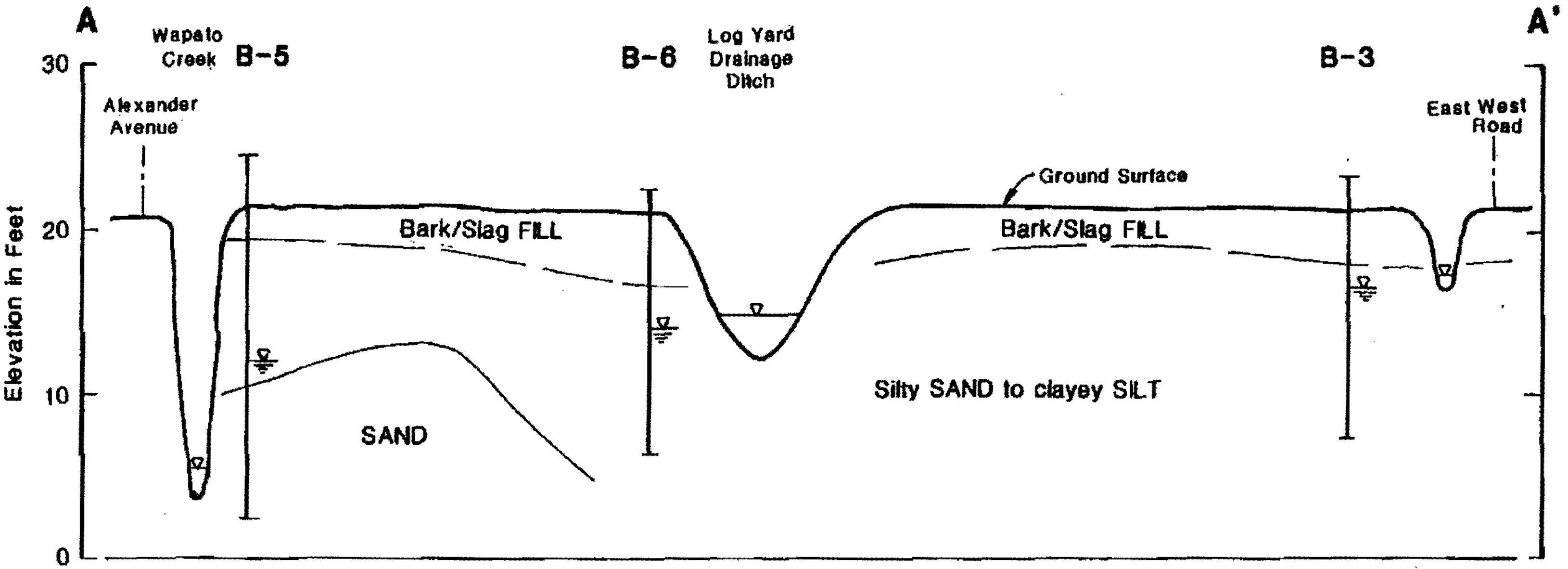
Figure 2

Generalized Subsurface Cross Section



Note: Contact lines between soil types are based on interpolation between borings, and represent our interpretation of subsurface conditions based on currently available data.

