APPENDIX B

Remedial Investigation/Feasibility Study Report (Kennedy/Jenks, 2001)

Kennedy/Jenks Consultants

530 South 336th Street
Federal Way, WA 98003

Remedial Investigation/ Feasibility Study Report Former Tacoma Metals Facility

Volume 1 of 3

19 June 2001

Prepared for

Portland Avenue Associates, LLC
c/o Eisenhower & Carlson, PLLC
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19 June 2001

Panjini Balaraju, P.E.
Department of Ecology
Toxics Cleanup Program
P.O. Box 47775
Olympia, WA 98504

Subject: Remedial Investigation/Feasibility Study Report
Tacoma Metals, Inc. Site
Agreed Order No. DE 97-5435
K/J 996080.00

Dear Mr. Balaraju:

Please find enclosed two copies of the Remedial Investigation/Feasibility Study Report for the Tacoma Metals, Inc. site located at 1919 Portland Avenue in Tacoma, Washington. This report is submitted in accordance with the requirements of the Agreed Order (No. DE 97-5435) between the Washington Department of Ecology (Ecology) and Mr. & Mrs. Leslie Sussman and Portland Avenue Associates LLC.

This report has been prepared in accordance with the existing Model Toxics Control Act (MTCA) cleanup regulations (Chapter 173-340 WAC). We request a timely review of this report in order to facilitate approval of the recommended remedial alternative and preparation of the Corrective Action Plan (CAP) prior to the MTCA amendments which will become effective on 15 August 2001. As discussed in our telephone conversation of 12 June 2001, Kennedy/Jenks Consultants will prepare the CAP in order to facilitate this process and assist Ecology in completion of the required documents prior to 15 August 2001.

Should you have any questions regarding this report, please call me or Ty Schreiner at (253) 874-0555.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

Amanda J. Aldersley

Amanda J. Aldersley
Senior Associate Scientist

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Ty C. Schreiner
Manager Environmental/Facilities Engineering

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Enclosure

cc: Guy Sternal, Eisenhower & Carlson, PLLC

Kennedy/Jenks Consultants

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List of Acronyms

Abbreviation	Description
ARARs	Applicable, relevant, and appropriate requirements (ARARs for plural)
ARI	Analytical Resources, Inc.
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
CAP	Corrective Action Plan
CCI	CCI Analytical Laboratories, Inc.
CEC	Cation exchange capacity
CFR	Code of Federal Regulations
C_g	Chemical concentration in the vapor phase
C_l	Dissolved concentration in soil water
CLARC II	Cleanup Levels and Risk Calculations
cm/hr	Centimeters per hour
cm/s	Centimeters per second
COC	Chemical of concern (COCs for plural)
cPAH	Carcinogenic polycyclic aromatic hydrocarbon (cPAHs for plural)
C_s	Chemical concentration sorbed to soil
DF	Dilution Factor
D_i	Free air diffusion coefficient
E&E	Ecology and Environment, Inc.
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
EPH	Extractable petroleum hydrocarbon (EPHs for plural)
FESI	Forrester Environmental Services, Incorporated.
F_{oc}	Fraction of organic carbon
ft/min	Feet per minute
g/ml	Grams per milliliter
GC-MS/SIM	Chromagraph/mass spectrometer with select iron monitoring
HTTD	High temperature thermal desorption
K_d	Equilibrium partitioning factor
Kh	Horizontal hydraulic conductivity
K_h	Henry's Law Constant
K_{oc}	Organic carbon-normalized soil partition coefficient
Kv	Vertical hydraulic conductivity
LDRs	Land disposal restrictions
LNAPL	Light non-aqueous phase liquid
LTTD	Low temperature thermal desorption
meq/100 g	Milliequivalants/100 grams
mg/kg	Milligrams per kilogram
mg/l	Milligrams per liter
Morris	Morris Environmental Services
MSL	Mean sea level
MTCA	State of Washington Model Toxics Control Act

Abbreviation	**Description**
NPDES	National Pollutant Discharge Elimination System
NTR	National Toxics Rule
PAH	Polycyclic aromatic hydrocarbon (PAHs for plural)
PCB	Polychlorinated biphenyl (PCBs for plural)
PGG	Pacific Groundwater Group
POTW	Publicly owned treatment works
PQL	Practical quantification limit (PQLs for plural)
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
Rosa	Rosa Environmental and Geotechnical Laboratory L.L.C.
RWC	Revised Washington Code
Simpson	Simpson Tacoma Kraft
SPLP	Synthetic Precipitation Leaching Procedure
Struthers	Garry Struthers Associates, Inc.
SVE	Soil vapor extraction
SVOC	Semivolatile organic compound (SVOCs for plural)
SWQ	Surface Water Quality Standard
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total dissolved solids
TNT/DNT	Trinitrotoluene/Dinitrotoluene
TOC	Total organic carbon
ToC	Top of well casing
TPH	Total petroleum hydrocarbon (TPHs for plural)
USCS	Unified Soil Classification System
UST	Underground storage tank
VOC	Volatile organic compound
WAC	Washington Administrative Code
Work Plan	*Final Work Plan/Sampling and Analysis Plan* (Kennedy/Jenks Consultants 1998)
µg/l	Micrograms per liter

Executive Summary

This report presents the results of a remedial investigation and feasibility study (RI/FS) conducted at the former Tacoma Metals site. The purpose of the RI was to identify the distribution of chemicals in soil, groundwater, and surface water exceeding the Model Toxics Control Act (MTCA) cleanup levels and/or applicable, relevant, and appropriate requirements (ARARs) for sites located in an area zoned for industrial land use. The FS identified potential receptors and exposure pathways for chemicals of concern (COCs) identified during the RI and proposed "site cleanup levels" and "points of compliance" where the proposed site cleanup levels must be attained. Various remediation technologies and process options were screened in the FS. Technologies/process options that passed the initial screening were used to develop possible remediation alternatives for the site. The alternatives were then evaluated with respect to their ability to attain the proposed site cleanup levels at the points of compliance and their ability to meet various threshold requirements, expectations, and criteria defined in MTCA.

The site is located adjacent to the Puyallup River. Tidal influences of the river affect shallow zone groundwater flow directions at the site; however, the net groundwater flow direction is toward the river. Surface water flow in the eastern portion of the site is generally directed toward existing storm water catch basins. Surface water discharges from the site at several locations along Portland Avenue and along western and eastern property boundaries, respectively. Due to the presence of a man-made levee, there is no interaction between site surface water runoff and the adjacent Puyallup River.

The following COCs were identified in site soil at concentrations exceeding MTCA cleanup levels and/or ARARs: lead, chromium, polychlorinated biphenyls (PCBs), carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and petroleum hydrocarbons in the diesel- and oil-ranges. Impacted soil exceeding MTCA cleanup levels and/or ARARs can be divided into two broad categories. The first category is referred to as "metals-impacted" soil, typically identified at 3 feet or less below ground surface (bgs). Lead is the most widespread COC in this category of soil, but chromium, PCBs, cPAHs, and petroleum hydrocarbons are also present above cleanup levels and/or ARARs at locations within the limits of the lead-impacted areas. The metals-impacted soil is most widespread on the eastern portion of the site. The second category is referred to as "petroleum hydrocarbon-impacted" soil. This soil also contains cPAHs above MTCA cleanup levels and/or ARARs. Soil in this category extends down to the water table. Two main areas of petroleum hydrocarbon-impacted soil were identified on the western portion of the site. Light nonaqueous phase liquids (LNAPLs), also referred to as free product, were identified on the water table in these same areas.

The following two COCs were consistently identified in site groundwater beneath the western portion of the site at concentrations exceeding MTCA cleanup levels and/or ARARs: naphthalene and petroleum hydrocarbons in the gasoline-range. Other compounds (cPAHs, PCBs, dissolved selenium, and dissolved cadmium) were detected in either reconnaissance or wells samples collected at the site. These compounds were not considered to be representative of site groundwater quality due to their one time occurrence and/or lack of reproducibility, the possible effects of suspended entrained soil particles in the samples, and the low aqueous solubility's of these COCs in the environment. Metals, PCBs, and cPAHs were identified in surface water discharging from the site.

The fate and transport of COCs identified in unsaturated soil and groundwater at concentrations exceeding MTCA cleanup levels and/or ARARs was evaluated using the VLEACH and BIOSCREEN computer models, respectively. Modeling of the unsaturated zone was used in conjunction with leachability testing data to evaluate whether COCs identified in the shallow soil above the MTCA cleanup levels and/or ARARs pose a threat to groundwater. Groundwater migration modeling was directed specifically at the western portion of the site to evaluate the extent to which COCs above MTCA cleanup levels and/or ARARs could potentially migrate beyond the northern property boundary. Very conservative assumptions were used in both model simulations.

The unsaturated zone modeling and leachability testing indicate that COCs identified in the shallow soil are essentially immobile, provided surface water recharge is minimized or eliminated. Groundwater migration modeling indicated that naphthalene is not expected to extend beyond the northern property boundary toward the Puyallup River. Carcinogenic PAHs and benzene were also included in the groundwater modeling as surrogates for petroleum hydrocarbons. These compound were not detected in site groundwater at concentrations above MTCA cleanup levels and/or ARARs. Groundwater migration modeling indicated that cPAHs are not expected to extend beyond the northern property boundary. Benzene, the most mobile of the compounds modeled, may be present beyond the northern property boundary at concentrations below MTCA cleanup levels and/or ARARs.

Proposed cleanup standards for the site were identified in the FS. The site is currently vacant and approximately 80% of the site has been paved during previous site uses. Future potential receptors at the site may include workers and authorized visitors. The only complete exposure pathways identified for human receptors were via dermal adsorption of site soil, and ingestion and/or inhalation of chemicals adsorbed to fugitive dust particles. Groundwater ingestion via the shallow saturated zone was not considered a viable exposure pathway given the proximity of the site to the Puyallup River and the tidal influences of the river on site groundwater. Onsite potential ecological receptors include birds, reptiles, and mammals. Exposure pathways for ecological receptors include ionic uptake in plants, ingestion of contaminated soil or surface water by ground-feeding organisms, direct contact, or indirect contact through bioconcentration in the food chain. Some aquatic organisms could potentially ingest or dermally adsorb surface water or shallow zone groundwater discharging to the Puyallup River. However this is considered unlikely, since there is no interaction between site surface water and the Puyallup River and the groundwater migration modeling indicates that groundwater exceeding MTCA cleanup levels and/or ARARs is not anticipated beyond the northern property boundary. The site was excluded from a terrestrial ecological evaluation since all the proposed remedial alternatives identified in the FS include a low permeability cap and institutional controls.

Site cleanup levels for soil, groundwater, and surface water have been proposed based on MTCA cleanup levels and/or ARARs that are most appropriate to site conditions. The proposed site cleanup levels are based on an industrial land use scenario. Given the proximity of the site to the Puyallup River, site groundwater cleanup levels have been based on surface water criteria. The most restrictive of either the MTCA Method B surface water cleanup level or ARARs have been proposed. ARARs include the National Toxics Rule, Ecology's Acute Freshwater Surface Water Quality Standard, or Ecology's Model National Pollutant Discharge Elimination System Permit Standard. Soil cleanup levels based on the protection of potable water are not applicable to the site. Since there are no soil cleanup standards available for protection of surface water, the Method A or C industrial cleanup levels established under MTCA or calculated using Ecology's Total Petroleum Hydrocarbon Interim Policy have been proposed. However, MTCA does allow concentrations above site cleanup levels to remain on a site if it can be demonstrated that higher soil concentrations are protective of groundwater. The fate and transport modeling and leachability testing indicate that shallow-impacted soil above the proposed site cleanup levels does not pose a threat to groundwater, provided surface water recharge is minimized or eliminated.

The following points of compliance have been identified for soil, groundwater, and surface water, based on potential exposure pathways. The point of compliance for soil will be throughout the site to a depth of 15 feet bgs. Since the proposed groundwater cleanup levels are based on surface water criteria, a conditional point of compliance may be established in surface water as close as possible to the point of groundwater discharge to surface water. Since no seeps were identified along the riverbank adjacent to the site, for practical purposes a conditional point of compliance in the shallow groundwater zone along the northern property boundary is proposed. Since site surface water runoff does not discharge to the river, the proposed points of compliance for surface water will be those points where surface water discharges from the site.

The following three remedial action alternatives were developed for the site that could be expected to attain the proposed site cleanup levels at the points of compliance.

- Alternative 1: Source Control (Free Product Removal and Petroleum Hydrocarbon-Impacted Soil Excavation with Offsite Disposal), Asphalt Cap with Stormwater Control, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater/Surface Water Compliance Monitoring, and Periodic Review.

- Alternative 2: Source Control (Free Product Removal and Petroleum Hydrocarbon-Impacted Soil Excavation with Offsite Disposal), Limited Metals-Impacted Soil Excavation with Onsite Consolidation, Asphalt Cap with Stormwater Control, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater/Surface Monitoring, and Periodic Review.

- Alternative 3: Source Control (Free Product Removal and Petroleum Hydrocarbon-Impacted Soil Excavation), Limited Metals-Impacted Soil Excavation, Onsite Treatment & Reuse of Excavated Soil, Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater/Surface Monitoring, and Periodic Review.

Various technologies were screened as part of the development of the remedial alternatives, and evaluated with respect to the MTCA hierarchy of preferred remedial methods. Development of the alternatives gave consideration to Ecology's various requirements and expectations for cleanup actions. A detailed and comparative analysis of the three alternatives was performed with respect to the MTCA threshold criteria required for cleanup actions. Alternative 2 was identified as the most appropriate remedial action for the site.

Section 1: Introduction

This report presents the results of a remedial investigation and feasibility study (RI/FS) conducted at the former Tacoma Metals property (site) located in Tacoma, Washington. The RI/FS was performed in accordance with the Agreed Order (No. DE97-5435) between the Washington State Department of Ecology (Ecology) and Mr. and Mrs. Leslie Sussman and Portland Avenue Associates, LLC (owner). This RI/FS was performed in accordance with Ecology's Model Toxics Control Act (MTCA) regulations published in Washington Administrative Code (WAC) 173-340 (Ecology 1996a).

The purpose of this RI was to identify the distribution of chemicals in site soil, groundwater, and surface water. Based on these data, the FS compared the analytical results with established cleanup levels published by Ecology and other applicable and relevant and appropriate standards (ARARs) to evaluate the potential risks posed to human health and the environment. The FS also evaluated a range of potential remedial solutions to address site conditions and recommended a remedial alternative to address site conditions

1.1 Site Location and Description

The site is located at 1919 Portland Avenue in Tacoma, Washington, in an industrial-zoned area along the southern bank of the Puyallup River (refer to Figures 1-1 and 1-2). The site is separated from the river by a man-made levee with an approximate height of 20 feet that was constructed by the Army Corps of Engineers. The Lincoln Avenue Bridge, which crosses the Puyallup River, is adjacent to the site to the east. Other adjacent properties include a wood waste landfill operated by Simpson Tacoma Kraft (Simpson) to the west and various warehouse and shipping facilities to the south.

(Note: The Tacoma Metals site is geographically oriented with the long axis of the property trending northwest to southeast. To simplify descriptions of site locations in this report, the property boundary located along Portland Avenue will be considered the southern property boundary, and the property boundary along the Puyallup River will be considered the northern property boundary.)

The site covers an area of approximately 5.9 acres. Figure 1-2 provides an overview of the site layout including the location of previous structures identified in historical aerial photographs and Sanborn Fire Insurance Maps (Sanborn Maps). Approximately two-thirds of the site was paved with asphalt some time between 1976 and 1981. The majority of the asphalt pavement is in poor condition, with multiple cracks and holes. The remaining one-third of the site, located along the northern fence line, is unpaved.

The site was reportedly developed as a coke furnace in the 1940s by the federal government; however, it was never used for this purpose. In the early 1950s, Mr. Leslie Sussman purchased the site from the federal government. Mr. Sussman leased the site to General Metals, Inc., which operated a metal recycling facility at the site until approximately 1982. In 1983, Mr. Sussman leased the site to Tacoma Metals, Inc., a recycler of primarily nonferrous metals. In May 1998, Tacoma Metals' lease was terminated. Tacoma Metals, Inc. vacated the property by Fall of 1999.

The site has been used for recycling ferrous and nonferrous metals since the early 1950s. The principal original activities conducted onsite included automobile scrapping and recycling. Automobile recycling was reportedly discontinued more than 30 years ago; since then, primarily nonferrous metals have been handled.

Recent site activities by Tacoma Metals, Inc. have included processing and storage of various materials including, but not limited to, aluminum cans and scrap, wheels, radiators, engine blocks, computer cases, and other scrap metal. Materials were stored directly on the ground surface in piles or stacks. General site activities included compacting material in balers, cutting larger pieces into manageable sizes, sorting and grouping similar materials, and general shipping and receiving activities.

1.2 Historical Review

1.2.1 Sanborn Fire Insurance Maps

Sanborn Maps for the years 1912, 1950, and 1965 were obtained from Environmental Resources Data, Inc., of Southport, Connecticut, and were used to develop the RI sampling program presented in the Final WorkPlan/Sampling and Analysis Plan (Work Plan) prepared by Kennedy/Jenks Consultants (1998). Based on the 1912 Sanborn Map for Tacoma, Washington, the site and surrounding area was used by the St. Paul and Tacoma Lumber Company in 1912. The 1912 Sanborn Map shows a creosoting plant located in the approximate southwestern corner of the current site, and a bunkhouse and boarding house located in the approximate central portion of the current site. A bunker is shown east of the creosoting plant location, and a small office structure is located west of the creosoting plant area. An oil tank is shown within the creosoting plant area. In addition, various wood platforms, slabs, inclines, and tramways are shown in the approximate area of the current site, primarily along the current southern property boundary. A wharf and oil house shown on the Sanborn Maps may have been located near the northwest corner of the current site. Several additional small structures are shown on the Sanborn Maps, but are not labeled.

The creosoting plant, bunkhouse, boarding house, wharf, and oil house are not shown on the 1950 Sanborn Map. (Note: A notation on the 1950 Sanborn Map indicates that the Tacoma Metals site area was not updated after 1941.) The main warehouse building and red brick building are shown on the 1965 Sanborn Map. The dates of construction, operation, and demolition of the creosoting plant and other features shown on the 1912 Sanborn Map are unknown. The approximate former locations of the creosoting plant, bunkhouse, boarding house, and bunker are shown on Figure 1-2. Copies of the 1912, 1950, and 1965 Sanborn Maps are provided in Appendix A.

1.2.2 Aerial Photographs

Historical aerial photographs for the years 1965, 1971, 1976, 1981, 1985, 1989, and 1995 were also reviewed during development of the RI sampling program presented in the Work Plan. Additional aerial photographs for the years 1941, 1946, and 1961 were reviewed as part of the RI activities. Aerial photograph observations are summarized below.

The creosoting plant structure identified on the 1912 Sanborn Map was not observed on the aerial photographs; however, a faint outline of the former plant location was visible on the 1946 aerial photograph. The locations of the wharf and oil house structures identified on the Sanborn Maps were identified on the 1946 aerial photograph, although the structures were not intact. Other site structures shown on the 1912 Sanborn Map were not observed on the aerial photographs.

A variety of structures located on the site were observed on aerial photographs from the years 1941 through 1995. The former main warehouse building and red brick building were identified on the 1941 aerial photograph, and may have been under construction at the time. (Note: The scale of the 1941 photograph did not allow for detailed site observations.) Approximately eight additional structures were present on the western portion of the site, primarily near the western property boundary, on the 1946 aerial photograph. In addition, several linear structures that may have been platforms, tramways, walkways were present on the 1946 aerial photograph to the south and east of the main warehouse building, and other small outbuildings were located throughout the site. Most of the structures identified on the 1946 aerial photograph were likely associated with the coke furnace constructed in the 1940s. These structures are not readily apparent on the 1961 aerial photograph (except for the main warehouse building and red brick building), although the foundations of several structures are visible in the southwestern portion of the site, most notably a hexagonal concrete foundation. Foundations of two additional structures located in the northwestern corner of the site are visible on the 1965 aerial photograph.

Four railroad spur lines are present on the southern portion of the site on the 1946 aerial photograph. A main line parallels Portland Avenue near the southern property boundary, and three spur lines are parallel to the main line between Portland Avenue and the main warehouse building. Of these four rail lines, only the main line and the western portion of one of the spurs was identified on the 1961 aerial photograph. Two new spur lines are present on the western portion of the property on the 1961 aerial photograph, and additional rail spurs are present on the northern and eastern portions of the site on the 1965 aerial photograph.

Structures apparently associated with the handling and processing of metal materials were observed on aerial photographs from 1965 and later. A small shed is present west of the red brick building location on the 1965 and later photographs. The furnace building and existing small storage building located east of the main warehouse building are present on the 1976 aerial photograph in addition to several small shed structures. Several additional shed structures were present on the 1981 aerial photograph. These shed structures were located mainly on the western portion of the site and appeared to contain metal processing equipment such as balers and shears.

Metal materials stored on the ground surface throughout the site were identified on aerial photographs from years 1961 and later (refer to the Work Plan for additional description of materials storage and staging areas). Metal materials processing machinery is evident on the site on photographs from the years 1965 and later. Machinery visible on the photographs included cranes, trucks, and rail cars.

The southern bank of the Puyallup River was the northern boundary of the site on the 1946 aerial photograph. On the 1961 aerial photograph, the existing levee is present and the Puyallup River is located on its current course.

1.3 Previous Investigations

This section provides a summary of the findings from previous environmental activities performed at the site. More detailed information is provided in the documents cited in this section.

1.3.1 Environmental Protection Agency/Ecology and Environment, Inc.

In March 1988, representatives of the Environmental Protection Agency (EPA), Ecology, and Ecology and Environment, Inc. (E&E) inspected the site. As part of the inspection, Ecology and E&E collected samples of surface soil, surface residue on paved surfaces, catch basin sediment, and storm drain sediment. The storm drains and catch basins were all located on the eastern half of the property. Concentrations of lead, cadmium, chromium, barium, copper, mercury, nickel, and zinc were detected in the soil and sediment samples at concentrations exceeding Ecology's MTCA Method A or C industrial soil cleanup levels (E&E 1998). Concentrations of extractable lead [extracted by Toxicity Characteristic Leaching Procedure (TCLP)] and cadmium were detected above designated state dangerous waste levels (WAC 173-303). Elevated concentrations of iron and aluminum were also detected in soil samples. In addition, polychlorinated biphenyl (PCB) concentrations above the MTCA Method A industrial soil cleanup level were detected in soil samples collected from behind the main warehouse building near the northern fence line.

1.3.2 Hart-Crowser

In 1990, Hart-Crowser performed a limited subsurface investigation to evaluate site soil and groundwater conditions (Hart-Crowser 1990). Elevated concentrations of lead, chromium, cadmium, arsenic, extractable lead, PCBs, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and total petroleum hydrocarbons (TPHs) exceeding applicable MTCA Method A or C industrial soil cleanup levels were detected in test pit soil samples collected from the northern unpaved area of the site. [Note: PAH compounds that are classified by EPA as potentially carcinogenic include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.] In addition, elevated lead, chromium, cadmium, extractable lead, and TPH concentrations were detected in the vicinity of the existing furnace building (Hart-Crowser 1990). TPHs were also present at concentrations above the MTCA Method A industrial soil cleanup levels in soil samples collected from the former location of an underground storage tank (UST) at the eastern end of the main warehouse building (refer to Figure 1-2). The Hart-Crowser report indicated that army shells were formerly disposed of near the northeastern corner of the site; however, they did not provide further details regarding site conditions that might have resulted from the army shells.

Hart-Crowser also performed reconnaissance groundwater sampling in the northern unpaved area and in the former UST location. Elevated concentrations of lead, arsenic, cadmium, PCBs, cPAHs, and TPHs were documented in groundwater samples collected from the northern unpaved area. Elevated TPH and cPAH concentrations were also documented in the area of the former UST location.

1.3.3 Morris Environmental Services

The findings of Hart-Crowser's 1990 limited subsurface investigation were reviewed by Morris Environmental Services (Morris) and summarized in a letter report dated 9 July 1991 (Morris 1991). After reviewing the limited subsurface investigation data, visiting the site, and interviewing Tacoma Metals personnel, Morris postulated some possible contaminant sources, including the following:

- Motor blocks salvaged onsite may be a source of TPH concentrations.
- Incomplete combustion of lead-acid battery cases may be a possible source of PAH-impacted soils behind the former red brick building location.
- Creosote on buried piling may be a possible source of PAH concentrations.
- Radiator salvage may be a possible cadmium source.

Between August and December 1991, 53 soil samples were collected by Morris and analyzed for total lead (Morris 1992). The samples were collected from the unpaved section of the site along the northern property boundary. Morris indicated that the approximate western extent of lead contamination, but not the eastern extent, was identified during the first sampling event. Three additional sampling events were performed in an unsuccessful attempt to determine the approximate eastern extent of lead contamination in near-surface soil. No attempt was made to identify the northern and southern extents of lead contamination; however, Morris identified the potential existence of lead-impacted soil north of the existing fence line and south of the existing unpaved area.

Locations and lead concentrations of soil samples collected by Hart-Crowser and Morris are shown on Figure 1-3. (Note: These concentrations may not be indicative of current site conditions since surface soils were extensively disrupted during grading activities that were performed by the past site tenant.)

1.3.4 Pacific Groundwater Group

In 1992, Pacific Groundwater Group (PGG) conducted a groundwater investigation on the site including the installation and sampling of eight shallow groundwater monitoring wells installed in the uppermost saturated zone (PGG 1992).

Gasoline-range petroleum hydrocarbon compounds were detected at concentrations above the MTCA Method A groundwater cleanup level of 1.0 milligram per liter (mg/l) in samples collected from two of the existing site monitoring wells (MW-4 and MW-5). In addition, cPAHs were detected in samples collected from wells MW-7 and MW-8 at concentrations exceeding the MTCA Method A groundwater cleanup level of 0.1 micrograms per liter (μg/l).

PGG also performed short-term pump tests on wells screened in the wood debris and deltaic sand units. Hydraulic conductivities of 3.8 to 4.6 feet per day were reported for two wells screened in the wood debris unit (MW-4 and MW-5, respectively), and hydraulic conductivities of 100 to 140 feet per day were reported for wells MW-1 and MW-2 screened in the deltaic sand unit.

1.3.5 Garry Struthers Associates, Inc.

Garry Struthers Associates, Inc. (Struthers) prepared a Drainage Report concerning the site for the City of Tacoma Public Works Department (Struthers 1995a). The purpose of the report was to assess surface runoff conditions and address site improvements related to surface runoff including, but not limited to, the paved area. Struthers summarized site surface drainage conditions as follows:

- Approximately 2.6 acres in the eastern half of the site drains to an existing catch basin and conveyance storm system that discharges to a municipal storm drain located on the eastern side of Portland Avenue.
- Approximately 2.0 acres in the western half of the site drains by surface runoff (overland flow) to storm sewers in Portland Avenue or surface water ponds onsite.
- Approximately 1.3 acres along the northern property boundary is unpaved.

Struthers indicated that there is no additional drainage onto the site from surrounding properties. Surface water runoff to offsite points other than Portland Avenue was not mentioned in the report, except for a notation that there was no apparent offsite drainage from the unpaved area. Struthers indicated that runoff from the site does not interact with the Puyallup River, which is separated from the site by a man-made levee.

Based on the capacity of the existing municipal drain system (15-inch diameter concrete pipe located along Portland Avenue), Struthers concluded that detention of surface runoff onsite would be necessary as part of any site improvements. They also indicated that treatment may be necessary for surface runoff quality control, and that Shoreline Permits for the City of Tacoma would be required. Quality control for surface runoff is addressed in detail in Struthers' Technical Memorandum for Storm Runoff – Best Management Practices (Struthers 1995b).

1.4 Report Organization

This report is organized as follows:

- Section 2 summarizes the objectives and specific activities conducted as part of the RI. Section 2 also identifies approximate sampling locations and analytical methods for sample analyses performed during the RI.
- Section 3 summarizes the hydrogeologic conditions encountered at the site, including a summary of stratigraphic conditions encountered and the estimated direction of groundwater flow.

- Section 4 summarizes the analytical results of soil sampling performed during the RI activities.
- Section 5 summarizes the analytical results of reconnaissance and monitoring well groundwater sampling performed during the RI activities.
- Section 6 summarizes the analytical results of surface water sampling performed during the RI activities.
- Section 7 summarizes the findings and provides conclusions based on the results of the investigative activities performed during the RI.
- Section 8 summarizes the chemical fate and transport of chemicals of concern (COCs).
- Section 9 presents the FS performed for the site and recommends a remedial alternative to mitigate site conditions.
- Section 10 lists the references cited in this report.

Section 2: RI Objectives and Activities

2.1 Objectives

The principal objective of the RI was to identify the horizontal and vertical distribution of regulated chemicals that may pose a threat to human health and the environment. An additional objective was to develop adequate information to conduct a FS to select a remedial alternative to mitigate adverse site conditions and protect human health and the environment. During previous site investigations (refer to Section 1.3) issues of potential environmental concern were identified based on current site conditions and historical site practices. During the RI, investigative activities were performed to assess impacts to the site resulting from these and other potential environmental issues.

2.2 RI Activities Performed

The remainder of this section identifies the specific activities performed during the RI. This section also identifies the location of samples that were collected and the types of analyses performed. The RI was performed in accordance with the Work Plan (Kennedy/Jenks Consultants 1998). The investigative activities are summarized below.

2.2.1 Sampling and Characterization Activities

The horizontal and vertical extent of chemical impacts to soil and groundwater were characterized during the RI. Sample analyses were based on previous site findings regarding potential chemical impacts to site media as described in the Work Plan, and through ongoing RI findings. Specific analyses for some samples were based on field screening results of soil samples as described in the Work Plan.

Sampling and characterization were performed using a grid-based sampling approach in accordance with Ecology guidance (Ecology 1995). Sampling was also performed at specific suspect locations based on current and historical site conditions, and on grid-sample location results.

The RI included the following activities:

- Excavating 65 test pit trenches (TP-1 through TP-65) to depths of up to 12 feet below ground surface (bgs), and collecting and analyzing soil samples to assess soil impacts at areas of specific concern identified in the Work Plan.
- Advancing 18 soil probe borings (RGW-1 through RGW-18) to shallow groundwater depths (typically 10 to 15 feet bgs), and collecting reconnaissance groundwater samples for chemical analysis.
- Replacing two previously existing shallow monitoring wells [MW-4(R) and MW-8(R)] and installating four new monitoring wells (MW-9 through MW-12). During monitoring well

installation, soil samples were collected from soil borings for chemical and geotechnical analyses.

- Sampling 11 existing, replaced, and new shallow monitoring wells [MW-1 through MW-2, MW-4(R) through MW-7, and MW-8(R) through MW-12], and analyzing groundwater samples for chemical and general water quality parameters.
- Conducting hydraulic investigations, including water level monitoring, performing slug tests, and testing selected soil samples for geotechnical parameters.
- Sampling and analyzing surface water runoff from two locations (SW-1 and SW-2), and mapping of primary surface water flow pathways.

Soil, reconnaissance groundwater, groundwater, and surface water sampling locations are depicted on Figure 2-1.

2.2.2 Demolition Activities

Prior to the sampling and characterization activities, existing site structures (excluding one storage building) and approximately 1,800 feet of railroad track were demolished. The demolished structures included the main warehouse and office building, the red brick building, and various equipment and storage structures (refer to Figure 1-2). Solid waste materials generated from demolition activities included concrete, brick, glass, metal, wood, and other debris. In addition, liquid wastes were generated from several vault structures located below or in the vicinity of the red brick building (refer to Figure 1-2). These vaults were pumped, cleaned, and backfilled with clean imported soil material.

Waste materials derived from the demolition of site structures were transported offsite for disposal during 2000. Nonhazardous wastes were transported to Rabanco for landfill disposal. Hazardous waste materials were characterized, and hazardous waste profiles and shipping manifests were prepared. Hazardous waste streams were transported by licensed hazardous materials handlers to appropriate facilities for disposal. Disposal of these hazardous waste materials is documented in the 2000 Hazardous Waste Report submitted to Ecology. A copy of the 2000 Hazardous Waste Report is provided in Appendix B.

2.3 Investigative Methods

This section provides a brief summary of methods used to investigate soil and groundwater during the RI. Field sampling activities were conducted between March 2000 and April 2001. Detailed descriptions of the investigative activities performed and methods used are provided in the Work Plan.

2.3.1 Test Pit Soil Sampling

Test pit sampling was performed between 27 September 2000 and 15 November 2000. Test pits were excavated using a rubber-tired backhoe or trackhoe. Soil samples were collected directly from the test pit sidewalls at shallow depths of less than 3 feet bgs, and from the backhoe bucket at greater depths. Most test pits were excavated to approximately 10 feet bgs, with some as deep as 12 feet bgs.

Test pit soil samples were typically collected at depth intervals of 0 to 1 foot, 2 to 3 feet, 4 to 6 feet, and 6 to 10 feet in each test pit. At each test pit location, the vertical soil sequence from 0 to 10 feet bgs (where excavated to that depth) is represented in soil samples. Soil material was collected in 1-foot increments through the entire depth interval as follows:

- Samples designated as 0-1 foot included soil material collected from 0-1 foot bgs
- Samples designated as 2-3 feet included soil material collected from 1-2 and 2-3 feet bgs
- Samples designated as 4-6 feet included soil material collected from 3-4, 4-5, and 5-6 feet bgs
- Samples designated as 6-10 feet included soil material collected from 6-7, 7-8, 8-9, and 9-10 feet bgs.

For each sample, soil material from each applicable depth interval was transferred to a stainless steel bowl. The soil material was thoroughly mixed using a stainless steel spoon before being transferred to appropriate laboratory-supplied sample containers. The spoon and mixing bowl were decontaminated prior to each use.

Soil encountered in the test pits was logged in approximate accordance with the Unified Soil Classification System (USCS) by a Kennedy/Jenks Consultants' geologist. In addition, soil was subjected to field screening tests (i.e., visual inspection, hydrocarbon sheen tests, and headspace screening) to assess the potential for chemical impact. During test pit sampling, information regarding the occurrence and estimated depth of visible chemical impact, if encountered, was recorded on the field log along with the field screening results. Test pit conditions and field screening results are summarized Appendix C.

Soil samples collected for chemical analysis were placed in glass sampling jars and submitted to Analytical Resources, Inc. (ARI) of Seattle, Washington under standard chain-of-custody procedures. Soil samples were submitted for a variety of chemical analyses in accordance with the Work Plan. Specific chemical analyses were dependent upon field observations, field screening results, and the sampling plan described in the Work Plan. Test pit soil analyses typically included:

- Diesel- and oil- range petroleum hydrocarbons by Ecology Method NWTPH-diesel (extended)
- Resource Conservation and Recovery Act (RCRA) eight total metals plus copper by EPA Methods 6010/7000 series
- Volatile organic compounds (VOCs) by EPA Method 8260
- PCBs by EPA Method 8082
- Extractable Petroleum Hydrocarbons (EPHs) by Ecology's TPH Interim Policy methods

- PAHs by EPA Method 8270B using gas chromagraph/mass spectrometer with select ion monitoring (GC-MS/SIM)

- Trinitrotoluene/dinitrotoluene (TNT/DNT) by EPA Method 8330.

Test pit soil sample analysis was performed using an iterative process. Initially, the uppermost sample (0-1 foot interval) from each test pit was submitted for laboratory analysis. Additionally, specific samples that displayed positive field screening test results (visible staining, chemical odor, high vapor head-space readings) were submitted for laboratory analysis. These samples were typically analyzed for metals, petroleum hydrocarbons, and VOCs, although analysis of samples for VOCs was discontinued based on the analytical results for previous samples (refer to Section 4). Samples were submitted for PCB analysis from every other test pit location. Samples were collected from each depth interval, and those that were not included in the initial analyses were held frozen at the analytical laboratory for possible later analysis.

Additional sample analyses were performed based on exceedances of cleanup levels in the initial samples that were analyzed (refer to Section 4 for discussion of soil cleanup levels). Additional samples that were submitted for analyses were typically selected from the depth interval immediately below the sample in which the cleanup level exceedance was identified. These samples were typically analyzed only for the particular analyte that exceeded the cleanup level in the original sample, although samples in which petroleum hydrocarbon concentrations exceeded cleanup levels were also submitted for EPH and PAH analysis. This process was repeated until analyte concentrations were below the cleanup level, or the deepest sample collected at the test pit was analyzed. In the case of PCB analyses, samples from test pits adjacent to those in which exceedances were identified were also submitted for laboratory analysis.

Select soil samples were also analyzed for extractable metals and PAHs using TCLP and Synthetic Precipitation Leaching Procedure (SPLP) methods for use in the chemical fate and transport evaluation and FS (refer to Sections 8 and 9, respectively). Analytical results for test pit soil samples are discussed in Section 4.

2.3.2 Reconnaissance Groundwater Sampling

Reconnaissance groundwater samples were collected from 18 sampling locations (RGW-1 through RGW-18) on 25 and 26 May 2000. Reconnaissance groundwater samples were collected by installing a sampling line (equipped with a stainless steel screen sampling tip) to the base of the drilling rods and pushing the drill rods to the approximate depth of shallow groundwater. A sample was collected by pumping groundwater to the surface using a peristaltic pump through dedicated polyethylene tubing.

The groundwater samples were placed in appropriate sample containers (containing preservative as appropriate) provided by the analytical laboratory. Reconnaissance groundwater samples were submitted to CCI Analytical Laboratories, Inc. (CCI) of Everett, Washington under standard chain-of-custody procedures for the following analyses:

- PAHs by EPA Method 8270B GS-MS/SIM

- PCBs by EPA Method 8082
- RCRA eight dissolved metals by EPA Methods 6010/7000 series
- Gasoline-, diesel-, and oil- range petroleum hydrocarbons by Ecology Methods NWTPH-gas and NWTPH-diesel (extended)
- VOCs by EPA Method 8260.

Analytical results for reconnaissance groundwater monitoring are discussed in Section 5.1.

2.3.3 Monitoring Well Installation

Six groundwater monitoring wells were installed during the RI, including two replacement wells at locations of previously existing wells that site tenants had inadvertently destroyed [MW-8(R) and MW-4(R)], and four wells at new locations (MW-9 through MW-12). Three of these wells were installed on 9 May 2000, and three were installed on 10 November 2000 (refer to Figure 2-1 for monitoring well locations). [Note: One other well (MW-3), inadvertently destroyed by previous site tenants, was not replaced during the RI.]

Soil borings for monitoring well installation were drilled using hollow-stem auger drilling techniques. Soil samples were typically collected at 2.5- to 5-feet intervals using a split-spoon drive sampler for laboratory analysis and lithologic logging purposes. Recovered soil samples were logged using the USCS in general accordance with American Society of Testing and Materials (ASTM) Method D 2488. Selected soil samples were submitted to the laboratory for analysis based on field screening results. Lithological descriptions, sample designations, and field screening observations are provided on the boring and monitoring well construction logs in Appendix D.

Monitoring wells were constructed using 2-inch [MW-4(R), MW-8(R), MW-9, and MW-10] or 4-inch (MW-11 and MW-12) diameter Schedule 40 polyvinyl chloride (PVC) pipe. Each well consisted of a section of factory-slotted (0.01-inch or 0.02-inch slot size) screen and a section of blank PVC casing above the screened interval. Monitoring wells were completed above-grade using locking steel standpipe well enclosures [MW-4(R), MW-8(R), and MW-9] or at grade using flush-mount monuments enclosed in 4-inch-high boxes constructed of concrete (MW-10, MW-11, and MW-12). Protective bollards were installed around the three new aboveground enclosures and around two of the existing wells (MW-5 and MW-6). Construction details for monitoring wells are provided on the boring and monitoring well construction logs in Appendix D. Construction details for all site wells (new, replaced, and existing) are summarized in Table 2-1.

Following well installation, the wells were developed to remove fine-grained sediment placed in the filter pack during well installation. Well development consisted of surging with a vented surge block and over-pumping with a submersible pump in accordance with procedures identified in the Work Plan. Field documentation of well development is provided in Appendix E.

2.3.4 Groundwater Monitoring

Groundwater monitoring included the collection and laboratory analysis of groundwater samples from wells located on the site. Several groundwater monitoring events were conducted at the site. Five existing monitoring wells (MW-1, MW-2, MW-5, MW-6, and MW-7) were sampled in March 2000. The two replacement monitoring wells [MW-4(R) and MW-8(R)] and one new monitoring well (MW-9) were sampled in May 2000. All 11 monitoring wells were sampled in November 2000 and March 2001. Three of the monitoring wells [MW-8(R), MW-10, and MW-11) were resampled in May 2001. Carcinogenic PAH compounds were detected in unfiltered sampled collected from these three wells during previous monitoring events. Samples collected during the May 2001 monitoring event were field filtered prior to cPAH analysis (refer to Section 5.2 for a discussion of cPAH results).

Field procedures followed during the groundwater sampling are summarized in the Work Plan. Field parameters including temperature, pH, and specific conductivity were monitored during purging of the wells. Groundwater purge and sample field forms for each monitoring event are provided in Appendix E.

Groundwater samples collected during the March, May, and November 2000 and March 2001 monitoring events were analyzed for the following parameters:

- PAHs by EPA Method 8270B GC-MS/SIM
- PCBs by EPA Method 8082
- RCRA eight total and dissolved metals plus copper by EPA Methods 6010/7000 series
- Gasoline-, diesel-, and oil-range petroleum hydrocarbons by Ecology Methods NWTPH-gas and NWTPH-diesel (extended)
- VOCs by EPA Method 8260.

Samples collected from wells MW-8(R), MW-10, and MW-11 during the May 2001 monitoring event were analyzed only for PAHs, and were field filtered to minimize the inclusion of entrained soil particles in the sample.

Groundwater samples collected from select wells during the November 2000 and March 2001 monitoring events were also analyzed for general water quality parameters including sulfate, total dissolved solids (TDS), hardness, iron, manganese, potassium, sodium, calcium, pH, and conductivity.

Groundwater samples were submitted to ARI or CCI for chemical analysis under standard chain-of-custody procedures. Analytical results for groundwater monitoring are discussed in Section 5.2.

2.3.5 Hydraulic Testing

Rising-head slug tests were performed on monitoring wells MW-1, MW-2, MW-5, MW-7, MW-8(R), and MW-9 to provide an approximate estimate of the hydraulic conductivity of the shallow zone. Slug tests were performed by inducing a head (water level surface) fluctuation in the well and monitoring the rate of water level recovery over time. Head fluctuations were induced by submergence and removal of a 5-foot length of solid PVC pipe (slug). Water level changes were monitored by a pressure transducer suspended below the slug and recorded by a data logger. Five rising head tests (removal of the slug and recovery of the water level) were conducted at each well. The downhole slug test equipment was decontaminated prior to use at each well. Slug test results are discussed in Section 3.4.

2.3.6 Well Survey and Water Level Monitoring

The top-of-well casing elevation [relative to mean sea level (MSL)] and horizontal location of each monitoring well were surveyed by EarthTech, Inc. of Federal Way, Washington. This information was used in conjunction with water level depth data to assess the direction and magnitude of the hydraulic gradient at the site.

2.3.6.1 Groundwater Elevation Monitoring

Groundwater elevation monitoring of each site well was performed on 31 January 2001, 13 February 2001, and 28 February 2001. Water levels were measured in all site wells using electronic water level depth probes and converted to elevations using the surveyed top-of-casing elevations discussed above. If light non-aqueous phase liquid (LNAPL) was present, attempts were made to measure the approximate thickness of the LNAPL. Groundwater elevation monitoring results are discussed in Section 3.3.1.

2.3.6.2 Continuous Water Level Monitoring

Continuous groundwater level monitoring was performed in selected onsite groundwater monitoring wells MW-1, MW-2, MW-5, MW-7, MW-8(R), and MW-9 on 21 and 22 February 2001 to evaluate the range of tidally induced water level fluctuations from the Puyallup River. Monitoring was performed using pressure transducers equipped with battery-powered data loggers. The results of the continuous water level monitoring are discussed in Section 3.3.2.

2.3.7 Surface Water Monitoring

Surface water monitoring included observing water drainage pathways during rainfall events at the site, and collecting surface water samples at two locations where surface water discharges from the site (excluding discharges to Lincoln Avenue, which flow into the City of Tacoma storm sewer). Surface water samples were collected on 13 March 2001 and 29 April 2001. Surface water drainage monitoring is discussed further in Section 3.3.3.

Surface water samples collected during the RI were analyzed for the following parameters:

- PAHs by EPA Method 8270B GC-MS/SIM
- PCBs by EPA Method 8082
- RCRA eight total and dissolved metals plus copper by EPA Methods 6010/7000 series

- Diesel-, and oil-range petroleum hydrocarbons by Ecology Method NWTPH-diesel (extended).

Surface water samples were submitted to ARI for chemical analysis under standard chain-of-custody procedures. Analytical results for surface water monitoring are discussed in Section 6.

Section 3: Geologic and Hydrogeologic Conditions

This section presents the findings of hydrogeologic investigations performed at the site. The regional geologic setting is discussed first, followed by a discussion of the hydrogeologic conditions encountered.

3.1 Regional Geologic Setting

The site is located in the Tacoma tideflats, which are part of the Puyallup River delta. Typical stratigraphy of the Tacoma tideflats includes up to 10 feet of hydraulic fill (dredge) deposits of gravel, sand, silt, and organic debris underlain by silty and sandy deltaic sediments deposited by the Puyallup River. Glacial deposits underlie the Puyallup River sediments. The following descriptions are based on information provided by Hart-Crowser (1975).

The uppermost deltaic deposits in the Tacoma tideflats include an upper silt unit and a middle sand unit. The upper silt is composed of tidal marsh deposits and occurs as a surface layer and as interbedded layers within the underlying middle sand unit. The typical thickness of the silty surface layer is several feet to greater than 20 feet, with the thickest sections located in the central part of the delta. The silt layer is generally composed of sandy silt to clay, with silt and clayey silt being most common.

The upper boundary of the middle sand unit occurs at depths of several feet bgs to approximately 25 feet below MSL. The base of the unit is gradational with an underlying silt unit (lower silt) and is encountered at approximately 70 to 100 feet below MSL. Sand material is typically poorly graded and locally silty. The middle sand unit is locally interbedded with silty material.

3.2 Site Geology and Hydrogeology

The discussion presented below is based primarily on the observations of soil and groundwater conditions encountered by Kennedy/Jenks Consultants' geologists during the RI activities that included test pit excavations and soil borings. In addition, information was reviewed from soil boring logs from previous site investigations (PGG 1992).

3.2.1 Soil Stratigraphy

Soil materials encountered on the site include sandy and gravelly fill materials that typically contain abundant wood, metal, or other debris, and native materials including sand, silt, and clay. The materials encountered and their relative stratigraphic positions are described below. Generalized geologic cross sections based on site observations are provided on Figures 3-1, 3-2, and 3-3.

3.2.1.1 Mixed Fill Unit

The mixed fill unit is encountered throughout the site and is exposed at the surface or covered by asphalt and several inches of crushed surface top course gravel material. The mixed fill unit is approximately 3 to 9 feet thick and is underlain by fill material that contains abundant wood debris (wood fill unit).

The mixed fill unit primarily includes sand and gravel that is typically well graded, although poorly graded sands are locally present on the western portion of the site. Fine-grained materials, including clay, silt, and fine sand, are locally present and intermixed with coarse sand and gravel materials. The overall texture of the unit is highly variable across the site, and individual textural layers are generally not laterally traceable between test pit locations, with the exception of a metal debris layer described below. Metal, glass, wood, and other miscellaneous debris are present in the mixed fill unit throughout the site, most commonly in the upper portions of the unit, and are most abundant in the western portion of the site. The surfaces of unpaved areas of the site are typically strewn with metal and other debris.

3.2.1.2 Metal Debris Layer

A layer of abundant metal and other debris is locally present in the upper portion of the mixed fill unit. This metal debris layer contains abundant (typically 70 to 90 percent) metal, glass, concrete, brick, rubber, and other miscellaneous debris. Interstitial material is typically sand or gravel. The abundance of debris material distinguishes this layer from other portions of the mixed fill unit where debris material is less common. The metal debris layer is typically underlain by sand and gravel material of the mixed fill unit.

The metal debris layer is encountered primarily in the eastern portion of the site in the vicinity of a former railroad track, and in the northern portion of the site where asphalt pavement is not present. In the eastern portion of the site, the metal debris layer thins to the north and south (toward the Puyallup River and Portland Avenue, respectively) and is not readily apparent along the southern property boundary (refer to Figures 3-1, 3-2, and 3-3). The metal debris layer appears to extend beyond the eastern property boundary (refer to cross sections A-A' and B-B' on Figure 3-2).

3.2.1.3 Wood Fill Unit

The wood fill unit is encountered throughout the site and is located stratigraphically below the mixed fill unit, with the upper surface at depths of 3 to 9 feet bgs. The wood fill unit thickness observed in test pit excavations is typically 1 to 8 feet, and test pits excavated in the western portion of the site commonly were terminated in the wood fill unit at depths of 10 to 11 feet bgs. The unit is thickest in the western portion of the site, and soil boring observations indicate that wood fill may extend to depths of up to 18 feet bgs. The wood fill unit in the eastern and south-central (along Portland Avenue) portions of the site is approximately 1 to 4 feet thick. In the western and north-central (adjacent to the Simpson property) portions of the site, itis generally at least 4 feet thick and typically greater than 6 feet thick. Where the base of the wood fill unit was identified, it was underlain by apparently native materials including silt, clay, and sand.

The wood fill unit contains from 80 to 100 percent wood debris, depending on location, with interstitial silt, clay, and sand material. The size and texture of the wood material are highly variable, typically including wood dust, wood chips, wood scrap material, logs, planks, and large timbers. Wood fragments appear to be randomly oriented, although some of the material encountered appears to be vertically oriented pilings and horizontal planks. Interstitial matrix material is variable, but is most typically fine grained and includes silt, clay, and sand.

3.2.1.4 Native Materials

Apparently native sediment materials encountered at the site include clayey sandy silt with organic plant material and poorly graded sand with fine gravel. Native materials are stratigraphically below the wood fill unit and are initially encountered at depths of approximately 7 to 18 feet bgs. Where both the native silt and native sand layers are present, the silt layer is stratigraphically above the sand.

3.2.1.4.1 Native Silt Layer

The native silt layer was encountered primarily in the eastern and southern portions of the site. On the eastern half of the site, the silt layer was encountered in most of the test pits that were excavated in the central and southern portions of the site, but was present only locally in test pits excavated close to the northern property boundary. On the western half of the site, the silt layer was observed locally in test pits excavated along the southern property boundary, but was rarely encountered in test pits excavated in the central and northern portions of the site.

Portions of the site where the silt layer is not encountered correspond reasonably well with areas where the wood fill unit is thickest. Some of the interstitial materials observed within the wood fill unit are texturally similar to the silt layer material, indicating that wood debris might have been mixed with silt layer materials. Where the wood fill unit is less than approximately 3 feet thick, the silt layer is typically present.

The thickness of the silt layer observed in test pit excavations is 1 to 3 feet; however, test pits in which the silt layer was encountered were typically terminated within the silt layer. The silt layer was encountered in soil borings MW-2 and MW-9 at an approximate thickness of 3 feet. The native sand layer was present below the silt layer in these soil borings.

3.2.1.4.2 Native Sand Layer

The native sand layer is typically encountered in monitoring well soil borings at initial depths of 8 to 17 feet bgs. The sand layer is located stratigraphically below the native silt layer, if present, or the wood fill unit. The lower boundary of the native sand unit was not identified in any soil borings at the site. The native sand unit identified locally in test pits was located primarily in the northeastern portion of the site, but was generally not encountered in test pit excavations on other portions of the site. Most test pit excavations were terminated within the silt layer or wood fill unit.

3.2.2 Geotechnical Soil Properties

Four soil samples were collected from the pilot borings for monitoring wells MW-4(R), MW-8(R), and MW-9 and were submitted for geotechnical testing for parameters including vertical hydraulic conductivity (Kv), porosity, and grain size. The samples, which were collected at depths ranging from 0 to 15 feet bgs, were submitted to Rosa Environmental and Geotechnical Laboratory, L.L.C. (Rosa).

The measured vertical hydraulic conductivity ranged from 8.3×10^{-7} to 2.0×10^{-2} centimeters per second (cm/s). The lowest vertical hydraulic conductivity (8.3×10^{-7} cm/s) was measured in a sample collected from boring MW-8(R) at 6 to 6.5 feet bgs. The soil material was sandy silt with clay, and contained abundant wood fragments. A sample collected from boring MW-9 at 10.5 to 11 feet bgs had a vertical hydraulic conductivity of 3.2 x 10^{-5} cm/s and consisted of fine sand with silt and minor gravel and clay. Samples collected from boring MW-9 at 15 to 16 feet bgs and MW-4(R) at 0.5 to 1 foot bgs consisted primarily of medium to fine sand material and had vertical hydraulic conductivities of 3.8 x 10^{-3} cm/s and 2.0 x 10^{-2} cm/s, respectively. The sample collected from boring MW-4(R) contained abundant metal, glass, and other debris. Measured porosity values for the four samples ranged from 0.39 (39 percent) to 0.552 (55.2 percent).

Selected soil samples were also analyzed for total organic carbon (TOC) and cation exchange capacity (CEC). The percent of TOC ranged from 0.47 to 16. Measured CEC ranged from 2.4 to 26 milliequivalants/100 grams (meq/100 g), with an average CEC of 10 meq/100 g.

The results of geotechnical tests are summarized in Table 3-1. The analytical report sheets for these tests are provided in Appendix F.

3.3 Water Level Monitoring

This section discusses the results of periodic water level monitoring used to construct potentiometric surface contour maps, and the results of continuous water level monitoring performed in selected site wells.

3.3.1 Potentiometric Surface Contour Maps

Water elevations for site monitoring wells were calculated using water level data collected on 31 January 2001, 13 February 2001, and 28 February 2001 at the approximate published times for high and low tide (refer to Table 3-2). Potentiometric surface contour maps for these monitoring events are provided on Figures 3-4A, 3-4B, 3-5A, 3-5B, 3-6A, and 3-6B. Groundwater elevations at each well location are summarized in Table 3-2.

The direction of the hydraulic gradient at the site appears to be influenced by tidally induced fluctuations in the level of the Puyallup River. The direction of the hydraulic gradient appears to fluctuate by approximately 90 degrees between high and low tidal conditions.

At high tide conditions, the hydraulic gradient appears to be generally to the south. The magnitude of the gradient is highest (approximately 0.003 feet/foot) in the central portion of the site, and lowest (approximately 0.0008 feet/foot) in the eastern portion of the site. In the vicinity of well MW-4(R), the gradient appears to be to the northeast, toward the Puyallup River. This northeast gradient was most evident during the 13February 2001 monitoring event and may indicate a local hydraulic divide.

At low tide conditions, the general hydraulic gradient appears to be to the east, although the gradient direction in the western portion of the site may be to the northeast. The northeast gradient was most evident during the 31 January 2001 monitoring event. The gradient on the eastern portion of the site is between northeast and southeast, but cannot be resolved further with the current monitoring wells. A slight hydraulic mound appears to present during low tide conditions in the vicinity of well MW-9. This feature was observed during all of the monitoring events. The hydraulic gradient magnitude at low tide conditions is highest (approximately

0.004 feet/foot) in the central and western portions of the site, and lowest (approximately 0.001 feet/foot) in the eastern portion of the site.

The hydraulic gradient is slightly higher during low tide conditions where the gradient directions are approximately toward the Puyallup River than during high tide conditions where gradient directions are generally away from the Puyallup River. This suggests that the net groundwater flow is approximately toward the Puyallup River.

3.3.2 Continuous Water Level Monitoring

Continuous water level monitoring was performed in six monitoring wells [MW-1, MW-2, MW-5, MW-7, MW-8(R) and MW-9] during a 24-hour period between 21 and 22 February 2001. Wells MW-2, MW-5, MW-8(R), and MW-9 are located on a transect along the northern property boundary approximately parallel to the Puyallup River. Wells MW-1 and MW-7 are located along the southern property boundary adjacent to Portland Avenue. A hydrograph displaying the continuous water level monitoring results is provided on Figure 3-7.

The tidal influence on water levels is apparent in five of the six wells monitored. The wells on the river transect fluctuated by 1.40 to 2.58 feet, with the highest fluctuation at well MW-5. The water elevation in well MW-1 fluctuated by 1.29 feet; however, the elevation in well MW-7 fluctuated by only 0.11 foot. The apparent lack of tidal influence on water elevation in well MW-7 is consistent with groundwater elevations measured during the three monitoring events described in Section 3.3.1. The tidal fluctuation during the monitoring period, based on the published tide levels for Tacoma, Washington, was 12.4 feet. (Note: The published tide levels are for Commencement Bay. Tidally induced fluctuation of the Puyallup River stage near the site may be less than these published tidal levels. In addition, the highest and lowest water elevations at the site were measured approximately 1½ to 2 hours after the published times for high and low tide.)

The continuous groundwater monitoring results suggest that net groundwater flow is toward the Puyallup River, as indicated by elevation monitoring results (refer to Section 3.3.1). The water elevation in well MW-7, located near the southwestern corner of the site, is higher than the water elevation in well MW-8(R), located north of well MW-7, except under the highest tidal conditions. The water elevation in well MW-1, located in the south-central portion of the site, is consistently higher than the water elevation in well MW-9, located north of well MW-1 near the northern site boundary.

3.3.3 Surface Water Monitoring

Surface water flow pathways were observed during rainfall events at the site. Figure 3-8 shows the primary surface water flow pathways observed during rainfall events, and areas where ponded water was observed. Runoff on the eastern portion of the site is generally directed toward existing stormwater catch basins, and runoff on the western portion of the site generally flows offsite to the west. No catch basins are present on the western portion of the site.

Surface water discharges from the site at several locations along Portland Avenue, and flows into the City of Tacoma storm sewer catch basins located in Portland Avenue. Surface water also discharges from the site at two locations on the eastern and western property boundaries (refer to Figure 3-8). The discharge from the western property boundary (SW-1) flows west into a wide, shallow depression located on the adjacent property. The discharge from the eastern property boundary (SW-2) flows through a 6-inch culvert and discharges into a vegetated area on the adjacent property.

Due to the presence of a man-made levee, surface water runoff from the site does not discharge toward, or interact with, the Puyallup River. Based on this fact, Ecology did not require sediment sampling along the Puyallup River.

3.4 Hydraulic Testing

Rising-head slug tests were performed at six monitoring wells [MW-1, MW-2, MW-5, MW-7, MW-8(R) and MW-9] at the site to estimate the approximate hydraulic conductivity of shallow soils. The method of data analyses and the results of these tests are summarized in the following sections.

3.4.1 Slug Test Data Analysis Methods

The Bouwer and Rice (1976) method was used to evaluate the slug test data generated from wells installed at the site. This method is applicable to unconfined aquifers with completely or partially penetrating wells. Slug test data were analyzed using the AQTESOLV software package (HydroSOLVE, Inc. 1996). The solution equations were accomplished using visual-manual curve matching. Data analysis plots for the slug test solutions are provided in Appendix G.

In general, slug test results are useful to the extent to which the aquifer meets the assumptions established for the equation. Factors such as well construction, aquifer heterogeneity and anisotropy, and the degree of well development may affect the analytical results. The assumptions on which slug test analyses are based are rarely completely met by the saturated zone and well being tested. Therefore, it is generally accepted that slug tests are accurate to within one to two orders of magnitude.

3.4.2 Results of Slug Test Data Analyses

Results of the slug test data analyses are summarized in Table 3-3. The table identifies a horizontal hydraulic conductivity (Kh) value estimated for each individual slug test run and then provides an average value (calculated as a geometric mean) for the well. For the purposes of this report, the estimated average horizontal hydraulic conductivity value is considered to be representative of the saturated zone conditions surrounding that well. However, because of the procedures for performing slug tests, the results (in some cases) may be more indicative of the filter pack surrounding the tested well.

Average horizontal hydraulic conductivity values estimated for wells tested ranged from 1.2×10^{-3} cm/s [2.4×10^{-3} feet per minute (ft/min)] at well MW-5 to 1.7×10^{-2} cm/s (3.4×10^{-2} ft/min) at wells MW-1 and MW-2. The mean horizontal hydraulic conductivity value (geometric mean) for all tested wells is 6.8×10^{-3} cm/s (1.3×10^{-2} ft/min). These values are consistent with those calculated from short-term pump tests in a previous study, which ranged from 1.3×10^{-3} cm/s to 4.9×10^{-2} cm/s (PGG 1992, refer to Section 1.3.4).

The average horizontal hydraulic conductivity values calculated from the slug test data are generally consistent with published values (Freeze and Cherry 1979) expected for clean sand and silty sand soil types. These soil types are generally consistent with those encountered on the site at monitoring well depths. These data provide a reasonable (within two orders of magnitude) estimate of the horizontal hydraulic conductivity of the upper saturated zone.

Groundwater seepage velocities were estimated for each slug test well based on the calculated horizontal hydraulic conductivity values, an average porosity of approximately 0.49 for soil materials in the upper saturated zone (based on analyses by Rosa), and the average estimated hydraulic gradient of 0.004 feet/foot based on groundwater elevation monitoring. Estimated groundwater seepage velocities ranged from 10 to 147 feet/year, with an average seepage velocity for all slug test wells of 82 feet/year. Groundwater seepage velocities are listed in Table 3-3.

3.5 Additional Field Observations

The following additional conditions and features were observed during the RI activites:

- LNAPL (up to 2 inches thick) was encountered in two test pits (TP-11 and TP-55) and one monitoring well (MW-12) located west of the former red brick building, and in two test pits (TP-2 and TP-49) located in the vicinity of the former creosoting plant in the southwestern corner of the site. A sheen or film was present on excavation water in four additional test pits (TP-48, TP-51, TP-52, and TP-53) located around the former creosoting plant. LNAPL and sheen were not identified in monitoring wells MW-7, MW-10, and MW-11 located in the vicinity of the former creosoting plant.

- Steel pipes with diameters of 3 to 12 inches were encountered in test pits TP-14, TP-55, TP-63, and TP-64. Soil that was slightly to moderately impacted with petroleum hydrocarbon odor and/or stains was encountered in these test pits, suggesting that these pipes may have been used to transfer petroleum product.

- Battery casings were present in test pit TP-16, located immediately south of the former red brick building. This is consistent with the reported battery disposal areas identified during previous site investigations.

- An hydraulic shear located in a machine shed approximately 100 feet west of the red brick building contained hydrocarbon product that appeared to be clean hydraulic oil. The hydraulic oil was reportedly removed from the shear prior to removal, but a fluid reservoir was not identified. Structures and/or piping potentially associated with containment of hydraulic oil were not encountered in test pits near the shear location including TP-11 where LNAPL (possibly hydraulic oil) was encountered.

Section 4: Soil Analytical Results

This section summarizes the analytical results for soil samples collected and analyzed during the RI. Chemical concentrations detected in soil samples were compared to the MTCA Method C industrial cleanup levels published in Ecology's Cleanup Levels and Risk Calculations (CLARC II) database (Ecology 1996b). Where MTCA Method C industrial cleanup levels were not available (e.g., lead and chromium) the analytical results were compared to the MTCA Method A industrial cleanup levels. The analytical results for petroleum hydrocarbons were compared to the proposed amended MTCA Method A industrial cleanup level (Ecology 2001). Samples exceeding the amended MTCA cleanup level were further evaluated using the TPH Interim Policy guidance (Ecology 1997a). The use of these industrial cleanup levels in evaluating the need for removal action(s) at the site is discussed further in Section 9.1.5 of the FS.

Analytical results for soil samples are summarized in Tables 4-1 through 4-5. TPH Interim Policy (Ecology 1997a) analyses are summarized in Tables 4-6 and 4-7, and TCLP/SPLP analytical results for select metals and PAHs are summarized in Tables 4-8A and 4-8B.

Figures 4-1 through 4-4 depict soil sample results where analyte concentrations exceed the applicable MTCA cleanup level. In addition, the approximate exceedance areas for selected analytes at specific depth intervals are also shown on the figures.

Analytical reports and chain-of-custody documents for soil sample analyses are provided in Appendix H.

4.1 Metals

Analytical results for metals are presented in Table 4-1 and summarized below.

Arsenic was detected at concentrations above the laboratory reporting limits in 38 of 107 soil samples submitted for laboratory analysis. Arsenic concentrations ranged from 5 to 100 mg/kg. The MTCA Method C industrial soil cleanup level for arsenic of 219 mg/kg was not exceeded in the analyzed soil samples; however, the reporting limit for one sample (TP-21-2-3; reporting limit of less than 300 mg/kg) was above the cleanup level.

Barium was detected in 107 soil samples submitted for laboratory analysis at concentrations of 27.2 to 4,190 mg/kg. These concentrations are below the MTCA Method C industrial soil cleanup level of 245,000 mg/kg.

Cadmium was detected above the laboratory reporting limits in 93 of 125 samples submitted for laboratory analysis at concentrations ranging from 0.2 to 130 mg/kg. The MTCA Method C industrial soil cleanup level of 3,500 mg/kg was not exceeded in the soil samples analyzed.

Chromium was detected in 111 soil samples submitted for laboratory analysis at concentrations of 0.9 to 2,520 mg/kg. The MTCA Method A industrial soil cleanup level of 500 mg/kg was exceeded in seven soil samples at concentrations of 564 to 2,520 mg/kg. Soil sample locations where the chromium concentrations exceed the cleanup level are shown on Figure 4-1. Cleanup level exceedance areas for chromium are discussed in Section 4.1.1.2.

Copper was detected at concentrations above the laboratory reporting limit in 107 samples submitted for laboratory analysis. Copper concentrations ranged from 13 to 20,200 mg/kg. These concentrations are below the MTCA Method C industrial soil cleanup level of 130,000 mg/kg.

Lead was detected at concentrations above the laboratory reporting limits in 162 of 166 samples submitted for laboratory analysis. Lead concentrations ranged from 6 to 14,700 mg/kg. The lead concentration in 45 samples exceeded the MTCA Method A industrial soil cleanup level of 1,000 mg/kg, with concentrations ranging from 1,040 to 14,700 mg/kg. Soil sample locations where the lead concentrations exceed the cleanup level are shown on Figure 4-1. Cleanup level exceedance areas for lead are discussed in Section 4.1.1.1.

Mercury was detected at concentrations above the laboratory reporting limits in 94 of 120 samples submitted for laboratory analysis. Mercury concentrations ranged from 0.04 to 77 mg/kg. These concentrations are below the MTCA Method C industrial soil cleanup level of 1,050 mg/kg.

Selenium was detected above the laboratory reporting limit in 14 of 107 samples submitted for laboratory analysis at concentrations of 5 to 40 mg/kg. These concentrations are below the MTCA Method C industrial cleanup level of 17,500 mg/kg.

Silver was detected at concentrations above the laboratory reporting limit in 48 of 107 samples submitted for laboratory analysis. Silver concentrations ranged from 0.3 to 198 mg/kg. These concentrations are below the MTCA Method C industrial soil cleanup level of 17,500 mg/kg.

4.1.1 Metals Cleanup Level Exceedance Areas

Lead and chromium were detected in test pit soil samples at concentrations above their respective MTCA Method A industrial soil cleanup levels. The lateral and vertical distribution of affected soil material indicated by the analytical results for lead and chromium are discussed below.

4.1.1.1 Lead

Lead concentrations exceeding the MTCA Method A industrial soil cleanup level of 1,000 mg/kg were detected in soil samples collected from depth intervals of 0-1 foot, 2-3 feet, and 4-6 feet. The approximate areal extent of the lead exceedance areas for each depth interval are shown on Figure 4-1. [Note: The areal extent of the 0-1 foot exceedance area includes data from previous site investigations (refer to Section 1.3).]

The 0-1 foot depth interval exceedance area includes four separate regions, the largest of which is located on the eastern and north-central portion of the site. Three smaller exceedance regions are located on the western portion of the site. The approximate surface area of the 0-1 foot exceedance area is 142,534 square feet, and the approximate volume of affected material is up to 5,279 cubic yards.

The 2-3 feet depth interval exceedance area includes two separate regions. The larger of the two is located in the eastern and north-central portion of the site and roughly overlaps the 0-1 foot exceedance area, although it is smaller in extent. The smaller of the 2-3 feet exceedance regions is located south of the former red brick building location, and corresponds with part of the 0-1 foot exceedance area. The approximate surface area of the 2-3 feet exceedance area is 70,538 square feet, and the approximate volume of impacted soil is up to 5,225 cubic yards.

The lead cleanup level was exceeded in samples collected from two test pit locations in the 4-6 feet depth interval. These test pits (TP-34 and TP-46) are located on the eastern portion of the property. The approximate surface area of the 4-6 feet exceedance area is 8,318 square feet, and the approximate volume of impacted soil is up to 924 cubic yards.

The estimated volume of soil material that exceeds the MTCA Method A industrial soil cleanup level for lead of 1,000 mg/kg is 11,428 cubic yards (refer to Table 4-9). This estimate is based on analytical results for soil samples collected from test pits and previous investigation data and does not necessarily represent the maximum volume or extent of lead-impacted soil present on the site.

4.1.1.2 Chromium

Chromium concentrations exceeding the MTCA Method A industrial soil cleanup level of 500 mg/kg were detected in soil samples collected from depth intervals of 0-1 foot and 2-3 feet. The chromium cleanup level was exceeded in the 0-1 foot depth interval at five test pit locations. Three of these test pits (TP-40, TP-43, and TP-46) are located in the eastern portion of the site within the metal debris layer described in Section 3.2.1.2, and two of the test pits (TP-21 and TP-22) are located near the northern property boundary in the central portion of the site. The cleanup level was also exceeded in the 2-3 feet depth interval in test pits TP-21 and TP-22. Soil exceeding the chromium cleanup level is included within the limits of the lead cleanup level exceedance area.

4.2 PCBs

PCBs (Aroclors 1242, 1248, 1254, and 1260) were detected at concentrations above the laboratory reporting limits in 62 of 66 soil samples submitted for laboratory analysis. Total PCB concentrations ranged from 0.14 to 40.11 mg/kg. Total PCB concentrations were calculated by summing the concentrations of individual Aroclors in each sample. Where an Aroclor was not detected, a value of one-half the laboratory reporting unit was used. The MTCA Method C industrial soil cleanup level for total PCBs of 17 mg/kg was exceeded in six soil samples, with total PCB concentrations of 19.8 to 40.11 mg/kg. Analytical results for PCBs are summarized in Table 4-2.

PCB concentrations exceeded the MTCA Method C industrial soil cleanup level in samples collected at depth intervals of 0-1 foot and 2-3 feet. The 0-1 foot depth interval exceedance area is located on the eastern portion of the site with a surface area of approximately 20,945 square feet. The 2-3 feet depth interval exceedance area is also located on the eastern portion of the site within the horizontal boundaries of the 0-1 foot exceedance area. The approximate surface area of the 2-3 feet exceedance area is 3,503 square feet. The estimated volume of PCB-impacted soil is up to 1,035 cubic yards (refer to Table 4-9). This estimate is based on analytical results for soil samples collected from test pits and does not necessarily represent the maximum volume or extent of PCB-impacted soil present on the site. Test pit locations where the MTCA Method C industrial soil cleanup level was exceeded, and the approximate areal extent of the exceedance areas, are shown on Figure 4-2. The total PCB exceedance area is within the limits of the metals-impacted exceedance area in the eastern portion of the site.

4.3 PAHs

PAH compounds were detected in 19 soil samples submitted for laboratory analysis. Detected PAH compounds included cPAHs and noncarcinogenic PAHs. Concentrations of noncarcinogenic PAHs did not exceed the applicable MTCA Method C industrial soil cleanup level for any of the analytes (refer to Table 4-3). Individual cPAH analyte concentrations exceeded the MTCA Method C industrial soil cleanup level of 18 mg/kg in samples collected from four test pit locations. Specific cPAH compounds detected at concentrations above the MTCA Method C industrial soil cleanup level are listed in Table 4-3.

The total cPAH concentration exceeded the MTCA Method C industrial soil cleanup level of 18 mg/kg in six soil samples collected from six test pit locations (refer to Table 4-3 and Figure 4-3). Total cPAH concentrations were calculated by summing the concentrations of individual cPAH analytes in each soil sample. Where an analyte was not detected, a value of one-half the laboratory reporting limit was used. Total cPAH concentrations ranged from 0.169 to 730 mg/kg. Total cPAH concentrations in samples where the MTCA Method C industrial soil cleanup level was exceeded ranged from 19.71 to 730 mg/kg.

Total cPAH concentrations exceeded the MTCA Method C cleanup level of 18 mg/kg in samples collected at depth intervals of 0-1 foot, 2-3 feet, and 6-10 feet. Total cPAH concentrations exceeded the cleanup level for the 0-1 foot depth interval in two test pit locations. One test pit is located south of the former red brick building location (TP-16), and the other is located in the eastern portion of the site (TP-40). The approximate surface area of the 0-1 foot exceedance area is 6,209 square feet. The 2-3 feet depth interval exceedance area is located around TP-61 in the eastern portion of the site, and has an approximate surface area of 2,750 square feet. The 6-10 feet depth interval exceedance area is located in the southwestern corner of the site in the vicinity of the former creosoting plant, and has an approximate surface area of 7,540 square feet. The estimated total volume of soil impacted by cPAHs is 1,551 cubic yards (refer to Table 4-9). This estimate is based on analytical results for soil samples collected from test pits, and does not necessarily represent the maximum volume or extent of cPAH-impacted soil present on the site.

4.4 Petroleum Hydrocarbons

Petroleum hydrocarbons in the diesel- and oil- ranges were detected in soil samples collected at the site. Diesel-range petroleum hydrocarbons were detected above the laboratory reporting limit in 121 of 127 soil samples submitted for laboratory analysis at concentrations of 6.2 to 23,000 mg/kg. Oil-range petroleum hydrocarbons were detected above the laboratory reporting limit in 122 of 127 soil samples at concentrations of 15 to 12,000 mg/kg. Analytical results for petroleum hydrocarbons are presented in Table 4-4.

Diesel-range petroleum hydrocarbon concentrations equaled or exceeded the MTCA Method A industrial soil cleanup level of 2,000 mg/kg in 13 soil samples, with concentrations ranging from 2,000 to 23,000 mg/kg. Oil-range petroleum hydrocarbon concentrations equaled or exceeded the MTCA Method A industrial soil cleanup level of 2,000 mg/kg in 29 soil samples, with concentrations of 2,000 to 23,000 mg/kg. [Note: The MTCA Method A industrial soil cleanup level for diesel- and oil- range petroleum hydrocarbons is based on the concentrations given in the MTCA Adopted Amendments (Ecology 2001) anticipated to become effective in August 2001.] Soil sample locations with petroleum hydrocarbon concentrations greater than 2,000 mg/kg are shown on Figure 4-4.

Diesel- and oil- range petroleum hydrocarbon concentrations exceeded the MTCA Method A industrial soil cleanup level of 2,000 mg/kg in samples collected at depth intervals of 0-1 foot, 2-3 feet, 4-6 feet, and 6-10 feet. The approximate areal extent of the exceedance areas for each depth interval is shown on Figure 4-4.

Petroleum hydrocarbon concentrations exceeded the MTCA Method A industrial soil cleanup level in the 0-1 foot depth interval in five separate regions of the site with a total surface area of approximately 36,223 square feet. Petroleum hydrocarbon concentrations exceeded the MTCA Method A industrial soil cleanup level in the 2-3 feet depth interval in four separate regions with a total surface area of approximately 22,268 square feet. The petroleum hydrocarbon cleanup level exceedance area for the 4-6 feet depth interval includes three separate regions of the site, and the exceedance area for the 6-10 feet depth interval includes two separate regions. The estimated total volume of soil containing diesel- and oil- range petroleum hydrocarbon concentrations above the MTCA Method A industrial soil cleanup level of 2,000 mg/kg is 6,671 cubic yards (refer to Table 4-9). This estimate is based on analytical results for soil samples collected from test pits, and does not necessarily represent the maximum volume or extent of petroleum hydrocarbon-impacted soil present on the site.

Exceedance areas for petroleum hydrocarbons are located throughout the site, and each area typically includes one to three test pit locations, although exceedance areas on the eastern portion of the site include up to five test pit locations. Exceedance areas at different depth intervals overlap locally. Petroleum hydrocarbon exceedance areas are typically relatively small in areal extent and vertically continuous to depths of greater than 10 feet bgs on the western portion of the site, particularly in the vicinity of the former creosoting plant location in the southwestern corner of the site, and west of the former red brick building location. On the eastern portion of the site, petroleum hydrocarbon exceedance areas are larger in areal extent but do not appear to extend below approximately 3 feet bgs, with the exception of one isolated area up to 6 feet bgs that is located near the eastern property boundary. This location corresponds to an area where lead-impacted soil was encountered at the same depth interval.

Soil samples where diesel- or oil- range petroleum hydrocarbon concentrations exceeded the MTCA Method A industrial soil cleanup level of 2,000 mg/kg were evaluated using Ecology's TPH Interim Policy (Ecology 1997a).

4.5 TPH Interim Policy Analyses

Based on the results of petroleum hydrocarbon analyses, 19 soil samples containing diesel- and oil- range petroleum hydrocarbon concentrations above the proposed amended MTCA

Method A industrial soil cleanup level of 2,000 mg/kg were analyzed for EPHs. The analytical methods used were those identified in Ecology's TPH Interim Policy (Ecology 1997a). The sample with the highest petroleum hydrocarbon concentration from each test pit where the cleanup level was exceeded was selected for EPH analysis. These 19 samples were also analyzed for PAHs as discussed in Section 4.3. Analytical results for EPH analyses are summarized in Table 4-5 and discussed below.

Aliphatic and aromatic EPH analytes were detected at concentrations above the laboratory reporting limits in the 19 samples submitted for laboratory analysis. Both aromatic and aliphatic compounds were detected in the C10-C12 through C21-C34 ranges. The highest concentrations of both aromatics and aliphatics were in the C21-C34 range.

According to Ecology's TPH Interim Policy, compliance with MTCA industrial soil cleanup levels is evaluated on a sample-by-sample basis using established risk assessment procedures identified in the TPH Interim Policy. The procedure includes calculation of a hazard index for noncarcinogenic compounds and a total risk for carcinogenic compounds (including cPAHs). The MTCA industrial soil cleanup level is exceeded when the noncarcinogenic compound concentrations exceed a hazard index of 1.0, or the total carcinogenic risk exceeds 1 in 100,000 (1×10^{-5}) under an industrial scenario. In addition, the hazard quotient (the hazard index is the sum of hazard quotients) cannot exceed 1.0, and the carcinogenic risk cannot exceed 1×10^{-5} for any individual substance.

Ecology's TPH Interim Policy also uses a calculated "concentration at well" to determine if a soil cleanup level is protective of groundwater. The "concentration at well" is an estimate of the petroleum hydrocarbon concentration in a well located adjacent to the source area, and is calculated using a default dilution factor (DF) of 20 for soil in the unsaturated zone. A DF of 1 is applicable where petroleum hydrocarbon-impacted soil is present in the groundwater smear zone where impacted soils are intermittently in contact with groundwater (personal communication, Mr. Charles San Juan, Ecology 2000). Based on this, a DF of 20 was used for soil samples collected from the 0-1 foot, 2-3 feet, and 4-6 feet depth intervals, and a DF of 1 was used for soil samples collected from the 6-10 feet depth interval, where intermittent saturated conditions may exist on portions of the site. The MTCA industrial soil cleanup level is exceeded where the calculated "concentration at well" exceeds 1 mg/l. The TPH Interim Policy is not applicable to petroleum hydrocarbon-impacted soil where saturated conditions are continuous.

Using Ecology's spreadsheet, hazard indices, risks, and "concentrations at well" were calculated for each of the 19 soil samples. The spreadsheet used to perform the TPH Interim Policy calculations was obtained directly from Ecology through its Internet site. Calculation spreadsheets for each sample are provided in Appendix I. Aliphatic and aromatic hydrocarbon concentrations were used in the calculations, as were cPAH concentrations. Benzene, toluene, ethylbenzene, and total xylenes (BTEX) concentrations were used for those samples that were included in previous analyses for VOCs. TPH Interim Policy evaluation results are summarized in Table 4-6.

The MTCA industrial soil cleanup level was met for 12 of the 19 samples evaluated under the TPH Interim Policy using the industrial exposure scenario. For these 12 samples, the maximum calculated hazard index was 0.04, the maximum total carcinogenic risk was 8.23×10^{-6}, and the maximum "concentration at well" was 0.1 mg/l using a DF of 20 and 0.2 mg/l using a DF of 1.

Seven samples evaluated under the TPH Interim Policy using the industrial exposure scenario did not meet the MTCA Method C industrial soil cleanup level. These soil samples were from the following test pits:

- TP-2, TP-5, and TP-49 located in the southwestern corner of site in the vicinity of the former creosoting plant
- TP-10 located approximately 100 feet west of the former red brick building
- TP-16 located immediately south of the former red brick building
- TP-40 and TP-61 located in the eastern portion of the site.

The hazard index criterion of 1.0 was not exceeded in any of the samples. The total carcinogenic risk criterion of 1×10^{-5} was exceeded in six of the seven samples with the total carcinogenic risks ranging from 1.10×10^{-5} to 3.55×10^{-4}. The criterion was not exceeded in the sample from TP-10. The six locations correspond to those locations where cPAHs exceed the MTCA Method C industrial soil cleanup level of 18 mg/kg (refer to Section 4.3 and Figure 4-3).

The "concentration at well" criterion of 1 mg/l was exceeded in four of the seven samples from TP-2, TP-5, TP-10, and TP-49. These results correspond to those areas of the site where petroleum hydrocarbon- and cPAH-impacted soil has been identified down to the water table (refer to Sections 4.3 and 4.4 and Figures 4-3 and 4-4, respectively). These results also correspond to areas of the site where groundwater impacts have been identified (refer to Section 5.2 and Figures 5-2, 5-3).

4.6 VOCs

Individual VOC analytes were detected at concentrations above the laboratory reporting limits in 23 soil samples submitted for laboratory analysis. However, VOC concentrations did not exceed the applicable MTCA Method C industrial soil cleanup level for the VOC analytes. (Note: MTCA soil cleanup levels are not available for all VOC analytes.) Analytical results for VOCs are summarized in Table 4-4.

4.7 TNT/DNT

TNT and DNT analytes were not detected in five soil samples collected from test pits TP-39 and TP-40 at concentrations above the laboratory reporting limits. Analytical results for TNT and DNT analyses are summarized in Table 4-7.

4.8 TCLP/SPLP Analyses

TCLP and SPLP analyses were conducted on a select number of samples to evaluate leaching potential of metals and PAHs and to assist in characterizing impacted soil at the site with respect to state and federal waste disposal regulations.

Based on analytical results for total metals concentrations in soil samples, five samples were submitted for TCLP and SPLP analyses for lead to assist in waste disposal characterization.

Six additional samples were submitted for TCLP analysis for lead to assist in waste disposal characterization. Soil samples containing the highest detected concentrations of arsenic, barium, cadmium, chromium, copper, mercury, selenium, and silver were also submitted for TCLP and SPLP analyses. Three samples were submitted for TCLP and SPLP analysis for PAHs.

Analytical results for TCLP and SPLP analyses are summarized in Table 4-8A (metals) and Table 4-8B (PAHs). TCLP and SPLP analytical reports are provided in Appendix J. The results of TCLP and SPLP analyses are summarized below and discussed further in Section 8 (Chemical Fate and Transport) and Section 9 (Feasibility Study) of this report.

TCLP lead was detected above the laboratory reporting limit in 10 samples at concentrations ranging from 0.13 to 74.7 mg/l. Ecology's dangerous waste criterion (WAC 173-303-100) of 5 mg/l for TCLP lead was exceeded in eight samples at concentrations of 6.9to 74.7 mg/l. SPLP lead was detected in three samples at significantly lower concentrations of 0.03 to 0.07 mg/l.

TCLP barium, cadmium, copper, and mercury were detected at concentrations above the laboratory reporting limits, but below Ecology's dangerous waste criterion threshold values of the metals. (Note: A dangerous waste criterion threshold value is not available for copper.) SPLP barium, copper, and mercury were detected at low concentrations above the laboratory reporting limits.

TCLP and SPLP PAH compounds were detected in one of the samples submitted for laboratory analysis at a low concentration above the laboratory reporting limits. However, none of the TCLP or SPLP PAH compounds detected were cPAH compounds.

4.9 Summary of Soil Analytical Results

Analytical results for soil samples collected during the RI indicate that lead, chromium, cPAH, PCB, and petroleum hydrocarbon concentrations exceed the applicable MTCA Method A and C industrial soil cleanup levels. Soil exceeding the MTCA cleanup level for chromium, cPAHs, and PCBs is generally included within the exceedance areas identified for lead and petroleum hydrocarbons. Exceedance areas and volumes of soil material that may require remediation are summarized in Table 4-9.

Soil samples with lead, chromium, cPAH, and PCB concentrations exceeding the applicable MTCA Method A and C industrial soil cleanup levels were identified at various depth intervals from the surface to 10 feet bgs at test pit locations throughout the site. The lead exceedance areas are the most extensive for the 0-1 foot and 2-3 feet depth intervals (refer to Figure 4-1) and generally encompass the exceedance areas for chromium, PCBs, and cPAHs at those depths (refer to Figures 4-2 and 4-3), with the exception of cPAH concentrations in TP-61 at the 2-3 feet depth interval. Lead was also detected above the soil cleanup level at the 4-6 feet depth interval in two isolated areas in the vicinity of TP-34 and TP-46. At the 6-10 feet depth interval, cPAHs exceed the MTCA Method C industrial soil cleanup level in the southwestern corner of the site, in the vicinity of the former creosoting plant, in an area where lead concentrations above the cleanup level were not identified in test pit samples.

Petroleum hydrocarbon concentrations exceeded the MTCA Method A industrial soil cleanup level of 2,000 mg/kg in samples collected from the surface to 10 feet bgs at test pit locations throughout the site (refer to Figure 4-4). Petroleum hydrocarbon exceedance areas on the eastern portion of the site are confined to the uppermost 3 feet of soil and generally correspond with the lead exceedance areas. On the western portion of the site, petroleum hydrocarbon exceedance areas generally do not correspond with lead exceedance areas (with the exception of test pit locations TP-9, TP-16, TP-55, and TP-57 in the 0-1 foot depth interval). Petroleum hydrocarbon exceedances extend to the water table (10 feet bgs) in two areas on the western portion of the site, in the vicinity of the former creosoting plant and west of the former red brick building. Petroleum hydrocarbon exceedance areas throughout the site include the exceedance areas for total cPAHs.

The combined lead and petroleum hydrocarbon exceedance areas include the exceedance areas for other analytes detected in test pit samples at concentrations above the applicable MTCA industrial soil cleanup levels. The estimated volume of soil in the lead-impacted exceedance areas is approximately 11,400 cubic yards, and the estimated volume of soil in the petroleum hydrocarbon-impacted exceedance areas is approximately 6,700 cubic yards. (Note: Estimated volumes have been rounded to the nearest one hundred cubic yards.) These estimates are based on soil samples collected from test pits that were advanced to maximum depths of 12 feet bgs, but typically to depths of 10 feet bgs. Analyte concentrations above applicable cleanup levels may be present at locations where test pits were not excavated, and at depths below the maximum test pit depths.

Based on the evaluation of soil samples using Ecology's TPH Interim Policy, the petroleum hydrocarbon exceedance areas may be less extensive than described above. Based on TPH Interim Policy evaluation, the petroleum hydrocarbon exceedance areas may include only seven test pit locations, six of which correspond with the cPAH exceedance areas.

Section 5: Groundwater Analytical Results

This section summarizes the analytical results for reconnaissance and monitoring well groundwater samples.

Analyte concentrations detected in groundwater samples were compared to the MTCA Method B and C surface water cleanup levels published in Ecology's CLARC II database (Ecology 1996b) where cleanup levels are available for the given analyte. In addition, the groundwater analytical results were compared to other ARARs including:

- Ecology's Acute Freshwater Surface Water Quality Standard (SWQS) (WAC 173-201A, Ecology 1997b)
- National Toxics Rule (NTR) for Consumption of Organisms Only [40 Code of Federal Regulations (CFR) 131.36]
- Ecology's Model National Pollution Discharge Elimination System (NPDES) Permit Standards (WAC 173-226) for petroleum hydrocarbons.

Use of the above mentioned cleanup levels meets the requirements of MTCA established in WAC 173-340-720(6)(d) for protection of shallow groundwater discharging to an adjacent surface water body. The use of these cleanup levels and/or ARARs in evaluating the need for remedial action(s) at the site is discussed further in Section 9.1.5 of the FS.

Ecology's Acute Freshwater SWQS values for cadmium, chromium, copper, lead, and silver were calculated based on the average hardness of groundwater samples (refer to Section 5.2.7) using a computer spreadsheet obtained from Ecology.

Figure 5-1 summarizes reconnaissance and monitoring well groundwater analytical results for samples exceeding one or more of the cleanup levels and/or ARARs.

5.1 Reconnaissance Groundwater Analytical Results

Eighteen reconnaissance groundwater samples were submitted for laboratory analysis. Results of these analyses are summarized in Tables 5-1 through 5-4 and discussed below. Analytical reports and chain-of-custody documents for reconnaissance groundwater samples are provided in Appendix K.

Reconnaissance groundwater analytical results are typically used as a screening tool to evaluate the need for permanent groundwater monitoring wells. The analyte concentrations in reconnaissance samples are typically biased high due to the relatively high amount of suspended entrained soil particles in the samples.

5.1.1 Dissolved Metals

Dissolved metals detected in reconnaissance groundwater samples at concentrations at or above the laboratory reporting limit included barium, cadmium, and mercury. Complete analytical results are provided in Table 5-1, and detected analytes are summarized below.

- Dissolved barium was detected in all 18 reconnaissance groundwater samples at concentrations of 4 to 120 μg/l. MTCA surface water cleanup levels, Ecology's Acute Freshwater SWQS, and NTR criterion for barium are not available.
- Dissolved cadmium was detected in three of the 18 reconnaissance groundwater samples at concentrations of 5 to 9 μg/l, below the MTCA Method B and C surface water cleanup levels of 20.3 and 50.6 μg/l, respectively. The cadmium concentration in sample RGW-1 (9 μg/l) exceeds Ecology's Acute Freshwater SWQS of 7.0 μg/l (based on a hardness of 180 mg/l). An NTR criterion for cadmium is not available.
- Dissolved mercury was detected in one reconnaissance groundwater sample at a concentration of 0.2 μg/l. This concentration is below Ecology's Acute Freshwater SWQS of 2.10 μg/l and the NTR criterion of 1.5 μg/l. MTCA surface water cleanup levels for mercury are not available.

5.1.2 PCBs

PCB Aroclors were not detected in the 18 reconnaissance groundwater samples at concentrations above the laboratory reporting limits. Analytical results for PCBs are presented in Table 5-2.

5.1.3 PAHs

PAH compounds were detected in 18 reconnaissance groundwater samples submitted for laboratory analysis. Detected PAH compounds included cPAHs and noncarcinogenic PAHs. Concentrations of noncarcinogenic PAHs did not exceed the MTCA Method C surface water cleanup level, Ecology's Acute Freshwater SWQS, or NTR criteria for PAH compounds (where the particular ARAR was available for the given compound). One reconnaissance groundwater sample (RGW-2; 1,000 μg/l) exceeded the MTCA Method B surface water cleanup level for acenaphthene of 643 μg/l. Analytical results for PAHs are summarized in Table5-3.

Individual cPAH compound concentrations were detected in eight reconnaissance groundwater samples above either MTCA Method B and/or C surface water cleanup levels of 0.0296 and 0.740 μg/l, respectively, or above the NTR criterion of 0.31 μg/l. Total cPAH concentrations in the eight samples exceeded the MTCA Method B surface water cleanup level. The total cPAH concentrations in five samples exceeded the MTCA Method C surface water cleanup level and NTR criterion. Ecology's Acute Freshwater SWQS for cPAHs are not available.

5.1.4 Petroleum Hydrocarbons

Gasoline-, diesel-, and oil- range petroleum hydrocarbons were detected at concentrations above the laboratory reporting limits in reconnaissance groundwater samples. Analytical results for petroleum hydrocarbons are summarized in Table 5-4 and discussed below.

- Gasoline-range petroleum hydrocarbons were detected in three reconnaissance groundwater samples at concentrations of 0.09 to 0.33 mg/l

- Diesel-range petroleum hydrocarbons were detected in three reconnaissance groundwater samples at concentrations of 0.86 to 1.7 mg/l

- Oil-range petroleum hydrocarbons were detected in one reconnaissance groundwater sample at a concentration of 0.96 mg/l.

MTCA surface water cleanup levels, Ecology's Acute Freshwater SWQS, and NTR criteria are not available for petroleum hydrocarbons. The concentrations detected were below Ecology's Model NPDES Permit Standard of 1 mg/l for gasoline-range petroleum hydrocarbons and 10 mg/l for diesel- and oil- range petroleum hydrocarbons.

