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DRAFT
FOCUSED REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

FORMER COLUMBIA MARINE LINES SITE
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON

Evergreen

Facility:
Year: Left Right
Air Corr
Water Reports
NPDES Permit
WET-Tox Enf
DW/RCRA [✓ Eng]
[✓ Clean Up] Sub
SW
HWP2

Alcoa-Evergreen CU

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1. INTRODUCTION

1.1 PURPOSE

SLR International Corp (SLR) has prepared this Focused Remedial Investigation and Feasibility Study (RI/FS) Report on behalf of Crowley Maritime Corporation as part of the soil and groundwater investigation and cleanup being conducted at the former Columbia Marine Lines facility located at 6305 Lower River Road in Vancouver, Washington (**Figure 1**). This work was conducted under Order No. DE 85-591, issued to Columbia Marine Lines by the Washington State Department of Ecology (Ecology) on August 19, 1985. Crowley Maritime Corporation (Crowley), a successor to Columbia Marine Lines, is conducting the environmental work at the site.

The purposes of this Focused RI/FS are to: 1) summarize the previous investigation activities and results, 2) describe the process by which cleanup standards have been developed, 3) develop cleanup action alternatives for remediation of the contaminants of concern at the site, 4) evaluate the feasibility and effectiveness of the cleanup action alternatives, and 5) recommend a cleanup action for the site. The Focused RI/FS was developed in compliance with Chapter 173-340-350 of the Model Toxics Control Act (MTCA) Cleanup Regulation.

1.2 ORGANIZATION

This report presents the following information:

- Section 1: Introduction
- Section 2: Site Background
- Section 3: Nature and Extent of Contamination
- Section 4: Cleanup Standards
- Section 5: Cleanup Action Alternatives
- Section 6: Evaluation of Cleanup Action Alternatives
- Section 7: Recommended Remedial Action
- Section 8: References

2. SITE BACKGROUND

2.1 PROPERTY DESCRIPTION

The former Columbia Marine Lines property is located immediately north of the Columbia River within an industrial area that lies approximately three miles west of the city of Vancouver, Washington. The approximately 200-acre industrial area contains several separate parcels that are currently owned by Alcoa, Glencore Washington LLC [commonly known as Evergreen Aluminum (Evergreen)], and Russell Towboat and Moorage Company [commonly known as Tidewater Barge Lines (Tidewater)]. The approximate boundaries of the industrial area and property ownership are shown on **Figure 2**.

Columbia Marine Lines formerly operated on the property that is currently owned by Tidewater Barge Lines. Columbia Marine Lines also operated three former wastewater infiltration ponds that were located to the west of its property on property owned by Alcoa. Soil and groundwater contamination addressed under the Order and under this Focused RI/FS is associated only with the former ponds; therefore, for the purpose of this Focused RI/FS Report, the Columbia Marine Lines Site (the "Site") consists of the former pond area. This area is shown on **Figure 3**.

The current zoning classification for the Alcoa property on which the Site is located is industrial. It is Crowley's understanding that Alcoa plans to implement a deed restriction to ensure that the Site property, as well as the surrounding Alcoa property, continues to be solely used for industrial purposes in the future. The surrounding land use patterns indicate that the neighboring properties will also continue to be used for industrial purposes. Access to the Site is restricted by fencing and site security measures. Potable water is supplied to the industrial properties surrounding the Site by the city of Vancouver.

Site topography is uneven and the outer edges of the former east and west ponds are noticeable as humps in the ground surface. The highest point on the Site lies at an approximate elevation of 32 feet above mean sea level. There have been no significant changes in the surface features since the filling of the eastern wastewater infiltration pond in 1984.

The Site is vacant and the majority of the surrounding Aloca, Evergreen, and Tidewater properties are either paved or sparsely vegetated with grasses and mosses. Willows, alders, and brush are present in isolated low-lying areas in the northern portion of the Site. Besides the vegetation, the surface of the Site is primarily sand and gravel.

The neighboring Columbia River is tidally influenced and typically ranges from minus 5 to positive 5 feet above mean sea level near the Site. Two rectangular, lined, wastewater treatment lagoons operated by Evergreen are located on Evergreen's property to the northwest of the Site.

2.2 SITE HISTORY

From approximately 1963 to approximately 1985, Columbia Marine Lines operated a marine repair facility on the property currently owned by Tidewater. During the time Columbia Marine Lines owned the property, it periodically placed wastewater into infiltration ponds located on the adjacent Alcoa property. During the approximately 20 year operating period, three different infiltration ponds were used: the South Pond, the West Pond, and the East Pond.

As described in a May 21, 1984 letter from Columbia Marine Lines to the Washington Department of Ecology (Ecology), the wastewater that was placed in the ponds included barge slops, wash water from barge gas freeing operations, and tug bilge slops. Gas freeing was conducted to remove vapors from vessel compartments that had been used to haul diesel fuel, making the vessel interior safe for "hot work."

Figure 3 shows the approximate locations of the former ponds. The three pond locations are also visible on historical aerial photographs of the site area. Relevant aerial photos are presented on **Figure 4**. In addition to the photos shown on **Figure 4**, several other aerial photos were also reviewed. The South Pond was visible in photos dated 1963 and 1964; the West Pond was visible in photos dated 1968 and 1970; and the East Pond was visible in photos dated 1971, 1972, 1973, 1974, 1977, 1980, 1982, and 1983.

The South Pond was constructed and used from 1963 to between 1966 and 1968, when it was filled. After use of the South Pond was discontinued, the West Pond was constructed and used until 1970 or 1971, when it was filled. After use of the West Pond was discontinued, the East Pond was constructed. The East Pond was used until January 1984 when all liquids were removed and the pond was filled with dredge sand to prevent accumulation of surface water.