B-5 Well Number

Well Location

Maximum Observed Groundwater Level

Surface Water Level

Horizontal Scale in Feet
0 200 400

0 10 20
Vertical Scale in Feet
Vertical Exaggeration x 20

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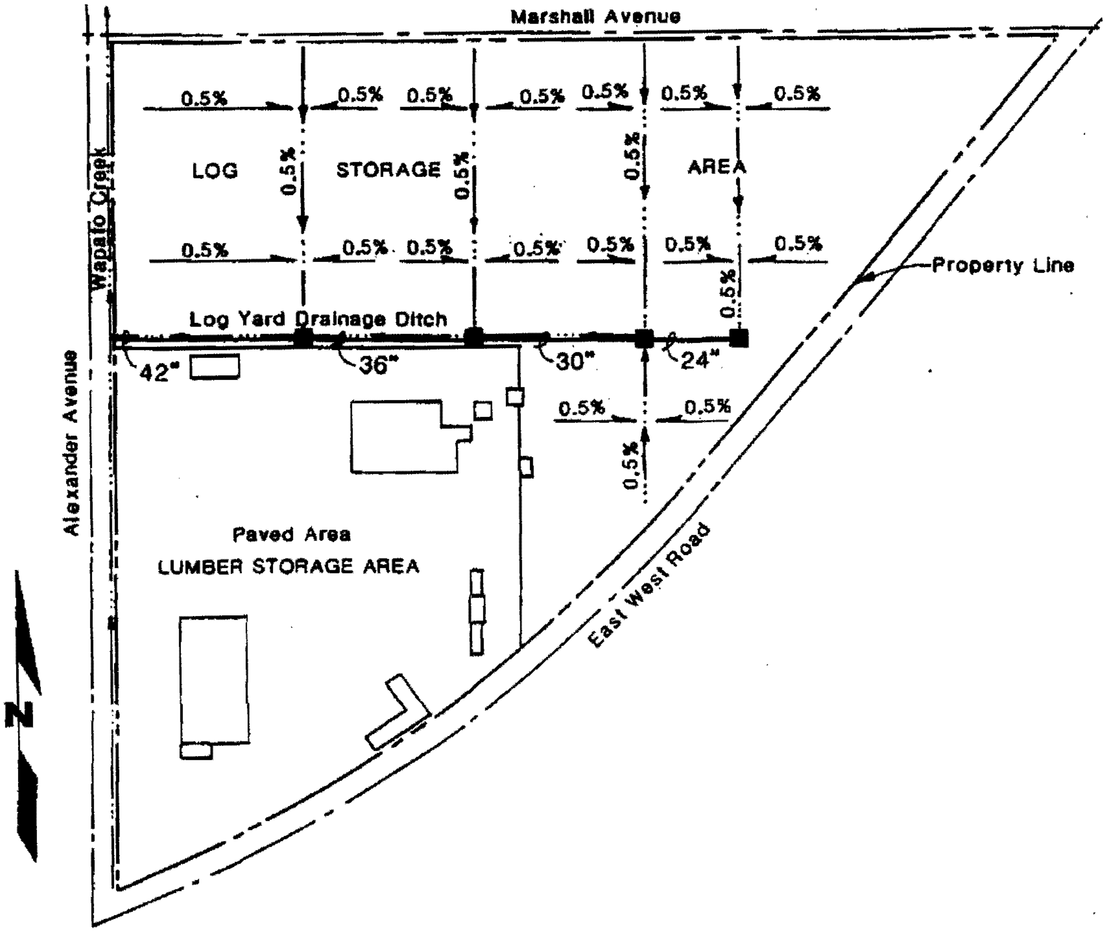
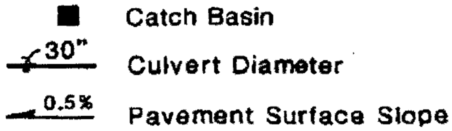
Figure 3

Site Drainage Plan
Alternative 1





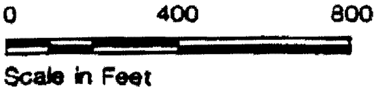


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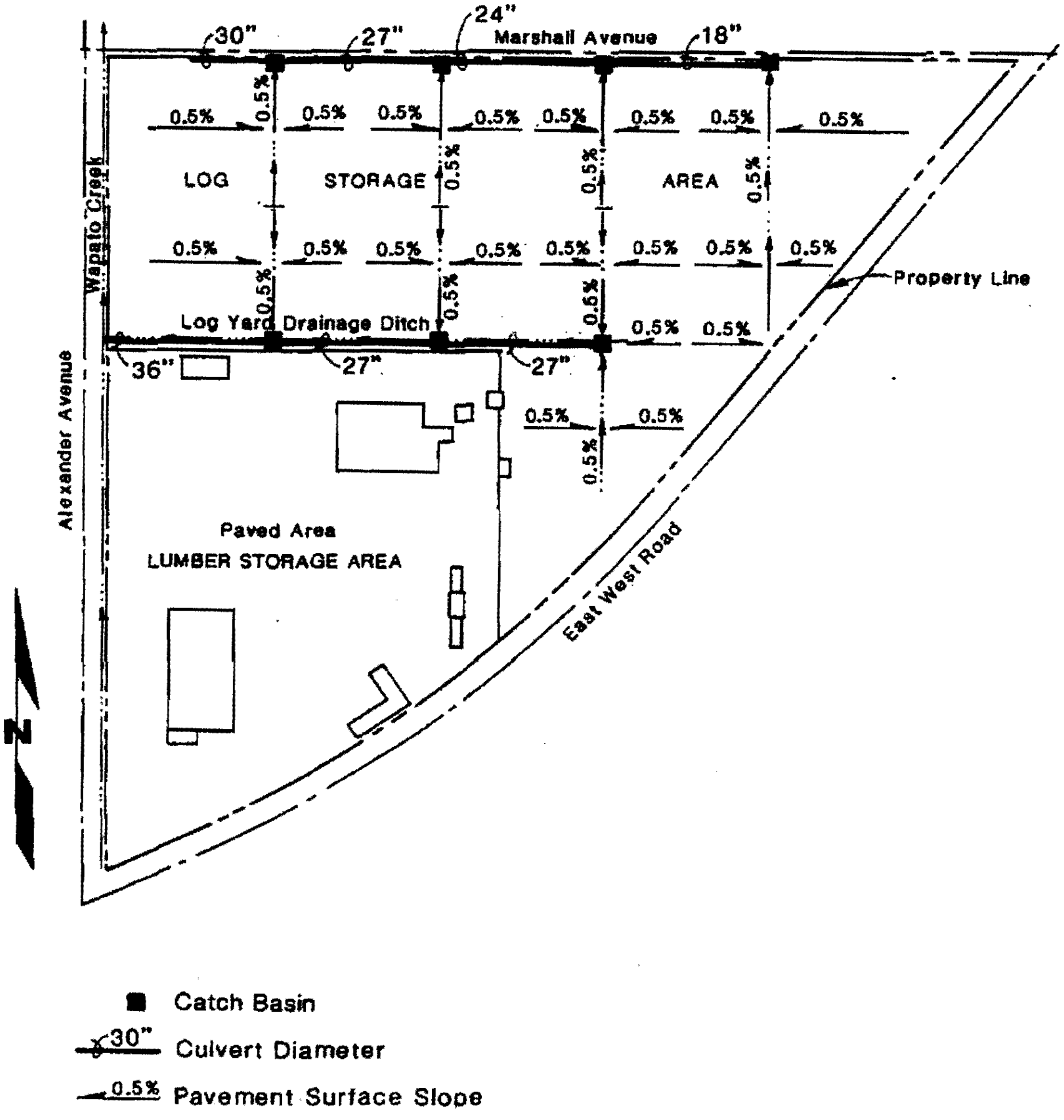
Figure 4