5.1.5 VOCs

Reconnaissance groundwater samples were analyzed for BTEX compounds and naphthalene [Note: Naphthalene is included in the compound list for both PAHs and VOCs (refer to Section 5.1.3).] Benzene and total xylenes were not detected above the laboratory reporting limits. Toluene (two samples) and ethylbenzene (one sample) were detected at or slightly above the laboratory reporting limits. Naphthalene was detected in four samples at concentrations ranging from 23 to 210 μg/l. None of the analytical results exceeded the MTCA Method B and C surface water cleanup levels, Ecology's Acute Freshwater SWQS, or NTR criteria. Analytical results for VOCs are summarized in Table5-4.

5.2 Monitoring Well Groundwater Analytical Results

Groundwater samples were collected from 11 monitoring wells located on the site. Up to four monitoring events were conducted as part of the RI (refer to Section 2.3.4). The highest analyte concentrations detected during these monitoring events are discussed below. Analytical results for monitoring well groundwater samples are provided in Tables 5-5 through 5-10. Analytical results for samples exceeding cleanup levels and/or ARARs are summarized on Figure 5-1, and concentration contour maps for select analytes are provided on Figures 5-2 and 5-3. Analytical reports and chain-of-custody documents for groundwater monitoring well samples are provided in Appendix L.

5.2.1 Total Metals

Total metals including barium, cadmium, chromium, copper, and lead were detected at concentrations above the laboratory reporting limits in groundwater samples. Analytical results for total metals are summarized in Table 5-5 and discussed below.

- Total barium was detected in the groundwater samples collected from 11 monitoring wells at concentrations of 2 to 90 µg/l. MTCA surface water cleanup levels, Ecology's Acute Freshwater SWQS, and NTR criterion are not available for barium.

- Total cadmium was detected in the groundwater sample collected from well MW-6 at a concentration of 3 µg/l. This concentration is below the MTCA Method B and C surface water cleanup levels of 20.3 µg/l and 50.6 µg/l, respectively, and below Ecology's Acute Freshwater SWQS of 7.0 µg/l (based on a hardness of 180 mg/l). An NTR criterion is not available for cadmium.

- Total chromium was detected in the groundwater samples collected from five monitoring wells at concentrations of 20 to 190 µg/l. These concentrations are below Ecology's Acute Freshwater SWQS of 888.04 µg/l (based on a hardness of 180 mg/l). MTCA surface water cleanup levels and NTR criterion are not available for total chromium. Chromium was detected only during the 14 March 2000 monitoring event. Chromium was not detected at concentrations above the laboratory reporting limits in subsequent monitoring events.

- Total copper was detected in the groundwater samples collected from eight monitoring wells at concentrations of 3 to 20 µg/l. These concentrations are below the MTCA Method B and C surface water cleanup levels of 2,660 and 6,660 µg/l, respectively, and below Ecology's Acute Freshwater SWQS of 29.61 µg/l (based on a hardness of 180 mg/l). An NTR criterion is not available for copper.

- Total lead was detected in the groundwater samples collected from three monitoring wells at concentrations of 6 to 20 µg/l. These lead concentrations are below Ecology's Acute Freshwater SWQS of 121.7 µg/l (based on a hardness of 180 mg/l). MTCA surface water cleanup levels and NTR criterion are not available for lead.

5.2.2 Dissolved Metals

Dissolved metals including barium and selenium were detected in groundwater samples at concentrations above the laboratory reporting limits. Analytical results for dissolved metals are summarized in Table 5-6 and discussed below

- Dissolved barium was detected in the groundwater samples collected from 11 monitoring wells at concentrations of 9 to 102 µg/l. MTCA surface water cleanup levels, Ecology's Acute Freshwater SWQS, and NTR criterion are not available for barium.

- Dissolved selenium was detected at a concentration of 70 µg/l in the groundwater sample collected from well MW-9 during the 21 November 2000 monitoring event. This concentration is above the Ecology's Acute Freshwater SWQS of 20 µg/l. MTCA surface water cleanup levels and NTR criterion are not available for selenium. The laboratory reporting limit for dissolved selenium for the other groundwater samples of 50 µg/l is above Ecology's Acute Freshwater SWQS. Dissolved selenium was not detected in subsequent monitoring event and total selenium (refer to Table 5-5) was not detected above the laboratory reporting limit in the samples collected from any of the site monitoring wells. The detection of dissolved selenium appears to be anomalous and is not considered representative of groundwater quality at the site since the results do not appear to be reproducible.

5.2.3 PCBs

PCB Aroclors 1242, 1248, and 1254 were detected in a duplicate groundwater sample collected from well MW-8(R) at concentrations of 5.6 μg/l, 1.9 μg/l, and 1.3 μg/l, respectively. PCB Aroclor 1242 was also detected in the groundwater sample collected from well MW-11 at a concentration of 2.0 μg/l. These concentrations were flagged "Y" by the analytical laboratory, indicating that the reported values represent a raised reporting limit due to matrix interference. The "Y" flag is essentially a "U" or "ND" flag at a slightly elevated reporting limit, and does not necessarily indicate the presence of an analyte.

These "Y" flagged reported values do not appear to be representative of PCB concentrations in site groundwater. PCB Aroclors were not detected during other monitoring events, and in the case of the well MW-8(R) duplicate sample, were not detected in the original sample collected from well MW-8(R). In addition, no PCB Aroclors were detected in the reconnaissance groundwater samples. Consequently, the detection of PCBs in groundwater appears to be anomalous and is not considered representative of groundwater quality at the site since the results do not appear to be reproducible.

PCB analytical results for groundwater samples are summarized in Table5-7.

5.2.4 PAHs

PAH compounds were detected in the groundwater samples collected from each of the 11 groundwater monitoring wells. Detected PAH compounds included cPAHs and noncarcinogenic PAHs. PAH analytical results for groundwater samples are summarized in Table 5-8.

With the exception of naphthalene, concentrations of noncarcinogenic PAHs did not exceed the MTCA Method B and C surface water cleanup levels, Ecology's Acute Freshwater SWQS, or the NTR criteria for PAH compounds (where the particular ARAR was available for the given compound).

Naphthalene was detected in the groundwater samples collected from 11 monitoring wells at concentrations of 0.07 to 6,200 μg/l. The naphthalene concentrations detected in samples from well MW-8(R) ranged from 4,000 to 6,200 μg/l during four monitoring events. These concentrations exceed Ecology's Acute Freshwater SWQS of 2,300 μg/l, but are below the MTCA Method B and C surface water cleanup levels of 9,880 and 24,700 μg/l, respectively. An NTR criterion is not available for naphthalene. A concentration contour map for naphthalene in site groundwater is provided as Figure 5-2. [Note: Naphthalene is included in the compound list for both PAHs and VOCs (refer to Section 5.2.6); concentrations shown on Figure 5-2 are the highest naphthalene value detected regardless of the particular analysis.]

Individual cPAH compound concentrations were detected in the groundwater samples collected from monitoring wells MW-8(R), MW-10, and MW-11 at concentrations of 0.05 to 4.8 μg/l. Individual cPAH analyte concentrations were above the MTCA Method B surface water cleanup level of 0.0296 µg/l. Some individual cPAH concentrations exceeded the MTCA Method C surface water cleanup level of 0.740 µg/l and the NTR criterion of 0.31 µg/l (refer to Table 5-8 for specific compounds and concentrations). Ecology's Acute Freshwater SWQS values are not available for cPAHs.

Total cPAH concentrations in the groundwater samples collected from monitoring wells MW-8(R), MW-10, and MW-11 exceeded the MTCA Method B and C surface water cleanup levels of 0.0296 and 0.740 µg/l, respectively, and the NTR criterion of 0.31 µg/l.

PAH compound concentrations were generally lowest in the samples collected from monitoring wells MW-8(R), MW-10, and MW-11 during the 14 May 2001 monitoring event. The groundwater samples collected during this event were field filtered. Noncarcinogenic PAH compound concentrations, with the exception of naphthalene, were lower in the filtered samples. Carcinogenic PAH compounds were not detected in any of the filtered samples, with the exception of a low concentration of benzo(a)anthracene (0.11 µg/l) slightly above the laboratory reporting limit in the filtered groundwater sample collected from well MW-10. This suggests that the cPAHs previously detected in the unfiltered samples were likely an artifact of suspended entrained soil in the samples and do not necessarily indicate the presence of cPAHs in site groundwater, especially since cPAHs have very low aqueous solubility's and are relatively immobile in groundwater.

5.2.5 Petroleum Hydrocarbons

Gasoline-, diesel-, and oil- range petroleum hydrocarbons were detected at concentrations above the laboratory reporting limits in groundwater samples collected from 9 of the 11 monitoring wells. Groundwater analytical results for petroleum hydrocarbons are summarized in Table 5-9 and discussed below.

- Gasoline-range petroleum hydrocarbons were detected in the groundwater samples collected from monitoring wells MW-8(R), MW-10, and MW-11 at concentrations of 0.39to 39 mg/l.
- Diesel-range petroleum hydrocarbons were detected in the groundwater samples collected from monitoring wells MW-4(R), MW-5, MW-6, MW-7, MW-8(R), MW-9, MW-10, MW-11, and MW-12 at concentrations of 0.33 to 4.1 mg/l.
- Oil-range petroleum hydrocarbons were detected in the groundwater sample collected from monitoring well MW-12 at a concentration of 1.4 mg/l.

MTCA surface water cleanup levels, Ecology's Acute Freshwater SWQS, and NTR criteria are not available for petroleum hydrocarbons. The concentrations of gasoline-range petroleum hydrocarbons exceeded Ecology's Model NPDES Permit Standard of 1 mg/l for groundwater samples collected from wells MW-8(R) and MW-11; diesel- and oil- range petroleum hydrocarbon concentrations were below Ecology's Model NPDES Permit Standard of 10 mg/l in all site wells. A concentration contour map for gasoline-range petroleum hydrocarbons in site groundwater is provided as Figure 5-3.

LNAPL was present in well MW-12 during each monitoring event, although petroleum hydrocarbons were not detected in groundwater samples at concentrations above Ecology's NPDES Permit Standards. Measured LNAPL thickness in this well was approximately 2 inches. Areas where LNAPL was observed/measured in monitoring wells and test pits are shown on Figure 5-3.

5.2.6 VOCs

Twenty VOCs were detected in monitoring well groundwater samples. Except for naphthalene, compound concentrations do not exceed the MTCA Method B or C surface water cleanup levels, Ecology's Acute Freshwater SWQS or the NTR criteria, where values are available for the given compound. Analytical results for VOCs are summarized in Table5-9.

Naphthalene was detected at concentrations above the laboratory reporting limits in groundwater samples collected from wells MW-8(R), MW-9, MW-10, MW-11, and MW-12. The naphthalene concentration in the groundwater sample from well MW-8(R) ranged from 2,000 to 8,500 μg/l during the monitoring events and exceeded Ecology's Acute Freshwater SWQS of 2,300 μg/l. Naphthalene concentrations were below the MTCA Method B and C surface water cleanup levels of 9,880 and 24,700 μg/l, respectively. An NTR criterion for naphthalene is not available. A concentration contour map for naphthalene in site groundwater is provided on Figure 5-2. [Note: Naphthalene was included in the compound list for both VOCs and PAHs (refer to Section 5.2.4); concentrations shown on Figure 5-2 are the highest naphthalene value detected regardless of the particular analysis.]

5.2.7 Water Quality Parameters

Analytical results for general water quality parameters are summarized in Table5-10. The average of the laboratory-reported hardness values (180 mg/l) was used to calculate Ecology's Acute Freshwater SWQS values for cadmium, chromium, copper, lead, and silver using a computer spreadsheet obtained from Ecology.

5.3 Summary of Groundwater Analytical Results

Naphthalene and gasoline-range petroleum hydrocarbons, exceeding applicable cleanup standards and/or ARARs, were identified in groundwater samples collected from site monitoring wells. Naphthalene concentrations exceeding Ecology's Acute Freshwater SWQS of 2,300 μg/l were identified in the groundwater samples collected from monitoring well MW-8(R) (refer to Figure 5-2). Gasoline-range petroleum hydrocarbon concentrations exceeded Ecology's Model NPDES Permit Standard of 1 mg/l in the groundwater samples collected from wells MW-8(R) and MW-11 (refer to Figure 5-3). Diesel- and oil-range petroleum hydrocarbon concentrations did not exceed Ecology's Model NPDES Permit Standard of 10 mg/l.

The highest concentrations of naphthalene and gasoline-range petroleum hydrocarbons were identified in groundwater samples collected from well MW-8(R). The approximate exceedance areas of these analytes are located in the northwestern portion of the site, downgradient of the former creosoting plant.

LNAPL was present in well MW-12 during all monitoring events, although detected petroleum hydrocarbon concentrations in groundwater samples collected from the well were below cleanup levels and/or ARARs. LNAPL was not encountered in well MW-8(R) where the highest petroleum hydrocarbon concentrations were identified, or in well MW-11 where LNAPL was encountered in nearby test pits.

Total cPAH concentrations exceeding the MTCA Method B and C surface water cleanup levels of 0.0296 and 0.740 μg/l, respectively, and the NTR criterion of 0.31 μg/l were identified in groundwater samples collected from monitoring wells in the western portion of the site. However, cPAHs (with the exception of a low concentration of benzo(a)anthracene just above the laboratory reporting limit) were not detected in groundwater samples which were filtered, suggesting that suspended entrained soil particles in the unfiltered groundwater samples may have imparted a high bias to the analytical results. Filtered sample analytical results are believed to be more representative of groundwater quality at the site with respect to cPAHs.

Dissolved selenium (reported in one sample) and PCBs (reported in two samples) concentrations also exceeded applicable cleanup levels and/or ARARs. However, as discussed in Sections 5.2.2 and 5.2.3, respectively, these results do not appear to be representative of site groundwater.

Section 6: Surface Water Analytical Results

This section summarizes the analytical results for surface water samples collected during two sampling events.

Surface water runoff on the eastern portion of the site is generally directed toward existing storm water catch basins, while runoff on the western portion of the site generally flows offsite to the west. Surface water samples (SW-1 and SW-2) were collected at two locations, on the western and eastern property boundaries, respectively (refer to Figure 3-8). Discharge on the western property boundary (SW-1) flows onto the ground surface and into a wide, shallow depression located on the adjacent property. Discharge on the eastern property boundary (SW-2) flows through a 6-inch culvert and discharges into a vegetated area on the adjacent property.

Analyte concentrations detected in surface water samples were compared to the MTCA Method B and C surface water cleanup levels published in Ecology's CLARC II database (Ecology 1996b) where cleanup levels are available for the given analyte. In addition, the surface water analytical results were compared to other ARARs including:

- Ecology's Acute Freshwater SWQS (WAC 173-201A, Ecology 1997b)
- NTR for Consumption of Organisms Only (40 CFR 131.36)
- Ecology's Model NPDES Permit Standards (WAC 173-226) for petroleum hydrocarbons.

The use of these cleanup levels and/or ARARs in evaluating the need for remedial action(s) at the site is discussed further in Section 9.1.5 of the FS.

Ecology's Acute Freshwater SWQS values for cadmium, chromium, copper, lead, and silver were calculated based on the average hardness for surface water samples (31 mg/l) using a computer spreadsheet obtained from Ecology.

Surface water analytical results and cleanup levels and/or ARARs are summarized in Table 6-1. Analytical reports and chain-of-custody documents are provided in Appendix M.

6.1 Total Metals

Total metals including barium, cadmium, chromium, copper, lead, mercury, and zinc were detected at concentrations above the laboratory reporting limits in surface water samples. Total metals concentrations exceeding one or more cleanup levels and/or ARARs are listed below.

- Total cadmium was detected in both surface water samples at concentrations of 2 to 8 μg/l. These concentrations exceed Ecology's Acute Freshwater SWQS of 1.04 μg/l (based on a hardness of 31 mg/l). These concentrations are below the MTCA Method B and C surface water cleanup levels of 20.3 and 50.6 μg/l, respectively. An NTR criterion is not available for cadmium.

- Total copper was detected in both surface water samples at concentrations of 231 to 2,070 µg/l. These concentrations are below the MTCA Method B and C surface water cleanup levels of 2,660 and 6,660 µg/l, respectively, but above Ecology's Acute Freshwater SWQS of 5.64 µg/l (based on a hardness of 31 mg/l). An NTR criterion is not available for copper.

- Total lead was detected in both surface water samples at concentrations of 250 to 8,090 µg/l. These concentrations are above Ecology's Acute Freshwater SWQS of 17.68 µg/l (based on a hardness of 31 mg/l). MTCA surface water cleanup levels and NTR criterion are not available for lead.

- Total mercury was detected in both surface water samples at concentrations of 0.3 to 9.4 µg/l. The total mercury concentration detected in surface water sample SW-1 collected during the March 2001 monitoring event was 9.4 µg/l, which is above Ecology's Acute Freshwater SWQS of 2.1 µg/l and the NTR criterion of 1.5 µg/l MTCA surface water cleanup levels are not available for mercury.

- Total silver was detected in surface water sample SW-1 collected during the March 2001 monitoring event at a concentration of 6 µg/l, which is above Ecology's Acute Freshwater SWQS of 0.46 µg/l (based on a hardness of 31 mg/l). The silver concentration of 6µg/l is below the MTCA Method B and C surface water cleanup levels of 25,900 and 64,800 µg/l, respectively. An NTR criterion is not available for silver.

6.2 Dissolved Metals

Dissolved metals including barium, cadmium, copper, and mercury were detected in surface water samples at concentrations above the laboratory reporting limits. Dissolved metals concentrations exceeding one or more cleanup levels and/or ARARs are listed below.

- Dissolved cadmium was detected in surface water sample SW-2 at concentrations of 5 and 8 µg/l. These concentrations exceed Ecology's Acute Freshwater SWQS of 1.04µg/l (based on a hardness of 31 mg/l), but are below the MTCA Method B and C surface water cleanup levels of 20.3 and 50.6 µg/l, respectively. An NTR criterion is not available for cadmium.

- Dissolved copper was detected in both surface water samples at concentrations of 90 to240 µg/l. These concentrations are below the MTCA Method B and C surface water cleanup levels of 2,660 and 6,660 µg/l, respectively, but above Ecology's Acute Freshwater SWQS of 5.64 µg/l (based on a hardness of 31 mg/l). An NTR criterion is not available for copper.

6.3 PCBs

PCB Aroclors 1254 and 1260 were detected in surface water samples ata maximum concentration of 2.7 µg/l. PCB Aroclors were not detected in surface water sample SW-2 collected during the April 2001 monitoring event. For those samples in which PCB Aroclors were detected, the total PCB concentrations ranged from 4.5 to 7.8 µg/l, which are above the MTCA Method B and C surface water cleanup levels of 0.000027 and 0.000674 µg/l, respectively. These concentrations also exceed Ecology's Acute Freshwater SWQS and NTR criterion of 2 and 0.0017 µg/l, respectively. (Note: The total PCB concentrations are likely biased high due to the inclusion of nondetected PCB Aroclors in the totals at concentrations of one-half the laboratory reporting limit.)

6.4 PAHs

PAH compounds were detected in surface water samples SW-1 and SW-2 collected during the March 2001 monitoring event, and in sample SW-1 collected during the April 2001 monitoring event. Detected PAH compounds included cPAHs and noncarcinorgenic PAHs.

Concentrations of noncarcinogenic PAHs did not exceed the MTCA Method B and C surface water cleanup levels, Ecology's Acute Freshwater SWQS, or the NTR criteria for PAH compounds (where the particular ARAR was available for the given compound).

Individual cPAH compound concentrations were detected in surface water samples SW-1 and SW-2, although only benzo(a)anthracene and chrysene were detected in surface water sample SW-2. Individual cPAH compounds were detected above the MTCA Method B surface water cleanup level of 0.0296 µg/l in surface water sample SW-1. Some individual cPAH concentrations were also detected in surface water sample SW-1 above the MTCAMethod C surface water cleanup level of 0.740 µg/l and the NTR criterion of 0.31µg/l. The concentrations of benzo(a)anthracene and chrysene detected in surface water sample SW-2 exceeded the MTCA Method B surface water cleanup level of 0.0296 µg/l Ecology's Acute Freshwater SWQS values are not available for cPAHs.

Total cPAH concentrations in surface water sample SW-1 exceeded the MTCA Method B and C surface water cleanup levels, and the NTR criterion. Total cPAH concentrations in surface water sample SW-2 exceeded the MTCA Method B surface water cleanup level, and the NTR criterion. (Note: The total cPAH concentrations are likely biased high due to the inclusion of nondetected cPAHs in the totals at concentrations of one-half the laboratory reporting limits.)

6.5 Petroleum Hydrocarbons

Diesel- and oil- range petroleum hydrocarbons were detected at concentrations above the laboratory reporting limits in surface water samples. Diesel-range petroleum hydrocarbons were detected at concentrations of 1.8 to 3.2 mg/l, and oil-range petroleum hydrocarbons were detected at concentrations of 1.4 to 3.2 mg/l. These concentrations do not exceed Ecology's Model NPDES Permit Standard of 10 mg/l for diesel- and oil- range petroleum hydrocarbons. MTCA surface water cleanup levels, Ecology's Acute Freshwater SWQS, and NTR criteria are not available for petroleum hydrocarbons.

Section 7: Summary of RI Findings

Soil impacted by metals (lead and chromium), petroleum hydrocarbons, cPAHs, and PCBs above applicable MTCA Method A or C industrial soil cleanup levels has been identified in various areas of the site. The estimated volumes (rounded to the nearest 100 cubic yards) of soil impacted by COCs above MTCA cleanup levels are as follows:

- Metals (lead and chromium) exceeding 1,000 mg/kg and 500 mg/kg, respectively, approximately 11,400 cubic yards
- Petroleum hydrocarbons exceeding 2,000 mg/kg, approximately 6,700 cubic yards
- Total cPAHs exceeding 18 mg/kg, approximately 1,600 cubic yards
- Total PCBs exceeding 17 mg/kg, approximately 1,000 cubic yards.

Soil with diesel- and oil- range petroleum hydrocarbon concentrations above the proposed amended MTCA Method A industrial cleanup level of 2,000 mg/kg was further evaluated using Ecology's TPH Interim Policy. Based on the TPH Interim Policy evaluation, the petroleum hydrocarbon exceedance area can be limited to seven test pit locations, six of which coincide with cPAH exceedance areas. These test pit locations are located in the vicinity of the former creosoting plant in the southwestern corner of the site and west of the former red brick building where impacted soil extends to the water table. The remaining areas are located immediately south of the former redbrick building and in the eastern portion of the site within the metals exceedance area and are confined to the shallower soil (less than 3 feet bgs).

Metals and petroleum hydrocarbons are the most widespread of the COCs detected in site soil. Soil impacted by metals and petroleum hydrocarbons also includes those areas of the site where PCBs and cPAHs are present above their respective cleanup levels. The volumes of metals- and petroleum hydrocarbon-impacted soil potentially requiring remediation are discussed further in the FS portion of this report (Section 9).

A significant source of petroleum hydrocarbons and cPAHs detected in site soil appears to be the former creosoting plant located in the southwestern corner of the site. A former hydraulic shear, located approximately 100 west of the red brick building, may be a source of petroleum hydrocarbons as hydraulic oil. The former creosoting plant and hydraulic shear also appear to be likely sources for LNAPL encountered at the site.

Metal debris from historical site practices (scrapping and recycling) appear to be the source of the metals detected in site soil, particularly on the eastern portion of the site and on the northern unpaved area. Elevated concentrations of lead in the area immediately south of the former red brick building appears to correspond to the reported location of a lead-acid battery disposal area. Battery casing were discovered in the test pit at this location. PCB-containing transformers were reportedly destroyed and/or recycled during past activities at the site and are believed to be the most likely source of the PCBs detected in shallow soil on the eastern portion of the property. Metals- and PCB-impacted soil does not appear to be in contact with groundwater since the maximum depth interval in which concentrations exceed the cleanup level is 4 to 6 feet bgs. In addition, most of the metals exceedance areas are located within the central and eastern portions of the site where groundwater elevations are typically lower than on the western portion of the site. Total and dissolved metals (RCRA eight and copper) concentrations above applicable cleanup levels and/or ARARs were not detected in groundwater samples collected from site monitoring wells except for an isolated detection of dissolved selenium in the sample collected from well MW-9 during the November 2000 monitoring event. This result appears to be anomalous, as total selenium was not detected in site groundwater and dissolved selenium was not detected during other groundwater monitoring events (refer to Section 5.2.2). Dissolved cadmium was detected in one reconnaissance groundwater sample at a concentration slightly above Ecology's Acute Freshwater SWQS; however, this result is likely biased high due to suspended entrained soil particles in the sample.

Carcinogenic PAHs were detected in unfiltered samples collected from site monitoring wells and in several reconnaissance groundwater samples. These compounds (with the exception of a low concentration of benzo(a)anthracene slightly above the reporting limit) were not detected in filtered samples. The unfiltered analytical results are believed to be biased high due to suspended entrained soil particles in the samples (refer to Section 5.2.4). Given the relatively low aqueous solubility and mobility of cPAHs in the environment, it is unlikely that cPAHs have impacted site groundwater. Similarly, it is unlikely that PCBs have impacted site groundwater. PCBs also have relatively low aqueous solubility and mobility in the environment. The low levels of PCBs detected in groundwater samples collected from monitoring wells MW-8(R) and MW-11 are considered to be anomalous. The PCBs results were detected in a single monitoring event and were not reproducible. The analytical results were also flagged by the analytical laboratory for matrix interference effects (refer to Section 5.2.3).

Naphthalene and gasoline-range petroleum hydrocarbons were detected at concentrations above cleanup levels and/or ARARs in samples collected from one monitoring well located in the northwestern portion of the site [MW-8(R)]. Gasoline-range petroleum hydrocarbon concentrations above cleanup levels and/or ARARs were also identified at upgradient well MW-11. Groundwater is in contact with soil that contains petroleum hydrocarbon and cPAH concentrations above cleanup levels at two locations within the western portion of the property. These locations include the former creosoting plant area in the southwestern corner of the site, and the area around a former hydraulic shear, located approximately 100 feet west of the former red brick building. LNAPL was identified in test pits at both of these locations. LNAPL was also present in well MW-12, located in the former hydraulic shear area; however, petroleum hydrocarbon concentrations above cleanup levels and/or ARARs were not detected in groundwater samples collected from well MW-12.

One source of groundwater contamination is believed to be the former creosoting plant located in the southwestern corner of the site. Petroleum hydrocarbons and PAHs (including cPAHs) were detected in the soil at 6 to 10 feet bgs in this portion of the site. Since groundwater is encountered at approximately 7 feet bgs in this portion of the site, the impacted soils are in direct contact with site groundwater.

Groundwater at the site is influenced by tidal fluctuations of the Puyallup River. During high tide the general groundwater flow direction is away from the river, while at low tide, the general groundwater flow direction is toward the river. Based on average groundwater gradients at high and low tide, the net groundwater flow direction is toward the Puyallup River. The highest concentrations of naphthalene and gasoline-range petroleum hydrocarbons were detected in the groundwater samples collected from well MW-8(R), located downgradient of the former creosoting plant. The lateral distribution of chemicals in groundwater in the western portion of the site is reflective of the mobility of these compounds in groundwater. An average groundwater seepage velocity of 82 feet per year was calculated based on slug test results. Hydraulic conductivities based on slug test results are consistent with those based on short-term pump tests conducted in a previous study (PGG 1992). The fate and transport of these chemicals in groundwater are discussed further in Section 8.3.

Surface water runoff was observed to discharge along the western and eastern property boundaries as well as to the catch basins located within the eastern portion of the site. No surface water runoff was observed from the northern unpaved area to the north, beyond the northern property boundary. Surface water cleanup levels were exceeded for a number of compounds (metals, PCBs, and cPAHs) at locations were the surface water discharges from the site.

Remedial options to address the findings of the RI are evaluated, and specific potential additional data needs identified, in the FS (refer to Section 9).

Section 8: Chemical Fate and Transport

Due to the proximity of the site to the Puyallup River, the fate of chemicals in the environment and the rate at which they may travel toward potential receptors are of concern. Chemical fate and transport is also an important consideration in the evaluation of the effectiveness of remedial technologies (refer to Section 9). Computer modeling was used to assess the fate and transport of COCs identified at the site (refer to Sections 4 and 5).

The results of the computer modeling performed to evaluate migration of COCs present in the unsaturated soil (at concentrations exceeding soil cleanup levels) to the underlying shallow groundwater zone are presented in this section. Groundwater beneath the western portion of the site has been impacted with naphthalene and petroleum hydrocarbons. The potential for the shallow impacted groundwater from this portion of the site to reach the Puyallup River has also been assessed.

A general overview of the fate and transport in the subsurface is presented in Section 8.1. Unsaturated zone modeling and groundwater migration assessment are discussed in Sections 8.2 and 8.3, respectively.

8.1 Fate and Transport

Chemical fate refers to a chemical's transformation, inter-media transfer, and ultimate disposition in the environment. Transport mechanisms are defined as those mechanisms that result in the movement of a chemical from one location to another within environmental media (soil, water, or air). Because the site is adjacent to the Puyallup River, the fate of the chemicals identified at the site and the rate at which they may travel to potential receptors are of concern.

Factors affecting chemical behavior in the environment include mode of release, chemical properties, and site-specific characteristics of soil and groundwater. Properties that are important to chemical mobility include solubility and the tendency to distribute between soil solids and the aqueous and vapor phases. The distribution between the soil and water phases is characterized by an equilibrium partitioning factor, K_d. This factor relates the chemical concentration sorbed to soil (C_s) to its dissolved concentration in soil water (C_l), as follows (Karickhoff 1984):

$$K_d = \frac{C_s}{C_l}$$

Partitioning to soil will result in a significant decrease in the rate of chemical movement in soil water (pore-water) and groundwater. However, it will not totally immobilize the chemical in the subsurface.

Several mechanisms (i.e., specific types of chemical interactions with soil) can potentially contribute to an observed K_d value at a site. The importance of each mechanism is determined in part by the soil properties. One important mechanism involves the amount of organic carbon (or organic materials) in soil. Increasing amounts of natural organic materials (e.g., humic and fulvic acids) increase the capacity of the soil to sorb nonpolar organic chemicals. In general, the amount of organic carbon tends to decrease with depth through a soil column. This appears to be case at the site, where the TOC content of the soil ranged from 16 percent near-surface to 0.47 percent at approximately 15 feet bgs (refer to Table 3-1). Research and numerous laboratory and field studies have shown that in many soil/water systems, K_d is related to the fraction of organic carbon, F_{oc}, in soil and a property of the chemical [organic carbon-normalized soil partition coefficient (K_{oc})], as shown below:

$$K_d = K_{oc} F_{oc} = \frac{C_s}{C_l}$$

Thus, a knowledge of F_{oc} for soils of interest and the K_{oc} value for a chemical allows calculation of C_s/C_l. If information on C_s is available, calculation of C_l is possible. K_{oc} is referred to as an organic carbon-normalized soil partition coefficient and may be experimentally determined from measured K_d and F_{oc} data for chemical/soil systems.

In the unsaturated soil above groundwater, the equilibrium distribution of an organic chemical between the aqueous (soil moisture) and vapor phases and subsequent vapor migration through molecular diffusion may be important for the more volatile compounds. This distribution is typically characterized through use of the dimensionless Henry's Law Constant, K_h, as defined below:

$$K_h = \frac{C_g}{C_l}$$

where C_g is the chemical concentration in the vapor phase.

The mobility of metals in soil and groundwater is often more difficult to understand and predict than that of organics. Some metals can be present in one or several oxidation states, and each state exhibits its own chemistry in interacting with soil particles, soil organics, and other inorganic constituents (Tessler et al. 1979).

The main process affecting the mobility of metals at the site is sorption to soil. The soil's capacity to sorb metal cations (positively charged ionic metals) is generally characterized by CEC. Surfaces of soil minerals possess negative charges. The negatives charges on soil mineral surfaces attract and accumulate dissolved cations. CEC is an aggregate quantity describing the degree to which cations will be retained on exchange sites. Soil exchange sites are typically occupied by the "major cations": (Ca, Mg, K, and Na) and not all these cations can be replaced by metal cations. When evaluating a given soil's relative capacity to retain metals, measured values from 5 to 15 milliequivalents of exchange capacity per 100 grams of soil (meq/100 g) are customarily regarded as medium CECs. Values greater than 15 meq/100 g are regarded as high CECs, while values less than 5 meq/100 g are considered to be low (EPA 1977). CEC values measured from samples collected at the site ranged from 2.4 (15 feet bgs) to 26 meq/100 g (6 feet bgs) (refer to Table 3-1). The mobility of heavy metals in soil is also strongly influenced by pH.

Metals such as arsenic and chromium are typically present in soil in anionic form (negatively charged ion). Anions are not retained on cation exchange sites, but instead may be retained in soil through other processes, including precipitation, formation of complexes, or anion exchange sites. However, anions are retained less strongly by the soil matrix and are generally more mobile than cation metals.

Chemical transport in site soil and shallow groundwater is affected by chemical properties but is also governed by physical properties such as water recharge and groundwater flow rate. The rate of surface water infiltration is the principal driving force for downward movement of chemicals present in the unsaturated zone. The variables controlling the movement of water through the saturated zone are the hydraulic conductivity and porosity of the saturated zone material and the hydraulic gradient (collectively referred to as "aquifer parameters"). Once chemicals have reached the saturated zone, physical transport mechanism such as advection, dispersion, and diffusion dominate. The interaction of these physical transport mechansims is complex and dependent on the aquifer parameters.

Figure 8-1 depicts the conceptual site model showing the potential chemical migration pathways for the site. These pathways are as follows:

- Unsaturated (vadose) zone vertical migration to shallow zone groundwater

- Horizontal migration in the shallow zone groundwater from the site toward the Puyallup River (low tide scenario)

- Horizontal migration in the shallow zone groundwater from the Puyallup River toward the site (high tide scenario).

The soil/groundwater to air pathway was not considered significant because the COCs, detected at the site are more likely to partition into the liquid phase rather than the gaseous phase.

The surface water pathway to the Puyallup River was not investigated because surface water runoff from the site exits the site boundaries to the south, east, and west (refer to Figure 3-8). Due to the presence of the man-made levee, there is no interaction of surface water runoff flow between the site and the Puyallup River.

The chemicals detected in site soil and groundwater are identified in Sections 4 and 5 of this report, respectively. Chemicals detected in the soil above soil cleanup levels include metals, PCBs, cPAHs, and diesel- and oil-range petroleum hydrocarbons. Due to various attenuation mechanisms present at the site these chemicals are expected to be heavily adsorbed to soil, and their movement into the underlying shallow groundwater significantly retarded. This appears to be the case over the majority of the site, where chemicals are found predominantly within the uppermost 2 to 3 feet of soil (refer to Figures 4-1 through 4-4). The potential for these chemicals to leach from the shallow soil to the groundwater is discussed in Section 8.2.

Carcinogenic PAH compounds and diesel- and oil-range petroleum hydrocarbons are also detected at concentrations exceeding soil cleanup levels in the deeper unsaturated (vadose) zone within two areas in the western portion of the site. Most notably in the vicinity of the test pits TP-2, TP-5, TP-49 (former creosoting plant location in the southwestern corner of the site), and in the vicinity of test pits TP-10, TP-11, and TP-55 (west of the former red brick building location). The highest concentrations of petroleum hydrocarbons and cPAHs were detected in soil samples collected from these areas of the site. The deeper impacted soil intercepts site groundwater, as a result groundwater in the western portion of the site has also been impacted with naphthalene and petroleum hydrocarbons (gasoline-range) above groundwater cleanup levels and/or ARARs (refer to Figures 5-2 and 5-3). The potential for these chemicals to migrate within the shallow groundwater zone from their respective source areas to the Puyallup River is discussed in Section 8.3.

8.2 Evaluation of Chemical Fate and Transport in Unsaturated Soil

This section presents a summary of the modeling conducted for unsaturated soil at the site. The modeling approach is presented first, followed by the model input parameter values, model sensitivity analysis, and a discussion of the model results.

8.2.1 Model Approach

The objective of the modeling was to evaluate whether concentrations of selected COCs in site soil would result in their leaching to groundwater under site-specific soil and recharge conditions. Computer modeling was conducted using conservative input values and assumptions to simulate scenarios for downward migration of these constituents toward groundwater.

8.2.1.1 Selected Chemicals

The compounds selected for unsaturated zone modeling represent the range of chemical groups (metals, PCBs, cPAHs) detected in soil at the site and represent:

- The highest (most conservative) chemical concentrations detected in soil samples.
- A range of mobility in soil and/or groundwater based on physical/chemical characteristics.
- Other chemicals that are of high environmental concern.

The metals, arsenic, chromium, copper, lead, and mercury were selected for analysis. Lead and chromium were detected throughout the site, predominantly in shallow soil at concentrations above soil cleanup levels. Arsenic and mercury were included for analysis as "other chemicals" that are typically of high environmental concern. Copper was also selected for analysis due to its presence in some areas of the site at elevated concentrations. It should be noted that these metals were not detected at the site at concentrations exceeding soil cleanup levels. Three PCBs (Aroclors 1248, 1254, and 1260) were selected for analysis because these were the Aroclors detected in shallow soil at the site. Carcinogenic PAHs have been detected in unfiltered groundwater samples collected from wells located in the western portion of the site, an area where elevated cPAH concentrations were detected in site soil. Since low levels of cPAHs were detected in the shallow soil and in unfiltered reconnaissance groundwater samples collected in the eastern portion of the site, the following cPAHs were selected for analysis: chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and benzo(a)anthracene. The noncarcinogenic naphthalene was also selected as a surrogate for high mobility PAHs. The rationale for selection of these COCs for modeling is summarized in Table 8-1. (Note: It is believed that the cPAHs detected in groundwater samples from wells in the western portion of the site and reconnaissance groundwater samples in the eastern portion of the site are the result of suspended entrained soil particles in the water samples, as discussed in Section 5; however, to be conservative they have been included in the modeling.)

8.2.1.2 Site Area Modeled

Migration modeling was conducted for selected COCs detected in soil samples that were collected from the eastern portion of the site (generally east of the line of monitoring wells MW-1 and MW-6). Soil sample results indicate that the eastern portion of the site contains higher metal and PCB concentrations compared to the western portion of the site. Carcinogenic PAH compounds are also present in shallow soil in this portion of the site. The modeled area represents impacted soil above cleanup levels that could potentially be left in place if migration modeling and leachability testing (SPLP) indicate that the COCs are unlikely to migrate beyond their initial zone of presence. As previously discussed, soil with COC concentrations above cleanup levels (cPAHs and petroleum hydrocarbons) have been identified to depths of 6 to 10 feet bgs in the western portion of the site that has already resulted in groundwater impact. The potential migration of COCs in groundwater is discussed further in Section 8.3.

8.2.1.3 Distribution of Chemicals in Unsaturated Soil Profile

The concentrations of COCs detected in soil samples collected during the RI were used as the initial distribution of COCs in the soil profile. In some cases, soil samples were not collected at more than one or two depths between ground surface and groundwater. In such cases, results for various depths from multiple sampling locations within the same area were combined to establish a more complete soil concentration profile.

8.2.1.4 Model Selected

The VLEACH model version 2.2a (Varadhan et al. 1997) was selected to perform the fate and transport simulations for the site. The EPA has developed this model for screening-level evaluation of chemical mobility and has used it at many sites across the United States. Kennedy/Jenks Consultants has used this model numerous times to develop an understanding of vertical migration potential for many organic chemicals and metals in soils.

VLEACH is a one dimensional finite-difference model that estimates the impact from mobilization and migration of a sorbed chemical in the vadose zone on the underlying groundwater over time. The model is used to show the movement of the chemical from the solid phase to the vapor phase (by gaseous diffusion) and from the solid phase to the dissolved phase in water (by advection in the liquid phase). Other attenuation mechanisms such as biodegradation or dispersion are not accounted for by this model and therefore, the model results provide a conservative estimate of chemical transport. Chemical transport mechanisms are simulated from initial conditions defined by the user. For each time step in the simulation, the total mass in each cell is re-calculated and re-equilibrated for each phase.

8.2.1.5 Model Assumptions

The results of the simulations are considered screening-level values based on site-specific data, literature-derived input parameters, and assumptions. Parameter values are provided in

Section 8.2.1.6. Several assumptions were made in performing the model simulations resulting in "conservative" model results (i.e., favoring leaching to groundwater). These assumptions are as follows:

- No Degradation. The VLEACH model does not account for environmental degradation pathways such as biodegradation of PAHs or chemical precipitation of metals, and other attenuation mechanisms such as transverse dispersion of chemicals in soil water. These natural attenuation mechanisms will generally reduce chemical concentrations in soil and decrease the potential of the chemical to reach groundwater. The VLEACH model design is therefore, inherently biased toward protection of groundwater quality.

- Conservative Initial Chemical Concentration. The simulations were performed to an observed average depth of 10 feet to groundwater. Chemical concentration data for every foot of the soil column were constructed by combining the maximum concentrations detected at various depths from different locations as described in Section 8.2.1.3.

8.2.1.6 Model Input Parameters and Values

Input parameters to the model include soil- and chemical-specific parameters and model run parameters. The key input parameters, their values, and rationale for the selected values are presented below. Input files containing input parameter values for the simulations are included in Appendix N.

- Soil Input Values. Key soil characteristic input parameters including the recharge rate, dry bulk density, porosity, volumetric water content, and F_{oc} used in the simulations were directly measured or calculated based on site-specific data. These characteristics are as follows:

    - Recharge. A recharge rate of 0.03 feet per year, equal to one percent of the total incident rainfall of approximately 3 feet per year (online data available from Western Regional Climate Center), was assumed for the site. This recharge rate was selected based on (1) presence of buildings on site and (2) presence of a competent pavement cap.

    - F_{oc} (Fraction of Organic Carbon). An F_{oc} value of 0.03 was calculated as 3 percent of the weighted total organic carbon values in unsaturated zone soil samples (MW-8-6-6.5 and MW-9-10.5-11) collected at the site.

    - Soil Bulk Density, Porosity, and Water Content. A soil dry bulk density of 1.35 grams per milliliter (g/ml) was calculated based on site-specific porosity and specific gravity of soil samples collected at the site. A porosity value of 0.49 and water content of 0.26 were used based on the average of measured values in the soil samples.

    - Depth to Groundwater. A depth to groundwater of 10 feet was used in the simulations based on the average depth of groundwater at the site during high tide.

8.2.1.7 Chemical Input Parameters

Key chemical input parameters used in the simulations were obtained from literature sources and include K_{oc} (organic carbon-normalized soil partition coefficient), K_h (Henry's Law Constant), and free air diffusion coefficient (D_i). The chemical input values used for the simulations are summarized in Table 8-2.

8.2.1.8 Model Sensitivity Analysis

The impact of varying several input parameters on soil water chemical concentrations over time was evaluated in a sensitivity analysis. The chemical-specific input values were not varied during this evaluation. Varying water recharge rate had a significant impact on migration rates of PAHs but not on metals. However, even when the recharge rate was increased to 80 percent of the average annual rainfall amount, the PAH concentrations in groundwater remained low. Changing the values of other parameters did not cause the predicted chemical concentrations at the water table to vary significantly.

8.2.1.9 Model Results and Discussion

The predicted distributions of aqueous chemical concentrations with depth were used to obtain the concentrations at the bottom of the soil column in contact with groundwater. The aqueous concentrations at the water table increased during the 500 years simulation time for all chemicals. The chemical concentrations predicted after 500 years are presented in Table 8-3. The results indicate that these chemicals are essentially immobile under the environmental conditions simulated. A combination of low water recharge rate and relatively high sorption partitioning caused only minimal downward migration of the selected COCs. The predicted immobility of these COCs at the site is consistent with results observed at many other sites and under a variety of environmental conditions.

Based on the modeling results, it appears that the concentrations of metals, PCBs, and PAHs (including cPAHs) detected in shallow soil at the site, are unlikely to leach to the groundwater, if left in place, provided surface water recharge is minimized.

A number of samples representing the range of metal concentrations found at the site were analyzed using the SPLP (refer to Tables 4-8A and 4-8B). The SPLP is similar to the TCLP used to characterize hazardous waste; however, the amount of acidity used in the test is significantly less, using a dilute nitric/sulfuric acid mixture. The SPLP was developed to simulate leaching under acid rain conditions and therefore better simulates the type of leaching likely to occur from infiltration of precipitation through the unsaturated soil column at the site. A range of total lead concentrations were analyzed using the SPLP. In the case of arsenic, barium, cadmium, chromium, copper, mercury, selenium, and silver, the sample containing the highest total metal concentration was analyzed using the SPLP.

The SPLP results indicate that low concentrations of barium (0.672 mg/l), copper (0.005 mg/l), lead (up to 0.07 mg/l), and mercury (0.0021 mg/l) leached from the soil samples (refer to Table 4-8A). This suggests the potential for movement of these metals beyond their initial zone of presence, if precipitation is allowed to infiltrate through the soil column, as indicated by the models sensitivity to surface water recharge. However, these metals have not been detected in site groundwater at or above surface water cleanup levels and/or ARARs suggesting that site conditions have limited the ability for metals to leach from site soil.

Select samples containing the highest concentrations of cPAHs were also analyzed using the SPLP (refer to Table 4-8B). None of the cPAHs leached from the samples. Some of the more mobile noncarcinogenic PAHs leached, again indicating the potential for movement of these chemicals beyond their initial zone of presence, if precipitation is allowed to infiltrate through the soil column. It should be noted that in the samples selected for analysis, naphthalene was not detected at an elevated concentration and was therefore not observed to leach from the sample tested. Naphthalene was chosen in the model to represent the more mobile PAHs due to its overall higher concentration in site soil. The presence of naphthalene in groundwater in the western potion of the site is indicative of its mobility in the environment when present in soil at higher concentrations.

8.3 Evaluation of Fate and Transport of Chemicals in Shallow Groundwater

As previously discussed, groundwater in the western portion of the site has been impacted by gasoline-range petroleum hydrocarbons and naphthalene (a constituent hydrocarbon) at concentrations exceeding surface water cleanup levels. Carcinogenic PAH compounds were detected in unfiltered groundwater samples collected from this portion of the site. While it is believed the results are an artifact of the sampling method (i.e., suspended entrained soil particles in the sample), these compounds have been included in the groundwater migration modeling in order to be conservative. Although benzene was not detected in site groundwater above cleanup levels and/or ARARs, it was included in the modeling since it is a mobile carcinogenic constituent of petroleum hydrocarbons. These compounds are expected to move in the direction of groundwater flow. Potential transport of benzene, cPAHs, and naphthalene within the shallow zone toward the Puyallup River at concentrations close to cleanup levels and/or ARARs is evaluated in this section.

8.3.1 Transport Scenario and Assumptions

Transport of benzene, cPAHs, and naphthalene in shallow groundwater toward the Puyallup River was evaluated under very conservative (i.e., favoring migration to the river) scenarios and assumptions as described below.

- Groundwater flow at the site is influenced by the tidal fluctuations of the Puyallup River, as discussed in Section 3.3.1. At low tide, groundwater flow is toward the Puyallup River. During high tide, groundwater recharge occurs along the river bank which causes a reversal in the groundwater gradient across the majority of the site (i.e., groundwater flow is away from the river). For the purpose of this evaluation, it has been assumed that groundwater flow is predominantly toward the river. This will provide a conservative estimate of transport within the shallow groundwater zone.

- The concentrations of all cPAH compounds were added to obtain a total cPAH value (refer to Table 5-8). This total concentration was then used along with the K_{oc} value for the most mobile cPAH compound, dibenz(a,h)anthracene, to evaluate cPAH compound migration in groundwater. As such, this is a conservative approach to modeling of cPAH migration.

- Migration of the selected compounds was evaluated over a distance of approximately 300 feet between the location of well MW-8(R) and the Puyallup River along the general direction of groundwater flow. Well MW-8(R) has consistently contained the highest concentrations of the selected COCs.

- Two groundwater flow rates were used in chemical migration evaluation. A conservatively fast rate was estimated based on the highest hydraulic conductivity of 0.05 centimeters per hour (cm/hr) (140 feet per day) measured at the site during a short-term pumping test (PGG 1992), and a second slower rate based on a hydraulic conductivity value of 0.011 cm/hr measured in well MW-8(R) using slug tests. A hydraulic gradient of 0.008 was used based on the 13 February 2001 data (refer to Figure 3-5B). A value of 0.004 has been used elsewhere in this report based on the more typical observations of water levels in wells.
- No degradation, whether biological, chemical, etc., were assumed for the selected compounds.
- An infinite source of the selected compounds was assumed to provide maximum mass in groundwater.

8.3.2 Evaluation Methodology

The model BIOSCREEN Version 1.3 (EPA 1996b) was used to simulate movement of the selected COCs from the location of well MW-8(R) toward the Puyallup River. BIOSCREEN is a two-dimensional analytical screening model developed by the EPA to simulate lateral migration of organic compounds dissolved in groundwater due to the processes of advection, dispersion, sorption, and biodegradation. In this evaluation, the results of model simulation in the absence of biodegradation are used to provide a conservative migration assessment. Additionally, the assumptions presented in Section 8.3.1 were used to determine the input values to the model. The key input values used in the model for each compound are summarized in Table 8-4.

The BIOSCREEN model results are typically most sensitive to groundwater flow rate and retardation factor. The highest value of conductivity measured at the site and typical values of K_{oc} available in the literature for the selected compounds were used in the simulations. Therefore, it is expected that a reasonable range of variability in these parameters has been accounted for in the simulations. The BIOSCREEN modeling input parameters and the numerical simulation results are presented in Appendix O.

8.3.3 Findings

The model results, presented on the figures in Appendix O, depict the compound concentrations along the centerline of the groundwater plume. The results indicate that even under the conservative assumptions and two values of hydraulic conductivity used, naphthalene and cPAHs are not expected to migrate beyond the northern property boundary toward the Puyallup River. Benzene (the most mobile of the compounds modeled) may be present beyond the property boundary at concentrations below the cleanup levels and/or ARARs presented in this report. It should be noted again that the simulations *included an assumption that groundwater continuously flows toward the river*. However, during high tides the reversal in hydraulic gradient causes groundwater movement onto the site and reversing the direction of chemical migration. Additionally, the alternating groundwater flow direction causes mixing of oxygenated river water with ambient groundwater that is expected to enhance aerobic biodegradation of all hydrocarbons, and specifically the relatively highly biodegradable benzene. Therefore, the model results may over-estimate the migration distance and concentrations of benzene between the site and the Puyallup River.

Section 9: Feasibility Study

The FS is presented in two sections: the first addresses the selection of cleanup standards, and the second presents the rationale for selecting remedial actions for the site.

9.1 Selection of Cleanup Standards

This section, which addresses the selection of cleanup standards for the site, is presented in seven subsections.

- Section 9.1.1 presents the chemicals and media of concern for the site
- Section 9.1.2 discusses potential receptors and exposure routes
- Section 9.1.3 describes MTCA Method A, B, and C cleanup levels
- Section 9.1.4 describes ARARs for the site
- Section 9.1.5 identifies and provides justification for cleanup levels and/or ARARs used for the site (collectively referred to as "site cleanup levels")
- Section 9.1.6 presents the points of compliance for attainment of soil, groundwater, and surface water site cleanup levels
- Section 9.1.7 presents an estimate of the areas and volume of site media that exceed site cleanup levels.

9.1.1 Chemicals and Media of Concern

During performance of the RI, the distribution and concentration of COCs in site media (soil, groundwater, surface water) that exceed MTCA cleanup levels and/or ARARs were delineated. Summaries of these COCs, the media in which they were detected, and their concentration ranges are presented in Table 9-1. In general, the site can be characterized by having widespread low-level chemically impacted soils with a few localized "hot spots."

9.1.2 Potential Receptors and Exposure Routes

9.1.2.1 Potential Human Receptors

Human receptors include current and future populations at and adjacent to the site. The site is currently unused but was previously developed for industrial use. The proposed future use of the site is unknown at this time; however, given the site's location in an area zoned for industrial land use, it is anticipated that any future land use will be of an industrial nature. Future potential site receptors include workers (e.g., employees who work at the site) and authorized visitors. These individuals could ingest small quantities of soil or surface water, absorb chemicals through their skin, or inhale chemicals adsorbed to fugitive dust particles. Dermal adsorption, ingestion, and inhalation of surface and subsurface soils are considered to be the most important exposure routes. However, the risks posed by widespread, low-level contamination may be mitigated by an asphalt pavement surface that would be required over the majority of the site as part of any future site development.

The site has been investigated to a maximum depth of approximately 24 feet bgs; however, the majority of the site investigations terminated at a depth of 10 to 12 feet bgs or less, which correlates with the top of the water table (refer to Section 3.2.1). Shallow subsurface stratigraphy beneath the site includes both fill and native deltaic units (refer to Figures 3-1, 3-2, and 3-3). A significant amount of wood type debris is encountered across the site beginning at depths of approximately 3 to 9 feet bgs. The thickness of the wood debris layer varies from a few feet at the eastern end of the site to possibly 18 feet (or more) at the western end of the site. Abundant metal, glass, and other miscellaneous debris are encountered at the eastern end of the site typically within the uppermost 4 feet of the fill material. Shallow groundwater has been identified at depths of approximately 7 to 12 feet bgs depending on tidal influences and location on the site. The net groundwater flow direction is toward the Puyallup River; however, actual flow direction is controlled by tidal fluctuations (refer to Figures 3-4A and 3-4B through 3-6A and 3-6B).

No production wells use the shallow zone locally; therefore, groundwater ingestion via the shallow saturated unit is not a viable exposure pathway.

Due to the industrial zoning of the area, it is very unlikely that the site and surrounding area will become residential in the future. Therefore, the exposure routes and development of remedial action objectives are based on an industrial land use scenario.

9.1.2.2 Potential Ecological Receptors.

Onsite ecological receptors could include birds, reptiles, and mammals. Exposure to site chemicals can occur through ionic uptake in plants, ingestion of contaminated soil or surface water by ground-feeding organisms, direct contact, or indirect ingestion through bioconcentration in the food chain. These risks may also be mitigated by an asphalt pavement surface that would be required over the majority of the site as part of any future site development. Some aquatic organisms could potentially ingest or dermally absorb surface water or shallow zone groundwater originating from the site that discharges to the Puyallup River. However, available modeling results indicate that it is unlikely that site contaminants could migrate to the Puyallup River, at concentrations exceeding cleanup levels and/or ARARs (refer to Section 8.3).

The site was excluded from a terrestrial ecological evaluation since all proposed remedial alternatives identified in the FS included a low permeability cap and institutional controls (refer to Section 9.2.2.5).

9.1.3 MTCA Cleanup Levels

MTCA cleanup levels are risk-based numbers used to evaluate risks to human health and the environment at the site. MTCA outlines three basic approaches (Methods A, B, and C) for establishing cleanup levels. Method A cleanup levels are established at concentrations at least as stringent as those specified in WAC 173-340 Tables 1, 2, and 3 and applicable state and federal laws. Methods B and C cleanup levels are based on risk assessment procedures [WAC 173-340-700(4)(c)] for residential and industrial land use scenarios, respectively.

WAC 173-340-700(3)(a) and -704 authorize Method A cleanup levels for some cleanup actions. Method A is appropriate for routine cleanups involving relatively few hazardous substances and for sites where numerical standards are available for indicator hazardous substances. Given the complexity of the site and the variety of chemical compounds detected [petroleum hydrocarbons, metals, VOCs, PAHs (including cPAHs), and PCBs], relying only on MTCA Method A cleanup levels is not appropriate for the site. However, in accordance with CLARC II tables (Ecology 1996b, page 5) use (mixing) of Method A cleanup levels is acceptable when using Method B or C cleanup levels.

Method B is the standard method for determining cleanup levels under a residential land use scenario for soil, groundwater, surface water, and air. Cleanup levels for individual hazardous substances are established using applicable state and federal laws or the risk assessment equations specified in WAC 173-340-720 through -750.

Method C is a conditional method for establishing cleanup levels. Method C provides cleanup levels that protect human health and the environment under an industrial land use scenario. Method C can be used where the cleanup action can be shown to comply with applicable state and federal laws, to use all practical methods of treatment, and to implement institutional controls. Method C can be used when the site is classified as an industrial site that meets the criteria for establishing the soil cleanup levels described in WAC 173-340-745. Method C cleanup levels, based on the risk assessment equations in WAC 173-340-720 through -750, must be as stringent as cleanup levels established under applicable state or federal laws and must be estimated to result in no significant adverse effects on the protection and propagation of aquatic and terrestrial life.

9.1.4 Potential ARARs

MTCA requires that all cleanup actions comply with ARARs [WAC 173-340-710(1)(a)]. MTCA presents the definitions for ARARs [WAC 173-340-710(2) and (3)] as follows:

- Applicable requirements include "... those cleanup standards, standards of control, and other environmental protection requirements, criteria, or limitations promulgated under state or federal law that specifically address a hazardous substance, cleanup action, location, or other circumstance at the site."

- Relevant and appropriate requirements include "... those cleanup standards, standards of control, and other environmental requirements, criteria, or limitations established under state or federal law that, while not legally applicable to the hazardous substance, cleanup action, location, or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site."

ARARs can be location-, action-, or chemical-specific. Location-specific ARARs address restrictions on activities or permissible chemical concentrations in a particular location. Potential location-specific ARARs include:

- The Shoreline Management Act of 1971 (Chapter 13.10 of City Code) requires construction activities within 200 feet of the shoreline to be performed in accordance with applicable City codes. This ARAR applies to site improvements, such as construction of a cap and storm drain up grades.

Action-specific ARARs regulate technologies or activities that involve handling or treating hazardous wastes. Action-specific ARARs are typically technology- or activity-based requirements or limitations. Table 9-2 describes the potential action-specific ARARs for the site.

Chemical-specific ARARs are typically health- or risk-based numerical values that result in acceptable concentrations of chemical concentrations that may be detected in or discharged to the environment. Chemical-specific ARARs for surface water include Ecology's Acute Freshwater SWQS established under WAC 173-201A, the NTR for the Consumption of Organisms Only established under 40 CFR 131.36, and Ecology's Model NPDES Permit Standards established under WAC 173-226. The ARARs for chemicals detected at the site are identified on applicable analytical tables presented in Sections 4, 5, and 6 of this report. Chemicals exceeding chemical-specific ARARs are summarized in Table 9-1.

9.1.5 Identification and Justification of Site Cleanup Levels

9.1.5.1 Soil Cleanup Levels

This section identifies appropriate site cleanup levels for soil. Site cleanup levels may be cleanup levels identified in MTCA or other ARARs. Both MTCA cleanup levels and chemical-specific ARARs are generally derived based on established equations or empirical studies for protection of human health and/or the environment. MTCA allows modification of the cleanup level values to address (1) background concentrations (such as metals) in the vicinity of the site [WAC 173-340-700(4)(d)] and (2) the practical quantification limits (PQLs) of an analyte (WAC 173-340-707), where the MTCA cleanup level is below a respective PQL. PQLs, based on current limitations of analytical procedures, are identified in Ecology's *Implementation Memo No. 3* (Ecology 1993).

The site meets the criteria for use of MTCA Method C industrial soil cleanup levels as identified in WAC 173-340-706 and WAC 173-340-745. Consequently, MTCA Method C industrial cleanup levels will be used to evaluate the need for soil remedial action at the site. Where there are no available Method C industrial soil cleanup levels (e.g., lead, chromium), MTCA Method A industrial soil cleanup levels will be used (WAC 173-340-704). For petroleum hydrocarbons, the proposed amended MTCA Method A industrial soil cleanup levels will be used (Ecology 2001).

Soil cleanup standards based on the protection of potable groundwater (i.e., drinking water) [WAC 173-340-745(4)(a)(ii)(A)], using 100 times the groundwater cleanup level provided in WAC 173-340-720, are not considered applicable to the site. Ecology derived this "safety factor" using empirical methods, and it is applied consistently to all compounds, regardless of their potential leachability and aqueous mobility. This "safety factor" appears to be overly conservative for a number of compounds encountered at the site (e.g., diesel- and oil-range petroleum hydrocarbons, metals, cPAHs, and PCBs).

Soil cleanup standards based on the protection of potable water are also not applicable because shallow groundwater at the site is not considered a potential future source of potable water due to its proximity to the Puyallup River (refer to Section 3.3). Since groundwater at the site discharges to surface water (Puyallup River), soil cleanup standards based on the protection of surface water [WAC 173-340-740(3)(b)(v)] are more appropriate for the site; however, Ecology has not established methods to calculate soil cleanup levels that are protective of surface water.

Ecology does allow soil concentrations above MTCA soil cleanup levels to remain at a site if it can be demonstrated that higher soil concentrations are protective of groundwater [WAC 173-340-745(4)(a)(ii)(A)]. Ecology has accepted a more appropriate method to assess the potential leachability of both organic and inorganic contaminants from soil as an alternative to using 100 times the groundwater cleanup level discussed above. This method includes performance of leaching tests (SPLP) to assess "worst-case" leachability of contaminants present in soil in accordance with WAC 173-340-740(4)(a)(ii)(A).

As indicated in the Section 8 of this report (chemical fate and transport), the leachability of COCs detected at the site is most sensitive to surface water infiltration. In lieu of appropriate soil cleanup standards to address protection of surface water, this FS will use the SPLP in conjunction with the need for surface water infiltration engineering controls to address soil concentrations that are protective of surface water (and groundwater) at the site.

9.1.5.2 Groundwater Cleanup Levels

This section identifies appropriate site cleanup levels for groundwater. Groundwater standards for the protection of human consumption are not appropriate for shallow zone groundwater at the site since the shallow zone groundwater is not considered a potential future source of potable water. Since shallow zone groundwater at the site discharges to the Puyallup River, site groundwater cleanup levels that are protective of surface water are appropriate. These include:

- MTCA Method B and C surface water cleanup levels established in WAC 173-340-730, which are risk-based cleanup levels developed for protection of human health and are based on consumption of food fish and shellfish. MTCA Method B and C surface water cleanup levels are tabulated in Ecology's CLARC II database (Ecology 1996b).

- Ecology's Acute Freshwater SWQS established in WAC 173-201A. These ARARs were derived for protection of aquatic organisms that may inhabit waters of the state, including the Puyallup River, which is adjacent to the site. (Note: Ecology's Acute Freshwater SWQS for certain metals are hardness dependent and have been calculated using equations provided in WAC 173-201A based on an average groundwater hardness of 180 mg/l measured during the RI.)

- NTR established in 40 CFR 131.36. These ARARs were derived for those states not complying with the Clean Water Act [40 CFR, Part 303(c)(2)(B)]. All waters assigned to the following use classifications as defined in WAC 173-201-045 [fish and shellfish, fish, water supply (domestic), recreation] are subject to this regulation. The NTR criteria for the consumption of organisms only, based on a 1 x 10^{-5} risk, are considered most applicable to the site.

Since no surface water cleanup levels have been established for petroleum hydrocarbons under MTCA, Ecology's Model NPDES Permit Standards for surface water discharge (WAC 173-226) will be used for petroleum hydrocarbons. These ARARs were developed to regulate the amount of pollution allowed in lakes, streams, bays, and groundwater as required by the federal Clean Water Act (40 CFR 131.36) and the state Water Pollution Control Act (90.48 RCW). Specifically, these ARARs are based on the protection of surface water from leaking UST sites containing diesel contamination. These ARARs are considered applicable given the types of compounds encountered in soil and groundwater at the site. Ecology's Model NPDES Permit Standard for gasoline-range petroleum hydrocarbons is the same as the MTCA Method A groundwater cleanup level for gasoline-range petroleum hydrocarbons. Other VOCs typically associated with petroleum hydrocarbons (BTEX) have not been detected above MTCA surface water cleanup levels and/or other chemical-specific ARARs.

Use of these standards as cleanup levels meets the requirements of MTCA established in WAC 173-340-720(6)(d) for protection of shallow groundwater discharging to an adjacent surface water body.

9.1.5.3 Surface Water Cleanup Levels

This section identifies appropriate site cleanup levels for surface water. Site surface water cleanup levels will be the same as those identified for groundwater, since the groundwater cleanup levels are based on the protection of surface water. (Note: Ecology's Acute Freshwater SWQS for certain metals are hardness dependent and have been calculated using equations provided in WAC 173-201A based on an average surface water hardness of 31 mg/l measured during the RI. This could result in different cleanup levels for these metals in surface water and groundwater at the site.)

9.1.5.4 Summary of Proposed Site Cleanup Levels

Proposed site cleanup levels for COCs in soil, groundwater, and surface water are summarized in Table 9-3. This table also includes proposed site cleanup levels for other petroleum hydrocarbon-related compounds (diesel-range hydrocarbons, BTEX) that have been detected in site groundwater and/or surface water at concentrations below the proposed site cleanup levels. The table also includes proposed groundwater cleanup levels for cPAHs. Carcinogenic PAH compounds were detected in unfiltered samples at concentrations exceeding the proposed site groundwater cleanup levels. These compounds were not detected in filtered samples above the method reporting limit [with the exception of a low concentration of benzo(a)anthracene slightly above the laboratory reporting limit]. The proposed site cleanup levels have been used to evaluate the need for remedial action at the site; *however, exceedance of the site cleanup levels does not necessarily indicate that remedial action is required.* Final cleanup levels for the site will be identified by Ecology in the Corrective Action Plan (CAP).

9.1.6 Points of Compliance

The point of compliance, which is based on the expected exposure pathway, is the point (or points) where cleanup levels established for the site are to be achieved. The following complete exposure pathways have been identified for the site (refer to Section 9.1.2). The first complete exposure pathway is human and ecological exposure to COCs at this site via direct contact or ingestion of site soils. The second complete exposure pathway is aquatic organisms that may be exposed to COCs through ingestion or direct contact with surface water or shallow zone groundwater discharging to the Puyallup River.

To address these potential exposure pathways, the following points of compliance are proposed for site media:

- Soil – The point of compliance for soil will be throughout the site to a depth of 15 feet below grade (the reasonable maximum depth of soil excavation for development purposes) based on WAC 173-340-740(6). MTCA recognizes that for cleanup actions that involve containment of hazardous substances, soil cleanup levels will not be met at the points of compliance. In these cases, the cleanup action may be determined to comply with cleanup standards, provided the compliance monitoring is designed to ensure the long-term integrity of the containment system, and other requirements for containment technologies in WAC 173-340-360(8) are met. Addressing COCs in site soils also reduces concerns regarding exposure of potential ecological receptors to these chemicals in surface water that could potentially discharge from the site, as well as impacts to shallow groundwater.

- Shallow Zone Groundwater – MTCA defines the point of compliance for groundwater as being throughout the site from the uppermost level of the saturated zone extending vertically to the lowest most depth that could potentially be affected by the site [WAC 173-340-720(6)(b)]. However, MTCA also recognizes that a site where affected groundwater flows to nearby surface water, cleanup levels may be based on the protection of surface water (refer to Section 9.1.5). At these sites, a conditional point of compliance [WAC 173-340-720(6)(d)] may be established in surface water as close as technically possible to the point of groundwater discharge to the surface water. Establishment of a conditional point of compliance is appropriate for this site. No seep discharges from the site have been identified along the bank of the Puyallup River adjacent to the site. Therefore, the conditional point of compliance for the site will be established in onsite shallow zone monitoring wells located along the northern property boundary closest to the river [i.e., wells MW-8(R), MW-4(R), MW-5, MW-6, MW-9, and MW-2].

- Surface Water Runoff – The point of compliance for surface water is the point or points of discharge from the site to surface waters of the state based on WAC 173-340-730(6). Although the site is adjacent to the Puyallup River, it is separated by a man-made levee, therefore, there is no interaction of surface water runoff flow between the site and the river. For practical purposes, the surface water points of compliance will be established at those points where the surface water discharges from the site.

9.1.7 Estimated Areas and Volume of Site Material That Exceed MTCA Cleanup Levels and/or ARARs

9.1.7.1 Soil

Figures 4-1 through 4-4 show the lateral and vertical extent of soil with COCs (metals, PCBs, cPAHs, and petroleum hydrocarbons) exceeding site cleanup levels. Elevated concentrations of metals in soil have been detected close to the northern property boundary. Given the flat topography of the site, the site drainage patterns (refer to Figure 3-8), and the fact that this portion of the site has historically not been paved, surface water flow beyond the northern property boundary is likely to have been limited in favor of surface water infiltration. Therefore, metals-impacted soil is not expected to extend a significant distance beyond the northern property boundary. The estimated volumes of soil exceeding site cleanup levels are summarized in Table 4-9.

9.1.7.2 Groundwater

As previously discussed, site groundwater cleanup levels are based on protection of surface water in the Puyallup River. Compliance with surface water standards is measured in surface water at the point where the groundwater discharges to surface water. Because the Army Corps of Engineers levee separates the site from the Puyallup River, compliance with site cleanup levels has been assessed at a conditional point of compliance located along the northern property boundary, closest to the Puyallup River [wells MW-8(R), MW-4(R), MW-5, MW-6, MW-9, and MW-2].

Groundwater samples collected from monitoring well MW-8(R) contained COCs at concentrations exceeding site groundwater cleanup levels for naphthalene and gasoline-range petroleum hydrocarbons. The maximum concentration of naphthalene was 8,500 μg/l, which exceeds Ecology's Acute Freshwater SWQS of 2,300 μg/l. The maximum concentration of gasoline-range petroleum hydrocarbons (39,000 μg/l) exceeds Ecology's Model NPDES Permit Standard of 1,000 μg/l. Gasoline-range petroleum hydrocarbons were also detected in groundwater samples collected from upgradient well MW-11 at concentrations exceeding site groundwater cleanup levels. (Note: Carcinogenic PAHs were also detected in unfiltered groundwater reconnaissance and monitoring well samples above site groundwater cleanup levels. As previously noted in Sections 5.1 and 5.2, the presence of cPAHs in monitoring well and reconnaissance groundwater samples may be an artifact of the sampling methods and are not considered representative of site groundwater quality.)

The lateral extent of the naphthalene and petroleum hydrocarbons in site groundwater are shown on Figures 5-2 and 5-3, respectively. Given the groundwater flow direction in this portion of the site and the areas of deep soil impact, the source of the groundwater contamination appears to be in the vicinity of a former creosoting plant located in the southwestern corner of the site. The distribution of contaminants within the plume appears to reflect the relative mobility of the COCs. Groundwater impact related to the other area of deep soil impact, in the vicinity of test pits TP-10, TP-11, TP-55, and well MW-12 (west of the former red brick building), appears to be limited to the presence of free product (LNAPL) on the water table.

Based on the groundwater migration modeling presented in Section 8.3, naphthalene is not expected to migrate passed the northern property boundary. Gasoline-range petroleum hydrocarbons were not modeled. Benzene, a carcinogenic and mobile constituent of gasoline, was modeled as a surrogate. The highest concentrations of benzene (25 μg/l) were detected in the groundwater samples collected from well MW-8(R), where the highest concentrations of gasoline-range petroleum hydrocarbons (39,000 μg/l) were detected. The highest benzene concentrations did not exceed the site groundwater cleanup levels. The modeling indicated that benzene may be present beyond the northern property boundary (at concentrations below site groundwater cleanup levels), based on the very conservative assumptions used in the modeling (refer to Section 8.3).

9.1.7.3 Surface Water

Surface water from the site does not discharge into the Puyallup River. The points of compliance for site surface water cleanup levels are the points where surface water discharges from the site. Currently, surface water discharges from the site along the eastern and western property boundaries as well as via catch basins located within the eastern portion of the site (refer to Figure 3-8). Surface water runoff occurs during and after rain events that produce sufficient water to create runoff. The quality of surface water discharging from the eastern and western property boundaries was evaluated during the RI. Surface water discharging from the site along the along the eastern and/or western property boundaries exceeded site surface water cleanup levels for metals, cPAHs, and PCBs. The volume of impacted surface water discharging from the site is unknown.

9.2 Rationale for Selecting the Remedial Action

This section presents the rationale for selecting remedial actions to address the soil, groundwater, and surface water containing COCs at concentrations exceeding the proposed site cleanup levels (refer to Table 9-3). Section 9.2.1 identifies and evaluates potential remedial methods. Section 9.2.2 identifies remedial alternatives that are applicable to the site conditions and defines the remediation areas within the site. A preliminary analysis of the remedial alternatives is presented in Section 9.2.3, followed by a detailed analysis in Section 9.2.4. Section 9.2.5 offers a comparative analysis using the criteria presented in the detailed analysis, and Section 9.2.6 concludes with the recommended remedial alternative.

9.2.1 Identification and Evaluation of Potential Remedial Methods

This section identifies and evaluates potentially applicable remedial methods based on effectiveness, ability to be implemented, and cost. Remedial methods passing this evaluation were then ranked according to the MTCA hierarchy of preferred remedial methods.

9.2.1.1 Identify and Evaluate Remedial Methods

General response actions, remedial technologies, and process options that may be appropriate for addressing site conditions were identified (EPA 1985; 1987a). General response actions are broad categories of remedial methods that can address the cleanup of a specific matrix. Remedial technologies are different techniques within the general response actions. Process options are specific processes within each remedial technology category. For example, aboveground treatment is a general response action. Physical/chemical treatment is a remedial technology within the aboveground treatment category, and soil washing is a process option within the physical/chemical remedial technology class.

Process options were screened for their effectiveness, ability to be implemented, and relative cost.

Effectiveness involves consideration of a process option's ability to:

- Process the anticipated volume of soil and groundwater

- Meet cleanup standards

- Protect human health and the environment during construction and implementation.

The second criterion for evaluating process options (i.e., ability to be implemented) includes technical and administrative considerations. This criterion focuses on the ability to technically address COCs in soil and groundwater at concentrations detected during the RI. It also evaluates the permits necessary for onsite and offsite activities and discharges, and the availability of offsite facilities, services, and materials.

Cost is the final criterion for evaluating process options. Cost is based on engineering judgments rather than detailed estimates. Process options that are judged to be similar in effectiveness and ability to be implemented, yet costing several times more than other process options in the same technology category, were eliminated from further consideration.

Process options that are not appropriate for site conditions, planned future site uses, or for COCs contained in soil and groundwater at concentrations detected during the RI were eliminated from further consideration. In addition, process options that are innovative but not yet proven were also eliminated. If more than one process option in a remedial technology group was identified as potentially appropriate for the site, one process option was selected to represent that technology group. Tables 9-4 and 9-5 presents the identification and evaluation of general response actions, remedial technologies, and process options for soil and groundwater, respectively. (Note: Process options were not evaluated for surface water since actions taken for soil will address surface water.)

9.2.1.2 MTCA Hierarchy of Preferred Remedial Methods

MTCA requires that the process options used minimize the amount of untreated hazardous substances remaining at a site and that attention be given to permanent solutions and a hierarchy of preferred remedial methods [WAC 173-340-360(3)-(5)]. The MTCA preference for process options, in descending order, is:

1. Reuse or recycling

2. Destruction or detoxification

3. Separation or volume reduction followed by reuse, recycling, destruction, or detoxification of the residual hazardous substance

4. Immobilization of hazardous substances

5. Onsite or offsite disposal at an engineered facility designed to minimize the future release of hazardous substances, and in accordance with applicable state and federal laws

6. Isolation or containment with attendant engineering controls

7. Institutional controls and monitoring.

In general, technologies that reuse, recycle, destroy, or detoxify hazardous substances will result in permanent solutions.

Soil - Table 9-6 summarizes the results of the process option evaluation, as detailed in Table 9-4. Table 9-6 also lists the MTCA preference for each process option considered potentially applicable to site soil conditions. At least one soil process option identified for further consideration fulfills each MTCA preference category.

Reuse/recycling of site materials ranks the highest of Ecology's technology preference criteria. Onsite reuse of untreated soil may be feasible to bring the site to grade prior to installation of a cap by consolidating impacted soil from excavation areas providing it can be shown that the soil will not leach compounds, even under worst-case conditions. Onsite reuse of treated soil may be feasible to backfill excavation areas or to bring the site to grade prior to installation of a cap. Offsite reuse of treated or untreated soil as daily cover at a permitted disposal may be feasible provided the soil meets the disposal facilities acceptance criteria. The amount of debris material present in site soil may significantly limit the reuse of excavated materials both onsite and offsite. Debris materials (i.e., metal, wood) encountered during site remediation activities may be recyclable, depending on volume recovered.

Aboveground biological remediation (bioremediation by landfarming) uses microorganisms to destroy organic contaminants (such as petroleum hydrocarbons) found in soil. Thermal desorption would separate the organic COCs from the soil for destruction or further treatment. These process options meet the MTCA expectation to use treatment technologies when practicable, and to destroy or remove hazardous substances to concentrations below site cleanup levels [WAC 173-340-360(9)(a) and (b)].

Excavation would separate soil exceeding soil cleanup criteria from soil that is below the criteria prior to reuse/recycling, destruction/detoxification, or chemical stabilization. Given the amount of debris material likely to be encountered in site soil, physical separation through sieving (or other form of mechanical separation) will be necessary prior to any treatment option.

Chemical stabilization would immobilize metals detected above site cleanup levels by forming insoluble molecular bonds, which significantly reduces a metals leaching potential. This process option also meets the MTCA expectation to use treatment technologies when practicable [WAC 173-340-360(9)(a) and (b)].

Process options shown in Table 9-6 also include the lower preference methods of offsite disposal, containment, and institutional controls. MTCA recognizes the need for institutional controls, such as deed restrictions, as well as engineering controls, such as containment, for sites that contain large volumes of material with relatively low levels of hazardous substances where treatment is impracticable [WAC 173-340-360(9)(c)].

Groundwater - MTCA requires that groundwater treatment be used to achieve cleanup levels at and beyond the point of compliance [WAC 173-340-360(7)(a)]. If groundwater treatment to achieve site cleanup levels at and beyond the point of compliance within an existing plume is not practicable then the following measures shall be taken [WAC 173-340-360(7)(b)]:

- Treatment shall be used to reduce the levels to the maximum extent practicable.

- Groundwater containment, including barriers or hydraulic control through pumping or both, shall be implemented to the maximum extent practicable to avoid lateral and vertical expansion of the groundwater water volume affected by the hazardous substance.
- Source control measures shall be implemented to prevent or minimize additional releases to the groundwater.
- Adequate groundwater monitoring to demonstrate control and containment of the hazardous substances shall be conducted.
- The potentially liable persons shall provide an alternative water supply or treatment for persons with water supplies rendered unusable by the release.
- The practicability of achieving groundwater cleanup levels by treating groundwater affected by the release shall be reevaluated during the periodic review under WAC 173-340-420.

Groundwater extraction (i.e., pumping) was not considered an appropriate remedial technology for this site, given the site-specific hydrogeologic conditions and tidal influences impacting the site in the vicinity of the groundwater plume. Any groundwater extraction system would not only extract impacted water from the site but non-impacted water entering the saturated zone from the Puyallup River during high tides. Fluctuating water levels would significantly reduce the effective radii of influence of the extraction system wells and their ability to contain the groundwater plume. Consequently high extraction rates may be required to effectively contain the plume thus increasing the volume of water, which would need to be removed from the saturated zone and the volume of water requiring treatment and management aboveground. Therefore, technologies and process options associated with groundwater extraction were not evaluated in this FS.

Air sparging is a process by which oxygen is introduced to the subsurface enabling a phase transfer of certain compounds (typically volatile constituents of petroleum hydrocarbons) from a dissolved state to a vapor phase. The vapors are then vented through the unsaturated zone. Air sparging is most often used in conjunction with soil vapor extraction (SVE) that removes and treats vapors from the unsaturated zone. In situ enhanced biological biodegradation is a passive remediation process option that uses oxygen to detoxify organic COCs by promoting naturally occurring microorganisms that can aerobically degrade organic compounds into harmless by-products such as carbon dioxide and water. These process options meet the MTCA expectation to use treatment technologies when practicable, and to destroy or remove hazardous substances to concentrations below site cleanup levels [WAC 173-340-360(9)(a) and (b)].

Source control measures include the removal of free product from the water table, via physical separation, to the maximum extent practicable and properly treat, discharge, or dispose of the recovery by-products. This process option meets the MTCA requirements of WAC 173-340-450 for releases from USTs. Free product has been detected in limited areas of the site in the vicinity of TP-10, TP-11, TP-55, and monitoring well MW-12 (west of the former red brick building) and to a lesser extent in the vicinity of the former creosoting plant located in the southwestern corner of the site (refer to Figure 5-3). While historical Sanborn Maps indicate the presence of an oil tank at the former creosoting plant location, no evidence of USTs were observed during the RI this location or west of the former red brick building. In addition to free product removal, soil excavation as discussed in the previous subsection also provides for additional source control measures.

Since the shallow groundwater at the site is not a water supply, the need to provide an alternative water supply or treatment for persons with water supplies rendered unusable by the release is not applicable. Institutional controls, such as deed restrictions, will provide for the protection of unauthorized use of shallow groundwater, and compliance monitoring and period review will evaluate the effectiveness of treatment in meeting the site groundwater cleanup levels.

9.2.2 Identification and Description of Remedial Alternatives

This section identifies alternatives that may be appropriate for remediating the site.

9.2.2.1 Description of Process Options Selected for Further Consideration in Developing Remedial Alternatives for Soil

This section presents specific descriptions of the process options considered potentially implementable at the site.

Reuse/Recycling – Soil from excavation areas can be reused onsite in order to consolidate untreated soil and to bring low areas within the consolidation area to grade prior to capping providing it can be shown that the material will be not be subject to leaching. Soil from excavation areas can also be reused onsite after treatment as backfill material for excavated areas or to bring the existing surface to grade prior to capping. Treated or untreated soil may be sent to a permitted offsite facility for disposal providing the material meets the disposal facilities waste acceptance criteria and land disposal restrictions. Soil that is sent to a permitted offsite disposal facility may be used by the facility as daily landfill cover material; however, the amount of debris material in the soil may limit its reuse.

Although the majority of the surficial debris-type materials have been removed from the site, metal, asphalt, and wood type debris still exist on the surface and in soil that may require excavation. The uppermost soil at the site is fill material that contains various types of debris type material. The amount of debris materials in the excavated soil may significantly limit the reuse of the soil onsite. Excavated soil will need to sieved or mechanically separated prior to any treatment process. Depending on the amount of recoverable materials obtained from the separation process, metal debris may be sent to a recycling facility, wood waste type debris may be used for industrial landscaping, and asphalt may be crushed and reused as base material. Aggressive extraction tests will need to be performed on any recoverable materials identified for reuse to determine whether there is leaching potential.

Landfarming – Aboveground bioremediation, also known as landfarming, refers to the bio-oxidation of organic contaminants by microorganisms. Landfarming involves the excavation of impacted soil and placement of the soil on a treatment pad with an impermeable surface and a passive leachate collection system. The soil is placed in 6- to 12-inch lifts, fortified with nutrients (fertilizer), and tilled periodically to increase aeration. When the desired level of treatment is achieved, the lift is removed and a new lift is constructed. It may be desirable to only remove the top of the remediated lift, then construct the new lift by adding more contaminated soil to the remaining material and mixing. This serves to inoculate the freshly added material with an actively degrading microbial culture, and can reduce treatment times.

Soil conditions need to be controlled to optimize the rate of contaminant degradation. Conditions normally controlled include: moisture content (usually by irrigation or spraying); aeration (by tilling the soil with a predetermined frequency, the soil is mixed and aerated); pH (buffered near neutral pH by adding crushed limestone or agricultural amendment); and other amendments (e.g., soil bulking agents, nutrients, etc.). The use of this process option will require a treatability study to identify the optimal approach for treatment at the site.

Ex situ landfarming has been proved most successful in treating petroleum hydrocarbons; however, it tends to be less effective for diesel- and heavy oil-range hydrocarbons than other treatment methods (i.e., thermal treatment). This process will not remediate the metals found at the site. Other factors that can limit the applicability and effectiveness of landfarming include: the amount of space required to implement the process; conditions affecting biological degradation that cannot be controlled, but can increase the length of time required to complete remediation (e.g., temperature, rainfall); the need for fugitive dust control during tilling; and the need for runoff collection facilities that have to be constructed and monitored. Given these factors and the length of time typically required to meet cleanup levels, this process option is eliminated from further consideration.

Thermal Desorption - Thermal treatment strips organics from the soil with applications of relatively low temperatures (400° to 1,100°F) compared to those used for incineration. Excavated soil is heated to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to a gas treatment system. The bed temperatures and residence times designed into these systems volatilize selected contaminants but will typically not oxidize them. Two common thermal desorption designs are rotary dryer and thermal screw. Rotary dryers are horizontal cylinders that can be indirect or direct-fired. The dryer is normally inclined or rotated. For the thermal screw units, screw conveyors or hollow augers are used to transport the soil through an enclosed trough. Hot oil or steam circulates through the auger to indirectly heat the medium. Since the thermal desorption process is actually a physical separation process, all thermal desorption systems require treatment of the off-gas to remove and destroy the particulates and contaminants. Contaminants are removed through condensation followed by carbon adsorption, or they are destroyed in a secondary combustion chamber or catalytic oxidizer.

Based on the operating temperature of the desorber, thermal desorption processes can be categorized into two groups: high temperature thermal desorption (HTTD) and low temperature thermal desorption (LTTD). The target contaminant groups for HTTD are semivolatile organic compounds (SVOCs), PAHs, and PCBs. The target contaminant groups for LTTD are nonhalogenated VOCs and fuels. Thermal desorption will not remediate the metals found at the site. Debris mixed throughout site soils may cause physical difficulties with treatments using thermal desorption. Physical separation of these materials from the soil will be required and will result in additional material handling; however, the volume of material requiring treatment will be reduced. This process requires only a limited amount of space to implement since most of the thermal desorption units are truck-mounted and mobile, and soil can be remediated to cleanup levels in a shorter timeframe than via landfarming.

Excavation – Excavation is the process of removing impacted soil from the ground and is a well proven and readily implementable process option. Excavation is the most effective means of separating soil that requires treatment and/or disposal from soil that does not require treatment and/or disposal. Excavation is an initial component to all ex situ treatments. Aboveground, the excavated soil can be further segregated into stockpiles, if necessary, depending on eventual disposition of the materials. Excavated soil can either be reused (see reuse/recycling) or transported to a permitted offsite disposal facility. Excavated soil may require treatment in order to meet the disposal facilities waste acceptance criteria and land disposal restrictions. Soil treatment can be conducted onsite prior to transportation or at the disposal facility. Excavation is applicable to all COCs encountered at the site. Others factors to be considered during excavation include the generation of fugitive dust and the depth and composition of the materials requiring excavation. If excavated materials are transported offsite, clean fill material will need to be imported to backfill the excavation areas and bring the site to grade.

Sieving/Separation - Sieving is a physical separation process that uses different size sieves and screens to sort grain sizes and remove undesirable materials (e.g., debris), which may impact a treatment process. Physical separation is based on the fact that most organic and inorganic contaminants tend to bind, either chemically or physically, to the fraction of a soil fine (i.e., clay and silt). The clay and silt particles are, in turn, physically bound to the coarser sand and gravel particles by compaction and adhesion. Thus, separating the fine clay and silt particles from the coarser sand, gravel, and debris would effectively concentrate the contaminants into a smaller volume of soil for treatment or disposal. Another form of mechanical separation may be required (using a backhoe) to separate and remove larger pieces of debris.

Recovered debris materials may be appropriate for recycling as previously discussed. Materials not appropriate for recycling will be disposed of at a permitted offsite disposal facility. Given the amount of debris likely in potential excavation areas at the site, sieving/physical separation will be required prior to any treatment process.

Chemical Stabilization - Chemical stabilization reduces the mobility of contaminants in the environment. Unlike other remedial technologies, stabilization seeks to immobilize contaminants within their "host" medium (i.e., soil) instead of removing them through chemical and/or physical treatment. Leachability testing is used to measure the degree of immobilization. Chemical stabilization can be performed both in situ and ex situ. This technology will require a limited bench-scale test to identify the optimum chemical mixture to be used for the stabilization and to determine whether the process is best performed in situ or ex situ. Target contaminants for this remedial technology are metals. Debris mixed throughout site soils may cause physical difficulties with treatments using chemical stabilization in situ. If the process is implemented ex situ physical separation of these materials from impacted soils can be performed, this will result in additional material handling but the volume of material requiring treatment will be reduced.

For the purposes of this FS, it has been assumed that a chemical stabilization process patented by Forrester Environmental Services, Incorporated (FESI) of Hampton, New Hampshire can be used. Kennedy/Jenks Consultants has used this patented process successfully on a number of sites impacted with heavy metals. The process entails application of phosphate-based liquid that causes substitution and co-precipitation of target metals (lead) into stable complexes. The result is lower solubility and mobility in the environment.

Offsite Disposal - Soil and debris transported to a permitted offsite disposal facility may be treated or untreated depending on the disposal facilities waste acceptance criteria and land disposal restrictions. Disposal facilities can accept soil impacted with COCs identified at the site; however, the type of chemical and its concentration will determine actual offsite disposal requirements. Soil characterization as dictated by land disposal restrictions (LDRs) will be required. Most hazardous and dangerous wastes require treatment either onsite or at the receiving disposal facility to meet either RCRA or nonRCRA treatment standards prior to land disposal. Physical separation of the debris materials mixed throughout site soil may be required to facilitate disposal. The distance of the disposal facility with the required permits from the site, and the difference between the transportation and disposal of hazardous/dangerous waste versus nonhazardous waste can significantly impact the cost of a site cleanup.

For the purposes of this FS, it has been assumed that the Roosevelt Regional Landfill located in Roosevelt, Washington, which is permitted to accept nonhazardous wastes will be used. Offsite disposal of hazardous/dangerous waste it not anticipated due to the significant costs involved (refer to Section 9.2.2.3); with the possible exception of a small quantity of soil containing lead-acid batteries from a limited area immediately south of the former red brick building.

Asphalt Cap - An asphalt cap typically consists of 3 inches of appropriate base material (crushed rock), covered with 3 inches of low permeability asphalt. Prior to capping, soils affected with higher levels of COCs may require excavation, treatment, and/or disposal. Treated soil can be used onsite as excavation backfill material or to bring the site to grade prior to installation of the cap. Untreated soil may also be used to bring the site to grade under specific circumstances (i.e., within a defined consolidation area). Imported clean fill material may be needed to complete backfilling of excavation areas and to bring the site to grade. Capping will include the installation of a stormwater collection system (designed to control surface water runoff) and inspections and repairs (as needed) to maintain the integrity of the cap. The cap would be installed over the entire site, excluding the area currently occupied by the storage building on the eastern portion of the site.

Asphalt is currently present over a large portion of the site; however, the integrity of the existing asphalt has been compromised through demolition of buildings and site investigation activities and will be further compromised during the proposed excavation activities. The existing asphalt can either be removed and crushed to be reused as base material for the new asphalt cover or removed from the site and disposed of at an appropriate facility. Alternatively, the existing asphalt can be left in place and the new cap constructed over it.

Although this FS evaluates asphalt, other caps (e.g., concrete) would provide equivalent protection to human health and the environment. However, asphalt provides adequate protection of human health, is cost-effective, and is a common paving material for parking and/or industrial areas.

Institutional Controls - Institutional controls (WAC 173-340-440) includes deed restrictions that are required whenever contaminants remain onsite at concentrations exceeding site cleanup levels (refer to Table 9-3). Deed restrictions are controls on land use that are described in a covenant on the property, as executed by the property owner and recorded with the Registrar of Deeds. Deed restrictions meet the requirement for institutional controls as defined in WAC 173-340-440(3). Institutional controls would include a 5-year periodic review in accordance with WAC 173-340-420 if soil containing COCs above site cleanup levels remains onsite or if conditional points of compliance have been established. The 5-year periodic review would entail evaluating the remedial actions to assess whether human health and the environment remain protected. In addition, long-term monitoring would be required under WAC 173-340-360(8) and WAC 173-340-410(c). At a minimum, annual inspections and repairs (as needed) of the asphalt cap would be needed to maintain the integrity of the cap, and compliance monitoring of the stormwater collection system discharge to monitor attainment of site surface water cleanup levels.

9.2.2.2 Description of Process Options Selected for Further Consideration for Developing Remedial Alternatives for Groundwater

This section presents specific descriptions of the process options to address groundwater considered potentially implementable at the site.

Free Product Removal – When a chemical is released on or into the ground, it divides into one or more phases: vapor or gaseous phase; adsorbed or residual phase (on soil); dissolved phase (in groundwater); and free or liquid phase. Liquid or pure phase, also known as free product, is characterized by having sufficient volume to saturate the soil that it accumulates on the water table and can readily flow into wells and excavations. When the free product is immiscible (i.e., does not readily dissolve in water) it is referred to as a LNAPL. Free product consists of both a residual (nondrainable) portion and a portion that is recoverable (drainable). Free product has been identified in limited areas of the site where soil contamination extends to the water table. Free product serves as a continual source of contamination by dissolving, volatilizing, smearing onto soil and groundwater.