Site Drainage Plan
Alternative 2



0 400 800
Scale in Feet

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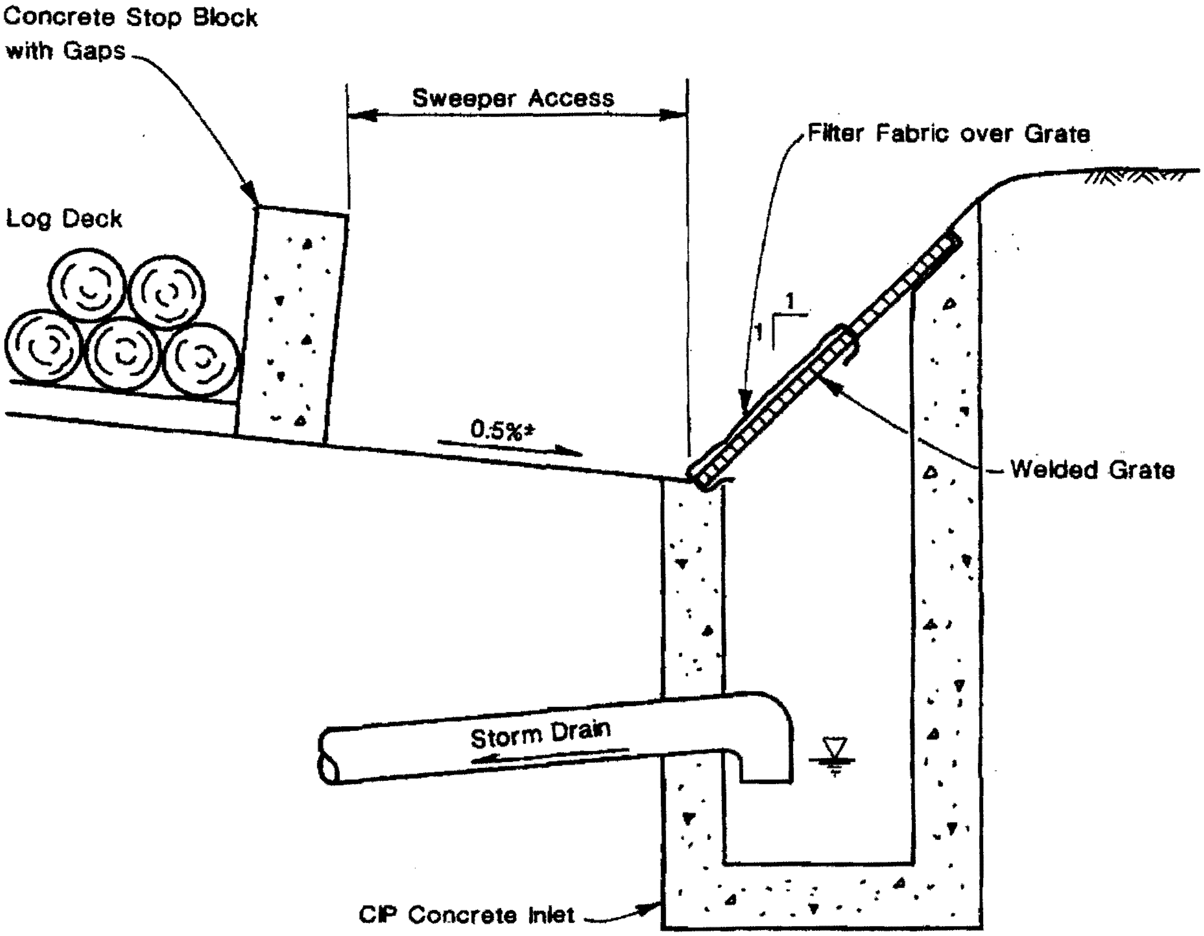
Figure 5

Log Yard Drainage/Filtration Scheme



Not to Scale

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Figure 6