LNAPLs can be removed using various methods depending on the lateral extent and other remediation activities being conducted at a site. The two most common systems use either recovery wells or a series of trenches/drains. Recovery wells use skimmers, canisters, or absorbent filters with the goal of collecting little or no groundwater. Trenches/drains can be installed perpendicular to the direction of groundwater flow or longitudinally along the plume of contamination. A perforated collection pipe is placed in the trench in order to drain the free product to a sump. The LNAPL is then periodically pumped from the sump. A modification of the trench/drain approach can be implemented if soil excavation is proposed down to or just below the water table in the area of LNAPL. Excavation in conjunction with free product removal reduces the amount of residual (nondrainable) soil contamination that also serves as a continual source of contamination. LNAPL removal from the open excavation may involve the removal of more groundwater than using other techniques. Depending on the amount of product and rate of groundwater entering the excavation area, the product can be skimmed directly from the excavation or alternatively groundwater/ LNAPL can be pumped from the excavation into a holding tank, where water/ LNAPL separation is allowed to occur. Product is then skimmed from the holding tank. Any groundwater removed as part of the LNAPL recovery may need to be treated prior to disposal.

Air Sparging - Air sparging is an in situ technology that reduces concentrations of volatile constituents of petroleum hydrocarbons that are adsorbed to soil and dissolved in groundwater. This process option involves the injection of atmospheric air into the saturated zone, enabling a phase transfer of hydrocarbons from a dissolved phase to a vapor phase. The air is then vented through the unsaturated zone. Air sparging is most often used together with a SVE system, which removes and treats the resultant vapors from the unsaturated soil zone. Air sparging is generally more applicable to the lighter gasoline constituents (BTEX) because they readily transfer from the dissolved to the vapor phase. Air sparging is less applicable to diesel-range petroleum hydrocarbons and PAHs. Addition of oxygen to the saturated zone via air sparging may also serve to increase the amount of available oxygen in the groundwater that can enhance biodegradation of organic contaminants. However, since oxygen has a relatively low water solubility, air sparging alone (which uses atmospheric air) may not be able to provide the amount of oxygen required to produce the optimum aerobic conditions for bioremediation to occur (see enhanced biodegradation).

Air sparging cannot be used if free product is present. The effectiveness of air sparging depends primarily on two factors. The vapor/dissolved phase partitioning of chemicals determines the equilibrium distribution of a chemical between the dissolved phase and the vapor phase. Vapor/dissolved partitioning is, therefore, a significant factor in determining the rate at which dissolved constituents can be transferred to the vapor phase. The other significant factor in determining the mass transfer rate of chemicals from the dissolved phase to the vapor phase is the permeability of the soil, which determines the rate at which air can be injected into the saturated zone. In general, air sparging is more effective for chemicals with greater volatility and lower solubility and for soils with higher permeability. Stratified or highly heterogeneous soil typically creates the greatest barriers to air sparging. Both injected air and stripped vapors will travel along the paths of least resistance and could travel great lateral distances from the injection point. Air sparging also has the potential for inducing chemical migration, and as previously stated may need to be implemented in conjunction with a SVE system especially if the site is developed and buildings constructed. This process option can take a moderate amount of time to reduce COCs to cleanup levels. This process option requires detailed pilot testing and monitoring to determine the number, spacing, and radii of influence of air sparging wells. Given these factors and the length of time typically required to meet cleanup levels (3 to 5 years), this process option is eliminated from further consideration.

In Situ Enhanced Biodegradation – Enhanced biodegradation introduces oxygen to the saturated zone in order to increase the rate of biodegradation. Increasing the concentration of electron acceptors and nutrients in the groundwater enhances the rate of biodegradation of organic contaminants by microbes. Oxygen is the main electron receptor for aerobic biodegradation. Nitrate serves as an alternative electron receptor under anaerobic (oxygen deficient) conditions. Enhanced biodegradation is a process that attempts to accelerate natural biodegradation processes by providing nutrients, electron receptors, and competent degrading microorganisms that may otherwise be limiting the rapid conversion of organic contaminants into innocuous end products. Oxygen enhancement can be achieved by either air sparging (as discussed above) or introducing oxygen releasing compounds to the saturated zone. Under anaerobic conditions, nitrate is introduced to enhance bioremediation. The advantage of using oxygen releasing compounds over air sparging is that it provides pure oxygen to the saturated zone. The concentration of oxygen from oxygen releasing compounds can build up in groundwater to very high concentrations (up to 45 mg/l) before leaving solution in the form of bubbles. This gives a tremendous advantage over air sparging in that the high concentrations of oxygen dramatically increase the rate of oxygen diffusion through the subsurface. Thus oxygen releasing compounds have the potential to impact a much greater area around an application point by simple diffusion than can be expected by applying atmospheric air.

Petroleum hydrocarbons degrade rapidly under aerobic conditions, but success is often limited by the inability to provide sufficient oxygen to contaminated zones as a result of low water solubility of oxygen and because available oxygen is rapidly consumed by aerobic microbes. Nitrate can also serve as an electron receptor and is more soluble in water than oxygen. The addition of nitrate results in the anaerobic biodegradation of toluene, ethylbenzene, and xylenes. The benzene component of fuel has been found to biodegrade slower under strict anaerobic conditions.

The groundwater contamination plume is located in an area of the site that contains a significant quantity of organic material (wood). It is likely that the presence of a large amount of organic material has created more anaerobic than aerobic conditions in this portion of the site. A limited-treatability study will be required to determine the optimum requirements for enhanced biodegradation at the site. For the purposes of this FS, it has been assumed that an oxygen releasing compound known as ORC®, patented by Regenesis Bioremediation Products, Inc., of San Clemente, California, can be used. Kennedy/Jenks Consultants has used this patented process successfully on a number of sites impacted with petroleum hydrocarbon-related compounds. ORC® can be applied in a number of ways depending on site conditions. ORC® can be introduced into existing site monitoring wells using filter socks filled with ORC® powder. ORC® can be mixed into a slurry and applied via a series of injection points throughout the plume or injected in a line to create an "oxygen barrier" at or near the point of compliance. ORC® can also be placed in the base of an excavation as a slurry (if water is present) or as powder (if water is not present). Enhanced biodegradation typically can achieve cleanup levels in a shorter period of time (1 to 2 years) than air sparging.

Compliance Monitoring – The effectiveness of the groundwater treatment process option will be monitored through both performance and confirmational monitoring [WAC 173-340-410(b)(c)]. Groundwater performance monitoring will be used to confirm that the cleanup action has attained the site groundwater cleanup levels (refer to Table 9-3). Groundwater confirmational monitoring will be used to confirm the long-term effectiveness of the cleanup action once the site groundwater cleanup levels have been achieved.

9.2.2.3 Development of Alternatives

This section identifies alternatives that could be appropriate for remediation of COC-impacted soil, groundwater, and surface water at the site. These alternatives are identified using the requirements and expectations described in MTCA (WAC 173-340-360), which include:

- Meeting threshold requirements for remedial alternatives (refer to Section 9.2.3)
- Using permanent solutions to the maximum extent practicable
- Providing for a reasonable restoration time frame
- Addressing public concerns raised during the public comment on the Draft CAP.

In addition to these requirements, Ecology has the following expectations for cleanup actions [WAC 173-340-360(9)]:

- Using treatment technologies whenever practicable

- Minimizing the need for long-term management of contaminated materials by destroying, detoxifying, or removing hazardous substances that are above cleanup levels

- Recognizing the need to use engineering controls, such as containment, for sites with large volumes of relatively low levels of hazardous substances

- Using institutional controls to supplement engineering controls

- Minimizing contact of precipitation and runon with contaminated material

- Consolidating hazardous substances to the maximum extent practicable, if the hazardous substances remain onsite

- Preventing or minimizing releases to surface water and not depending solely on dilution to demonstrate compliance with the cleanup standards

- Not undertaking cleanup actions that will result in a greater overall threat to human health and the environment when compared to other alternatives.

MTCA recognizes that treatment may not be practicable for all sites. Treatment is required, wherever practicable, for sites containing liquid wastes, areas contaminated with high concentrations of hazardous substances, highly mobile materials, or discrete areas of hazardous substances that lend themselves to treatment [WAC 173-340-360(9)(a)]. MTCA also recognizes that engineering controls, such as containment, are appropriate for sites that contain large volumes of materials with relatively low levels of hazardous substances where treatment is impracticable [WAC 173-340-360(9)(c)].

For discussion purposes throughout the remainder of this FS and to assist in the development of remedial alternatives, soil impacted with COCs at the site has been divided into the following two main categories:

- Metals-Impacted Soil – Categorized as near-surface soil less than 3 feet bgs. There are two isolated areas extending 4 to 6 feet bgs (TP-34 and TP-46) (refer to Figure 4-1). At TP-34, the concentration detected in the 4 to 6 feet depth interval (1,110 mg/kg) slightly exceeds the site cleanup level. Higher concentrations (4,320 mg/kg) were detected in the 4 to 6 feet depth interval at TP-46, located along the eastern property boundary. The most widespread COC in this category of soil is lead exceeding the MTCA Method A industrial cleanup level of 1,000 mg/kg. This soil may also contain chromium, PCBs, PAHs (including cPAHs), and diesel- and oil-range petroleum hydrocarbons at concentrations above site cleanup levels (refer to Table 9-3). Except for the isolated areas identified above, metals-impacted soil is located at least 4 feet or more above the high tide water table.

- Petroleum Hydrocarbon-Impacted Soil – Categorized as soil that has been impacted down to the water table and has resulted in groundwater impact. Petroleum hydrocarbon-impacted soil up to 10 feet bgs has been identified in two areas of the site (refer to Figure 4-4). One area is in the vicinity of the former creosoting plant located in the southwestern corner of the site. The second area is in the vicinity of test pits TP-10, TP-11, and TP-55, west of the former red brick building. The most widespread COCs in this category of soil are diesel- and oil-range petroleum hydrocarbons and cPAHs. The petroleum hydrocarbon and cPAH concentrations detected in the deeper petroleum hydrocarbon-impacted soil are typically an order of magnitude greater than the concentrations of these same COCs detected in the shallow metals-impacted soil category described above.

The following remediation alternatives have been developed from the selected soil and groundwater process options.

Alternative 1: Source Control (Free Product Removal and Petroleum Hydrocarbon-Impacted Soil Excavation with Offsite Disposal), Asphalt Cap with Stormwater Control, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater/Surface Water Compliance Monitoring, and Periodic Review. Source control in those areas of the site where groundwater has been impacted by potentially mobile contaminants. Source control will include free product removal and excavation of petroleum hydrocarbon-impacted soil where impacted soil has been identified down to the water table. Petroleum hydrocarbon-impacted soil will be disposed of offsite. Source control will also include the removal of lead-acid battery casings located in the shallow soil immediately south of the former red brick building. These battery casings, if left in place, could act as a continual source of lead to soil in this area. The lead-acid battery casings and impacted soil will be disposed offsite. Since COCs above the site soil cleanup levels will remain onsite, this alternative includes the installation of a low permeability asphalt cap with a stormwater collection system, institutional controls, compliance monitoring, and periodic reviews. This alternative includes enhanced biodegradation to accelerate bioremediation of groundwater contaminants in the western portion of the site.

Alternative 2: Source Control (Free Product Removal and Petroleum Hydrocarbon-Impacted Soil Excavation with Offsite Disposal), Limited Metals-Impacted Soil Excavation with Onsite Consolidation, Asphalt Cap with Stormwater Control, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater/Surface Monitoring, and Periodic Review. Source control measures as described in Alternative 1. Petroleum hydrocarbon-impacted soil and soil containing lead-acid battery casings will be disposed of offsite. This alternative includes the limited excavation of shallow metals-impacted soil along portions of the property boundary to site cleanup levels in order to create a "buffer zone" between shallow metals-impacted soil being left in place onsite and the adjacent properties. The excavated metals-impacted soil will be consolidated onsite within the limits of the shallow metals-impacted soil footprint. Since COCs above the site cleanup levels will remain onsite, this alternative also includes the installation of a low permeability asphalt cap with a stormwater collection system and implementation of institutional controls and monitoring, as described in Alternative 1. This alternative also includes enhanced biodegradation to accelerate bioremediation of groundwater contaminants, as described in Alternative 1.

Alternative 3: Source Control (Free Product Removal and Petroleum Hydrocarbon-Impacted Soil Excavation), Limited Metals-Impacted Soil Excavation, Onsite Treatment & Reuse of Excavated Soil, Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater/Surface Monitoring, and Periodic Review. Source control measures, as described in Alternative 1. This alternative also includes the limited excavation of shallow metals-impacted soil along portions of the property boundary to site cleanup levels in order to create a "buffer zone" between shallow metals-impacted soil being left in place onsite and the adjacent properties, as described in Alternative 2. However, in this alternative, excavated soil will be treated onsite using thermal desorption for petroleum hydrocarbon-impacted soil and chemical stabilization for metals-impacted soil, respectively. (Note: Impacted soil containing lead-acid battery casing will be disposed of offsite.) Sieving or mechanical separation of debris will be performed prior to implementation of treatment processes. The debris material will be stockpiled pending characterization for recycling or offsite disposal. Treated soil will be used onsite to backfill excavation areas or bring the site to grade for capping. Since COCs above the site cleanup levels will remain onsite, this alternative also includes the installation of a low permeability asphalt cap with a stormwater collection system and implementation of institutional controls and monitoring, as described in Alternative 1. This alternative also includes enhanced biodegradation to accelerate bioremediation of groundwater contaminants, as described in Alternative 1.

9.2.2.4 Discussion of Alternatives Relative to MTCA Criteria

All the alternatives include source control measures in the portion of the site where groundwater has been impacted by petroleum hydrocarbon compounds. All alternatives also include the removal of lead-acid battery casings and associated impacted soil in a limited area of the site immediately south of the former red brick building. Source control meets Ecology's expectation to minimize the need for long-term management by removing hazardous substances that are above cleanup levels.

The rationale for determining whether COCs above site soil cleanup levels could be left in place in those areas of the site where soil has not been impacted down to the water table was based on an assessment of the following: (1) the ability of an alternative to minimize the potential for direct contact with COCs (e.g., via dermal contact, ingestion, inhalation), and (2) the ability of an alternative to reduce a COCs potential to be leached from the soil into the groundwater and migrate toward the Puyallup River.

The most widespread COC in the shallow metals-impacted soil is lead (refer to Figure 4-1). The proposed cleanup level for lead is the MTCA Method A industrial cleanup level of 1,000 mg/kg. The estimated volume of soil with concentrations of lead exceeding 1,000 mg/kg is approximately 11,400 cubic yards (refer to Table 4-9). Soil samples with a range of concentrations exceeding 1,000 mg/kg were analyzed using the TCLP (refer to Table 4-8A). The TCLP is used to characterize waste with respect to toxicity. Based on the TCLP results, generally speaking, soil exceeding 1,000 mg/kg of total lead also exceeds the TCLP criterion for lead of 5 mg/l. Therefore, excavated soil with lead concentrations exceeding 1,000 mg/kg would need to be managed as a dangerous waste (WAC 173-303-090). The costs associated with handling and treatment and/or disposal of dangerous waste are prohibitive. Futhermore, the potential risks posed by leaching to groundwater appear minimal if engineering controls (asphalt cap with a stormwater collection system) are used.

As previously discussed in Section 9.1.5.1, Ecology does allow soil concentrations above MTCA soil cleanup levels to remain at a site if it can be demonstrated that higher concentrations are protective of groundwater [WAC 173-340-745(4)(a)(ii)(A)]. Soil samples with concentrations of metals and cPAHs exceeding site cleanup levels were evaluated using the SPLP, a procedure designed to simulate leaching under acid rain conditions. The SPLP results (refer to Tables 4-8A and 4-8B) indicate that low concentrations of metals (below the proposed site groundwater cleanup levels) leached from the samples suggesting the low potential for migration of metals beyond their initial zone of presence, if precipitation is allowed to infiltrate through the soil column. This is supported by the fate and transport modeling presented in

Section 8.2, which found COCs encountered in the shallow soil to be virtually immobile (under the conditions modeled) at concentrations exceeding soil cleanup levels at the site. The most sensitive parameter in the model was recharge rate, indicating that in order to minimize the potential for leaching, surface water infiltration should be kept to a minimum or eliminated. Installation of an asphalt cap and a stormwater collection system will significantly reduce (and possibly eliminate) the potential for surface water infiltration at the site. Other COCs (chromium, cPAHs, and PCBs) are detected in the shallow soil above their respective site cleanup levels within the area of soil impacted by lead. These chemicals are also considered to be virtually immobile (refer to Tables 4-8A and 4-8B and Section 8.2.1.9). [Note: Metals (with the exception of dissolved selenium) and PCBs have not been detected in site groundwater above cleanup levels, cPAHs were detected in the unfiltered groundwater reconnaissance and well samples; however, as previously discussed these results are believed to be an artifact of the sampling method and not representative a groundwater quality.]

Petroleum hydrocarbons in the diesel- and oil-range are also present in the shallow soil at the site. Soil samples exceeding the proposed site cleanup level of 2,000 mg/kg (amended MTCA Method A industrial soil cleanup level) for petroleum hydrocarbons in the diesel- and oil-ranges were evaluated using Ecology's TPH Interim Policy (refer to Section 4.5). The TPH Interim Policy addresses two pathways: direct human health contact, and soil-to-groundwater, the two exposure pathways of concern at the site (refer to 9.1.2). Based on the evaluation, the sum of the hazard quotients (the hazard index) did not exceed 1.0; however, at those locations where cPAHs were also detected, the $1x10^{-5}$ cancer risk was exceeded. This is only of concern if a direct contact exposure pathway exists. The direct contact exposure pathway can be effectively eliminated by the installation of an asphalt cap and institutional controls (i.e., deed restrictions).

Each alternative includes installation of an asphalt cap with a stormwater collection system and deed restrictions. This meets Ecology's expectation of using engineering controls for sites with large volumes of relatively low levels of hazardous substances, using institutional controls to supplement engineering controls, and minimizing contact with precipitation and runon with contaminated material.

Ecology's TPH Interim Policy does not take into account long-term exposures to petroleum hydrocarbon vapors or address ecological protection. The most volatile COC at the site is benzene. Benzene was not detected in groundwater at concentrations exceeding site groundwater cleanup levels; however, as a carcinogenic, mobile and volatile constituent of gasoline, its fate and transport in the environment is of potential concern. Volatilization to the outdoor (ambient) air may occur, but given the extensive dilution that occurs outdoors compared to an indoor air scenario, this pathway is not of concern. Installation of an asphalt cap will reduce the potential migration of vapors at the site. A groundwater to indoor air risk assessment may be necessary if future buildings are constructed in the northwestern corner of the site based on groundwater quality at that time. (Note: It is anticipated that if buildings are constructed sometime in the future, the source control measures and groundwater remediation activities proposed in each of the alternatives will have reduced benzene in site groundwater to levels where a risk assessment may not be warranted.)

According to the groundwater migration modeling performed in Section 8.3, under the conservative assumptions used in the model (i.e., groundwater flows continuously toward the Puyallup River) it is possible that benzene may have migrated beyond the northern property boundary toward the river at concentrations below site cleanup levels. However, as benzene is transported from groundwater to surface water and potential ecological receptors, natural attenuation (dilution, biodegradation, volatilization) will occur. If benzene reaches surface water it will be subject to rapid volatilization. The estimated half-life for volatilization of benzene from a model river one meter deep flowing at 1 meter per second with a wind speed of velocity of 3 meters per second is estimated to be 2.7 hours at 20 degree Celsius (National Park Service 1997). Benzene is not expected to significantly adsorb to sediment, bioconcentrate in aquatic organisms or hyrolyze, and may be subject to biodegradation based on a reported biodegradation half-life of 16 days in an aerobic river die-away test (National Park Service 1997).

Each alternative includes groundwater treatment through enhanced biodegradation to accelerate the bioremediation of contaminants in site groundwater. Enhanced biodegradation will be achieved by introducing an oxygen releasing compound into the saturated zone. All of the organic COCs detected in site groundwater can be bioremediated using enhanced biodegradation. Benzene is particularly amenable to aerobic biodegradation using oxygen release compounds. Alternative 3 also includes the use of treatment technologies for soil. This meets Ecology's expectation of using treatment technologies whenever practical and minimizing the need for long-term management of contaminated materials by detoxifying or destroying hazardous substances that are above cleanup levels and to treat hazardous substances whenever practicable.

Each alternative includes compliance monitoring and periodic reviews. This will include protection monitoring during remedial activities, and performance and confirmational monitoring for a period of 3 to 5 years. This will include one year of quarterly monitoring, followed by semiannual monitoring for the remainder of the performance/confirmational period. Long-term groundwater monitoring is not anticipated at the site, since the source(s) of the groundwater contamination will be removed from the site. The length of the performance/confirmational monitoring period will be dependent on how quickly the site groundwater cleanup levels are achieved. At a minimum, the asphalt cap will be inspected on an annual basis to verify the caps integrity. Periodic monitoring of the stormwater collection system discharge will also be conducted to ensure compliance with site surface water cleanup levels. Ecology may stipulate requirements for different monitoring frequencies and duration in the CAP.

All the alternatives use permanent solutions to the maximum extent practicable through either offsite disposal or onsite treatment. It is not considered practicable to remove all metals-impacted soil above site cleanup levels since implementation of engineering and institutional controls can be shown to be protective of human health and the environment, as described above. In accordance with MTCA [WAC 173-340-360(5)(d)(vi)], a cleanup action is not considered practical if the incremental cost of the cleanup action is substantial and disproportional to the incremental degree of protection it would achieve over a lower preference cleanup action. Approximately 11,400 cubic yards of shallow metals-impacted soil exceeding the site soil cleanup level have been characterized as a hazardous waste based on the TCLP results (refer to Section 4.8). Therefore, it is recognized that the costs associated with the handling and management (treatment and/or disposal) of such a large volume of soil would be significant and impractical.

All the alternatives provide for a reasonable restoration time frame. Excavation and offsite disposal can be achieved within a relatively short time frame. The soil treatment process options (thermal desorption and chemical stabilization) were chosen because they can also achieve site soil cleanup levels in relatively short periods of time. Removal of the source(s) of groundwater contamination will greatly assist in the rate at which site groundwater cleanup levels can be achieved.

All the alternatives meet the MTCA expectation to avoid cleanup actions that result in a greater overall threat to human health and the environment. MTCA requirements for meeting threshold requirements, using permanent solutions to the maximum extent practicable, providing for reasonable restoration time frame, addressing public comments are further addressed in Section 9.2.4.

9.2.2.5 Detailed Description of Alternatives

This section further describes the three remedial alternatives identified in Section 9.2.2.3.

Alternative 1: Source Control (Free Product Removal and Petroleum Hydrocarbon-Impacted Soil Excavation with Offsite Disposal), Asphalt Cap with Stormwater Control, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater/Surface Water Compliance Monitoring, and Periodic Review.

This alternative involves implementing source control measures through the excavation of potentially mobile petroleum-impacted soil in two areas of the site down to the water table (refer to Figure 9-1) and free product removal. Metals-impacted soil may be encountered in the uppermost 1 foot of soil within portions of the two areas identified for deep excavation. Additional separation of the excavated soil into various stockpiles for disposal characterization may be required. Petroleum hydrocarbon-impacted soil will be excavated vertically down to groundwater and laterally until sidewall confirmation samples indicate petroleum hydrocarbon and cPAH concentrations below the site cleanup levels of 2,000 mg/kg (petroleum hydrocarbons) and 18 mg/kg (total cPAHs). Free product is expected to be present in the excavation areas in the vicinity of the TP-10, TP-11, and TP-55 and may be present to a lesser extent in the excavation in the vicinity of the former creosoting plant. The amount of free product encountered will determine the removal method. This alternative also involves the removal of lead-acid battery casings and associated impacted soil from a limited area south of the former red brick building. Excavated materials from this area of the site will be stockpiled separately from the petroleum hydrocarbon-impacted soil pending characterization and offsite disposal.

It is estimated that approximately 3,300 cubic yards of soil will require excavation in the vicinity of the former creosoting plant in the southwestern portion of the site and approximately 4,500 cubic yards of soil will require excavation west of the former red brick (refer to Figure 9-1). In this alternative, excavated soil will be transported offsite for disposal at a permitted facility and possible reuse as daily landfill cover material; however, its reuse may be limited by the amount of debris material in the soil. The excavated soil will be temporarily stockpiled onsite in order to characterize the material for offsite disposal. Control measures, such as covering or wetting the stockpiles and creating earth berms, will be used as necessary to control fugitive dust emissions and control precipitation runon and runoff. For the purposes of this FS, it has been assumed that the petroleum hydrocarbon-impacted soil will be disposed of as a nonhazardous waste. It is estimated that approximately 10 cubic yards of lead-acid battery casings and associated impacted soil will require excavation immediately south of the former red brick building. This material may need to be disposed of as a hazardous waste. Imported clean fill material will be used to backfill the excavated areas.

Any existing asphalt will be left in place. Additional fill and base course materials will be imported as necessary to bring the site to grade and compacted according to the design specifications. The base course material will be covered by a 3-inch layer of low permeability asphalt. The asphalt pavement will cover the entire site to the property boundaries with the exception of the existing storage building located on the eastern portion of the site. Stormwater controls will be installed in the asphalt cap. The cap will be graded to collect surface water and convey it to a stormwater collection system. The stormwater collection system will be able to treat stormwater to meet site surface water cleanup levels.

This alternative will also include institutional controls (i.e., deed restrictions) because soil exceeding the MTCA industrial soil cleanup levels will be left in place. A registered engineer will inspect the pavement at a frequency identified by Ecology and identify necessary repairs. The results of the inspection will be provided to Ecology.

This alternative includes enhanced biodegradation of the groundwater plume through the application of an oxygen releasing compound, known as ORC® (provided by Regenesis, Bioremediation Products, Inc.). A limited treatability study will need to be conducted to assess the optimum approach to accelerate the biodegradation of COCs in site groundwater using ORC®. Groundwater treatment may need to be implemented in several phases. For example, ORC® may initially be introduced into the excavation areas to provide an oxygen source across a large treatment area. This approach will create an oxygenated zone to enhance aerobic biodegradation of the residual soil and groundwater contamination in the excavation areas and biodegradation of the groundwater contaminant plume downgradient of the excavation areas. Depending on its effectiveness, additional future applications of ORC® throughout the plume by injection or via groundwater monitoring wells may be warranted.

In this alternative, scheduled groundwater monitoring will be performed for 3 to 5 years to evaluate enhanced biodegradation in meeting site groundwater cleanup levels at the conditional point of compliance and assess the need for future groundwater controls. The need for future groundwater control and longer-duration groundwater monitoring will depend on the monitoring results obtained over the initial period. Potential impacts to surface water from site runoff will be controlled with the installation of a stormwater collection system. Captured stormwater runoff will be routed to the City of Tacoma stormwater system. This alternative includes 5-year periodic reviews since hazardous substances exceeding site cleanup levels will remain onsite, and conditional points of compliance are being used to evaluate effectiveness of the cleanup action.

Alternative 2: Source Control (Free Product Removal and Petroleum Hydrocarbon-Impacted Soil Excavation with Offsite Disposal), Limited Metals-Impacted Soil Excavation with Onsite Consolidation, Asphalt Cap with Stormwater Control, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater/Surface Monitoring, and Periodic Review.

This alternative includes source control via free product removal, excavation and offsite disposal of petroleum hydrocarbon-impacted soil from the western portion of the site and excavation and offsite disposal of lead-acid battery casings and associated impacted soil south of the former red brick building, as described in Alternative 1. This alternative also includes additional limited excavation of metals-impacted soil (approximately 700 cubic yards) along portions of the property boundary as indicated on Figure 9-1. Soil from along the property boundary areas will be excavated vertically until confirmational samples show that the site soil cleanup levels (MTCA Method A Industrial) have been achieved. Although relatively high concentrations of lead were detected at the property boundary, the metals-impacted soil is not anticipated to have extended a significant distance offsite (if at all). This area has been historically unpaved; therefore, surface water infiltration is more likely to have occurred rather than surface water runoff onto adjacent properties. For the purposes of this FS, a 5-foot wide buffer zone excavated to an average depth of 3 feet bgs has been assumed along portions of the property boundary (refer to Figure 9-1). In actuality, it is likely that only 1 foot may need to be excavated along the property boundary encompassing the western portion of the site, while excavation may be required down to 4 to 6 feet along a limited portion of the eastern property boundary in the vicinity of TP-46. Excavated metals-impacted soil will be consolidated and placed in the central portions of the site in a manner that will assist in bringing the ground surface to grade prior to cap installation. Imported clean fill material will be used to backfill all the excavated areas.

This alternative also includes installation of the asphalt cap and stormwater collection system, enhanced biodegradation of the groundwater plume, institutional controls, groundwater and surface water compliance monitoring, and periodic reviews, as described in Alternative 1.

Alternative 3: Source Control (Free Product Removal and Petroleum Hydrocarbon-Impacted Soil Excavation), Limited Metals-Impacted Soil Excavation, Onsite Treatment & Reuse of Excavated Soil, Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater/Surface Monitoring, and Periodic Review.

This alternative is the same as Alternative 2, with the exception that excavated petroleum hydrocarbon- and metals-impacted soil removed from the various excavation areas will be treated onsite and reused as backfill material. Prior to treatment, the excavated soil will be sieved or mechanically separated to remove debris materials. The debris materials will be characterized and either recycled or disposed of at a permitted offsite disposal facility. Petroleum hydrocarbon-impacted soil will be treated by thermal desorption using a mobile thermal desorption unit. The metals-impacted soil will be treated via chemical stabilization. Imported clean fill material will be used as necessary to make up the balance of fill material required to backfill the excavation areas and bring to site to grade prior to cap installation.

9.2.3 Preliminary Analysis of Alternatives

A remedial action must meet the following threshold criteria to be considered a "cleanup" under MTCA [WAC 173-340-360(2)]:

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable state and federal laws
- Provide for compliance monitoring.

An alternative is not available for selection if it cannot meet these threshold requirements. This section presents a preliminary analysis of each of the alternatives using these criteria to assess whether the alternatives are available for selection for the site.

A cleanup is presumed to be protective of human health and the environment at the site if it achieves the cleanup levels. Compliance with cleanup standards involves achieving cleanup levels, establishing points of compliance, and complying with applicable federal and state laws (ARARs). Compliance monitoring assesses the protection of human health and the environment during construction and the operation and maintenance period of a cleanup action (protection monitoring). Compliance monitoring also confirms that the remedial action has met cleanup standards (performance monitoring) and verifies its long-term effectiveness (confirmational monitoring).

Compliance with the threshold requirements does not mean that hazardous substances cannot remain onsite untreated. MTCA recognizes that containment can comply with cleanup standards, provided that compliance monitoring is included to ensure the long-term integrity of the containment system.

Table 9-2 identifies potential action-specific ARARs. Table 9-3 identifies the proposed site cleanup levels that include both MTCA cleanup levels as defined in WAC 173-340 and other chemical-specific ARARs that are considered applicable to the site. Tables 9-7 and 9-8 present an evaluation of each alternative's ability to meet these potential ARARs.

Three alternatives were developed to address site conditions (refer to Section 9.2.2.3). All three alternatives include containment (asphalt cap), deed restrictions, and compliance monitoring as well as treatment of impacted groundwater in the western portion of the site. Alternatives 1 and 2 achieve site soil cleanup levels through excavation and offsite disposal of petroleum hydrocarbon-impacted soil in limited areas of the site where attainment of cleanup levels is practicable and necessary for the protection groundwater. Alternative 2 also achieves site soil cleanup levels for COCs at the property boundary through excavation and onsite consolidation of metals-impacted soil, thus providing additional containment of COCs remaining onsite above site cleanup levels. Alternative 3 achieves soil cleanup levels for COCs using onsite treatment processes that allows onsite reuse of soil removed from the limited excavation areas. Table 9-9 summarizes the evaluation of these alternatives with MTCA's threshold criteria. In the evaluations, compliance with cleanup standards includes only a discussion of the point of compliance because the other threshold criteria include descriptions of the remaining components of the cleanup standards (i.e., cleanup levels and compliance with ARARs).

MTCA requires that alternatives meet the threshold criteria, at a minimum, to be eligible for selection as a cleanup action. Based on the evaluation presented in Tables 9-7, 9-8, and 9-9, all alternatives meet the threshold criteria. All alternatives can achieve overall protection of human health and the environment. All the alternatives can comply with the cleanup standards (points of compliance, cleanup levels, and compliance with ARARs) through selective excavation, offsite disposal or onsite treatment, containment, institutional controls, compliance monitoring, and periodic reviews.

9.2.4 Detailed Analysis of Alternatives

In addition to meeting the threshold criteria, MTCA requires (WAC 173-340-360) that cleanup actions:

- Use permanent solutions to the maximum extent practicable
- Provide for a reasonable restoration time frame
- Consider public concerns raised during the public comment period.

Permanent solutions are actions that meet cleanup standards without requiring further remedial activities at or off the site [WAC 173-340-360(5)(b)]. Permanent solutions must prevent or minimize future releases of hazardous substances; provide for a net reduction in the amount of hazardous substances being released from the source area; and not rely on institutional controls and monitoring, offsite disposal, or dispersion and dilution if active remedial measures are technically possible [WAC 173-340-360(5)(e)].

Ecology recognizes that permanent solutions may not be practicable for all sites. The following criteria are used to determine whether a cleanup action is permanent to the maximum extent practicable.

9.2.4.1 Overall Protection of Human Health and the Environment

This criterion evaluates the degree to which existing risks are reduced, the time required to reduce the risks and achieve cleanup standards, onsite and offsite risks resulting from implementation of the alternative, the degree the cleanup action may surpass the specific standards in WAC 173-340-700 through -760, and improvement of the overall environmental quality. Because overall protection of human health and the environment was evaluated for each alternative in Section 9.2.3.1, it is not evaluated further in this section.

9.2.4.2 Compliance with ARARs

This criterion evaluates how each alternative complies with federal and state ARARs. Tables 9-7 and 9-8 present evaluations of ARARs for each alternative.

9.2.4.3 Long-term Effectiveness

Long-term effectiveness evaluates the degree of certainty that the alternative will be successful, long-term reliability, the magnitude of residual risk, and the effectiveness of controls required to manage treatment residues or remaining wastes.

9.2.4.4 Short-term Effectiveness

Short-term effectiveness describes the protection of human health and the environment during remediation and the degree of risk prior to achieving cleanup standards.

9.2.4.5 Permanent Reduction of Toxicity, Mobility, and Volume of the Hazardous Substance

This criterion evaluates an alternative's ability to permanently and significantly reduce toxicity, mobility, or volume of the contaminated material. This criterion includes an evaluation of the alternative's adequacy in destroying the hazardous substance, reduction or elimination of the hazardous substance releases and source of releases, degree of irreversibility of the waste treatment process, and the characteristics and quantity of treatment residuals generated.

9.2.4.6 Ability to Be Implemented

Ability to be implemented considers whether the alternative is technically possible; the availability of necessary offsite facilities, services and materials; administrative and regulatory requirements; scheduling, size, and complexity; monitoring requirements; access for construction, operations, and monitoring; and integration with existing facility operations and other current or potential remedial actions.

9.2.4.7 Cost

The cost criterion is used to select from among two or more cleanup action alternatives that are equivalent with respect to cleanup technologies and process options. Costs are also used to determine practicability. A cleanup action is not considered practicable if the incremental cost of the cleanup action is substantial and disproportionate to the incremental degree of protection achieved compared to a lower preference cleanup action.

The detailed analysis of alternatives using these MTCA criteria is presented in Tables 9-10 through 9-14.

Selection of a cleanup alternative must also involve the restoration time frame. Establishment of a restoration time frame should consider:

- Potential risks posed by the site
- Practicability of achieving a shorter restoration time frame
- Current and future uses of the site, surrounding areas, and associated resources that are, or could be, affected by releases of hazardous substances
- Availability of alternative water supplies
- Likely effectiveness and reliability of institutional controls
- Ability to control and monitor hazardous substance migration from the site
- Toxicity of the hazardous substances
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site, or under similar site conditions.

Community concerns would be addressed by following the requirements described in WAC 173-340-550(5)(c)(iii). These requirements include:

- Sending written notification of the proposed remedial action to various parties
- Posting a sign at the site indicating what remedial actions are being conducted
- Identifying a party to contact for more information.

9.2.5 Comparative Analysis of Alternatives

9.2.5.1 Long-term Effectiveness

All the alternatives offer long-term effectiveness in reducing exposure pathways and protecting potential receptors even though impacted soil above site cleanup levels will remain in place. All three alternatives reduce the magnitude of residual risk to acceptable levels through containment of impacted soil left in place via installation of an asphalt cap and stormwater collection system. The asphalt cap will prevent direct contact with impacted soil and decrease (or eliminate) the infiltration of surface water and the potential migration of COCs left in place in the shallow soil from leaching to the uppermost saturated zone. Provided the asphalt cap is maintained through regular inspections, caps have been proven reliable in effectively reducing long-term surface water infiltration. Alternatives 2 and 3 provide for additional containment along the property boundaries providing a buffer between impacted soil remaining onsite and adjacent properties. Alternative 3 requires the implementation of two treatment processes. While both treatment processes have been implemented successfully, there remains some uncertainties regarding the effectiveness of thermal treatment in destroying contaminants and the ability of chemical stabilization in reducing the long-term potential for leaching of metals from soil. All the alternatives also include the removal of lead-acid battery casings and associated impacted soil, which could act as a potential continual source of lead in soil, if left in place.

All three alternatives include groundwater treatment via enhanced biodegradation, a process that has been proven to be effective at sites where groundwater has been impacted by petroleum hydrocarbons and related compounds. All the alternatives include removal of free product and removal of petroleum hydrocarbon-impacted soil (source removal) that currently intercepts the shallow groundwater that will provide for long-term effectiveness of groundwater remediation.

9.2.5.2 Short-term Effectiveness

Each alternative offers similar degrees of short-term risks. Each involves the disruption of soil containing COCs and the potential for producing fugitive dust and/or organic vapors. However, these risks are easily managed by standard dust control measures. During performance of all three alternatives, remedial workers would be adequately protected with clothing and respirators, if required, during construction and operation of the remedial action. Installation of an asphalt cap (all alternatives) is routine construction that would not significantly impact remedial workers, the community, or the environment. Treatment residuals resulting from Alternative 3 (thermal treatment) would be managed in accordance with applicable state and federal regulations.

Each alternative poses minimal potential risks to remedial workers from exposure to free product, lead-acid battery casings, COC-impacted soil, falling hazards, and work around heavy equipment for protracted periods. Open excavations and stockpiles could also pose a threat to the environment due to the potential contamination of stormwater runon and runoff. Fencing, onsite controls (i.e., barricades), and management of stockpiled materials through covering and/or construction of stormwater runon/runoff berms, can effectively be used to control these potential threats. Although Alternative 3 (thermal treatment) has short-term risks associated with air emissions, air pollution controls can be implemented to comply with air quality standards.

9.2.5.3 Permanent Reduction of Toxicity, Mobility, and Volume

Alternative 3 (thermal treatment/chemical stabilization) would destroy and immobilize COCs in the soil from specific excavation areas to site soil cleanup levels thus reducing overall toxicity, mobility, and volume of soil exceeding site cleanup levels remaining onsite. Alternatives 1 and 2 manage COCs at a permitted offsite landfill where long-term mobility of COCs should not pose a significant concern. All the alternatives include an asphalt cap that reduces the mobility of residual COCs left in place above site cleanup levels through placement of an impermeable barrier above the residual impacted soil. The volume of petroleum hydrocarbon-impacted soil above site cleanup levels will be reduced by all the alternatives. The volume of metals-impacted soil remaining onsite is the same for all the alternatives; however, chemical stabilization (Alternative 3) will significantly reduce the potential mobility of metals in soil after treatment.

All three alternatives include potential reuse of soil. Recycling and/or reuse ranks the highest on Ecology's preferred remedial methods. Alternative 3 offers the greatest potential for onsite reuse. Treated soil (thermal/chemical stabilization) will be used as backfill material for the excavation areas and to bring the site to grade for asphalt cap installation. Alternatives 1 and 2 offer the potential for offsite reuse of soil transported to a permitted offsite disposal as daily landfill cover, if deemed suitable by the facility; however, the amount of debris material likely to be present in the soil may limit its use by the facility. Alternative 2 reuses untreated shallow metals-impacted soil excavated from the property boundary buffer zone, for onsite consolidation and grading within the shallow metals-impacted soil footprint.

All three alternatives include groundwater treatment via enhanced biodegradation which will reduce the toxcity of the COCs in groundwater. All the alternatives include removal of free product and removal of petroleum hydrocarbon-impacted soil (source removal) that currently intercepts the shallow groundwater that will provide for permanent reduction of COCs in groundwater.

9.2.5.4 Ability to be Implemented

Alternative 1 would be the simplest to implement because it involves routine construction activities and the excavation and handling of the least amount of soil. Alternative 2 would be slightly more complex due to the additional areas being excavated along the property boundary and the consolidation/grading within the shallow metals-impacted soil footprint. Alternative 3 would be the most complex alternative to implement. This alternative includes additional handling of the soil to separate and remove debris materials as well as implementing the two separate treatment processes. All the alternatives include treatment of groundwater via enhanced biodegradation. Introduction of ORC® to the saturated zone can be easily implemented by placing ORC® at the base of the excavation area prior to backfilling and/or by borehole injection or through existing monitoring wells throughout the plume. This technology has been successfully implemented at many sites. A limited treatability study would need to be performed to obtain the optimum design for implementation.

All the alternatives require excavation (up to 10 feet bgs) to the water table that may require shoring. If shoring is not used, the excavation areas will need to be expanded to accommodate sidewall sloping and/or benching, which will result in the excavation and management of a larger volume of soil. Alternatives 2 and 3 also include shallow excavation (3 feet or less) along the property boundary. This excavation will not require shoring; however, access to adjacent properties may limit the ability to excavate to site cleanup levels beyond the property boundary. Alternative 3 involves uncertainties regarding the thermal treatment process and the ability to chemically stabilize soils containing high organic carbon and petroleum hydrocarbons. These uncertainties could be overcome by passing metals-impacted soil through the thermal treatment unit prior to chemical stabilization. However, this would require additional handling of the soil and pretreatment of a portion of the soil. Additional handling will be required prior to the treatment in order to remove debris materials that may impact the effectiveness of the treatment processes. A limited bench-scale test would be required for the chemical stabilization process to identify the optimum chemical mixture. Soil moisture conditions, materials handling problems, presence of wood and debris, and air pollution control system performance deficiencies could also adversely affect the thermal treatment process.

Permits for the alternatives are expected to be relatively easily obtainable, although the permitting process could take up to 6 months. Delays resulting from acquiring permits can be mitigated by developing an Agreed Order or Consent Decree for the remedial action in accordance with WAC 173-340-530, which requires substantial compliance with administrative requirements. The availability of offsite facilities, services, and materials is adequate for Alternatives 1 and 2. However, the availability of a mobile thermal treatment unit or a mobile chemical stabilization unit is unknown. All the alternatives can be monitored effectively during remedial action implementation to assess the attainment of site cleanup levels.

9.2.5.5 Cost

A summary of costs for the alternatives is presented in Table 9-14, and detailed cost information is provided in Appendix P. Alternative 1 is the least expensive remedial alternative. This alternative would have the greatest amount of soil above site cleanup levels remaining onsite; however, the residual COCs would be adequately contained by the asphalt cap. Alternative 2 has the same amount of residual soil above site cleanup levels remaining onsite as Alternative 1 but provides for additional containment and consolidation through the creation of the buffer zone along the property boundary. Alternative 3 is the most expensive remedial alternative due to the implementation of two different treatment processes required to treat the different types of COCs encountered in site soil (i.e., petroleum hydrocarbon- and metals-impacted soil). Alternative 3 reduces the overall amount of soil above site cleanup levels with the potential capacity to leach to groundwater remaining onsite.

9.2.5.6 Restoration Time Frame

The permitting, design, and construction activities (excavation, offsite disposal and/or onsite consolidation, capping) associated with Alternatives 1 and 2 could be accomplished in approximately 3 to 6 months. Alternative 3 could require 8 to 12 months to complete, with additional time needed for treatability testing and identification of appropriate contractors with suitable equipment. The restoration time for groundwater remediation is anticipated to be accomplished in 1 to 3 years. Due to the amount of organic material present in the saturated zone, it is possible that several phased applications of ORC® may be required to attain site groundwater cleanup levels. The treatability study will determine the optimum remediation approach. Performance monitoring will be used to determine whether additional applications of ORC® are required.

9.2.5.7 Community Concerns

Community concerns will be addressed as described in Section 9.2.4.7.

9.2.6 Recommended Alternative

The recommended alternative for the site is Alternative 2. Alternative 2 provides for the containment of residual soil containing COCs above site cleanup levels through installation of the asphalt cap (including a stormwater collection system) and a perimeter buffer zone between residual impacted soil onsite and adjacent properties. This alternative also includes institutional controls, compliance monitoring, and periodic reviews in accordance with the MTCA requirement for alternatives using engineering controls to comply with cleanup standards. This alternative also includes remediation of impacted groundwater beneath the western portion of the site. Future concerns regarding human and ecological exposure to residual impacted soil, shallow groundwater, and surface water will be substantially reduced or eliminated by the containment system and groundwater remediation.

Offsite disposal provides for the shortest time requirement for achieving site soil cleanup levels and offers the greatest degree of certainty that soil cleanup levels in designated areas of the site will be achieved over the long-term. Uncertainties exist regarding the effectiveness of thermal treatment due to high organic and moisture content of the soil. The effectiveness of chemical stabilization is also questionable due to the presence of petroleum hydrocarbons. Addressing these issues would require pre-treatment of soil containing metals and additional material handling. There are also some uncertainties regarding the long-term potential for leaching from chemically stabilized soil.

Alternative 2 involves routine construction activities including excavation, stockpiling, backfilling and compaction, grading, and installation of an asphalt cap. This alternative requires more material handling than Alternative 1 due to the additional excavation along the property boundaries and onsite consolidation; however, significantly less material handling is required for Alternative 2 than Alternative 3.

Alternative 2 is moderately expensive. Alternative 2 is more expensive than Alternative 1 due to the additional excavation areas and material handling. Alternative 2 is less expensive than Alternative 3, which includes two separate treatment processes. The incremental cost associated with the treatment processes in Alternative 3 is considered to be disproportionate to the incremental degree of protection it would achieve [WAC 173-340-360(5)(vi)] given the uncertainties outlined above.

9.2.7 Additional Field Investigations in Support of the Remedial Design

Additional field investigations may be required in support of the recommended remedial alternative. As indicated, a limited treatability study will be required prior to implementation of the recommended remedial alternative to determine the optimum approach for enhanced biodegradation of impacted groundwater beneath the western portion of the site. The limited treatability study may include the collection of additional groundwater samples from existing site wells for analysis of redox potential, pH, dissolved oxygen, ferrous iron, biochemical oxygen demand, and chemical oxygen demand. The study may also include the installation of additional groundwater monitoring wells to further define the lateral extent of the plume offsite toward the Puyallup River. While additional information appears warranted in some locations of the site, the information developed will not substantially change the proposed remedial alternative. These additional investigations will be presented in a pre-engineering design document that will be prepared upon approval by Ecology of the proposed site cleanup levels and recommended remedial alternative.

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Tables

TABLE 2-1

MONITORING WELL CONSTRUCTION DETAILS
Former Tacoma Metals Facility

Well Designation	Previous Designation[a]	Date of Installation	Casing Diameter/ Construction	Borehole Diameter	ToC Elevation (ft)[b,c]	Total Well Depth (ft)	Length of Screen (ft)	Slot Size (in)
MW-1	MW-1	25-Aug-92	2 inch / PVC	9 inch	12.23	16.5	6	0.010
MW-2	MW-2	25-Aug-92	2 inch / PVC	9 inch	12.04	16.5	6	0.010
MW-3(D)[d]	MW-3	26-Aug-92	2 inch / PVC	9 inch	NA	16.5	6	0.010
MW-4(R)[e]	NMW-2	9-May-00	2 inch / PVC	9 inch	12.55	22.8	17.8	0.010
MW-5	MW-5	27-Aug-92	2 inch / PVC	9 inch	10.9	16.5	6	0.010
MW-6	MW-6	26-Aug-92	2 inch / PVC	9 inch	10.07	16.5	6	0.010
MW-7	MW-7	11-Sep-92	2 inch / PVC	9 inch	9.45	16.5	6	0.010
MW-8(R)[f]	NMW-3	9-May-00	2 inch / PVC	9 inch	11.16	23.6	18.6	0.010
MW-9	NMW-1	9-May-00	2 inch / PVC	9 inch	13.61	23.5	18.5	0.010
MW-10	NMW-4	10-Nov-00	2 inch / PVC	9 inch	9.41	20	12	0.010
MW-11	NMW-5	10-Nov-00	4 inch / PVC	12 inch	9.47	20	14	0.020
MW-12	NMW-6	10-Nov-00	4 inch / PVC	12 inch	10.8	20	12	0.020

Notes:

(a) Wells installed in 2000 by Kennedy/Jenks Consultants were initially designated NMW-# but were subsequently numbered in sequential order with the existing site monitoring wells. The critical NMW-# designations are used in some of the analytical reports for groundwater samples (Appendix L) and for geotechnical soil samples (Appendix F).
(b) ToC elevations are based on a survey performed by Earth Tech on 21 November 2000.
(c) Elevations measured at north side of PVC casing.
(d) MW-3(D) was originally installed on 26 August 1992 by Pacific Groundwater Group. MW-3(D) was demolished (D) by a former Tacoma Metals site tenant.
(e) MW-4(R) was originally installed on 26 August 1992 by Pacific Groundwater Group. MW-4(R) was replaced (R) 9 May 2000 by Kennedy/Jenks Consultants.
(f) MW-8(R) was originally installed on 25 August 1992 by Pacific Groundwater Group. MW-8(R) was replaced (R) 9 May 2000 by Kennedy/Jenks Consultants.

PVC - Polyvinyl chloride (Schedule 40)
ToC - Top of well casing
in - inches
ft - feet

TABLE 3-1

GEOTECHNICAL TESTING RESULTS
Former Tacoma Metals Facility

Boring Identification	Lithology	Sample Depth (ft)	Total Porosity %[a]	Vertical Hydraulic Conductivity (Kv)(cm/s)[a]	TOC %[b]	CEC (meq/100 g)[c]	Total Solids %[d]
MW-4(R)	Medium to fine sand	0.5-1.0	0.53	2.0x10^{-2}	16	4.9	93.1
MW-8(R)	Sandy silt with clay	6-6.5	0.552	8.3x10^{-7}	7.3	26	54.8
MW-9	Fine sand with silt and gravel	10.5-11	0.48	3.2x10^{-5}	0.99	6.5	69.6
MW-9	Medium to fine sand	15-16	0.39	3.8x10^{-3}	0.47	2.4	82.8

Notes:

(a) Geotechnical testing was conducted according to ASTM D-5084.
(b) Soil samples were analyzed for total organic carbon (TOC) by Plumb1981.
(c) Soil samples were analyzed for cation exchange capacity (CEC) by EPA Method 9076.
(d) Soil samples were analyzed for total solids by EPA Method 160.3.

ft - feet
% - percent
cm/s - centimeters per second
meq/100 g - milliequivalent per 100 grams

TABLE 3-2

GROUNDWATER ELEVATION MONITORING SUMMARY

Former Tacoma Metals Facility

Well Number	Top of Well Casing Elevation (ft)(a)	Water Elevation (ft)(a) 1/31/01		Water Elevation (ft)(a) 2/13/01		Water Elevation (ft)(a) 2/28/01	
		High Tide	Low Tide	High Tide	Low Tide	High Tide	Low Tide
MW-1	12.23	1.61	0.95	1.42	0.96	1.45	0.94
MW-2	12.04	1.33	0.26	1.22	0.33	1.24	0.21
MW-4(R)	12.55	2.49	0.98	2.03	1.00	2.31	1.03
MW-5	10.90	2.54	0.71	2.39	0.73	2.38	0.54
MW-6	10.07	2.21	0.55	2.04	0.64	2.05	0.54
MW-7	9.45	2.30	2.27	2.41	2.37	2.09	2.09
MW-8(R)	11.16	2.40	1.31	2.27	1.44	2.20	1.44
MW-9	13.61	1.58	0.74	1.42	1.10	1.44	1.00
MW-10	9.41	2.34	2.25	2.39	2.32	2.12	2.06
MW-11	9.47	2.29	2.23	2.41	2.36	2.09	2.08
MW-12	10.80	2.22	1.78	2.40(b)	1.86(b)	2.16(c)	1.38(c)

Notes:

(a) Vertical elevation in feet relative to mean sea level (MSL) based on a well survey performed by Earth Tech, Inc. on 21 November 2000. Elevations are based on the City of Tacoma datum.

(b) Product present in well on 13 February 2001; measured product elevation 1.91 feet MSL at low tide.

(c) Product present in well on 28 February 2001; measured product elevations 2.69 feet MSL at high tide and 1.79 feet MSL at low tide.

ft - feet

TABLE 3-3

ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY AND GROUNDWATER SEEPAGE VELOCITY FROM SLUG TESTING

Former Tacoma Metals Facility

	Horizontal Hydraulic Conductivity (Kh[a]			Average Horizontal Hydraulic Conductivity ($Kh_{(avg)}$)[b]		Estimated Groundwater Seepage Velocity (V)[c,d,e]
Well #	**Test #**	**(ft/min)**	**(cm/sec)**	**(ft/min)**	**(cm/sec)**	**(ft/year)**
MW-1	1	2.35E-02	1.19E-02			
	2	3.15E-02	1.60E-02			
	3	3.87E-02	1.96E-02			
	4	4.05E-02	2.06E-02			
	5	4.01E-02	2.04E-02	3.4E-02	1.7E-02	147
MW-2	1	2.91E-02	1.48E-02			
	2	3.61E-02	1.83E-02			
	3	3.27E-02	1.66E-02			
	4	3.41E-02	1.73E-02			
	5	3.77E-02	1.91E-02	3.4E-02	1.7E-02	145
MW-5	1	2.78E-03	1.41E-03			
	2	2.22E-03	1.13E-03			
	3	2.13E-03	1.08E-03			
	4	2.34E-03	1.19E-03			
	5	2.48E-03	1.26E-03	2.4E-03	1.2E-03	10
MW-7	1	4.83E-03	2.45E-03			
	2	6.33E-03	3.22E-03			
	3	6.69E-03	3.40E-03			
	4	5.09E-03	2.58E-03			
	5	5.75E-03	2.92E-03	5.7E-03	2.9E-03	24
MW-8(R)	1	1.62E-02	8.21E-03			
	2	1.75E-02	8.90E-03			
	3	2.76E-02	1.40E-02			
	4	2.44E-02	1.24E-02			
	5	3.00E-02	1.52E-02	2.2E-02	1.1E-02	96
MW-9	1	1.89E-02	9.59E-03			
	2	1.44E-02	7.31E-03			
	3	1.90E-02	9.67E-03			
	4	1.44E-02	7.33E-03			
	5	1.74E-02	8.83E-03	1.7E-02	8.5E-03	72
Average Values for All Wells:				**1.3.E-02**	**6.8.E-03**	**82**

Notes:

(a) Graphs of all slug tests are included in Appendix G

(b) Average hydraulic conductivity calculated as geometric mean.

(c) Groundwater seepage velocity (V) = ($Kh_{(avg)}$ * (hydraulic gradient[d] / porosity[d]))

(d) Hydraulic gradient = 0.004; Porosity = 0.49

(e) Estimated seepage velocity does not consider hydraulic gradient reversals caused by tital influences.

TABLE 4-1
SOIL ANALYTICAL RESULTS - METALS
Former Tacoma Metals Facility

Sample Designation	Sample Depth	Sample Date	Total Metals (mg/kg)[a]								
			Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver
TP-1	0-1'	9/27/00	40	290	8.5	76	873	***2,230***	1.53	<10	1.4
	2-3'	9/27/00	---[b]	---	---	---	---	120	0.11	---	---
	4-6'	9/27/00	---	---	---	---	---	90	---	---	---
	6-10'	9/27/00	---	---	---	---	---	30	---	---	---
TP-2	0-1'	9/27/00	<10[c]	404	18.2	67	1,090	831	0.88	<10	0.9
	2-3'	9/27/00	<5	47.2	<0.2	18.6	20	10	0.04	<5	<0.3
	4-6'	9/27/00	<6	58.1	<0.2	15.4	35.2	85	<0.06	<6	0.4
	6-10'	9/27/00	<6	53.8	1.1	18.6	79.6	72	0.13	<6	<0.4
TP-3	0-1'	9/27/00	<5	63.5	2.7	26.9	44.1	46	0.13	<5	<0.3
	2-3'	9/27/00	---	---	---	---	---	---	---	---	---
	4-6'	9/27/00	7	63.8	0.4	15.4	33.2	106	0.21	<7	<0.4
	6-10'	9/27/00	<10	110	<0.5	18	42.4	93	0.13	<10	<0.7
TP-4	0-1'	9/27/00	30	609	21.6	82	4,650	***1,760***	0.55	<10	1.2
	2-3'	9/27/00	---	---	8	---	---	443	---	---	---
	4-6'	9/27/00	---	---	---	---	---	160	---	---	---
	6-10'	9/27/00	<7	60.1	<0.3	16.9	24.6	9	<0.06	<7	<0.4
TP-5	0-1'	10/4/00	<5	59.4	<0.2	59.9	28	8	<0.05	5	0.4
	2-3'	10/4/00	---	---	---	---	---	---	---	---	---
	4-6'	10/4/00	<6	67.7	<0.3	38.2	37.3	56	0.20	<6	<0.4
	6-10'	10/4/00	<10	52.3	<0.5	24	56.1	248	0.3	<10	<0.8
TP-6/600[d]	0-1'	10/4/00	30/30	196/208	5.6/4.9	92/59	711/237	***1,550***/867	0.5/0.45	20/20	1.9/2.1
	2-3'	10/4/00	---	---	---	---	---	54	---	---	---
	4-6'	10/4/00	---	---	---	---	---	40	---	---	---
	6-10'	10/4/00	---	---	---	---	---	60	---	---	---
TP-7	0-1'	10/4/00	10	697	12.3	103	361	796	0.88	8	1.5
	2-3'	10/4/00	---	---	9	---	---	---	---	---	---
	4-6'	10/4/00	---	---	---	---	---	---	---	---	---
	6-10'	10/4/00	---	---	---	---	---	---	---	---	---
TP-8	0-1'	10/4/00	<5	235	0.9	33.9	41	31	<0.05	<5	0.3
	2-3'	10/4/00	---	---	---	---	---	---	---	---	---
TP-8/800	4-6'	10/4/00	<6/<5	38.4/42.1	0.3/<0.2	17.5/15.7	29.6/47.8	25/26	<0.06/<0.05	<6/<5	<0.4/0.7
	6-10'	10/4/00	---	---	---	---	---	---	---	---	---
TP-9	0-1'	10/5/00	40	1,990	59	132	1,260	***1,960***	0.90	<30	<2
	2-3'	10/5/00	---	---	---	---	---	20	---	---	---
	4-6'	10/5/00	<6	224	2.1	24.2	59.9	93	<0.05	<6	<0.4
	6-10'	10/5/00	---	---	---	---	---	---	---	---	---
TP-10	0-1'	10/5/00	<5	218	4.2	49.2	217	460	0.54	7	0.5
	2-3'	10/5/00	---	---	---	---	---	---	---	---	---
	4-6'	10/5/00	<5	61	0.7	32.2	60.3	72	0.07	<5	0.3
	6-10'	10/5/00	<6	49.5	0.4	28.8	29.3	15	<0.06	<6	<0.4
MTCA Method C Industrial Soil Cleanup Levels [e]			219	245,000	3,500	500[f]	130,000	1,000[f]	1,050	17,500	17,500

Analytes detected in samples at concentrations exceeding respective cleanup levels are shown in bold and italics.

TABLE 4-1
SOIL ANALYTICAL RESULTS - METALS
Former Tacoma Metals Facility

Sample Designation	Sample Depth	Sample Date	Total Metals (mg/kg)[a]								
			Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver
TP-11	0-1'	10/5/00	<5	254	5.7	54.4	157	202	0.27	5	0.3
	2-3'	10/5/00	---	---	---	---	---	---	---	---	---
	4-6'	10/5/00	---	---	---	---	---	---	---	---	---
	6-10'	10/5/00	<9	164	<0.3	18.4	31.5	57	0.1	<9	<0.5
TP-12	0-1'	10/5/00	<5	37.5	3.3	19.4	21.3	17	<0.04	<5	<0.3
	2-3'	10/5/00	---	---	---	---	---	---	---	---	---
	4-6'	10/5/00	---	---	---	---	---	---	---	---	---
	6-10'	10/5/00	---	---	---	---	---	---	---	---	---
TP-13	0-1'	10/5/00	<5	96	3	49.3	266	167	0.71	<5	1
	2-3'	10/5/00	---	---	---	---	---	---	---	---	---
	4-6'	10/5/00	---	---	---	---	---	---	---	---	---
	6-10'	10/5/00	---	---	---	---	---	---	---	---	---
TP-14	0-1'	10/6/00	<5	41.8	<0.2	22.2	13	8	<0.05	<5	<0.3
	2-3'	10/6/00	---	---	---	---	---	560	---	---	---
	4-6'	10/6/00	---	---	---	---	---	20	---	---	---
	6-10'	10/6/00	<6	84.9	2.3	35.3	78.6	152	0.07	<6	<0.4
TP-15	0-1'	10/6/00	<5	42.6	<0.2	32.8	29.4	79	<0.04	<5	0.3
	2-3'	10/6/00	---	---	---	---	---	---	---	---	---
	4-6'	10/6/00	---	---	---	---	---	---	---	---	---
	6-10'	10/6/00	---	---	---	---	---	---	---	---	---
TP-16/160	0-1'	10/6/00	40/30	999/592	45/22	105/85	804/1,210	***2,590/2,040***	1.82/2.19	<30/<30	2/2
	2-3'	10/6/00	---	---	68	---	---	***8,240***	---	---	---
TP-17	0-1'	10/6/00	60	272	15	120	2,930	***1,470***	0.4	<50	<3
	2-3'	10/6/00	---	---	---	---	---	30	---	---	---
	4-6'	10/6/00	---	---	---	---	---	30	---	---	---
	6-10'	10/6/00	---	---	---	---	---	20	---	---	---
TP-18	0-1'	10/10/00	8	107	3.3	26.3	451	311	0.88	<5	0.9
	2-3'	10/10/00	---	---	---	---	---	---	---	---	---
	4-6'	10/10/00	---	---	---	---	---	---	---	---	---
	6-10'	10/10/00	---	---	---	---	---	---	---	---	---
TP-19	0-1'	10/10/00	20	111	4	46	1,060	204	1.35	<10	3.4
	2-3'	10/10/00	---	---	---	---	---	---	---	---	---
	4-6'	10/10/00	---	---	---	---	---	---	---	---	---
	6-10'	10/10/00	---	---	---	---	---	---	---	---	---
TP-20	0-1'	10/10/00	<6	35.9	<0.2	22	17.2	6	<0.06	6	<0.3
TP-20/2000[g]	2-3'	10/10/00	20/<10	304/292	17/26.2	84/83	6,970/4,350	***6,790/10,200***	0.94/0.95	<30/<10	<2/2.8
	4-6'	10/10/00	---	---	1	---	---	540	---	---	---
	6-10'	10/10/00	---	---	---	---	---	230	---	---	---
MTCA Method C Industrial Soil Cleanup Levels [e]			219	245,000	3,500	500[f]	130,000	1,000[f]	1,050	17,500	17,500

Analytes detected in samples at concentrations exceeding respective cleanup levels are shown in bold and italics.

TABLE 4-1
SOIL ANALYTICAL RESULTS - METALS
Former Tacoma Metals Facility

Sample Designation	Sample Depth	Sample Date	Total Metals (mg/kg)(a)								
			Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver
TP-21	0-1'	10/10/00	70	1,580	66	***574***	12,800	***6,020***	22.4	<30	31
	2-3'	10/10/00	<300	4,190	130	***1,080***	13,200	***7,570***	10.2	<300	90
	4-6'	10/10/00	---	---	<1	42	---	20	---	---	---
	6-10'	10/10/00	---	---	---	---	---	50	---	---	---
TP-22	0-1'	10/10/00	30	372	51	***2,520***	13,000	***3,180***	5.3	<30	36
	2-3'	10/10/00	<60	464	52	***913***	20,200	***3,690***	5.1	<60	198
	4-6'	10/10/00	---	---	---	47	---	360	---	---	---
	6-10'	10/10/00	---	---	---	---	---	80	---	---	---
TP-23	0-1'	10/11/00	<5	40.4	<0.2	25.1	21.9	11	<0.04	<5	<0.3
	2-3'	10/11/00	30	376	15.3	127	1,560	***1,190***	1.21	<10	1.4
	4-6'	10/11/00	---	---	---	---	---	140	0.19	---	---
	6-10'	10/11/00	---	---	---	---	---	130	---	---	---
TP-24	0-1'	10/11/00	6	105	2.3	34.3	539	438	0.7	6	0.5
	2-3'	10/11/00	---	---	---	---	---	---	---	---	---
	4-6'	10/11/00	---	---	---	---	---	---	---	---	---
	6-10'	10/11/00	---	---	---	---	---	---	---	---	---
TP-25	0-1'	10/11/00	<5	52.5	0.3	28.4	151	48	0.14	<5	<0.3
	2-3'	10/11/00	---	---	---	---	---	---	---	---	---
	4-6'	10/11/00	---	---	---	---	---	---	---	---	---
	6-10'	10/11/00	---	---	---	---	---	---	---	---	---
TP-26	0-1'	10/11/00	<5	47.4	0.3	30.3	21.6	9	<0.05	<5	<0.3
	2-3'	10/11/00	---	---	---	---	---	---	---	---	---
	4-6'	10/11/00	<6	272	0.2	20.8	40.9	17	<0.05	<6	<0.3
	6-10'	10/11/00	<7	80.1	<0.3	17.3	31.1	13	<0.06	<7	<0.4
TP-27/270	0-1'	10/11/00	30/40	261/259	6.8/8.4	99/119	577/806	***5,000/14,700***	1.83/1.62	<10/<10	1.2/1.7
	2-3'	10/11/00	<10	217	6.2	49	3,130	575	1.82	<10	1.3
	4-6'	10/11/00	---	---	---	---	---	---	<0.06	---	---
	6-10'	10/11/00	---	---	---	---	---	---	---	---	---
TP-28	0-1'	10/11/00	20	382	16.5	91	789	***1,430***	1.56	10	1.5
	2-3'	10/11/00	20	444	16.5	88	3,000	***2,340***	1.12	<10	1.8
	4-6'	10/11/00	---	---	<1	---	---	<10	<0.05	---	---
	6-10'	10/11/00	---	---	---	---	---	7	---	---	---
TP-29	0-1'	10/12/00	5	67.9	0.2	29.7	24.6	16	<0.04	<5	<0.3
	2-3'	10/12/00	---	---	---	---	---	---	---	---	---
	4-6'	10/12/00	---	---	---	---	---	---	---	---	---
	6-10'	10/12/00	---	---	---	---	---	---	---	---	---
TP-30	0-1'	10/12/00	30	733	59.5	108	1,960	***2,410***	2.06	<10	2.6
	2-3'	10/12/00	20	805	21.2	90	540	***1,110***	0.57	<10	1.4
	4-6'	10/12/00	---	---	<1	---	---	<10	---	---	---
	6-10'	10/12/00	---	---	---	---	---	50	---	---	---
MTCA Method C Industrial Soil Cleanup Levels (e)			219	245,000	3,500	500(f)	130,000	1,000(f)	1,050	17,500	17,500

Analytes detected in samples at concentrations exceeding respective cleanup levels are shown in bold and italics.

TABLE 4-1
SOIL ANALYTICAL RESULTS - METALS
Former Tacoma Metals Facility

Sample Designation	Sample Depth	Sample Date	Total Metals (mg/kg)[a]								
			Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver
TP-31	0-1'	10/12/00	<10	558	19.3	58	417	***1,040***	0.63	<10	1
	2-3'	10/12/00	<10	189	6.4	40	182	387	0.42	<10	0.7
	4-6'	10/12/00	---	---	---	---	---	---	---	---	---
	6-10'	10/12/00	---	---	---	---	---	---	---	---	---
TP-32	0-1'	10/12/00	30	2,010	84	271	3,720	***4,470***	2.36	<30	3
TP-33	0-1'	10/12/00	40	3,070	89	353	2,970	***6,470***	2.91	<30	5
	2-3'	10/12/00	---	---	---	---	---	***4,560***	1.69	---	---
	4-6'	10/12/00	---	---	---	---	---	10	---	---	---
	6-10'	10/12/00	---	---	---	---	---	70	---	---	---
TP-34/340	0-1'	10/12/00	<10/<30	196/1,740	4/42	65.6/92	4,030/1,640	***1,530/5,100***	0.93/1.23	<10/<30	1.6/<2
	2-3'	10/12/00	30	1,400	52	91	1,570	***3,990***	1.08	<30	<2
	4-6'	10/12/00	---	---	---	---	---	***1,110***	<0.05	---	---
	6-10'	10/12/00	---	---	---	---	---	40	---	---	---
TP-35	0-1'	10/13/00	<10	290	8.4	153	1,260	***4,230***	0.52	<10	2.2
	2-3'	10/13/00	---	---	---	---	---	240	---	---	---
	4-6'	10/13/00	---	---	---	---	---	30	---	---	---
	6-10'	10/13/00	---	---	---	---	---	20	---	---	---
TP-36	0-1'	10/13/00	<10	54.5	0.9	31	39.3	36	0.12	<10	<0.6
	2-3'	10/13/00	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	<10	31.7	0.5	19	25.3	15	0.06	<10	<0.8
TP-37	0-1'	10/13/00	30	979	26.6	124	625	***1,900***	4.18	10	1.1
	2-3'	10/13/00	20	1,630	24.7	112	483	***1,630***	2.66	<10	<0.6
	4-6'	10/13/00	---	---	<1	---	---	20	<0.05	---	---
	6-10'	10/13/00	---	---	---	---	---	30	---	---	---
TP-38	0-1'	10/13/00	60	2,710	125	263	3,320	***9,380***	14.3	30	6
	2-3'	10/13/00	---	---	---	---	---	70	0.12	---	---
	4-6'	10/13/00	---	---	---	---	---	50	---	---	---
	6-10'	10/13/00	---	---	---	---	---	11	---	---	---
TP-39/390	0-1'	10/13/00	10/<10	110/134	13.2/16.8	30/27	1,100/107	***1,040***/374	0.21/0.24	<10/<10	<0.8/<0.7
	2-3'	10/13/00	---	---	10.4	---	---	---	---	---	---
	4-6'	10/13/00	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---
TP-40	0-1'	10/13/00	60	738	36	***670***	2,530	***3,700***	15	<50	4
	2-3'	10/13/00	<30	851	40	212	1,240	***2,050***	3.19	<30	3
	4-6'	10/13/00	<10	126	3.7	31	94	192	0.22	<10	<0.7
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---
MTCA Method C Industrial Soil Cleanup Levels [e]			219	245,000	3,500	500[f]	130,000	1,000[f]	1,050	17,500	17,500

Analytes detected in samples at concentrations exceeding respective cleanup levels are shown in bold and italics.

TABLE 4-1
SOIL ANALYTICAL RESULTS - METALS
Former Tacoma Metals Facility

Sample Designation	Sample Depth	Sample Date	Total Metals (mg/kg)(a)								
			Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver
TP-41	0-1'	10/16/00	<30	38	<1	39	20	20	5.5	<30	<2
	2-3'	10/16/00	---	---	---	---	---	---	---	---	---
	4-6'	10/16/00	---	---	---	---	---	---	---	---	---
	6-10'	10/16/00	---	---	---	---	---	---	---	---	---
TP-42	0-1'	10/16/00	<30	78	2	31	98	130	4.33	<30	<2
	2-3'	10/16/00	---	---	---	---	---	---	---	---	---
	4-6'	10/16/00	---	---	---	---	---	---	---	---	---
	6-10'	10/16/00	---	---	---	---	---	---	---	---	---
TP-43/430	0-1'	10/16/00	90/80	1,620/1,400	53/54	***564/566***	5,620/5,000	***5,840/9,370***	47/41	<30/<30	5/6
	2-3'	10/16/00	80	1,280	46	259	2,520	***12,300***	21	<30	5
	4-6'	10/16/00	---	---	<1	---	---	10	<0.04	---	---
	6-10'	10/16/00	---	---	---	---	---	70	---	---	---
TP-44	0-1'	10/13/00	<10	27.2	0.4	17.2	21.5	13	<0.05	<10	<0.6
	2-3'	10/13/00	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---
TP-45	0-1'	10/16/00	100	774	30	368	3,560	***4,060***	47	30	7
	2-3'	10/16/00	---	---	15	---	---	950	16	---	---
	4-6'	10/16/00	---	---	---	---	---	180	---	---	---
	6'-10'	10/16/00	---	---	---	---	---	80	---	---	---
TP-46	0-1'	10/16/00	40	302	15	***721***	1,820	***2,100***	10.6	<30	69
	2-3'	10/16/00	---	---	9	104	---	970	2.88	---	---
	4-6'	10/16/00	50	1,910	93	93	1,180	***4,320***	0.83	<30	2
	6'-10'	10/16/00	---	---	---	0.9	---	82	---	---	---
TP-47	0-1'	10/16/00	<30	33	<1	25	13	<10	<0.05	<30	<2
	2-3'	10/16/00	---	---	---	---	---	---	---	---	---
	4-6'	10/16/00	---	---	---	---	---	---	---	---	---
	6'-10'	10/16/00	---	---	---	---	---	---	---	---	---
TP-48	0-1'	10/17/00	40	232	8	52	588	630	0.45	<30	<2
	2-3'	10/17/00	---	---	---	---	---	---	---	---	---
	4-6'	10/17/00	---	---	---	---	---	---	---	---	---
	6'-8.5'	10/17/00	<70	67	<3	18	45	40	<0.1	<70	<4
TP-49	0-1'	10/17/00	<30	71	1	33	78	150	0.13	<30	<2
	2-3'	10/17/00	<30	64	<1	20	20	10	<0.05	<30	<2
	4-6'	10/17/00	<30	78	<1	15	20	150	0.44	<30	<2
	6'-10'	10/17/00	<50	51	<2	23	942	430	0.12	<50	<3
MTCA Method C Industrial Soil Cleanup Levels (e)			219	245,000	3,500	500(f)	130,000	1,000(f)	1,050	17,500	17,500

Analytes detected in samples at concentrations exceeding respective cleanup levels are shown in bold and italics.

TABLE 4-1
SOIL ANALYTICAL RESULTS - METALS
Former Tacoma Metals Facility

Sample Designation	Sample Depth	Sample Date	Total Metals (mg/kg)$^{(a)}$								
			Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver
TP-50/500	0-1'	10/17/00	<30/<30	208/293	8/18	37/55	1,100/530	380/570	0.49/0.61	<30/<30	<2/<2
	2-3'	10/17/00	<30	69	<1	44	29	150	<0.05	<30	<2
	4-6'	10/17/00	---	---	---	---	---	---	---	---	---
	6'-10'	10/17/00	---	---	---	---	---	---	---	---	---
TP-51	0-1'	11/14/00	<30	73	<1	34	61	100	0.05	<30	<2
	2-3'	11/14/00	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	---	---	---	---	---	---	---	---	---
	6'-10'	11/14/00	---	---	---	---	---	---	---	---	---
TP-52	0-1'	11/14/00	<20	50	<1.0	27	38.2	38	0.06	<20	<1
	2-3'	11/14/00	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	---	---	---	---	---	---	---	---	---
	6'-10'	11/14/00	---	---	---	---	---	---	---	---	---
TP-53	0-1'	11/14/00	<30	63	<1	31	40	20	0.05	<30	<2
	2-3'	11/14/00	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	---	---	---	---	---	---	---	---	---
	6'-10'	11/14/00	---	---	---	---	---	---	---	---	---
TP-54	0-1'	11/14/00	<30	242	8	48	273	410	0.98	<30	<2
	2-3'	11/14/00	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	---	---	---	---	---	---	---	---	---
	6'-10'	11/14/00	---	---	---	---	---	---	---	---	---
TP-55	0-1'	11/14/00	<30	1,080	29	117	465	***1,750***	0.83	<30	<2
	2-3'	11/14/00	---	---	21.1	---	---	772	---	---	---
	4-6'	11/14/00	---	---	---	---	---	106	---	---	---
	6'-10'	11/14/00	---	---	---	---	---	70	---	---	---
TP-56	0-1'	11/14/00	<30	63	2	31	88	70	0.12	<30	<2
	2-3'	11/14/00	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	---	---	---	---	---	---	---	---	---
	6'-10'	11/14/00	---	---	---	---	---	---	---	---	---
TP-57	0-1'	11/14/00	60	2,740	70	145	7,410	***2,710***	0.6	40	<2
	2-3'	11/14/00	---	---	1.7	---	---	28	---	---	---
	4-6'	11/14/00	---	---	---	---	---	80	---	---	---
	6'-10'	11/14/00	---	---	---	---	---	23	---	---	---
TP-58	0-1'	11/15/00	<30	45	<1	29	21	<10	0.06	<30	<2
	2-3'	11/15/00	<30	602	17	105	2,070	***2,340***	62	<30	<2
	4-6'	11/15/00	---	---	<0.5	---	---	9	---	---	---
	6'-10'	11/15/00	---	---	---	---	---	70	---	---	---
TP-59	0-1'	11/15/00	40	871	34	173	3,010	***2,250***	1.55	<30	2
	2-3'	11/15/00	<30	194	9	35	388	350	0.22	<30	<2
	4-6'	11/15/00	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---
MTCA Method C Industrial Soil Cleanup Levels$^{(e)}$			219	245,000	3,500	500$^{(f)}$	130,000	1,000$^{(f)}$	1,050	17,500	17,500

Analytes detected in samples at concentrations exceeding respective cleanup levels are shown in bold and italics.

TABLE 4-1
SOIL ANALYTICAL RESULTS - METALS
Former Tacoma Metals Facility

Sample Designation	Sample Depth	Sample Date	Total Metals (mg/kg)[a]								
			Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver
TP-60	0-1'	11/15/00	50	1,050	30	225	2,330	***10,800***	77	40	2
	2-3'	11/15/00	<30	1,410	20	99	773	***3,260***	1.41	<30	<2
	4-6'	11/15/00	---	---	0.9	---	---	116	0.08	---	---
	6-10'	11/15/00	---	---	---	---	---	49	---	---	---
TP-61	0-1'	11/15/00	<30	377	10	53	356	***4,180***	0.76	<30	<2
	2-3'	11/15/00	<30	352	1	25	40	80	0.23	<30	<2
	4-6'	11/15/00	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---
TP-62	0-1'	11/15/00	<30	201	5	72	208	420	0.92	<30	2
	2-3'	11/15/00	<30	265	11	283	407	800	2.05	<30	<2
	4-6'	11/15/00	---	---	<0.5	---	---	---	<0.04	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---
TP-63	0-1'	11/15/00	<30	584	38	61	304	700	0.37	<30	<2
	2-3'	11/15/00	<30	637	50	64	299	***1,800***	0.24	30	<2
	4-6'	11/15/00	---	---	0.7	---	---	123	---	---	---
	6-10'	11/15/00	---	---	---	---	---	102	---	---	---
TP-64	0-1'	11/15/00	<30	163	5	31	459	450	0.98	<30	<2
	2-3'	11/15/00	---	---	---	---	---	---	---	---	---
	4-6'	11/15/00	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---
TP-65	0-1'	11/15/00	<30	58	<1	28	19	<10	0.05	<30	<2
	2-3'	11/15/00	---	---	---	---	---	---	---	---	---
	4-6'	11/15/00	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---
MTCA Method C Industrial Soil Cleanup Levels [e]			219	245,000	3,500	500[f]	130,000	1,000[f]	1,050	17,500	17,500

Analytes detected in samples at concentrations exceeding respective cleanup levels are shown in bold and italics.

Notes

(a) Soil samples were analyzed for total metals by EPA Methods 6010/7000 series.
(b) "---" Sample not tested for selected analyte.
(c) "<" denotes analyte was not detected at the indicated reporting limit.
(d) Second number signifies analysis of duplicate sample.
(e) MTCA Method C industrial soil cleanup levels are based on CLARC II, dated February 1996.
(f) Method A industrial soil cleanup levels (WAC 173-340-745) used where Method C soil industrial cleanup levels are not available.
(g) TP-20/2000-2-3 was re-analyzed for lead and arsenic due to suspected sample homogeneity issues. (The re-analysis result is presented in this table).

mg/kg - milligrams per kilogram

TABLE 4-2
SOIL ANALYTICAL RESULTS - PCBs
Former Tacoma Metals Facility

Sample Designation	Sample Depth	PCBs (mg/kg)[a]							Total PCBs[b]
		Aroclor 1016	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1221	Aroclor 1232	
TP-1	0-1'	<0.036[c]	<0.036	<0.036	0.64	0.50	<0.073	<0.036	1.25
TP-3	0-1'	<0.035	<0.035	<0.035	0.17	0.061	<0.070	<0.035	0.336
TP-4	0-1'	<0.037	<0.037	1.1	4.7	2.4	<0.073	<0.037	8.3
	2-3'	<0.035	<0.035	0.390	1.4	0.970	<0.071	<0.035	2.85
TP-5	0-1'	<0.036	<0.036	<0.036	<0.036	<0.036	<0.073	<0.036	0.145
TP-6	0-1'	<0.036	<0.036	0.110	0.360	0.300	<0.073	<0.036	0.86
	2-3'	<0.035	<0.035	0.018J	0.050	0.028J	<0.069	<0.035	0.183
TP-7	0-1'	<0.370	<0.370	4.3	7.7	2.7	<0.740	<0.370	0.186
	2-3'	<0.036	<0.036	2.1	5.2	1.9	<0.071	<0.036	9.28
TP-9	0-1'	<0.040	0.53	<0.040	0.87	1.1	<0.081	<0.040	2.6
TP-10	0-1'	<0.037	<0.037	0.56	0.65	0.29	<0.073	<0.037	1.6
	2-3'	<0.037	<0.037	<0.037	0.045	<0.037	<0.074	<0.037	0.17
TP-11	0-1'	<0.036	<0.036	0.52	1.5Y	1.1	<0.073	<0.036	3.21
TP-12	0-1'	<0.035	<0.035	0.031J	0.063	0.030J	<0.069	<0.035	0.211
	2-3'	<0.034	<0.034	0.150	0.430	0.170	<0.068	<0.034	0.835
TP-13	0-1'	<0.034	<0.034	<0.034	1	2	<0.069	<0.034	3.1
TP-14	0-1'	<0.034	<0.034	<0.034	<0.034	<0.034	<0.069	<0.034	0.14
	2-3'	<0.037	<0.037	0.098Y	0.60	0.26	<0.073	<0.037	1.05
TP-15	0-1'	<0.035	<0.035	<0.035	0.043	0.058	<0.070	<0.035	0.206
TP-16/160[d]	0-1'	<1.1/<0.040	<1.1/<0.040	1.0J/0.39	3.1/1.9	4.6/2.7	<2.3/<0.080	<1.1/<0.040	11.5/5.09
TP-17	0-1'	<0.035	<0.035	0.43	0.67	1.6	<0.071	<0.035	2.79
TP-19	0-1'	<0.038	<0.038	<0.038	0.057	0.060	<0.076	<0.038	0.231
TP-20	0-1'	<0.035	<0.035	<0.035	0.020J	0.023J	<0.070	<0.035	0.148
	2-3'	<0.036	<0.036	0.180Y	0.970	0.320	<0.072	<0.036	1.56
TP-21	0-1'	<0.041	<0.041	1.4	6.9	5.2	<0.082	<0.041	13.6
	2-3'	<0.040	0.088	<0.040	2.3	1.1	<0.080	<0.040	3.6
TP-22	0-1'	<0.042	<0.042	0.43Y	1.4	0.66	<0.083	<0.042	2.59
	2-3'	<0.041	<0.041	0.520Y	1.3	0.990	<0.083	<0.041	2.91
TP-23	0-1'	<0.035	<0.035	<0.035	0.019J	0.020J	<0.070	<0.035	0.144
TP-25	0-1'	<0.036	<0.036	0.042	0.043	0.048	<0.072	<0.036	0.223
TP-27/270[d]	0-1'	<0.038/<0.039	<0.038/<0.039	0.14/0.14	0.53/0.49	0.94/0.93	<0.077/<0.077	<0.038/<0.039	1.7/1.66
TP-29	0-1'	<0.036	<0036	<0.036	<0.036	0.024J	<0.071	<0.036	0.15
TP-31	0-1'	<0.037	<0.037	0.15	0.71	0.76	<0.074	<0.037	1.71
TP-33	0-1'	<0.037	<0.037	0.52	1.7	1.2	<0.075	<0.037	3.51
TP-34[e]	0-1'	<0.040	<0.040	0.12	0.57	0.5	<0.080	<0.040	1.3
	2-3'	<0.041	<0.041	0.11	0.51	0.40	<0.081	<0.041	1.12
TP-35	0-1'	<0.036	<0.036	<0.036	0.21	0.30	<0.073	<0.036	0.619
TP-36	0-1'	<0.037	<0.037	0.031J	0.056	0.060	<0.074	<0.037	0.24
TP-37	0-1'	<0.037	<0.037	0.46	1.5	1.3	<0.074	<0.037	3.35
TP-39/390[d]	0-1'	<0.035/<0.042	<0.035<0.042	<0.035<0.042	2.7/1.5	<0.035/<0.042	<0.069/<0.084	<0.035/<0.042	2.82/1.65
TP-40	0-1'	<0.038	<0.038	3.7Y	18	6	<0.077	<0.038	***27.8***
	2-3'	<0.038	<0.038	0.600Y	3.2	1.7	<0.076	<0.038	5.6
MTCA Method C Industrial Soil Cleanup Levels[f]		NA[g]	NA	NA	NA	NA	NA	NA	**17**

Analytes detected in samples at concentrations exceeding cleanup levels or comparison values are shown in bold and italics.

TABLE 4-2
SOIL ANALYTICAL RESULTS - PCBs
Former Tacoma Metals Facility

Sample Designation	Sample Depth	PCBs (mg/kg)[(a)] Aroclor 1016	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1221	Aroclor 1232	Total PCBs[(b)]
TP-41	0-1'	<0.035	<0.035	<0.035	0.049	0.021J	<0.070	<0.035	0.175
TP-43/430[(d)]	0-1'	<0.48/<0.46	<0.48/<0.46	2.6Y/2.2Y	14/11	6.8/5.8	<0.95/<0.92	<0.48/<0.46	***23.9/20.2***
	2-3'	<0.47	<0.47	1.9Y	8.1	8.6	<0.93	<0.47	***19.8***
	4-6'	<0.036	<0.036	<0.036	0.036J	<0.036	<0.072	<0.036	0.162
TP-44	0-1'	<0.035	<0.035	<0.035	<0.035	<0.035	<0.070	<0.035	0.14
TP-45	0-1'	<0.46	<0.46	1.9Y	12	9.5	<0.92	<0.46	***24.6***
	2-3'	<0.88	<0.88	<0.88	7	4.6	<1.8	<0.88	14.26
TP-46	0-1'	<0.036	<0.036	0.90Y	8.3	4.3	<0.073	<0.036	13.6
	2-3'	<0.038	<0.038	<0.038	0.051	<0.038	<0.076	<0.038	0.184
TP-47	0-1'	<0.037	<0.037	<0.037	<0.037	<0.037	<0.075	<0.037	0.149
TP-49	0-1'	<0.035	<0.035	<0.035	0.190	0.130	<0.070	<0.035	0.425
TP-50	0-1'	<0.036	<0.036	0.87	5.3	1.3	<0.071	<0.036	7.6
	2-3'	<0.037	<0.037	<0.037	0.036J	<0.037	<0.073	<0.037	0.165
TP-51	0-1'	<0.036	<0.036	0.043	0.14	0.14	<0.072	<0.036	0.413
TP-53	0-1'	<0.035	<0.035	<0.035	0.054	0.046	<0.070	<0.035	0.205
TP-55	0-1'	<0.036	<0.036	0.83	3	1.5	<0.073	<0.036	5.42
TP-57	0-1'	0.71Y	<0.041	1.4	1.2	0.29	<0.082	<0.041	3.68
TP-59	0-1'	<0.038	<0.038	13	9.8	2.1	<0.076	<0.038	***25***
	2-3'	<0.036	<0.036	0.38	0.55	0.20	<0.072	<0.036	1.22
TP-60	0-1'	<0.93	<0.93	<0.93	29	8.3	<1.9	<0.93	***40.11***
	2-3'	<0.045	<0.045	0.12Y	1.1	0.58	<0.090	<0.045	1.913
TP-61	0-1'	<0.036	<0.036	0.71	1.9	0.83	<0.072	<0.036	3.53
TP-63	0-1'	<0.036	<0.036	0.33Y	2.6	0.35	<0.072	<0.036	3.37
TP-65	0-1'	<0.036	<0.036	<0.036	0.020J	<0.036	<0.071	<0.036	0.146
MTCA Method C Industrial Soil Cleanup Level[(f)]		NA[(g)]	NA	NA	NA	NA	NA	NA	17

Analytes detected in samples at concentrations exceeding cleanup levels or comparison values are shown in bold and italics.

Notes:
(a) Samples were analyzed for polychlorinated biphenyls (PCBs) by EPA Method 8082.
(b) The total PCBs were calculated by summing the concentrations of all the probable PCBs. If a probable PCB was not detected, a value equal to one-half the reporting limit was used.
(c) "<" denotes analyte was not detected at the indicated reporting limit.
(d) Duplicate sample.
(e) Analytical report reads TP-34 as TP-340.
(f) MTCA Method C industrial soil cleanup levels based on CLARC II, dated February 1996.
(g) "NA" = No cleanup level available.

Qualifiers:
J - Indicates as estimated value of analyte found and confirmed by analyst but with low spectral match.
Y - Indicates raised reporting limit due to background interference.

mg/kg - milligrams per kilogram

TABLE 4-4

SOIL ANALYTICAL RESULTS - TPHs AND VOCs
Former Tacoma Metals Facility

			TPHs (mg/kg)(a)		Volatile Organic Compounds (µg/kg)(b)																				
Sample Designation	Sample Depth (ft)	Collection Date	TPH-Diesel	TPH-motor oil	Benzene	Toluene	Ethyl-benzene	Total(c) Xylenes	Acetone	1,1-Di-chloro-ethene	1,1-Di-chloro-ethane	Cis-1,2-di-chloro-ethene	Chloro-form	2-Butanone	1,1,1-Tri-chloro-ethane	Trichloro-ethene	Tetrachloro-ethene	1,1,2-Tri-chloro-fluoroethane	1,3,5-Tri-methyl-benzene	1,2,4-Tri-methyl-benzene	Hexa-chlorobut-adiene	4-Isopropyl-toluene	Styrene	Naphthalene	Isopropy-benzene
TP-59	0-1'	11/15/00	520B	1,200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-60	0-1'	11/15/00	980B	1,700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-61	0-1'	11/15/00	***3,700B***	1,900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/15/00	***8,500B***	***2,300***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/15/00	120	87	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-62	0-1'	11/15/00	320B	910	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-63	0-1'	11/15/00	340B	1,100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/15/00	860B	***2,100***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/15/00	240	640	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-64	0-1'	11/15/00	150B	330	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-65	0-1'	11/15/00	<5.3	<11	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MTCA Method C Industrial(g) Soil Cleanup Levels			2,000(h)	2,000(h)	4.53E+06	7.00E+08	3.50E+08	7.00E+09	3.50E+08	2.19E+05	3.50E+08	3.50E+07	2.15E+07	NA(i)	3.15E+09	1.19E+04	2.57E+06	NA	NA	NA	7.00E+05	NA	4.38E+06	1.40E+05	NA

Analytes detected in samples at concentrations exceeding cleanup levels or comparison values are shown in bold and italics.

Notes:

(a) Total diesel- and motor oil-range hydrocarbons were analyzed by Ecology Method NWTPH-Diesel (Extended).
(b) Samples were analyzed for volatile organic compounds (VOCs) by EPA Method 8260.
(c) Total xylenes were calculated by summing the concentrations of m,p- and o-xylene isomers.
(d) "---" = Sample not tested for selected analyte.
(e) "<" denotes analyte was not detected at the indicated reporting limit.
(f) Duplicate sample.
(g) MTCA Method C industrial soil cleanup levels are based on CLARC II, dated February 1996.
(h) MTCA Method A industrial soil cleanup levels used where Method C industrial soil cleanup levels are not available. MTCA Method A cleanup level based on amended MTCA cleanup regulation (WAC-173-340-745) anticipated by Ecology to become effective August 2001.
(i) "NA" = No cleanup level is available.

Qualifiers:
J - Indicates an estimated value below the calculated detection limit.
B - Indicates compound also detected in method blank.

mg/kg - milligrams per kilogram
µg/kg - micrograms per kilogram

TABLE 4-4

SOIL ANALYTICAL RESULTS - TPHs AND VOCs
Former Tacoma Metals Facility

			TPHs (mg/kg)[a]		Volatile Organic Compounds (µg/kg)[b]																				
Sample Designation	Sample Depth (ft)	Collection Date	TPH-Diesel	TPH-motor oil	Benzene	Toluene	Ethyl-benzene	Total[c] Xylenes	Acetone	1,1-Di-chloro-ethene	1,1-Di-chloro-ethane	Cis-1,2-di-chloro-ethene	Chloro-form	2-Butanone	1,1,1-Tri-chloro-ethane	Trichloro-ethene	Tetrachloro-ethene	1,1,2-Tri-chloro-fluoroethane	1,3,5-Tri-methyl-benzene	1,2,4-Tri-methyl-benzene	Hexa-chlorobut-adiene	4-Isopropyl-toluene	Styrene	Naphthalene	Isopropy-benzene
TP-48	0-1'	10/17/00	130	290	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/17/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/17/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-8.5'	10/17/00	630	870	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-49	0-1'	10/17/00	220	1,500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/17/00	29	50	<1.1	3.7	<1.1	<2.2	<5.7	<1.1	<1.1	<1.1	<1.1	<5.7	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<5.7	<1.1	<1.1	<5.7	<1.1
	4-6'	10/17/00	***11,000***	***4,000***	<9.0	1,600	27	78	510	<9.0	<9.0	<9.0	<9.0	120	<9.0	<9.0	<9.0	<9.0	580	950	<45	200	<7.8	16,000	17
	6-10'	10/17/00	***14,000***	***2,900***	<22	270	24	142	530	<22	<22	<22	<22	120	<22	<22	<22	<22	490	820	<110	250	<22	8,800	39
TP-50/500[f]	0-1'	10/17/00	90/110	190/230	1.2/1 3	430/610	<1.1/<1.1	<2.2/<2.2	90/94	<1.1/<1.1	<1.1/<1.1	<1.1/<1.1	<1.1/<1.1	12/12	<1.1/<1.1	<1.1/<1.1	<1.1/<1.1	<1.1/<1.1	<1.1/<1.1	<1.1/<1.1	<5.4/<5.7	<1.1/<1.1	<1.1/<1.1	<5.4/<5.7	<1.1/<1.1
	2-3'	10/17/00	39	54	<10	270	<1.1	<2.2	49	<1.1	<1.1	<1.1	<1.1	<5.6	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<5.6	<1.1	<1.1	<5.6	<1.1
	4-6'	10/17/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/17/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-51	0-1'	11/14/00	35B	100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-8'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-52	0-1'	11/14/00	86B	440	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	240	140	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/14/00	730	870	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-53	0-1'	11/14/00	690B	700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-54	0-1'	11/14/00	160B	310	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-55	0-1'	11/14/00	1,700B	***6,300***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/14/00	***2,000***	***8,000***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	1,700	***6,500***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/14/00	***2,400***	***12,000***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-56	0-1'	11/14/00	16B	54	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/14/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-57	0-1'	11/14/00	***2,200B***	***4,700***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/14/00	66	98	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/14/00	170	200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/14/00	88	350	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-58	0-1'	11/15/00	11B	<10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	11/15/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MTCA Method C Industrial[g] Soil Cleanup Levels			2,000[h]	2,000[h]	4.53E+06	7.00E+08	3.50E+08	7.00E+09	3.50E+08	2.19E+05	3.50E+08	3.50E+07	2.15E+07	NA[i]	3.15E+09	1.19E+04	2.57E+06	NA	NA	NA	7.00E+05	NA	4.38E+06	1.40E+05	NA

Analytes detected in samples at concentrations exceeding cleanup levels or comparison values are shown in bold and italics.

TABLE 4-4

SOIL ANALYTICAL RESULTS - TPHs AND VOCs
Former Tacoma Metals Facility

			TPHs (mg/kg)(a)		Volatile Organic Compounds (µg/kg)(b)																						
Sample Designation	Sample Depth (ft)	Collection Date	TPH-Diesel	TPH-motor oil	Benzene	Toluene	Ethyl-benzene	Total(c) Xylenes	Acetone	1,1-Di-chloro-ethene	1,1-Di-chloro-ethane	Cis-1,2-di-chloro-ethene	Chloro-form	2-Butanone	1,1,1-Tri-chloro-ethane	Trichloro-ethene	Tetrachloro-ethene	1,1,2-Tri-chloro-fluoroethane	1,3,5-Tri-methyl-benzene	1,2,4-Tri-methyl-benzene	Hexa-chlorobut-adiene	4-Isopropyl-toluene	Styrene	Naphthalene	Isopropy-benzene
TP-37	0-1'	10/13/00	810	***2,100***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/13/00	970	***2,800***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	60	84	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-38	0-1'	10/13/00	1,400	***2,700***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/13/00	68	88	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-39/390(f)	0-1'	10/13/00	81/83	340/350	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-40	0-1'	10/13/00	1,100	***2,300***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/13/00	670	1,600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	100	230	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-41	0-1'	10/13/00	<5.2	16	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-42	0-1'	10/13/00	42	130	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-43/430(f)	0-1'	10/13/00	1,000/1,000	***2,500/2,800***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/13/00	1,500	***3,400***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	<5.3	<11	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-44	0-1'	10/13/00	19	28	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-45	0-1'	10/16/00	450	1,100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/16/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/16/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/16/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-46	0-1'	10/16/00	140	450	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/16/00	170	510	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/16/00	1,000	***2,700***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/16/00	45	150	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-47	0-1'	10/16/00	6.2	<11	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/16/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/16/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/16/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MTCA Method C Industrial(g) Soil Cleanup Levels			2,000(h)	2,000(h)	4.53E+06	7.00E+08	3.50E+08	7.00E+09	3.50E+08	2.19E+05	3.50E+08	3.50E+07	2.15E+07	NA(i)	3.15E+09	1.19E+04	2.57E+06	NA	NA	NA	7.00E+05	NA	4.38E+06	1.40E+05	NA

Analytes detected in samples at concentrations exceeding cleanup levels or comparison values are shown in bold and italics.

TABLE 4-4

SOIL ANALYTICAL RESULTS - TPHs AND VOCs
Former Tacoma Metals Facility

			TPHs (mg/kg)[a]		Volatile Organic Compounds (µg/kg)[b]																				
Sample Designation	Sample Depth (ft)	Collection Date	TPH-Diesel	TPH-motor oil	Benzene	Toluene	Ethylbenzene	Total[c] Xylenes	Acetone	1,1-Dichloroethene	1,1-Dichloroethane	Cis-1,2-dichloroethene	Chloroform	2-Butanone	1,1,1-Trichloroethane	Trichloroethene	Tetrachloroethene	1,1,2-Trichlorofluoroethane	1,3,5-Trimethylbenzene	1,2,4-Trimethylbenzene	Hexachlorobutadiene	4-Isopropyltoluene	Styrene	Naphthalene	Isopropybenzene
TP-25	0-1'	10/11/00	58	380	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-26	0-1'	10/11/00	6.4	15	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/11/00	120	470	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/11/00	26	78	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-27/270[f]	0-1'	10/11/00	610/670	***2,000/2,200***	<5.7/<5.0	320/270	<5.7/<5.0	<11.4/<10	<28/<25	<5.7/<5.0	<5.7/<5.0	<5.7/<5.0	<5.7/<5.0	<28/<25	<5.7/<5.0	<5.7/<5.0	<5.7/<5.0	<5.7/<5.0	<5.7/<5.0	<5.7/<5.0	<28/<25	<5.7/<5.0	<5.7/<5.0	<28/<25	<5.7/<5.0
	2-3'	10/11/00	120	430	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-28	0-1'	10/11/00	190	940	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/11/00	930	1,000	<5.5	150	<5.5	<11	<28	<5.5	<5.5	<5.5	<5.5	<28	<5.5	<5.5	<5.5	<5.5	<5.5	<5.5	<28	<5.5	<5.5	<28	<5.5
	4-6'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-29	0-1'	10/12/00	39	320	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/12/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/12/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/12/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-30	0-1'	10/12/00	330	1,800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/12/00	700	***2,500***	<4.8	640	<4.8	16.4	130	<4.8	<4.8	<4.8	<4.8	<24	<4.8	<4.8	<4.8	<4.8	150	180	<24	<4.8	<4.8	<24	35
	4-6'	10/12/00	8.5	15	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/12/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-31	0-1'	10/12/00	490	1,300	<4.7	640	<4.7	<9.4	92	<4.7	<4.7	<4.7	<4.7	<23	<4.7	<4.7	<4.7	<4.7	<4.7	<4.7	<23	7.6	<4.7	<23	<4.7
	2-3'	10/12/00	290	610	<5.5	170	<5.5	6.6	76	<5.5	<5.5	<5.5	<5.5	<27	<5.5	<5.5	<5.5	<5.5	14	22	<27	<5.5	<5.5	<27	<5.5
	4-6'	10/12/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/12/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-32	0-1'	10/12/00	450	1,700	<5.1	780	<5.1	13.7	300	<5.1	<5.1	<5.1	<5.1	45	<5.1	<5.1	<5.1	<5.1	9	12	<25	<5.1	<5.1	<25	<5.1
TP-33	0-1'	10/12/00	970	***2,000***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/12/00	420	1,000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/12/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/12/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-34/340[f]	0-1'	10/12/00	350/460	1,100/1,400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/12/00	710	***2,600***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/12/00	59	160	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/12/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-35	0-1'	10/13/00	190	350	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-36	0-1'	10/13/00	15	56	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/13/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/13/00	280	220	<4.3	84	3.0J	<8.6	30B	<4.3	<4.3	<4.3	<4.3	<22	<4.3	<4.3	<4.3	<4.3	10	6.2	<22	7.4	<4.3	150	2.2J
MTCA Method C Industrial[g] Soil Cleanup Levels			2,000[h]	2,000[h]	4.53E+06	7.00E+08	3.50E+08	7.00E+09	3.50E+08	2.19E+05	3.50E+08	3.50E+07	2.15E+07	NA[i]	3.15E+09	1.19E+04	2.57E+06	NA	NA	NA	7.00E+05	NA	4.38E+06	1.40E+05	NA

Analytes detected in samples at concentrations exceeding cleanup levels or comparison values are shown in bold and italics.

TABLE 4-4

SOIL ANALYTICAL RESULTS - TPHs AND VOCs
Former Tacoma Metals Facility

			TPHs (mg/kg)[a]		Volatile Organic Compounds (µg/kg)[b]																				
Sample Designation	Sample Depth (ft)	Collection Date	TPH-Diesel	TPH-motor oil	Benzene	Toluene	Ethyl-benzene	Total[c] Xylenes	Acetone	1,1-Di-chloro-ethene	1,1-Di-chloro-ethane	Cis-1,2-di-chloro-ethene	Chloro-form	2-Butanone	1,1,1-Tri-chloro-ethane	Trichloro-ethene	Tetrachloro-ethene	1,1,2-Tri-chloro-fluoroethane	1,3,5-Tri-methyl-benzene	1,2,4-Tri-methyl-benzene	Hexa-chlorobut-adiene	4-Isopropyl-toluene	Styrene	Naphthalene	Isopropy-benzene
TP-13	0-1'	10/5/00	27	59	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/5/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/5/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/5/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-14	0-1'	10/6/00	<5.2	15	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/6/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/6/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/6/00	48	110	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-15	0-1'	10/6/00	13	30	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/6/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/6/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/6/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-16/160[f]	0-1'	10/6/00	***2,600***/300	***2,500***/890	<9.9/<9.1	720/380	15/<9.1	20/<9.1	140B/<45	<9.9/<9.1	<9.9/<9.1	<9.9/<9.1	<9.9/<9.1	<49/<45	<9.9/<9.1	<9.9/<9.1	<9.9/<9.1	<9.9/<9.1	83/<9.1	90/<9.1	<49/<45	44/<9.1	<9.9/<9.1	400Y/<45	<9.9/<9.1
	2-3'	10/6/00	940	1,400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-17	0-1'	10/6/00	300	1,200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/6/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/6/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/6/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-18	0-1'	10/10/00	55	160	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-19	0-1'	10/10/00	75	220	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-20	0-1'	10/10/00	<5.2	<10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-20/2000[f]	2-3'	10/10/00	130/140	380/410	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-21	0-1'	10/10/00	200	660	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/10/00	100	240	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-22	0-1'	10/10/00	60	250	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/10/00	48	170	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/10/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-23	0-1'	10/11/00	<5.2	17	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/11/00	260	970	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-24	0-1'	10/11/00	28	130	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/11/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MTCA Method C Industrial[g] Soil Cleanup Levels			2,000[h]	2,000[h]	4.53E+06	7.00E+08	3.50E+08	7.00E+09	3.50E+08	2.19E+05	3.50E+08	3.50E+07	2.15E+07	NA[i]	3.15E+09	1.19E+04	2.57E+06	NA	NA	NA	7.00E+05	NA	4.38E+06	1.40E+05	NA

Analytes detected in samples at concentrations exceeding cleanup levels or comparison values are shown in bold and italics.

TABLE 4-4

SOIL ANALYTICAL RESULTS - TPHs AND VOCs
Former Tacoma Metals Facility

			TPHs (mg/kg)[a]		Volatile Organic Compounds (µg/kg)[b]																				
Sample Designation	Sample Depth (ft)	Collection Date	TPH-Diesel	TPH-motor oil	Benzene	Toluene	Ethyl-benzene	Total[c] Xylenes	Acetone	1,1-Di-chloro-ethene	1,1-Di-chloro-ethane	Cis-1,2-di-chloro-ethene	Chloro-form	2-Butanone	1,1,1-Tri-chloro-ethane	Trichloro-ethene	Tetrachloro-ethene	1,1,2-Tri-chloro-fluoroethane	1,3,5-Tri-methyl-benzene	1,2,4-Tri-methyl-benzene	Hexa-chlorobut-adiene	4-Isopropyl-toluene	Styrene	Naphthalene	Isopropy-benzene
TP-1	0-1'	9/27/00	560	1,200	---[d]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	9/27/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	9/27/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	9/27/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-2	0-1'	9/27/00	130	400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	9/27/00	1,700	1,200	3.6	120	6	14.4	200B	<1.2[e]	<1.2	<1.2	<1.2	47	<1.2	<1.2	<1.2	<1.2	3	7.1	<6	<1.2	2.4	120	<1.2
	4-6'	9/27/00	***2,900***	1,700	58	850	140	410	460B	<1.5	<1.5	<1.5	<1.5	120	<1.5	<1.5	<1.5	<1.5	520	1,400	<7.3	91	12M	120,000	55
	6-10'	9/27/00	***10,000***	***2,100***	73	430	870	3,600	940J	<1.6	<1.6	<1.6	<1.6	110	<1.6	<1.6	<1.6	<1.6	2,800	6,200	<7.9	1,600	<1.6	390,000	480
TP-3	0-1'	9/27/00	14	26	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	9/27/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	9/27/00	1,300	1,200	<1.8	830	<1.8	<38	530	<1.8	<1.8	<1.8	<1.8	73	<1.8	<1.8	<1.8	<1.8	<19	<19	<9.2	<1.8	<19	130	<1.8
	6-10'	9/27/00	280	240	<3.3	8	4.60	27	200	<3.3	<3.3	<3.3	<3.3	27	<3.3	<3.3	<3.3	<3.3	18	42	<17	27	<3.3	210	12
TP-4	0-1'	9/27/00	270	530	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	9/27/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	9/27/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	9/27/00	67	31	<1.7	7.30	<1.7	<3.4	<8.6	<1.7	<1.7	<1.7	<1.7	<8.6	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<8.6	<1.7	<1.7	8.60	<1.7
TP-5	0-1'	10/4/00	18	21	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/4/00	81	75	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/4/00	***2,000***	***2,300***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/4/00	***23,000***	***8,600***	<230	1,200	<230	<230	<1,200	<230	<230	<230	<230	<1,200	<230	<230	<230	<230	360	660	<1,200	750	<230	26,000	<230
TP-6/600[f]	0-1'	10/4/00	160/190	210/220	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/4/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/4/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/4/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-7	0-1'	10/4/00	330	760	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/4/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/4/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/4/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-8	0-1'	10/4/00	440	1,200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/4/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-8/800[f]	4-6'	10/4/00	32/34	49/70	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/4/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-9	0-1'	10/4/00	1,900	***3,000***	<140	98J	<140	<140	<700	<140	<140	<140	<140	<700	<140	<140	<140	<140	490	220	<700	74J	<140	710	<140
	2-3'	10/4/00	54	72	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/4/00	160	250	<7.0	130	<7.0	<7.0	<35	<7.0	<7.0	<7.0	<7.0	<35	<7.0	<7.0	<7.0	<7.0	6.9J	6.8J	<35	<7.0	<7.0	<35	<7.0
	6-10'	10/4/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-10	0-1'	10/4/00	64	260	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/5/00	43	280	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/5/00	440	***2,000***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/5/00	1,400	***8,700***	<150	1,800	<150	<150	<770	<150	<150	<150	<150	<770	<150	<150	<150	<150	<150	<150	<770	<150	<150	<770	<150
TP-11	0-1'	10/5/00	800	***2,400***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/5/00	440	540	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/5/00	870	610	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/5/00	***3,900***	***8,500***	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TP-12	0-1'	10/5/00	17	17	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	2-3'	10/5/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	4-6'	10/5/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-10'	10/5/00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MTCA Method C Industrial[g] Soil Cleanup Levels			2,000[h]	2,000[h]	4.53E+06	7.00E+08	3.50E+08	7.00E+09	3.50E+08	2.19E+05	3.50E+08	3.50E+07	2.15E+07	NA[i]	3.15E+09	1.19E+04	2.57E+06	NA	NA	NA	7.00E+05	NA	4.38E+06	1.40E+05	NA

Analytes detected in samples at concentrations exceeding cleanup levels or comparison values are shown in bold and italics.

TABLE 4-3

SOIL ANALYTICAL RESULTS - PAHs
Former Tacoma Metals Facility

Sample Designation	Sample Date	PAHs (mg/kg)(a)									cPAHs(mg/kg)(a)(b)							
		Naphth-alene	Acenaph-thlyene	Acenaph-thene	Fluorene	Phenan-threne	Anth-racene	Fluoran-thene	Pyrene	Benzo (g,h,i) perylene	Chrysene	Benzo (b)-fluoranthene	Benzo (k)-fluoranthene	Benzo (a)-pyrene	Indeno (1,2,3-cd) pyrene	Dibenz (a,h)-anthracene	Benzo (a)-anthracene	Total cPAHs(b)
TP-2-6-10	9/27/00	440	7.1	240	200	460	380	370	430	34	***230***	***90***	***110***	***110***	***33***	17	***140***	***730***
TP-5-6-10	10/4/00	41	19	260	360	750	750	470	400	39	***190***	***93***	***80***	***95***	***35***	16	***130***	***639***
TP-9-0-1	10/4/00	0.35	0.014J	0.028	0.028	0.16	0.067	0.27	0.24	0.17	0.28	0.17	0.12	0.14	0.094	0.035	0.15	0.989
TP-10-6-10	10/5/00	0.011J	0.0068J	0.023	0.014J	0.023	0.014J	0.032M	0.018J	0.041M	0.038	0.036M	0.023MJ	0.025	0.018JM	0.0091MJ	0.020MJ	0.169
TP-11-6-10	10/5/00	0.7J	0.16J	1.6	1.4	2.7	0.86M	4.6	2.8	0.55J	1.8	1	0.78J	0.94	0.55J	0.16MJ	1.2	6.43
TP-16-0-1	10/6/00	0.99	18	1.8	1	2.2	1.8	6.9	6.2	3.5	4.3	4.5	5.6	7	3.8	1.4	3.8	***30.4***
TP-27-0-1	10/11/00	0.08	0.025	0.011MJ	0.011J	0.13	0.034	0.15	0.19	0.22	0.27	0.19	0.12	0.14	0.16	0.048	0.11	1.038
TP-30-2-3	10/12/00	0.14	0.11	0.053J	0.091	0.5	0.2	0.84	0.95	0.49	1.9	0.82	0.44	0.52	0.38	0.12	0.5	4.68
TP-33-0-1	10/12/00	0.31	0.067J	0.075	0.097	0.51	0.17	0.6	0.94	0.49	0.65	0.46	0.39	0.49	0.34	0.12	0.36	2.81
TP-34-2-3	10/12/00	0.95	0.1	1.9	0.91	4.3	1.3	4.7	4	0.93	4.2	2	1.1	1.3	0.79	0.24	1.9	11.53
TP-37-2-3	10/13/00	0.3	0.094	0.078	0.2	1.1	0.34	1.9	2	1.2	1.2	1.1	0.75	1	0.87	0.27	0.81	6
TP-38-0-1	10/13/00	0.3	0.24	0.59	0.51	4.2	1	5.1	4.9	2	3.2	2	2.1	2.4	2	0.59	2.5	14.79
TP-40-0-1	10/13/00	0.98	3.8	0.74	1.4	17	4.7	43	51	13	***41***	***24***	***23***	***28***	14	4.8	***33***	***167.8***
TP-43-2-3	10/16/00	0.29	0.34	0.31	0.25	2.3	0.83	3.6	2.6	1.3	2.2	1.5M	1.4	1.7	1.1	0.44	1.6	9.94
TP-46-4-6	10/16/00	0.21	0.055J	0.055J	0.063J	0.35	0.11	0.62	0.43	0.35	0.45	0.3M	0.3M	0.31M	0.2	0.094	0.25	1.904
TP-49-6-10	10/17/00	8.4	16	440	390	1,300	250	810	620	38	***230***	***73***	***54***	***82***	***31***	14M	***150***	***634***
TP-55-6-10	11/14/00	<1.3(c)	<1.3	3.9	3.6	7.0	1.4	4.6	3.1	<1.3	1.7M	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	5.6
TP-57-0-1	11/14/00	0.68	<0.081	<0.081	<0.081	0.26	<0.081	0.53	0.63	0.31M	0.32M	0.31M	0.22	0.25	0.19	<0.081	0.22	1.55
TP-61-2-3	11/15/00	2.8	0.67	0.68M	1.7	7.2	2.5M	9.3	7.8	1.1	4.9	2.9	2.7	2.9	1.6	0.61M	4.1	***19.71***
MTCA Method C Industrial Soil Cleanup Level(d)		1.40E+05	NA(e)	2.10E+05	1.40E+05	NA	1.05E+06	1.40E+05	1.05E+05	NA	18	18	18	18	18	18	18	18

Analytes detected in samples at concentrations exceeding cleanup levels or comparison values are shown in bold and italics.

Notes:

(a) Samples were analyzed for polycyclic aromatic hydrocarbons (PAHs) by EPA Method 8270B GC/MS SIM.
(b) The total probable carcinogenic polycyclic aromatic hydrocarbons (cPAHs) were calculated by summing the concentrations of all the probable cPAHs. If a probable cPAH was not detected in the sample, a value equal to one-half the reporting limit was used.
(c) "<" denotes analyte was not detected at the indicated reporting limit.
(d) MTCA Method C industrial soil cleanup levels based on CLARC II, dated February 1996.
(e) "NA" = No cleanup level is available.

Qualifiers:

M - Indicates an estimated value of analyte found and confirmed by analyst but with low spectral match.
J - Indicates an estimated concentration when the value is less than the calculated reporting limit.

mg/kg - milligrams per kilogram

TABLE 4-5

SUMMARY OF EXTRACTABLE PETROLEUM HYDROCARBONS ANALYTICAL RESULTS

Former Tacoma Metals Facility

Analytes	Sample Designation									
	TP-2-6-10	TP-5-6-10	TP-9-0-1	TP-10-6-10	TP-11-6-10	TP-16-0-1	TP-27-0-1	TP-30-2-3	TP-33-0-1	TP-34-2-3
EXTRACTABLE PETROLEUM HYDROCARBONS (mg/kg)(a)										
Aliphatics										
C8-C10	<50(b)	<65.9	<50	<50	<50	<20	<50	<50	<50	<50
C10-C12	<50	<65.9	137	<50	<50	96	<50	<50	<50	<50
C12-C16	150	419	145	<50	241	280	137	<50	85.5	<50
C16-C21	122	442	463	231	1,630	145	133	202	366	94.1
C21-C34	150	278	2,290	4,580	6,720	475	1,250	1,980	1,200	740
Aromatics										
C10-C12	376	73.2	<50	<50	<5	36	<50	<50	<50	<50
C12-C16	1,260	2,300	<50	<50	<50	106	<50	<50	<50	<50
C16-C21	3,030	5,590	88.8	<50	178	208	<50	53	75.6	<50
C21-C34	3,280	4,950	396	468	761	438	389	295	309	199

Analytes	Sample Designation								
	TP-37-2-3	TP-38-0-1	TP-40-0-1	TP-43-2-3	TP-46-4-6	TP-49-6-10	TP-55-6-10	TP-57-0-1	TP-61-2-3
EXTRACTABLE PETROLEUM HYDROCARBONS (mg/kg)(a)									
Aliphatics									
C8-C10	<10	<50	<20	<50	<50	<119	<28	<50	<10
C10-C12	<10	<50	<20	<50	<50	<119	<28	<50	12
C12-C16	20	<50	<20	<50	<50	319	151	<50	695
C16-C21	163	106	151	339	304	243	1,540	386	3,160
C21-C34	925	948	861	1,520	2,120	172	10,100	2,430	1,190
Aromatics									
C10-C12	<10	<50	<20	<50	<50	<119	<28	<50	<10
C12-C16	19	<50	41.8	55.7	<50	1,960	93	<50	65
C16-C21	95	71.2	265	267	74.6	4,270	308	94	521
C21-C34	559	360	632	670	521	3,260	3,360	676	495

Notes:

(a) Results for analysis of extractable petroleum hydrocarbons (EPHs) by methods identified in Ecology's TPH Interim Policy, dated January 1997.
(b) "<" denotes analyte was not detected at the indicated reporting limit.

mg/kg - milligrams per kilogram

TABLE 4-6

SUMMARY OF TPH INTERIM POLICY CALCULATIONS
Former Tacoma Metals Facility

Sample	Hazard Index	Total Carcinogenic Risk Factor	Concentration at Well DF=20(a)	Concentration at Well DF=1(b)
TP-2-6-10	0.08	***4.06E-04***	---	***3.2***
TP-5-6-10	0.13	***3.55E-04***	---	***1.8***
TP-9-0-1	0.01	5.50E-07	0.0	---
TP-10-6-10	0.01	7.47E-08	---	***4.2***
TP-11-6-10	0.02	3.38E-06	---	0.0
TP-16-0-1	0.01	***1.69E-05***	0.1	---
TP-27-0-1	0.00	5.77E-07	0.0	---
TP-30-2-3	0.00	2.60E-06	0.1	---
TP-33-0-1	0.01	1.56E-06	0.0	---
TP-34-2-3	0.00	6.41E-06	0.0	---
TP-37-2-3	0.01	3.34E-06	0.0	---
TP-38-0-1	0.00	8.23E-06	0.0	---
TP-40-0-1	0.01	***9.33E-05***	0.0	---
TP-43-2-3	0.01	5.53E-06	0.0	---
TP-46-4-6	0.01	1.06E-06	0.0	---
TP-49-6-10	0.09	***3.53E-04***	---	***1.7***
TP-55-6-10	0.04	3.12E-06	---	0.2
TP-57-0-1	0.01	8.62E-07	0.0	---
TP-61-2-3	0.03	***1.10E-05***	0.0	---
Exceedence Levels	1	1x10E-05	1 mg/l	1 mg/l

Notes:

(a) Dilution factor (DF) of 20 was used to evaluate samples collected from above the saturated or groundwater smear zone.
(b) Dilution factor (DF) of 1 was used to evaluate samples collected from the groundwater smear zone.

mg/l - milligrams per liter

TABLE 4-7

SOIL ANALYTICAL RESULTS - TNT/DNT
Former Tacoma Metals Facility

Sample Designation	Sample Depth	Sample Date	TNT/DNT (mg/kg)[a] 2,4-Dinitri-toluene	2,6-Dinitro-toluene	2,4,6-Trinitro-toluene	4-Amino-2,6-Dinitrotoluene	2-Amino-4,6-Dinitrotoluene
TP-39	0-1'	10/13/00	<50[b]	<50	<50	<50	<50
TP-390[c]	0-1'	10/13/00	<50	<50	<50	<50	<50
TP-39	2-3'	10/13/00	<50	<50	<50	<50	<50
TP-39	4-6'	10/13/00	<50	<50	<50	<50	<50
TP-39	6-10'	10/13/00	<50	<50	<50	<50	<50
TP-44	0-1'	10/13/00	<50	<50	<50	<50	<50
MTCA Method C Industrial Soil Cleanup Levels [d]			7,000	3,500	N/A[e]	N/A	N/A

Notes

(a) Samples were analyzed for trinitrotoluene/dinitrotoluene (TNT/DNT) by EPA Method 8330.
(b) "<" denotes analyte was not detected at the indicated reporting limit.
(c) Duplicate sample.
(d) MTCA Method C industrial soil cleanup levels are based on CLARC II, dated February 1996.
(e) "NA" = No cleanup level available.

mg/kg - milligrams per kilogram

TABLE 4-8A

SPLP AND TCLP ANALYTICAL RESULTS - METALS(a)
Former Tacoma Metals Facility

Analyte	Analysis	Sample Designation/Depth														Criteria
		TP-1-0-1	TP-14-6-10	TP-16-2-3	TP-21-2-3	TP-22-2-3	TP-33-2-3	TP-38-0-1	TP-39-0-1	TP-40-2-3	TP-43-2-3	TP-45-0-1	TP-55-0-1	TP-60-0-1	TP-61-0-1	
Arsenic	Total (mg/kg)	40	<6(b)	---(c)	<300	<60	---	60	10	<30	80	100	<30	50	<30	219(d)
	TCLP (mg/l)	---	---	---	---	---	---	---	---	---	---	<0.05	---	---	---	5.0(e)
	SPLP (mg/l)	---	---	---	---	---	---	---	---	---	---	<0.05	---	---	---	NA(f)
Barium	Total (mg/kg)	290	84.9	---	4,190	464	---	2,710	110	851	1,280	774	1,080	1,050	377	245,000(d)
	TCLP (mg/l)	---	---	---	6.99	---	---	---	---	---	---	---	---	---	---	100.0(e)
	SPLP (mg/l)	---	---	---	0.672	---	---	---	---	---	---	---	---	---	---	NA
Cadmium	Total (mg/kg)	8.5	2.3	68	130	52	---	125	13.2	40	46	30	29	30	10	3,500(d)
	TCLP (mg/l)	---	---	---	0.94	---	---	---	---	---	---	---	---	---	---	1.0(e)
	SPLP (mg/l)	---	---	---	<0.002	---	---	---	---	---	---	---	---	---	---	NA
Chromium	Total (mg/kg)	76	35.3	---	***1,080***	913	---	263	30	212	259	368	117	225	53	500(g)
	TCLP (mg/l)	---	---	---	<0.05	---	---	---	---	---	---	---	---	---	---	1.0(a)
	SPLP (mg/l)	---	---	---	<0.005	---	---	---	---	---	---	---	---	---	---	NA
Copper	Total (mg/kg)	873	78.6	---	13,200	20,200	---	3,320	1,100	1,240	2,520	3,560	465	2,330	356	130,000(d)
	TCLP (mg/l)	---	---	---	---	66.2	---	---	---	---	---	---	---	---	---	NA
	SPLP (mg/l)	---	---	---	---	0.005	---	---	---	---	---	---	---	---	---	NA
Lead	Total (mg/kg)	***2,230***	152	***8,240***	***7,570***	***3,690***	***4,560***	***9,380***	***1,040***	***2,050***	***12,300***	***4,060***	***1,750***	***10,800***	***4,180***	1,000(g)
	TCLP (mg/l)	***11.7***	<0.1	3.3	***74.7***	---	***22.4***	***20.6***	0.13	***6.9***	***63.6***	---	***26.5***	---	***12.2***	5.0(a)
	SPLP (mg/l)			<0.02	---	---	---	---	0.03	<0.02	0.03	---	---	---	0.07	NA
Mercury	Total (mg/kg)	1.53	0.07	---	10.2	5.1	1.69	14.3	0.21	3.19	21	47	0.83	77	0.76	1,050(d)
	TCLP (mg/l)	---	---	---	---	---	---	---	---	---	---	---	---	0.0005	---	0.2(e)
	SPLP (mg/l)	---	---	---	---	---	---	---	---	---	---	---	---	0.0021	---	NA
Selenium	Total (mg/kg)	<10	<6	---	<300	<60	---	30	<10	<30	<30	30	<30	40	<30	17,500(d)
	TCLP (mg/l)	---	---	---	---	---	---	---	---	---	---	---	---	<0.2	---	1.0(e)
	SPLP (mg/l)	---	---	---	---	---	---	---	---	---	---	---	---	<0.05	---	NA
Silver	Total (mg/kg)	1.4	<0.4	---	90	198	---	6	<0.8	3	5	7	<2	2	<2	17,500(d)
	TCLP (mg/l)	---	---	---	---	<0.02	---	---	---	---	---	---	---	---	---	5.0(e)
	SPLP (mg/l)	---	---	---	---	<0.003	---	---	---	---	---	---	---	---	---	NA

Analytes detected in samples at concentrations exceeding criteria are shown in bold and italics.

Notes:

(a) Samples were analyzed for TCLP and SPLP Metals by EPA Methods 1311/1312/6010.
(b) "<" denotes analyte was not detected at the indicated reporting limit.
(c) "---" Sample not tested for selected analyte.
(d) MTCA Method C industrial soil cleanup levels are based on CLARC II, dated February 1996.
(e) Toxicity characteristics based on Dangerous Waste Criteria (WAC 173-303-100).
(f) "NA" = No criteria available.
(g) Method A industrial soil cleanup levels (WAC 173-340-745) used where Method C industrial soil cleanup levels are not available.

mg/kg - milligrams per kilogram
mg/l - milligrams per liter

TABLE 4-8B

SPLP AND TCLP ANALYTICAL RESULTS - PAHs
Former Tacoma Metals Facility

			PAHs[a]									cPAHs[a][b]							
Sample Designation	**Sample Depth**	**Totals**	**Naphth-alene**	**Acenaph-thlyene**	**Acenaph-thene**	**Fluorene**	**Phenan-threne**	**Anth-racene**	**Fluoran-thene**	**Pyrene**	**Benzo (g,h,i) perylene**	**Chrysene**	**Benzo (b)-fluoranthene**	**Benzo (k)-fluoranthene**	**Benzo (a)-pyrene**	**Indeno (1,2,3-cd) pyrene**	**Dibenz (a,h)-anthracene**	**Benzo (a)-anthracene**	**Total cPAHs[b]**
TP-40	0-1	Total (mg/kg)	0.98	3.8	0.74	1.4	17	4.7	43	51	13	41	24	23	28	14	4.8	33	167.8
		TCLP (µg/l)	<10[c]	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	35
		SPLP (µg/l)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	35
TP-49	6-10	Total (mg/kg)	8.4	16	440	390	1,300	250	810	620	38	230	73	54	82	31	14M	150	634
		TCLP (µg/l)	<10	<10	300	180	190	20	28	18	<10	<10	<10	<10	<10	<10	<10	<10	35
		SPLP (µg/l)	<10	<10	230	140	150	15	23	18	<10	<10	<10	<10	<10	<10	<10	<10	35
TP-61	2-3	Total (mg/kg)	2.8	0.67	0.68M	1.7	7.2	2.5M	9.3	7.8	1.1	4.9	2.9	2.7	2.9	1.6	0.61M	4.1	19.71
		TCLP (µg/l)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	35
		SPLP (µg/l)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	35

Notes:
(a) Samples were analyzed for TCLP and SPLP polycyclic aromatic hydrocarbons (PAHs) by EPA Methods 1311/1312/8270.
(b) The total probable carcinogenic polycyclic aromatic hydrocarbons (cPAHs) were calculated by summing the concentrations of all the probable cPAHs. If a probable cPAH was not detected in the sample, a value equal to one-half the reporting limit was used.
(c) "<" denotes analyte was not detected at the indicated reporting limit.

Qualifiers:
M - Indicates an estimated value of analyte found and confirmed by analyst but with low spectral match.

mg/kg - milligrams per kilogram
µg/l - micrograms per liter

TABLE 4-9

ESTIMATED SOIL CLEANUP LEVEL EXCEEDANCE VOLUMES

Former Tacoma Metals Facility

ESTIMATED EXCEEDANCE AREA VOLUMES FOR SPECIFIC ANALYTES					
Analyte	**Depth Interval (ft)**	**Interval Thickness (ft)**	**Surface Area (ft^2)**	**Volume (yd^3)**	
Lead	0-1	1	142,534	5,279[a]	
	2-3	2	70,538	5,225	
	4-6	3	8,318	924	
	Total Lead Soil Cleanup Level Exceedance Volume:			**11,428[a]**	**(11,400)[b]**
Petroleum Hydrocarbons	0-1	1	36,223	1,342	
	2-3	2	22,268	1,649	
	4-6	3	13,875	1,542	
	6-10	4	14,430	2,138	
	Total Petoleum Hydrocarbon Soil Cleanup Level Exceedance Volume:			**6,671**	**(6,700)**
cPAHs	0-1	1	6,209	230	
	2-3	2	2,750	204	
	6-10	4	7,540	1,117	
	Total cPAH Soil Cleanup Level Exceedance Volume:			**1,551**	**(1,600)**
PCBs	0-1	1	20,945	776	
	2-3	2	3,503	259	
	Total PCB Soil Cleanup Level Exceedance Volume:			**1,035**	**(1,000)**

Notes:

ft - feet
ft^2 - square feet
yd^3 - cubic yards
cPAHs - Carcinogenic polycyclic aromatic hydrocarbons.
PCBs - Polychlorinated biphenyls.
(a) Includes area identified in previous investigations.
(b) Volume rounded to nearest hundred cubic yards.

TABLE 5-1

RECONNAISSANCE GROUNDWATER ANALYTICAL RESULTS - DISSOLVED METALS
Former Tacoma Metals Facility

Sample Designation	Sample Date	Dissolved Metals (µg/l)(a)(b)							
		Arsenic	**Barium**	**Cadmium**	**Chromium**	**Lead**	**Mercury**	**Selenium**	**Silver**
RGW -1	5/25/00	<5(c)	61	***9***	<10	<4	<0.2	<50	<7
RGW -2	5/25/00	<5	49	6	<10	<4	<0.2	<50	<7
RGW -3	5/25/00	<5	62	<5	<10	<4	<0.2	<50	<7
RGW -4	5/25/00	<5	33	<5	<10	<4	<0.2	<50	<7
RGW -5	5/25/00	<5	44	5	<10	<4	<0.2	<50	<7
RGW -6	5/25/00	<5	14	<5	<10	<4	<0.2	<50	<7
RGW -7	5/25/00	<5	23	<5	<10	<4	<0.2	<50	<7
RGW -8	5/25/00	<5	120	<5	<10	<4	<0.2	<50	<7
RGW -9	5/25/00	<5	30	<5	<10	<4	<0.2	<50	<7
RGW -10	5/25/00	<5	17	<5	<10	<4	<0.2	<50	<7
RGW -11	5/25/00	<5	9	<5	<10	<4	<0.2	<50	<7
RGW -12	5/25/00	<5	10	<5	<10	<4	<0.2	<50	<7
RGW -13	5/26/00	<5	11	<5	<10	<4	<0.2	<50	<7
RGW -14	5/26/00	<5	4	<5	<10	<4	<0.2	<50	<7
RGW -15	5/26/00	<5	4	<5	<10	<4	<0.2	<50	<7
RGW -16	5/26/00	<5	12	<5	<10	<4	<0.2	<50	<7
RGW -17	5/26/00	<5	14	<5	<10	<4	<0.2	<50	<7
RGW -18	5/26/00	<5	7	<5	<10	<4	0.2	<50	<7
MTCA Method B Surface Water Cleanup Level(d)		0.0982	NA(e)	20.3	NA	NA	NA	NA	25,900
MTCA Method C Surface Water Cleanup Level(d)		2.46	NA	50.6	NA	NA	NA	NA	64,800
Ecology Acute Freshwater Surface Water Cleanup Level(f)		360	NA	7.0(g)	888.04(g,h)	121.70(g)	2.10	20	9.48(g)
National Toxics Rule for Consumption of Organisms(i)		1.4	NA	NA	NA	NA	1.5	NA	NA

Analytes detected in samples at concentrations exceeding one or more of the comparison values are shown in bold and italics.

TABLE 5-1

RECONNAISSANCE GROUNDWATER ANALYTICAL RESULTS - DISSOLVED METALS
Former Tacoma Metals Facility

Notes:

(a) Reconnaissance groundwater samples were analyzed for dissolved metals by EPA Methods 6010/7000 series.
(b) All groundwater samples were field filtered. All concentrations are dissolved.
(c) "<" denotes analyte was not detected at the indicated reporting limit.
(d) MTCA Method B and C surface water cleanup levels based on CLARC II, dated February 1996.
(e) "NA" = No cleanup level available.
(f) Ecology Acute Freshwater Surface Water Standard (WAC 173-201A).
(g) Surface Water Quality Standard is based on an average groundwater hardness of 160 mg/l.
(h) Chromium as chromium III (CAS# 7440-47-3).
(i) National Toxics Rule for consumption of organisms only based on 40 CFR 131.36 for a risk level of 1×10^{-5}.

mg/l - milligrams per liter
µg/l - micrograms per liter

TABLE 5-2

RECONNAISSANCE GROUNDWATER ANALYTICAL RESULTS - PCBs
Former Tacoma Metals Facility

Sample Designation	Sample Date	PCBs (µg/l)[a]							Total PCBs[c]
		Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	
RGW-1	5/25/00	<0.2[b]	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.7
RGW-2	5/25/00	<1	<1	<1	<1	<1	<1	<1	3.5
RGW-3	5/25/00	<1	<1	<1	<1	<1	<1	<1	3.5
RGW-4	5/25/00	<1	<1	<1	<1	<1	<1	<1	3.5
RGW-5	5/25/00	<2	<2	<2	<2	<2	<2	<2	7.0
RGW-6	5/25/00	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.35
RGW-7	5/25/00	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.35
RGW-8	5/25/00	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.35
RGW-9	5/25/00	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.7
RGW-10	5/25/00	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.7
RGW-11	5/25/00	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.7
RGW-12	5/25/00	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.7
RGW-13	5/26/00	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.35
RGW-14	5/26/00	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.35
RGW-15	5/26/00	<1	<1	<1	<1	<1	<1	<1	3.5
RGW-16	5/26/00	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.7
RGW-17	5/26/00	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.7
RGW-18	5/26/00	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.7
MTCA Method B Surface Water Cleanup Level[d]		NA[e]	NA	NA	NA	NA	NA	NA	2.70E-05 (1)
MTCA Method C Surface Water Cleanup Level[d]		NA	NA	NA	NA	NA	NA	NA	6.74E-04 (1)
Ecology Acute Freshwater Surface Water Quality Standard[f]		NA	NA	NA	NA	NA	NA	NA	2.0
National Toxics Rule for Consumption of Organisms[g]		NA	NA	NA	NA	NA	NA	NA	0.0017 (1)

TABLE 5-2

RECONNAISSANCE GROUNDWATER ANALYTICAL RESULTS - PCBs
Former Tacoma Metals Facility

Notes:
(a) Samples were analyzed for polychlorinated biphenyls (PCBs) by EPA Method 8082.
(b) "<" denotes analyte was not detected at the indicated reporting limit.
(c) The total PCBs were calculated by summing the concentrations of all the probable PCBs. If a probable PCB was not detected, a value equal to one-half the reporting limit was used.
(d) MTCA Method B and C surface water cleanup levels based on CLARC II, dated February 1996. "(1)" denotes practical quantification limit (PQL) is greater than cleanup level, or standard (Ecology 1993).
(e) "NA" = No cleanup level available.
(f) Ecology Acute Freshwater Surface Water Quality Standards (WAC 173-201A).
(g) National Toxics Rule for consumption of organisms only based on 40 CFR 131.36 for a risk level of 1×10^{-6}.

µg/l - micrograms per liter

TABLE 5-3

RECONNAISSANCE GROUNDWATER ANALYTICAL RESULTS - PAHs
Former Tacoma Metals Facility

		PAHs (μg/l)$^{(a)}$									cPAHs (μg/l)$^{(a)(b)}$							
Sample Designation	**Sample Date**	**Naphthalene**	**Acenaphthlyene**	**Acenaphthene**	**Fluorene**	**Phenanthrene**	**Anthracene**	**Fluoranthene**	**Pyrene**	**Benzo (g,h,i) perylene**	**Chrysene**	**Benzo (b)-fluoranthene**	**Benzo (k)-fluoranthene**	**Benzo (a)-pyrene**	**Indeno (1,2,3-cd) pyrene**	**Dibenz (a,h)-anthracene**	**Benzo (a)-anthracene**	**Total cPAHs**
RGW -1	5/25/00	<0.02$^{(c)}$	<0.02	0.24	0.23	0.09	0.07	0.22	0.14	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	***0.03***	***0.1***
RGW -2	5/25/00	<0.02	<0.02	***1100***	0.05	0.03	0.03	0.08	0.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
RGW -3	5/25/00	<0.02	<0.02	0.17	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
RGW -4	5/25/00	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
RGW -5	5/25/00	0.02	<0.02	<0.02	0.04	0.06	<0.02	0.07	0.06	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.08
RGW -6	5/25/00	<0.02	<0.02	0.16	<0.02	0.04	<0.02	0.09	0.16	0.07	***0.55***	***0.21***	***0.09***	***0.04***	***0.04***	<0.02	***0.09***	***1.03***
RGW -7	5/25/00	0.02	<0.02	0.55	0.4	1.2	0.18	0.38	0.25	<0.02	***0.04***	<0.02	<0.02	<0.02	<0.02	<0.02	***0.05***	***0.14***
RGW -8	5/25/00	<0.02	<0.02	0.02	<0.02	0.09	<0.02	0.05	0.06	<0.02	***0.03***	<0.02	<0.02	0.02	<0.02	<0.02	0.02	***0.11***
RGW -9	5/25/00	0.02	<0.02	0.04	<0.02	0.06	<0.02	0.03	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
RGW -10	5/25/00	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
RGW -11	5/25/00	0.13	<0.02	1.4	0.03	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
RGW -12	5/25/00	0.02	<0.02	0.1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
RGW -13	5/26/00	34	0.61	140	57	31	2.4	4.4	3.1	0.24	***0.47***	***0.27***	***0.23***	***0.38***	***0.21***	***0.07***	***0.43***	***2.06***
RGW -14	5/26/00	8.6	0.05	3.6	2.2	2.2	0.64	2.7	1.6	0.03	***0.22***	***0.07***	***0.07***	***0.06***	***0.03***	<0.02	***0.28***	***0.74***
RGW -15	5/26/00	110	0.37	64	38	27	5.3	9.2	7.1	0.18	***0.54***	***0.26***	***0.23***	***0.38***	***0.15***	<0.02	***0.59***	***2.16***
RGW -16	5/26/00	0.21	0.01	0.13	0.1	0.2	0.04	0.05	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
RGW -17	5/26/00	0.22	<0.02	0.19	0.03	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
RGW -18	5/26/00	45	0.82	66	47	130	26	88	79	7.4	***19***	***13***	***13***	***16***	***6.6***	***2.4***	***26***	***96***
MTCA Method B Surface Water Cleanup Level$^{(d)}$		9,880	NA$^{(e)}$	643	3,460	NA	25,900	90.2	2,590	NA	0.0296 (1)	0.0296 (1)	0.0296 (1)	0.0296 (1)	0.0296 (1)	0.0296 (1)	0.0296 (1)	0.0296 (1)
MTCA Method C Surface Water Cleanup Level$^{(d)}$		24,700	NA	1,610	8,640	NA	64,800	225	6,480	NA	0.740 (1)	0.740 (1)	0.740 (1)	0.740 (1)	0.740 (1)	0.740 (1)	0.740 (1)	0.740 (1)
Ecology Acute Freshwater Surface Water Quality Standard$^{(f)}$		2,300	NA	1,700	NA	NA	NA	3,980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
National Toxics Rule for Consumption of Organisms$^{(g)}$		NA	NA	NA	1.4×10^5	NA	1.1×10^6	3,700	1.1×10^5	NA	0.31 (1)	0.31 (1)	0.31 (1)	0.31 (1)	0.31 (1)	0.31 (1)	0.31 (1)	0.31 (1)

Analytes detected in samples at concentrations exceeding one or more of the cleanup levels or comparison values are shown in bold and italics.

Notes:

(a) Samples were analyzed for polycyclic aromatic hydrocarbons (PAHs) by EPA Method 8270B GC/MS SIM.

(b) The total probable carcinogenic polycyclic aromatic hydrocarbons (cPAHs) were calculated by summing the concentrations of all the probable cPAHs. If a probable cPAH was not detected in the sample, a value equal to one-half the reporting limit was used.

(c) "<" denotes analyte was not detected at the indicated reporting limit.

(d) MTCA Method B and C surface water cleanup levels based on CLARC II, dated February 1996. "(1)" denotes practical quantification limit (PQL) is greater than cleanup level or standard (Ecology 1993).

(e) "NA" = No cleanup level is available.

(f) Ecology Acute Freshwater Surface Water Quality Standards (WAC 173-201A).

(g) National Toxics Rule for consumption of organisms only based on 40 CFR 131.36 for a risk level of 1×10^{-5}. "(1)" denotes practical quantification limit (PQL) is greater than cleanup level or standard (Ecology 1993).

μg/l - micrograms per liter

TABLE 5-4

RECONNAISSANCE GROUNDWATER ANALYTICAL RESULTS - TPHs AND VOCs
Former Tacoma Metals Facility

Sample Designation	Sample Date	TPHs (mg/l)(a)			Volatile Organic Compounds (µg/l)(b)				
		TPH-Gas	TPH-Diesel	TPH-Motor Oil	Benzene	Toluene	Ethylbenzene	Total xylenes	Naphthalene
RGW -1	5/25/00	<0.05(c)	<0.25	<0.5	<2	3	<2	<6	<2
RGW -2	5/25/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -3	5/25/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -4	5/25/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -5	5/25/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -6	5/25/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -7	5/25/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -8	5/25/00	<0.05	<0.25	<0.5	<2	2	<2	<6	<2
RGW -9	5/25/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -10	5/25/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -11	5/25/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -12	5/25/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -13	5/26/00	0.33	0.88	<0.5	<2	<2	2	<6	33
RGW -14	5/26/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	23
RGW -15	5/26/00	0.2	0.96	0.96	<2	<2	<2	<6	210
RGW -16	5/26/00	<0.05	1.7	<0.5	<2	<2	<2	<6	<2
RGW -17	5/26/00	<0.05	<0.25	<0.5	<2	<2	<2	<6	<2
RGW -18	5/26/00	0.09	0.86	<0.5	<2	<2	<2	<6	77
MTCA Method B Surface Water Cleanup Level(d)		NA(e)	NA	NA	43	48,500	6,910	NA	9,880
MTCA Method C Surface Water Cleanup Level(d)		NA	NA	NA	1,070	121,000	17,300	NA	24,700
Ecology Acute Freshwater Surface Water Quality Standard(f)		NA	NA	NA	5,300	17,500	32,000	NA	2,300
National Toxics Rule for Consumption of Organisms(g)		NA	NA	NA	710	2,000,000	290,000	NA	NA
Ecology Model NPDES Permit Standard(h)		1	10	10	NA	NA	NA	NA	NA

Analytes detected in samples at concentrations exceeding one or more of the cleanup levels or comparison values are shown in bold and italics.

TABLE 5-4

RECONNAISSANCE GROUNDWATER ANALYTICAL RESULTS - TPHs AND VOCs
Former Tacoma Metals Facility

Notes:

(a) Samples were analyzed for total petroleum hydrocarbons (TPHs) by the appropriate Ecology Methods NWTPH-Gas and NWTPH-Diesel (extended).
(b) Soil and groundwater samples were analyzed for volatile organic compounds (VOCs) by EPA Method 8260.
(c) "<" denotes analyte was not detected at the indicated reporting limit.
(d) MTCA Method B and C surface water cleanup levels based on CLARC II, dated February 1996.
(e) "NA" = No cleanup level available.
(f) Ecology Acute Freshwater Surface Water Quality Standards (WAC 173-201A).
(g) National Toxics Rule for consumption of organisms only based on 40 CFR 131.36 for a risk level of $1x10^{-5}$.
(h) Ecology's Model National Pollutant Discharge Elimination System (NPDES) Permit Standard for discharges to surface water from leaking underground storage tank (LUST) cleanups where gasoline or diesel fuel are the pollutants of concern.

mg/l - milligrams per liter
µg/l - micrograms per liter

TABLE 5-5

GROUNDWATER ANALYTICAL RESULTS - TOTAL METALS

Former Tacoma Metals Facility

Sample Designation	Sample Date	Total Metals (µg/l)(a)								
		Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver
MW-1	3/14/00	<5(b)	12	<5	30	---(c)	<4	<0.2	<50	<7
	11/21/00	<50	9	<2	<5	11	<20	<0.1	<50	<3
	3/5/01	<50	13	<2	<5	<2	<20	<0.1	<50	<3
MW-2	3/14/00	<5	5	<5	190	---	<4	<0.2	<50	<7
	11/21/00	<50	28	<2	<5	20	<20	<0.1	<50	<3
	3/5/01	<50	13	<2	<5	<2	<20	<0.1	<50	<3
MW-4(R)(d)	5/11/00	<5	8	<5	<10	---	20	<0.2	<50	<7
	11/20/00	<50	12	<2	<5	<2	<20	<0.1	<50	<3
	3/5/01	<50	14	<2	<5	8	<20	<0.1	<50	<3
MW-5	3/14/00	<5	18	<5	30	---	<4	<0.2	<50	<7
	11/21/00	<50	2	<2	<5	4	<20	<0.1	<50	<3
	3/5/01	<50	21	<2	<5	3	<20	<0.1	<50	<3
MW-6	3/14/00	<5	24	<5	70	---	<4	<0.2	<50	<7
	11/21/00	<50	3	<2	<5	5	<20	<0.1	<50	<3
	3/5/01	<50	22	3	<5	<2	<20	<0.1	<50	<3
MW-7	3/14/00	<5	23	<5	20	---	<4	<0.2	<50	<7
	11/21/00	<50	31	<2	<5	8	<20	<0.1	<50	<3
	3/6/01	<50	34	<2	<5	<2	<20	<0.1	<50	<3
MW-8(R)/MW-800(e)	5/12/00	<5	15	<5	<10	---	6	<0.2	<50	<7
	11/20/00	<50/<50	13/11	<2/<2	<5/<5	2/<2	<20/<20	<0.1/<0.1	<50/<50	<3/<3
	3/6/01	<50/<50	14/15	<2/<2	<5/<5	<2/<2	<20/<20	<0.1/<0.1	<50/<50	<3/<3
MW-9	5/11/00	<5	17	<5	<10	---	6	<0.2	<50	<7
	11/21/00	<50	16	<2	<5	<2	<20	<0.1	<50	<3
	3/5/01	<50	90	<2	<5	<2	<20	<0.1	<50	<3
MW-10	11/20/00	<50	10	<2	<5	3	<20	<0.1	<50	<3
	3/6/01	<50	9	<2	<5	4	<20	<0.1	<50	<3
MW-11	11/20/00	<50	9	<2	<5	3	<20	<0.1	<50	<3
	3/6/01	<50	8	<2	<5	<2	<20	<0.1	<50	<3
MW-12	11/20/00	<50	3	<2	<5	<2	<20	<0.1	<50	<3
	3/6/01	<50	31	<2	<5	<2	<20	<0.1	<50	<3
MTCA Method B Surface Water Cleanup Level(f)		0.00982	NA(g)	20.3	NA	2,660	NA	NA	NA	25,900
MTCA Method C Surface Water Cleanup Level(f)		2.46	NA	50.6	NA	6,660	NA	NA	NA	64,800
Ecology Acute Freshwater Surface Water Cleanup Level(h)		360	NA	7.0(i)	888.04(i,j)	29.61(i)	121.70(i)	2.10	20	9.48(i)
National Toxics Rule for Consumption of Organisms(k)		1.4	NA	NA	NA	NA	NA	1.5	NA	NA

TABLE 5-5

GROUNDWATER ANALYTICAL RESULTS - TOTAL METALS

Former Tacoma Metals Facility

Notes:

(a) Groundwater samples were analyzed for metals by EPA Methods 6010/7000 series.
(b) "<" denotes analyte was not detected at the indicated reporting limit.
(c) "---" Sample not analyzed for indicated analyte.
(d) "R" = Replacement well.
(e) Sample MW-800 is a duplicate sample collected from well MW-8(R).
(f) MTCA Method B and C surface water cleanup levels based on CLARC II, dated February 1996.
(g) "NA" = No cleanup level available.
(h) Ecology Acute Freshwater Surface Water Standard (WAC 173-201A).
(i) Surface Water Quality Standard is based on an average groundwater hardness of 180 mg/l.
(j) Chromium as chromium III, (CAS# 7440-47-3).
(k) National Toxics Rule for consumption of organisms only based on 40 CFR 131.36 for a risk level of $1x10^{-5}$.

µg/l - micrograms per liter
mg/l - milligrams per liter

TABLE 5-6

GROUNDWATER ANALYTICAL RESULTS - DISSOLVED METALS

Former Tacoma Metals Facility

Sample Designation	Sample Date	Dissolved Metals (µg/l)[a][b]								
		Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver
MW-1	11/21/00	<50[c]	19	<2	<5	<2	<20	<0.1	<50	<3
	3/5/01	<50	14	<2	<5	<2	<20	<0.1	<50	<3
MW-2	11/21/00	<50	11	<2	<5	<2	<20	<0.1	<50	<3
	3/5/01	<50	10	<2	<5	<2	<20	<0.1	<50	<3
MW-4(R)[d]	11/20/00	<50	13	<2	<5	<2	<20	<0.1	<50	<3
	3/5/01	<50	10	<2	<5	<2	<20	<0.1	<50	<3
MW-5	11/21/00	<50	35	<2	<5	<2	<20	<0.1	<50	<3
	3/5/01	<50	21	<2	<5	<2	<20	<0.1	<50	<3
MW-6	11/21/00	<50	34	<2	<5	<2	<20	<0.1	<50	<3
	3/5/01	<50	22	<2	<5	<2	<20	<0.1	<50	<3
MW-7	11/21/00	<50	39	<2	<5	3	<20	<0.1	<50	<3
	3/6/01	<50	34	<2	<5	<2	<20	<0.1	<50	<3
MW-8(R)/MW-800[e]	11/20/00	<50/<50	15/15	<2/<2	<5/<5	<2/<2	<20/<20	<0.1/<0.1	<50/<50	<3/<3
	3/6/01	<50/<50	19/19	<2/<2	<5/<5	<2/<2	<2/<2	<0.1/<0.1	<50/<50	<3/<3
MW-9	11/21/00	<50	102	<2	<5	<2	<20	<0.1	***70***	<3
	3/5/01	<50	97	<2	<5	<2	<20	<0.1	<50	<3
MW-10	11/20/00	<50	12	<2	<5	<2	<20	<0.1	<50	<3
	3/6/01	<50	11	<2	<5	<2	<20	<0.1	<50	<3
MW-11	11/20/00	<50	10	<2	<5	<2	<20	<0.1	<50	<3
	3/6/01	<50	9	<2	<5	<2	<20	<0.1	<50	<3
MW-12	11/20/00	<50	35	<2	<5	<2	<20	<0.1	<50	<3
	3/6/01	<50	33	<2	<5	<2	<20	<0.1	<50	<3
MTCA Method B Surface Water Cleanup Level[f]		0.00982	NA[g]	20.3	NA	2,660	NA	NA	NA	25,900
MTCA Method C Surface Water Cleanup Level[f]		2.46	NA	50.6	NA	6,660	NA	NA	NA	64,800
Ecology Acute Freshwater Surface Water Cleanup Level[h]		360	NA	7[i]	888.04[i,j]	29.61[i]	121.70[i]	2.10	20	9.48[i]
National Toxics Rule for Consumption of Organisms[k]		1.4	NA	NA	NA	NA	NA	1.5	NA	NA

Analytes detected in samples at concentrations exceeding one or more of the cleanup levels or comparison values are shown in bold and italics.

TABLE 5-6

GROUNDWATER ANALYTICAL RESULTS - DISSOLVED METALS

Former Tacoma Metals Facility

Notes:

(a) Groundwater samples were analyzed for metals by EPA Methods 6010/7000 series.
(b) All groundwater samples were field filtered. All concentrations are dissolved.
(c) "<" denotes analyte was not detected at the indicated reporting limit.
(d) "R" = Replacement well.
(e) Sample MW-800 is a duplicate sample collected from well MW-8(R).
(f) MTCA Method B and C surface water cleanup levels based on CLARC II, dated February 1996.
(g) "NA" = No cleanup level available.
(h) Ecology Acute Freshwater Surface Water Standard (WAC 173-201A).
(i) Surface Water Quality Standard is based on an average groundwater hardness of 180 mg/l.
(j) Chromium as chromium III, (CAS # 7440-47-3).
(k) National Toxics Rule for consumption of organisms only based on 40 CFR 131.36 for a risk level of $1x10^{-5}$.

mg/l - milligrams per liter
µg/l - micrograms per liter

TABLE 5-7

GROUNDWATER ANALYTICAL RESULTS - PCBs
Former Tacoma Metals Facility

Sample Designation	Sample Date	PCBs (µg/l)(a)							Total PCBs(b)
		Aroclor 1016	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1221	Aroclor 1232	
MW-1	3/14/00	<0.1(c)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.35
	11/21/00	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
	3/5/01	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
MW-2	3/14/00	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.35
	11/21/00	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
	3/5/01	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
MW-4(R)(d)	5/11/00	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.35
	11/20/00	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
	3/5/01	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
MW-5	3/14/00	<0.1	<0.1	<0.1	<1.0	<1.0	<0.1	<0.1	1.25
	11/21/00	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
	3/5/01	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
MW-6	3/14/00	<0.1	<0.1	<0.1	<1.0	<1.0	<0.1	<0.1	1.25
	11/21/00	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
	3/5/01	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
MW-7	3/14/00	<0.5	<0.5	<0.5	<2.0	<2.0	<0.5	<0.5	3.25
	11/21/00	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
	3/6/01	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
MW-8(R)/MW-800(e)	5/12/00	<1.0	<1.0	<1.0	<1.0	<1.0	<20	<5	15
	11/20/00	<1.0/<1.0	<1.0/5.6Y(f)	<1.0/1.9Y	<1.0/1.3Y	<1.0/<1.0	<2.0/<2.0	<1.0/<1.0	4.0/***11.3***
	3/6/01	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<2.0/<2.0	<1.0/<1.0	4.0/4.0
MW-9	5/11/00	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.35
	11/21/00	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
	3/5/01	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
MW-10	11/20/00	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
	3/6/01	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
MW-11	11/20/00	<1.0	2.0Y	<1.0	<1.0	<1.0	<2.0	<1.0	***5.5***
	3/6/01	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
MW-12	11/20/00	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
	3/6/01	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	4.0
MTCA Method B Surface Water Cleanup Level(g)		NA(h)	NA	NA	NA	NA	NA	NA	2.70E-05 (1)
MTCA Method C Surface Water Cleanup Level(g)		NA	NA	NA	NA	NA	NA	NA	6.74E-04 (1)
Ecology Acute Freshwater Surface Water Quality Standard(i)		NA	NA	NA	NA	NA	NA	NA	2.0
National Toxics Rule for Consumption of Organisms(j)		NA	NA	NA	NA	NA	NA	NA	0.0017 (1)

Analytes detected in samples at concentrations exceeding one or more of the cleanup levels or comparison values are shown in bold and italics.

TABLE 5-7

GROUNDWATER ANALYTICAL RESULTS - PCBs
Former Tacoma Metals Facility

Notes:
(a) Samples were analyzed for polychlorinated biphenyls (PCBs) by EPA Method 8082.
(b) The total PCBs were calculated by summing the concentrations of all the probable PCBs. If a probable PCB was not detected, a value equal to one-half the reporting limit was used.
(c) "<" denotes analyte was not detected at the indicated reporting limit.
(d) "R" Replacement well.
(e) Sample MW-800 is a duplicate sample collected from well MW-8(R).
(f) "Y" indicates a raised reporting limit due to matrix interferences. The analyte may be present at or below the listed concentration.
(g) MTCA Method B and C surface water cleanup levels based on CLARC II, dated February 1996. "(1)" denotes practical quantification limit (PQL) is greater than cleanup level or standard (Ecology 1993).
(h) "NA" = No cleanup level available.
(i) Ecology Acute Freshwater Surface Water Quality Standards (WAC 173-201A).
(j) National Toxics Rule for consumption of organisms only based on 40 CFR 131.36 for a risk level of 1x10^{-5}.

µg/l - micrograms per liter

TABLE 5-9

GROUNDWATER ANALYTICAL RESULTS - TPHs AND VOCs
Former Tacoma Metals Facility

Sample Designation	Sample Date	TPHs (mg/l)[a]			Volatile Organic Compounds (µg/l)[b]																			
		TPH-Gas	TPH-Diesel	TPH-Motor Oil	Benzene	Toluene	Ethyl-benzene	Total xylenes	Naphth-alene	Chloro-benzene	Carbon Disulfide	Acetone	Methylene Chloride	P-Isopropy -toluene	1,1,1,2-Tetra chloroethane	1,3,5 Trimethyl benzene	1,2,4 Trimethyl benzene	Isopropyl-benzene	n-Propyl benzene	4-Isopropy toluene	n-Butyl benzene	Styrene	1,4, Dichloro-benzene	1,1 Dichloro-ethane
MW-1	3/14/00	<0.05[c]	<0.25	<0.50	<5	<5	<5	<15	<5	<5	—	<150	<5	<5	<5	<5	<5	<5	<5	—	<5	<5	<5	<5
	11/21/00	<0.25	<0.25	<0.50	<0.2	<0.2	<0.2	<0.6	<0.5	<0.2	<0.2	1.8	<0.3	---	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	3/5/01	<0.25	<0.25	<0.50	<1.0	<1.0	<1.0	<2.0	<5.0	<1.0	<1.0	<5.0	<2.0	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MW-2	3/14/00	<0.05	<0.25	<0.50	<5	<5	<5	<15	<5	<5	---	<150	<5	<5	<5	<5	<5	<5	<5	—	<5	<5	<5	<5
	11/21/00	<0.25	<0.25	<0.50	<0.2	<0.2	<0.2	<0.6	<0.5	<0.2	<0.2	<1.0	<0.3	---	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
	3/5/01	<0.25	<0.25	<0.50	<1.0	<1.0	<1.0	<2.0	<5.0	<1.0	<1.0	<5.0	<2.0	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MW-4(R)[d]	5/11/00	---[e]	0.42	<0.50	<2	<2	<2	<6	<2	<2	---	<20	<2	5	<2	<2	<2	<2	<2	---	<2	<2	<2	<2
	11/20/00	<0.25	0.56	<0.50	<1.0	<1.0	<1.0	<2.0	<5.0	<1.0	<1.0	<5.0	<2.0	—	<1.0	<1.0	<1.0	<1.0	<1.0	10	<1.0	<1.0	<1.0	<1.0
	3/5/01	<0.25	0.67	<0.50	<1.0	<1.0	<1.0	<2.0	<5.0	<1.0	<1.0	<5.0	<2.0	—	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MW-5	3/14/00	<0.05	<0.25	<0.50	<5	<5	<5	<15	<5	<5	---	<150	<5	<5	<5	<5	<5	<5	<5	---	<5	<5	<5	<5
	11/21/00	<0.25	0.62	<0.50	<0.2	<0.2	<0.2	<0.6	<0.5	<0.2	<0.2	1.7	<0.3	---	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	3/5/01	<0.25	0.76	<0.50	<1.0	<1.0	<1.0	<2.0	<5.0	<1.0	<1.0	<5.0	<2.0	—	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MW-6	3/14/00	<0.05	<0.25	<0.50	<5	<5	<5	<15	<5	36	—	<150	<5	<5	<5	<5	<5	<5	<5	—	<5	<5	<5	<5
	11/21/00	<0.25	1.2	<0.50	<0.2	<0.2	<0.2	<0.6	<5.0	72	0.3	1.3	<0.3	---	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.4	<0.2
	3/5/01	<0.25	1.0	<0.50	<1.0	<1.0	<1.0	<2.0	<5.0	88	<1.0	<5.0	<2.0	—	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MW-7	3/14/00	<0.05	<0.25	<0.50	<5	<5	<5	<15	<5	<5	—	<150	<5	<5	<5	<5	<5	<5	<5	—	<5	<5	<5	<5
	11/21/00	<0.25	0.44	<0.50	<0.2	<0.2	<0.2	<0.6	<0.5	<0.2	<0.2	1.1	<0.3	—	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	3/6/01	<0.25	0.33	<0.50	<1.0	<1.0	<1.0	<2.0	<5.0	<1.0	<1.0	<5.0	<2.0	—	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MW-8(R)/MW-800[f]	5/12/00	---	4.1	<0.50	23	47	220	880	2000	<2	—	<20	<2	38	<2	120	<2	58	<2	—	10	<20	<2	<2
	11/20/00	***29/30***	4/3.8	<0.50/<0.50	23/25	98/100	280/280	1,560/1,680	***8,500/7,200***	<0.2/<0.2	<0.2/<0.2	4.2/4.5	<0.3/<0.3	---	<0.2/<0.2	170/180	520/540	59/59	12/12	45/44	12M/<0.2	<0.2/<0.2	<0.2/<0.2	<0.2/<0.2
	3/6/01	***38/39***	3.8/3.7	<0.50/<0.50	24/25	70/61	190/190	1,070/1,000	***5,600/6,000***	<10/<10	<10/<10	<50/<50	<20/<20	---	<10/<10	150/150	430/420	44/44	<10/<10	34/34	<10/<10	<10/<10	<10/<10	<10/<10
MW-9	5/11/00	---	<0.25	<0.50	<2	<2	<2	<6	<2	16	—	<20	<2	<2	<2	<2	<2	<2	<2	—	<2	<2	<2	<2
	11/21/00	<0.25	0.52	<0.50	<0.2	<0.2	1.8	2.4	43	11	<0.2	<1.0	<0.3	---	<0.2	0.2	1.5	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	3/5/01	<0.25	0.63	<0.50	<1.0	<1.0	<1.0	<2.0	6.0	19	<1.0	<5.0	<2.0	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MW-10	11/20/00	0.42	1.3	<0.50	0.6	0.4	0.6	2.1	96	<0.2	<0.2	1.5	<0.3	---	<0.2	0.6	1.8	0.9	0.3	5.8	<0.2	<0.2	<0.2	<0.2
	3/6/01	0.39	1.1	<0.50	1.2	<1.0	<1.0	1.6	29	<1.0	<1.0	<5.0	<2.0	---	<1.0	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MW-11	11/20/00	***1.9***	3.6	<0.50	1.5	1.4	6.6	12.5	1,100	<0.2	<0.2	3.7	<0.3	---	<0.2	6.0	17	3.8	2.2	14	<0.2	<0.2	<0.2	<0.2
	3/6/01	**2.5**	3.1	<0.50	<5.0	<5.0	7.6	12.1	550	<5.0	<5.0	<25	<10	---	<5.0	<5.0	14	<5.0	<5.0	28	<5.0	<5.0	<5.0	<5.0
MW-12	11/20/00	<0.25	0.64	<0.50	<1.0	<1.0	<1.0	<2.0	11	<1.0	<1.0	<5.0	<2.0	---	<1.0	<1.0	<1.0	<1.0	<1.0	4.5	<1.0	<1.0	<1.0	<1.0
	3/6/01	<0.25	1	1.4	<1.0	<1.0	<1.0	<2.0	<5.0	<1.0	<1.0	<5.0	<2.0	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MTCA Method B Surface Water Cleanup Level[g]		NA[h]	NA	NA	43	48,500	6,910	NA	9,880	5,030	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.86	NA
MTCA Method C Surface Water Cleanup Level[g]		NA	NA	NA	1,070	121,000	17,300	NA	24,700	12,600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	121	NA
Ecology Acute Freshwater Surface Water Quality Standard[i]		NA	NA	NA	5,300	17,500	32,000	NA	2,300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
National Toxics Rule for Consumption of Organisms[j]		NA	NA	NA	710	2,000,000	290,000	NA	NA	210,000	NA	NA	16,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	26,000	NA
Ecology Model NPDES Permit Standard[k]		1	10	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Analytes detected in samples at concentrations exceeding one or more of the cleanup levels or comparison values are shown in bold and italics.

Notes:
- (a) Samples were analyzed for total petroleum hydrocarbons (TPHs) by Ecology Methods NWTPH-Gas and NWTPH-Diesel (extended).
- (b) Groundwater samples were analyzed for volatile organic compounds (VOCs) by EPA Method 8260.
- (c) "<" denotes analyte was not detected at the indicated reporting limit.
- (d) "R" Replacement well.
- (e) "—" Sample not tested for indicated analyte.
- (f) Sample MW-800 is a duplicate sample collected from well MW-8(R).
- (g) MTCA Method B and C surface water cleanup levels based on CLARC II, dated February 1996.
- (h) "NA" = No cleanup level available.
- (i) Ecology Acute Freshwater Surface Water Quality Standards (WAC 173-201A).
- (j) National Toxics Rule for consumption of organisms only based on 40 CFR 131.36 for a risk level of 1x10^{-5}.
- (k) Ecology's Model National Pollutant Discharge Elimination System (NPDES) Permit Standard for discharges to surface water from leaking underground storage tank (LUST) cleanups where gasoline or diesel fuel are the pollutants of concern.

mg/l - milligrams per liter
µg/l - micrograms per liter

TABLE 5-8

GROUNDWATER ANALYTICAL RESULTS - PAHs

Former Tacoma Metals Facility

		PAHs (µg/l)(a)									cPAHs (ug/l)(a)(b)							
Sample Designation	Sample Date	Naphthalene	Acenaphthlyene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo (g,h,i) perylene	Chrysene	Benzo (b)-fluoranthene	Benzo (k)-fluoranthene	Benzo (a)-pyrene	Indeno (1,2,3-cd) pyrene	Dibenz (a,h)-anthracene	Benzo (a)-anthracene	Total cPAHs(b)
MW-1	3/14/00	<0.02(c)	<0.02	0.09	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
	11/21/00	0.09J	<0.10	0.26	<0.10	0.09J	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
	3/5/01	<0.10	<0.10	0.22	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
MW-2	3/14/00	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
	11/21/00	0.08J	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
	3/5/01	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
MW-4(R)(d)	5/11/00	<0.02	<0.02	0.30	0.05	<0.02	<0.02	0.04	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
	11/20/00	2.4	<0.10	0.54	0.17	0.21	0.05J	0.10	0.06J	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
	3/5/01	0.13	<0.10	0.34	0.08J	0.10	<0.10	0.10	0.06J	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
MW-5	3/14/00	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
	11/21/00	0.40	<0.10	0.06J	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
	3/5/01	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
MW-6	3/14/00	0.17	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
	11/21/00	0.12	<0.10	0.09J	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
	3/5/01	0.10	<0.10	0.15	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
MW-7	3/14/00	<0.02	<0.02	0.25	0.11	<0.02	0.03	0.08	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
	11/21/00	0.19	<0.10	0.79	0.28	0.06J	0.13	0.26	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
	3/6/01	0.12	<0.10	0.72	0.28	0.06J	0.13	0.20	0.13	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
MW-8(R)/MW-800(e)	5/12/00	***6200***	2.1	130	68	50	38	3.9	2.5	<0.02	***0.32***	***0.05***	***0.06***	***0.06***	<0.02	<0.02	***0.30***	***0.81***
	11/20/00	***6,200/5,600***	3/2.9	220/200	100/95	70/65	5.2/4.9	5.9/6.2	2.9/2.8	<0.10/<0.10	***0.17/0.18***	<0.10/<0.10	<0.10/<0.10	<0.10/<0.10	<0.10/<0.10	<0.10/<0.10	***0.18/0.19***	***0.6/0.62***
	3/6/01	***4,500/4,000***	3.6M/3.6M	210/190	88/79	60/54	5.0/4.9	5.4/4.7	3.0/2.5	<0.10/<0.10	***0.21M/0.13***	***0.06J***/<0.10	***0.05J***/<0.10	***0.06MJ***/<0.10	<0.10/<0.10	<0.10/<0.10	***0.29/0.19***	***0.77/0.57***
	5/14/01(f)	***4,900***	2.8	140	<50	<50	2.7	1.1	0.57	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
MW-9	5/11/00	0.07	<0.02	0.46	0.06	0.15	0.07	0.12	0.10	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07
	11/21/00	28	<0.10	3.9	1.1	0.77	0.15	0.32	0.22	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
	3/5/01	4.9	<0.10	1.4	0.37	0.60	0.20	0.40	0.30	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
MW-10	11/20/00	63	0.44	96	50	66	8	10	7.9	0.11	***0.59***	***0.27***	***0.21***	***0.28***	***0.11***	<0.10	***0.70***	***2.21***
	3/6/01	7	0.86M	68	36	46	6.9	8.5	8.9	0.31	***1.2***	***0.56***	***0.63***	***0.71***	***0.26***	***0.09MJ***	***1.4***	***4.85***
	5/14/01(f)	3.7	<0.10	18	9.9	9.9	1.4	1.2	0.76	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	***0.11***	***0.41***
MW-11	11/20/00	0.46M	2.4Y	340	190	230	26	38	30	0.75	***4.0M***	***1.8***	***1.5***	***1.8***	***0.72***	***0.23***	***4.8***	***14.85***
	3/6/01	280	2.2M	210	140	170	16	18	18	0.26	***1.1***	***0.52***	***0.51***	***0.65***	***0.23***	***0.07MJ***	***1.8***	***4.88***
	5/14/01(f)	0.28	<0.10	0.23	<0.10	<0.10	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
MW-12	11/20/00	1.3	<0.10	2.3	0.83	0.25	0.14	0.24	0.14	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
	3/6/01	2.1	<0.10	2	0.82	0.11	0.13	0.18	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
MTCA Method B Surface Water Cleanup Level(g)		9,880	NA(h)	643	3,460	NA	25,900	90.2	2,590	NA	0.0296 (1)	0.0296 (1)	0.0296 (1)	0.0296 (1)	0.0296 (1)	0.0296 (1)	0.0296 (1)	0.0296 (1)
MTCA Method C Surface Water Cleanup Level(g)		24,700	NA	1,610	8,640	NA	64,800	225	6,480	NA	0.740 (1)	0.740 (1)	0.740 (1)	0.740 (1)	0.740 (1)	0.740 (1)	0.740 (1)	0.740 (1)
Ecology Acute Freshwater Surface Water Quality Standard(i)		2,300	NA	1,700	NA	NA	NA	3,980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
National Toxics Rule for Consumption of Organisms(j)		NA	NA	NA	1.4x10^5	NA	1.1x10^6	3,700	1.1x10^5	NA	0.31 (1)	0.31 (1)	0.31 (1)	0.31 (1)	0.31 (1)	0.31 (1)	0.31 (1)	0.31 (1)

Analytes detected in samples at concentrations exceeding one or more of the cleanup levels or comparison values are shown in bold and italics.

Notes:
- (a) Samples were analyzed for polycyclic aromatic hydrocarbons (PAHs) by EPA Method 8270B GC/MS SIM.
- (b) The total probable carcinogenic polycyclic aromatic hydrocarbons (cPAHs) were calculated by summing the concentrations of all the probable cPAHs. If a probable cPAH was not detected in the sample, a value equal to one-half the reporting limit was used.
- (c) "<" denotes analyte was not detected at the indicated reporting limit.
- (d) "R" replacement well.
- (e) Sample MW-800 is a duplicate sample collected from well MW-8(R).
- (f) Samples were field filtered.
- (g) MTCA Method B and C surface water cleanup levels based on CLARC II, dated February 1996. "(1)" denotes practical quantification limit (PQL) is greater than cleanup level or standard (Ecology 1993).
- (h) "NA" = No cleanup level is available.
- (i) Ecology Acute Freshwater Surface Water Quality Standards (WAC 173-201A).
- (j) National Toxics Rule for consumption of organisms only based on 40 CFR 131.36 for a risk level of 1x10^{-5}. "(1)" denotes practical puantification limit (PQL) is greater than cleanup level or standard (Ecology 1993).

Qualifiers:
- J: Indicates an estimated concentration when the value is less than the calculated reporting limit.
- M: Indicates an estimated value of analyte found and confirmed by analyst but with low spectral match.

µg/l - micrograms per liter

Figures

TABLE 5-10

GROUNDWATER ANALYTICAL RESULTS - GENERAL WATER QUALITY PARAMETERS

Former Tacoma Metals Facility

Sample Designation	Sample Date	Total Metals (mg/l)[a]						Water Quality Parameters			
		Calcium	Iron	Manganese	Potassium	Sodium	Hardness	Total Dissolved Solids (mg/l)[b]	Sulfate (mg/l)[c]	pH (Std. Units)	Conductivity (umhos/cm)
MW-1	11/29/00	30.8	36.8	0.746	9	23.6	140	300	13	---[d]	---
	3/5/01	25.9	31.7	14.4	7.3	18	120	250	30	6.26	350
MW-2	11/29/00	35.7	14.1	0.309	17.8	277	290	910	72		
	3/5/01	32.5	10.2	45.7	16.2	289	270	1,100	65	6.43	2,100
MW-5	11/29/00	31.7	6.22	0.627	6.3	20.2	210	320	14	---	---
MW-8(R)[e]	11/29/00	10	26.2	0.365	8.3	14.3	78	290	45	---	---
	3/6/01	10.5	28.4	0.393	9.4	14.5	88	280	52	6.31	340
MW-11	3/6/01	22.4	6.16	0.557	2.9	13.1	92	180	18	6.19	260

Notes:

(a) Groundwater samples were analyzed for total metals by EPA Methods 6010/7000 series.
(b) Total dissolved solids (TDS) were analyzed by referencing EPA Method 160.1.
(c) Sulfates were analyzed by referencing EPA Method 375.2.
(d) "---" Sample not analyzed for indicated parameter.
(e) "R" - Replacement well.

mg/l - milligrams per liter
Std Units - Standard units
umhos/cm - micromhos per centimeter

TABLE 6-1

1 of 2

SURFACE WATER ANALYTICAL RESULTS
Former Tacoma Metals Facility

Analyte	Sample Designation				MTCA Method B$^{(a)}$	MTCA Method C$^{(a)}$	Ecology Standard$^{(b)}$	National Toxics Rule$^{(c)}$	Ecology Model NPDES$^{(d)}$
	SW-1		SW-2						
Total Metals (μg/l)$^{(e)}$	**3/13/01**	**4/29/01**	**3/13/01**	**4/29/01**					
Arsenic	<50$^{(f)}$	<50	<50	<50	0.00982	2.46	360	1.4	NA
Barium	175	49	57	27	NA$^{(g)}$	NA	NA	NA	NA
Cadmium	***8***	***2***	***8***	***5***	20.3	50.6	1.04$^{(h)}$	NA	NA
Chromium	127	8	7	<5	NA	NA	210.28$^{(h)}$	NA	NA
Copper	***2,070***	***437***	***410***	***231***	2,660	6,660	5.64$^{(h)}$	NA	NA
Lead	***8,090***	***360***	***250***	<20	NA	NA	17.68$^{(h)}$	NA	NA
Mercury	***8.4***	0.9	0.7	0.3	NA	NA	2.10	1.5	NA
Selenium	<50	<50	<50	<50	NA	NA	20	NA	NA
Silver	***6***	<3	<3	<3	25,900	64,800	0.46$^{(h)}$	NA	NA
Dissolved Metals (μg/l)$^{(i)}$									
Arsenic	<50	<50	<50	<50	0.00982	2.46	360	1.4	NA
Barium	12	21	35	27	NA	NA	NA	NA	NA
Cadmium	<2	<2	***8***	***5***	20.3	50.6	1.04$^{(h)}$	NA	NA
Chromium	<5	<5	<5	<5	NA	NA	210.28$^{(h)}$	NA	NA
Copper	***90***	***181***	***172***	***240***	2,660	6,660	5.64$^{(h)}$	NA	NA
Lead	<20	<20	<20	<20	NA	NA	17.68$^{(h)}$	NA	NA
Mercury	<0.1	0.2	0.1	0.2	NA	NA	2.10	1.5	NA
Selenium	<50	<50	<50	<50	NA	NA	20	NA	NA
Silver	<3	<3	<3	<3	25,900	64,800	0.46$^{(h)}$	NA	NA
PCBs (μg/l)$^{(j)}$									
Aroclor 1016	<1.0	<1.0	<1.0	<1.0	NA	NA	NA	NA	NA
Aroclor 1242	<1.0	<1.0	<1.0	<1.0	NA	NA	NA	NA	NA
Aroclor 1248	<1.0	<1.0	<1.0	<1.0	NA	NA	NA	NA	NA
Aroclor 1254	2.7	1.8	1.0	<1.0	NA	NA	NA	NA	NA
Aroclor 1260	2.1	<1.0	<1.0	<1.0	NA	NA	NA	NA	NA
Aroclor 1221	<2.0	<2.0	<2.0	<2.0	NA	NA	NA	NA	NA
Aroclor 1232	<1.0	<1.0	<1.0	<1.0	NA	NA	NA	NA	NA
Total PCBs$^{(k)}$	***7.8***	***5.3***	***4.5***	***4***	2.70E-05	6.74E-04	2	0.0017	NA
TPH (mg/l)$^{(l)}$									
Diesel	1.8	3.2	2	2.8	NA	NA	NA	NA	10
Motor Oil	2.9	3.2	2.6	1.4	NA	NA	NA	NA	10
PAHs (μg/l)$^{(m)}$									
Naphthalene	0.63	0.5	0.12	<0.10	9,880	24,700	2,300	NA	NA
2-Methylnaphthalene	0.33	0.24	<0.10	<0.10	NA	NA	NA	NA	NA
Acenaphthylene	0.33	0.24	<0.10	<0.10	NA	NA	NA	NA	NA
Acenaphthene	0.37	0.33	0.15	<0.10	643	1,610	1,700	NA	NA
Fluorene	0.36	0.27	0.1	<0.10	3,460	8,640	NA	140,000	NA
Phenanthrene	0.99	0.74	0.24	<0.10	NA	NA	NA	NA	NA
Anthracene	0.81	0.69	<0.10	<0.10	25,900	64,800	NA	1,100,000	NA
Fluoranthene	2.0	1.1	0.28	<0.10	90.2	225	3,980	3,700	NA
Benzo(g,h,i)perylene	0.59	0.36	<0.10	<0.10	NA	NA	NA	NA	NA
Dibenzofuran	0.39	0.29	0.08J$^{(n)}$	<0.10	NA	NA	NA	NA	NA
Pyrene	2.1	1.2	0.17	<0.10	2,590	6,480	NA	110,000	NA
Benzo(a)anthracene$^{(o)}$	***0.71***	***0.34***	***0.08J***	<0.10	0.0296 (1)	0.740 (1)	NA	0.31 (1)	NA
Chrysene$^{(o)}$	***1.8***	***1.4***	***0.11***	<0.10	0.0296 (1)	0.740 (1)	NA	0.31 (1)	NA
Benzo(b)fluoranthene$^{(o)}$	***1.0***	***0.73***	<0.10	<0.10	0.0296 (1)	0.740 (1)	NA	0.31 (1)	NA
Benzo(k)fluoranthene$^{(o)}$	***1.2***	***0.70***	<0.10	<0.10	0.0296 (1)	0.740 (1)	NA	0.31 (1)	NA
Benzo(a)pyrene$^{(o)}$	***1.0***	***0.44***	<0.10	<0.10	0.0296 (1)	0.740 (1)	NA	0.31 (1)	NA
Indeno(1,2,3-cd)pyrene$^{(o)}$	***0.71***	***0.36***	<0.10	<0.10	0.0296 (1)	0.740 (1)	NA	0.31 (1)	NA
Dibenz(a,h)anthracene$^{(o)}$	***0.2***	***0.12***	<0.10	<0.10	0.0296 (1)	0.740 (1)	NA	0.31 (1)	NA
Total cPAHs$^{(o,p)}$	***6.62***	***4.09***	***0.44***	0.35	0.0296 (1)	0.740 (1)	NA	0.31 (1)	NA

Analytes detected in samples at concentrations exceeding one or more of the cleanup levels or comparison values are shown in bold and italics.

Notes:

(a) MTCA Method B and C surface water cleanup levels based on CLARC II, dated February 1996. "(1)" denotes pratical quantification limit (PQL) is greater than cleanup level or standard (Ecology 1993).

(b) Ecology Acute Freshwater Surface Water Quality Standards (WAC 173-201A).

(c) National Toxics Rule based on 40 CFR 131.36 for a risk level of 1x10^{-5}. "(1)" denotes pratical quantification limit (PQL) is greater than cleanup level or standard (Ecology 1993).

(d) Ecology's Model National Pollutant Discharge Elimination System (NPDES) Permit Standard for discharges to surface water from leaking underground storage tank (LUST) cleanups where gasoline or diesel fuel are the pollutants of concern.

TABLE 6-1

SURFACE WATER ANALYTICAL RESULTS
Former Tacoma Metals Facility

(e) Surface water samples were analyzed for total metals by EPA Methods 6010/7000 series.
(f) "<" denotes analyte was not detected at the indicated reporting limit.
(g) "NA" = No cleanup level is available.
(h) Surface Water Quality Standard is based on an average groundwater hardness of 31 mg/L.
(i) Surface water samples for dissolved metals were field filtered and analyzed by EPA Methods 6010/7000 series.
(j) Surface water samples were analyzed for polychlorinated biphenyls (PCBs) by EPA Method 8082.
(k) The total polychlorinated biphenyls (PCBs) were calculated by summing the concentrations of all the probable PCBs. If a probable PCB was not detected, a value equal to one-half the reporting limit was used.
(l) Suface water samples were analyzed for total petroleum hydrocarbons (TPHs) by the Ecology Method NWTPH-Diesel (extended).
(m) Method A groundwater cleanup levels used when Method B surface water cleanup levels are not available.
(n) Surface water samples were analyzed for polycyclic aromatic hydrocarbons (PAHs) by EPA Method 8270B GC/MS SIM.
(o) "J" Indicates an estimated concentration when the value is less than the calculated reporting limit.
(p) Carcinogenic polycyclic aromatic hydrocarbons (cPAHs).
(q) The total cPAHs were calculated by summing the concentrations of all the probable cPAHs. If a probable cPAH was not detected in the sample, a value equal to one-half the reporting limit was used.

mg/l - milligrams per liter
µg/l - micrograms per liter

TABLE 8-1

RATIONALE FOR SELECTION OF CHEMICALS OF CONCERN FOR UNSATURATED ZONE MODELING

Former Tacoma Metals Facility

Group	Chemical	Selection Rationale
PAHs[a]	Naphthalene	• Most mobile noncarcinogenic PAH detected in the subsurface based on relatively low sorption (surrogate for high mobility PAHs in modeled area).
	Chrysene	• Carcinogenic PAH (cPAH). • Higher mobility relative to other cPAHs. • Present in soil in modeled area above MTCA Method C industrial soil cleanup level of 18 mg/kg[b].
	Benzo(a)pyrene	• Carcinogenic PAH (cPAH). • Relatively lower mobility than other detected cPAHs. • Present in soil in modeled area above MTCA Method C industrial soil cleanup level of 18 mg/kg.
	Benzo(b)fluoranthene Benzo(k)fluoranthene Dibenz(a,h)anthracene Benzo(a)anthrecene	• Carcinogenic PAHs (cPAHs) detected in site soil. • Present in modeled area above MTCA Method C industrial soil cleanup level of 18 mg/kg.
Metals	Lead	• Human carcinogen. • Present in soil in modeled area above MTCA Method A industrial soil cleanup level of 1,000 mg/kg.
	Chromium	• Present in soil in modeled area above MTCA Method A industrial soil cleanup level of 500 mg/kg.
	Arsenic Copper Mercury	• Metals not detected at site at concentrations above soil cleanup levels; however, these metals are generally considered to be of high environmental concern and were selected to evaluate whether they may leach to groundwater at elevated levels. • Copper was selected since it was detected in soil sample TP-22 at a relatively high concentration of 13,000 mg/kg in 0-1 foot sample and 20,200 mg/kg in 2-3 feet sample.
PCBs[c]	Aroclor 1248 Aroclor 1254 Aroclor 1260	• Human carcinogens. • Selected Aroclors are those PCBs detected in soil at highest concentrations.

Notes:
- (a) PAHs – Polycyclic aromatic hydrocarbons.
- (b) mg/kg – milligrams per kilogram.
- (c) PCBs – Polychlorinated biphenyls.

TABLE 8-2

SUMMARY OF CHEMICAL INPUT VALUES USED FOR MODEL SIMULATIONS

Former Tacoma Metals Facility

Analyte	Chemical Input Parameters		
	K_{oc} (ml/g)[(a)]	K_h (dimensions)	D_i (m^2/d)[(b)]
PAHs			
Naphthalene	$5.5\text{x}10^4$	0.019	0.51
Chrysene	$1.3\text{x}10^7$	0.0001	0.21
Benzo(b)flouranthene	$5.3\text{x}10^7$	0.001	0.195
Benzo(k)flouranthene	$5.6\text{x}10^7$	$2.2\text{x}10^{-6}$	0.195
Benzo(a)pyrene	$8.5\text{x}10^7$	0.0001	0.37
Dibenz(a,h)anthracene	$3.3\text{x}10^6$	$3.0\text{x}10^{-6}$	0.17
Benzo(a)anthracene	$1.85\text{x}10^7$	0.0001	0.44
PCBs			
Aroclor 1248	$1.16\text{x}10^7$	0.089	0
Aroclor 1254	$3.8\text{x}10^7$	0.015	0
Aroclor 1260	$8.2\text{x}10^7$	0.032	0
Metals			
Arsenic	29	0	0
Chromium	$2.5\text{x}10^6$	0	0
Copper	22	0	0
Lead	10,000	0	0
Mercury	82	0	0

Notes:

K_{oc} - Organic carbon-normalized soil partition coefficient.

K_h - Henry's Law Constant.

D_i - Free air diffusion coefficient.

(a) ml/g - milliliters per gram.

(b) m^2/d - square meters per day.

TABLE 8-3

SUMMARY RESULTS FOR DOWNWARD MIGRATION
Former Tacoma Metals Facility

Analyte	Predicted Concentrations After 500 Years of Simulation (µg/l)(a)
PAHs	
Naphthalene	1x10^{-4}
Chrysene	6x10^{-11}
Benzo(b)flouranthene	2x10^{-11}
Benzo(k)flouranthene	4x10^{-14}
Benzo(a)pyrene	1x10^{-12}
Dibenz(a,h)anthracene	4x10^{-12}
Benzo(a)anthracene	2x10^{-11}
PCBs	
Aroclor 1248	8x10^{-23}
Aroclor 1254	1x10^{-23}
Aroclor 1260	1x10^{-24}
Metals	
Arsenic	3x10^{-9}
Chromium	4x10^{-18}
Copper	2x10^{-5}
Lead	5
Mercury	7x10^{-10}

Note:

(a) µg/l = micrograms per liter

TABLE 8-4

SUMMARY OF KEY INPUT VALUES USED IN GROUNDWATER MIGRATION MODEL

Former Tacoma Metals Facility

Input Parameter	Benzene	Naphthalene	Total cPAHs	Reference
Hydraulic conductivity (cm/s)[(a)]	0.05 or 0.011	0.05 or 0.011	0.05 or 0.011	The 0.05 value is based on a site maximum value of 140 feet per day reported by Pacific Groundwater Group (1992) for the deltaic sand unit encountered at the site. The 0.011 value is based on slug tests performed at well MW-8(R).
Hydraulic gradient	0.008	0.008	0.008	Based on low tide water levels observed at the site on 13 February 2001.
Porosity	0.49	0.49	0.49	See Table 3-1.
Plume length (ft)	300	300	300	Approximate distance along the groundwater flow path between well MW-8(R) and the river.
Organic carbon-normalized soil partition coefficient (K_{oc}) (ml/g)[(b)]	70	5.5×10^4	3.3×10^6	Mackay et. al (1999).
Soil bulk density (g/ml)[(c)]	1.35	1.35	1.35	See Section 8.2.1.6.
Fraction organic carbon (F_{oc})	0.03	0.03	0.03	See Section 8.2.1.6.
Simulation time (years)	30	30	30	Assumed to represent a reasonable remediation time frame.
Source thickness (feet)	10	10	10	Assumed as a reasonable overall depth of groundwater containing the selected compounds.
Beginning concentration (mg/l)[(d)]	2.4×10^{-2}	6.825	6.2×10^{-4}	Average of values measured in well MW-8(R) samples collected in May and November 2000 and March 2001.
Source life	Infinite	Infinite	Infinite	A conservative assumption.

Notes:

(a) cm/s – centimeter per second.
(b) ml/g – milliliters per gram.
(c) g/ml – grams per milliliter.
(d) mg/l – milligrams per liter.

TABLE 9-1

SUMMARY OF ANALYTES EXCEEDING MTCA CLEANUP LEVELS AND/OR CHEMICAL-SPECIFIC ARARs IN SOIL, SHALLOW GROUNDWATER, AND SURFACE WATER

Former Tacoma Metals Facility

Media/Chemicals	Analytical Units	Concentration Range (Remedial Investigation)	Concentration Range (Previous Investigations)	Cleanup Level/ Chemical-Specific ARAR	Basis
Soil					
Lead	mg/kg	<10 – 14,700	<10 – 32,000	1,000	Method A Industrial Soil Cleanup Level(a)
Chromium	mg/kg	0.9 – 2,520	11 – 340	500	Method A Industrial Soil Cleanup Level(a)
Total PCBs	mg/kg	0.14 – 40.11	<0.11 – 43.73	17	MTCA Method C Industrial Soil Cleanup Level(b)
TPH (diesel range)	mg/kg	<5.2 – 23,000	<5 – 2,400	2,000	MTCA Method A Industrial Soil Cleanup Level (Amended)(c)
TPH (motor oil range)	mg/kg	<10 – 12,000	<25 – 1,500	2,000	MTCA Method A Industrial Soil Cleanup Level (Amended)(c)
Total cPAHs	mg/kg	0.169 – 730	1.48 – 28.2	18	MTCA Method C Industrial Soil Cleanup Level(b)
Shallow Groundwater					
TPH (gasoline range)	µg/l	<50 – 39,000	<3,000 – 18,000	1,000	Ecology Model NPDES Permit for Surface Water Discharge(d)
Total cPAHs (unfiltered)	*µg/l*	*0.07 – 14.85*	*0.12 – 0.78*	*0.31*	*National Toxics Rule for Consumption of Organisms(e)*
Total cPAHs (filtered)	µg/l	<0.10 – 0.11	- - - (f)	0.31	National Toxics Rule for Consumption of Organisms(e)
Naphthalene	µg/l	<0.5 – 8,500	<0.50 – 99	2,300	Ecology Freshwater Acute SWQS(g)
Total PCBs	*µg/l*	*0.35 – 11.3*	- - -	*2.70E – 05*	*MTCA Method B Surface Water Cleanup Levels(h)*
Selenium (Dissolved)	*µg/l*	*<50 – 70*	- - -	*20*	*Ecology Acute Freshwater SWQS(g)*
Surface Water					
Cadmium (Total)	µg/l	2 – 8	<2	1.04	Ecology Acute Freshwater SWQS(g)(i)
Cadmium (Dissolved)	µg/l	<2 – 8	- - -	1.04	Ecology Acute Freshwater SWQS(g)(i)
Copper (Total)	µg/l	231 – 2,070	- - -	5.64	Ecology Acute Freshwater SWQS(g)(i)
Copper (Dissolved)	µg/l	90 – 240	- - -	5.64	Ecology Acute Freshwater SWQS(g)(i)
Lead (Total)	µg/l	<20 – 8,090	1	17.68	Ecology Acute Freshwater SWQS(g)(i)
Mercury (Total)	µg/l	0.3 – 9.4	- - -	2.10	Ecology Freshwater Acute SWQS(g)
Silver (Total)	µg/l	<3 - 6	- - -	0.46	Ecology Acute Freshwater SWQS(g)(i))
Total PCBs	µg/l	4 – 7.8	- - -	2	Ecology Freshwater Acute SWQS(g)
Total cPAHs	µg/l	0.35 – 6.62	0.12	0.31	National Toxics Rule for Consumption of Organisms(e)

TABLE 9-1

SUMMARY OF ANALYTES EXCEEDING MTCA CLEANUP LEVELS AND/OR CHEMICAL-SPECIFIC ARARs IN SOIL, SHALLOW GROUNDWATER, AND SURFACE WATER

Former Tacoma Metals Facility

Notes:

(a) Method A Industrial Soil Cleanup Level is based on WAC 173-340-745(2), Table 3.
(b) Method C Industrial Soil Cleanup Level is based on WAC 173-340-745(4) and MTCA Cleanup Levels and Risk Calculations (CLARC II, February 1996).
(c) Method A Industrial Soil Cleanup Level is based on Amended WAC 173-340-745(3), Table 745-1.
(d) Ecology's Model National Pollutant Discharge Elimination System (NPDES) Permit for discharges from cleanups at leaking underground storage tank sites containing diesel contamination based on WAC 173-226.
(e) National Toxics Rule is based on 40 CFR 131.36 for a risk level of 1 x 10^{-5}.
(f) "- - -" = Sample not tested for selected analyte.
(g) Ecology Acute Freshwater Ambient Surface Water Quality Standards (SWQS) are based on WAC 173-201A.
(h) Method B Surface Water Cleanup Levels is based on WAC 173-340-730(3) and MTCA Cleanup Levels and Risk Calculations (CLARC II, February 1996).
(i) Based on an average surface water hardness of 31 mg/l.

mg/l - milligrams per liter
µg/l - micrograms per liter

Italicized chemicals are considered to be anomalous and not representative of site groundwater quality. Analytical results presented were either not reproducible in multiple monitoring events, or the samples were impacted by suspended entrained soil particles.

TABLE 9-2

POTENTIAL ACTION-SPECIFIC ARARs
Former Tacoma Metals Facility

Federal Citation	State Citation	Description	Potential Requirement	Justification
29 CFR 1910.120	WAC 296-62	General safety and health standards for workers, including requirements for responses involving hazardous substances.	Applicable	Required for protection of remedial action workers.
40 CFR 50.6 and .12 40 CFR 60.5	WAC 173-400 WAC 173-460 WAC 173-470 PSAPCA Regulations I, II, and III	General regulations for air pollution sources; particulate matter emissions standards; control standards for toxic air pollutants.	Applicable	Applicable for remedial processes emitting air pollutants.
40 CFR 262.12, 262.20 through .33, and 262.40 through .43	WAC 173-303-160, 170, 180, 190, 210, and 220	Requirements for generators of hazardous and dangerous waste.	Applicable	Required if hazardous or dangerous wastes are transported offsite.
40 CFR 268	WAC 173-303-140	Land disposal restrictions.	Applicable	Applicable if dangerous wastes are disposed in an offsite landfill.
None	WAC 173-304	Standards for disposal of solid waste.	Applicable	Applicable for disposal of solid waste.
49 CFR 107, 171 through 179	WAC 446-50	Transportation regulations for hazardous materials.	Applicable	Applicable for offsite transportation of dangerous or hazardous waste.
None	WAC 173-160 WAC 173-162	Regulations for construction and maintenance of new water wells; licensing of drillers.	Applicable	Applicable for new and existing wells.
None	WAC 173-340-360	Model Toxics Cleanup Act (MTCA) requirements for selection of cleanup actions.	Applicable	Regulations outline requirements for hazardous substance cleanups.
None	WAC 173-340-410	MTCA requirements regarding compliance monitoring during remedial activities.	Applicable	Required for protecting human health and confirming attainment of cleanup standards.
None	WAC 173-340-440 and -702(4)	MTCA requirements regarding institutional controls to limit activities at a site that may result in exposure to hazardous substances.	Applicable	Applicable if residual concentrations exceed cleanup levels or if conditional points of compliance have been established.
None	WAC 173-340-450(2), (3), (7), and (8)	MTCA regulations regarding releases from underground storage tanks (USTs).	Applicable	Free product and chemicals associated with releases from USTs detected in the groundwater.
None	WAC 173-340-704,-705, and -706	Use of Methods A, B, and C for determining cleanup levels.	Applicable	Applicable methods for determining cleanup levels.
None	WAC 173-340-707	MTCA analytical methods for evaluating the effectiveness of a cleanup action.	Applicable	Applicable if remedial action requires chemical analyses.

TABLE 9-2

POTENTIAL ACTION-SPECIFIC ARARs
Former Tacoma Metals Facility

Federal Citation	State Citation	Description	Potential Requirement	Justification
None	WAC 173-340-708	MTCA regulation on human health risk assessment procedures.	Applicable	Required for determining site cleanup levels.
None	WAC 173-201A	Surface Water Quality Standards (SWQS) for the State of Washington	Applicable	Required for determining site cleanup levels.
None	WAC 173-340-720, -730, -740, and -745	MTCA cleanup standards for groundwater, surface water, and soil.	Applicable	Required for determining site cleanup levels.
None	WAC 197-11	Washington State Environmental Policy Act (SEPA).	Applicable	Required to ensure environmental concerns are adequately addressed.
40 CFR 131.36 (National Toxics Rule)	WAC 173-226	Regulations developed to implement the federal Clean Water Act [33 USC 466 *et seq*] and State Water Pollution Control Act for protection of aquatic life in nations waters (lakes, rivers, aquifers, and coastal areas).	Applicable	Applicable if groundwater seeps or surface water runoff discharge to the Puyallup River.

TABLE 9-3

SUMMARY OF PROPOSED SITE CLEANUP LEVELS FOR SOIL, SHALLOW GROUNDWATER, AND SURFACE WATER

Former Tacoma Metals Facility

Media/Chemicals	Analytical Units	Proposed Cleanup Level	Basis
Soil			
Lead	mg/kg	1,000	Method A Industrial Soil Cleanup Level(a)
Chromium	mg/kg	500	Method A Industrial Soil Cleanup Level(a)
Total PCBs	mg/kg	17	MTCA Method C Industrial Soil Cleanup Level(b)
TPH (diesel range)	mg/kg	2,000	MTCA Method A Industrial Soil Cleanup Level (Amended)(c)
TPH (motor oil range)	mg/kg	2,000	MTCA Method A Industrial Soil Cleanup Level (Amended)(c)
Total cPAHs	mg/kg	18	MTCA Method C Industrial Soil Cleanup Level(b)
Shallow Groundwater			
TPH (diesel range)	µg/l	10,000	Ecology Model NPDES Permit for Surface Water Discharge(d)
TPH (motor oil range)	µg/l	10,000	Ecology Model NPDES Permit for Surface Water Discharge(d)
TPH (gasoline range)	µg/l	1,000	Ecology Model NPDES Permit for Surface Water Discharge(d)
Benzene	µg/l	43	MTCA Method B Surface Water Cleanup Level(e)
Toluene	µg/l	17,500	Ecology Acute Freshwater SWQS(f)
Ethylbenzene	µg/l	6,910	MTCA Method B Surface Water Cleanup Level(e)
Total cPAHs	µg/l	0.31	National Toxics Rule for Consumption of Organisms(g)
Naphthalene	µg/l	2,300	Ecology Acute Freshwater SWQS(f)
Surface Water			
Cadmium (Total & Dissolved)	µg/l	1.04	Ecology Acute Freshwater SWQS(f)(h)
Copper (Total & Dissolved)	µg/l	5.64	Ecology Acute Freshwater SWQS(f)(h)
Lead (Total)	µg/l	17.68	Ecology Acute Freshwater SWQS(f)(h)
Mercury (Total)	µg/l	2.10	Ecology Acute Freshwater SWQS(h)
Silver	µg/l	0.46	Ecology Acute Freshwater SWQS(f)(h)
Total PCBs	µg/l	2	Ecology Acute Freshwater SWQS(f)
TPH (diesel range)	µg/l	10,000	Ecology Model NPDES Permit for Surface Water Discharge(d)
TPH (motor oil range)	µg/l	10,000	Ecology Model NPDES Permit for Surface Water Discharge(d)
TPH (gasoline range)	µg/l	1,000	Ecology Model NPDES Permit for Surface Water Discharge(d)
Benzene	µg/l	43	MTCA Method B Surface Water Cleanup Level(e)
Toluene	µg/l	17,500	Ecology Acute Freshwater SWQS(f)
Ethylbenzene	µg/l	6,910	MTCA Method B Surface Water Cleanup Level(e)
Total cPAHs	µg/l	0.31	National Toxics Rule for Consumption of Organisms(g)

Notes:

(a) Method A Industrial Soil Cleanup Level is based on WAC 173-340-745(2), Table 3.
(b) Method C Industrial Soil Cleanup Level is based on WAC 173-340-745(4) and MTCA Cleanup Levels and Risk Calculations (CLARC II, February 1996).
(c) Method A Industrial Soil Cleanup Level is based on proposed amended WAC 173-340-745(3), Table 745-1.
(d) Ecology's Model National Pollutant Discharge Elimination System (NPDES) Permit for discharges from cleanups at leaking underground storage tank sites containing diesel contamination based on WAC 173-226.
(e) Method B Surface Water Cleanup Level is based on WAC 173-340-730(3) and MTCA Cleanup Levels and Risk Calculations (CLARC II, February 1996).
(f) Ecology Acute Freshwater Ambient Surface Water Quality Standards (SWQS) are based on WAC 173-201A.
(g) National Toxics Rule is based on 40 CFR 131.36 based on a risk level of 1 x 10^{-5}.
(h) Based on an average surface water hardness of 31 mg/l.

TABLE 9-4

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
Institutional Controls	Access Restrictions	Physical Restrictions	Physical restrictions (e.g., fencing and signs) limit contact with media.	**Potentially implementable.**
		Deed Restrictions	Restrictive covenants recorded in the property deed prohibit site activities (e.g., excavation) that could result in exposure to chemicals of concern.	**Potentially implementable.**
Containment	Covers	Soil	Clean soil is placed over ground surface to provide a physical barrier to chemicals of concern.	Asphalt cover selected for further evaluation.
		Clay	Low permeability clay layer overlain with soil over chemically impacted materials provides physical barrier that minimizes potential for contact and infiltration.	Not appropriate for site awaiting development.
		Concrete	Similar to clay cover description with concrete used as low permeability barrier.	Asphalt cover selected for further evaluation.
		Asphalt	Similar to clay cover description with asphalt used as low permeability barrier.	**Potentially implementable.**
		RCRA	Multi-media barrier consisting of low-permeability layer, synthetic liner, drainage layer, and vegetative cover. Performs functions similar to those described for clay cover.	Asphalt cover selected for further evaluation.
	Vertical Barriers	Slurry Wall	Subsurface vertical barrier consisting of low-hydraulic conductivity material surrounds a subsurface source to prevent chemical migration.	Not appropriate for site conditions.
		Grout Curtain	Subsurface vertical barrier consisting of low-hydraulic conductivity material is pressure injected into soil or rock. Performs function similar to slurry wall.	Not appropriate for site conditions.
		Sheet Pile Cutoff Wall	Interlocking sheet piling driven vertically into subsurface to form a low permeability barrier. Performs function similar to slurry wall.	Not appropriate for site conditions.
	Horizontal Barriers	Grout Injection	Injection of grout to form a horizontal barrier in the ground underneath chemical source to reduce the vertical movement of chemicals.	Not appropriate for site conditions.
		Block Displacement	Vertical barrier (slurry trench or grout curtain) surrounds source. Continued injection of grout through injection holes causes displacement of source and forms a barrier beneath source.	Not appropriate for site conditions.

TABLE 9-4

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
Containment (continued)	Surface Controls	Revegetation	Planting grasses, shrubs, or trees to minimize contact with soil, reduce dust generation, and control surface water runoff.	Asphalt cover selected for further evaluation.
	Dust Suppression	Wet Suppression	Watering ground surface to control dust generation.	Asphalt cover selected for further evaluation.
		Chemical Stabilization	A suppressant sprayed on the ground binds dust and surface particles into a protective crust that minimizes dust generation.	Asphalt cover selected for further evaluation.
		Physical Stabilization	Placing a cover (e.g. rock, soil, straw) on exposed surfaces to prevent particles from becoming airborne.	Asphalt cover selected for further evaluation.
		Vegetative Stabilization	Same as revegetation above.	Asphalt cover selected for further evaluation.
		Wind Fences/Screens	Fences or screens are installed around site perimeter to block wind and reduce dust generation.	Asphalt cover selected for further evaluation.
Removal	Excavation	Backhoe, Excavators, Loaders, Dozers	Excavate material for subsequent aboveground treatment and/or disposal.	**Potentially implementable.**
Ex Situ (Aboveground) Treatment	Solidification/ Stabilization	Pozzolanic Solidification	Siliceous materials are combined with a setting agent (e.g., lime, cement, or gypsum) and soil. Treatment results in a solidified product that resists leaching.	Chemical-based stabilization selected for further evaluation.
		Chemical-Based Stabilization	Dry or liquid chemical mix which forms insoluble molecular bonds through hydroxyapaptite crystal formations with heavy metals [and polychlorinated biphenyls (PCBs)] which significantly reduces the metals leaching potential.	**Potentially implementable.**
		Organic Polymer Solidification	Urea formaldehyde and several specialty organic polymers are mixed with soil to seal chemicals in a sponge-like polymer matrix.	Chemical-based stabilization selected for further evaluation.
		Thermoplastic Microencapsulation	Mixing of heated dried soil within asphalt bitumen, paraffin, or polyethylene matrix, resulting in a solid mass suitable for land disposal.	Chemical-based stabilization selected for further evaluation.
	Physical/Chemical	Soil Washing	Removal of inorganic or organic chemicals by washing excavated soil with a liquid medium (e.g., water). The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.	Other more effective treatment methods are available. Creates secondary waste stream.

TABLE 9-4

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
Ex Situ (Aboveground) Treatment (continued)	Physical/Chemical (continued)	Organic Solvent Extraction	Removal of organics, oil, and grease from soil, using an organic solvent as the mass transfer medium and then recovering the solvent by distillation.	Other more effective treatment methods are available. Creates secondary waste stream.
		Vapor Extraction	Removal of low molecular weight organics by creating a vacuum pressure gradient in soil that causes volatile organics to transfer from soil to air stream.	Not appropriate for chemicals of concern.
		Chemical Dehalogenation	Specially synthesized chemical reagents are used to dehalogenate certain classes of chlorinated organics (e.g., PCBs).	Other more effective treatment methods are available.
		Chemical Oxidation/Reduction	Reduction/oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.	Other more effective treatment methods are available.
		Solar Detoxification	Solar detoxification is a process that destroys contaminants by photochemical and thermal reactions using the ultraviolet energy in sunlight.	Other more effective treatment methods are available.
		Separation/Sieving	Sieving and physical separation processes use different size sieves and screens to effectively concentrate contaminants into smaller volumes. Physical separation can also be used to remove undesirable materials (i.e., debris) which may impact treatment processes.	**Potentially implementable**
	Biological/ Bioremediation	Landfarming	Contaminated soil is excavated, applied into lined beds, and periodically turned over or tilled to aerate the waste.	**Potentially implementable.**
		Land Treatment	Contaminated surface soil is treated in-place by tilling to achieve aeration, and if necessary, by addition of amendments. Periodically tilling, to aerate the waste, enhances the biological activity.	Landfarm/aerobic selected from the technology group for evaluation.
		Composting	Contaminated soil is excavated and mixed with bulking agents and organic amendments such as wood chips, hay, manure, and vegetative (e.g., potato) wastes. Proper amendment selection ensures adequate porosity and provides a balance of carbon and nitrogen to promote thermophilic, microbial activity.	Landfarm/aerobic selected from the technology group for evaluation.
		Biopiles	Excavated soils are mixed with soil amendments and placed in aboveground enclosures. It is an aerated static pile composting process in which compost is formed into piles and aerated with blowers or vacuum pumps.	Landfarm/aerobic selected from the technology group for evaluation.

TABLE 9-4

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
Ex Situ (Aboveground) Treatment (continued)	Biological/ Bioremediation (continued)	Fungal Biodegradation	Fungal biodegradation refers to the degradation of a wide variety of organopollutants by using their lignin-degrading or wood-rotting enzyme system. White rot fungas has been tested under two different treatment configurations: in situ and bioreactor.	Other more effective treatment methods are available.
		Bio-Reactor System	Degradation with the use of a liquid/solids contact reactor. Reactor environment enhances mass transfer rates and contact between chemicals and microorganisms capable of degrading the chemicals.	Landform/aerobic selected from the technology group for evaluation.
	Thermal	Thermal Desorption	Soils are heated, driving off water and organics with boiling points less than 1,100°F. Organics are incinerated in an afterburner or collected for subsequent treatment.	**Potentially implementable.**
		Rotary Kiln Incineration	Incineration process (in the presence of oxygen) uses temperatures ranging from 1,500°F to 3,000°F and turbulence caused by rotation to vaporize and destroy organics.	Not appropriate. Other more cost-effective thermal treatment options are available.
		Infrared Thermal Incineration	Thermal destruction of organics in soil using electrically powered silicon carbide rods to heat organics to combustion temperatures. Remaining combustibles are incinerated in an afterburner.	Not appropriate. Other more cost-effective thermal treatment options are available.
		Pyrolysis	Thermal conversion (in an oxygen-deficient atmosphere) of organic material into solid, liquid, and gaseous components.	Not appropriate. Other more cost-effective thermal treatment options are available.
		Fluidized Bed/ Circulating Bed Combustor	A bed of granular sand-like material is fluidized by air injected into the incinerator to create a turbulent atmosphere and improve heat transfer.	Not appropriate. Other more cost-effective thermal treatment options are available.
		Multiple Hearth Incineration	Multiple levels of shifting plates move materials through the combustion chamber. Each hearth has fuel burners mounted on walls that incinerate organics as materials descend to lower hearths in increasingly hotter combustion zones.	Not appropriate. Other more cost-effective thermal treatment options are available.
		Vitrification	Application of heat destroys organics and immobilizes inorganics by incorporating them into a glass or glass-like structure.	Not appropriate. Other more cost-effective thermal treatment options are available.

TABLE 9-4

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
In Situ Treatment	Solidification/ Stabilization	Pozzolanic Cement-Based	In situ treatment of soil by the injection and mixing of solidifying agents with soil. Treatment results in a solidified product that resists leaching.	Chemical stabilization selected for further evaluation.
		Chemical-Based Stabilization	Liquid chemical mix which forms insoluble molecular bonds through hydroxyapaptite crystal formations with heavy metals (and PCBs) which significantly reduces the metals leaching potential.	**Potentially implementable.**
	Physical/Chemical	Soil Freezing	Freezing surrounding soil to create a physical barrier to chemical migration.	Not appropriate. Only a temporary measure.
		Soil Flushing	In situ extraction of inorganics or organics from soils, accomplished by passing solvents through soil using an injection/recirculation process.	Not appropriate. Difficult to control; may result in groundwater contamination.
		Soil Vapor Extraction	Extraction of volatile organics from subsurface soil by creating a pressure gradient that causes volatile organics to transfer from soil to airstream.	Not appropriate for chemicals of concern.
		Electrokinetic Separation	The Electrokinetic Remediation (ER) process removes metals and organic contaminants from low permeability soil. ER uses electrochemical and electrokinetic processes to desorb, and then remove, metals and polar organics. This in situ soil processing technology is primarily a separation and removal technique for extracting contaminants from soils.	Not appropriate for site conditions.
		Fracturing	Cracks are developed by fracturing beneath the surface in low permeability and over-consolidated sediments to open new passageways that increase the effectiveness of many in situ processes and enhance extraction efficiencies.	Not appropriate for site conditions.
		Precipitation	Application of specific treatment reagents which aid in the formation of insoluble metal precipitates that reduce chemical mobility. Metals could later resolubilize as conditions change.	Not appropriate for organics; may result in groundwater contamination.
		Oxidation	Oxidation state of chemicals is raised to detoxify a few inorganics and oxidizable organics and to make some organics more amenable to biological degradation.	Not appropriate for chemicals of concern.
		Reduction	Reduction in the oxidation state of a few heavy metals (chromium, lead, mercury) to reduce toxicity or solubility or to transform them to a form that can be more easily handled.	Not appropriate for chemicals of concern.

TABLE 9-4

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
In Situ Treatment (continued)	Biological/ Bioremediation	Enhanced Bioremediation (Aerobic)	Application of nutrients, oxygen, and microorganisms to accelerate the natural biodegradation of organic compounds.	**Potentially implementable.**
		Enhanced Bioremediation (Anaerobic)	Same as aerobic process with the omission of oxygen application. The anaerobic process degrades organics slower than the aerobic process, but is better suited to chlorinated hydrocarbons.	Not appropriate for chemicals of concern.
		Bioventing	Oxygen is delivered to contaminated unsaturated soils by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation.	Enhanced bioremediation selected from the technology group for evaluation.
		Phytoremediation	Phytoremediation is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment. Contaminants may be either organic or inorganic.	Experimental. Not appropriate for site conditions.
	Thermal	Vitrification	Using high temperatures to melt soil and bind chemicals in a stable non-crystalline solid that resists leaching. Organics are destroyed by pyrolysis.	Not appropriate for chemicals of concern. More cost-effective methods are available.
		Steam-Enhanced Vapor Extraction	Vapor extraction with the addition of steam to increase chemical mobility and removal rate.	Not appropriate for chemicals of concern. More cost-effective methods are available.
		Radio Frequency Heating	Application of radio frequency waves to heat soil and vaporize volatile organics. Volatiles are then collected for destruction or treatment.	Experimental. More tested and cost-effective methods are available.
Disposal	Offsite	Management Unit	Disposal of soil in a permitted offsite management unit.	**Potentially implementable.**
	Onsite	Containment	Containment of soil onsite.	Asphalt cover selected for further evaluation.
Reuse/Recycling	Onsite	Backfilling	Onsite reuse/recycling of site materials for suitable applications in accordance with applicable local, state, and federal regulations. One option may be reuse treated soil onsite to backfill excavation areas.	**Potentially implementable.**

TABLE 9-4

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
Reuse/Recycling (continued)	Onsite (continued)	Grading	Onsite reuse/recycling of site materials for suitable applications in accordance with applicable local, state, and federal regulations. One option may be reuse untreated soil onsite to consolidated impacted soils or bring low areas within an impacted zone to grade prior to placement of a cover.	**Potentially implementable.**

TABLE 9-5

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR GROUNDWATER

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
Institutional Controls	Addressed under Evaluation of General Response Actions, Remedial Technologies, and Process Options for Soil (see Table 9-4).			
Containment	Covers	Addressed under Evaluation of General Response Actions, Remedial Technologies, and Process Options for Soil (see Table 9-4).		
	Vertical Barriers	Slurry Wall	Trench around area of contamination filled with a soil (or cement) bentonite slurry.	Not appropriate for site conditions.
		Grout Curtain	Pressure injection of grout in a regular pattern of drilled holes around are of contamination.	Not appropriate for site conditions.
Collection	Extraction	Extraction Wells	Series of wells to extract contaminated groundwater.	Not appropriate for site conditions given proximity to Puyallup River and tidal fluctuations.
		Extraction/Injection Wells	Inject treated of uncontaminated groundwater to increase flow to extraction wells.	Not appropriate for site conditions given proximity to Puyallup River and tidal fluctuations.
	Subsurface Drains	Interceptor Trenches	Perforated pipe in trenches backfilled with porous media to collect contaminated water.	Not appropriate for site conditions given proximity to Puyallup River and tidal fluctuations.
Aboveground Treatment (assuming extraction)	Physical/Chemical	Adsorption/ Absorption	In liquid adsorption, solutes concentrate at the surface of a sorbent, thereby reducing their concentration in the bulk liquid phase.	Not appropriate. Groundwater extraction not selected for further evaluation.
		Air Stripping	Volatile organics are partitioned from extracted ground water by increasing the surface area of the contaminated water exposed to air. Aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration.	Not appropriate. Groundwater extraction not selected for further evaluation.
		Granulated Activated Carbon (GAC)/Liquid Phase Carbon Adsorption	Ground water is pumped through a series of canisters or columns containing activated carbon to which dissolved organic contaminants adsorb. Periodic replacement or regeneration of saturated carbon is required.	Not appropriate. Groundwater extraction not selected for further evaluation.
		Ion Exchange	Ion exchange removes ions from the aqueous phase by exchange with counter ions on the exchange medium.	Not appropriate. Groundwater extraction not selected for further evaluation.

TABLE 9-5

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR GROUNDWATER

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
Aboveground Treatment (assuming extraction) (continued	Physical/Chemical (continued)	Precipitation/ Coagulation/ Flocculation	This process transforms dissolved contaminants into an insoluble solid, facilitating the contaminant's subsequent removal from the liquid phase by sedimentation or filtration. The process usually uses pH adjustment, addition of a chemical precipitant, and flocculation.	Not appropriate. Groundwater extraction not selected for further evaluation.
		Separation	Separation techniques concentrate contaminated waste water through physical and chemical means. Includes distillation, filtration.ultrafiltartion/microfiltration, freeze crystallization, membrane pervaporation, and reverse osmosis.	Not appropriate. Groundwater extraction not selected for further evaluation.
		Sprinkler Irrigation	The process that involves the pressurized distribution of volatile organic compound (VOC)-laden water through a standard sprinkler irrigation system.	Not appropriate. Groundwater extraction not selected for further evaluation.
		UV Oxidation	Ultraviolet (UV) radiation, ozone, and/or hydrogen peroxide are used to destroy organic contaminants as water flows into a treatment tank. If ozone is used as the oxidizer, an ozone destruction unit is used to treat collected off-gases from the treatment tank and downstream units where ozone gas may collect, or escape.	Not appropriate. Groundwater extraction not selected for further evaluation.
	Biological/ Bioremediation	Bioreactors	Contaminants in extracted groundwater are put into contact with microorganisms in attached or suspended growth biological reactors. In suspended systems, such as activated sludge, contaminated groundwater is circulated in an aeration basin. In attached systems, such as rotating biological contractors and trickling filters, microorganisms are established on an inert support matrix.	Not appropriate. Other more cost-effective treatment options are available.
		Constructed Wetlands	The constructed wetlands-based treatment technology uses natural geochemical and biological processes inherent in an artificial wetland ecosystem to accumulate and remove metals, explosives, and other contaminants from influent waters. The process can use a filtration or degradation process.	Not appropriate. Other more cost-effective treatment options are available.
In Situ Treatment	Physical/Chemical	Aeration	Aeration is the process by which the area of contact between water and air is increased, either by natural methods or by mechanical devices.	Air sparging selected from technology group for evalaution.
		Air Sparging	Air is injected into saturated matrices to remove contaminants through volatilization.	**Potentially Implementable.**

TABLE 9-5

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR GROUNDWATER

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
In Situ Treatment (continued)	Physical/Chemical (continued)	Bioslurping	Bioslurping combines the two remedial approaches of bioventing and vacuum-enhanced free-product recovery. Bioventing stimulates the aerobic bioremediation of hydrocarbon-contaminated soils. Vacuum-enhanced free-product recovery extracts light nonaqueous phase liquids (LNAPLs) from the capillary fringe and the water table.	Not appropriate. Other more cost-effective treatment options are available.
		Directional Wells (enhancement)	Drilling techniques are used to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling.	Not appropriate for site conditions.
		Dual Phase Extraction	A high vacuum system is applied to simultaneously remove various combinations of contaminated groundwater, separate-phase petroleum product, and hydrocarbon vapor from the subsurface.	Not appropriate. Other more cost-effective treatment options are available.
		Fluid/Vapor Extraction	A high vacuum system is applied to simultaneously remove liquid and gas from low permeability or heterogeneous formations.	Not appropriate. Other more cost-effective treatment options are available.
		Hot Water or Steam Flushing/Stripping	Steam is forced into an aquifer through injection wells to vaporize volatile and semivolatile contaminants. Vaporized components rise to the unsaturated zone where they are removed by vacuum extraction and then treated.	Not appropriate. Other more cost-effective treatment options are available.
		Hydrofracturing	Injection of pressurized water through wells into low permeability and over-consolidated sediments. Cracks are filled with porous media that serve as substrates for bioremediation or to improve pumping efficiency.	Not appropriate for site conditions.
		In-Well Air Stripping	Air is injected into a double screened well, lifting the water in the well and forcing it out the upper screen. Simultaneously, additional water is drawn in the lower screen. Once in the well, some of the VOCs in the contaminated groundwater are transferred from the dissolved phase to the vapor phase by air bubbles. The contaminated air rises in the well to the water surface where vapors are drawn off and treated by a soil vapor extraction system.	Not appropriate. Other more cost-effective treatment options are available.
		Passive/Reactive Treatment Walls	These barriers allow the passage of water while causing the degradation or removal of contaminants by employing such agents as zero-valent metals, chelators (ligands selected for their specificity for a given metal), sorbents, microbes, and others.	Not appropriate for site conditions.

TABLE 9-5

EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS FOR GROUNDWATER

Former Tacoma Metals Facility

General Response Action	Remedial Technologies	Process Options	Description	Evaluation Comments
In Situ Treatment (continued)	Biological/ Bioremediation	Co-metabolic Treatment	Injection of a dilute solution of primary substrate (e.g., toluene, methane) into the contaminated ground water zone to support the co-metabolic breakdown of targeted organic contaminants.	Emerging technology. Other process options considered for further evaluation.
		Enhanced Biodegradation	Rate of bioremediation of organic contaminants by microbes is enhanced by increasing the concentration of electron acceptors and nutrients in groundwater. Oxygen is the main electron acceptor for aerobic bioremediation. Nitrate serves as an alternative electron acceptor under anoxic conditions.	**Potentially implementable.**
		Natural Attenuation	Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminant concentrations to acceptable levels.	Enhanced Biodegradation selected from technology group for evaluation.
		Phytoremediation	Phytoremediation is a set of processes that uses plants to remove, transfer, stabilize and destroy organic/inorganic contamination in groundwater, surface water, and leachate.	Not appropriate for site conditions.
Disposal/Discharge	Onsite	Stormdrain	Discharge of treated groundwater to storm drain.	Not appropriate. Groundwater extraction not selected for further evaluation.
	Offsite	Publicly Owned Treatment Works (POTW)	Discharge untreated groundwater for treatment at POTW.	Not appropriate. Groundwater extraction not selected for further evaluation.
Reuse/Recycling	Onsite/Offsite	Landscape Irrigation	Use of treated groundwater for landscape irrigation.	Not appropriate. Groundwater extraction not selected for further evaluation.

TABLE 9-6

SUMMARY OF POTENTIAL REMEDIAL PROCESS OPTIONS FOR SOIL
Former Tacoma Metals Facility

MTCA Preference(a)	General Technology Description	Soil Process Option
1	Reuse or Recycling	<u>Soil</u> Onsite: Soil for backfill/grading Offsite: Soil for daily landfill cover material <u>Debris</u> Offsite: Metal recycling
2	Destruction or Detoxification	Landfarming Thermal Desorption
3	Separation Followed by Reuse or Destruction	Excavation Sieving
4	Immobilization	In situ or Ex situ Chemical Stabilization
5	Onsite or Offsite disposal	Offsite Management Unit (Landfill)
6	Containment	Cover (Asphalt Cap with Stormwater Controls)
7	Institutional Controls or Monitoring	Deed Restrictions and Compliance Monitoring

Note:
(a) Source: WAC 173-340-360(4).

TABLE 9-7

COMPLIANCE OF ALTERNATIVES WITH POTENTIAL ACTION-SPECIFIC ARARs
Former Tacoma Metals Facility

ARAR		ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review
Federal/State Citation	**Description**			
29 CFR 1910.120 WAC 296-62	General safety and health standards for workers, including requirements for responses involving hazardous substances.	Remedial action workers can be adequately protected.	Same as Alternative 1.	Same as Alternative 1.
40 CFR 50.6 and .12 40 CFR 60.5 WAC 173-400 WAC 173-460 WAC 173-470 PSAPCA Regulations I, II, and III	General regulations for air pollution sources; particulate matter emissions standards; control standards for toxic air pollutants.	Fugitive dust control during excavation and soil management activities can be adequately controlled with water.	Same as Alternative 1.	Same as Alternative 1. Thermal desorption unit baghouse and air pollution system expected to meet requirements.
40 CFR 262.12, 262.20 through .33, and 262.40 through .43 WAC 173-303-160, 170, 180, 190, 210, and 220	Requirements for generators of hazardous and dangerous waste.	Alternative can meet requirements.	Same as Alternative 1.	Same as Alternative 1.

TABLE 9-7

COMPLIANCE OF ALTERNATIVES WITH POTENTIAL ACTION-SPECIFIC ARARs
Former Tacoma Metals Facility

ARAR		ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review
Federal/State Citation	**Description**			
40 CFR 268 WAC 173-303-140	Land disposal restrictions.	Alternative can meet requirements for disposal of impacted soil and debris. Disposal of hazardous/dangerous waste at a permitted offsite disposal facility not anticipated, with the exception of small amounts of lead-acid battery casings and associated impacted soils which may be characterized as hazardous/dangerous waste.	Same as Alternative 1.	Alternative can meet requirements for disposal of recovered debris materials. Disposal of hazardous/dangerous waste at a permitted offsite disposal facility not anticipated, with the exception of small amounts of lead-acid battery casings and associated impacted soils which may be characterized as hazardous/dangerous waste.
None WAC 173-304	Standards for disposal of solid waste.	Alternative can meet requirements for disposal of impacted soil.	Alternative can meet requirements for disposal of impacted soil.	Alternative can meet requirements for disposal of debris type materials.
49 CFR 107, 171 through 179 WAC 446-50	Transportation regulations for hazardous materials.	Alternative can meet requirements.	Same as Alternative 1.	Same as Alternative 1.
None WAC 173-160 WAC 173-162	Regulations for construction and maintenance of new water wells; licensing of drillers.	Alternative can meet requirements should additional monitoring wells are required as part of the compliance monitoring.	Same as Alternative 1.	Same as Alternative 1.

TABLE 9-7

COMPLIANCE OF ALTERNATIVES WITH POTENTIAL ACTION-SPECIFIC ARARs
Former Tacoma Metals Facility

ARAR		ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Federal/State Citation	**Description**	**Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**
None WAC 173-340-360	Model Toxics Control Act (MTCA) requirements for selection of cleanup actions .	Offsite disposal (soil) is a low-preference remedial method. Treatment (groundwater) is a preferred remedial method. Meets other requirements.	Same as Alternative 1.	Treatment (soil and groundwater) is preferred remedial method. Meets other requirements.
None WAC 173-340-410	MTCA requirements regarding compliance monitoring during remedial activities.	Meets requirements.	Meets requirements.	Meets requirements.
None WAC 173-340-440 and -702(4)	MTCA requirements regarding institutional controls to limit activities at a site that may result in exposure to hazardous substances.	Meets requirements.	Meets requirements.	Meets requirements.
None WAC 173-340-450	MTCA regulations regarding releases from underground storage tanks (USTs).	Meets requirements for free product and impacted soil removal.	Meets requirements for free product and impacted soil removal.	Meets requirements for free product and impacted soil removal.
None WAC 173-340-704,-705, and -706	Use of Methods A, B, and C for determining cleanup levels.	MTCA Method A and C industrial cleanup levels used for site soil cleanup levels. ARARs used for site groundwater and surface water cleanup levels	Same as Alternative 1.	Same as Alternative 1.
None WAC 173-340-707	MTCA analytical methods for evaluating the effectiveness of a cleanup action.	Approved methods will be used.	Approved methods will be used.	Approved methods will be used.
None WAC 173-340-708	MTCA regulation on human health risk assessment procedures.	Addressed with selection of cleanup levels.	Addressed with selection of cleanup levels.	Addressed with selection of cleanup levels.

TABLE 9-7

COMPLIANCE OF ALTERNATIVES WITH POTENTIAL ACTION-SPECIFIC ARARs
Former Tacoma Metals Facility

ARAR		ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review
Federal/State Citation	**Description**			
None WAC 173-201A	Surface Water Quality Standards (SWQS) for the State of Washington	Cleanup level achieved through groundwater treatment and asphalt cap and stormwater collection system. Cleanup levels will be monitored through compliance monitoring.	Same as Alternative 1.	Same as Alternative 1.
None WAC 173-340-720, -730, -740, and -745	MTCA cleanup standards for groundwater, surface water, and soil.	Cleanup standards achieved through offsite soil disposal, groundwater treatment, engineering controls (cap and stormwater collection system), institutional controls, compliance monitoring, and periodic reviews.	Same as Alternative 1.	Cleanup standards achieved through soil and groundwater treatment, engineering controls (cap and stormwater collection system), institutional controls, compliance monitoring, and periodic reviews.
None WAC 197-11	Washington State Environmental Policy Act (SEPA).	Alternative complies with the intent of SEPA (through SEPA integration with MTCA).	Same as Alternative 1.	Same as Alternative 1.
40 CFR 131.36 (National Toxics Rule) 90.48 RWC WAC 173-226	Regulations developed to implement the Federal Clean Water Act [33 USC 466 *et seq*] and State Water Pollution Control Act for protection of aquatic life in nations waters (lakes, rivers, aquifers, and coastal areas).	Cleanup level achieved through groundwater treatment and asphalt cap and stormwater collection system.	Same as Alternative 1.	Same as Alternative 1.

TABLE 9-7

COMPLIANCE OF ALTERNATIVES WITH POTENTIAL ACTION-SPECIFIC ARARs
Former Tacoma Metals Facility

Notes:

ARARs	- Applicable, relevant, and appropriate requirements.
CFR	- Code of Federal Regulations.
WAC	- Washington Administrative Code.
RWC	- Revised Washington Code.
USC	- United States Code.

TABLE 9-8

COMPLIANCE OF ALTERNATIVES WITH POTENTIAL CHEMICAL-SPECIFIC ARARs
Former Tacoma Metals Facility

ARAR		ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review
Citation	**Description**			
Model Toxics Control Act Cleanup Levels (WAC 173-340-740)	Specifies cleanup levels for soil, groundwater, and surface water that protect human health and the environment.	Petroleum hydrocarbon and cPAH soil cleanup levels achieved through excavation and offsite disposal of deeper soil in contact with groundwater. Shallow soil impacted with metals, petroleum hydrocarbons, cPAHs, and PCBs above cleanup levels left in-place; however, potential for direct contact and leaching to groundwater mitigated through installation of asphalt cap, institutional controls, and periodic reviews. Groundwater cleanup levels achieved through treatment of groundwater and compliance monitoring. Surface water - See Note 1.	Petroleum hydrocarbon and cPAH soil cleanup levels achieved through excavation and offsite disposal of deeper soil in contact with groundwater. Shallow soil cleanup levels achieved through excavation along portions of property boundary where elevated concentrations of COCs exist to create a "buffer zone" between impacted soils above cleanup levels left onsite and adjacent properties. Potential for direct contact and leaching to groundwater of shallow soil above cleanup levels mitigated through installation of asphalt cap, institutional controls, and periodic reviews. Groundwater cleanup levels achieved through treatment of groundwater and compliance monitoring. Surface water - See Note 1.	Petroleum hydrocarbon and cPAH soil cleanup levels achieved through excavation, onsite treatment, and reuse of deeper soil in contact with groundwater. Shallow soil cleanup levels achieved through excavation, onsite treatment, and reuse along portions of property boundary where elevated concentrations of COCs exist to create a "buffer zone" between impacted soils above cleanup levels left onsite and adjacent properties. Potential for direct contact and leaching to groundwater of shallow soil above cleanup levels mitigated through installation of asphalt cap, institutional controls, and periodic reviews. Groundwater cleanup levels achieved through treatment of groundwater and compliance monitoring. Surface water - See Note 1.

TABLE 9-8

COMPLIANCE OF ALTERNATIVES WITH POTENTIAL CHEMICAL-SPECIFIC ARARs
Former Tacoma Metals Facility

ARAR		ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review
Citation	**Description**			
Ecology Freshwater Acute Surface Water Quality Standards (WAC 173-201A)	Specifies cleanup levels for surface waters.	See Note 1.	See Note 1.	See Note 1.
National Toxic Rule for Consumption of Water and Organisms (40 CFR 131.36)	Specifies cleanup levels for surface waters.	See Note 1.	See Note 1.	See Note 1.
Ecology Model NPDES Permit for Surface Water Discharge (WAC 173-226)	Specifies discharge levels to surface waters of the state from cleanups where gasoline and diesel are the pollutants of concern.	See Note 1.	See Note 1.	See Note 1.

Notes:

ARARs – Applicable, relevant, and appropriate requirements.
cPAHs – Carcinogenic polycyclic aromatic hydrocarbons.
PCBs – Polychlorinated biphenyls.
COCs – Chemicals of concern.
NPDES – National Pollutant Discharge Elimination System.

1. This alternative addresses surface water quality standards through the monitoring of the shallow zone groundwater, which discharges to the Puyallup River, and by monitoring surface water runoff to the asphalt cap stormwater collection system.

TABLE 9-9

ALTERNATIVE EVALUATION WITH MTCA'S THRESHOLD CRITERIA
Former Tacoma Metals Facility

Threshold Criteria	ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review
Overall Protection of Human Health and Environment	Reduces risk to an acceptable level through removal of free product and petroleum hydrocarbon-impacted soil(a) above cleanup levels in those areas of the site where attainment of cleanup levels is practicable and necessary for the protection of groundwater. Also includes the removal of lead-acid battery casings and associated impacted soil. Potential risk to human and health and the environment associated with leaving chemicals of concern (COCs) above site cleanup levels is mitigated by installation of cap, institutional controls, compliance monitoring, and periodic reviews. Lowest potential risk to workers during earthwork activities due to the limited area and volume of materials to be handled. Potential risks to workers would be controlled through use of personal protective equipment. Potential air pollution threats would be controlled. Provides for groundwater treatment and surface water and groundwater monitoring which reduces the potential risk to surface water receptors.	Reduces risk to an acceptable level through removal of free product and petroleum hydrocarbon-impacted soil(a) above cleanup levels in those areas of the site where attainment of cleanup levels is practicable and necessary for the protection of groundwater. Also includes the removal of lead-acid battery casings and associated impacted soil. Provides for additional protection to human health and the environment by creating a "buffer zone" between shallow metals-impacted soil(b) remaining on site above site cleanup levels and adjacent properties. Potential risk to human and health and the environment associated with leaving COCs above site cleanup levels is mitigated by installation of cap and institutional controls. Slightly higher potential risk to workers during earthwork activities due to the greater volume of materials to be handled. Potential risks to workers would be controlled through use of personal protective equipment. Potential air pollution threats would be controlled. Provides for groundwater treatment and surface water and groundwater monitoring which reduces the potential risk to surface water receptors.	Same as Alternative 2, but reduces risks to acceptable level through onsite treatment of excavated petroleum hydrocarbon-impacted soil(a) and shallow metals-impacted soil(b). Also includes the removal of lead-acid battery casings and associated impacted soil. Highest potential risk to workers due to the additional handling of soil during excavation, sieving/separation of debris, treatment, and backfilling activities. Potential risks to workers would be controlled through use of personal protective equipment. Potential air pollution threats would be controlled. Provides for groundwater treatment and surface water and groundwater monitoring which reduces the potential risk to surface water receptors.

TABLE 9-9

ALTERNATIVE EVALUATION WITH MTCA'S THRESHOLD CRITERIA
Former Tacoma Metals Facility

Threshold Criteria	**ALTERNATIVE 1** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**ALTERNATIVE 2** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**ALTERNATIVE 3** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**
Point of Compliance	Soil throughout the site to a depth of 15 feet below grade for protection of surface water and human contact. The point of compliance for soil is not achieved throughout the site; however, Model Toxics Control Act (MTCA) recognizes that containment can comply with cleanup standards, provided compliance monitoring (see below) is included to ensure long-term integrity of containment system. The point of compliance for shallow zone groundwater is at the point of discharge to the Puyallup River; for practical purposes wells monitoring the shallow groundwater zone along the northern property boundary will serve as a conditional point of compliance. The point of compliance for surface water is at the point of discharge from the site to the Puyallup River. Since there is no interaction between the site surface water and the Puyallup River, the stormwater collection system will serve as the surface water compliance point	Same as Alternative 1.	Same as Alternative 1.
Applicable State and Federal Laws	See Tables 9-7 and 9-8.	See Tables 9-7 and 9-8.	See Tables 9-7 and 9-8.

TABLE 9-9

ALTERNATIVE EVALUATION WITH MTCA'S THRESHOLD CRITERIA
Former Tacoma Metals Facility

Threshold Criteria	ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review
Compliance Monitoring	Threshold criteria met through protection monitoring during earthwork activities and performance monitoring to confirm that soil cleanup levels have been attained in designated excavation areas. Includes annual monitoring (at a minimum) and periodic reviews of the asphalt cap. Groundwater and surface water performance and confirmational monitoring (3 to 5 years minimum) to assess changing site conditions and attainment of groundwater and surface water cleanup levels.	Same as Alternative 1.	Same as Alternative 1.

Notes:

(a) Petroleum hydrocarbon-impacted soil is categorized as deep soil (up to 10 feet bgs) exceeding cleanup levels that intercepts the water table and has resulted in groundwater impact. Soil in this category may contain diesel- and oil-range petroleum hydrocarbons and carcinogenic polycyclic aromatic hydrocarbons (cPAHs).

(b) Metals-impacted soil is categorized as shallow soil (typically 3 feet or less bgs) exceeding cleanup levels. This category of soil predominantly contains lead but may contain other metals (e.g., chromium), diesel- and oil-range petroleum hydrocarbons, cPAHs, and polychlorinated biphenyls (PCBs).

TABLE 9-10

EVALUATION OF LONG-TERM EFFECTIVENESS FOR REMEDIAL ALTERNATIVES
Former Tacoma Metals Facility

Subcriteria	**ALTERNATIVE 1** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**ALTERNATIVE 2** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**ALTERNATIVE 3** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**
Degree of certainty that alternative will be successful	Long-term effectiveness concerns would not be significant because free product and soil potentially impacting site groundwater will have been removed. Permitted disposal facility is expected to adequately manage landfilled soil for the long-term. Asphalt cap well proven as an effective engineering control measure for containing shallow soil left in-place above site cleanup levels and for reducing surface water infiltration that could potentially leach chemicals of concern (COCs) from subsurface soil to shallow groundwater. Institutional controls frequently selected for addressing sites containing hazardous substances. Groundwater treatment option well proven to be successful at site with similar COCs. Surface water runoff will be controlled through the stormwater collection system that will be an integral part of the asphalt cap design. Alternative expected to be successful and demonstrated as such through compliance monitoring and periodic reviews.	Same as Alternative 1.	See Alternative 1. Permitted disposal facility is expected to adequately manage any landfilled debris materials for the long-term. Success of the soil treatment options may be limited by how effectively debris materials can be removed prior to treatment. Uncertainties exist regarding the ability to chemically stabilize metals-impacted soil[a] containing high organic carbon and petroleum hydrocarbons. These could be overcome by pre-treating the metals-impacted soil via thermal desorption; however, this will require additional handling of soil.

TABLE 9-10

EVALUATION OF LONG-TERM EFFECTIVENESS FOR REMEDIAL ALTERNATIVES
Former Tacoma Metals Facility

Subcriteria	**ALTERNATIVE 1** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**ALTERNATIVE 2** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**ALTERNATIVE 3** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**
Long-term reliability	Long-term reliability at the site is not a significant concern because compliance monitoring and periodic reviews will be conducted. Long-term reliability of the permitted disposal facility is expected to be adequate.	Same as Alternative 1.	See Alternative 1. Treatment process (thermal desorption/chemical stabilization) will result in the permanent destruction/detoxification/immobilization of COCs.
Magnitude of residual risk	Soil containing COCs above site soil cleanup levels will remain on site. Alternatives 1 and 2 have the most amount of metals-impacted soil(a) remaining onsite. Magnitude of residual groundwater impact reduced through treatment and source removal (free product and petroleum hydrocarbon-impacted soil(b) down to water table and lead-acid battery casings and associated impacted soil).	Soil containing COCs above site soil cleanup levels will remain onsite. Alternatives 1 and 2 have the most amount of metals-impacted soil(a) remaining onsite. Residual risk reduced along property boundary by creation of a "buffer zone" remediated to site cleanup levels. Magnitude of residual groundwater impact reduced through treatment and source removal (free product and petroleum hydrocarbon-impacted soil(b) down to water table and lead-acid battery casings and associated impacted soil).	Soil containing COC above site soil cleanup levels will remain on site. Alternative 3 has the least amount of metals-impacted soil(a) remaining onsite. Residual risk reduced along property boundary by creation of a "buffer zone" remediated to site cleanup levels. Magnitude of residual groundwater impact reduced through treatment and source removal (free product and petroleum hydrecarbon-impacted soil(b) down to water table and lead-acid battery casings and associated impacted soil).
Effectiveness of controls required to manage treatment residues or remaining wastes	Controls not required.	Controls not required.	Controls not required.

Notes:

(a) Metals-impacted soil is categorized as shallow soil (typically 3 feet or less bgs) exceeding cleanup levels. This category of soil predominantly contains lead but may contain other metals (e.g., chromium), diesel- and oil-range petroleum hydrocarbons, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and polychlorinated biphenyls (PCBs).

(b) Petroleum hydrocarbon-impacted soil is categorized at deep soil (up to 10 feet bgs) exceeding cleanup levels that intercepts the water table and has resulted in groundwater impact. Soil in this category may contain diesel- and oil-range petroleum hydrocarbons and cPAHs.

TABLE 9-11

EVALUATION OF SHORT-TERM EFFECTIVENESS FOR REMEDIAL ALTERNATIVES
Former Tacoma Metals Facility

Subcriteria	ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review
Protection of human health during construction and implementation	Fugitive dust emissions could be generated during soil excavation, transportation, and handling. Chemicals of concern (COCs), adsorbed to dust particles or in vapor phase, could be ingested or inhaled; however, potential air pollution threats would be controlled. Potential for contamination of runon/runoff during earthwork activities. Risks to remedial workers because of moving heavy equipment, and direct contact with soil. Offsite tracking of contaminants on construction vehicles could occur. Increased vehicular traffic should not be a concern.	Same as Alternative 1.	See Alternative 1. Thermal treatment of petroleum hydrocarbon-impacted soil(a) could potentially increase air pollution risks as could mixing of metal-impacted soil(b) during chemical stabilization . Treatment also requires additional handling of soil to remove debris which may result in potential greater risk of exposure to remediation workers; however, potential air pollution threats would be controlled through dust control and the use of personal protective equipment.
Degree of risk prior to attainment of cleanup standards	Degree of risk can be controlled. Spraying the site with water would minimize generation and release of fugitive dust emissions. Remediation workers would wear protective clothing and respirators, if required. Surface water controls (e.g., covering stockpiled soil with plastic) and earth berms would be used to control potential contamination runon/runoff. Vehicles would be decontaminated before departing offsite.	Same as Alternative 1.	See Alternative 1. Thermal treatment pollution control features expected to meet local air quality standards.

Notes:

(a) Petroleum hydrocarbon-impacted soil is categorized at deep soil (up to 10 feet bgs) exceeding cleanup levels which intercepts the water table and has resulted in groundwater impact. Soil in this category may contain diesel- and oil-range petroleum hydrocarbons and carcinogenic polycyclic aromatic hydrocarbons (cPAHs).

(b) Metals-impacted soil is categorized as shallow soil (typically 3 feet or less bgs) exceeding cleanup levels. This category of soil predominantly contains lead but may contain other metals (e.g., chromium), diesel- and oil-range petroleum hydrocarbons, cPAHs, and polychlorinated biphenyls (PCBs).

TABLE 9-12

EVALUATION OF PERMANENT REDUCTION OF TOXICITY, MOBILITY, OR VOLUME FOR REMEDIAL ALTERNATIVES
Former Tacoma Metals Facility

Subcriteria	**ALTERNATIVE 1** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**ALTERNATIVE 2** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**ALTERNATIVE 3** **Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**
Adequacy of alternative in destroying hazardous substances	Does not include treatment.	Does not include treatment.	Thermal desorption and subsequent destruction expected to virtually destroy (i.e., greater than 99 percent) organic chemicals of concern (COCs) in petroleum hydrocarbon-impacted soil(a). Chemical stabilization of metals-impacted soil(b) does not involve destruction of metals; however, the mobility of the metals are significantly reduced or eliminated.
Reduction or elimination of hazardous substance releases and sources of releases	Does not destroy or treat hazardous materials. However, approximately 7,800 cubic yards of petroleum hydrocarbon-impacted(a) soil would be excavated and disposed of at a permitted offsite disposal facility (landfill), thereby eliminating source of groundwater contamination and reducing the amount of hazardous substances remaining on the site. Free product removal will also reduce the amount of hazardous substances onsite, as will the removal of lead-acid battery casings and associated impacted soil (approximately 10 cubic yards).	Does not destroy or treat hazardous materials. However, approximately 7,800 cubic yards of petroleum hydrocarbon-impacted soil (a) would be excavated and disposed of at a permitted offsite landfill, thereby eliminating site source of groundwater contamination and reducing the amount of hazardous substances remaining on the site. Free product removal will also reduce the amount of hazardous substances onsite, as will the removal of lead-acid battery casings and associated impacted soil (approximately 10 cubic yards). The volume of metals-impacted soil(b) would not be reduced; however, it would be consolidated onsite within the shallow-impacted soil footprint.	Thermal desorption would treat petroleum-hydrocarbon-impacted soil(a) containing organic COCs above the cleanup levels (approximately 7,800 cubic yards). Chemical stabilization of metals-impacted soil(b) does not involve destruction of metals; however, the mobility of the metals are significantly reduced or eliminated (approximately 700 cubic yards).
Irreversibility of waste treatment process	Not applicable.	Not applicable.	Thermal and chemical stabilization treatment processes are irreversible.

TABLE 9-12

EVALUATION OF PERMANENT REDUCTION OF TOXICITY, MOBILITY, OR VOLUME FOR REMEDIAL ALTERNATIVES
Former Tacoma Metals Facility

Subcriteria	**ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**	**ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review**
Characteristics and quantity of treatment residuals generated	Not applicable.	Not applicable.	Organic COCs removed bythermal desorption are destroyed in afterburner . No residuals produced as a result of chemical stabilization.

Notes:

(a) Petroleum hydrocarbon-impacted soil is categorized at deep soil (up to 10 feet bgs) exceeding cleanup levels that intercepts the water table and has resulted in groundwater impact. Soil in this category may contain diesel- and oil-range petroleum hydrocarbons and carcinogenic polycyclic aromatic hydrocarbons (cPAHs).

(b) Metals-impacted soil is categorized as shallow soil (typically 3 feet or less bgs) exceeding cleanup levels. This category of soil predominantly contains lead but may contain other metals (e.g., chromium), diesel- and oil-range petroleum hydrocarbons, cPAHs, and polychlorinated biphenyls (PCBs).

TABLE 9-13

EVALUATION OF ABILITY TO IMPLEMENT REMEDIAL ALTERNATIVES
Former Tacoma Metals Facility

Subcriteria	ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review
Consideration of whether alternative is technically possible	Alternative is technically possible, uses reliable and well proven process options.	Alternative is technically possible, uses reliable and well proven process options.	Treatment processes involved in this alternative are common remedial methods that can be readily implemented. The amount of debris in the soil is of concern; however, sieving/mechanical separation prior to treatment is expected to reduce the amount of debris material. There are some concerns regarding chemical stabilization of metals-impacted soil[a] containing high organics concentrations.
Availability of necessary offsite facilities, services, and materials	Adequate offsite facilities, services, and materials are available.	Adequate offsite facilities, services, and materials are available.	The availability of a suitable offsite or mobile (onsite) thermal treatment unit and a mobile (onsite) chemical stabilization unit are unknown.
Administrative and regulatory requirements	Requirements include clearing and grading permit and Shoreline Permit. State Environmental Policy Act (SEPA) checklist may also be necessary.	Same as Alternative 1.	See Alternative 1. Thermal treatment units typically are pre-permitted to address local air quality requirements.
Scheduling, size, and complexity	Routine construction operation that can be scheduled at most times of year. Dry season is more suitable for construction activities to reduce potential stormwater runon/runoff contamination. Least complex of the alternatives.	Same as Alternative 1. Slightly more complex than Alternative 1 due to the additional excavation and consolidation of metals-impacted soil[a].	Thermal desorption and chemical stabilization are more suited to summer months because of potential stormwater runon/runoff contamination and because of increased energy required to treat wet soil (for thermal treatment). Most complex of the alternatives.

TABLE 9-13

EVALUATION OF ABILITY TO IMPLEMENT REMEDIAL ALTERNATIVES
Former Tacoma Metals Facility

Subcriteria	ALTERNATIVE 1 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 2 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	ALTERNATIVE 3 Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review
Monitoring requirements	Air monitoring would be performed during remedial activities (protection monitoring). Soil and groundwater samples would be collected and analyzed during remediation to evaluate compliance with cleanup levels (performance monitoring). Post remediation monitoring of groundwater and surface water would be conducted for a period specified by Ecology (confirmational monitoring). Asphalt cap inspections and periodic site reviews would also be conducted.	Same as Alternative 1.	See Alternative 1. Air samples also would be collected during thermal treatment to determine compliance with air quality standards.
Access for construction, operations, and monitoring	Available.	Available.	Available.
Integration with existing facility operations and other current or potential remedial actions	Future site land use unknown at this time. Site located in industrial-zoned area, anticipated land use will be industrial. Asphalt cap can be easily integrated into future site developments. Replacement wells may need to be installed for future confirmational monitoring depending onsite development. Risk assessment may be required to evaluate groundwater/soil to indoor air exposure pathway if buildings are proposed in the area of the groundwater plume.	Same as Alternative 1.	Same as Alternative 1.

Notes:

(a) Metals-impacted soil is categorized as shallow soil (typically 3 feet or less bgs) exceeding cleanup levels. This category of soil predominantly contains lead but may contain other metals (i.e., chromium), diesel- and oil-range petroleum hydrocarbons, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and polychlorinated biphenyls (PCBs).

TABLE 9-14

SUMMARY OF COST ESTIMATES FOR ALTERNATIVES
Former Tacoma Metals Facility

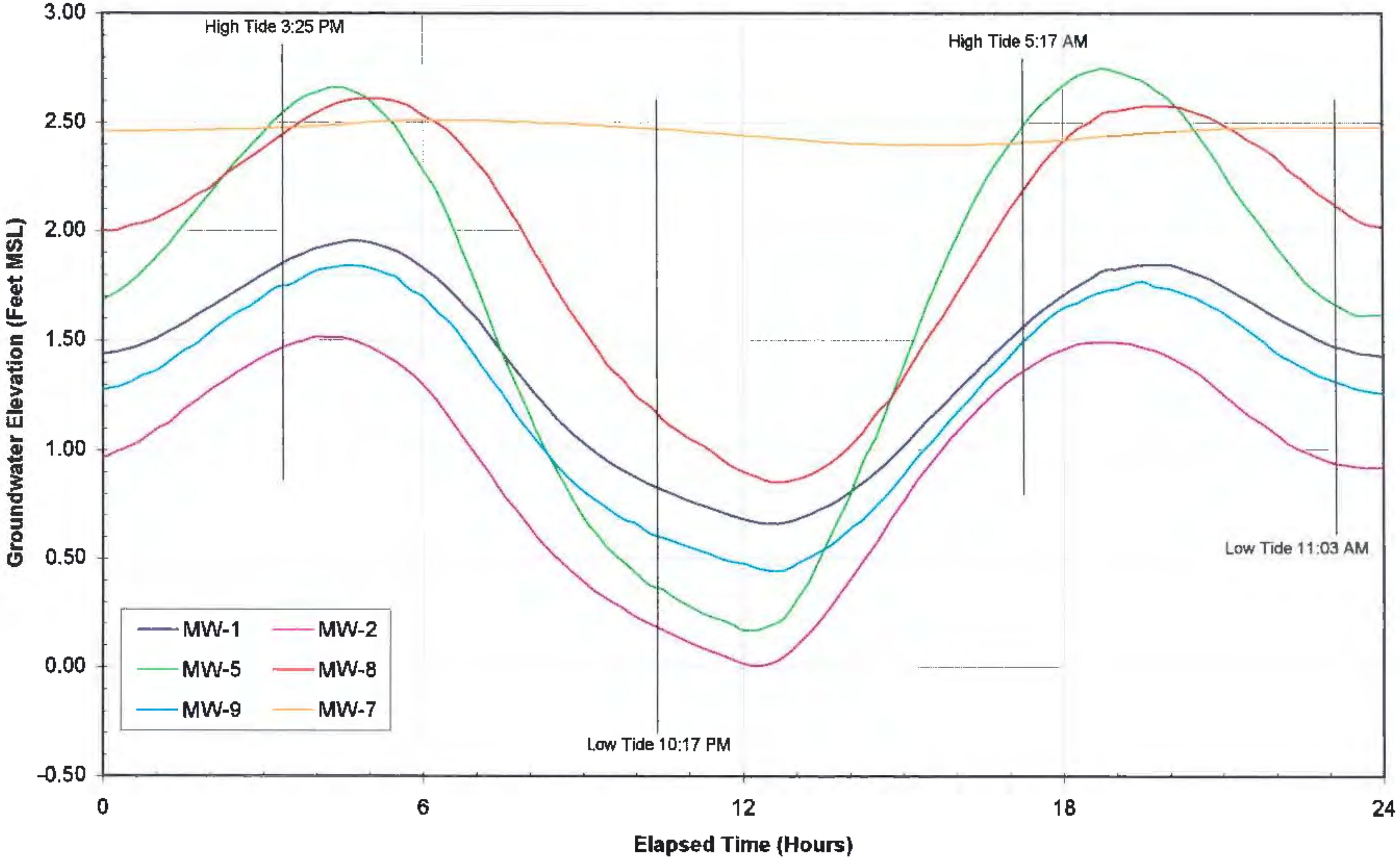
Alternative	Description	Estimated Total Present Worth[a] ($)
1	Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	$1,679,000
2	Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation with Offsite Disposal), Lead Excavation & Consolidation, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	$1,750,000
3	Source Control (Free Product Removal & Petroleum Hydrocarbon Excavation), Lead Excavation, Onsite Treatment & Reuse, Asphalt Cap, Enhanced Groundwater Biodegradation, Institutional Controls, Groundwater & Surface Water Compliance Monitoring, Periodic Review	$2,860,000

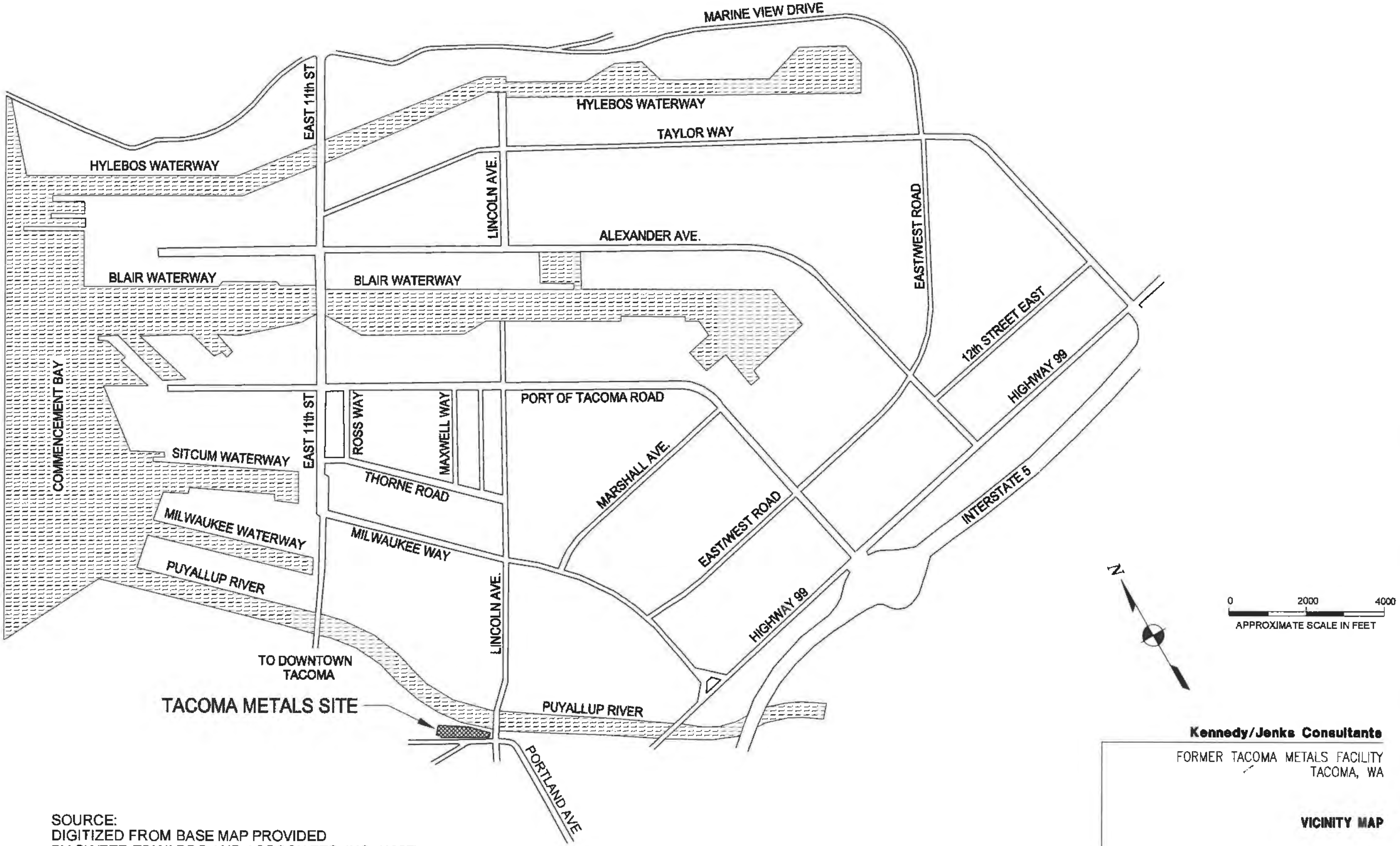
Note:

(a) Refer to Appendix P for detailed cost estimates.

FIGURE 3-7

Continuous Groundwater Level Monitoring Hydrograph
21-22 February 2001
Former Tacoma Metals Facility, Tacoma, WA





SOURCE:
DIGITIZED FROM BASE MAP PROVIDED
BY SWEET-EDWARDS AND ASSOCIATES, INC. (1987).

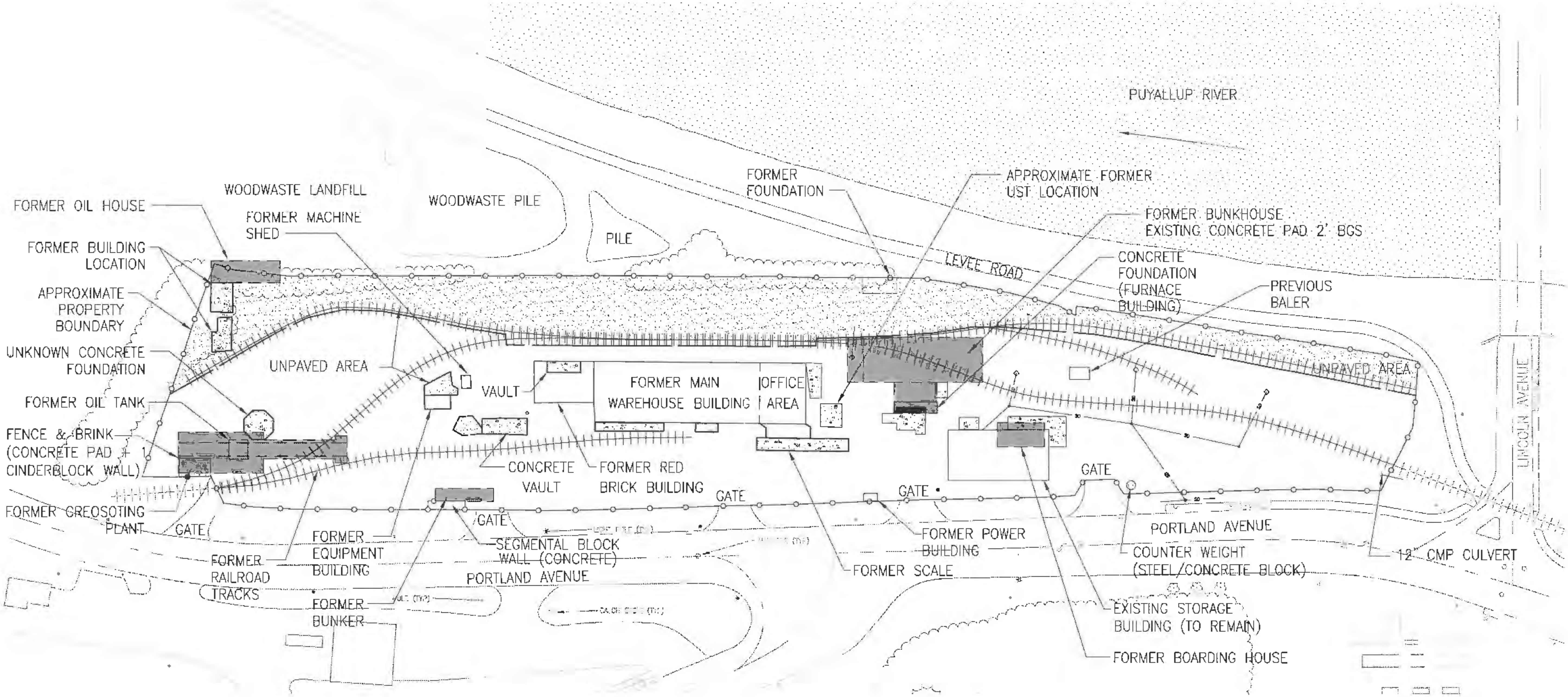
Kennedy/Jenks Consultants

FORMER TACOMA METALS FACILITY
TACOMA, WA

VICINITY MAP

996098.00/P01SK001–1

FIGURE 1-1



LEGEND:

◇ CATCHBASIN

——SD—— STORMDRAIN LINES

-o——o——o- 8' CHAINLINK FENCE W/BARBED WIRE

┼┼┼┼┼┼┼┼ FORMER RAILROAD TRACK LOCATION

EXISTING RAILROAD TRACK LOCATION

▨ UNPAVED AREA

▨ CONCRETE

▨ APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. INFORMATION SHOWN OUTSIDE OF PROPERTY BOUNDARIES IS BASED ON 1993 CITY OF TACOMA GEOGRAPHIC INFORMATION SYSTEM, TACOMA AREA MAPS.
3. PREVIOUS TRUNCATED RAILROAD SPUR LOCATION IS APPROXIMATE.
4. PROPERTY AREA = 249,223±sq.ft. (5.72±AC.)

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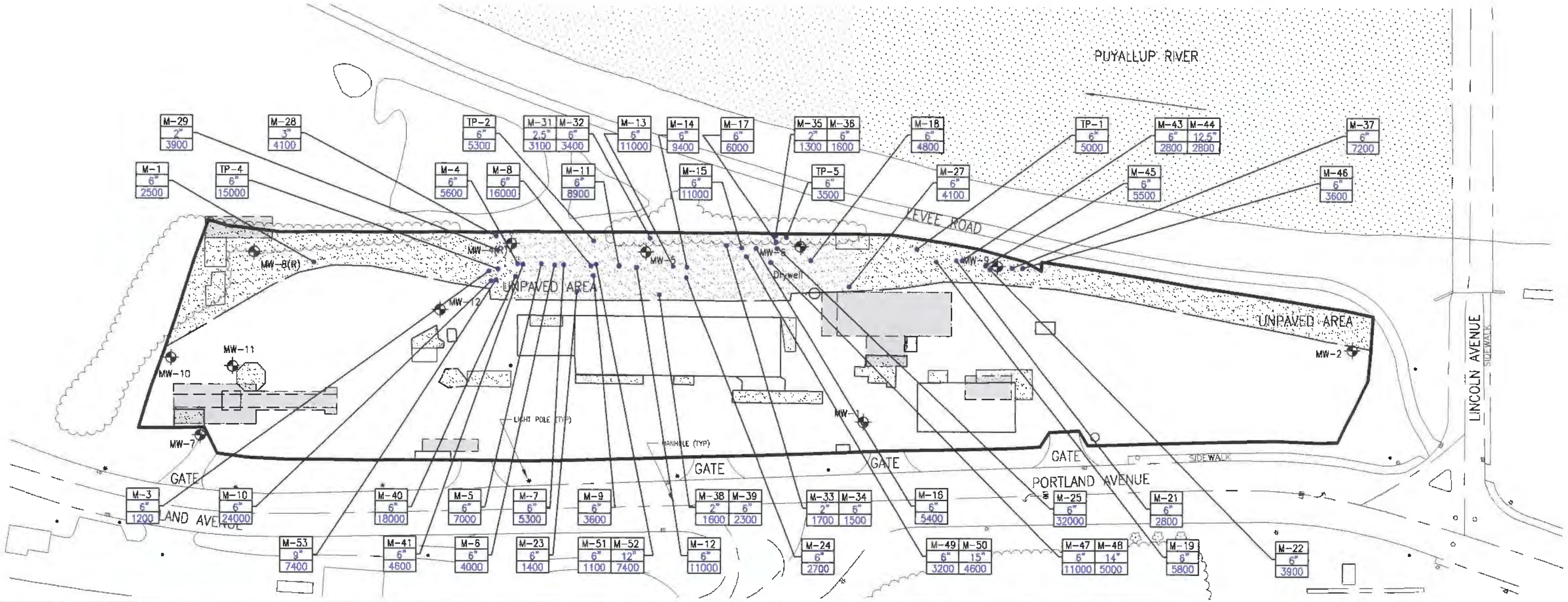
FORMER TACOMA METALS FACILITY
TACOMA, WA

SITE OVERVIEW MAP

996098.00/P01SK001-2

FIGURE 1-2



LEGEND:

⊕ MW-1 MONITORING WELL LOCATION
(R) = REPLACEMENT

● SOIL CONCENTRATIONS EXCEEDING MTCA METHOD A INDUSTRIAL SOIL CLEANUP LEVEL (LEAD 1000 mg/kg).

HART-CROWSER SURFACE SOIL SAMPLES (1990)

MORRIS ENVIRONMENTAL SERVICES SURFACE SOIL SAMPLES (1991)

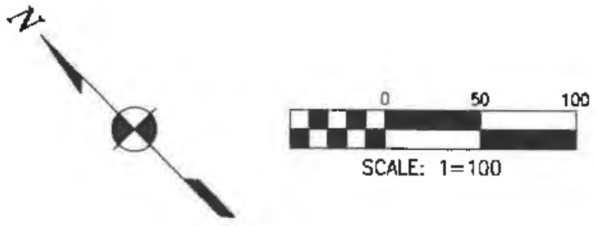
TP-4	M-1	
6"	6"	DEPTH(ft)
15000	2500	CONCENTRATION(mg/kg)

▨ UNPAVED AREA

▭ APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. MAP IS BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. FIGURE SHOWS LEAD CONCENTRATIONS GREATER THAN OR EQUAL TO 1000 mg/kg.



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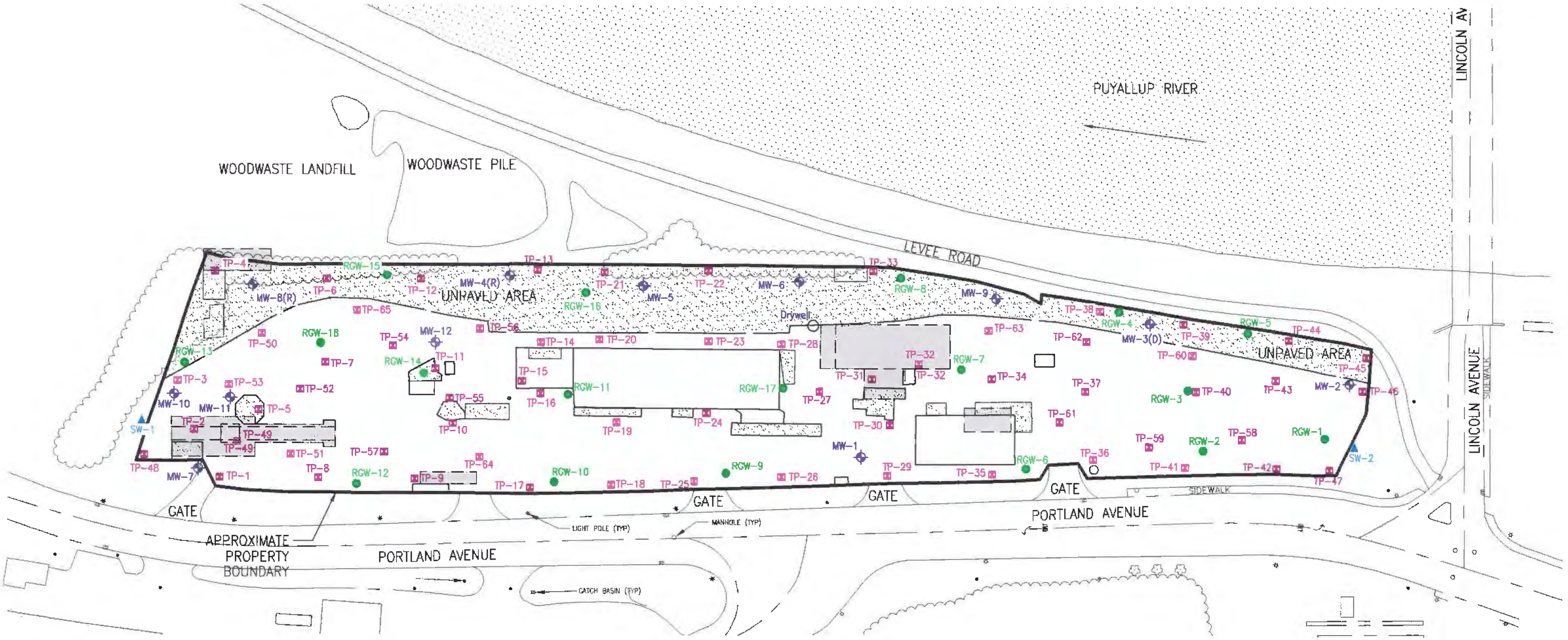
FORMER TACOMA METALS FACILITY
TACOMA, WA

PREVIOUS INVESTIGATIONS
LEAD CONCENTRATIONS IN SOIL

996098.00/P01SK001-3

FIGURE 1-3

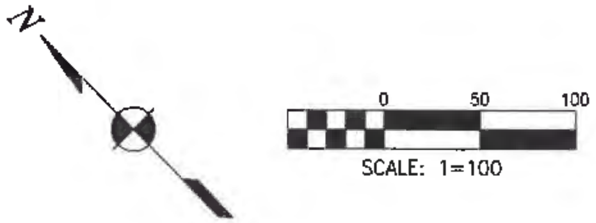


LEGEND:

⌖	MW-10	MONITORING WELL LOCATIONS (R) = REPLACEMENT (D) = DEMOLISHED
●	RGW-12	RECONNAISSANCE GROUNDWATER SAMPLING LOCATIONS
☒	TP-64	TEST PIT SAMPLING LOCATIONS
▲	SW-1	SURFACE WATER SAMPLING LOCATIONS
▨		UNPAVED AREA
▩		APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. INFORMATION SHOWN OUTSIDE OF PROPERTY BOUNDARIES IS BASED ON 1993 CITY OF TACOMA GEOGRAPHIC INFORMATION SYSTEM, TACOMA AREA MAPS.
3. PROPERTY AREA = 249,223±sq.ft. (5.72±AC.)



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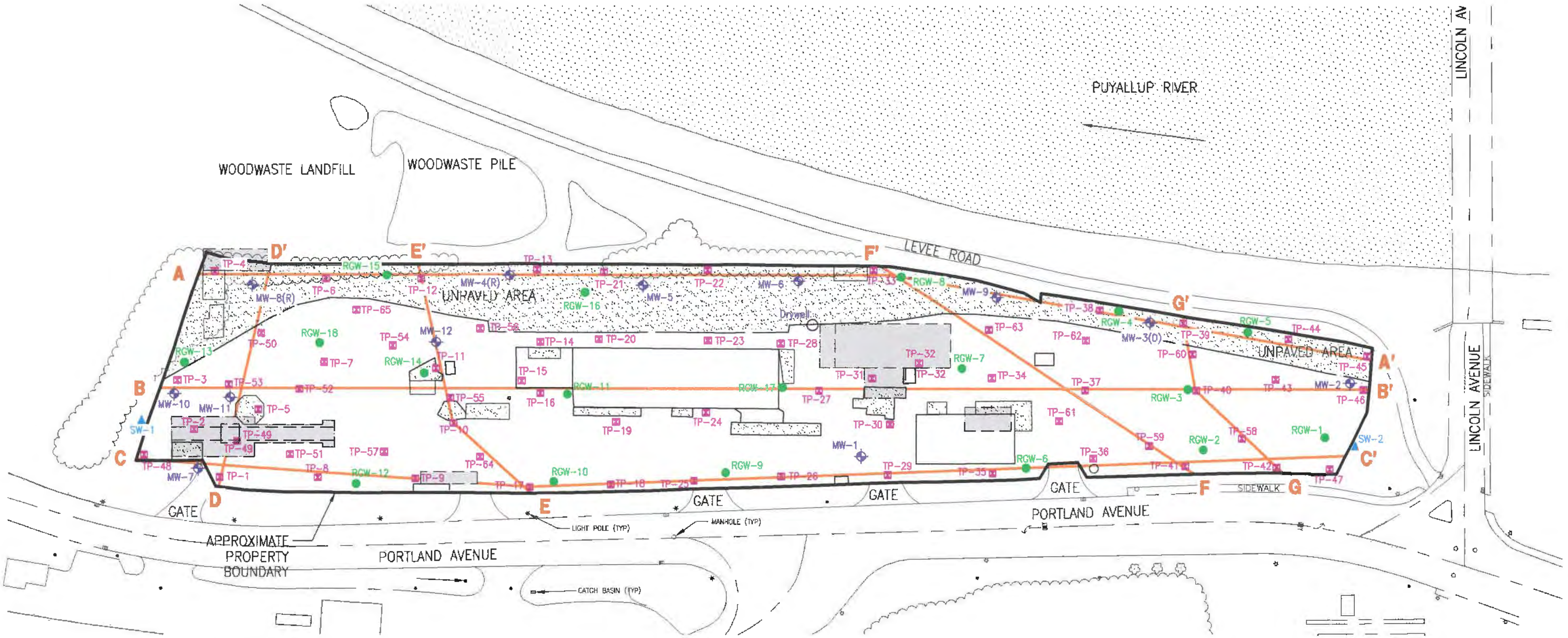
FORMER TACOMA METALS FACILITY
TACOMA, WA

SAMPLE LOCATION SUMMARY MAP

996098.00/P01SK002-1

FIGURE 2-1



LEGEND:

⌖ MW-10	MONITORING WELL LOCATIONS (R) = REPLACEMENT (D) = DEMOLISHED
● RGW-12	RECONNAISSANCE GROUNDWATER SAMPLING LOCATIONS
⊠ TP-64	TEST PIT SAMPLING LOCATIONS
▲ SW-1	SURFACE WATER SAMPLING LOCATIONS
—	CROSS SECTION LINES
▒	UNPAVED AREA
▭	APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)
▨	METAL DEBRIS FILL – ABUNDANT MIXED METAL AND OTHER DEBRIS WITH SOIL MATRIX. DEBRIS INCLUDES CABLE, WIRE, SHEET METAL, SPRINGS, MACHINE PARTS, SCRAP METAL, RUBBER, GLASS, BRICK, CONCRETE, AND OTHER MATERIAL. MATRIX MATERIAL IS TYPICALLY SAND AND GRAVEL MIXTURE.
▨	MIXED FILL – VARIABLE FILL MATERIAL TYPICALLY INCLUDING WELL GRADED SAND AND GRAVEL, POORLY GRADED SAND, SILTY SAND AND GRAVEL, AND SOME SILT AND CLAY. COMMONLY CONTAINS SOME METAL, GLASS, BRICK, CONCRETE, AND OTHER DEBRIS.
▨	WOOD FILL – MIXED WOOD DEBRIS INCLUDES LOGS, BOARDS, BARK, CHIPS, WOOD DUST, PLANKS, AND PILINGS. MATRIX MATERIAL INCLUDES MEDIUM TO FINE, SAND, SILT, AND CLAY MIXTURES. MATRIX CONTENT IS TYPICALLY 0–20%.
▨	NATIVE MATERIAL – APPARENTLY NATIVE DELTAIC AND ALLUVIAL DEPOSITS INCLUDING CLAYEY SANDY SILT WITH ORGANIC PLANT MATERIAL, AND POORLY GRADED SAND WITH FINE GRAVEL MATERIAL.

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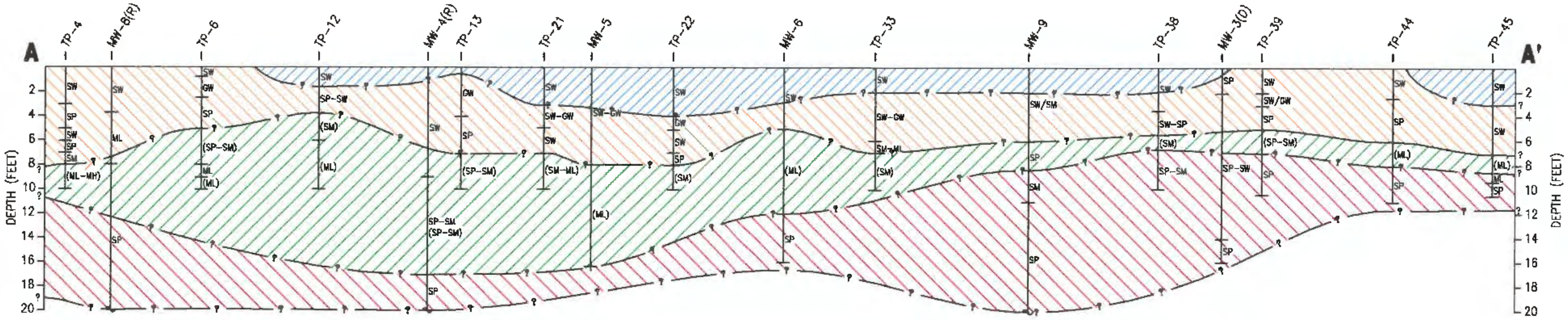
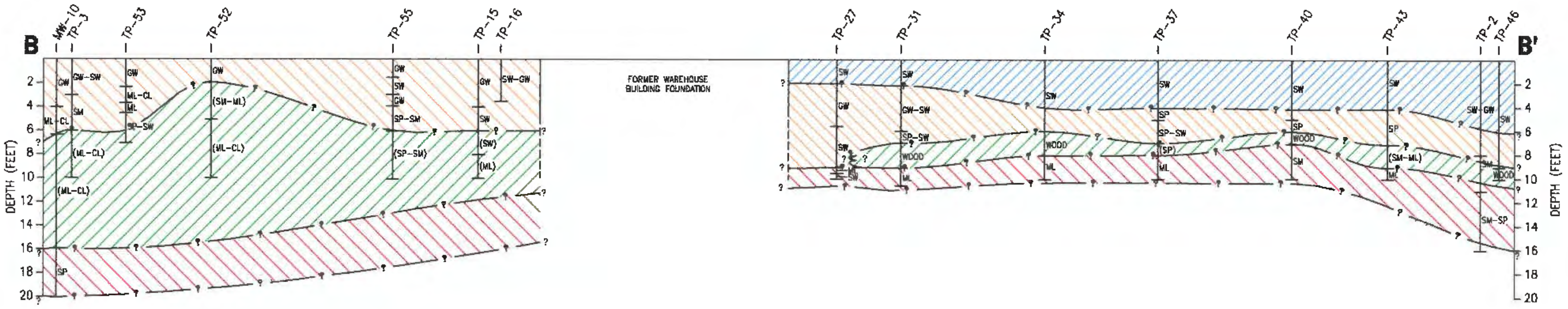
TACOMA, WA

GEOLOGIC CROSS SECTION LOCATIONS AND LEGEND

996098.00/P01SK003-1

FIGURE 3-1



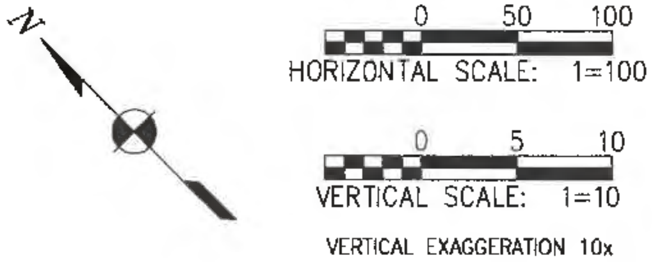


NOTES:

1. REFER TO FIGURE 3-1 FOR LEGEND AND NOTES.
2. SOIL CLASSIFICATIONS IN PARENTHESES INDICATE THE MATRIX MATERIAL IN THE WOOD FILL UNIT.

USCS SOIL CLASSIFICATION

SP	POORLY-GRADED SAND
SW	WELL-GRADED SAND
GW	WELL-GRADED GRAVEL
ML	SILT
SM	SILTY SAND
CL	LEAN CLAY



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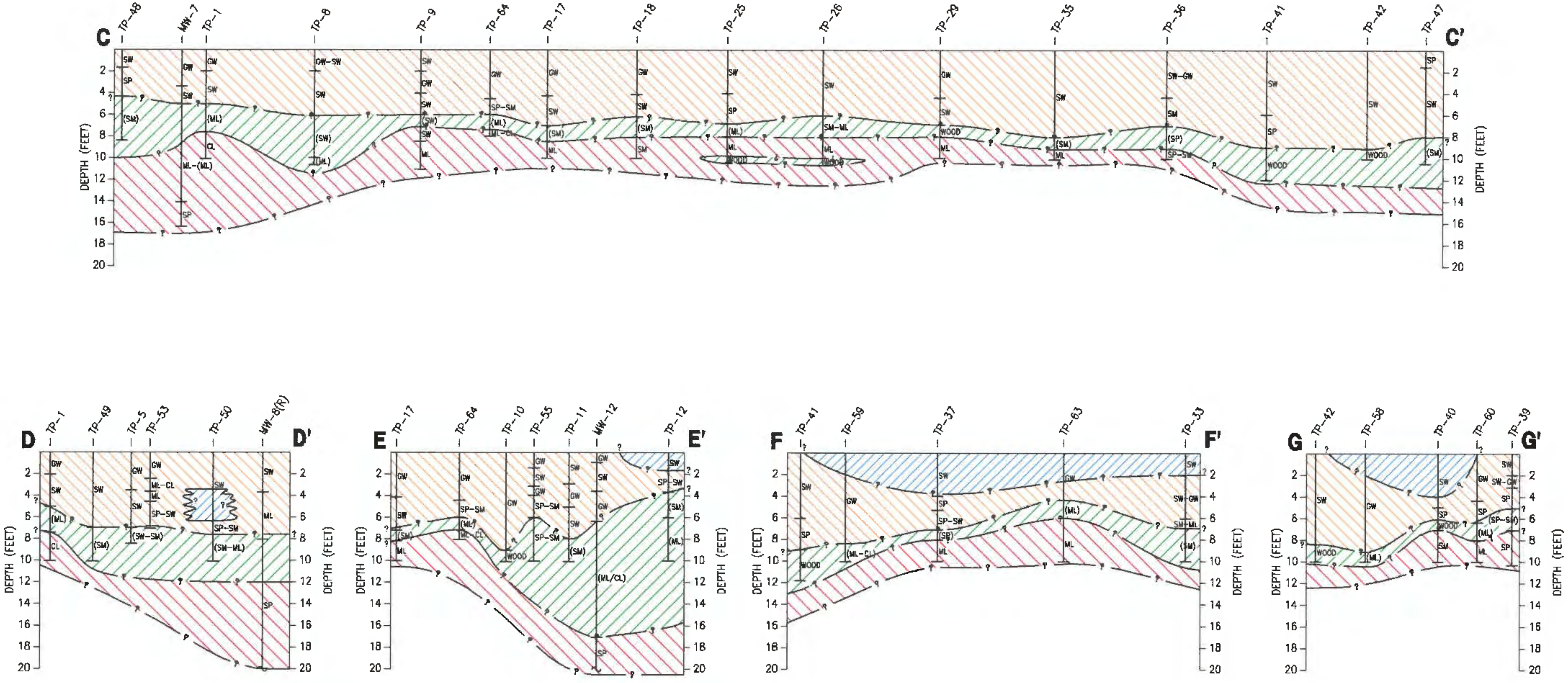
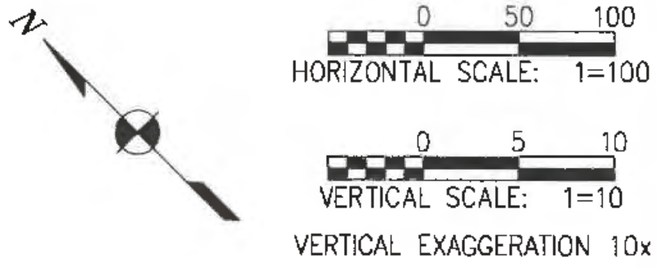
TACOMA, WA

**GEOLOGIC CROSS SECTIONS
A-A' AND B-B'**

996098.00/P01SK003-2

FIGURE 3-2





HORIZONTAL SCALE: 1=100

VERTICAL SCALE: 1=10

VERTICAL EXAGGERATION 10x

NOTES:

1. REFER TO FIGURE 3-1 FOR LEGEND AND NOTES.
2. SOIL CLASSIFICATIONS IN PARENTHESES INDICATE THE MATRIX MATERIAL IN THE WOOD FILL UNIT.

USCS SOIL CLASSIFICATION

SP	POORLY-GRADED SAND
SW	WELL-GRADED SAND
GW	WELL-GRADED GRAVEL
ML	SILT
SM	SILTY SAND
CL	LEAN CLAY

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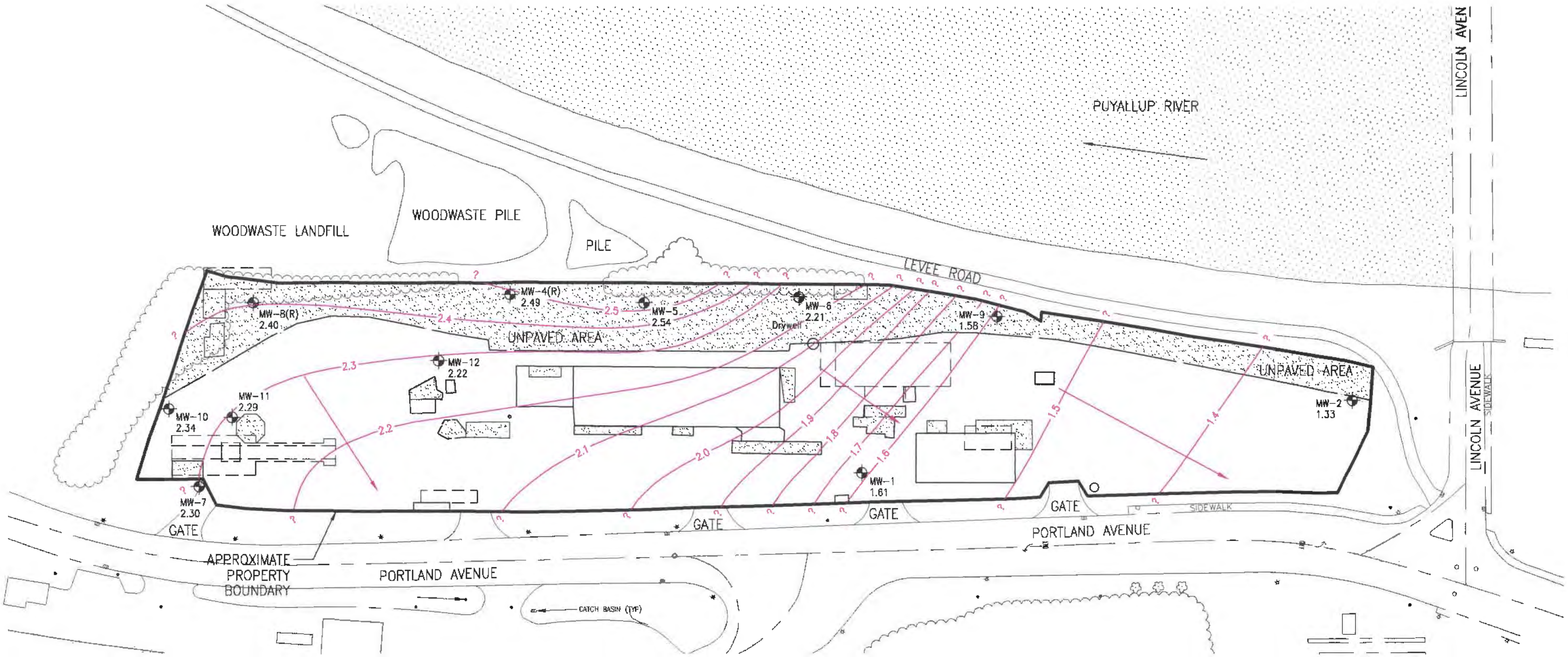
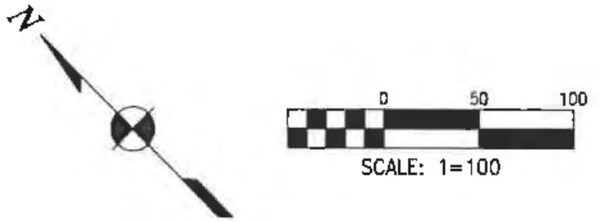
TACOMA, WA

GEOLOGIC CROSS SECTIONS
C-C', D-D', E-E', F-F' AND G-G'

996098.00/P01SK003-3

FIGURE 3-3





LEGEND:

⊕ MW-1 1.61	MONITORING WELL LOCATION AND GROUNDWATER ELEVATION (FEET MSL) (R) = REPLACEMENT
—2.00—	APPROXIMATE POTENTIOMETRIC SURFACE CONTOURS (FEET MSL)
→	APPROXIMATE HYDRAULIC GRADIENT DIRECTION
▨	UNPAVED AREA
┌ ┐ └ ┘	APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. INFORMATION SHOWN OUTSIDE OF PROPERTY BOUNDARIES IS BASED ON 1993 CITY OF TACOMA GEOGRAPHIC INFORMATION SYSTEM, TACOMA AREA MAPS.
3. CONTOUR INTERVAL = 0.1 FEET.

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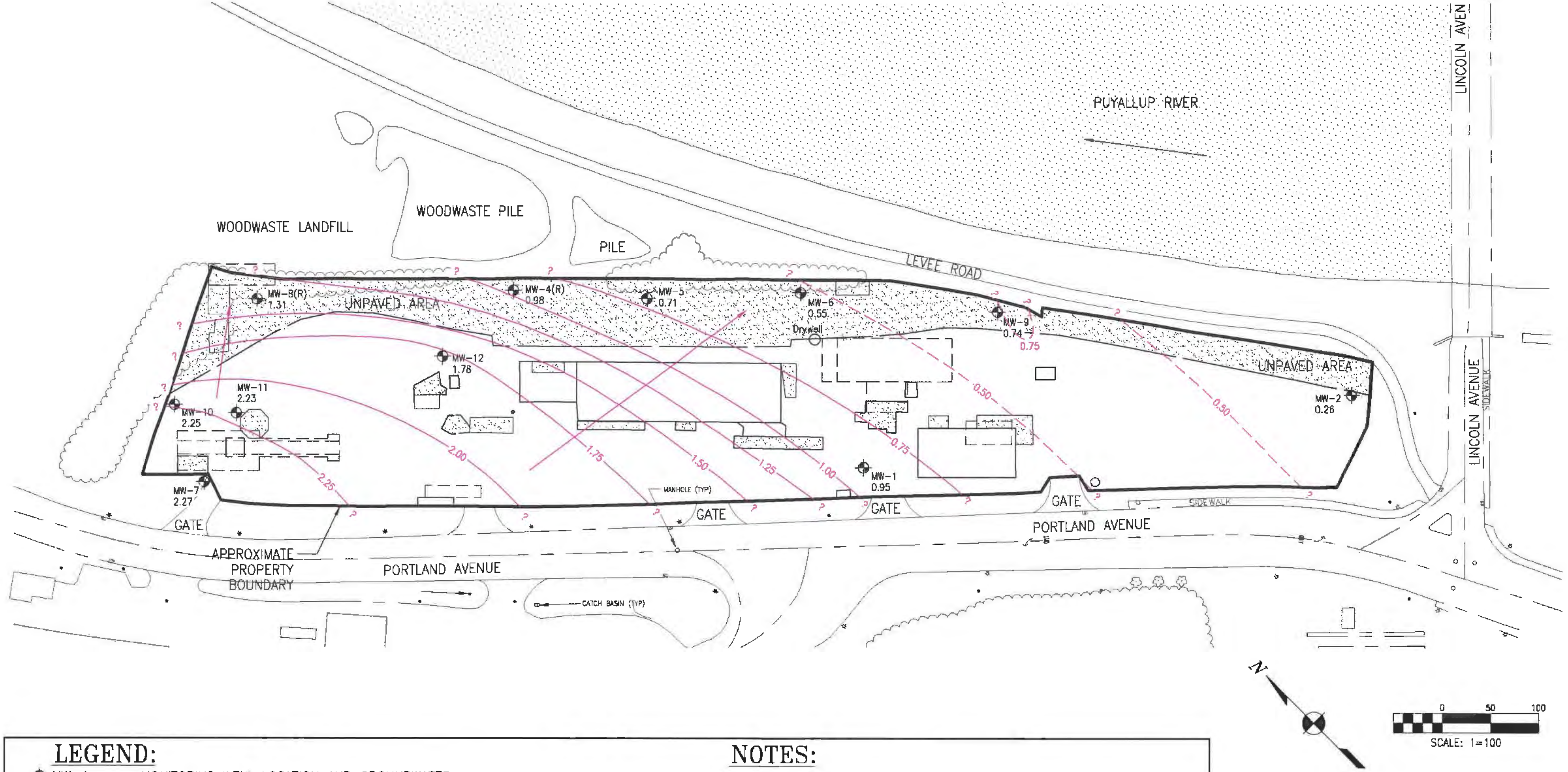
TACOMA, WA

POTENTIOMETRIC SURFACE CONTOUR
HIGH TIDE - 31 JANUARY 2001

996098.00/P01SK003-4A

FIGURE 3-4A



LEGEND:

⊕ MW-1 0.95	MONITORING WELL LOCATION AND GROUNDWATER ELEVATION (FEET MSL) (R) = REPLACEMENT
—2.00—	APPROXIMATE POTENTIOMETRIC SURFACE CONTOURS (FEET MSL) DASHED WHERE UNCERTAIN
——→	APPROXIMATE HYDRAULIC GRADIENT DIRECTION
▨	UNPAVED AREA
⬚	APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. INFORMATION SHOWN OUTSIDE OF PROPERTY BOUNDARIES IS BASED ON 1993 CITY OF TACOMA GEOGRAPHIC INFORMATION SYSTEM, TACOMA AREA MAPS.
3. CONTOUR INTERVAL = 0.25 FEET.

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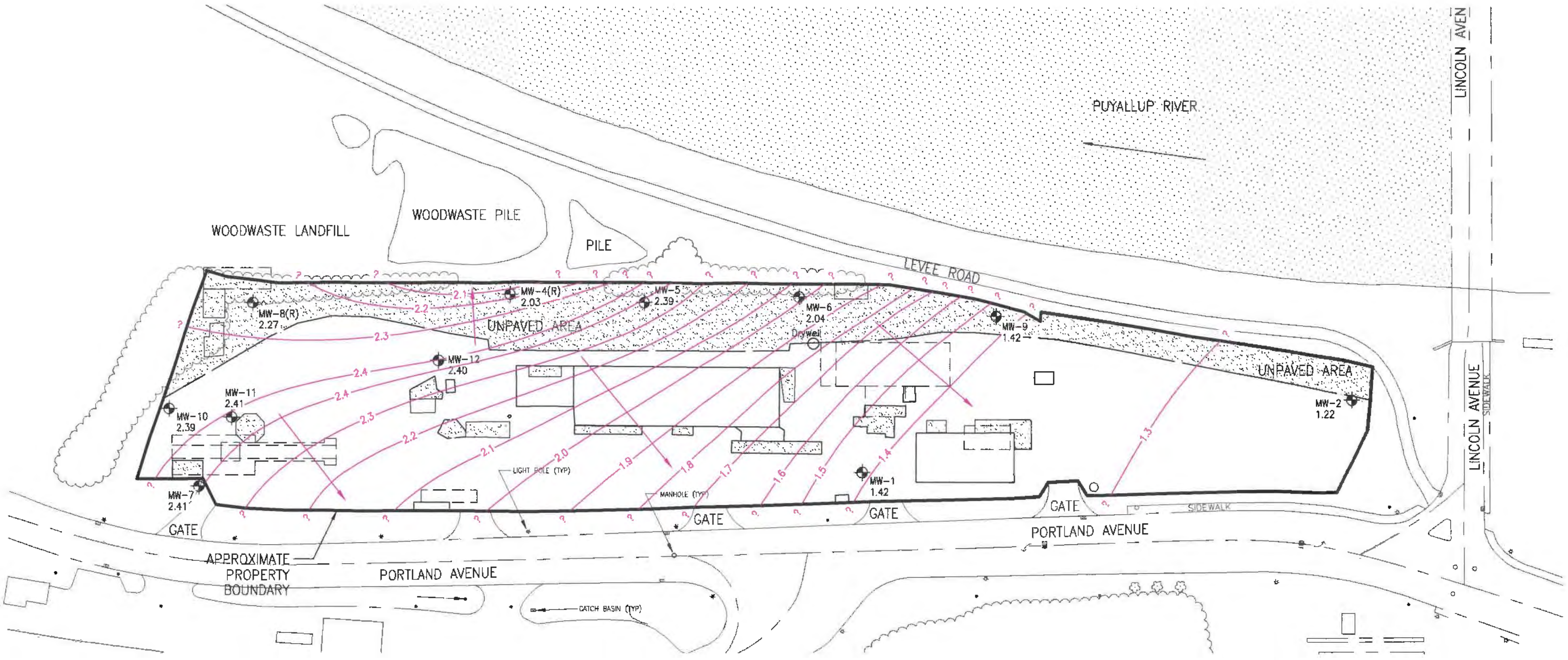
TACOMA, WA

POTENTIOMETRIC SURFACE CONTOUR
LOW TIDE - 31 JANUARY 2001

996098.00/P01SK003-4B

FIGURE 3-4B



LEGEND:

⊕ MW-1 1.42	MONITORING WELL LOCATION AND GROUNDWATER ELEVATION (FEET MSL) (R) = REPLACEMENT
—2.00—	APPROXIMATE POTENTIOMETRIC SURFACE CONTOURS (FEET MSL)
⟶	APPROXIMATE HYDRAULIC GRADIENT DIRECTION
▨	UNPAVED AREA
⬚	APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. INFORMATION SHOWN OUTSIDE OF PROPERTY BOUNDARIES IS BASED ON 1993 CITY OF TACOMA GEOGRAPHIC INFORMATION SYSTEM, TACOMA AREA MAPS.
3. CONTOUR INTERVAL = 0.1 FEET.

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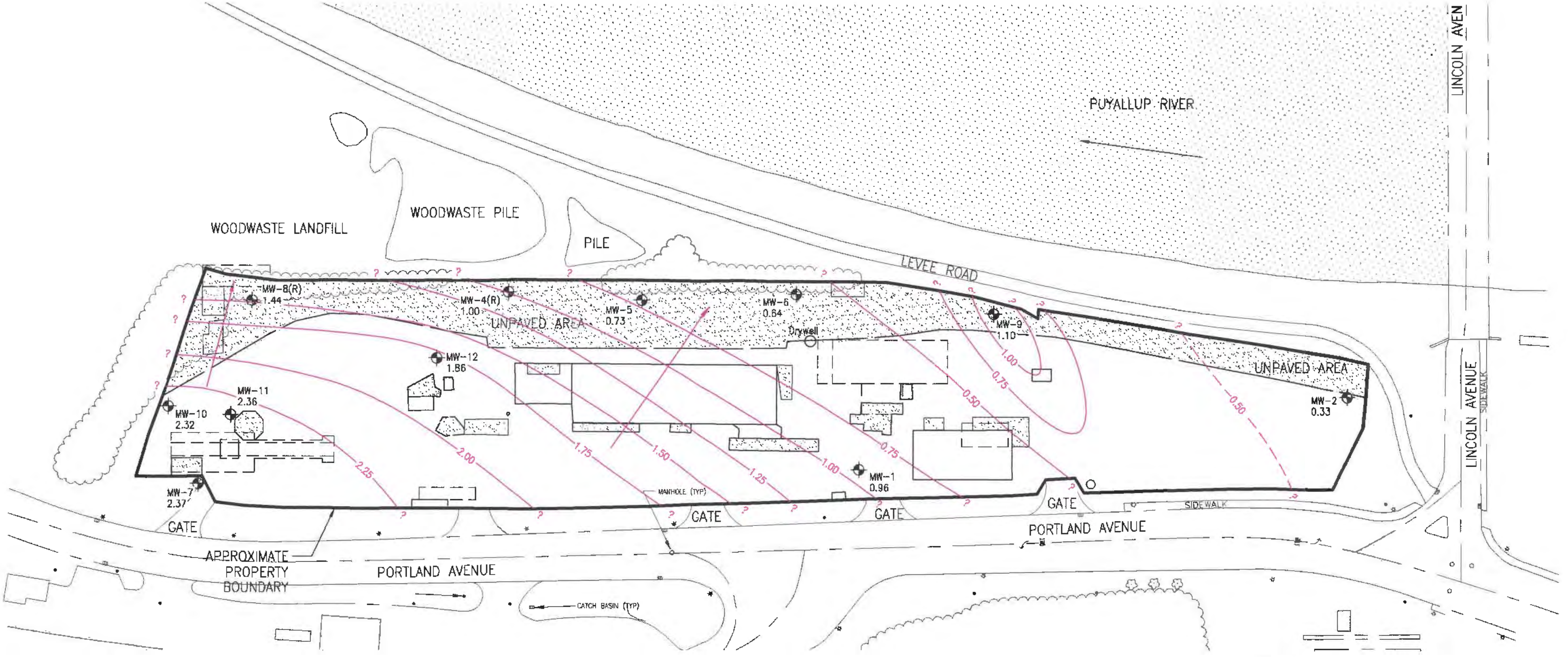
POTENTIOMETRIC SURFACE CONTOUR
HIGH TIDE - 13 FEBRUARY 2001

996098.00/P01SK003-5A

FIGURE 3-5A



LEGEND:

⊕ MW-1 0.96	MONITORING WELL LOCATION AND GROUNDWATER ELEVATION (FEET MSL) (R) = REPLACEMENT
—2.00—	APPROXIMATE POTENTIOMETRIC SURFACE CONTOURS (FEET MSL) DASHED WHERE UNCERTAIN
——→	APPROXIMATE HYDRAULIC GRADIENT DIRECTION
▨	UNPAVED AREA
⬚	APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. INFORMATION SHOWN OUTSIDE OF PROPERTY BOUNDARIES IS BASED ON 1993 CITY OF TACOMA GEOGRAPHIC INFORMATION SYSTEM, TACOMA AREA MAPS.
3. CONTOUR INTERVAL = 0.25 FEET.

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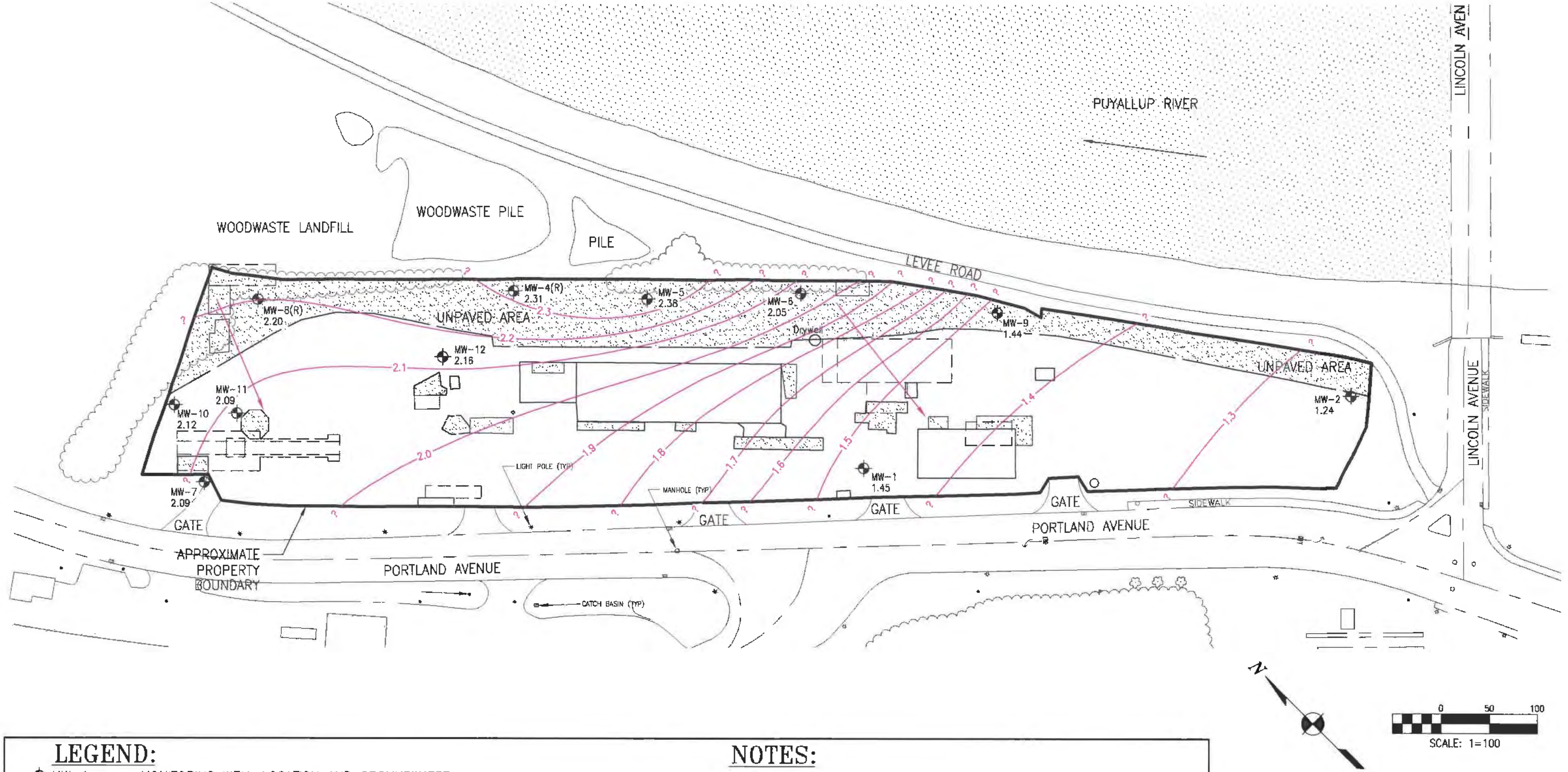
TACOMA, WA

POTENTIOMETRIC SURFACE CONTOUR
LOW TIDE - 13 FEBRUARY 2001

996098.00/P01SK003-5B

FIGURE 3-5B



LEGEND:

⊕ MW-1 1.45	MONITORING WELL LOCATION AND GROUNDWATER ELEVATION (FEET MSL) (R) = REPLACEMENT
—2.00—	APPROXIMATE POTENTIOMETRIC SURFACE CONTOURS (FEET MSL)
——→	APPROXIMATE HYDRAULIC GRADIENT DIRECTION
▨	UNPAVED AREA
┌ ─ ┐	APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. INFORMATION SHOWN OUTSIDE OF PROPERTY BOUNDARIES IS BASED ON 1993 CITY OF TACOMA GEOGRAPHIC INFORMATION SYSTEM, TACOMA AREA MAPS.
3. CONTOUR INTERVAL = 0.1 FEET.

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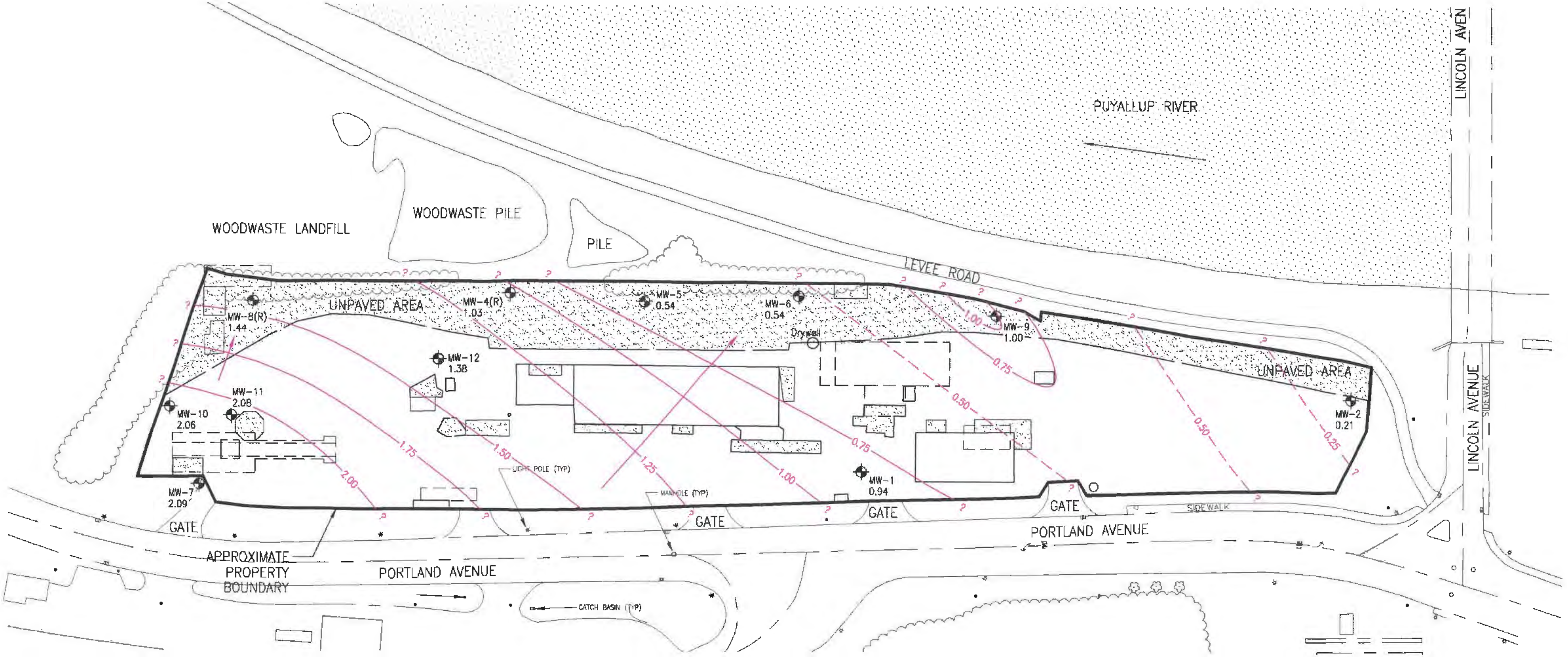
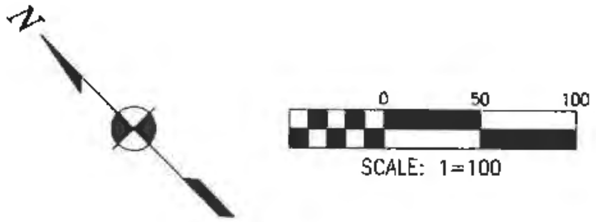
FORMER TACOMA METALS FACILITY
TACOMA, WA

POTENTIOMETRIC SURFACE CONTOUR
HIGH TIDE - 28 FEBRUARY 2001

996098.00/P01SK003-6A

FIGURE 3-6A





LEGEND:

⊕ MW-1 0.94	MONITORING WELL LOCATION AND GROUNDWATER ELEVATION (FEET MSL) (R) = REPLACEMENT
—2.00—	APPROXIMATE POTENTIOMETRIC SURFACE CONTOURS (FEET MSL) DASHED WHERE UNCERTAIN
——→	APPROXIMATE HYDRAULIC GRADIENT DIRECTION
▨	UNPAVED AREA
☐	APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. INFORMATION SHOWN OUTSIDE OF PROPERTY BOUNDARIES IS BASED ON 1993 CITY OF TACOMA GEOGRAPHIC INFORMATION SYSTEM, TACOMA AREA MAPS.
3. CONTOUR INTERVAL = 0.25 FEET.

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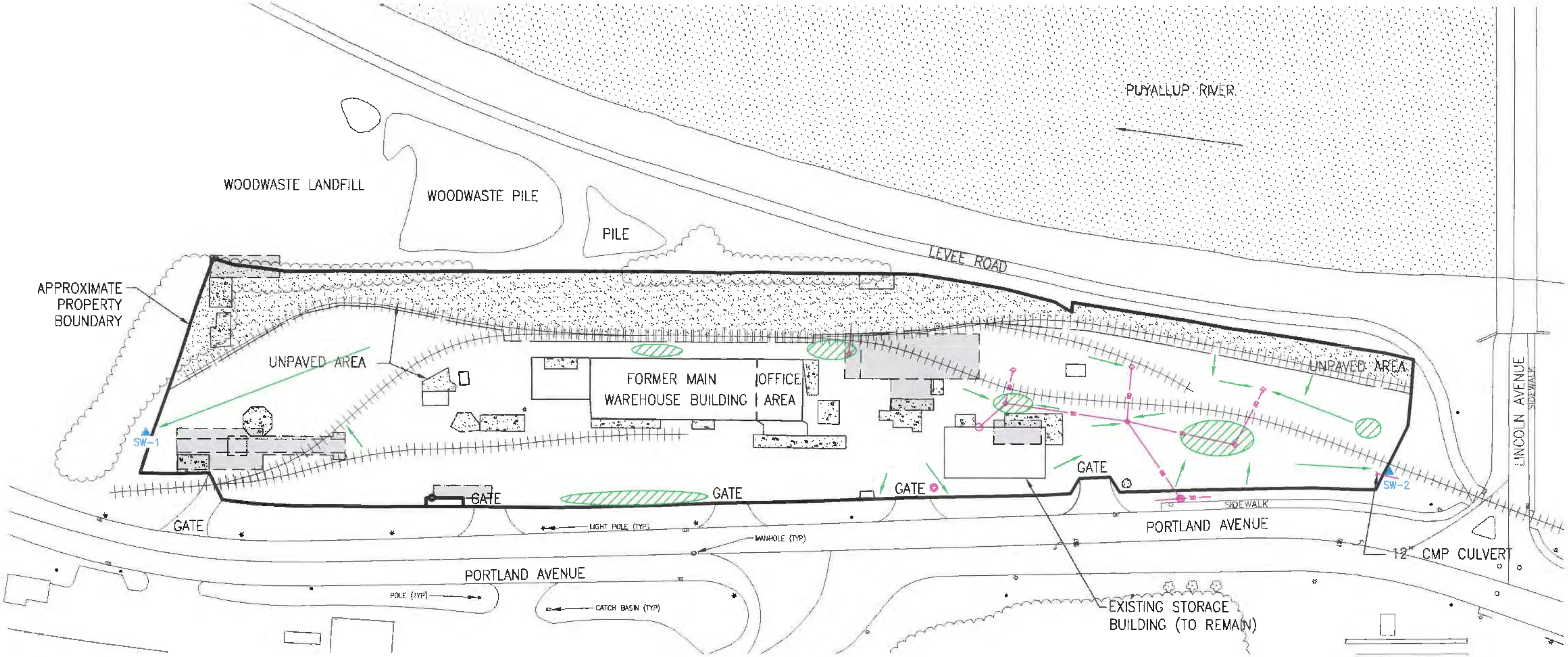
FORMER TACOMA METALS FACILITY
TACOMA, WA

POTENTIOMETRIC SURFACE CONTOUR
LOW TIDE - 28 FEBRUARY 2001

996098.00/P01SK003-6B

FIGURE 3-6B

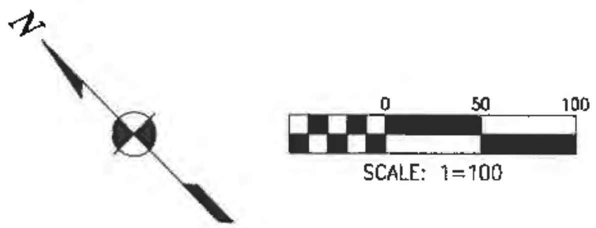


LEGEND:

◇	CATCHBASIN
—SD—	STORM DRAIN LINES
▲ SW–1	SURFACE WATER SAMPLING LOCATIONS
→	APPROXIMATE SURFACE DRAINAGE FLOWLINES
▨	APPROXIMATE SURFACE WATER PONDING AREAS
┼┼┼┼┼┼┼┼	FORMER RAILROAD TRACK LOCATION
░	UNPAVED AREA
▒	APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. INFORMATION SHOWN OUTSIDE OF PROPERTY BOUNDARIES IS BASED ON 1993 CITY OF TACOMA GEOGRAPHIC INFORMATION SYSTEM, TACOMA AREA MAPS.



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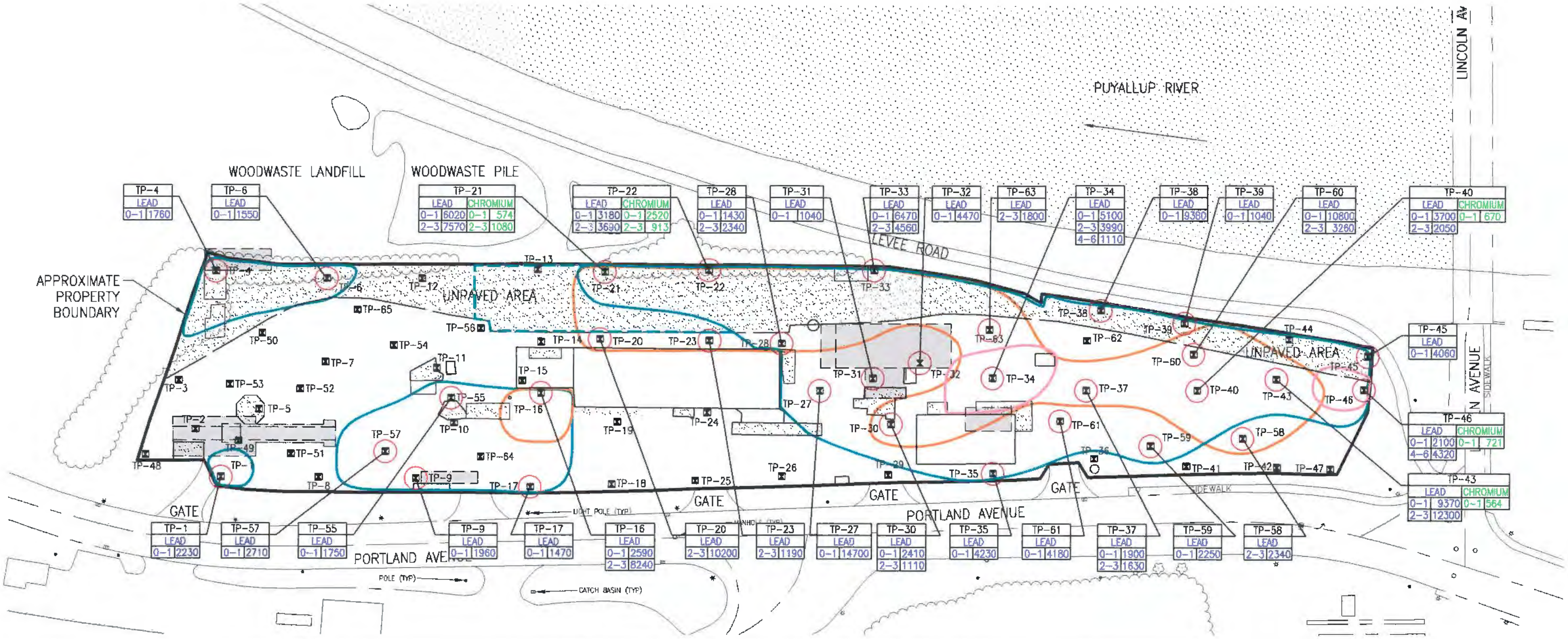
TACOMA, WA

SURFACE WATER FLOW AND SAMPLING MAP

996098.00/P01SK003-8

FIGURE 3-8



LEGEND:

⊠ TP-1 TEST PIT LOCATION

⊠ SOIL CONCENTRATIONS EXCEEDING MTCA METHOD A INDUSTRIAL SOIL CLEANUP LEVELS (LEAD 1000 mg/kg, CHROMIUM 500 mg/kg).

TP-43			
LEAD		CHROMIUM	
0-1	9370	6-10	564

TEST PIT DESIGNATION

ANALYTE — DEPTH(ft) — CONCENTRATION(mg/kg) (LEAD)

ANALYTE — DEPTH(ft) — CONCENTRATION(mg/kg) (CHROMIUM)

▨ UNPAVED AREA

▨ APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

APPROXIMATE LEAD CLEANUP LEVEL EXCEEDANCE AREAS. (MTCA METHOD A, 1000 mg/kg)

- 0-1 ft bgs
- 0-1 ft bgs (previous investigations)
- 2-3 ft bgs
- 4-6 ft bgs

NOTES:

1. MAP IS BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. FIGURE SHOWS LEAD CONCENTRATIONS GREATER THAN OR EQUAL TO 1000 mg/kg AND CHROMIUM CONCENTRATIONS GREATER THAN OR EQUAL TO 500 mg/kg.
3. SOIL SAMPLES WERE ANALYZED FOR RCRA METALS AND COPPER BY EPA METHODS 6010/7000 SERIES.
4. WHERE DUPLICATE SAMPLES WERE ANALYZED, THE HIGHER CONCENTRATION IS SHOWN.

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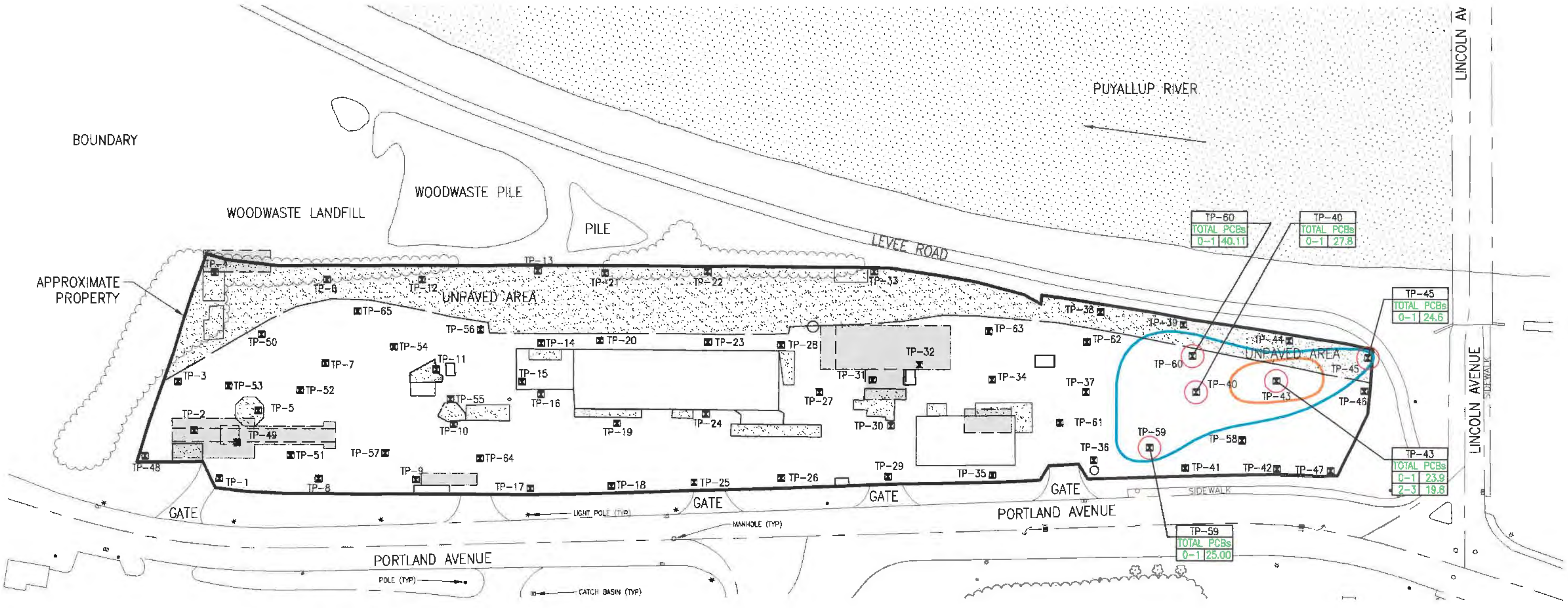
TACOMA, WA

METAL CONCENTRATIONS IN SOIL

996098.00/P01SK004-1

FIGURE 4-1



LEGEND:

☒ TP-1 TEST PIT LOCATION

☒ TOTAL PCB CONCENTRATIONS EXCEEDING THE MTCA METHOD C INDUSTRIAL SOIL CLEANUP LEVEL OF 17 mg/kg

TP-59		
TOTAL PCBs		
0-1	25.00	

TEST PIT DESIGNATION
ANALYTE
DEPTH(ft)
CONCENTRATION(mg/kg)

▨ UNPAVED AREA

▨ APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

0-1 ft bgs
2-3 ft bgs
APPROXIMATE TOTAL PCB CLEANUP LEVEL EXCEEDANCE AREAS. (MTCA METHOD C, 17 mg/kg)

NOTES:

1. MAP IS BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. FIGURE SHOWS PCB CONCENTRATIONS GREATER THAN OR EQUAL TO 17 mg/kg.
3. PCBs WERE ANALYZED BY EPA METHOD 8082.
4. WHERE DUPLICATE SAMPLES WERE ANALYZED, THE HIGHER CONCENTRATION IS SHOWN.

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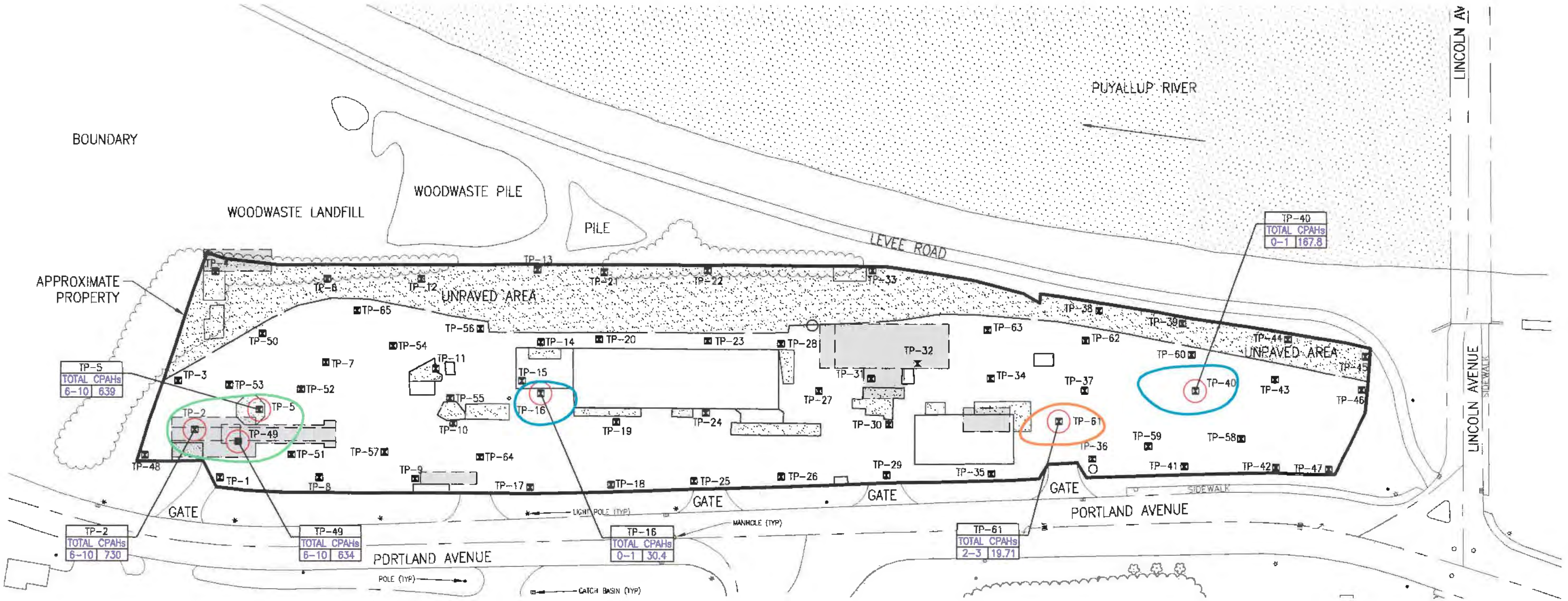
FORMER TACOMA METALS FACILITY
TACOMA, WA

TOTAL PCB CONCENTRATIONS IN SOIL

996098.00/P01SK004-2

FIGURE 4-2



LEGEND:

☒ TP-1 TEST PIT LOCATION

⊠ TOTAL CPAHs CONCENTRATIONS EXCEEDING MTCA METHOD C INDUSTRIAL SOIL CLEANUP LEVEL OF 18 mg/kg

TP-49	
TOTAL CPAHs	
6-10	634

TEST PIT DESIGNATION
ANALYTE
DEPTH(ft)
CONCENTRATION(mg/kg)

▨ UNPAVED AREA

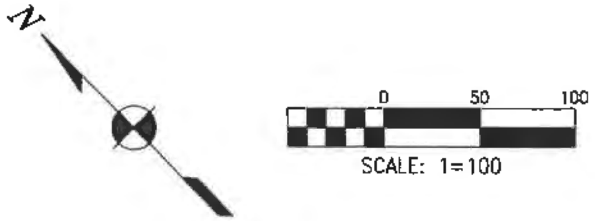
▒ APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

— 0-1 ft bgs
— 2-3 ft bgs
— 6-10 ft bgs

APPROXIMATE TOTAL CPAH CLEANUP LEVEL EXCEEDANCE AREAS. (MTCA METHOD C, 18 mg/kg)

NOTES:

1. MAP IS BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. FIGURE SHOWS TOTAL CPAH CONCENTRATIONS GREATER THAN OR EQUAL TO 18 mg/kg.
3. SAMPLES WERE ANALYZED FOR POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) BY EPA METHOD 8270B GC/MS-SIM. TOTAL CARCINOGENIC POLYCYCLIC AROMATIC HYDROCARBONS (CPAHs) WERE CALCULATED BY SUMMING THE CONCENTRATIONS OF ALL PROBABLE CPAHs. IF A PROBABLE CPAH WAS NOT DETECTED IN THE SAMPLE, A VALUE EQUAL TO 1/2 THE DETECTION LIMITS WAS USED.
4. WHERE DUPLICATE SAMPLES WERE ANALYZED, THE HIGHER CONCENTRATION IS SHOWN.



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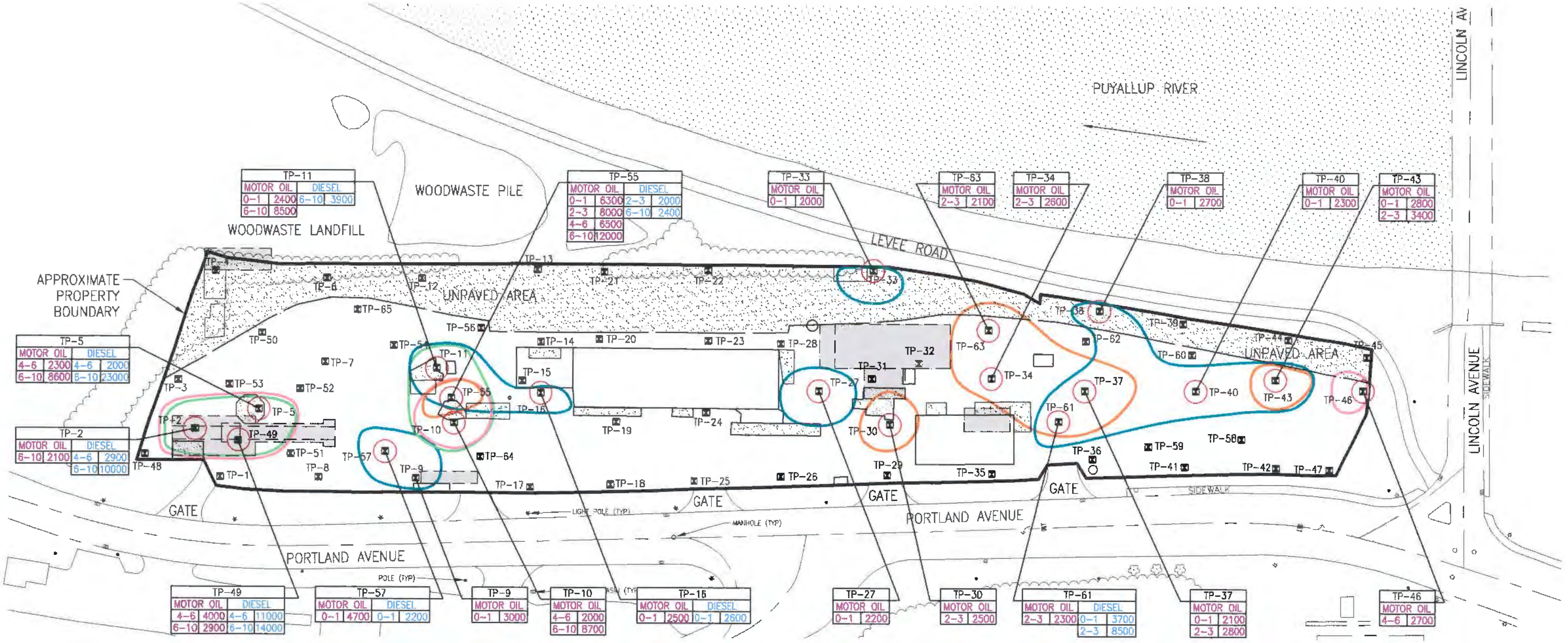
TACOMA, WA

TOTAL CPAH CONCENTRATIONS IN SOIL

996098.00/P01SK004-3

FIGURE 4-3



LEGEND:

☒ TP-1 TEST PIT LOCATION

☒ TPH CONCENTRATIONS EXCEEDING THE MTCA METHOD A INDUSTRIAL SOIL CLEANUP LEVEL OF 2000 mg/kg

TP-57			
MOTOR OIL		DIESEL	
0-1	4700	0-1	2200

TEST PIT DESIGNATION

ANALYTE

DEPTH(ft)

CONCENTRATION(mg/kg)

ANALYTE

DEPTH(ft)

CONCENTRATION(mg/kg)

▨ UNPAVED AREA

▨ APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

— 0-1 ft bgs

— 2-3 ft bgs

— 4-6 ft bgs

— 6-10 ft bgs

APPROXIMATE TPH CLEANUP LEVEL EXCEEDANCE AREAS. (MTCA METHOD A, 2000 mg/kg)

NOTES:

1. MAP IS BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. FIGURE SHOWS TPH CONCENTRATIONS GREATER THAN OR EQUAL 2000 mg/kg.
3. WHERE DUPLICATE SAMPLES WERE ANALYZED, THE HIGHER CONCENTRATION IS SHOWN.
4. MTCA METHOD A INDUSTRIAL SOIL CLEANUP LEVEL BASED ON MTCA ADOPTED AMENDMENTS (ECOLOGY 2001).
5. SAMPLES WERE ANALYZED FOR DIESEL- AND OIL-RANGE PETROLEUM HYDROCARBONS BY ECOLOGY METHOD NWTPH-DIESEL (EXTENDED).

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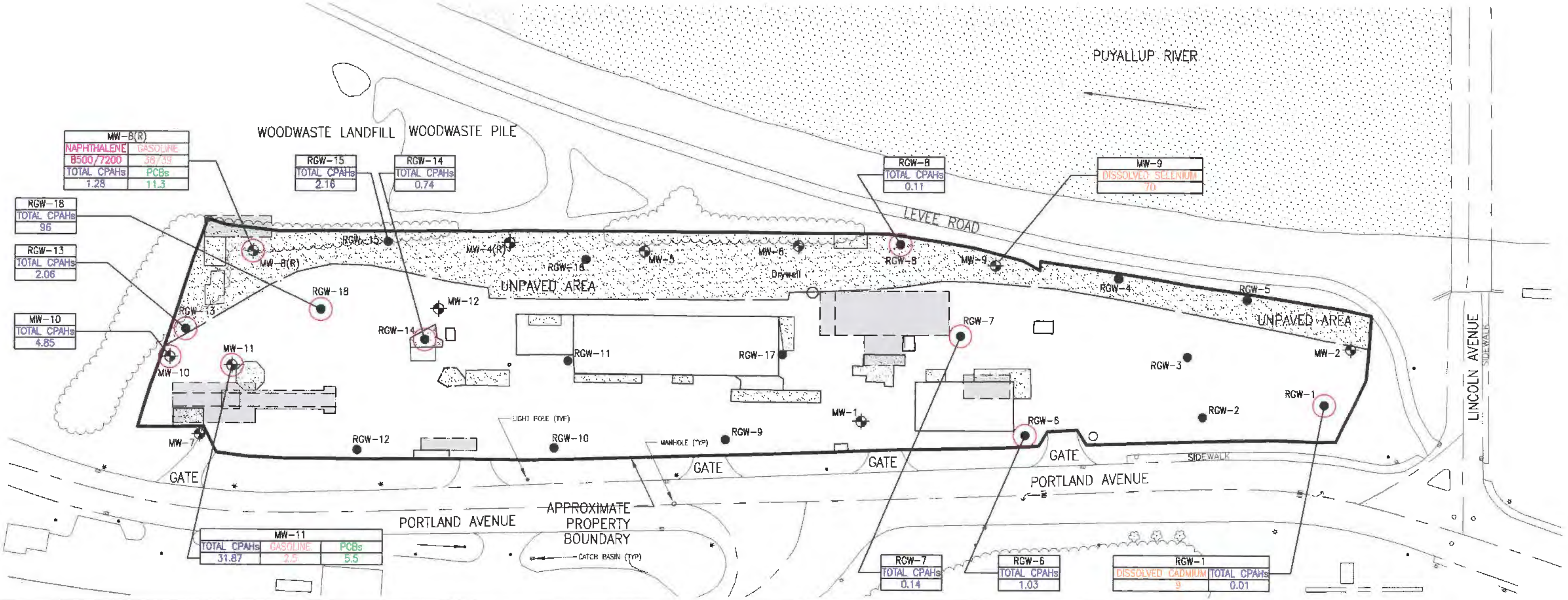
TACOMA, WA

PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL

996098.00/P01SK004-4

FIGURE 4-4



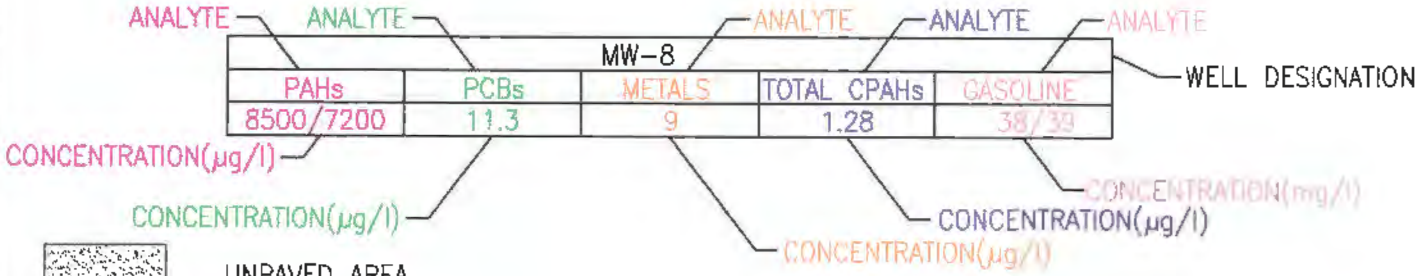
LEGEND:

⊕ MW-1 MONITORING WELL LOCATION

(R) = REPLACEMENT

● RECONNAISSANCE GROUNDWATER SAMPLING LOCATION

⊕ GROUNDWATER CONCENTRATIONS EXCEEDING CLEANUP LEVELS (MTCA METHOD B SURFACE WATER AND/OR OTHER ARAR)

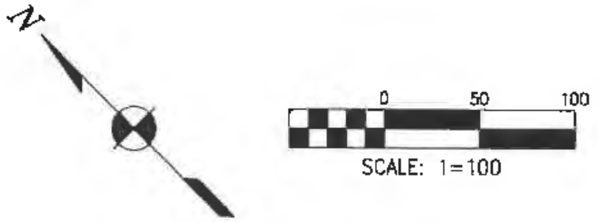


▨ UNPAVED AREA

▭ APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. MAP IS BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. WHERE TWO RESULTS ARE PRESENTED, THE SECOND VALUE IS A DUPLICATE SAMPLE. (FIGURE SHOWS ONLY CONCENTRATIONS EXCEEDING CLEANUP LEVELS.)
3. ANALYTE CONCENTRATIONS REPRESENT THE MAXIMUM DETECTED VALUE REPORTED DURING THE MONITORING EVENTS.



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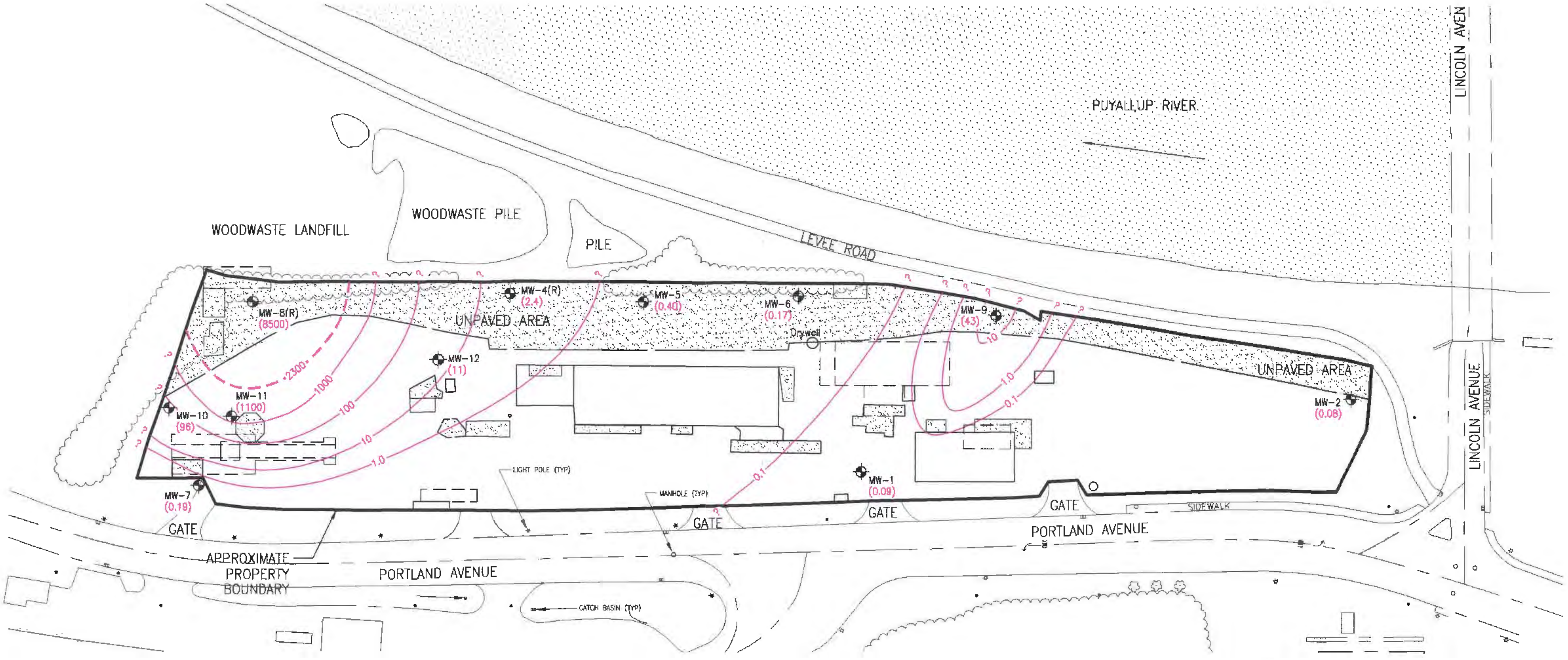
FORMER TACOMA METALS FACILITY
TACOMA, WA

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS (WELLS AND RECONNAISSANCE SAMPLES)

996098.00/P01SK005-1

FIGURE 5-1



N

0 50 100

SCALE: 1=100

LEGEND:

MW-10 (96) — MONITORING WELL LOCATION NAPHTHALENE CONCENTRATION (µg/l)
(R) = REPLACEMENT

—10— APPROXIMATE NAPHTHALENE CONCENTRATION CONTOUR (µg/l). ADJACENT CONTOURS DIFFER BY ONE ORDER OF MAGNITUDE.

▨ UNPAVED AREA

┌ ┐ APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

- -2300- - ECOLOGY'S ACUTE FRESHWATER SURFACE WATER QUALITY STANDARD

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. ANALYTE CONCENTRATIONS REPRESENT THE MAXIMUM DETECTED VALUE REPORTED DURING THE MONITORING EVENTS.

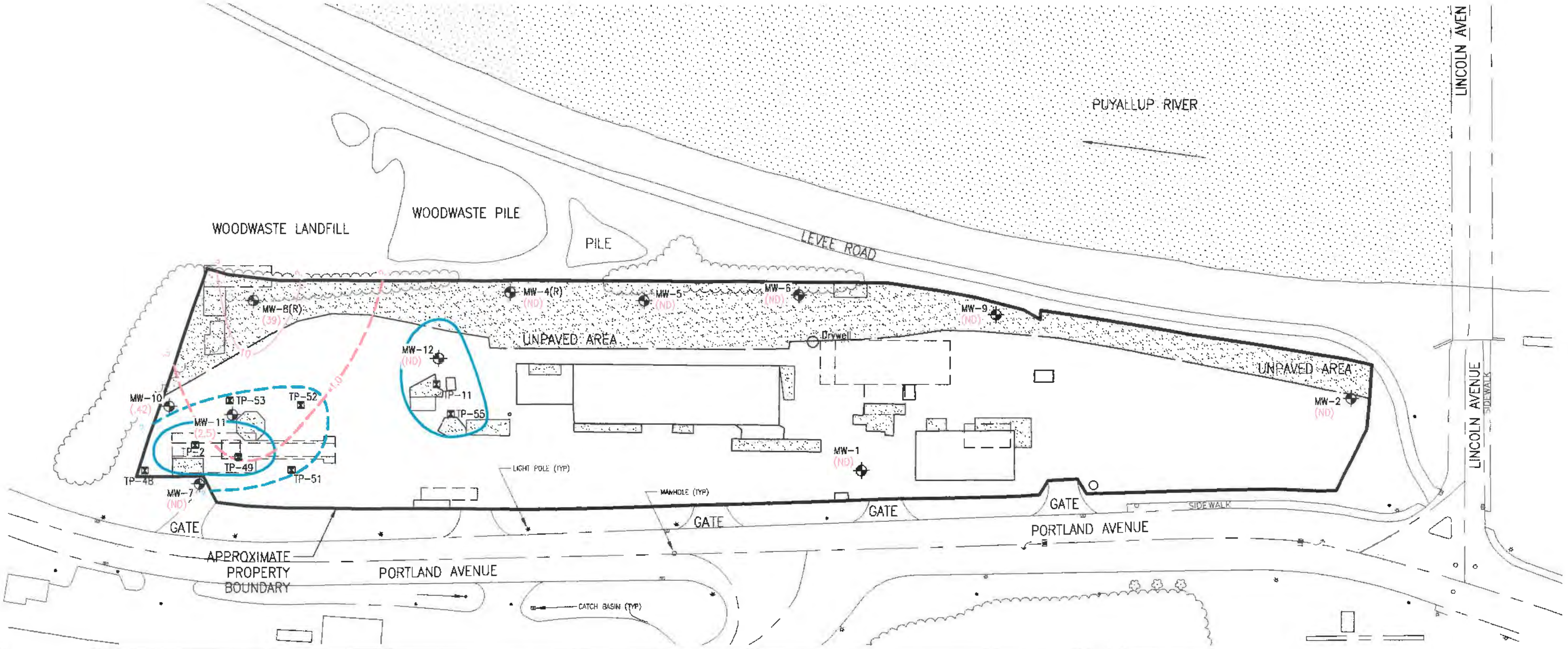
Kennedy/Jenks Consultants

FORMER TACOMA METALS FACILITY
TACOMA, WA

NAPHTHALENE GROUNDWATER CONCENTRATION CONTOUR MAP

996098.00/P01SK005-2

FIGURE 5-2



LEGEND:

⊕ MW-10 (.42)	MONITORING WELL LOCATION GASOLINE CONCENTRATION (mg/l) (R) = REPLACEMENT ND = ANALYTED NOT DETECTED
☒ TP-1	TEST PIT LOCATION
—10—	APPROXIMATE GASOLINE CONCENTRATION CONTOUR (mg/l). ADJACENT CONTOURS DIFFER BY ONE ORDER OF MAGNITUDE.
▨	UNPAVED AREA
☐	APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)
——	APPROXIMATE EXTENT OF LNAPL OBSERVED IN TEST PITS AND MONITORING WELLS.
— —	APPROXIMATE EXTENT OF SHEEN/FILM OBSERVED IN TEST PITS.
—1.0—	ECOLOGY'S NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT STANDARD (1 mg/l)

NOTES:

1. LOCATIONS SHOWN WITHIN PROPERTY BOUNDARIES ARE BASED ON SITE SURVEY BY EARTH TECH, INC. ON 28 MARCH 2000.
2. ANALYTE CONCENTRATIONS REPRESENT THE MAXIMUM DETECTED VALUE REPORTED DURING THE MONITORING EVENTS.
3. LNAPL = LIGHT NON-AQUEOUS PHASE LIQUID.

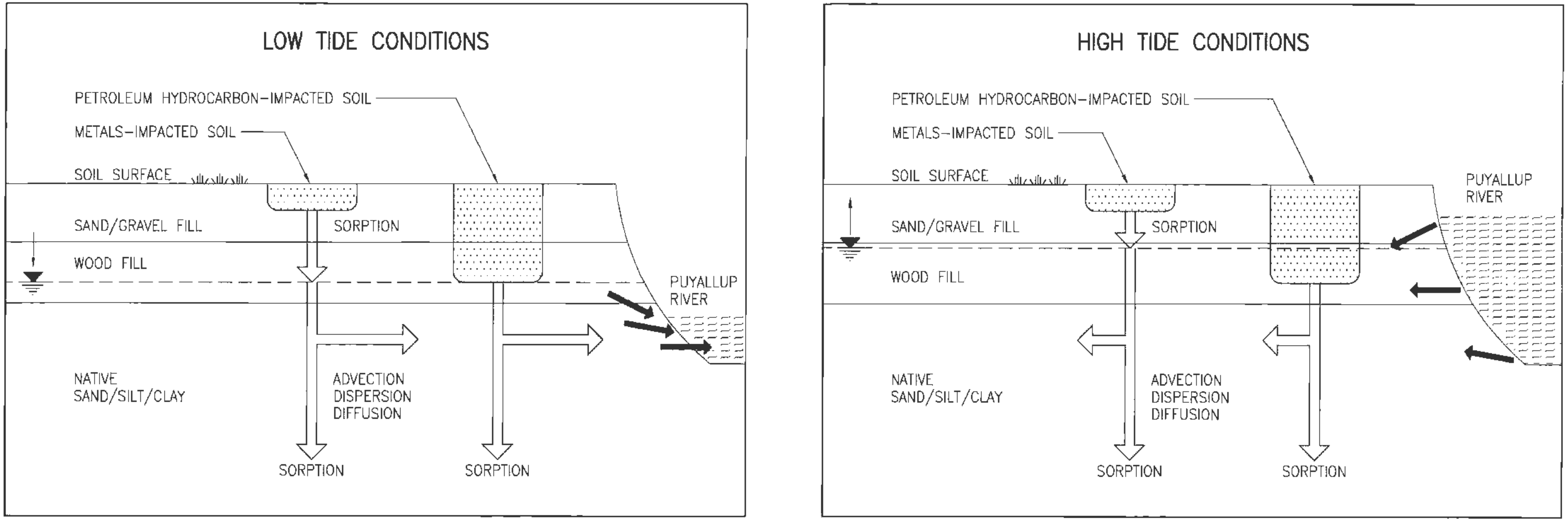
Kennedy/Jenks Consultants

FORMER TACOMA METALS FACILITY
TACOMA, WA

GASOLINE-RANGE PETROLEUM HYDROCARBONS GROUNDWATER CONCENTRATION CONTOUR MAP

996098.00/P01SK005-3

FIGURE 5-3



LEGEND:

↓ FALLING POTENTIOMETRIC SURFACE

↑ RISING POTENTIOMETRIC SURFACE

➞ GROUNDWATER FLOW PATH

NOTE:

1. THIS FIGURE REPRESENTS THE CONCEPTUAL CONDITIONS ASSUMED FOR CHEMICAL TRANSPORT MODELING. REFER TO FIGURES 3-1, 3-2, AND 3-3 FOR INTERPRETIVE CROSS SECTIONS OF SITE GEOLOGIC CONDITIONS.

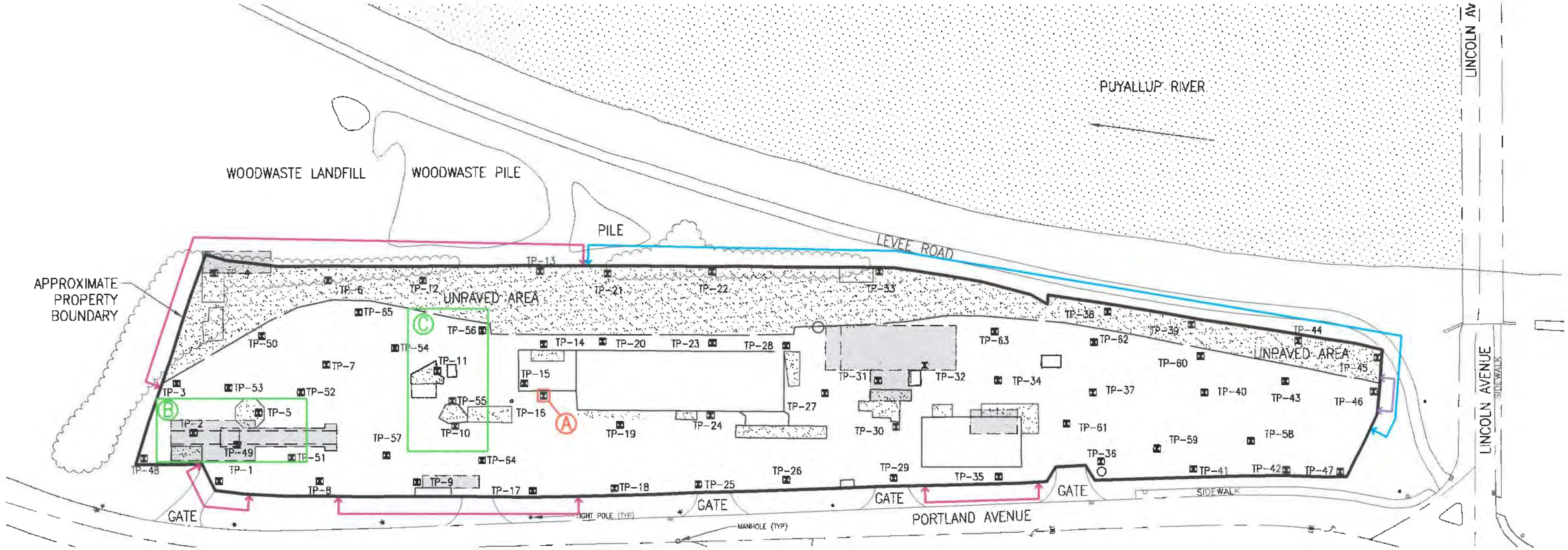
Kennedy/Jenks Consultants

FORMER TACOMA METALS FACILITY
TACOMA, WA

CONCEPTUAL MODEL OF CHEMICAL MIGRATION

996098.00/P01SK008-1

FIGURE 8-1



LEGEND:

☒ TP-1 TEST PIT LOCATION

▨ UNPAVED AREA

☐ APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. MAP IS BASED ON SITE SURVEY BY EARTH TECH INC., ON 28 MARCH 2000.
2. REFER TO FIGURE 4-4 FOR CONCENTRATIONS OF PETROLEUM HYDROCARBONS IN SOIL.
3. REFER TO FIGURE 4-1 FOR CONCENTRATIONS OF METALS IN SOIL.

ALTERNATIVES 1, 2, AND 3
LEAD-ACID BATTERY CASINGS AND ASSOCIATED IMPACT SOIL

🟥 Ⓐ 10ft LONG x 10ft WIDE x 3ft DEEP (AVERAGE)
(10 CUBIC YARDS)

TOTAL 10 CUBIC YARDS (APPROXIMATE).

ALTERNATIVES 1, 2, AND 3
PETROLEUM HYDROCARBON-IMPACTED SOIL EXCAVATION AREAS (INCLUDES AREAS OF ANTICIPATED FREE PRODUCT).

🟩 Ⓑ FORMER CREOSOTING PLANT
150ft LONG x 60ft WIDE x 10ft DEEP (AVERAGE)
(3,333 CUBIC YARDS)

🟩 Ⓒ WEST OF RED BRICK BUILDING
150ft LONG x 80ft WIDE x 10ft DEEP (AVERAGE)
(4,444 CUBIC YARDS)

TOTAL 7,800 CUBIC YARDS (APPROXIMATE).

ALTERNATIVES 2 AND 3 ONLY
PROPERTY BOUNDARY METALS-IMPACTED SOIL EXCAVATION AREAS (BUFFER ZONE)

930ft 5ft WIDE x 1ft DEEP (AVERAGE)
(172 CUBIC YARDS)

920ft 5ft WIDE x 3ft DEEP (AVERAGE)
(511 CUBIC YARDS)

30ft 5ft WIDE x AN ADDITIONAL 3ft DEEP (AVERAGE)
(17 CUBIC YARDS)

TOTAL 700 CUBIC YARDS (APPROXIMATE).

Kennedy/Jenks Consultants

FORMER TACOMA METALS FACILITY
TACOMA, WA

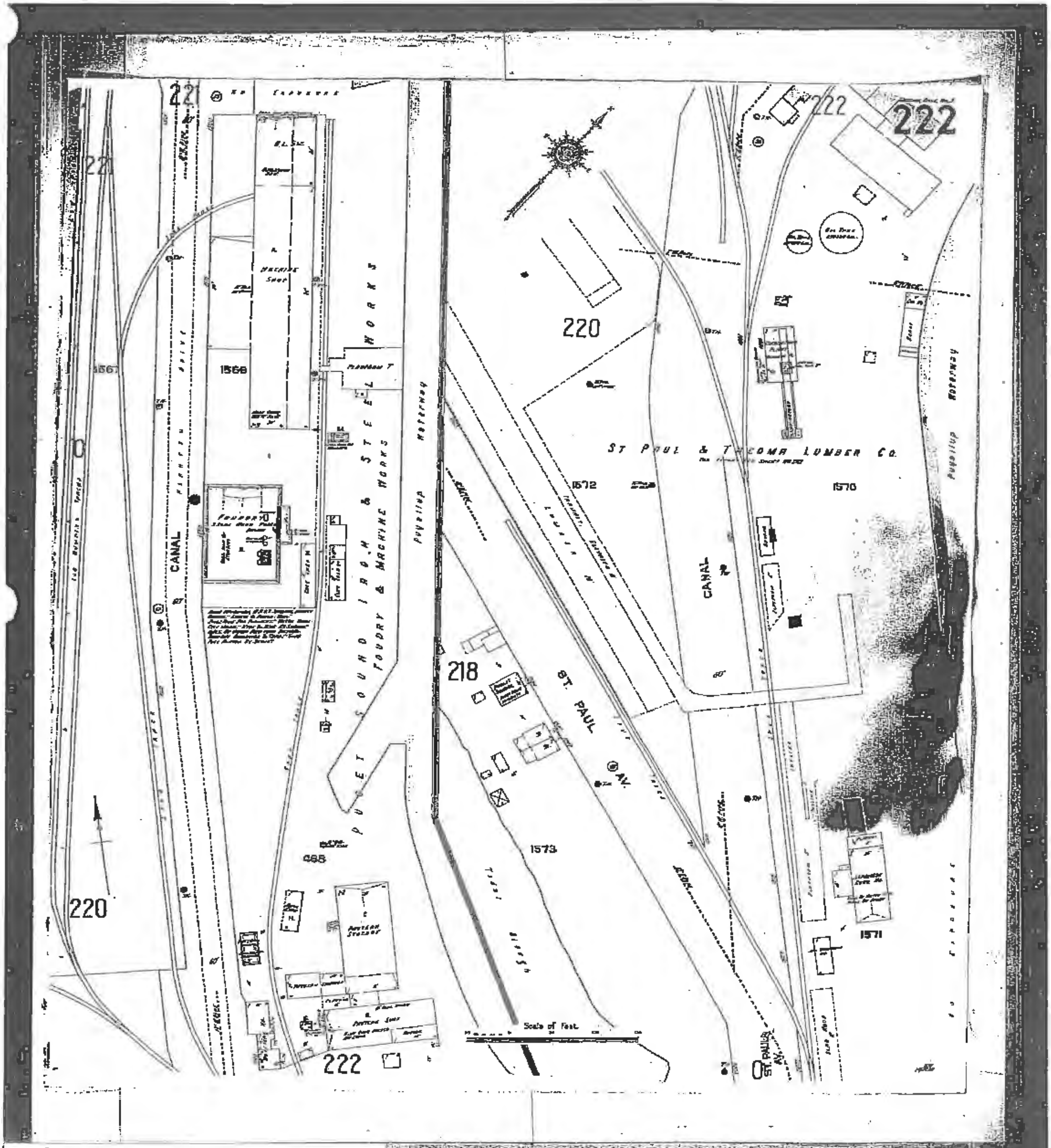
PROPOSED REMEDIAL ACTION EXCAVATION AREAS

996098.00/P01SK009-1

FIGURE 9-1

Appendix A

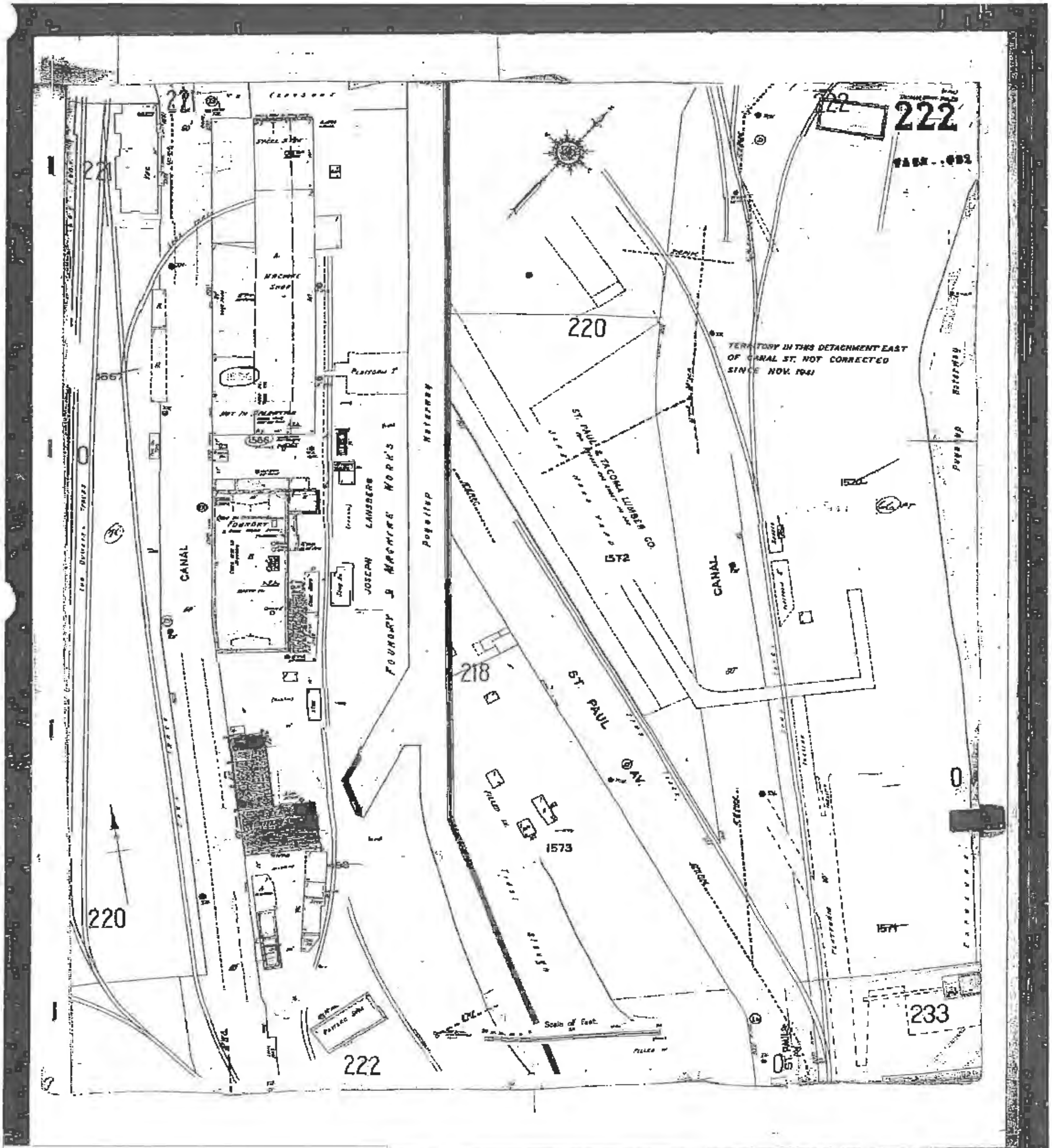
Sanborn Fire Insurance Maps (1912, 1950, and 1965)



The Sanborn Library, LLC

This Sanborn Map™ is a certified copy produced by Environmental Data Resources, Inc. under arrangement with The Sanborn Library, LLC. Information on this Sanborn Map™ is derived from Sanborn field surveys conducted in:

Copyright © 1912 The Sanborn Library, LLC JMB
Year EDR Research Associate



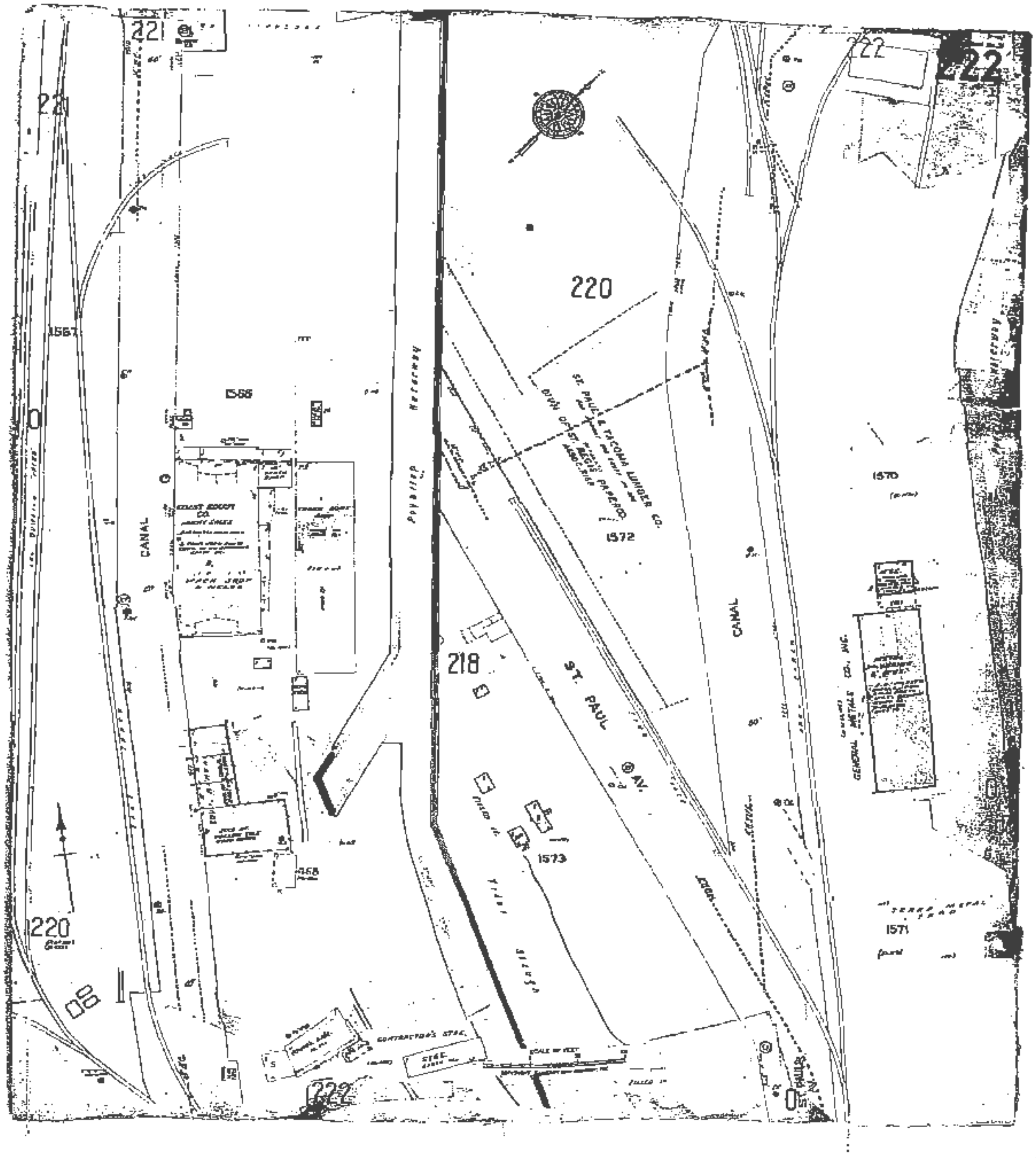
The Sanborn Library, LLC

This Sanborn Map™ is a certified copy produced by Environmental Data Resources, Inc. under arrangement with The Sanborn Library, LLC. Information on this Sanborn Map™ is derived from Sanborn field surveys conducted in:

Year

JMB

EDR Research Associate


221
221
220
220
218
222
222
1567
1566
CANAL
CANAL
Puyallup Waterway
Waterway
ST. PAUL & TACOMA LUMBER CO.
DIV. OF ST. REGIS PAPER CO.
1572
ST. PAUL AV.
1573
1570
1571
GENERAL METALS CO. INC.
TERRA METAL
CONTRACTOR'S STGE.
STGE.
SCALE OF FEET
1568
ST. PAUL AV.

Appendix B

2000 Hazardous Waste Report

ASHINGTON STATE
EPARTMENT OF
ECOLOGY

Dangerous Waste Annual Report Verification Form 2000

Washington State Department of Ecology
Hazardous Waste Information
P. O. Box 47658
Olympia, WA 98504-7658
(800) 874-2022 (within state)
(360) 407-6170

For Ecology Use Only - Date Received :

Form	Review	HWIMSy Entry	Verification	
VF				
GM				
WR				
OI				

Site Location Information

RCRA Site ID: WAD 102 875 556
Company Name: TACOMA METALS SITE FORMER
Site Location: 1919 PORTLAND AVE
City/State/Zip: TACOMA, WA 98421-2804 County: PIERCE
Dept. of Revenue Tax Registration Number: 600-484-238 Primary SIC : 3449
Current company name if different from above ____________

This Report is Due No Later Than March 1, 2001

All information listed below is required. If information is missing or incorrect, please enter the changes in the right hand column.

1a The mailing address for this site is

Name: Kennedy Jenks Consultants
Mail Address: 530 S 336th St
FEDERAL WAY, WA 98003

1b

Name: ____________
Mail Address: ____________

2a The legal company/agency owner of this site is

Name: Portland Ave Associates
Mail Address: Wells Fargo Plaza Ste 1200
TACOMA, WA 98402
rk Phone: (253)572-4500 Ext:

2b

Name: ____________
Mail Address: ____________
Phone: ____________ Ext: ______

Did the company ownership of this site change in 2000?

☐ Yes Date: ________ (continue to the right):

☒ No (go to 3a):

I represent the

☐ Current Company Owner
☐ Previous Company Owner

This report covers waste activity for:

☐ Entire year
☐ My term of ownership only

3a The land owner of this site is

Name: Portland Ave Associates
Mail Address: Wells Fargo Plaza Ste 1200
TACOMA, WA 98402
Phone: (253)572-4500 Ext:

3b

Name: ____________
Mail Address: ____________
Work Phone: ____________ Ext: ______

4a The contact for site visits and inspections is

Name/Title: Ty Schreiner
Mail Address: 530 S 336th St
FEDERAL WAY, WA 98003
Work Phone: (253)874-0555 Ext: 232

4b

Name/Title: ____________
Mail Address: ____________
Work Phone: ____________ Ext: ______

5a The contact for annual report forms is

Name/Title: Ty Schreiner
Address: 530 S 336th St
FEDERAL WAY, WA 98003
Work Phone: (253)874-0555 Ext: 232

5b

Name/Title: ____________
Mail Address: ____________
Work Phone: ____________ Ext: ______

1257

Page 1 of 17

6. Generator Status and Waste Management Activities

Indicate the facility's generator status for 2000 by checking the appropriate boxes below. If your status has changed from last year, please use the Comments section (#8, below) to explain.

6a. Generator Status

☒ Large Quantity Generator (LQG)
☐ Medium Quantity Generator (MQG)
☐ Small Quantity Generator (SQG)
☐ No regulated dangerous waste generated

6b. Transportation Activity (requires prior notification)

☐ Transporter for your own waste
☐ Transporter for commercial purposes
☐ Transfer facility

6c. Treatment, Storage, Disposal, Recycling (TSDR) Facility (Requires Permit)

☐ For waste generated at this facility
☐ For waste generated by other facilities

6d. Excluded On-Site Waste Management Activities (for waste streams that are not reported on a GM form)

☐ Permit-by-Rule - (PBR)
☐ Recycling without prior storage or accumulation

7. Report Summary

Please check off which forms are included in this report and provide the total number of pages. For electronic data submittal, please indicate method of your submission.

7a. Paper Form Submittal

☒ Verification (VF) Form
☒ Generation and Management (GM) Form
☒ Off-site Identification Information (OI) Form
☐ Waste Received (WR) Form
☐ Recycling Credit documentation attached
17 Total Number of pages submitted

7b. Electronic Data Submittal

☐ Verification (VF) Form (paper only)
☐ Disk(s) included
☐ Data submitted on Internet
☐ Recycling Credit documentation attached (paper only)

8. Comments

____
____
____
____

9. Certification

The following must be signed by authorized representative of the company/agency. This certification language is required under EPA's Biennial Report. Ecology is required to implement reporting requirements at least as stringent as those in that report.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that thera are significant penalties for submitting false information, including the possiblity of fine and mprisonment for knowing violations.

ignature (in ink) ______________________________
ame (print/type) ______________________________
ate ______________________________
itle ______________________________

you have special accommodation needs or require this document in an alternative format, please contact the azardous Waste and Toxics Reduction Program at (360) 407-6700 (voice) or (360) 407-6006 (TDD).

Do Not FAX this document unless requested by the Department of Ecology.

GENERATION AND MANAGEMENT FORM ANSWER SHEET

Please enter your RCRA Site ID number and your site name in the small box at the right, before making as many two-sided copies of this answer sheet as you will need to report each of your waste streams. Then complete one answer sheet for each waste stream.

PLEASE ENTER:
YOUR SITE ID #: WAD 102 875 556
Site name: Tacoma Metals Site Former

FOR ECOLOGY USE ONLY:
Date received:

Reference the instructions on pages 19 through 28 as you complete this form. Please type or print legibly in blue or black ink.

A. Description of Dangerous Waste Stream

A-1. ______ (optional)

A-2. Waste water from storm drain cleaning

A-3. D008 D009 | A-4.

A-5. ☐ EHW ☒ DW | A-6. ☒ No ☐ Yes | A-7. A 69

A-8. B 119 | A-9. ☐ i ☒ ii ☐ iii ☐ iv ☐ v (If v, answer A-9.a.)

A-9.a. M

B. Waste Management Activities

B-1. 3,600 ☐ ST ☐ MT ☐ P ☐ K ☒ G ☐ L ☐ C (If G, L, or C, answer B-1.a.)

B-1.a. 8.34 ☒ Lbs/gal ☐ Specific Gravity ☐ Lbs/yd³

B-2. ☐ On-site ☒ Off-site ☐ Both

B-3. ______ M ______ | B-3a. ☐ Yes ☐ No

B-4.

i. Designated Facility (TSDR) ID Numbers	*ii.* System Code	*iii.* Quantity	*iv.* Recycling Percent
	M		
ORD089452353	M 111	3,600 G	
	M		
	M		

Page 3 of 17

PLEASE ENTER :
YOUR SITE ID #: WAD 102 875 556
Site name: Tacoma Metals Site Former

B-5. To be completed by LQG & TSDR only.

i. Date Shipped (mm/dd)	*ii* . Manifest Document Number	*iii.* Internal Tracking Code (optional)	*iv.* Desigation Facility (TSDR) RCRA Site ID Number	v. Quantity Shipped
5/5	(TUK)00266		ORD089452353	3,600 G

If additional space is required, use continuation sheet on the following page.

C. Comments
Form Code B119 – Lead and Mercury contaminated waste water From storm drain cleaning

Page 4 of 17

GENERATION AND MANAGEMENT FORM ANSWER SHEET

Please enter your RCRA Site ID number and your site name in the small box at the right, before making as many two-sided copies of this answer sheet as you will need to report each of your waste streams. Then complete one answer sheet for each waste stream.

PLEASE ENTER:
YOUR SITE ID #: WAD 102 875 556
Site name: Tacoma Metals Site Former

FOR ECOLOGY USE ONLY:
Date received:

Reference the instructions on pages 19 through 28 as you complete this form. Please type or print legibly in blue or black ink.

A. Description of Dangerous Waste Stream

A-1. (optional)

A-2. Creosote-impacted solid waste (metal and wood) from vault

A-3. D018

A-4.

A-5. ☐ EHW ☒ DW

A-6. ☒ No ☐ Yes

A-7. A 69

A-8. B 319

A-9. ☐ i ☒ ii ☐ iii ☐ iv ☐ v (If v, answer A-9.a.)

A-9.a. M

B. Waste Management Activities

B-1. 20 ☐ ST ☐ MT ☐ P ☐ K ☐ G ☐ L ☒ C (If G, L, or C, answer B-1.a.)

B-1.a. 2,700 ☐ Lbs/gal ☐ Specific Gravity ☒ Lbs/yd³

B-2. ☐ On-site ☒ Off-site ☐ Both

B-3. M

B-3a. ☐ Yes ☐ No

B-4.

i. Designated Facility (TSDR) ID Numbers	*ii.* System Code	*iii.* Quantity	*iv.* Recycling Percent
	M		
ORD089452353	M 137	20 C	
	M		
	M		

Page 5 of 17

PLEASE ENTER :
YOUR SITE ID #: WAD 102 875 556
Site name: Tacoma Metals Site Former

B-5. To be completed by LQG & TSDR only.

i. Date Shipped (mm/dd)	*ii* . Manifest Document Number	*iii.* Internal Tracking Code (optional)	*iv.* Desigation Facility (TSDR) RCRA Site ID Number	*v.* Quantity Shipped
7/14	(TOK)00364		ORD089452353	20C

If additional space is required, use continuation sheet on the following page.

C. Comments

Form Code B319- Creosote-impacted pipe, wood, and metal waste

Page 6 of 17

GENERATION AND MANAGEMENT FORM ANSWER SHEET

Please enter your RCRA Site ID number and your site name in the small box at the right, before making as many two-sided copies of this answer sheet as you will need to report each of your waste streams. Then complete one answer sheet for each waste stream.

PLEASE ENTER:
YOUR SITE ID #: WAD 102 875 556
Site name: Tacoma Metals Site Former

FOR ECOLOGY USE ONLY:
Date received: ____

Reference the instructions on pages 19 through 28 as you complete this form. Please type or print legibly in blue or black ink.

A. Description of Dangerous Waste Stream

A-1. ____ (optional)

A-2. Creosote-impacted waste solids

A-3. D018

A-4. ____ ____

A-5. ☐ EHW ☒ DW

A-6. ☒ No ☐ Yes

A-7. A 69

A-8. B 319

A-9. ☐ i ☒ *ii* ☐ *iii* ☐ *iv* ☐ *v* (If *v*, answer A-9.a.)

A-9.a. M ____

B. Waste Management Activities

B-1. 1,500 ☐ ST ☐ MT ☒ P ☐ K ☐ G ☐ L ☐ C (If G, L, or C, answer B-1.a.)

B-1.a. ____ ☐ Lbs/gal ☐ Specific Gravity ☐ Lbs/yd³

B-2. ☐ On-site ☒ Off-site ☐ Both

B-3. ____ M ____

B-3a. ☐ Yes ☐ No

B-4.

i. Designated Facility (TSDR) ID Numbers	*ii*. System Code	*iii.* Quantity	*iv.* Recycling Percent
	M		
ORD089452353	M 137	1,500 P	
	M		
	M		

Page 7 of 17

PLEASE ENTER :
YOUR SITE ID #: WAD 102 875 556
Site name: Tacoma Metals Site Former

B-5. To be completed by LQG & TSDR only.

i. Date Shipped (mm/dd)	*ii* . Manifest Document Number	*iii.* Internal Tracking Code (optional)	*iv.* Desigation Facility (TSDR) RCRA Site ID Number	v. Quantity Shipped
7/31	(TUK)00366		ORD089452353	1,500 P

If additional space is required, use continuation sheet on the following page.

C. Comments

Form Code B319- creosote-impacted wood and metal waste

Page 8 of 17

GENERATION AND MANAGEMENT FORM ANSWER SHEET

Please enter your RCRA Site ID number and your site name in the small box at the right, before making as many two-sided copies of this answer sheet as you will need to report each of your waste streams. Then complete one answer sheet for each waste stream.

PLEASE ENTER:

YOUR SITE ID #: WAD 102 875 556

Site name: Tacoma Metals Site Former

FOR ECOLOGY USE ONLY:

Date received: ____________

Reference the instructions on pages 19 through 28 as you complete this form. Please type or print legibly in blue or black ink.

A. Description of Dangerous Waste Stream

A-1. ____________ (optional)

A-2. creosote-impacted vault water

A-3. D018

A-4. ______ ______

A-5. ☐ EHW ☒ DW

A-6. ☒ No ☐ Yes

A-7. A 69

A-8. B 219

A-9. ☐ i ☒ ii ☐ iii ☐ iv ☐ v (If v, answer A-9.a.)

A-9.a. M ________

B. Waste Management Activities

B-1. 1,595 ☐ ST ☐ MT ☐ P ☐ K ☒ G ☐ L ☐ C (If G, L, or C, answer B-1.a.)

B-1.a. 8.34 ☒ Lbs/gal ☐ Specific Gravity ☐ Lbs/yd³

B-2. ☐ On-site ☒ Off-site ☐ Both

B-3. ____________ M ______

B-3a. ☐ Yes ☐ No

B-4.

i. Designated Facility (TSDR) ID Numbers	*ii*. System Code	*iii.* Quantity	*iv.* Recycling Percent
	M		
COD980591184	M 141	1,595 G	
	M		
	M		

Page 9 of 17

PLEASE ENTER :
YOUR SITE ID #: WAD 102 875 556
Site name: Tacoma Metals Site Former

B-5. To be completed by LQG & TSDR only.

i. Date Shipped (mm/dd)	*ii* . Manifest Document Number	*iii.* Internal Tracking Code (optional)	*iv.* Desigation Facility (TSDR) RCRA Site ID Number	v. Quantity Shipped
7/24	TUK00363		COD980591184	1,595 G

If additional space is required, use continuation sheet on the following page.

C. Comments

Form Code B219 - creosote contaminated water From concrete vault

Page 10 of 17

GENERATION AND MANAGEMENT FORM ANSWER SHEET

Please enter your RCRA Site ID number and your site name in the small box at the right, before making as many two-sided copies of this answer sheet as you will need to report each of your waste streams. Then complete one answer sheet for each waste stream.

PLEASE ENTER:
YOUR SITE ID #: WAD 102 875 556
Site name: Tacoma Metals Site Former

FOR ECOLOGY USE ONLY:
Date received: ______

Reference the instructions on pages 19 through 28 as you complete this form. Please type or print legibly in blue or black ink.

A. Description of Dangerous Waste Stream

A-1. ______ (optional)

A-2. Lead-impacted waste solids

A-3. D008

A-4. ______ ______

A-5. ☐ EHW ☒ DW

A-6. ☒ No ☐ Yes

A-7. A 69

A-8. B 319

A-9. ☐ *i* ☒ *ii* ☐ *iii* ☐ *iv* ☐ *v* (If *v*, answer A-9.a.)

A-9.a. M ______

B. Waste Management Activities

B-1. 6,540 ☐ ST ☐ MT ☒ P ☐ K ☐ G ☐ L ☐ C (If G, L, or C, answer B-1.a.)

B-1.a. ______ ☐ Lbs/gal ☐ Specific Gravity ☐ Lbs/yd³

B-2. ☐ On-site ☒ Off-site ☐ Both

B-3. ______ M ______

B-3a. ☐ Yes ☐ No

B-4.

i. Designated Facility (TSDR) ID Numbers	*ii.* System Code	*iii.* Quantity	*iv.* Recycling Percent
	M		
ORD089452353	M 137	6,540 P	
	M		
	M		

Page 11 of 17

PLEASE ENTER:
YOUR SITE ID #: WAD 102 875 556
Site name: Tacoma Metals Site Former

B-5. To be completed by LQG & TSDR only.

i. Date Shipped (mm/dd)	*ii.* Manifest Document Number	*iii.* Internal Tracking Code (optional)	*iv.* Desigation Facility (TSDR) RCRA Site ID Number	*v.* Quantity Shipped
5/10	00001		ORD089452353	6,540 P

If additional space is required, use continuation sheet on the following page.

C. Comments

State Manifest Document Number was not listed on the shipping manifest. Shipped by WAR000001263.

Form Code 319 – Lead-impacted waste solids

Page 12 of 17

GENERATION AND MANAGEMENT FORM ANSWER SHEET

Please enter your RCRA Site ID number and your site name in the small box at the right, before making as many two-sided copies of this answer sheet as you will need to report each of your waste streams. Then complete one answer sheet for each waste stream.

PLEASE ENTER:
YOUR SITE ID #: WAD 102 875 556
Site name: Tacoma Metals Site Former

FOR ECOLOGY USE ONLY:
Date received: ______

Reference the instructions on pages 19 through 28 as you complete this form. Please type or print legibly in blue or black ink.

A. Description of Dangerous Waste Stream

A-1. ______ (optional)

A-2. Hydrocarbon sludge and DNAPL from concrete vault

A-3. D018

A-4. ______

A-5. ☐ EHW ☒ DW

A-6. ☒ No ☐ Yes

A-7. A 69

A-8. B 603

A-9. ☐ *i* ☒ *ii* ☐ *iii* ☐ *iv* ☐ *v* (If *v*, answer A-9.a.)

A-9.a. M ______

B. Waste Management Activities

B-1. 2,100 ☐ ST ☐ MT ☐ P ☐ K ☒ G ☐ L ☐ C (If G, L, or C, answer B-1.a.)

B-1.a. 8.34 ☒ Lbs/gal ☐ Specific Gravity ☐ Lbs/yd³

B-2. ☐ On-site ☒ Off-site ☐ Both

B-3. ______ M ______

B-3a. ☐ Yes ☐ No

B-4.

i. Designated Facility (TSDR) ID Numbers	*ii.* System Code	*iii.* Quantity	*iv.* Recycling Percent
	M		
ILD098642424	M 042	2,100 G	
	M		
	M		

Page 13 of 17

PLEASE ENTER :

YOUR SITE ID #: WAD 102 875 556

Site name: Tacoma Metals Site Former

B-5. To be completed by LQG & TSDR only.

i. Date Shipped (mm/dd)	*ii* . Manifest Document Number	*iii.* Internal Tracking Code (optional)	*iv.* Desigation Facility (TSDR) RCRA Site ID Number	v. Quantity Shipped
7/7	IL7781768(00010)		ILD098642424	2,100 G

If additional space is required, use continuation sheet on the following page.

C. Comments

2000 GM

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OFF-SITE IDENTIFICATION INFORMATION FORM

ANSWER SHEET

Please enter your RCRA Site ID number and your site name in the small box at the right, before making as many copies of this two-sided answer sheet as you will need.

PLEASE ENTER:

Your Site ID #: WAD 102 875 556

Site name: Tacoma Metals Site Former

FOR ECOLOGY USE ONLY:

Date received:

Please complete this form if your facility received dangerous waste from off-site or shipped dangerous waste off-site during 2000.

Please type or print legibly in blue or black ink.

RCRA Site ID Number: WAR000001263

Name: Steve Forler Trucking, Inc

Address: PO Box 1479
Orting, WA 98360

Handler type: (Check all that apply.) ☐ Generator ☒ Transporter ☐ TSDR

RCRA Site ID Number: ORD089452353

Name: Chemical Waste Management of the Northwest

Address: 17629 Cedar Springs Lane
Arlington, OR 97812

Handler type: (Check all that apply.) ☐ Generator ☐ Transporter ☒ TSDR

RCRA Site ID Number: NJD080631369

Name: Onyx Environmental Services, LLC

Address: 1 Eden Lane
Flanders, NJ 07836

Handler type: (Check all that apply.) ☐ Generator ☒ Transporter ☐ TSDR

Comments:

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PLEASE ENTER:

YOUR Site ID #: WAD 102 875 556

Site name: Tacoma Metals Site Former

RCRA Site ID Number: CA0000367755

Name: Diablo Transportation, Inc.

Address: 5401 Byron Hot Springs Rd.
Byron, CA 94514

Handler type: (Check all that apply.) ☐ Generator ☒ Transporter ☐ TSDR

RCRA Site ID Number: CAR000000505

Name: Onyx Indostrial Services

Address: 451 West Channel Rd
Benicia, CA 94510

Handler type: (Check all that apply.) ☐ Generator ☒ Transporter ☐ TSDR

RCRA Site ID Number: COD980591184

Name: Onyx Environmental Services

Address: 9131 East 96TH Ave
Henderson, CO 80640

Handler type: (Check all that apply.) ☐ Generator ☐ Transporter ☒ TSDR

RCRA Site ID Number: OKD981588791

Name: Triad Transport, Inc.

Address: PO Box 818
McAlester, OK 74502

Handler type: (Check all that apply.) ☐ Generator ☒ Transporter ☐ TSDR

RCRA Site ID Number: ILD098642424

Name: Trade Waste Incineration

Address: 7 Mobile Avenue
Sauget, IL 62201

Handler type: (Check all that apply.) ☐ Generator ☐ Transporter ☒ TSDR

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END OF REPORT
(Attach this page as the last page of your submission)

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Appendix C

Summary of Test Pit Observations

APPENDIX B

SUMMARY OF TEST PIT OBSERVATIONS
Former Tacoma Metals Facility

Test Pit Number	Test Pit Location	Depth (feet)	Unit Depths (feet)	Noticeable Odors[a]	Water Sheen[b]	OVM (ppm)	Soil Sample Number[c]	Description	USCS Symbol	Comments
TP-1	Grid Location	10	0.0-0.5	NONE	NS	—[e]	TP-1-0-1[f]	Crushed surface top coarse (CSTC) = gravel fill, dense (compacted)	GP	
			0.5-2.0	NONE	NS			Fill=Sandy Gravel, well-graded gravel (50-60%), mixed fine-medium sand; dense, brown, dry	GW	contains some organic fragments, mixed
			2.0-5.0	decaying wood	NS	—	TP-1-2-3	Fill=Gravelly Sand, Fine-medium sand, well-graded gravel (15-25%); dense, brown/dark gray, dry	SW	contains some brick fragments, mixed.
			5.0-7.5	decaying wood	NS	—	TP-1-4-6	Fill=wood debris, Sandy silt matrix; fine-medium gravel (10-15%), brown, moist to wet	(ML)	contains wood debris below 5.0', mixed
			7.5-10.0+	NONE	NS	—	TP-1-6-10	Silty Clay w/Very Fine Sand, very soft, moderately plastic, gray, wet to saturated, laminar, water @9.0'	CL	contains some decaying tree fragments (limbs), organics (estuary grass?)
TP-2	Grid Location	10	0.0-0.4	NONE	NS			CSTC	GP	0.2' asphalt cover
			0.4-0.8	NONE	NS	—	TP-2-0-1	Fill=Gravelly Sand, fine-medium sand, well-graded gravel (15-25%), dense, brown, dry	SW	
			0.8-2.2	VSL creosote/PH	MS	—	TP-2-2-3	Fill=Gravelly Sand, fine-medium sand, well-graded gravel (20-30%), dense, rusty brown/gray, dry	SW	wood planks @ 2.2' (former platform)- extends 18' S & 14' NW
			2.2-6.0	VSL creosote/PH	MS	—	TP-2-4-6	Fill=Gravelly Sand, fine-medium sand, well-graded gravel (20-30%), dense, dark brown, dry to moist	SW-GW	fissile wood layer (charcoalized?) from 5-6' (saturated w/creosote/PH product)
			6.0-8.0	SL creosote/PH	SS	—	TP-2-6-10	Fill=wood debris (logs, timber, chips), sandy matrix, fine-medium sand, medium dense	(SP)	predominantly wood debris
			8.0-10.0+	VSL creosote/PH	HS			Sandy Silt/Silty Clay, very fine sand, gray, stiff, wet, laminar, water@8.0'	ML-CL	product in sampling spoon; 1-2" product floating on water surface
TP-3	Grid Location	10	0.0-3.0	NONE	NS	—	TP-3-0-1	Fill=Sandy Gravel/Gravelly Sand, well-graded sand, well-graded gravel (35-60%), dense, brown, dry	GW-SW	0.2' asphalt cover; gravel content increases w/depth
				NONE	NS	—	TP-3-2-3			
			3.0-4.5	NONE	NS	—	TP-3-4-6	Fill=Silty Fine Sand, trace small gravel (<3%), medium dense, brown, dry, non-plastic silt (30%)	SM	contains some organics
			4.5-6.0	VSL PH	NS			Fill=Silty Sand, highly organic, fine sand, silt (30-35%), dark brown, medium dense	SM	
			6.0-10.0+	SL-MOD PH	SS-HS	—	TP-3-6-10	Fill=wood debris, sandy clayey silt matrix, water@8.0'	(ML-CL)	predominantly wood debris, logs, timber, chips
TP-4	Grid Location	10	0.0-3.0	NONE	NS	—	TP-4-0-1	Fill=Gravelly Sand, fine to medium sand (predominantly medium sand), well-graded gravel (20-25%), loose, brown, dry, <5% fines	SW	contains some small metal/glass/concrete debris
			3.0-5.0	NONE	NS	—	TP-4-2-3	Fill=medium Sand, poorly-graded sand, contains some fine sand, medium dense to loose, brown, dry, mixed	SP	contains some small metal/glass debris
			5.0-6.0	NONE	NS	—	TP-4-4-6	Fill=Gravelly Sand, fine to medium sand, well-graded gravel (30-35%), medium dense, brown, dry, mixed	SW	contains some small metal/glass/wood debris
			6.0-7.0	NONE	NS			Fill=Fine Sand, contains some silt (<10%), medium dense to dense, gray, dry to moist, mixed	SP	contains some small metal debris
			7.0-8.0	NONE	NS	—	TP-4-6-10	Fill=Silty Sand, fine sand (20-30%), non-plastic silt, dense, gray, moist, laminar	SM	
			8.0-10.0	MOD PH	NS			Fill=wood debris, clayey sandy silt matrix (65-75%), soft, mod to highly plastic fines, gray, wet, mixed	(ML-MH)	large decaying logs and boards
TP-5	Grid Location	8.5	0.0-3.5	NONE	NS	26	TP-5-0-1	Fill=Sandy Gravel, well-graded gravel (55-60%), loose, brown, dry,	GW	note: TP in center of former octagon fndn; appx. 1.5' below surrounding grade
				NONE	NS	5.3	TP-5-2-3	Fill=Sandy Gravel, well-graded gravel (55-60%), loose, brown, dry,	GW	
			3.5-7.0	MOD-VS PH	VSS-HS	303	TP-5-4-6	Fill=Gravelly Sand, well-graded sand, well-graded gravel (30-40%), ~10% fines, medium dense, brown	SW	abundant wood debris below 6.0', wet at 7.0'
			7.0-8.5+	VS PH	HS	1176(?)	TP-5-6-10	Fill=wood debris, silty sand matrix, fine-medium sand, fine-course gravel (20%), medium dense, brown	(SW-SM)	refusal at 8.5' (large timbers at bottom of TP)
TP-6	Grid Location	10	0.0-1.0	NONE	NS	1653(?)	TP-6-0-1	Fill=Gravelly Sand, fine-medium sand, well-graded gravel (20-30%), no fines, loose, brown, dry, mixed	SW	
			1.0-2.5	NONE	NS	1.1	TP-6-2-3	Fill=Sandy Gravel, well-graded gravel (60-65%), fine to medium sand, <10% fines, loose, brown, dry, mixed	GW	
			2.5-5.0	NONE	NS	66.1	TP-6-4-6	Fill=Fine to medium Sand, trace gravel, medium dense, brown, dry, mixed	SP	
			5.0-8.0	NONE	NS			Fill=wood debris (wood chips, pressboard, etc), mixed gravelly sand/silty sand/sand matrix, medium dense, wet, mixed	(SP/SM)	6.0-7.0 feet entirely wood debris (no soil matrix)
			8.0-9.0	VSL PH	NS	2.3	TP-6-6-10	Fill=Sandy Silty Clay, silt (~35%), v. fine sand (~10%), very soft to medium stiff, gray, wet, moderately plastic, mixed	ML	
			9.0-10.0	VSL PH	NS			Fill=wood debris, clay/silt/fine sand matrix	(ML)	
TP-7	Grid Location	10	0.0-0.9	NONE	NS	1485	TP-7-0-1	CSTC	GP	0.4' asphalt cover
			0.9-4.0	NONE	NS	1573	TP-7-2-3	Fill=Gravelly Sand, well-graded sand, well-graded gravel (30-40%), dense, gray/brown, dry, mixed	SW	Soil stained from 0.9'-2.0'; contains metal debris
			4.0-6.5	SL-MOD PH	NS	35.8	TP-7-4-6	Fill=Gravelly Sand with Silt, fine to medium sand, well-graded gravel (15-30%), silt (10-15%), dense, moist, mixed	SW	soil stained, contains some wood debris
			6.5-8.5	VS PH	NS	53.2	TP-7-6-10	Fill=wood debris, no soil matrix	–	wood chips, pressboard
			8.5-10.0	NONE	NS			Fill=wood debris, clayey silt matix with very fine sand (3%) and clay (20%), soft, wet, plastic	(ML)	contains abundant wood debris
TP-8	Grid Location	10	0.0-2.0	SL uknown	SS	838	TP-8-0-1	Fill=Sandy Gravel/Gravelly Sand, well-graded gravel (45-55%), well-graded sand, <5% fines, dense, dry, mixed	GW-SW	0.3' asphalt cover, soil stained from 0-0.6'
			2.0-6.0	MOD PH	VSS	139	TP-8-2-3	Fill=Gravelly Sand, fine to medium sand, fine-medium gravel (10-25%), medium dense, dark gray, dry	SW	no odor below 4.0'
			6.0-10.0	decaying organic	NS	42.2	TP-8-4-6	Fill=wood debris, gravelly fine to medium sand matrix, fine-medium gravel (10-25%), medium dense, dark gray, moist to wet	(SW)	soil content 25-30%
			10.0+	decaying organic	NS	40	TP-8-6-10	Fill=wood debris, sandy clayey silt matrix, soft, wet	(ML)	
TP-9	Grid Location	10.5	0.0-2.0	SL PH	VSS	69.1	TP-9-0-1	Fill=Gravelly Sand, well-graded sand, well-graded gravel (35-45%), dense, dark gray, dry, mixed	SW	0.3' asphalt cover; soil heavily stained, contains abundant glass fragments
			2.0-4.0	VS PH	SS	20.5	TP-9-2-3	Fill=Sandy Gravel, well-graded gravel (55-60%), well-graded sand, dense, gray, dry, mixed	GW	contains some small cobbles (max. = 0.3').
			4.0-7.0	VS PH	SS	9.8	TP-9-4-6	Fill=Gravelly Sand, fine-medium sand, well-graded gravel (15-20%), 10% fines, medium dense, gray, dry, mixed	SW	contains wood debris @ 5.5'-7.0'
			7.0-8.5	NONE	NS	4.2	TP-9-6-10	Fill=Fine to medium Sand, some silt (<10%) trace small gravel (<3%), medium dense gray, dry	SW	
			8.5-10.5+	NONE	NS			Sandy Clayey Silt; very fine sand (10-15%), clay (~20%). medium stiff, low plasticity, gray, moist to wet, stratified	ML	contains decaying estuary grasses; layers of sandy clayey silt and silty sand

APPENDIX B

SUMMARY OF TEST PIT OBSERVATIONS
Former Tacoma Metals Facility

Test Pit Number	Test Pit Location	Depth (feet)	Unit Depths (feet)	Noticeable Odors[a]	Water Sheen[b]	OVM (ppm)	Soil Sample Number[c]	Description	USCS Symbol	Comments
TP-10	Adjacent to former vault/ metal crusher	10	0.0-9.0	NONE	NS	4.1	TP-10-0-1	Fill=Sandy Gravel. well-graded gravel (55-60%), well-graded sand, dense, gray, dry to moist. mixed	GW	0.4' asphalt cover
				NONE	NS	0.8	TP-10-2-3			
				S PH below 6.0	SS	13.8	TP-10-4-6			
			9.0-10.0	MOD PH	NS	145	TP-10-6-10	Fill=wood debris (wood chips, limber, manufactured wood)	—	No soil matrix
			10.0+	MOD PH	NS			Silty Sand, fine sand, dense, gray/brown, wet, stratified(?)	SM	contains decaying estuary grasses
TP-11	Grid Location	10	0.0-2.8	NONE	VSS	212	TP-11-0-1	Fill=Gravelly Sand, fine to medium sand, well-graded gravel (25-35%), loose, brown, dry, mixed	SW	
			2.8-5.0	NONE	SS	>2000?	TP-11-2-3	Fill=Sandy Gravel, well-graded gravel (55-65%), well-graded sand, dense, brown, dry, mixed	GW	
				NONE	SS	26.1	TP-11-4-6			
			5.0-6.0	SL-S PH	SS	7.0	TP-11-6-10	Fill=Gravelly Sand, fine to medium sand, well-graded gravel (15-20%), silt (<10%), medium dense, brown, dry mixed	SW	contains some wood fragments and metal debris
			6.0-10.0	S PH	HS			Fill=wood debris, silty sand to fine sand matirx, medium dense, light gray/brown, moist, mixed	(SM)	free oil product layer at 9.6' bgs (clear amber liquid, 0.3' thick)
TP-12	Grid Location	10	0.0-1.5	NONE	NS	118	TP-12-0-1	Fill=Gravelly Sand, well-graded sand, well-graded gravel (35-40%), loose, brown, dry, mixed	SW	contains metal debris
			1.5-3.5	NONE	NS	>2000?	TP-12-2-3	Fill=medium Sand, some gravel (<10%), loose, grey, dry, mixed	SP-SW	contains some small debris
			3.5-6.0	NONE	NS	80	TP-12-4-6	Fill=Silty Sand, very fine sand, fine gravel (5-10%), medium dense, light gray/brown, dry to wet	(SM)	contains abundant wood debris; bedding planes noted
			6.0-10.0	NONE	NS	11.8	TP-12-6-10	Fill=wood debris, sandy clayey silt matix, very fine sand (~15%), clay (20%), medium stiff, very soft, gray, wet, mixed	(ML)	old boards, timber, wood chips
			@10.0	NONE	NS			Fill=wood debris, clayey silty sand matix, very fine sand, silt (30-40%), clay (10-15%), loose, gray, wet, mixed	(ML)	contains wood planks, timber, manuf. Wood
TP-13	Grid Location	10	0.0-4.0	NONE	NS	1461?	TP-13-0-1	Fill=Sandy Gravel, well-graded gravel (55-65%), silt (<10%) well-graded sand, loose, brown, dry, mixed, contains ashes	GW	contains abundant metal debris 0-0.6'
				NONE	NS	>2000?	TP-13-2-3			
			4.0-6.0	NONE	NS	>2000?	TP-13-4-6	Fill=medium Sand, contains some fine sand, some fine-medium gravel (~5%), loose, dark gray, dry,mixed	SP	contains some small wood & glass debris
			6.0-7.0	NONE	NS	415?	TP-13-6-10	Fill=Fine Sand, poorly-graded sand, medium dense, light brown, dry, slight Fe-oxidation mottling	SP	
			7.0-10.0+	NONE	NS			Fill=wood debris, fine sand to silty sand matrix, medium dense, gray, dry, mixed	(SP-SM)	logs, boards, timbers; matrix % decreases with depth
TP-14	Northeast side of former red brick building	10	0.0-9.0	NONE	NS	5.6	TP-14-0-1	Fill=Sandy Gravel, well-graded gravel (50-70%), well-graded sand, dense, gray, dry to moist, mixed	GW	SW layer at 2.0-2.5'
				NONE	NS	105	TP-14-2-3			2 steel pipes in TP that are perpendicular to former red brick bldg. concrete vault;
				NONE	NS	38.3	TP-14-4-6			1 pipe (12" dia.) is 7.5' and other (6" dia.) is 13.5' from 'south' end of vault; 5.0' bgs
			9.0-10.0	SL PH	NS	34.8	TP-14-6-10	Fill=Sandy Gravel, well-graded gravel (55-60%), well-graded sand, silt (~10%) and clay (~5-10%), dense, moist-wet	GW	contains wood debris
			10.0-10.5	decaying organic	NS			Fill=wood debris, silty sandy gravel matrix, wet	(GM)	wood chips, timber, pressboard
TP-15	Grid Location	10	0.0-4.0	NONE	NS	—	TP-15-0-1	Fill=Sandy Gravel, well-graded gravel (55-60%), well-graded sand, medium dense to dense, gray, dry, mixed	GW	
						—	TP-15-2-3			
			4.0-8.0	NONE	NS	—	TP-15-4-6	Fill=Gravelly Sand, fine to medium sand, well-graded gravel (30-35%), medium dense, brown, dry, mixed	SW-(SW)	contains abundant wood fragments from 6.0-8.0' bgs
			8.0-10.0	NONE	NS	—	TP-15-6-10	Fill=wood debris, sandy silt matrix, v. fine sand (~30-45%), clay (~10%), soft, gray, wet, moderately plastic	(ML)	wood timbers, logs, chips
			@10.0	NONE	NS			Silty Sand, fine to medium sand, silt (30-35%), medium dense, gray, moist	SM	native material?
TP-16	SW side red brick building	3.5	0.0-3.5	VS PH	MS	—	TP-16-0-1	Fill=Gravelly Sand/Sandy Gravel, well-graded gravel (45-55%), well-graded sand, medium dense to dense, brown/gray/black, moist to wet, mixed	SW-GW	0.4' asphalt cover; contains abundant auto/machinery battery casings; heavily stained; water perched in TP@2.5' bgs (remained perched for 6 days); possible vault (40'x17') on western side of former red brick building
				VS PH	HS	—	TP-16-2-3			
TP-17	Grid Location	10	0.0-4.4	NONE	NS	—	TP-17-0-1	Fill=Sandy Gravel, well graded gravel (55-65%) medium-course sand, dense, mixed	GW	heavily stained black from 0-1.5'
			4.4-7.0	SL PH @5.0'	NS	—	TP-17-2-3	Fill=Gravelly Sand, fine-medium sand, subrounded-subangular gravel (20-35%), medium dense, moist	SW	wood fragments @ 6'
			7.0-8.5	NONE	NS	—	TP-17-4-6	Fill=wood debris (logs, pressboard, chips) in silty sand matrix, fine-medium sand, silt (10-20%) loose, medium-dense, wet	(SM)	
			8.5-10	NONE	NS	—	TP-17-6-10	Sandy Clayey Silt, very fine sand (25-30%) medium stiff, mod-plastic, grey, moist, laminar, w/organics (marsh grass?)	ML	Water at 7.5', native materials?
TP-18	Grid Location	10	0.0-4.3	NONE	NS	—	TP-18-0-1	Fill=Sandy Gravel, well graded gravel (55-60%), medium-course sand, moist, mixed, gray	GW	
			4.3-6.5	NONE	NS	—	TP-18-2-3	Gravelly Sand, fine-medium sand, well graded gravel (30-35%) medium dense, moist, mixed	SW	contains brick fragments; wood fragments above 6.0', abundant below 6.0'
			6.5-7.8	NONE	NS	—	TP-18-4-6	Fill=wood debris, silty sand matrix (15%), medium-dense, moist, mixed	(SM)	timbers, wood chips, boards
			7.8-10.0	NONE	NS	—	TP-18-6-10	Silty Sand, fine-medium sand, (10-20%) silt, laminated/stratified, medium dense-dense, moist, some organics (esturary grasses)	SM	native materials?

APPENDIX B

SUMMARY OF TEST PIT OBSERVATIONS
Former Tacoma Metals Facility

Test Pit Number	Test Pit Location	Depth (feet)	Unit Depths (feet)	Noticeable Odors$^{(a)}$	Water Sheen$^{(b)}$	OVM (ppm)	Soil Sample Number$^{(c)}$	Description	USCS Symbol	Comments
TP-19	Grid Location	10.5	0.0-2.0	NONE	NS	—	TP-19-0-1	Fill= Gravelly Sand, fine-medium, well graded gravel (25-45%), loose, dry, mixed	SW	contains brick and demolished concrete
			2.0-8.0	NONE	NS	—	TP-19-2-3	Fill=Gravelly Sand, fine-medium sand, well-graded gravel (30-40%), medium dense, dry, mixed, brown-light brown	SW	contains white bricks at 6.0'
			8.0-9.0	NONE	NS	—	TP-19-4-6	Fill=Gravely Sand, well-graded gravel (45-60%), medium dense, dry, mixed, medium-coarse sand	SW-GW	
			9.0-9.5	NONE	NS	—	TP-19-6-10	Fill=Gravelly Sand, fine-medium gravel (25-35%) dense, dry, mixed, gray	SW	
			9.5-10.5	NONE	NS			Clayey Silty Sand, fine-medium sand, silt (25-35%), clay (10-15%), laminated, medium dense, stiff, moist, gray	SM-ML	native material?
TP-20	Grid Location	10.5	0.0-2.2	NONE	NS	—	TP-20-0-1	Fill=Sandy Gravel, gravel (50-60%), medium course sand, dense, compacted, moist, mixed	GW	
			2.2-4.3	SL PH	NS	—	TP-20-2-3	Fill=Sandy Gravel/Gravelly Sand, well-graded gravel (45-55%), well graded sand, dry, dense, mixed, stained	GW-SW	contains brick, metal and wood debris
			4.3-6.0	NONE	NS	—	TP-20-4-6	Fill= Sandy Gravel, 50-60% gravel, course sand, dense, compacted, dry, mixed	GW	
			6.0-7.5	NONE	NS	—	TP-20-6-10	Fill=Sandy Gravel, 55-60% gravel, some sand 40% silt, moist, dense, mixed	GM	
			7.5-10.5	NONE	NS			Fill=wood debris in sandy clayey silt matrix (15-25%), medium-stiff, wet, gray	(ML)	boards, timber, chips, pressboard
TP-21	Grid Location	10	0.0-3.0	NONE	NS	—	TP-21-0-1	Fill=Gravelly Sand, medium-course sand, gravel (20-25%), loose, dry, mixed, brown,	SW	contains metal debris, capacitors, and other debris
			3.0-5.0	NONE	NS	—	TP-21-2-3	Fill=Gravelly Sand/Sandy Gravel, well graded gravel (45-60%), dense, dry, brown, mixed	GW-SW	contains lenses of sandy silt
			5.0-7.0	NONE	NS	—	TP-21-4-6	Fill=Gravelly Sand, medium sand, fine-medium gravel (10%), loose, dry, gray	SW	
			7.0-10.0	NONE	NS	—	TP-21-6-10	Fill=wood debris, matrix 10-15%, sand and silty sand with clay, loose, dry, mixed	(SM-ML)	wood chips, boards, timbers
TP-22	Grid Location	10	0.0-4.0	NONE	NS	—	TP-22-0-1	Fill=Gravelly Sand w/ ash cinders, poorly graded fine-medium sand, well-graded gravel (25-30%), loose, dry, mixed, brown, stained	SW	Contains metal debris, stained, oxidized (Cu)
			4.0-5.0	NONE	NS	—	TP-22-2-3	Fill=Sandy Gravel , well graded gravel (55-60%), well-graded sand, dense, dry, mixed, brown	GW	
			5.0-7.0	NONE	NS	—	TP-22-4-6	Fill=Gravelly Sand, medium sand , fine-medium gravel (20%), loose, dense, dry, mixed, brown	SW	
			7.0-8.0	NONE	NS	—	TP-22-6-10	Fill=Fine-Medium Sand, medium dense, dry, mixed, brown	SP	
			8.0-10.0	NONE	NS			Fill=wood debris, matrix 20%, brown silty sand, silt (30-35%), medium dense, moist	(SM)	logs, timbers, chips; entirely wood debris 8.0-10.0', matrix present at 10.0'
TP-23	Grid Location	10	0.0-2.0	NONE	NS	0.0	TP-23-0-1	Fill=Sandy Gravel, well graded gravel (50-55%), medium course sand, dense, moist, mixed, gray	GW	
			2.0-7.0	MOD PH	NS	19.4?	TP-23-2-3	Fill=Gravelly Sand/Sandy Gravel, well graded sand, well graded gravel (45-55%), dense, mixed, stained, brown	GW-SW	contains metal debris
			7.0-8.0	NONE	NS	13.4?	TP-23-4-6	Fill=wood debris, no soil	—	logs, chips, timber, boards
			8.0-10.0	NONE	NS	17.2?	TP-23-8-10	Clayey Silty Sand, very fine sand, silt (35%), clay (10%), medium dense, plastic fines, moist-wet, laminar, some organics (grasses), gray	ML	native material?
TP-24	Grid Location	10	0.0-2.0	NONE	NS	1.4?	TP-24-0-1	Fill=Gravelly Sand/Sandy Gravel, well graded gravel (45-60%), well graded sand, dense, mixed, moist, brown	GW-SW	contains some brick debris
			2.0-5.8	NONE	NS	10.6?	TP-24-2-3	Fill=Gravelly Sand, well graded gravel (25-40%), dense, dry, brown	SW	gravel content increases with depth
			5.8-8.0	SL ORGANIC	NS	5.6?	TP-24-4-6	Fill=wood debris, dark brown fine-medium sand and gray silty fine sand matrix	(SP-SM)	wood chips, timber
			8.0-10.0	NONE	NS	4.3?	TP-24-6-10	Sandy Clayey Silt, very fine sand (20%), clay (20%), silt (60%), medium-stiff, moderately plastic, gray	ML	native materials?
TP-25	Grid Location	10.3	0.0-4.1	NONE	NS	17.8?	TP-25-0-1	Fill=Sandy Gravel, fine-medium gravel (35-45%), coarse sand, dense, compacted, moist, brown	SW	
			4.1-6.8	NONE	NS	148?	TP-25-2-3	Fill=Fine to Medium Sand, some fine-medium gravel (<10%), medium-dense, dry, dark gray	SP	
			6.8-8.0	NONE	NS	163?	TP-25-4-6	Fill=wood debris in sandy silt/fine sand matrix (25%), very soft, plastic, wet, mixed, brown	(ML)	timber, logs, wood chips, wood dust
			8.0-9.8	NONE	NS	3.5?	TP-25-6-10	Fill=Sandy Clayey Silt, very fine sand (20-30%), clay (20-30%), stiff, mod-plastic, moist, w/organics (estuary grasses), blocky, gray	ML	
			9.8-10.3	NONE	NS			Fill=wood debris, no soil	—	logs, chips, dust, timbers
TP-26	Grid Location	10	0.0-4.5	NONE	NS	12.2	TP-26-0-1	Fill=Gravelly Sand, well graded sand, well graded medium gravel (35-45%), dense, moist-dry, brown	SW	
			4.5-6.0	NONE	NS	13.3	TP-26-2-3	Fill=Gravelly Sand, medium-course sand, well graded gravel (30-35%), contains charcoal, medium dense, dry, dk. Gray	SW	
			6.0-8.0	NONE	NS	1171	TP-26-4-6	Fill=Silty Sand, silt (30%), medium stiff, moist, mixed, grades to sandy silt @ 7.0', fine sand (30%)	SM-ML	some wood debris
			8.0-10.0	NONE	NS	65.6	TP-26-6-10	Fill=Silty Sand/Sandy Silt, some clay (5-15%), very fine sand, silt (35-55%), conteins abundant organics, dense, moist, gray	ML	abundant wood debris at 10'
TP-27	Southeast of former UST area	10	0.0-2.0	MD PH	MS	>2000?	TP-27-0-1	Fill=Gravelly Sand, well graded sand, well graded medium gravel (35-40%), dense, mixed, dry, brown, stained	SW	contains metal debris
			2.0-5.5	VSL	NS	566	TP-27-2-3	Fill=Sandy Gravel, medium-course sand, well graded gravel (50-55%), dense, compact, moist	GW	slight unknown oder (detergent-like)
			5.5-9.0	VSL	NS	22.3	TP-27-4-6	Fill=Gravelly Sand, medium-course sand, well graded gravel (30-35%), dense, brown	SW	
			9.0-9.5	NONE	NS	17.6	TP-27-6-10	Fill?=Clayey Silt, clay (25-35%), moist, stiff to very stiff, plastic,brown	ML	native material?
			9.5-10.0	NONE	NS			Fill?=Gravelly Sand, medium sand, well graded gravel (30-35%), dense, dry, brown	SW	native material?

APPENDIX B

SUMMARY OF TEST PIT OBSERVATIONS
Former Tacoma Metals Facility

Test Pit Number	Test Pit Location	Depth (feet)	Unit Depths (feet)	Noticeable Odors(a)	Water Sheen(b)	OVM (ppm)	Soil Sample Number(c)	Description	USCS Symbol	Comments
TP-28	Grid Location	10	0.0-0.9	NONE	NS	2.4	TP-28-0-1	Fill=Gravelly Sand, medium-course sand, well graded gravel (45-50%), dense, dry, brown	SW	
			0.9-3.5	VS PH	MS	58.4	TP-28-2-3	Fill=Gravelly Sand,well graded sand, well graded gravel (40-50%), dense, dry, brown	SW	contains metal debris, heavily stained, (Cu) oxidation @ 0.9-1.2'
			3.5-8.0	NONE	NS	8	TP-28-4-6	Fill=Gravelly Sand/Sandy Gravel, medium-course sand, well graded gravel (40-55%), dense, moist, brown	SW-GW	
			8.0-9.0	NONE	NS	5.3	TP-28-6-10	Fill=wood debris, clayey sandy silt matrix, very fine sand (30%), clay (10-15%), medium stiff, wet, mod-plastic, gray	(ML)	
			9.0-10.0	NONE	NS			Silty Sand, silt (30-35%), stratified	SM	native material?
TP-29	Grid Location	10	0.0-4.5	NONE	NS	1100?	TP-29-0-1	Fill=Sandy Gravel, well graded gravel (50-60%), medium-coarse sand, dense, moist, brown/gray	GW	
			4.5-7.0	NONE	NS	560?	TP-29-2-3	Fill=Gravelly Sand, fine-medium sand, well graded gravel (35-40%), medium-dense, moist, brown	SW	
			7.0-8.0	NONE	NS	480?	TP-29-4-6	Fill=wood debris, no soil	—	timber, wood chips
			8.0-10.0	NONE	NS	—	TP-29-6-10	Sandy Clayey Silt, very fine sand (20%), clay (15-20%), stiff, moist, plastic, laminar, contains organics (estuary grasses)	ML	native material?
TP-30	South corner of former foundation	10	0.0-1.8	MOD PH	MS	—	TP-30-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (30-40%), medium-dense, stained	SW	contains abundant metal debris
			1.8-5.0	NONE	NS	—	TP-30-2-3	Fill=Sandy Gravel/Gravelly Sand, medium-course sand, well graded gravel (45-55%), dense, dry-moist, brown	GW-SW	
			5.0-7.0	NONE	NS	—	TP-30-4-6	Fill=Gravelly Sand/Sandy Gravel, medium-course sand, well graded gravel (45-55%), dense, moist, brown	GW-SW	
			7.0-8.0	NONE	NS			Fill=Silty Sand, silt (10%), dense, moist, mixed	SM	
			8.0-9.0	NONE	NS	—	TP-30-6-10	Fill=wood debris, brown silty sand matrix (20%), wet, dense	(SM)	logs, boards, wood chips, logs
			9.0-10.0	NONE	NS			Clayey Sandy Silt, clay (15%), very fine sand (30%), soft, medium stiff, plastic, w/organics (esturary gass), gray	ML	native material?
TP-31	Grid Location	10.3	0.0-2.2	MOD PH	MS	—	TP-31-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (30-40%), medium-dense, stained, brown	SW	contains abundant metal debris
			2.2-6.0	NONE	NS	—	TP-31-2-3	Fill= Gravelly Sand/ Sandy Gravel, medium-course sand, well graded gravel (45-55%), dense, dry, gray	GW-SW	
			6.0-7.0	MOD ORGANIC	NS	—	TP-31-4-6	Fill= medium sand w/ some gravel, poorly graded sand, fine-medium gravel (5-10%), dense, dry, mixed, brown	SP-SW	
			7.0-9.0	NONE	NS	—	TP31--6-10	Fill=wood debris, no soil	—	wood chips, timber, logs, boards, bark dust
			9.0-10.3	NONE	NS	—		Clayey Silty Sand/Clayey Sandy Silt, silt (40-55%), clay (10-15%), very fine sand, dense, dry, laminar, contains estuary grasses	ML	native meterial?
TP-32	West corner of former foundation	2	0.0-2.0	MOD PH	MS	—	TP-32-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (30-40%), dense, dry, heavily stained, brown	SW	contains abundant metal debris
										Refusal: concrete pad @2' Pad extends for 25-50' N, E, S, W, of Test Pit
TP-33	Grid Location	10	0.0-2.0	NONE	NS	—	TP-33-0-1	Fill=Gravely Sand, well-graded gravel (20-30%)	SW	contains abundant metal debris, glass, styrofoam, brick, and wood
			2.0-4.5	NONE	NS	—	TP-33-2-3	Fill=Gravelly Sand/Sandy Gravel, medium-course sand, well graded gravel (45-60%), dense, dry, brown, mixed	SW-GW	
			4.5-6.0	NONE	NS	—	TP-33-4-6	Fill=Gravelly Sand/Sandy Gravel, medium course sand, well graded gravel (45-60%), dense, dry, mixed, gray	SW-GW	
			6.0-7.0	NONE	NS	—	TP-33-6-10	Fill=Silty Sand, very fine-fine sand, silt (30-35%), dense, dry, gray/brown	SM-ML	
			7.0-10.0	NONE	NS			Fill=wood debris, silty sand matrix (15%), medium dense, mixed	(SM)	logs, timber, chips, boards
TP-34	Grid Location	10	0.0-4.0	MOD PH	MS	—	TP-34-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (30-35%), dense, heavily stained	SW	contans abundant metal debris-car parts, sheet metal, cable, wire
			4.0-6.0	NONE	VS	—	TP-34-2-3	Fill=Medium Sand, well graded gravel (10-20%), medium dense, mixed, brown	SW	
			6.0-8.0	NONE	NS	—	TP-34-4-6	Fill=wood debris, no soil	—	boards, wood ships, bark dust, timber
			8.0-10.0	NONE	NS	—	TP-34-8-10	Clayey Silty Sand/Sandy Silt, very fine sand, silt (40-45%), dense/stiff, clay (20%), dry, slightly plastic, gray, estuary grasses	ML	native materials?
TP-35	Grid Location	10	0.0-1.0	NONE	NS	—	TP-35-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (35-40%), dense, mixed, stained, dk. Gray, moist	SW	some metal debris and oxidation staining
			1.0-6.0	NONE	NS	—	TP-35-2-3	Fill=Gravelly Sand, medium-course sand, well graded gravel (40-50%), dense, moist, brown	SW	
			6.0-7.8	NONE	NS	—	TP-35-4-6	Fill=Gravelly Sand, medium-course sand, well graded gravel (20-35%), medium dense, moist, dk. Brown	SW	
			7.8-9.0	NONE	NS	—	TP-35-6-10	Fill=wood debris, silty sand (fine-medium sand) matrix, medium dense, moist, mixed	(SM)	
			9.0-10.0	NONE	NS	—		Clayey Sandy Silt, very fine sand (20%), clay (20%), stiff, moist, abundant organics (estuary grasses), gray, massive	ML	native materials?
TP-36	Grid Location	10	0.0-4.6	NONE	NS	—	TP-36-0-1	Fill=Gravelly Sand/Sandy Gravel, well graded sand, well graded gravel (35-50%),dense, mixed, brown/gray	SW-GW	heavily stained from 2.7 to 3.4'
			4.5-7.0	NONE	NS	—	TP-36-2-3	Fill=Silty Sand, fine-medium sand, silt (15-20%), dense, dry, mixed, gray	SM	
			7.0-9.0	MOD CREOSOTE	HS	—	TP-36-4-6	Fill=wood debris, fine-medium sand matrix (5-10%), medium dense, mixed	(SP)	logs, timber, chips, boards
			9.0-10.0	NONE	NS	—	TP-36-6-10	Silty Fine-Medium Sand, silt (5%), poorly graded sand, stratified, dense, dry-moist, gray	SP-SM	native material?

APPENDIX B

SUMMARY OF TEST PIT OBSERVATIONS
Former Tacoma Metals Facility

Test Pit Number	Test Pit Location	Depth (feet)	Unit Depths (feet)	Noticeable Odors(a)	Water Sheen(b)	OVM (ppm)	Soil Sample Number(c)	Description	USCS Symbol	Comments
TP-37	Grid Location	10	0.0-0.5	NONE	NS	1010?	TP-37-0-1	CSTC	GW	
			0.5-3.3	MOD PH	SS	781?	TP-37-2-3	Fill=Gravelly Sand, well graded sand, well graded gravel (35-40%), dense, mixed, brown	SW	contains metal debris and brick
			3.3-4.0	NONE	NS			Fill=Gravelly Sand, well graded sand, well graded gravel (30-40%), dense, dry, mixed, gray	SW	
			4.0-5.2	NONE	NS	620?	TP-37-4-6	Fill=Fine-Medium Sand, trace gravel (3-5%), loose, dry, brown/charcoal gray	SP	
			5.2-7.0	SL PH	NS	600?	TP-37-6-10	Fill=Fine-Medium Sand, medium-course gravel (10%), dry, brown	SP-SW	abundant wood debris
			7.0-8.0	SL ORGANIC	NS			Fill=wood debris, medium-fine sand matrix (5%)	(SP)	logs, timber, chips, boards
			8.0-10.0	NONE	NS			Clayey Sandy Silt, very fine sand (30-40%), clay (10-20%), silt (40-50%), very stiff, dry, mod-plastic, gray, estuary grasses	ML	native material?
TP-38	Grid Location	10	0.0-3.0	NONE	NS	625?	TP-38-0-1	Fill=Gravelly Sand, fine-medium sand, well-graded gravel (20-25%), loose-medium dense, dry, brown	SW	contains metal debris 0-2', charcoal cinders 1.5-2'
			3.0-5.5	NONE	NS	700?	TP-38-2-3	Fill=Medium Sand, some gravel (5-10%), some fine sand, loose, dry, brown	SW-SP	
			5.5-6.5	NONE	NS	965?	TP-38-4-6	Fill=wood debris, silty sand matrix (20%), fine-medium sand, silt (15-20%), medium-dense, dry	(SM)	logs, timber, boards, wood chips; piling in test pit from 6.0' down
			6.5-10.0	NONE	NS	800?	TP-38-6-10	Fine-Medium Sand, silt (10%), non-plastic fines, medium-dense, moist, gray, stratified, contains estuary grasses	SP-SM	native material?
TP-39	Grid Location	10.5	0.0-1.8	NONE	NS	2000?	TP-39-0-1	Fill=Fine-Medium Sand, well-graded gravel (15-25%), poorly graded sand, loose, dry, brown	SW	slag material 1.6-1.8'
			1.8-3.0	NONE	NS	2000?	TP-39-2-3	Fill=Gravelly Sand/Sandy Gravel w/ cobble (0.7"), well graded sand, well graded gravel (40-55%), dense, dry, brown	SW-GW	
			3.0-5.2	NONE	NS	685?	TP-39-4-6	Fill=Fine-Medium Sand, trace well graded gravel (3-5%), loose, dry, brown	SP	
			5.2-7.0	NONE	NS	780?	TP-39-6-10	Fill=wood debris, brown fine-medium sand to silty sand matrix (5-15%)	(SP-SM)	timbers, logs, chips, boards
			7.0-10.5	NONE	NS			Medium-course sand, medium dense, wet	SP	native material?
TP-40	Grid Location	10	0.0-4.0	MOD PH	SS	—	TP-40-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (30-35%), dense, stained	SW	contains abundant metal and brick debris
			4.0-5.0	NONE	NS	—	TP-40-2-3	Fill=Gravelly sand, medium-course sand, well graded gravel (40-45%), dense, moist, gray, mixed	SW	
			5.0-6.0	NONE	NS	—	TP-40-4-6	Fill=medium Sand, charcoal gray/mauvish, loose, dry, massive	SP	
			6.0-7.0	NONE	NS	—	TP-40-6-10	Fill=wood debris, no soil matrix	—	logs, chips, bark, timber
			7.0-10.0	NONE	NS			Fine-Medium Sand, some silt, contains estuary grasses, dense, dry, gray, stratified	SM	contains silty sand lenses, native material?
TP-41	Grid Location	11.8	0.0-6.0	NONE	NS	—	TP-41-0-1	Fill=Gravelly Sand, medium-course sand,well graded gravel (40-50%), dense, moist, gray	SW	
						—	TP-41-2-3			
			6.0-9.0	NONE	NS	—	TP-41-4-6	Fill=Fine-Medium Sand, fine-medium gravel (10-15%), poorly graded sand,medium dense, dry, mixed, gray	SP	contains some wood debris
			9.0-11.8	NONE	NS	—	TP-41-6-10	Fill=wood debris, no soil matix	—	logs, timber, chips, dust
TP-42	Grid Location	10	0.0-6.8	NONE	NS	—	TP-42-0-1	Fill-Gravelly Sand, medium-course sand, well graded gravel (35-50%), dense, moist, gray, mixed	SW	
						—	TP-42-2-3			
						—	TP-42-4-6			
			6.8-10.0	NONE	NS	—	TP-42-6-10	Fill=wood debris, no soil matrix	—	timber, wood chips, boards, sawdust, bark
TP-43	Grid Location	10	0.0-3.5	NONE	NS	—	TP-43-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (30-35%), dense, moist, mixed, stained, dk. Brown	SW	contains metal and brick debris, Cu oxidation stains
			3.5-4.2	NONE	NS	—	TP-43-2-3	Fill=Gravelly Sand, medium-course sand, well graded gravel (40-40%), dense, moist, gray/brown	SW	
			4.2-7.0	NONE	NS	—	TP-43-4-6	Fill=Medium-Course Sand, medium gravel (5%), medium-dense, moist, dk grey	SP	
			7.0-9.0	NONE	NS	—	TP-43-6-10	Fill=wood debris, brown silty sand/sandy silt matrix	(SM-ML)	logs, chips, timber, boards, no soil below 7.8'
			9.0-10.0	NONE	NS			Clayey Sandy Silt , very fine sand (30%), clay (10%), plastic fines, soft-medium, stiff, moist-wet, laminar, contains estuary grass	ML	
TP-44	Grid Location	11	0.0-2.2	NONE	NS	—	TP-44-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (20-45%), dense, dry, mixed, brown	SW	
			2.2-6.0	NONE	NS	—	TP-44-2-3	Fill=Fine-Medium Sand, trace well graded gravel (3-5%), loose, dry, brown	SP	
			6.0-8.0	NONE	NS	—	TP-44-4-6	Fill=wood debris, sand/clay/silt matrix	(ML)	board, logs, chips; matrix 25-35% @ 7.0', entirely wood 6.0-7.0'
			8.0-11.0	NONE	NS	—	TP-44-6-10	Medium-Course Sand, medium gravel (5%), medium-dense, moist, dk gray	SP	native material?
TP-45	Grid Location	10.5	0.0-3.0	NONE	NS	0	TP-45-0-1	Fill=Gravelly Sand, fine-medium sand, well-graded gravel (15-20%), loose, dry, brown, mixed, stained	SW	contains metal, brick, and concrete debris
			3.0-7.0	NONE	NS	0	TP-45-2-3	Fill=Gravelly Sand, well graded sand, well graded gravel (30-35%), medium dense, dry, light brown	SW	
			7.0-8.5	NONE	NS	0	TP-45-4-6	Fill=wood debris, clayey sandy silt matrix at 8.0'	(ML)	no soil at 7.0-8.0'
			8.5-9.2	NONE	NS	0	TP-45-6-10	Clayey Silty Sand, very fine sand, plastic fines, silt (30-35%), clay (10-15%), medium dense, moist, some organics, gray, laminar	ML	native material?
			9.2-10.5	NONE	NS			Medium-Course Sand, trace fine gravel (3%), medium-dense, moist-wet, dk gray	SP	native material?

APPENDIX B

SUMMARY OF TEST PIT OBSERVATIONS
Former Tacoma Metals Facility

Test Pit Number	Test Pit Location	Depth (feet)	Unit Depths (feet)	Noticeable Odors(c)	Water Sheen(b)	OVM (ppm)	Soil Sample Number(d)	Description	USCS Symbol	Comments
TP-46	Grid Location	10	0.0-2.5	NONE	NS	0	TP-46-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (20-25%), dense, mixed, dark brown	SW	contains some metal debris and Cu oxidization, stained
			2.5-3.4	NONE	NS	0	TP-46-2-3	Fill=Gravelly Sand, well graded sand, well graded gravel (35-40%), dense, mixed, dry, brown	SW	contains metal debris
			3.4-5.9	MOD HC	MS	0	TP-46-4-6	Fill=Gravelly Sand, well graded sand, well graded gravel (25-35%), dense, mixed, charcoal gray	SW	abundant metal and glass debris, heavily stained
			5.9-8.8	NONE	NS	0	TP-46-6-10	Fill=Gravelly Sand, well graded sand, well graded gravel (40-45%), dense, moist, gray, mixed	SW	
			8.8-10	NONE	NS			Fill=wood debris, no soil matrix	—	logs, timber, boards, chips
TP-47	Grid Location	10.5	0.0-1.4	NONE	NS	0	TP-47-0-1	Fill=Medium Sand, some gravel (5%), loose, dry, brown	SP	
			1.4-8.0	NONE	NS	0	TP-47-2-3	Fill=Gravelly Sand, medium-course sand, well graded gravel (35-50%), dense, dry, brown	SW	
						0	TP-47-4-6			
			8.0-10.5	NONE	NS	0	TP-47-6-10	Fill=wood debris, brown silty sand matrix (30%), fine-medium sand, silt (35%)	(SM)	timber, boards, chips
TP-48	Northwest corner of property	8.5	0.0-1.4	NONE	NS	0	TP-48-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (30-35%), dense, dry, brown	SW	
			1.4-4.4	NONE	NS	0	TP-48-2-3	Fill=Fine-Medium Sand, some fine-medium gravel (<5%), loose, dry, gray	SP	
			4.4-8.5	SL PH	MS	0	TP-48-4-6	Fill=wood debris, silty sand matrix (<10%), moist, mixed	(SM)	wood chips, boards, bark, wood dust
						0	TP-48-6-8.5			water at 7.4', heavy sheen on water surface
TP-49	Former creosoting plant area	10	0.0-2.0	NONE	NS	0	TP-49-0-1	Fill=Gravelly Sand, well graded sand, well graded gravel (40-50%), dense, dry-moist, gray	SW	
			2.0-3.3	SL PH	NS	0.2	TP-49-2-3	Fill=Gravelly Sand, medium sand, well graded gravel (25-30%), dense, dry, mixed, gray	SW	
			3.3-7.0	VS CREOSOTE	HS	6.5	TP-49-4-6	Fill=Fine-Course Sand, well graded gravel (20-25%), dark gray	SW	heavily stained, locally saturated with PH/creosote product, contians wood debris
			7.0-10.0	VS CREOSOTE	HS	1.7	TP-49-6-10	Fill=wood debris, brown silty sand matrix (10-30%), loose, moist, mixed	(SM)	wood chips, boards, bark; water @ 8.5', PH product on surface; heavily stained
TP-50	South of NMW-3 (north corner)	10	0.0-3.3	NONE	NS	0.4	TP-50-0-1	Fill=Gravelly Sand, medium-coarse sand, well graded gravel (35-45%), dry, mixed, gray	SW	
			3.3-6.3	SL PH	NS	0.2	TP-50-2-3	Fill=Gravelly Sand, medium-coarse sand, well graded gravel (25-35%), medium-dense, stained, brown, mixed	SW	contains wood, brick, slag, cable, glass debris
			6.3-7.5	NONE	NS	0	TP-50-4-6	Fill=Gravely Sand, well graded sand, well graded gravel (25-30%), silt (30%), wet, mixed, brown	SP-SM	contains 45-55% wood debris
			7.5-10	MOD CREOSOTE	SS	0	TP-50-6-10	Fill-wood debris, silty sand matrix (20-40%), very fine to fine sand, brown, lt gray, wet, sandy clayey silt matrix @ 9'	(SM-ML)	chips, boards, timber
TP-51	SW Corner	8	0.0-1.0	NONE	NS	0	TP-51-0-1	Fill=Sandy Gravel, well-graded gravel (60-65%), fine to medium sand, <10% fines, loose, brown, dry, mixed	GW	some metal and rubber debris
			1.0-4.3	NONE	NS	0	TP-51-2-3	Fill=Sandy Gravel, well-graded gravel, fine to medium sand (40-45%), gray	GW	
			4.3-5.0	NONE	NS	0	TP-51-4-6	Fill=Fine Sand, poorly graded sand, some gravel (<5%), brown, mixed	SP	
			5.0-6.5	NONE	NS			Fill=Fine Sand, sand/silt/clay mixture, 15-20% wood debris	SM-ML	fibrous to blocky wood debris
			6.5-8.0	NONE	NS	0	TP-51-6-8	Fill=wood debris, silty clay matrix (5-20%), brown, wet	(ML-CL)	sheen visible on water in the test pit
TP-52	East of TP-5	10	0.0-0.8	NONE	NS	0	TP-52-0-1	Fill=Sandy Gravel, well-graded gravel (55-60%), gray/brown, dry, mixed	GW	
			0.8-1.6	NONE	NS			Fill=Sandy Gravel, well-graded gravel with sand/silt, dark brown, dry, mixed	GW	some metal debris
			1.6-2.2	NONE	NS	0	TP-52-2-3	Fill=Sandy Gravel, well-graded gravel, gray, dry, mixed	GW	
			2.2-5.0	MOD CREOSOTE	MS	2.3	TP-52-4-6	Fill=wood debris, clayey sandy silt matrix (10-20%)	(SM-ML)	
			5.0-10.0	MOD CREOSOTE	MS	2.5	TP-52-6-10	Fill=wood debris, silty/clayey matrix (10%)	(ML-CL)	water @ 9.8', heavy sheen/product film on water surface
TP-53	North of TP-5	7	0.0-2.3	NONE	NS	0	TP-53-0-1	Fill=Sandy Gravel, well-graded gravel (55-60%) with sandy matrix, gray/brown, dry, mixed	GW	trace silt in dark brown layers
			2.3-3.8	NONE	NS	0	TP-53-2-3	Fill?=Silty Clay and Fine Sand, layered, hard, crumbly, light brown	ML-CL	gradational with underlying material
			3.8-4.5	NONE	NS	0	TP-53-4-6	Fill?=Silt, isolated small pods/lenses of fine sand/silt/clay	ML	pilings are visible in the pit sidewall below 4.5', no other wood material
			4.5-7.0	MOD CREOSOTE	MS	1.2	TP-53-6-7	Fill?=Gravelly Sand, sand to fine gravel material, cumbly, granular texture, dark brown, mixed	SP-SW	water @7.4", slight sheen on surface, gravel content increases with depth
TP-54	East of TP-7	10	0.0-1.5	NONE	NS	0	TP-54-0-1	Fill=Sandy Gravel, well graded gravel with sand and some silt, brown/tan, dry, mixed	GW	
			1.5-3.0	NONE	VSS	0	TP-54-2-3	Fill=Sandy Gravel, well graded gravel with sand and silt, dark brown	GW	contians some wood chip and metal debris
			3.0-5.2	NONE	NS	0	TP-54-4-6	Fill=Fine Sand, poorly graded sand, some gravel (5%), uniform texture	SP	
			5.2-6.0	NONE	NS			Fill=wood debris, silty/clayey matrix (5%), red/brown	(ML-CL)	primarily wood chips
			6.0-10.0	VSL	SS	0.6	TP-54-6-10	Fill=wood debris, silty/clayey matrix (5-10%)	(ML-CL)	decaying wood material, coarser with depth, wood surfaces coated with silt/clay

APPENDIX B

SUMMARY OF TEST PIT OBSERVATIONS
Former Tacoma Metals Facility

Test Pit Number	Test Pit Location	Depth (feet)	Unit Depths (feet)	Noticeable Odors[a]	Water Sheen[b]	OVM (ppm)	Soil Sample Number[c]	Description	USCS Symbol	Comments
TP-55	NE of TP-10	10	0.0-1.5	NONE	NS	0.7	TP-55-0-1	Fill=Sandy Gravel, well graded gravel with sand and some silt, brown/grey, dry, mixed	GW	contains some metal debris
			1.5-2.9	MOD HC	MS	3.6	TP-55-2-3	Fill=Gravelly Sand, well graded sand, gray, slightly moist, mixed	SW	
			2.9-3.8	MOD HC	NS	4.1	TP-55-4-6	Fill=Sandy Gravel, well graded gravel with sand and some silt, gray, mixed	GW	
			3.8-6.0	MOD HC	MS			Fill=Fine Sand, poorly graded, mixed with silt below 5.0', dark gray/brown, mixed	SP-SM	3" diameter pipe at 4' depth, oriented N-S, with HC product inside
			6.0-10.0	MOD HC	MS	4.2	TP-55-6-10	Fill=wood debris, sand/silt matrix (80-90%), dark brown, wet	(SP-SM)	water @ 9.5', dark brown HC product entering at sides of TP
TP-56	East of TP-11	10	0.0-0.8	NONE	SS	0.7	TP-56-0-1	Fill=Sandy Gravel, well graded gravel with sand and silt, dark brown, mixed	GW	
			0.8-2.0	NONE	SS	1.4	TP-56-2-3	Fill=Sandy Gravel, well graded gravel (55-60%) with sand, brown, slightly moist, mixed	GW	
			2.0-3.4	NONE	SS	1.9	TP-56-4-6	Fill=Gravelly Sand, well graded sand, gravel (45%), trace silt, dk brown, slightly moist, mixed	SW	
			3.4-5.8	NONE	NS			Fill=Fine Sand, slightly moist, dark brown	SP	
			5.8-10.0	NONE	NS	1.2	TP-56-6-10	Fill=wood debris, silt/clay/fine sand matrix (10-20%), dark red/brown, slightly moist	(ML-CL)	planks, wood chips, wood material becomes coarser with depth
TP-57	North of TP-9	10	0.0-0.3	NONE	NS	4.3	TP-57-0-1	Fill=Sandy Gravel, well graded gravel with sand, brown, mixed	GW	
			0.3-1.8	NONE	SS			Fill=Gravelly Sand, well graded sand, gravel (30-35%), some silt (5%), dark brown, mixed	SW	contains 20% metal and glass debris
			1.8-3.4	MOD HC	SS	16.2	TP-57-2-3	Fill=Sandy Gravel, gravel (55-60%), grey, dry, mixed	GW	
			3.4-6.2	NONE	VSS	6.7	TP-57-4-6	Fill=Fine Sand, granular coarse sand with some fine gravel, dark brown, trace silt, dry	SP	
			6.2-10.0	NONE	VSS	16	TP-57-6-10	Fill=wood debris, silty/clayey matrix (75-95%) with some fine sand, moist, dark red/brown to gray	(ML-CL)	wood content increases with depth and coarsens with depth
TP-58	North of TP-42	10	0.0-1.2	NONE	NS	0	TP-58-0-1	Fill=Sandy Gravel, well graded gravel (55-60%), medium sand, brown/tan, mixed	GW	
			1.2-2.2	NONE	VSS	0	TP-58-2-3	Fill=Sandy Gravel, well graded gravel (50-55%), well graded sand (40%), silt (5%), dk brown, mixed	GW	contains abundant metal debris (plates, cans pipes), bricks, minor glass
			2.2-5.8	NONE	NS	0	TP-58-4-6	Fill=Sandy Gravel, well graded gravel (55-60%), fine/medium sand (35-40%), silt (<5%), gray/brown, moist, mixed	GW	
			5.8-9.2	NONE	NS	0	TP-58-6-10	Fill=Sandy Gravel, well graded gravel (60%), medium sand, slightly moist, gray/brown	GW	
			9.2-10.0	NONE	NS			Fill=wood debris, silt matrix (15%), dark red/brown	(ML)	
TP-59	North of TP-41	10	0.0-0.6	NONE	NS	0	TP-59-0-1	Fill=Sandy Gravel, well graded gravel (55-60%), silt (5%), brown/tan, mixed	GW	
			0.6-2.0	NONE	NS	0	TP-59-2-3	Fill=Sandy Gravel, well graded gravel with sand and silt, red/brown, mixed	GW	contains abundant metal debris, granular charcoal-like material in 2-6" layer
			2.0-8.5	NONE	NS	0	TP-59-4-6	Fill=Sandy Gravel, well graded gravel (60%), sand (35-40%), trace silt, brown/tan, mixed	GW	
			8.5-10	NONE	NS	0	TP-59-6-10	Fill=wood debris, silt/clay matrix (10%) coating between wood fragments, brown, moist	(ML-CL)	coarse wood material
TP-60	East of TP-40	10	0.0-1.1	NONE	NS	0	TP-60-0-1	Fill=Sandy Gravel, well graded gravel (55-60%), sand, minor silt (<5%), tan/brown, dry, mixed	GW	
			1.1-4.3	NONE	NS	0	TP-60-2-3	Fill=Sandy Gravel, well graded gravel (50-55%), fine sand (30%), silt (15%), brown, dry, mixed	GW	contains 5-10% metal, brick, and glass debris
			4.3-6.5	NONE	NS	0	TP-60-4-6	Fill=Fine Sand, poorly graded, fine gravel (5%), dark gray	SP	
			6.5-8.10	NONE	NS	0	TP-60-6-10	Fill=wood debris; silt matrix, red/brown, moist, mixed	(ML)	contains some brick and metal debris
			8.10-10.0	NONE	NS			Silt, fine sand (5%), gray, moist	ML	native material?
TP-61	North of TP-36	10	0.0-3.2	SL HC	NS	0	TP-61-0-1	Fill=Sandy Gravel, well graded gravel (50-55%), fine sand (35%), silt (10-15%), gray/brown, dry, mixed	GW/GM	abundant brick, metal, glass, and rubber debris
			3.2-4.2	SL HC	SS	2.2	TP-61-2-3	Fill=Sandy Gravel, well graded gravel (55-60%), sand (35%), trace silt (5%), gray, dry, mixed	GW	
			4.2-6.10	SL HC	SS	0.6	TP-61-4-6	Fill=Fine to Medium Sand, poorly graded, locally with 10-15% silt, brown, dry	SP/SM	wood debris with silt at 4.2 to 4.8'
			6.10-7.10	NONE	NS	0	TP-61-6-10	Fill=wood debris, silt matrix (10-15%), red/brown, moist, mixed	(ML)	
			7.10-10.0	NONE	NS			Sandy Silt, silt (60-70%), fine sand (~30%), trace clay (<5%), moist, gray, irregularly layered, blocky at 10.0'	ML	wood pilings at 10', native material?
TP-62	SE of TP-38	10	0.0-1.0	NONE	NS	0	TP-62-0-1	Fill=Sandy Gravel, well graded gravel (55-60%), medium/fine sand (35%), trace silt (<5%), brown, dry, mixed	GW	
			1.0-3.5	NONE	NS	0	TP-62-2-3	Fill=Sandy Gravel, well graded gravel (50-55%), sand (30%), silt (15-20%), dark brown, dry, mixed	GW	
			3.5-4.0	NONE	VSS	0	TP-61-4-6	Fill=Sandy Gravel, well graded gravel with sand, trace silt, gray/brown, dry, mixed	GW	
			4.0-7.0	NONE	NS			Fill=Fine Sand, up to 5% coarse sand and fine gravel	SP	
			7.0-9.2	NONE	NS	0	TP-62-6-10	Fill=Silt, moderate organic content, moist, dark brown	ML-OL	contians wood, brick and metal debris (30-40% above 8.5'), wood abundant below 8.5'
			9.2-10.0	NONE	NS			Clayey Silt, silt (90%), clay (10%), gray, moist	ML	wood pilings at 9.5', native material?

APPENDIX B

SUMMARY OF TEST PIT OBSERVATIONS
Former Tacoma Metals Facility

Test Pit Number	Test Pit Location	Depth (feet)	Unit Depths (feet)	Noticeable Odors(a)	Water Sheen(b)	OVM (ppm)	Soil Sample Number(f)	Description	USCS Symbol	Comments
TP-63	East of TP-32	10	0.0-0.8	NONE	NS	4.3	TP-63-0-1	Fill=Sandy Gravel, poorly graded gravel (55-60%), medium sand (40%), trace silt, brown, dry, mixed	GW	three foot diameter steel pipe along west sidewall oriented east-west
			0.8-2.4	MOD HC	SS	15.1	TP-63-2-3	Fill=Sandy Gravel, well graded gravel with sand and silt, dark brown, mixed	GW	abundant metal debris (30%), springs, wire, hubcaps, sheet metal, minor glass debris
			2.4-4.5	MOD HC	SS-MOD			Fill=Sandy Gravel, gravel with sand and silt, gray/brown, moist, mixed	GW	liquid with strong HC sheen seeping into pit at top of gravel layer
			4.5-6.10	NONE	SS	15.2	TP-63-4-6	Fill=wood debris, silt metirx (30%), brown, moist, mixed	(ML)	soft brown silt above wood debris (4.5-5.2'), contains brick debris
			6.10-10.0	NONE	NS	0	TP-63-6-8	Clayey Silt, silt (90%), clay (10%), gray, moist	ML	interbedded silt/clay/clayey silt at 9.0-10.0', native material?
TP-64	NE of TP-17	8	0.0-0.9	NONE	NS	0	TP-64-0-1	Fill=Sandy Gravel, well graded gravel with sand, trace silt, brown, dry, mixed	GW	
			0.9-4.0	NONE	VSS	0	TP-74-2-3	Fill=Sandy Gravel, well graded gravel (55-65%), sand (30-35%), trace silt (<5%), gray/brown, dry, mixed	GW	contains 10-15% metal and glass debris at 1.0-1.5'
			4.0-4.6	NONE	NS	0	TP-64-4-6	Fill=Sandy Gravel, well graded fine gravel with sand and silt, dark brown, mixed	GW	contains coarse wood debris
			4.6-5.8	NONE	NS			Fill=Fine Sand, poorly graded, local pods of silt/clayey silt (15%), brown, mixed	SP-SM	
			5.8-7.10	NONE	VSS	0	TP-64-6-8	Fill=wood debris, silt matrix (10%), red/brown, mixed	(ML)	coarse wood material
			7.10-8.0	NONE	NS			Silty Clay/Clayey Silt, gray, moist, contains roots	ML-CL	water entering test pit @ 9'
TP-65	NE of TP-7	9	0.0-1.2	NONE	NS	0	TP-65-0-1	Fill=Sandy Gravel, well graded gravel with sand and trace silt, brown/tan, dry, mixed	GW	
			1.2-3.0	NONE	NS	0	TP-65-2-3	Fill=Sandy Gravel, well graded gravel (55-60%), sand (30-35%), some silt, dark brown, dry, mixed	GW	3" diameter pipe at ~3' depth, exposed from east side of pit oriented E-W
			3.0-5.0	NONE	NS	0	TP-65-4-6	Fill=Gravelly Sand, poorly graded medium to fine sand with 5-10% fine gravel, brown, mixed	SP-SW	
			5.0-7.0	NONE	NS	0	TP-65-6-9	Fill=wood debris, silt/clay matrix (10%), brown/gray, moist, mixed	(ML-CL)	
			7.0-9.0	SL Creosote	VSS			Fill=wood debris, clayey silt to silty clay matrix (10%), brown/gray, mixed	(ML-CL)	water entering test pit @ 9', coarse wood material

Notes:

(a) Noticeable odors: none = no odor, VSL = very slight, SL = slight, MOD = moderate, S = strong, VS = very strong, PH = petroleum hydrocarbon

(b) Water sheen: NS = no sheen, VSS = very slight sheen, SS = slight sheen, MS = moderate sheen, HS = heavy sheen.

(c) OVM = organic vapor meter. Photoionization detector (PID) calibrated to 100 ppm isobutylene. Background = 0.0 ppm; ? = PID/OVM data questionable

(e) -- = not tested

(f) Soil sample number with depth of soil sample indicated (i.e., sample TP-1-6-10 is a composite sample obtained from 6.0 to 10.0 feet below ground surface [bgs]).

Appendix D

Monitoring Well Construction and Soil Boring Logs

Boring & Well Construction Log

Kennedy/Jenks Consultants

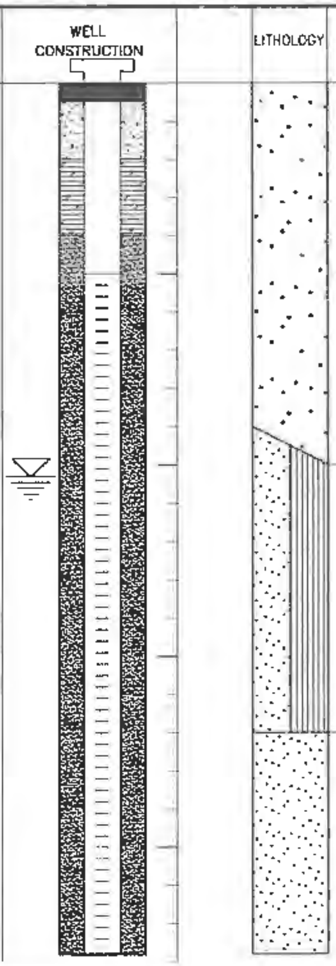
BORING LOCATION	EAST-NORTHEAST OF RED BRICK BUILDING		
DRILLING COMPANY	CASCADE DRILLING, INC.	DRILLER	SCOTT KREUGER
DRILLING METHOD	HOLLOW STEM AUGER	DRILL BIT(S) SIZE:	9 INCH
ISOLATION CASING	NONE	FROM TO FT.	
BLANK CASING	2" DIA. SCH 40 PVC	FROM 0.0 TO 5.0 FT.	
PERFORATED CASING	2" DIA. SCH 40 PVC 0.010 SLOTTED	FROM 5.0 TO 22.8 FT.	
SIZE AND TYPE OF FILTER PACK	LAPIS LUSTRE #2/12 SILICA	FROM 4.0 TO 22.8 FT.	
SEAL	BENTONITE CHIPS	FROM 2.0 TO 4.0 FT.	
GROUT	CONCRETE	FROM 0.0 TO 2.0 FT.	

Boring/Well Name	MW-4(R)
Project Name	TACOMA METALS
Project Number	996098.00

ELEVATION AND DATUM 10.0	TOTAL DEPTH 22.8
DATE STARTED 05/09/2000	DATE COMPLETED 05/09/2000
INITIAL WATER DEPTH (FT) 10.3	
LOGGED BY TAH/DKM	
SAMPLING METHODS 2.5" ID SPLIT SPOON	WELL COMPLETION ▬ SURFACE HOUSING ▬ STAND PIPE 3.0 FT.

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.
S	1.5	24 25 28		NMW-2-0.0
S	1.5	5 5 6	5	NMW-2-5.0
S	1.5	15 17 20	10	NMW-2-10.0
S	1.0	32 50	15	NMW-2-15.0
			20	
S	1.5	27 30 32		NMW-2-21.3

WELL CONSTRUCTION · LITHOLOGY



USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
SW	**Well-graded SAND with gravel** Mixed gravelly sand. Well-graded sand, well-graded gravel (~20%), medium dense, moist, brown, contains wood, glass, and metal fragments, moderate to strong creosote-like odor, no sheen.
SP/SM	**Poorly graded SAND with silt** Highly organic (woody) silty sand, fine sand, dense, brown, wet. Organic material is partially decomposed wood w/strong to very strong creosote-like odor. Very strong odor at 15.0 feet bgs.
SP	**Poorly graded SAND** Angular to sub-angular medium to coarse clean sand (predominantly coarse sand), dense, charcoal gray/black, wet, massive, strong creosote-like odor.

Notes:

1 Creosote-like odor detected in all soil samples collected. Strongest odor occurs at elevation of wood fill material.

2 Below depth of 10 feet bgs, soil also has diesel-like petroleum odor

Boring & Well Construction Log

Kennedy/Jenks Consultants

BORING LOCATION	NORTHEAST CORNER OF SITE			
DRILLING COMPANY	CASCADE DRILLING, INC.	DRILLER SCOTT KREUGER		
DRILLING METHOD	HOLLOW STEM AUGER	DRILL BIT(S) SIZE 9 INCH		
ISOLATION CASING	NONE	FROM	TO	FT.
BLANK CASING	2" DIA. SCH 40 PVC	FROM 0.0	TO 5.0	FT.
PERFORATED CASING	2" DIA. SCH 40 PVC 0.010 SLOTTED	FROM 5.0	TO 23.6	FT.
SIZE AND TYPE OF FILTER PACK	LAPIS LUSTRE #2/12 SILICA	FROM 4.0	TO 23.6	FT.
SEAL	BENTONITE CHIPS	FROM 2.0	TO 4.0	FT.
GROUT	CONCRETE	FROM 0.0	TO 2.0	FT.

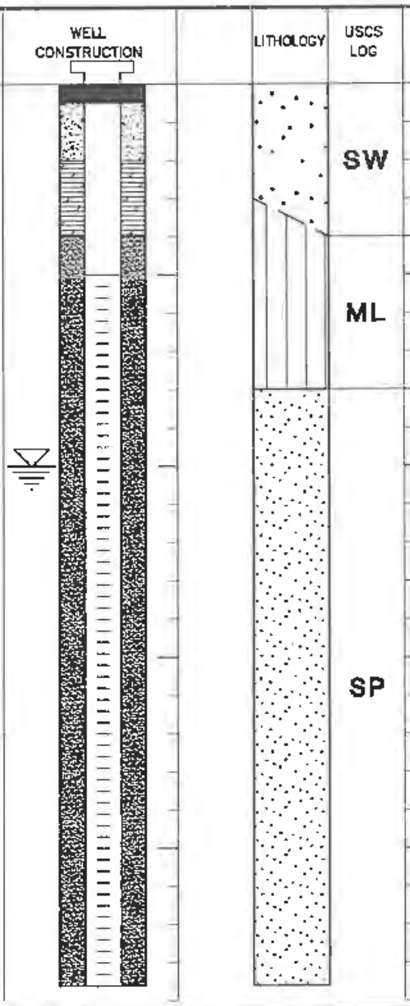
Boring/Well Name MW-8(R)

Project Name TACOMA METALS

Project Number 996098.00

ELEVATION AND DATUM 8.5	TOTAL DEPTH 23.6
DATE STARTED 05/09/2000	DATE COMPLETED 05/09/2000
INITIAL WATER DEPTH (FT) 10.0	
LOGGED BY TAH/DKM	
SAMPLING METHODS 2.5" ID SPLIT SPOON	WELL COMPLETION ▬ SURFACE HOUSING ▬ STAND PIPE 3.0 FT.

SAMPLES TYPE	RECOVERY (FEET)	PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.
S	1.5	25 25 22		
S	1.5	5 5 6	5	NMW-3-5.0
S	1.5	12 15 16	10	NMW-3-10.0
S	1.5	12 13 15	15	
			20	
S	1.5	12 15 15		NMW-3-22.1



SAMPLE DESCRIPTION AND DRILLING REMARKS

Well-graded SAND with gravel

Mixed gravelly sand with some silt, medium dense, brown, moist, mixed, contains some small metal scrap, no hydrocarbon sheen, no odor.

Sandy SILT

Sandy silt/silty sand. Fine sand, loose, gray, wet, heterogeneous, contains trace small wood fragments, no hydrocarbon odor, no sheen.

Poorly graded SAND

Angular to sub-angular fine to medium clean sand, dense, charcoal gray/black, wet, massive. Heavy sheen, very strong hydrocarbon odor. At 15' bgs, strong odor, no sheen. At 20' bgs, moderate odor, no sheen.

Boring & Well Construction Log

Kennedy/Jenks Consultants

BORING LOCATION	EAST OF STORAGE BUILDING			
DRILLING COMPANY	CASCADE DRILLING, INC.	**DRILLER** SCOTT KREUGER		
DRILLING METHOD	HOLLOW STEM AUGER	**DRILL BIT(S) SIZE:** 9 INCH		
ISOLATION CASING	NONE	**FROM**	**TO**	**FT.**
BLANK CASING	2" DIA. SCH 40 PVC	**FROM** 0.0	**TO** 5.0	**FT.**
PERFORATED CASING	2" DIA. SCH 40 PVC 0.010 SLOTTED	**FROM** 5.0	**TO** 23.5	**FT.**
SIZE AND TYPE OF FILTER PACK	LAPIS LUSTRE #2/12 SILICA	**FROM** 4.0	**TO** 23.5	**FT.**
SEAL	BENTONITE CHIPS	**FROM** 2.0	**TO** 4.0	**FT.**
GROUT	CONCRETE	**FROM** 0.0	**TO** 2.0	**FT.**

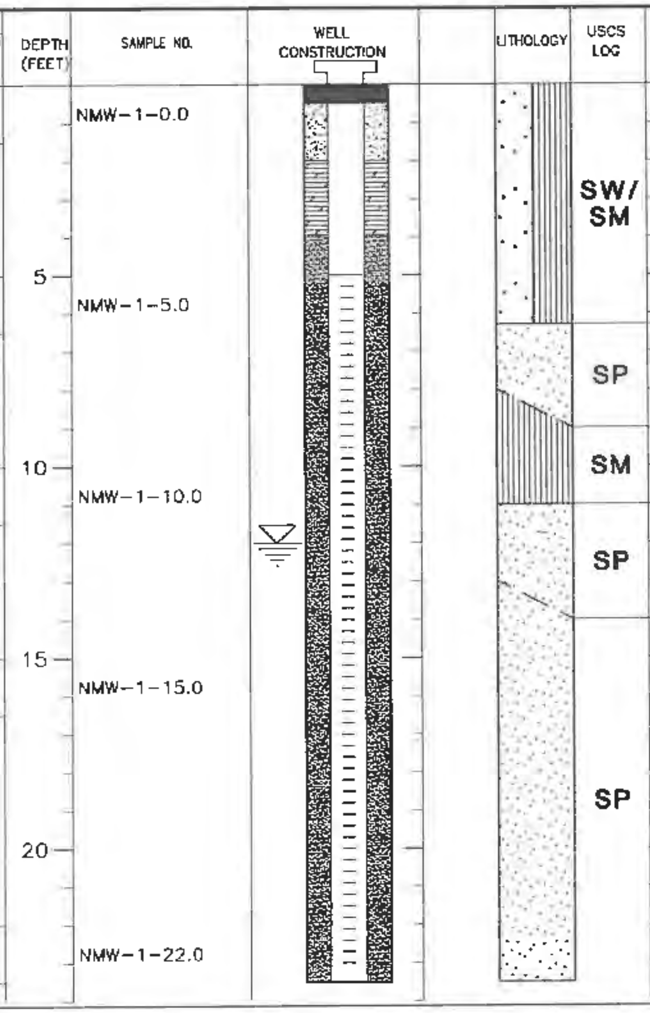
Boring/Well Name MW-9

Project Name TACOMA METALS

Project Number 996098.00

ELEVATION AND DATUM 12.0	TOTAL DEPTH 23.5
DATE STARTED 05/09/2000	DATE COMPLETED 05/09/2000
INITIAL WATER DEPTH (FT) 12.0	
LOGGED BY TAH/DKM	
SAMPLING METHODS 2.5" ID SPLIT SPOON	WELL COMPLETION ▬ SURFACE HOUSING ▬ STAND PIPE 3.0 FT.

SAMPLES TYPE	RECOVERY (FEET)	PENETRATION RESIST (BLOWS/6 IN.)	SAMPLE NO.
S	0.7	16 12 12	NMW-1-0.0
S	1.5	3 4 12	NMW-1-5.0
S	1.5	15 15 16	NMW-1-10.0
S	1.5	42 35 37	NMW-1-15.0
S	1.5	18 29 30	NMW-1-22.0



SAMPLE DESCRIPTION AND DRILLING REMARKS

Well-graded SAND with silt and gravel

Mixed gravelly sand with some silt, medium dense, brown, moist, contains some wood and small metal scrap, no hydrocarbon sheen, no odor.

Poorly graded SAND

Fine to medium sand (predominantly medium), medium dense, wet, gray, contains small glass fragments, no hydrocarbon sheen, no odor.

Silty SAND

Fine sand, medium dense, gray, wet, homogeneous, no hydrocarbon sheen, no odor.

Poorly graded SAND

Medium Sand, medium dense, gray, wet, homogeneous, no hydrocarbon sheen, no odor.

Poorly graded SAND

Angular to sub-angular fine to medium clean sand, dense, charcoal gray/black, wet, massive, no sheen, no odor

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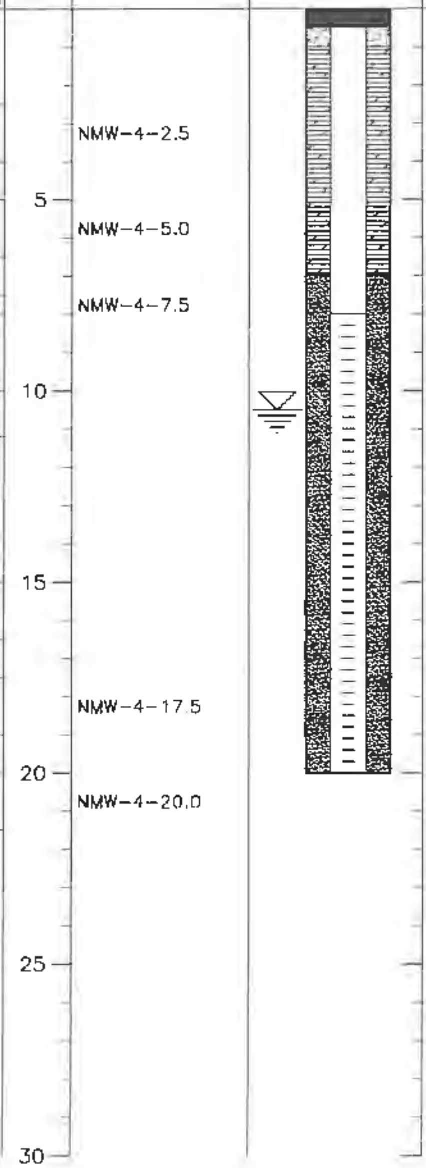
Boring & Well Construction Log

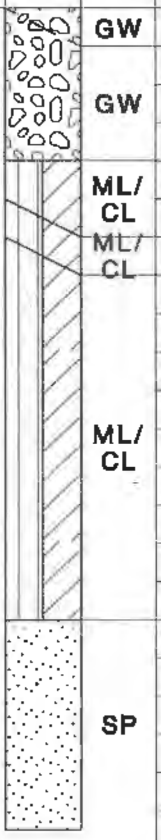
Kennedy/Jenks Consultants

BORING LOCATION	WEST PROPERTY LINE				
DRILLING COMPANY	CASCADE	DRILLER			
DRILLING METHOD	HSA	DRILL BIT(S) SIZE:	9 INCH		
ISOLATION CASING		FROM		TO	FT.
BLANK CASING	2-INCH SCHEDULE 40 PVC	FROM	0.0	TO	8.0 FT.
PERFORATED CASING	2-INCH SCHEDULE 40 PVC 0.010 SLOT	FROM	8.0	TO	20.0 FT.
SIZE AND TYPE OF FILTER PACK	RMC #2/12 LAPIS LUSTRE SAND	FROM	7.0	TO	20.0 FT.
SEAL	PURE GOLD MEDIUM BENTONITE CHIPS	FROM	1.0	TO	7.0 FT.
GROUT	CONCRETE	FROM	0.0	TO	1.0 FT.

Boring/Well Name	MW-10
Project Name	TACOMA METALS
Project Number	996098.00
ELEVATION AND DATUM	TOTAL DEPTH
DATE STARTED 11/10/1900	DATE COMPLETED 11/10/1900
INITIAL WATER DEPTH (FT) 10.5	
LOGGED BY DKM	
SAMPLING METHODS SPLIT SPOON	WELL COMPLETION ■ SURFACE HOUSING ☐ STAND PIPE ______ FT.

SAMPLES TYPE	RECOVERY (FEET)	PENETRATION RESIST (BLOWS/6 IN.)	SAMPLE NO.	OVA
S	1.0	16 12 9	NMW-4-2.5	0.0
S	1.5	4 5 6	NMW-4-5.0	0.0
S	0.5	6	NMW-4-7.5	10
S	1.0	10 7 50/3		
S	0.3	35 25 20		
S	1.5	5 7 10	NMW-4-17.5	7
S	1.0	4 10 10	NMW-4-20.0	6





SAMPLE DESCRIPTION AND DRILLING REMARKS

Well-graded GRAVEL with sand

Brown, dry, gravel (60%) with medium and fine sand (35%) and minor (<5%) silt.

Well-graded GRAVEL with sand

Medium brown, dry, gravel (50%) with fine and medium sand (50%). Gravel material is generally fine-grained.

Clayey SILT with sand

Light brown, crumbly, moderately dense silt with 5-10% fine sand. Includes some clay.

Clayey SILT

Mixed silt and clay, dark brown, soft, low density.

Clayey SILT

Brown to gray, wet, soft silt and fine sand with some clay. Mixed with wood debris. Wood debris is typically 85%-95% of material. Silt, sand and clay are around and coating the wood material.

Poorly graded SAND

Dark brown, wet, poorly graded medium to fine grained sand.

SHEET 1 OF 1

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Boring & Well Construction Log

Kennedy/Jenks Consultants

BORING LOCATION	WEST OF OCTAGON FOUNDATION			
DRILLING COMPANY	CASCADE	DRILLER		
DRILLING METHOD	HSA	DRILL BIT(S) SIZE:	12 INCH	
ISOLATION CASING		FROM	TO	FT.
BLANK CASING	4-INCH SCHEDULE 40 PVC	FROM 0.0	TO 6.0	FT.
PERFORATED CASING	4-INCH SCHEDULE 40 PVC 0.020 SLOT	FROM 6.0	TO 20.0	FT.
SIZE AND TYPE OF FILTER PACK	RMC #2/12 LAPIS LUSTRE SAND	FROM 5.0	TO 20.0	FT.
SEAL	PURE GOLD MEDIUM BENTONITE CHIPS	FROM 1.0	TO 5.0	FT.
GROUT	CONCRETE	FROM 0.0	TO 1.0	FT.

Boring/Well Name MW-11

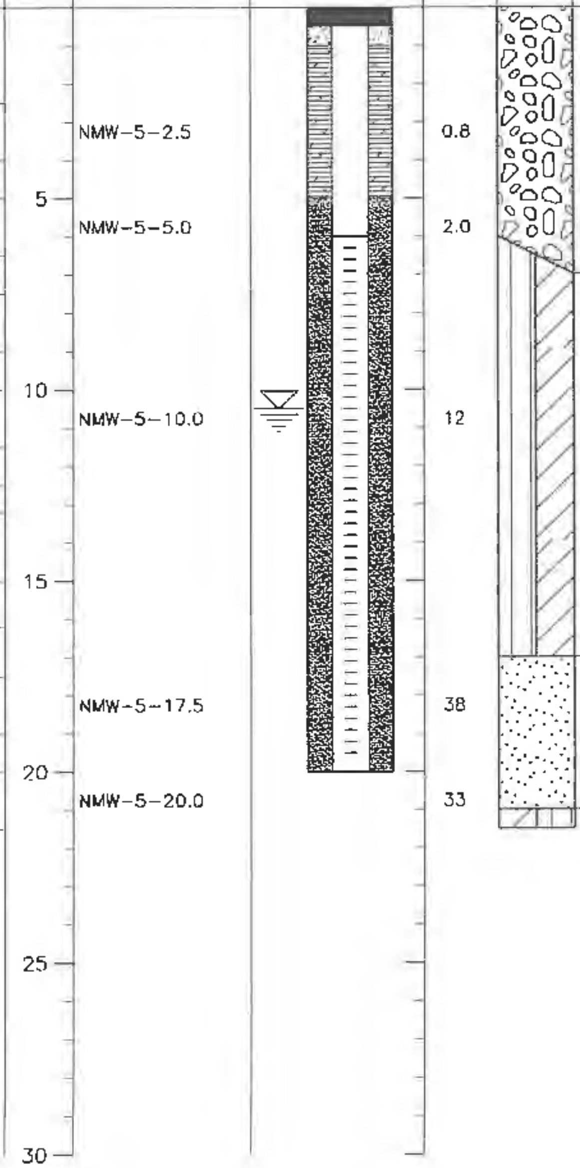
Project Name TACOMA METALS

Project Number 996098.00

ELEVATION AND DATUM	TOTAL DEPTH
DATE STARTED 11/10/1900	DATE COMPLETED 11/10/1900
INITIAL WATER DEPTH (FT) 10.5	
LOGGED BY DKM	
SAMPLING METHODS SPLIT SPOON	WELL COMPLETION ■ SURFACE HOUSING ▭ STAND PIPE ____ FT.

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	SAMPLE NO.	OVA
S	0.7	20 20 9	NMW-5-2.5	0.8
S	0.5	5 3 2	NMW-5-5.0	2.0
S		40 18 10		
S	0.2	23 13 8	NMW-5-10.0	12
S		50/3		
S	0.2	25 20 50/2		
S	0.4	7 10 12	NMW-5-17.5	38
S	1.5	2 5 37	NMW-5-20.0	33

DEPTH (FEET)



USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
GW	**Well-graded GRAVEL with sand** Gray to brown-orange, slightly moist, gravel with 25-30% sand and some (<5%) silt. Fill material.
ML/CL	**Clayey SILT** Brown to gray, wet, soft silt and fine sand with some clay. Mixed with wood debris. Wood debris is typically 85%-95% of material. Silt, sand and clay are around and coating the wood material.
SP	**Poorly graded SAND** Dark brown, wet, poorly graded medium to fine grained sand.
CL/ML	**Silty CLAY** Light brown, soft slay to silty clay with small fibrous wood fragments.

Boring & Well Construction Log

Kennedy/Jenks Consultants

BORING LOCATION	WEST OF MACHINE SHED			
DRILLING COMPANY	CASCADE	DRILLER		
DRILLING METHOD	HSA	DRILL BIT(S) SIZE: 12 INCH		
ISOLATION CASING		FROM	TO	FT.
BLANK CASING	4-INCH SCHEDULE 40 PVC	FROM 0.0	TO 7.0	FT.
PERFORATED CASING	4-INCH SCHEDULE 40 PVC 0.020 SLOT	FROM 7.0	TO 19.0	FT.
SIZE AND TYPE OF FILTER PACK	RMC #2/12 LAPIS LUSTRE SAND	FROM 6.0	TO 19.0	FT.
SEAL	PURE GOLD MEDIUM BENTONITE CHIPS	FROM 1.0	TO 6.0	FT.
GROUT	CONCRETE	FROM 0.0	TO 1.0	FT.

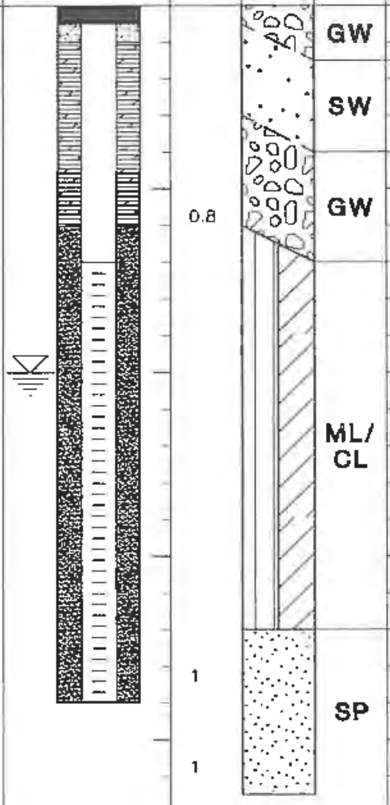
Boring/Well Name MW-12

Project Name TACOMA METALS

Project Number 996098.00

ELEVATION AND DATUM	TOTAL DEPTH
DATE STARTED 11/10/1900	DATE COMPLETED 11/10/1900
INITIAL WATER DEPTH (FT) 10	
LOGGED BY DKM	
SAMPLING METHODS SPLIT SPOON	WELL COMPLETION ■ SURFACE HOUSING ☐ STAND PIPE ____ FT.

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	OVA
S	0.3	6 14 14			
S	1.0	8 6 6	5	NMW-6-5.0	0.8
S	0.1	8 2 6			
S	0.5	5 5 15	10		
S	0.3	5 10 25			
S	0.2	4 7 35	15		
S	1.5	7 20 20		NMW-6-17.5	1
S	1.0	2 5 8	20	NMW-6-20.0	1
			25		
			30		



SAMPLE DESCRIPTION AND DRILLING REMARKS

Well-graded GRAVEL with sand

Dark brown to gray, slightly moist, gravel (55-60%) with sand (35%) and some silt (<5%).

Well-graded SAND with gravel

Medium brown sand and gravel (40%) with some silt (5%), moist, includes some wood fragments.

Well-graded GRAVEL with sand

Dark gray to brown, moist, gravel (60-65%) with sand.

Clayey SILT

Brown to gray, wet, soft silt and fine sand with some clay. Mixed with wood debris. Wood debris is typically 85%-95% of material. Silt, sand and clay are around and coating the wood material.

Poorly graded SAND

Gray/brown, wet, poorly graded medium to fine grained sand.

SHEET 1 OF 1

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Appendix E

Groundwater Purge and Sample Forms

Groundwater Purge and Sample Form Date: 3/14/00 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals

WELL NUMBER: MW-1

PROJECT NUMBER:

PERSONNEL: T Leavitt

STATIC WATER LEVEL (FT): 10.11

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: Solinst

PURGE METHOD: Peristaltic

TIME START PURGE: 10:05

PURGE DEPTH (FT) 14'

TIME END PURGE: 10:25

TIME SAMPLED: 10:18

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN) 2	4	6	=	CASING VOLUME (GAL)
	15.75		10.11		5.64		[✓ 0.16]	0.64	1.44		.9

TIME	10:07	10.10	10.13	10.16			
VOLUME PURGED (GAL)	.5	.5	.5	.5			
PURGE RATE (GPM)	.2	.2	.2	.2			
TEMPERATURE (°C)	56.5	56.7	56.5	56.5			
pH	6.61	6.52	6.53	6.55			
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	419	384	387	371			
DISSOLVED OXYGEN (mg/L)	-	-	-	-			
eH(MV)Pt-AgCl ref.	-	-	-	-			
TURBIDITY/COLOR	clear	-	-	-			
ODOR	NO	-	-	-			
DEPTH OF PURGE INTAKE (FT)	14'	-	-	-			
DEPTH TO WATER DURING PURGE (FT)	-	-	-	-			
NUMBER OF CASING VOLUMES REMOVED	.5	-	-	-			
DEWATERED?	NO	-	-	-			

Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals WELL NUMBER: MW-1

PROJECT NUMBER: ________ PERSONNEL: T Leavitt

SAMPLE DATA:

TIME SAMPLED: 10:05 COMMENTS: ________

DEPTH SAMPLED (FT): 14'

SAMPLING EQUIPMENT: Peristaltic

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
MW-1	2	Amber	NO	NO NO	1L ~~500~~ 1L ~~500~~				PCB PAH	
	2 3	VOA	HCl	NO	2 x 40ml 2 3 x 40ml				TPH-G VOCs	
	2	Amber	NO	NO	500 ml				TPH-D	
	1	HDPE	HNO3	Yes	500ml				metals	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): Drum COMMENTS: ________

DISPOSAL METHOD: ________

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND [✓ LOCK])?: YES [✓ NO]

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ________

GENERAL:

WEATHER CONDITIONS: ________

TEMPERATURE (SPECIFY °C OR °F): ________

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________
Job File: ________
Other: ________

Groundwater Purge and Sample Form Date: 3 13 00 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals WELL NUMBER: MW-2

PROJECT NUMBER: PERSONNEL: T Leavitt

STATIC WATER LEVEL (FT): 10.45 MEASURING POINT DESCRIPTION:

WATER LEVEL MEASUREMENT METHOD: Solinst PURGE METHOD:

TIME START PURGE: 3:43 PURGE DEPTH (FT)

TIME END PURGE:

TIME SAMPLED:

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)		DEPTH TO WATER (FT)		WATER COLUMN (FT)		MULTIPLIER FOR CASING DIAMETER (IN) 2	4	6		CASING VOLUME (GAL)
	15.64	-	10 45	=	5.19	X	[✓ 0.16]	0.64	1.44	=	.83

TIME	3 43	3 46	3:49	3.51	3:53	3:56	
VOLUME PURGED (GAL)	.5	.5	.5	.5	.5	5	
PURGE RATE (GPM)	.2	.2	.2	.2	.2	.2	
TEMPERATURE (°C)	54.4	53.3	52.9	53.1	53.0	52.9	
pH	6 60	6.64	6.67	6.68	6.67	6.70	
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	980	975	960	925	890	880	
DISSOLVED OXYGEN (mg/L)	—	—	—				
eH(MV)Pt-AgCl ref.	—	—	—				
TURBIDITY/COLOR	Clear	→					
ODOR	None	→					
DEPTH OF PURGE INTAKE (FT)	14'	→					
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED	.5	1/2	1/2	1/2			
DEWATERED?	no	→					

Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma metals WELL NUMBER: MV-2

PROJECT NUMBER: ________ PERSONNEL: ________

SAMPLE DATA:

TIME SAMPLED: ________ COMMENTS: ________

DEPTH SAMPLED (FT): ________

SAMPLING EQUIPMENT: ________

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
MV2	2	Amber	no	No	1L				PCB PAH	
|	2/3	VOA	HCl	No	40mL				TPH-G VOC	
|	2	Amb	no	NO	500				TPH-D	
✓	1	HDPE	HNO_3	Yes	500				metals	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): ________ COMMENTS: ________

DISPOSAL METHOD: ________

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: YES NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: YES NO

WELL CASING OK?: YES NO

COMMENTS: ________

GENERAL:

WEATHER CONDITIONS: ________

TEMPERATURE (SPECIFY °C OR °F): ________

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________
Job File: ________
Other: ________

Groundwater Purge and Sample Form Date: 3/14/00 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals
WELL NUMBER: MW-5/Dup-1
PROJECT NUMBER:
PERSONNEL: T Leavitt

STATIC WATER LEVEL (FT): 8.35
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: Solinst
PURGE METHOD: Peristaltic
TIME START PURGE: 11:35
PURGE DEPTH (FT) 13'
TIME END PURGE:
TIME SAMPLED: 11:45
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN) 2	4	6	=	CASING VOLUME (GAL)
	15.91		8.35		7.56		[✓ 0.16]	0.64	1.44		1.2

TIME	11:36	11:40	11:42	11:44			
VOLUME PURGED (GAL)	.5	.5	.5	.5			
PURGE RATE (GPM)	.2	.2	.2	.2			
TEMPERATURE (°C)	54.4	54.5	54.4	54.3			
pH	6.95	6.94	7.02	7.06			
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	360	362	361	361			
DISSOLVED OXYGEN (mg/L)	—	—	—	—			
eH(MV)Pt-AgCl ref.	—	—	—	—			
TURBIDITY/COLOR	Clear	—	—	—			
ODOR	ND	—	—	—			
DEPTH OF PURGE INTAKE (FT)	13'	—	—	—			
DEPTH TO WATER DURING PURGE (FT)	—	—	—	—			
NUMBER OF CASING VOLUMES REMOVED	—	—	—	—			
DEWATERED?	—	—	—	—			

Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma mtlS WELL NUMBER: MW-5

PROJECT NUMBER: ________ PERSONNEL: T Leavitt

SAMPLE DATA:

TIME SAMPLED: ________ COMMENTS: ________

DEPTH SAMPLED (FT): ________

SAMPLING EQUIPMENT: ________

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
MW-5	2	Amber	—	NO	1L				PCB PAH	
	2/3	VOA	HCL	NO	40				TPH-G VOC	
	2	Amb	—	NO	500				TPH-D	
	1	HDPE	HNO3	Y/S	500				mtls	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): ________ COMMENTS: ________

DISPOSAL METHOD: ________

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: YES [✓ NO]

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ________

GENERAL:

WEATHER CONDITIONS: ________

TEMPERATURE (SPECIFY °C OR °F): ________

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________
Job File: ________
Other: ________

Groundwater Purge and Sample Form Date: 3/14/00 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals

WELL NUMBER: MW-6

PROJECT NUMBER:

PERSONNEL: T Lewitt

STATIC WATER LEVEL (FT): 8.10

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: Solinst

PURGE METHOD: Peristaltic

TIME START PURGE: 10:48

PURGE DEPTH (FT) 13'

TIME END PURGE:

TIME SAMPLED: 11:09

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN) 2	4	6	=	CASING VOLUME (GAL)
	15.86		8.10		7.76		0.16	0.64	1.44		1.2

TIME	10:50	10:54	10:57	10:59	11:02	11:05	
VOLUME PURGED (GAL)	.5	.5	.5	.5	.5	.5	
PURGE RATE (GPM)	.2	.2	.2	.2	.2	.2	
TEMPERATURE (°C)	54.6	54.5	54.3	54.5	54.7	54.6	
pH	6.55	6.56	6.55	6.56	6.57	6.53	
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	959	901	878	821	792	788	
DISSOLVED OXYGEN (mg/L)	—	—	—	—	—	—	
eH(MV)Pt-AgCl ref.	—	—	—	—	—	—	
TURBIDITY/COLOR	slight	—	—	—	—	—	
ODOR	—	—	—				
DEPTH OF PURGE INTAKE (FT)	—	—	—	—	—	—	
DEPTH TO WATER DURING PURGE (FT)	—	—	—	—	—	—	
NUMBER OF CASING VOLUMES REMOVED	—	—	—	—	—	—	
DEWATERED?	—	—	—	—	—	—	

Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma metals WELL NUMBER: MW-6

PROJECT NUMBER: ________ PERSONNEL: T Leavitt

SAMPLE DATA:

TIME SAMPLED: ________ COMMENTS: ________

DEPTH SAMPLED (FT): ________

SAMPLING EQUIPMENT: ________

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
MW6	2	Amber	—		1L				PCB PAH	
	2/3	VOA	HCl		40				TPH-G VOC	
	2	Amber	—		500				TPH-D	
	1	HDPE	HNO3	Yes	500				metals	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): ________ COMMENTS: ________

DISPOSAL METHOD: ________

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: YES [✓ NO]

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ________

GENERAL:

WEATHER CONDITIONS: ________

TEMPERATURE (SPECIFY °C OR °F): ________

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________

Job File: ________

Other: ________

Groundwater Purge and Sample Form Date: 3/17/00 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals
WELL NUMBER: MW-7
PROJECT NUMBER:
PERSONNEL: T Leavitt

STATIC WATER LEVEL (FT): 4 50
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: Solinst
PURGE METHOD: Peristaltic
TIME START PURGE: 2:30
PURGE DEPTH (FT) 13'
TIME END PURGE:
TIME SAMPLED: 2:50

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)		DEPTH TO WATER (FT)		WATER COLUMN (FT)		MULTIPLIER FOR CASING DIAMETER (IN) 2	4	6		CASING VOLUME (GAL)
	13.81	-	4.50	=	9 3	X	[✓ 0.16]	0.64	1.44	=	1.5

TIME	2:40	2:43	2 45	2 48			
VOLUME PURGED (GAL)	.5	.5	.5	.5			
PURGE RATE (GPM)	.2	.2	.2	.2			
TEMPERATURE (°C)	50.7	50.3	50.0	50.1			
pH	6.62	6.57	6.55	6.54			
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	220	218	215	213			
DISSOLVED OXYGEN (mg/L)	—	—	—	—			
eH(MV)Pt-AgCl ref.	—	—					
TURBIDITY/COLOR	Clear						
ODOR	No						
DEPTH OF PURGE INTAKE (FT)	13'						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED							
DEWATERED?							

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Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma metals WELL NUMBER: MW-7

PROJECT NUMBER: ________ PERSONNEL: T Lewitt

SAMPLE DATA:

TIME SAMPLED: 2:50 COMMENTS: ________

DEPTH SAMPLED (FT): 13'

SAMPLING EQUIPMENT: Peristltic

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
MW-7	2	Amber	—	/	1L				PCB PAH	
	2/3	VOA	Hcl	/	40				TPH-G VOC	
	2	Amb	/	—	500				TPH-D	
	1	HDPE	HNO3	Yes	500				metals	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): Drum COMMENTS: ________

DISPOSAL METHOD: ________

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: YES [✓ NO]

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ________

GENERAL:

WEATHER CONDITIONS: ________

TEMPERATURE (SPECIFY °C OR °F): ________

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________

Job File: ________

Other: ________

Groundwater Purge and Sample Form

Date: 4/17/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS

WELL NUMBER: NMW-5

PROJECT NUMBER: 996098.00

PERSONNEL: DKM / JRB

STATIC WATER LEVEL (FT): 7.36

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD:

PURGE METHOD: SUB. PUMP

TIME START PURGE: 11:05

PURGE DEPTH (FT) VARIABLE

TIME END PURGE: 12:15

TIME SAMPLED:

COMMENTS: INITIAL WELL DEVELOPMENT

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)		DEPTH TO WATER (FT)		WATER COLUMN (FT)		MULTIPLIER FOR CASING DIAMETER (IN)				CASING VOLUME (GAL)
							2	[✓ 4]	6		
	20	-	7.36	=	12.64	X	0.16	0.64	1.44	=	8.09

TIME	11:20	11:30	11:45	11:55	12:02	12:06	12:10
VOLUME PURGED (GAL)	20	35	50	65	75	85	95
PURGE RATE (GPM)							
TEMPERATURE (°C)	13.0	12.7	12.6	12.2	12.3	12.2	12.1
pH	7.04	7.00	7.02	7.05	7.02	7.01	7.00
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	519	514	275	256	255	251	249
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	MED-BROWN	MED BROWN	MED BROWN	MED BROWN	LT BROWN	LT BROWN	LT BROWN
ODOR	MOD HC MS	MOD HC MS	MOD HC SS	MOD HC SS	SL HC VSS	SL HC VSS	SL HC NS
DEPTH OF PURGE INTAKE (FT)							
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED							
DEWATERED?							

Groundwater Purge and Sample Form

Date: 11/17/00

Kennedy/Jenks Consultants

PROJECT NAME: Tacoma Metals

WELL NUMBER: MW-5

PROJECT NUMBER: 996098.00

PERSONNEL:

SAMPLE DATA:

TIME SAMPLED:

COMMENTS:

DEPTH SAMPLED (FT):

SAMPLING EQUIPMENT:

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL):

COMMENTS:

DISPOSAL METHOD: DRUM.

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: YES NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: YES NO

WELL CASING OK?: YES NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS:

TEMPERATURE (SPECIFY °C OR °F):

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:

Job File:

Other:

Groundwater Purge and Sample Form Date: 1/17/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS

WELL NUMBER: NMW-6

PROJECT NUMBER: 996098.00

PERSONNEL: DKM/JRB

STATIC WATER LEVEL (FT): 8.7

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD:

PURGE METHOD: SUB. PUMP

TIME START PURGE: 12:30

PURGE DEPTH (FT) VARIABLE

TIME END PURGE:

TIME SAMPLED:

COMMENTS: INITIAL WELL DEVELOPMENT.

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							2	[✓ 4]	6		
	19		8.7		10.3		0.16	0.64	1.44		6.6

TIME	12:44	1:00	1:10	1:20	1:25	1:32	
VOLUME PURGED (GAL)	20	35	50	60	70	80	
PURGE RATE (GPM)							
TEMPERATURE (°C)	13.4	13.1	13.0	15.1	15.1	13.9	
pH	7.02	6.98	6.97	6.91	6.91	6.97	
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	451	458	455	438	452	450	
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	High Brown	High Brown	MOD BROWN	LT Brown LOW	LT LOW Brown	LT LOW Brown	
ODOR	mod slt. sheen HC	MOD SS HC	MOD SS HC	SL SS HC	SL SS HC	SL VSS HC	
DEPTH OF PURGE INTAKE (FT)							
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED							
DEWATERED?							

Groundwater Purge and Sample Form Date: 1/17/01 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals WELL NUMBER: DMW-6

PROJECT NUMBER: 996092.00 PERSONNEL: ____________________

SAMPLE DATA:

TIME SAMPLED: ____________________ COMMENTS: ____________________

DEPTH SAMPLED (FT): ____________________

SAMPLING EQUIPMENT: ____________________

SAMPLE NO.	NO. OF CONTAIN-ERS	CON-TAINER TYPE	PRESER-VATIVE	FIELD FILTRA-TION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUS-TODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): ____________________ COMMENTS: ____________________

DISPOSAL METHOD: ____________________

DRUM DESIGNATION(S)/VOLUME PER (GAL): ____________________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: YES NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: YES NO

WELL CASING OK?: YES NO

COMMENTS: ____________________

GENERAL:

WEATHER CONDITIONS: ____________________

TEMPERATURE (SPECIFY °C OR °F): ____________________

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ____________________

cc: Project Manager: ____________________
Job File: ____________________
Other: ____________________

Groundwater Purge and Sample Form Date: 11/20/00 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals
WELL NUMBER: NMW-4
PROJECT NUMBER:
PERSONNEL: DKM/JRB

STATIC WATER LEVEL (FT): 8.21
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: Heron
PURGE METHOD: Peristaltic
TIME START PURGE: 9:38
PURGE DEPTH (FT) ~14
TIME END PURGE:
TIME SAMPLED: 10:00
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	20		8 21		11.79		0.16	0.64	1.44		1.89

TIME	9:43	9:52	9:54	9:57			
VOLUME PURGED (GAL)	1/2	1	1 1/2	2			
PURGE RATE (GPM)							
TEMPERATURE (°C)	15.8	15.8	15.7	15.5			
pH	6.23	6.32	6.33	6.28			
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	300	293	293	299			
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	clear	clear	clear	clear			
ODOR	MOD HC	MOD HC	MOD HC	MOD HC			
DEPTH OF PURGE INTAKE (FT)	~14			→			
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED				≈1			
DEWATERED?	N			→			

Groundwater Purge and Sample Form

Date: 11/20/00

Kennedy/Jenks Consultants

PROJECT NAME: Tacoma Metals

WELL NUMBER: NMW-4

PROJECT NUMBER:

PERSONNEL: DKM/JRB

SAMPLE DATA:

TIME SAMPLED:

COMMENTS:

DEPTH SAMPLED (FT): ~14

SAMPLING EQUIPMENT: Peristaltic

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO_3	N	1 L	Clear		✓	Tot. Metal	
2	1	P	HNO_3	Y	1 L				Diss Metal	
3	1	A	—	N	1 L				Diesel	
4	1	A	—	N	1 L				PCB	
5	1	A	—	N	1 L				PAH	
6	3	VOA	HCl	N	120 ml				VOC	
7	2	VOA	HCl	N	80 ml	↓		↓	Gas	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 2

COMMENTS:

DISPOSAL METHOD: Drummed on site

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS: Cold & Clear

TEMPERATURE (SPECIFY °C OR °F): 40

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:

Job File:

Other:

Groundwater Purge and Sample Form Date: 4/20/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS

WELL NUMBER: NMW-5

PROJECT NUMBER:

PERSONNEL: JRB

STATIC WATER LEVEL (FT): 7.70

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: HERON

PURGE METHOD: PERISTALTIC

TIME START PURGE: 10:21

PURGE DEPTH (FT) ~13'

TIME END PURGE:

TIME SAMPLED:

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							2	[✓ 4]	6		
	20		7.70		12.3		0.16	0.64	1.44		7.87

TIME	10:40	10:58	11:15	11:22	11:28	11:32	
VOLUME PURGED (GAL)	2	4	6	7	7½	8	
PURGE RATE (GPM)							
TEMPERATURE (°C)	12.5	12.8	12.5	12.9	12.6	12.5	
pH	6.7	6.7	6.6	6.57	6.55	6.55	
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	303	306	296	287	286	283	
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	clear	clear	clear	clear	clear	clear	
ODOR	MOD HC	MOD HC	MOD HC	MOD HC	MOD HC	MOD HC	
DEPTH OF PURGE INTAKE (FT)	~13					→	
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED						≈1	
DEWATERED?	N						→

Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS
WELL NUMBER: NMW-5
PROJECT NUMBER: ________
PERSONNEL: JRB

SAMPLE DATA:
TIME SAMPLED: ________
COMMENTS: ________
DEPTH SAMPLED (FT): ~13
SAMPLING EQUIPMENT: PERISTALTIC

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1L	clear		Y	Total Metal	
2	1	P	HNO3	Y	1L				Diss Metal	
3	1	A	—	N	1L	↓		↓	Diesel	
4	1	A	—	N	1L				PCB	
5	1	A	—	N	1L				PAH	
6	3	VOA	HCl	N	120ml				VOC	
7	2	VOA	HCl	N	80ml				GAS	

PURGE WATER DISPOSAL NOTES:
TOTAL DISCHARGE (GAL): ~8
COMMENTS: ________
DISPOSAL METHOD: DRUMMED ONSITE
DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):
WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO
INSIDE OF WELL HEAD AND OUTER CASING DRY?: YES [✓ NO]
WELL CASING OK?: [✓ YES] NO
COMMENTS: ________

GENERAL:
WEATHER CONDITIONS: ________
TEMPERATURE (SPECIFY °C OR °F): COLD/CLEAR 40'
PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________
Job File: ________
Other: ________

Groundwater Purge and Sample Form Date: 11/20/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: NMW-6

PROJECT NUMBER: 996098.00 PERSONNEL: JRB DKM

STATIC WATER LEVEL (FT): 9.22 MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: HERON PURGE METHOD: PERISTALTIC

TIME START PURGE: 12:02 PURGE DEPTH (FT) ~ 12

TIME END PURGE:

TIME SAMPLED:

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)		DEPTH TO WATER (FT)		WATER COLUMN (FT)		MULTIPLIER FOR CASING DIAMETER (IN)				CASING VOLUME (GAL)
							2	[✓ 4]	6		
	19	-	9.22	=	9.78	X	0.16	0.64	1.44	=	6.26

TIME	12:15	11:20	12:35	12:40	12:46	12:52	
VOLUME PURGED (GAL)	1 1/2	2 1/2	4	5	6	6 1/2	
PURGE RATE (GPM)							
TEMPERATURE (°C)	12.7	12.6	12.2	12.1	12.2	12.3	
pH	6.28	6.42	6.36	6.45	6.43	6.46	
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	500	472	436	435	432	431	
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	clear →						
ODOR	SL-MOD HC	SL-MOD HC					
DEPTH OF PURGE INTAKE (FT)	~12						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED						≈ 1	
DEWATERED?	N →						

Groundwater Purge and Sample Form Date: 1/20/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: NMW-6

PROJECT NUMBER: ______ PERSONNEL: [illegible]

SAMPLE DATA:

TIME SAMPLED: ______ COMMENTS: ______

DEPTH SAMPLED (FT): ~12'

SAMPLING EQUIPMENT: PERISTALTIC

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1L	Clear		Y	TOTAL METAL	
2	1	P	HNO3	Y	1L	↓			DISS METAL	
3	1	A	—	N	1L			↓	DIESEL	
4	1	A	—	N	1L				PCB	
5	1	A	—	N	1L				PAH	
6	3	VOA	HCl	N	120ml				VOC	
7	2	VOA	HCl	N	80ml				GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 6.5 COMMENTS: ______

DISPOSAL METHOD: DRUMMED ONSITE

DRUM DESIGNATION(S)/VOLUME PER (GAL): ______

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ______

GENERAL:

WEATHER CONDITIONS: ______

TEMPERATURE (SPECIFY °C OR °F): COLD / CLEAR 40°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ______

cc: Project Manager: ______
Job File: ______
Other: ______

Groundwater Purge and Sample Form Date: 11/20 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS
WELL NUMBER: NMW-3
PROJECT NUMBER:
PERSONNEL: JRB

STATIC WATER LEVEL (FT): 9.1
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: HERON
PURGE METHOD: PERASTALTIC
TIME START PURGE: 1:24
PURGE DEPTH (FT) ~14
TIME END PURGE:
TIME SAMPLED:
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	23.5		9.1		14.4		0.16	0.64	1.44		2.304

TIME	1:42	1:46	1:51	1:56	2:02		
VOLUME PURGED (GAL)	1/2	1	1 1/2	2	2 1/2		
PURGE RATE (GPM)							
TEMPERATURE (°C)	14.2	14.1	13.8	13.6	13.7		
pH	6.50	6.57	6.61	6.66	6.68		
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	433	429	425	424	419		
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	clear	→	→	→	→		
ODOR	MOD HC	MOD HC	MOD HC	MOD HC	MOD HC		
DEPTH OF PURGE INTAKE (FT)							
DEPTH TO WATER DURING PURGE (FT)	~14						
NUMBER OF CASING VOLUMES REMOVED					≈1		
DEWATERED?	N	→	→	→	→		

Groundwater Purge and Sample Form Date: 11/20/10 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: NMW-3

PROJECT NUMBER: 996098.00 PERSONNEL: JRB

SAMPLE DATA:

TIME SAMPLED: COMMENTS:

DEPTH SAMPLED (FT): ~14

SAMPLING EQUIPMENT: PERISTALTIC

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO_3	N	1L	clear		Y	TOTAL METALS	
2	1	P	HNO_3	Y	1L				DISS METALS	
3	1	A	—	N	1L				DIESEL	
4	1	A	—	N	1L				PCB	
5	1	A	—	N	1L				PAH	
6	3	VOA	HCl	N	120ml				VOC	
7	2	VOA	HCl	N	80ml	↓		↓	GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 2 1/2 COMMENTS:

DISPOSAL METHOD: DRUMMED ONSITE

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: YES [✓ NO]

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS:

TEMPERATURE (SPECIFY °C OR °F): COLD/CLEAR @40°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form Date: 11/20/06 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals

WELL NUMBER: NMW-2

PROJECT NUMBER:

PERSONNEL: JRB

STATIC WATER LEVEL (FT): 10.2

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: Heron

PURGE METHOD: PERISTALTIC

TIME START PURGE: 2:56

PURGE DEPTH (FT) ~14

TIME END PURGE:

TIME SAMPLED:

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)		DEPTH TO WATER (FT)		WATER COLUMN (FT)		MULTIPLIER FOR CASING DIAMETER (IN)				CASING VOLUME (GAL)
							[✓ 2]	4	6		
	23	-	10.2	=	12.8	X	0.16	0.64	1.44	=	2.05

TIME	3:01	3:06	3:12	3:17	3:22		
VOLUME PURGED (GAL)	1/2	1	1 1/2	2	2 1/2		
PURGE RATE (GPM)							
TEMPERATURE (°C)	11.7	13.0	13.1	13.0	13.0		
pH	6.40	6.41	6.41	6.43	6.42		
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	595	562	543	535	536		
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	Clear				→		
ODOR	SL → MOD HC	SL-MOD HC	SL-MOD HC	SL-MOD HC	SL-MOD HC		
DEPTH OF PURGE INTAKE (FT)							
DEPTH TO WATER DURING PURGE (FT)	~14						
NUMBER OF CASING VOLUMES REMOVED					≈1		
DEWATERED?	N				→		

Groundwater Purge and Sample Form Date: 4/20/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: NMW-2

PROJECT NUMBER: PERSONNEL: JRB

SAMPLE DATA:

TIME SAMPLED: COMMENTS: TOC

DEPTH SAMPLED (FT): ~ 14 PERISTALTIC

SAMPLING EQUIPMENT: PERISTALTIC

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1L	CLEAR		Y	TOTAL METAL	
2	1	P	HNO3	Y	1L				DISS METAL	
3	1	A	–	N	1L				DIESEL	
4	1	A	–	N	1L				PCB	
5	1	A	–	N	1L				PAH	
6	3	VOA	HCl	N	120ML				VOC	
7	2	VOA	HCl	N	80mL				GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 2.5 COMMENTS:

DISPOSAL METHOD: DRUMMED ONSITE

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS: COLD/CLEAR 40°

TEMPERATURE (SPECIFY °C OR °F):

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form Date: 11/21/00 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals
WELL NUMBER: MW-5
PROJECT NUMBER:
PERSONNEL: JRB

STATIC WATER LEVEL (FT): 10.5
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: HERON
PURGE METHOD: PERISTALTIC
TIME START PURGE: 8:41
PURGE DEPTH (FT) ~13
TIME END PURGE:
TIME SAMPLED:
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	16		10.5		5.5		0.16	0.64	1.44		.88

TIME	8:47	8:53	8:59				
VOLUME PURGED (GAL)	1/2	1	1 1/2				
PURGE RATE (GPM)							
TEMPERATURE (°C)	12.1	12.4	12.2				
pH	6.2	6.26	6.27				
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	536	525	504				
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	clear →	→	→				
ODOR	organic →	→	→				
DEPTH OF PURGE INTAKE (FT)	~13						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED			≃ 1				
DEWATERED?	N →	→	→	→	→		

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Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: MW-5

PROJECT NUMBER: ________ PERSONNEL: JRB

SAMPLE DATA:

TIME SAMPLED: ________ COMMENTS: ________

DEPTH SAMPLED (FT): ~13

SAMPLING EQUIPMENT: PERISTALTIC

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1L	clear		Y	total metal	
2	1	P	HNO3	Y	1L				Diss metal	
3	1	A	—	N	1L				Diesel	
4	1	A	—	N	1L				PCB	
5	1	A	—	N	1L				PAH	
6	3	VOA	Hcl	N	120ml				VOC	
7	2	VOA	HCl	N	80ml				GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 1 1/2 COMMENTS: ________

DISPOSAL METHOD: Drummed onsite

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ________

GENERAL:

WEATHER CONDITIONS: COLD / CLEAR

TEMPERATURE (SPECIFY °C OR °F): @40'

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________
Job File: ________
Other: ________

Groundwater Purge and Sample Form Date: 11/21/00 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals

WELL NUMBER: MW-6

PROJECT NUMBER: 996098.00

PERSONNEL: RB

STATIC WATER LEVEL (FT): 9.6

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: Heron

PURGE METHOD: Peristaltic

TIME START PURGE: 9:36

PURGE DEPTH (FT) ~13

TIME END PURGE:

TIME SAMPLED:

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)		DEPTH TO WATER (FT)		WATER COLUMN (FT)		MULTIPLIER FOR CASING DIAMETER (IN)				CASING VOLUME (GAL)
		-		=		X	[✓ 2]	4	6	=	
	16		9.6		6.4		0.16	0.64	1.44		1.024

TIME	9:41	9:47	9:52						
VOLUME PURGED (GAL)	1/2	1	1 1/2						
PURGE RATE (GPM)									
TEMPERATURE (°C)	12.1	11.9	11.8						
pH	6.63	6.60	6.56						
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	621	619	623						
DISSOLVED OXYGEN (mg/L)									
eH(MV)Pt-AgCl ref.									
TURBIDITY/COLOR	clear								
ODOR	organic								
DEPTH OF PURGE INTAKE (FT)									
DEPTH TO WATER DURING PURGE (FT)	13								
NUMBER OF CASING VOLUMES REMOVED									
DEWATERED?									

Groundwater Purge and Sample Form Date: 4/21/00 **Kennedy/Jenks Consultants**

PROJECT NAME: ______ WELL NUMBER: ______

PROJECT NUMBER: ______ PERSONNEL: ______

SAMPLE DATA:

TIME SAMPLED: ______ COMMENTS: ______

DEPTH SAMPLED (FT): ______

SAMPLING EQUIPMENT: ______

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1L	clear		Y		
2	1	P	HNO3	Y	1L	↓		↓		
3	1	A	–	N	1L					
4	1	A	–	N	1L					
5	1	A	–	N	1L					
6	3	VOA	HCl	N	120ml					
7	2	VOA	HCl	N	80ml					

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): ______ COMMENTS: ______

DISPOSAL METHOD: ______

DRUM DESIGNATION(S)/VOLUME PER (GAL): ______

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ______

GENERAL:

WEATHER CONDITIONS: COLD/CLEAR

TEMPERATURE (SPECIFY °C OR °F): 40° F

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ______

cc: Project Manager: ______
Job File: ______
Other: ______

Groundwater Purge and Sample Form Date: 11/21/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS
WELL NUMBER: MW-2
PROJECT NUMBER:
PERSONNEL: JRB

STATIC WATER LEVEL (FT): 11.4
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: HERON
PURGE METHOD: PERISTALTIC
TIME START PURGE: 11:24
PURGE DEPTH (FT) ~13
TIME END PURGE:
TIME SAMPLED:
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	16		11.4		4.6		0.16	0.64	1.44		.736

TIME	11:24	11:30	11:36				
VOLUME PURGED (GAL)	1/2	1	1 1/2				
PURGE RATE (GPM)							
TEMPERATURE (°C)	11.8	11.9	12.0				
pH	6.48	6.46	6.44				
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	662	654	657				
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	CLEAR →						
ODOR	None →						
DEPTH OF PURGE INTAKE (FT)	~13						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED			≈ 1				
DEWATERED?	N →						

Groundwater Purge and Sample Form Date: 11/21/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: MW-2

PROJECT NUMBER: PERSONNEL:

SAMPLE DATA:

TIME SAMPLED: COMMENTS:

DEPTH SAMPLED (FT): ~13

SAMPLING EQUIPMENT: PERISTALTIC

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1L	Clear		Y	TOTAL	METAL
2	1	P	HNO3	Y	1L				DISS	METAL
3	1	A	—	N	1L				DIESEL	
4	1	A	—	N	1L				PCB	
5	1	A	—	N	1L				OAH	
6	3	VOA	HCl	N	120 ml				VOC	
7	2	VOA	HCl	N	80 ml				GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 1 1/2 COMMENTS:

DISPOSAL METHOD: Drummed onsite

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS: COLD/CLEAR

TEMPERATURE (SPECIFY °C OR °F): 40°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form Date: 11/21/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: NMW-1

PROJECT NUMBER: 996098.00 PERSONNEL: JRB

STATIC WATER LEVEL (FT): 12.65 MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: HERON PURGE METHOD: PERISTALTIC

TIME START PURGE: 12:05 PURGE DEPTH (FT) ~14

TIME END PURGE:

TIME SAMPLED:

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	23.5		12.65		10.85		0.16	0.64	1.44		1.73

TIME	12:11	12:16	12:21	12:26				
VOLUME PURGED (GAL)	1/2	1	1 1/2	2				
PURGE RATE (GPM)								
TEMPERATURE (°C)	12.4	12.2	12.1	12.0				
pH	6.64	6.63	6.61	6.61				
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	783	812	819	831				
DISSOLVED OXYGEN (mg/L)								
eH(MV)Pt-AgCl ref.								
TURBIDITY/COLOR	clear	→						
ODOR	none	→						
DEPTH OF PURGE INTAKE (FT)	~14							
DEPTH TO WATER DURING PURGE (FT)								
NUMBER OF CASING VOLUMES REMOVED				≈1				
DEWATERED?	N	→						

Groundwater Purge and Sample Form Date: 11/21/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: DMW-1

PROJECT NUMBER: PERSONNEL: JRB

SAMPLE DATA:

TIME SAMPLED: COMMENTS:

DEPTH SAMPLED (FT): ~14

SAMPLING EQUIPMENT: PERISTALTIC

SAMPLE NO.	NO. OF CONTAIN-ERS	CON-TAINER TYPE	PRESER-VATIVE	FIELD FILTRA-TION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUS-TODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1L	Clear		Y	TOTAL METAL	
2	1	P	HNO3	Y	1L	↓		↓	DISS METAL	
3	1	A	—	N	1L	↓		↓	DIESEL	
4	1	A	—	N	1L	↓		↓	PCB	
5	1	A	—	N	1L	↓		↓	PAH	
6	3	VOA	HCl	N	120ml	↓		↓	VOC	
7	2	VOA	HCl	N	80ml	↓		↓	GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 2 COMMENTS:

DISPOSAL METHOD: DRUMMED ONSITE

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS: COLD / CLEAR 40'

TEMPERATURE (SPECIFY °C OR °F):

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form Date: 11/21/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS

WELL NUMBER: MW-7

PROJECT NUMBER: 99609800

PERSONNEL:

STATIC WATER LEVEL (FT): 7.68

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: Heron

PURGE METHOD: Peristaltic

TIME START PURGE: 1:15

PURGE DEPTH (FT):

TIME END PURGE:

TIME SAMPLED:

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	14	-	7.68	=	6.32	X	0.16	0.64	1.44	=	1.01

TIME	1:20	1:25	1:30					
VOLUME PURGED (GAL)	1/2	1	1 1/2					
PURGE RATE (GPM)								
TEMPERATURE (°C)	13.5	13.6	13.3					
pH	6.36	6.35	6.34					
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	428	407	409					
DISSOLVED OXYGEN (mg/L)								
eH(MV)Pt-AgCl ref.								
TURBIDITY/COLOR	clear →							
ODOR	SL HC	SL HC	SL HC					
DEPTH OF PURGE INTAKE (FT)	~11							
DEPTH TO WATER DURING PURGE (FT)								
NUMBER OF CASING VOLUMES REMOVED								
DEWATERED?	N →							

Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: ____________ WELL NUMBER: MW-7

PROJECT NUMBER: ____________ PERSONNEL: ____________

SAMPLE DATA:

TIME SAMPLED: ____________ COMMENTS: ____________

DEPTH SAMPLED (FT): ____________

SAMPLING EQUIPMENT: ____________

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO_3	N	1L	clear		Y		
2	1	P	HNO_3	Y	1L					
3	1	A	–	N	1L					
4	1	A	–	N	1L					
5	1	A	–	N	1L					
6	3	VOA	HCl	N	120ml					
7	2	VOA	HCl	N	80ml					

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): ____________ COMMENTS: ____________

DISPOSAL METHOD: ____________

DRUM DESIGNATION(S)/VOLUME PER (GAL): ____________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ____________

GENERAL:

WEATHER CONDITIONS: COLD / CLEAR

TEMPERATURE (SPECIFY °C OR °F): 40° F

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ____________

cc: Project Manager: ____________
Job File: ____________
Other: ____________

Groundwater Purge and Sample Form Date: 4/21/00 **Kennedy/Jenks Consultants**

PROJECT NAME: tacoma metals
WELL NUMBER: MW-1
PROJECT NUMBER: 994098.00
PERSONNEL: JRB

STATIC WATER LEVEL (FT): 11.52
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: HERON
PURGE METHOD: PERISTALTIC
TIME START PURGE: 10:35
PURGE DEPTH (FT) ≈13
TIME END PURGE:
TIME SAMPLED:
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	16		11.52		4.48		0.16	0.64	1.44		.72

TIME	10:35	10:40	10:45					
VOLUME PURGED (GAL)	1/2	1	1 1/2					
PURGE RATE (GPM)								
TEMPERATURE (°C)	13.5	13.5	13.8					
pH	6.47	6.48	6.48					
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	548	536	531					
DISSOLVED OXYGEN (mg/L)								
eH(MV)Pt-AgCl ref.								
TURBIDITY/COLOR	clear	→	→					
ODOR	NONE	→	→					
DEPTH OF PURGE INTAKE (FT)	~13							
DEPTH TO WATER DURING PURGE (FT)								
NUMBER OF CASING VOLUMES REMOVED				≈ 1				
DEWATERED?	N	→	→	→				

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Groundwater Purge and Sample Form Date: 6/21/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: MW-1

PROJECT NUMBER: PERSONNEL:

SAMPLE DATA:

TIME SAMPLED: COMMENTS:

DEPTH SAMPLED (FT): ~13

SAMPLING EQUIPMENT:

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1L	clear		Y		
2	1	P	HNO3	Y	1L					
3	1	A	—	N	1L					
4	1	A	—	N	1L					
5	1	A	—	N	1L					
6	3	VOA	HCl	N	120mL					
7	2	VOA	HCl	N	80ml	↓		↓		

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 1 1/2 COMMENTS:

DISPOSAL METHOD: Drummed onsite

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS:

TEMPERATURE (SPECIFY °C OR °F): COLD/CLEAR 40°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? No

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form Date: 11/20/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS
WELL NUMBER: NMW-3
PROJECT NUMBER: 996098.00
PERSONNEL: DMK, JRB

STATIC WATER LEVEL (FT): 9.0
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: HERON
PURGE METHOD: PERASTALTIC
TIME START PURGE: 9:47
PURGE DEPTH (FT) ~19
TIME END PURGE:
TIME SAMPLED:
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
			9.1		14.4		[✓ 2]	4	6		2.304 ~/4
	23.5		9		14.5		0.16	0.64	1.44		2.32

TIME	10:00	10:07	10:14	10:20			
VOLUME PURGED (GAL)	1	1 1/2	2	2 1/2			
PURGE RATE (GPM)							
TEMPERATURE (°C)	13.45	13.47	13.50	13.45			
pH	6.50	6.45	6.44	6.44			
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	437	416	412	408			
DISSOLVED OXYGEN (mg/L)	4.42	4.95	4.29	5.43			
eH(MV)Pt-AgCl ref. ORP	-32.6	-21.7	-29.7	-16.4			
TURBIDITY/COLOR	clear	→	→	→			
ODOR	no HC	→	→	→			
DEPTH OF PURGE INTAKE (FT)	≈14						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED				≈1			
DEWATERED?	N	→	→				

Groundwater Purge and Sample Form Date: 11/29/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: NMW - 3

PROJECT NUMBER: 996098.00 PERSONNEL: DMK, JRB

SAMPLE DATA:

TIME SAMPLED: COMMENTS:

DEPTH SAMPLED (FT):

SAMPLING EQUIPMENT: PERISTALTIC

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1 Liter	CLEAR		Y	METALS HARDNESS	CA, MN FE
2	1	P	—	N	lg oz				TDS	
3	1	P	—	N	½ Liter				SULFATE	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): COMMENTS:

DISPOSAL METHOD: DRUMMED ONSITE

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: YES [✓ NO]

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS: RAIN

TEMPERATURE (SPECIFY °C OR °F): 45° F

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form Date: 11/29/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS
WELL NUMBER: MW-5
PROJECT NUMBER: 996098.00
PERSONNEL: DMK, JRB

STATIC WATER LEVEL (FT): 9'
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: HERON
PURGE METHOD: PERISTALTIC
TIME START PURGE: 11:56
PURGE DEPTH (FT) ~13
TIME END PURGE:
TIME SAMPLED:
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)		10.5 DEPTH TO WATER (FT)		5.5 WATER COLUMN (FT)		MULTIPLIER FOR CASING DIAMETER (IN)				.88 ~13 CASING VOLUME (GAL)
							[✓ 2]	4	6		
	16	-	9.0	=	7	X	0.16	0.64	1.44	=	1.12

TIME	12:02	12:07	12:15				
VOLUME PURGED (GAL)	1/2	1	1 1/2				
PURGE RATE (GPM)							
TEMPERATURE (°C)	14.5	14.52	14.48				
pH	6.20	6.19	6.18				
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	526	527	528				
DISSOLVED OXYGEN (mg/L)	3.88	3.78	3.52				
eH(MV)Pt-AgCl ref. ORP	18.3	13.4	12.3				
TURBIDITY/COLOR	Clear none →						
ODOR							
DEPTH OF PURGE INTAKE (FT)	~13						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED			≈1				
DEWATERED?	N →						

Groundwater Purge and Sample Form Date: 11/29/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: MW-5

PROJECT NUMBER: PERSONNEL: DML, JDB

SAMPLE DATA:

TIME SAMPLED: COMMENTS:

DEPTH SAMPLED (FT): ~13

SAMPLING EQUIPMENT:

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO_3	N	1 liter	clear		Y	METALS HARDNESS	CA, MG FE
2	1	P	–	N	16 oz	|		|	TDS	
3	1	P	–	N	½ Ltr	|		|	SULFATE	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): COMMENTS:

DISPOSAL METHOD: DRUMMED ONSITE

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: YES [✓ NO]

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS: RAIN 45 F

TEMPERATURE (SPECIFY °C OR °F):

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form

Date: 11/29/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS

WELL NUMBER: MW-1

PROJECT NUMBER: 996098.00

PERSONNEL:

STATIC WATER LEVEL (FT): 9.0

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: HERON

PURGE METHOD: PERISTALTIC

TIME START PURGE: 10:40

PURGE DEPTH (FT) ~13

TIME END PURGE:

TIME SAMPLED:

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	11.52 DEPTH TO WATER (FT)	=	4.48 WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN) [✓ 2]	4	6	=	.72 ~.3 CASING VOLUME (GAL)
	16		9		7		0.16	0.64	1.44		1 1/2

TIME	10:45	10:52	10:58				
VOLUME PURGED (GAL)	1/2	1	1 1/2				
PURGE RATE (GPM)							
TEMPERATURE (°C)	16.04	16.16	16.31				
pH	6 30	6.30	6.29				
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	522	524	544				
DISSOLVED OXYGEN (mg/L)	3.87	4.0	4.04				
eH(MV)Pt-AgCl ref.	-4.6	-16.4	-30.5				
TURBIDITY/COLOR	clear →						
ODOR	none →						
DEPTH OF PURGE INTAKE (FT)	~13						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED			≈ 1				
DEWATERED?	N →						

Groundwater Purge and Sample Form Date: 11/29/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: MW-1

PROJECT NUMBER: 996098.00 PERSONNEL: DMK, JRD

SAMPLE DATA:

TIME SAMPLED: ______ COMMENTS: ______

DEPTH SAMPLED (FT): ______

SAMPLING EQUIPMENT: PERISTALTIC

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1L	clear		Y	METALS HARDNESS	CA, MG, FE
2	1	P	-	N	16 OZ				TDS	
3	1	P	—	N	1/2 Ltr				SULFATE	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): ______ COMMENTS: ______

DISPOSAL METHOD: DRUMMED ONSITE

DRUM DESIGNATION(S)/VOLUME PER (GAL): ______

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: YES [✓ NO]

WELL CASING OK?: [✓ YES] NO

COMMENTS: ______

GENERAL:

WEATHER CONDITIONS: RAIN

TEMPERATURE (SPECIFY °C OR °F): 45°F

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? NO

cc: Project Manager: ______
Job File: ______
Other: ______

Groundwater Purge and Sample Form Date: 11/29/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS

WELL NUMBER: MW-2

PROJECT NUMBER: 996098.00

PERSONNEL:

STATIC WATER LEVEL (FT): 9.0

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: HERON

PURGE METHOD: PERISTALTIC

TIME START PURGE: 11:12

PURGE DEPTH (FT) ~13

TIME END PURGE:

TIME SAMPLED:

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN) [✓ 2]	4	6	=	CASING VOLUME (GAL)
			11.4		4.6						.736
	16		9.0		7		0.16	0.64	1.44		1 12

TIME	11:18	11:23	11:28				
VOLUME PURGED (GAL)	1/2	1	1 1/2				
PURGE RATE (GPM)							
TEMPERATURE (°C)	13.28	13.25	13.26				
pH	6.32	6.38	6.41				
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	1570	1870	1967				
DISSOLVED OXYGEN (mg/L)	11.21	14.03	14.29				
eH(MV)Pt-AgCl ref.	39.2	15.5	7.8				
TURBIDITY/COLOR	CLEAR/none low	→	→				
ODOR	none	→	→				
DEPTH OF PURGE INTAKE (FT)	~13						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED			≥1				
DEWATERED?	N	→	→				

Groundwater Purge and Sample Form Date: 11/29/00 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS WELL NUMBER: MW-2

PROJECT NUMBER: PERSONNEL: DMK JRB

SAMPLE DATA:

TIME SAMPLED: COMMENTS:

DEPTH SAMPLED (FT):

SAMPLING EQUIPMENT: PERISTALTIC

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	P	HNO3	N	1L	clear		Y	METAL HARDNESS	CA, MG FE
2	1	P	—	N	16 OZ	↓		↓	TDS	
3	1	P	—	N	1/2 GAL	⊥		⊥	SULFATE	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): COMMENTS:

DISPOSAL METHOD: DRUMMED ONSITE

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: YES [✓ NO]

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS: RAIN

TEMPERATURE (SPECIFY °C OR °F): 45

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form Date: 3/5/01 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS

WELL NUMBER: MW-1

PROJECT NUMBER: 996098.00

PERSONNEL: JRB

STATIC WATER LEVEL (FT): 10.45

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: Heron

PURGE METHOD: Peristaltic (Micro)

TIME START PURGE: 9:50

PURGE DEPTH (FT) ~13

TIME END PURGE: 10:05

TIME SAMPLED: 10:10

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	16		10.45		5.55		0.16	0.64	1.44		.88

TIME	9:50	9.57	10:01	10:05			
VOLUME PURGED (GAL)	0	1/2	3/4	1			
PURGE RATE (GPM)							
TEMPERATURE (°C)	13.73	13.61	13.61	13 61			
pH	6.24	6.30	6 31	6.32			
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	419	353	341	338			
DISSOLVED OXYGEN (mg/L)	1.42	0.84	0.75	0.73			
eH(MV)Pt-AgCl ref. ORP	-35.8	-45.0	-43 2	-46.1			
TURBIDITY/COLOR	clear			→			
ODOR	N			→			
DEPTH OF PURGE INTAKE (FT)	~13			→			
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED							
DEWATERED?	N			→			

Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: ________ WELL NUMBER: MW-1

PROJECT NUMBER: ________ PERSONNEL: ________

SAMPLE DATA:
TIME SAMPLED: ________ COMMENTS: ________

DEPTH SAMPLED (FT): ________

SAMPLING EQUIPMENT: ________

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	OJ	N	N	L	clear		Y	TDS	
2	1	OJ	N	N	L				Hardness/Metals Ca MG Fe	
3	1	P	HNO3	N					TOTAL Metals	
4	1	P	HNO3	Y	L				DISSOLVED Metals	
5	1	A	N	N	L				Diesel	
6	1	A	N	N	L				PCB	
7	1	A	N	N	L				PAH	
8	3	VOA	HCl		120ml				VOC	
9	2	VOA	HCl	N	80ml				GAS	

PURGE WATER DISPOSAL NOTES:
TOTAL DISCHARGE (GAL): 1 COMMENTS: ________

DISPOSAL METHOD: Drum

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ________

GENERAL:
WEATHER CONDITIONS: Clear

TEMPERATURE (SPECIFY °C OR °F): 55°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________
Job File: ________
Other: ________

Groundwater Purge and Sample Form Date: 3/5/01 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals

WELL NUMBER: MW-2

PROJECT NUMBER: 996098.00

PERSONNEL: JB

STATIC WATER LEVEL (FT): 10.62

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: Heron

PURGE METHOD: Peristaltic

TIME START PURGE: 10 43

PURGE DEPTH (FT) ~13

TIME END PURGE: 10:59

TIME SAMPLED: 11.00

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	16		10.62		5.38		0.16	0.64	1.44		.86

TIME	10:48	10:53	10:59				
VOLUME PURGED (GAL)	1/2	1	1 1/2				
PURGE RATE (GPM)							
TEMPERATURE (°C)	11.56	11.53	11.51				
pH	6.27	6.28	6.32				
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	1588	1573	1556				
DISSOLVED OXYGEN (mg/L)	0.67	0.46	0.38				
eH(MV)Pt-AgCl ref.	47.9	45.9	39.9				
TURBIDITY/COLOR	clear		→				
ODOR	none		→				
DEPTH OF PURGE INTAKE (FT)	~13						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED			≈1				
DEWATERED?	N		→				

Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: TALOMA METALS WELL NUMBER: MW-2

PROJECT NUMBER: 996018.00 PERSONNEL: JB

SAMPLE DATA:

TIME SAMPLED: ________ COMMENTS: ________

DEPTH SAMPLED (FT): ________

SAMPLING EQUIPMENT: ________

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	oj	N	N	L				TDS	
2	1	oj	N	N	L	Clear now		Y	Hardness/Metals CA MG +	
3	1	P	HNO3	N	L				TOTAL METALS	
4	1	P	HNO3	Y	L				DISSOLVED METALS	
5	1	A	N	N	L				DIESEL	
6	1	A	N	N	L				PCB	
7	1	A	N	N	L				PAH	
8	3	VOA	HCl	N	120				VOC	
9	2	VOA	HCl	N	80				GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 1½ COMMENTS: ________

DISPOSAL METHOD: Drum

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ________

GENERAL:

WEATHER CONDITIONS: Clear

TEMPERATURE (SPECIFY °C OR °F): 55°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________
Job File: ________
Other: ________

Groundwater Purge and Sample Form Date: 3/5/01 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals
WELL NUMBER: MW-9
PROJECT NUMBER: 99409800
PERSONNEL: JB

STATIC WATER LEVEL (FT): 11.69
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: HERON
PURGE METHOD: PERISTALTIC LowFl
TIME START PURGE: 1150
PURGE DEPTH (FT) ~17
TIME END PURGE: 12:15
TIME SAMPLED: 12:15
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	23.5		11.69		11.81		0.16	0.64	1.44		1.88

TIME	11:55	12:02	12:08	12:15				
VOLUME PURGED (GAL)	½	1	1½	2				
PURGE RATE (GPM)								
TEMPERATURE (°C)	12.01	12.00	11.97	11.95				
pH	6.34	6.36	6.37	6.38				
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	1796	1833	1741	1620				
DISSOLVED OXYGEN (mg/L)	0.56	0.67	0.67	0.58				
eH(MV)Pt-AgCl ref.	-16.0	-25.4	-33.0	-36.4				
TURBIDITY/COLOR	clear →							
ODOR	none →							
DEPTH OF PURGE INTAKE (FT)	~17							
DEPTH TO WATER DURING PURGE (FT)								
NUMBER OF CASING VOLUMES REMOVED				≈ 1				
DEWATERED?	N →							

Groundwater Purge and Sample Form Date: ____ **Kennedy/Jenks Consultants**

PROJECT NAME: ____ WELL NUMBER: MW-9

PROJECT NUMBER: 96098.00 PERSONNEL: AB

SAMPLE DATA:

TIME SAMPLED: ____ COMMENTS: ____

DEPTH SAMPLED (FT): ____

SAMPLING EQUIPMENT: ____

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1 2 3	1 1 1	OS OS P	N N HNO3	N N N	L L L	Clear	None	YES	TDS Hardness/metals CA MG Total metals	
4 5	1 1	P A	HNO3 N	Y N	L L				DISSOLVED METALS DIESEL	
6 7	1 1	A A	N N	N N	L L				PCB PAH	
8 9	3 2	VOA VOA	HCl HCl	N N	120 80				VOC GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 2 COMMENTS: ____

DISPOSAL METHOD: Drum

DRUM DESIGNATION(S)/VOLUME PER (GAL): ____

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ____

GENERAL:

WEATHER CONDITIONS: ____

TEMPERATURE (SPECIFY °C OR °F): CLEAR

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? 55° F

cc: Project Manager: ____
Job File: ____
Other: ____

Groundwater Purge and Sample Form

Date: 3/5/01

Kennedy/Jenks Consultants

PROJECT NAME: Tacoma Metals

WELL NUMBER: MW-6

PROJECT NUMBER: 994093.00

PERSONNEL: JB

STATIC WATER LEVEL (FT): 7.54

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: HERON

PURGE METHOD: PERISTALTIC C.MICR

TIME START PURGE: 1:00

PURGE DEPTH (FT) ~12

TIME END PURGE: 1:15

TIME SAMPLED: 1:15

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	16		7.54		8.46		0.16	0.64	1.44		1.35

TIME	1:05	1:10	1:15					
VOLUME PURGED (GAL)	1/2	1	1 1/2					
PURGE RATE (GPM)								
TEMPERATURE (°C)	12.14	12.15	12.17					
pH	6.31	6.29	6.28					
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	920	916	881					
DISSOLVED OXYGEN (mg/L)	0.70	0.51	0.43					
eH(MV)Pt-AgCl ref.	44.3	23.3	5.7					
TURBIDITY/COLOR	clear	→	→					
ODOR	SL organic	→	→					
DEPTH OF PURGE INTAKE (FT)	~12							
DEPTH TO WATER DURING PURGE (FT)								
NUMBER OF CASING VOLUMES REMOVED			~1					
DEWATERED?	N	→	→					

Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals WELL NUMBER: MW-6

PROJECT NUMBER: 996098.00 PERSONNEL: SD

SAMPLE DATA:

TIME SAMPLED: ________ COMMENTS: ________

DEPTH SAMPLED (FT): ________

SAMPLING EQUIPMENT: ________

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	OJ	N	N	L	Clear		YES	TDS	
2	1	OJ	N	N	L				Hardness/metals	CA MG FE
3	1	P	HNO3	N	L				TOTAL METALS	
4	1	P	HNO3	Y	L				DISSOLVED METALS	
5	1	A	N	N	L				DIESEL	
6	1	A	N	N	L				PCB	
7	1	A	N	N	L				PAH	
8	3	VOA	HCl	N	120				VOC	
9	2	VOA	HCl	N	80				GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 1½ COMMENTS: ________

DISPOSAL METHOD: Drum

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ________

GENERAL:

WEATHER CONDITIONS: Clear ☼

TEMPERATURE (SPECIFY °C OR °F): 55°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________

Job File: ________

Other: ________

Groundwater Purge and Sample Form Date: 3/5/01 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals WELL NUMBER: MW-5

PROJECT NUMBER: 946098.10 PERSONNEL: [illegible]

STATIC WATER LEVEL (FT): 8.46 MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: Heron PURGE METHOD: Peristaltic (micro)

TIME START PURGE: 2:07 PURGE DEPTH (FT) ~12.5

TIME END PURGE: 2:24

TIME SAMPLED: 2:25

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	16		8.46		7.54		0.16	0.64	1.44		1.21

TIME	2:12	2:18	2:24				
VOLUME PURGED (GAL)	1/2	1	1 1/2				
PURGE RATE (GPM)							
TEMPERATURE (°C)	12.96	12.93	12.84				
pH	6.08	6.07	6.05				
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	568	569	570				
DISSOLVED OXYGEN (mg/L)	1.34	1.21	0.96				
eH(MV)Pt-AgCl ref.	22	22.4	19.5				
TURBIDITY/COLOR	Clear →	→	→				
ODOR	SL HYDROCARBON →	→	→				
DEPTH OF PURGE INTAKE (FT)	~12.5						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED			≈ 1				
DEWATERED?	N →	→	→				

Groundwater Purge and Sample Form Date: ______ **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals WELL NUMBER: MW-5

PROJECT NUMBER: 996098.00 PERSONNEL: B

SAMPLE DATA:

TIME SAMPLED: ______ COMMENTS: ______

DEPTH SAMPLED (FT): ______

SAMPLING EQUIPMENT: ______

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1 2 3	1 1 1	OJ OJ P	N N HNO3	N N N	L L L	Clear		Y	TDS Hardness/metals TOTAL METALS	CA MG FE
4 5	1 1	P A	HNO3 N	Y N	L L				DISSOLVED METALS DIESEL	
6 7	1 1	A A	N N	N N	L L				PCB PAH	
8 9	3 2	VOA VOA	HCl HCl	N N	120 80				VOC GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 1 1/2 COMMENTS: ______

DISPOSAL METHOD: Drum

DRUM DESIGNATION(S)/VOLUME PER (GAL): ______

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ______

GENERAL:

WEATHER CONDITIONS: Clear

TEMPERATURE (SPECIFY °C OR °F): 55°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ______

cc: Project Manager: ______

Job File: ______

Other: ______

Groundwater Purge and Sample Form Date: 3/5/01 **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals
WELL NUMBER: MW - 4
PROJECT NUMBER: 996098.00
PERSONNEL:

STATIC WATER LEVEL (FT): 10.02
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: HERON
PURGE METHOD: Peristaltic
TIME START PURGE: 2:55
PURGE DEPTH (FT) ~16
TIME END PURGE: 3:20
TIME SAMPLED: 3:20
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	23		10.02		12.98		0.16	0.64	1.44		2.07

TIME	3:00	3:05	3:10	3:15	3:20		
VOLUME PURGED (GAL)	1/2	1	1 1/2	2	2 1/2		
PURGE RATE (GPM)							
TEMPERATURE (°C)	13.18	13.18	13.19	13.19	13.19		
pH	6.05	6.05	6.05	6.05	6.05		
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	456	457	456	457	459		
DISSOLVED OXYGEN (mg/L)	1.03	.91	0.72	0.64	0.65		
eH(MV)Pt-AgCl ref.	-9.8	-10.9	-13.7	-16.2	-17.4		
TURBIDITY/COLOR	Clear →						
ODOR	S - MOD HC →						
DEPTH OF PURGE INTAKE (FT)	~16						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED					≈ 1		
DEWATERED?	N →						

Groundwater Purge and Sample Form Date: __ **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metzer WELL NUMBER: MW-4

PROJECT NUMBER: 996098.00 PERSONNEL: JB

SAMPLE DATA:

TIME SAMPLED: COMMENTS:

DEPTH SAMPLED (FT):

SAMPLING EQUIPMENT:

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1 2 3	1 1 1	OJ OJ P	N N HNO3	N N N	L L L	clear		Y	TDS Hardness /metals CA MG FE TOTAL METALS	
4 5	1 1	P A	HNO3 N	Y N	L L				DISSOLVED METALS DIESEL	
6 7	1 1	A A	N N	N N	L L				PCB PAH	
8 9	3 2	VOA VOA	HCl HCl	N N	120 80				VOC GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 2 1/2 COMMENTS:

DISPOSAL METHOD: Drum

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS: Clear

TEMPERATURE (SPECIFY °C OR °F): 55°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form Date: 3/6/01 **Kennedy/Jenks Consultants**

8.37 product
8.43 8.72 8.51/8.52

PROJECT NAME: T. Metals
WELL NUMBER: MW-12
PROJECT NUMBER: 994098.00
PERSONNEL: JB

STATIC WATER LEVEL (FT): 8.51
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: HERON
PURGE METHOD: Peristaltic
TIME START PURGE: 1:50
PURGE DEPTH (FT) ~13
TIME END PURGE: 3:00
TIME SAMPLED: 3:00
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN) 2	[✓ 4]	6	=	CASING VOLUME (GAL)
	19		8.51		10.49		0.16	0.64	1.44		6.71

TIME	2:10	2:30	2:50	2:55	3:00		
VOLUME PURGED (GAL)	2	4	6	6½	7		
PURGE RATE (GPM)							
TEMPERATURE (°C)	13.51	13.6	13.63	13.09	13.10		
pH	6.42	6.28	6.27	6.23	6.22		
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	220	211	209	211	210		
DISSOLVED OXYGEN (mg/L)	5.77	7.72	7.71	5.46	5.42		
eH(MV)Pt-AgCl ref.	36.5	28.5	26.3	25.4	21.7		
TURBIDITY/COLOR	clear	———	———	———	→		
ODOR	MOD HC smell product	———	———	———	product 8.37	water	8.51?
DEPTH OF PURGE INTAKE (FT)	~13						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED					≈1		
DEWATERED?	N	———	———	———	———		

Groundwater Purge and Sample Form

Date: ________

Kennedy/Jenks Consultants

PROJECT NAME: T. Metals

WELL NUMBER: MW-12

PROJECT NUMBER: 996098.00

PERSONNEL: JB

SAMPLE DATA:

TIME SAMPLED: ________

COMMENTS: ________

DEPTH SAMPLED (FT): ________

SAMPLING EQUIPMENT: ________

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	OJ	N	N	L	Clear		Y	TDS	
2	1	OJ	N	N	L				HARDNESS/METALS	CA MG FE
3	1	P	HNO3	N	L				TOTAL METALS	
4	1	P	HNO3	Y	L				DISSOLVED METALS	
5	1	A	N	N	L				DIESEL	
6	1	A	N	N	L				PCB	
7	1	A	N	N	L				PAH	
8	3	VOA	HCl	N	120				VOC	
9	2	VOA	HCl	N	90				GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 7

COMMENTS: ________

DISPOSAL METHOD: Drum

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ________

GENERAL:

WEATHER CONDITIONS: Clear

TEMPERATURE (SPECIFY °C OR °F): 55°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________
Job File: ________
Other: ________

Groundwater Purge and Sample Form Date: 3/6/01 **Kennedy/Jenks Consultants**

PROJECT NAME: TACOMA METALS

WELL NUMBER: MW-8

PROJECT NUMBER: 996098.00

PERSONNEL: JRB

STATIC WATER LEVEL (FT): 8.61

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: HERON

PURGE METHOD: Peristaltic

TIME START PURGE: 1:00

PURGE DEPTH (FT) ~16

TIME END PURGE: 1:25

TIME SAMPLED: 1:25

COMMENTS: Hardness & Dup

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN) [✓ 2]	4	6	=	CASING VOLUME (GAL)
	23.5		8.61		14.89		0.16	0.64	1.44		2.38

TIME	1:10	1:15	1:20	1:25			
VOLUME PURGED (GAL)	1	1½	2	2½			
PURGE RATE (GPM)							
TEMPERATURE (°C)	13.47	13.38	13.37	13.34			
pH	6.43	6.34	6.33	6.32			
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	203	199	193	172			
DISSOLVED OXYGEN (mg/L)	6.00	7.70	7.79	7.76			
eH(MV)Pt-AgCl ref.	33.2	18.2	7.4	3.2			
TURBIDITY/COLOR	clear						
ODOR	MOD HC						
DEPTH OF PURGE INTAKE (FT)	~16						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED				≈1			
DEWATERED?	N						

Groundwater Purge and Sample Form Date: ____ **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals WELL NUMBER: MW-8

PROJECT NUMBER: 996098.00 PERSONNEL: dB

SAMPLE DATA:
TIME SAMPLED: ____ COMMENTS: ____

DEPTH SAMPLED (FT): ____

SAMPLING EQUIPMENT: ____

SAMPLE NO.	NO. OF CONTAIN-ERS	CON-TAINER TYPE	PRESER-VATIVE	FIELD FILTRA-TION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUS-TODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	OJ	N	N	L			Y	TDS	
2	1	OJ	N	N	L	Clear			Hardness/metals CA MGFE	
3	1	P	HNO3	N	L				TOTAL METALS	
4	1	P	HNO3	Y	L				DISSOLVED METALS	
5	1	A	N	N	L				DIESEL	
6	1	A	N	N	L				PCB	
7	1	A	N	N	L				PAH	
8	3	VOA	HCl	N	120				VOC	
9	2	VOA	HCl	N	80				GAS	

PURGE WATER DISPOSAL NOTES:
TOTAL DISCHARGE (GAL): 2 1/2 COMMENTS: ____

DISPOSAL METHOD: Drum

DRUM DESIGNATION(S)/VOLUME PER (GAL): ____

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ____

GENERAL:
WEATHER CONDITIONS: Clear

TEMPERATURE (SPECIFY °C OR °F): 55°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ____

cc: Project Manager: ____
Job File: ____
Other: ____

1=3

Groundwater Purge and Sample Form Date: 3/6/01 **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals

WELL NUMBER: MW-10

PROJECT NUMBER: 996098.00

PERSONNEL: JD

STATIC WATER LEVEL (FT): 7.04

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: HERON

PURGE METHOD: Peristaltic

TIME START PURGE: 10:37

PURGE DEPTH (FT) ~13

TIME END PURGE: 10:57

TIME SAMPLED: 11:00

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	20		7.04		12.96		0.16	0.64	1.44		2.07

TIME	10:42	10:47	10:52	10:57			
VOLUME PURGED (GAL)	½	1	1½	2			
PURGE RATE (GPM)							
TEMPERATURE (°C)	11.82	11.85	11.88	11.89			
pH	6.05	6.04	6.03	6.03			
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	286	287	287	286			
DISSOLVED OXYGEN (mg/L)	1.54	1.01	0.76	0.69			
eH(MV)Pt-AgCl ref.	2.5	-2.9	-6.0	-8.3			
TURBIDITY/COLOR	clear →						
ODOR	MOD HC →						
DEPTH OF PURGE INTAKE (FT)	~13						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED				≈1			
DEWATERED?	N →						

Groundwater Purge and Sample Form Date: 7/6/01 **Kennedy/Jenks Consultants**

PROJECT NAME: t. Meters
WELL NUMBER: MW-10
PROJECT NUMBER: 996098.00
PERSONNEL: DB

SAMPLE DATA:
TIME SAMPLED:
COMMENTS:
DEPTH SAMPLED (FT):
SAMPLING EQUIPMENT:

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	OJ	N	N	L	Clear		Y	TDS	
2	1	OJ	N	N	L				Hardness/metals CA FE MG	
3	1	P	HNO3	N	L				Total metals	
4	1	P	HNO3	Y	L				Dissolved metals	
5	1	A	N	N	L				DIESEL	
6	1	A	N	N	L				PCB	
7	1	A	N	N	L				PAH	
8	3	VOA	HCl	N	120				VOC	
9	2	VOA	HCl	N	80				GAS	

PURGE WATER DISPOSAL NOTES:
TOTAL DISCHARGE (GAL): 2 gal
COMMENTS:
DISPOSAL METHOD: DRUM
DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:
WEATHER CONDITIONS: Clear
TEMPERATURE (SPECIFY °C OR °F): 55°
PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form Date: 3/6/01 **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals
WELL NUMBER: MW-11
PROJECT NUMBER: 996098.00
PERSONNEL: JB

STATIC WATER LEVEL (FT): 7.13
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: HERON
PURGE METHOD: Peristaltic
TIME START PURGE: 11.20
PURGE DEPTH (FT) ~13
TIME END PURGE: 12:45
TIME SAMPLED: 12:45
COMMENTS:

Hardness +

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN) 2	[✓ 4]	6	=	CASING VOLUME (GAL)
	20		7.13		12.87		0.16	0.64	1.44		8.23

TIME	11:40	12:00	12:20	12:40	12:45		
VOLUME PURGED (GAL)	2	4	6	8	8½		
PURGE RATE (GPM)							
TEMPERATURE (°C)	12.19	12.34	12.27	12.25	12.28		
pH	6.30	6.41	6.44	6.45	6.44		
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	127	126	128	127	130		
DISSOLVED OXYGEN (mg/L)	8.65	5.04	4.79	4.72	4.99		
eH(MV)Pt-AgCl ref.	15.5	1.8	6.7	6.4	5.9		
TURBIDITY/COLOR	clear						
ODOR	MOD HC						
DEPTH OF PURGE INTAKE (FT)	~13						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED					~1		
DEWATERED?	N						

Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals WELL NUMBER: MW-11

PROJECT NUMBER: 99609800 PERSONNEL: JB

SAMPLE DATA:

TIME SAMPLED: ________ COMMENTS: ________

DEPTH SAMPLED (FT): ________

SAMPLING EQUIPMENT: ________

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1 2 3	1 1 1	OJ OJ P	N N HNO3	N N N	L L L	Clear		Y	TDS Hardness/metals TOTAL METALS	CA MG FE
4 5	1 1	P A	HNO3 N	Y N	L L				DISSOLVED METALS DIESEL	
6 7	1 1	A A	N N	N N	L L				PCB PAH	
8 9	3 2	VOA VOA	HCl HCl	N N	120 30				VOC GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 8½ COMMENTS: ________

DISPOSAL METHOD: Drum

DRUM DESIGNATION(S)/VOLUME PER (GAL): ________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ________

GENERAL:

WEATHER CONDITIONS: Clear

TEMPERATURE (SPECIFY °C OR °F): 55°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ________

cc: Project Manager: ________
Job File: ________
Other: ________

Groundwater Purge and Sample Form Date: 3/6 **Kennedy/Jenks Consultants**

PROJECT NAME: Tacoma Metals
WELL NUMBER: MW-7
PROJECT NUMBER: 994098.00
PERSONNEL: JB

STATIC WATER LEVEL (FT): 7.10
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: Heron
PURGE METHOD: Persitaltic
TIME START PURGE: 9.40
PURGE DEPTH (FT) ~11
TIME END PURGE: 9:55
TIME SAMPLED: 10:00
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	14		7.10		6.9		0.16	0.64	1.44		1.104

TIME	9:45	9:50	9:55					
VOLUME PURGED (GAL)	1/2	1	1 1/2					
PURGE RATE (GPM)								
TEMPERATURE (°C)	11.91	11.88	11.87					
pH	6.06	6.04	6.03					
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	373	366	358					
DISSOLVED OXYGEN (mg/L)	2.2	1.61	1.10					
eH(MV)Pt-AgCl ref.	55.7	51.1	43.7					
TURBIDITY/COLOR	clear ——→							
ODOR	SL HC ——→							
DEPTH OF PURGE INTAKE (FT)	~11							
DEPTH TO WATER DURING PURGE (FT)								
NUMBER OF CASING VOLUMES REMOVED			≈1					
DEWATERED?	N ——→							

Groundwater Purge and Sample Form Date: ___ ___ **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals WELL NUMBER: MW-7

PROJECT NUMBER: 996098.00 PERSONNEL: JB

SAMPLE DATA:

TIME SAMPLED: ______ COMMENTS: ______

DEPTH SAMPLED (FT): ______

SAMPLING EQUIPMENT: ______

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	OJ	N	N	L	Clear	none	Y	TDS	
2	1	OJ	N	N	L				Hardness Metals	Ca Mg Fe
3	1	P	HNO_3	N	L				TOTAL METALS	
4	1	P	HNO_3	Y	L				DISSOLVED METALS	
5	1	A	N	N	L				DIESEL	
6	1	A	N	N	L				PCB	
7	1	A	N	N	L				PAH	
8	3	VOA	HCl	N	120				VOC	
9	2	VOA	HCl	N	80				GAS	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): 1½ COMMENTS: ______

DISPOSAL METHOD: Drum

DRUM DESIGNATION(S)/VOLUME PER (GAL): ______

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ______

GENERAL:

WEATHER CONDITIONS: CLEAR

TEMPERATURE (SPECIFY °C OR °F): 55°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ______

cc: Project Manager: ______
Job File: ______
Other: ______

Groundwater Purge and Sample Form Date: 9/4/01 **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals
WELL NUMBER: MW-11
PROJECT NUMBER: 996098.00
PERSONNEL:

STATIC WATER LEVEL (FT): 8 53
MEASURING POINT DESCRIPTION: TOC
WATER LEVEL MEASUREMENT METHOD: Heron
PURGE METHOD: Peristaltic
TIME START PURGE: 2:40
PURGE DEPTH (FT)
TIME END PURGE:
TIME SAMPLED: 4:00
COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)		DEPTH TO WATER (FT)		WATER COLUMN (FT)		MULTIPLIER FOR CASING DIAMETER (IN)				CASING VOLUME (GAL)
							2	[✓ 4]	6		
	20	-	8.53	=	11.47	X	0.16	0.64	1.44	=	7.34

TIME	3:00	3:20	3:45	3:50	3:55		
VOLUME PURGED (GAL)	2	4	6	7	7½		
PURGE RATE (GPM)							
TEMPERATURE (°C)	14.8	14.5	14.1	14.1	14.0		
pH	6.47	6.41	6.38	6.56	6.30		
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	240	242	238	216	227		
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR							
ODOR	HCO	HC	→	→	→		
DEPTH OF PURGE INTAKE (FT)	~16						
DEPTH TO WATER DURING PURGE (FT)	-						
NUMBER OF CASING VOLUMES REMOVED	~1						
DEWATERED?	N						

Groundwater Purge and Sample Form Date: 5/18/01 **Kennedy/Jenks Consultants**

PROJECT NAME: T. Mottles WELL NUMBER: MW-11

PROJECT NUMBER: 996098.06 PERSONNEL: ______

SAMPLE DATA:

TIME SAMPLED: ______ COMMENTS: ______

DEPTH SAMPLED (FT): ______

SAMPLING EQUIPMENT: ______

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	A	N	Y	L	clear		YES	PAH	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): ______ COMMENTS: ______

DISPOSAL METHOD: ______

DRUM DESIGNATION(S)/VOLUME PER (GAL): ______

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS: ______

GENERAL:

WEATHER CONDITIONS: Rainy

TEMPERATURE (SPECIFY °C OR °F): 54°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ______

cc: Project Manager: ______

Job File: ______

Other: ______

Groundwater Purge and Sample Form Date: 9/14/01 **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals

WELL NUMBER: MW-10

PROJECT NUMBER: 996078.00

PERSONNEL: JB

STATIC WATER LEVEL (FT): 7.02

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: Heron

PURGE METHOD: Peristaltic

TIME START PURGE: 1:15

PURGE DEPTH (FT)

TIME END PURGE:

TIME SAMPLED: 1:40

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	20		7.02		12.98		0.16	0.64	1.44		2.07

TIME	120	125	130	135			
VOLUME PURGED (GAL)	1/2	1	1 1/2	2			
PURGE RATE (GPM)							
TEMPERATURE (°C)	14.3	14.1	13.9	13.8			
pH	6.27	6.23	6.24	6.21			
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	272	274	271	269			
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	clear →						
ODOR	Mod HC →						
DEPTH OF PURGE INTAKE (FT)	~16						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED	~1						
DEWATERED?	N						

Groundwater Purge and Sample Form Date: 5/14/01 **Kennedy/Jenks Consultants**

PROJECT NAME: T. Metals WELL NUMBER: MW-10

PROJECT NUMBER: 996098.00 PERSONNEL:

SAMPLE DATA:

TIME SAMPLED: COMMENTS:

DEPTH SAMPLED (FT):

SAMPLING EQUIPMENT:

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS
1	1	A	N	Y	L	clear		Y	PAH	

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): COMMENTS:

DISPOSAL METHOD:

DRUM DESIGNATION(S)/VOLUME PER (GAL):

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: [✓ YES] NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: [✓ YES] NO

WELL CASING OK?: [✓ YES] NO

COMMENTS:

GENERAL:

WEATHER CONDITIONS: Rainy

TEMPERATURE (SPECIFY °C OR °F): 59°

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING?

cc: Project Manager:
Job File:
Other:

Groundwater Purge and Sample Form Date: 5/18/01 **Kennedy/Jenks Consultants**

PROJECT NAME: T. METALS

WELL NUMBER: MW-8

PROJECT NUMBER: 996079.00

PERSONNEL:

STATIC WATER LEVEL (FT): 9.19

MEASURING POINT DESCRIPTION: TOC

WATER LEVEL MEASUREMENT METHOD: Meter

PURGE METHOD: Peristaltic

TIME START PURGE: 1:50

PURGE DEPTH (FT)

TIME END PURGE:

TIME SAMPLED: 2:20

COMMENTS:

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)	-	DEPTH TO WATER (FT)	=	WATER COLUMN (FT)	X	MULTIPLIER FOR CASING DIAMETER (IN)			=	CASING VOLUME (GAL)
							[✓ 2]	4	6		
	23.5		9.19		14.31		0.16	0.64	1.44		2.28

TIME	2:00	2:05	2:10	2:15			
VOLUME PURGED (GAL)	1	1½	2	2½			
PURGE RATE (GPM)							
TEMPERATURE (°C)	14.4	14.3	14.1	13.9			
pH	6.72	6.69	6.61	6.63			
SPECIFIC CONDUCTIVITY (micromhos/cm) (uncorrected)	452	448	442	437			
DISSOLVED OXYGEN (mg/L)							
eH(MV)Pt-AgCl ref.							
TURBIDITY/COLOR	Clear ⟶						
ODOR	MOD HC ⟶						
DEPTH OF PURGE INTAKE (FT)	~18						
DEPTH TO WATER DURING PURGE (FT)							
NUMBER OF CASING VOLUMES REMOVED	~1						
DEWATERED?	N						