The former Site has been inactive since the East Pond was filled in 1984, and the Site area is currently vacant.

2.3 PREVIOUS ENVIRONMENTAL INVESTIGATIONS

On April 3, 1984, Columbia Marine Lines notified Ecology in writing of the past operating practices at the Site and the closure of the East Pond. In response to the notification, Ecology issued Order No. DE 85-591 on August 19, 1985. The Order required the installation and operation of a hydrocarbon recovery system, submittal of a report defining the vertical and horizontal extent of groundwater contamination, and a plan for ongoing cleanup.

From 1983 to 2007, several phases of subsurface investigation were conducted at the Site to initially assess the potential presence of contamination and then to delineate the extents of petroleum-impacted soil and groundwater in the vicinity of the former wastewater ponds. During the initial investigations from 1983 to 1986, 21 groundwater monitoring wells (designated MW-1 to MW-21) were installed. The monitoring well locations are shown on **Figure 3**. From 1999 to 2007, 65 soil borings were also drilled and sampled by Geoprobe methods. The locations of the Geoprobe borings are shown on **Figure 5**. Soil boring logs from the monitoring wells and the Geoprobe borings are included in **Appendix A**.

2.3.1 GeoEngineers Soil and Groundwater Investigations

GeoEngineers Inc. began work at the site in 1983. Phase 1 of their investigation included drilling of eight soil borings and subsequent installation of monitoring wells (MW-1 to MW-8) in those borings. Soil samples were collected from selected borings, and groundwater samples were collected from monitoring wells. The results of the investigation showed that petroleum hydrocarbons (diesel range) were detected in soil and groundwater in the vicinity of the former ponds. Floating petroleum free product was present on the groundwater (GeoEngineers, 1983).

GeoEngineers conducted Phase 2 of their assessment in December 1984 to further delineate the type, extent, and concentration of shallow soil and groundwater contamination. The Phase 2 work included drilling of 6 soil borings and subsequent installation of monitoring wells (MW-9 to MW-14). Soil samples were collected from selected borings, and groundwater samples were collected from monitoring wells. During this phase of the investigation, free phase petroleum hydrocarbons were present at thicknesses ranging from 0.005 feet to 6.62 feet in wells MW-2, MW-6, MW-7, MW-8, and MW-9 (GeoEngineers, 1985a).

GeoEngineers conducted Phase 3 of their assessment in January 1986 to further define the extent of subsurface contamination in the former pond area. The work included drilling 7 soil borings and subsequent installation of monitoring wells (MW-15 to MW-21). Soil samples were collected from selected borings, and groundwater samples were collected from monitoring wells (GeoEngineers, 1986).

2.3.2 SECOR and SLR Soil and Groundwater Investigations

In 1996, Crowley contracted SECOR International Incorporated (SECOR) to conduct additional subsurface investigation services to further assess the extents of the hydrocarbon-impacted soil in the vicinity of the former ponds and to evaluate the effectiveness of potential remedial alternatives. The subsurface investigations conducted by SECOR consisted of the following activities:

- In May 1999, nine Geoprobe soil borings (GP-1 through GP-9) were drilled and sampled. The purpose of the work was to evaluate residual hydrocarbon extent in the vicinity of the three former ponds.

- In September 1999, 13 Geoprobe soil borings (GP-1A through GP-13A) were drilled and sampled in the vicinity of wells MW-1, MW-7, MW-8, MW-18 and MW-19 to further evaluate the extent of residual total petroleum hydrocarbons as diesel (TPH-D) in the vicinity of the former West Pond.

- On January 31, 2002, 11 Geoprobe borings (GPC-1 to GPC-11) were drilled and sampled. These borings were located near previous borings to evaluate the effectiveness of the dual-phase extraction system that is described in Section 2.6.

- On May 10, 2005, 16 Geoprobe borings (GPD-1 to GPD-16) were drilled and sampled. These borings were also located near previous borings to evaluate the effectiveness of the dual-phase extraction system.

The results of the investigation activities were used to further define the nature and extent of petroleum hydrocarbon contamination and also to evaluate the effectiveness of interim remedial actions taken at the Site (SECOR, 1999a; SECOR, 1999b; SECOR, 2000).

In August 2007, SLR conducted an investigation to further delineate soil impacts in the vicinity of the West Pond, to evaluate the effectiveness of the dual-phase extraction interim action (see Section 2.6) at reducing soil concentrations, and to collect additional analytical data required to assess potential risks to human health and the environment. Eight soil borings (GPE-1 to GPE-8) were completed – three of which were completed as temporary wells – and soil and groundwater samples were collected for laboratory analysis. In December 2007, eight additional soil borings (GPF-1 to GPF-8) were completed to collect additional analytical data required for assessing potential risks to human health and the environment (SLR, 2008).

2.3.3 Investigation Results

During the investigation activities conducted since 1999, soil and groundwater samples have been analyzed for total petroleum hydrocarbons (TPH) in the gasoline range, diesel range, and/or the heavy oil range. To evaluate the hydrocarbon compositions, selected samples were also analyzed for benzene, toluene, ethylbenzene, and total xylenes (BTEX); for polycyclic aromatic hydrocarbons (PAHs), and for volatile and extractable petroleum hydrocarbons (VPH/EPH) fractions. Two soil samples were also analyzed for the full volatile organic compound (VOC) analyte list and the full semi-volatile organic compound (SVOC) analyte list. Samples collected in December 2007 were analyzed for TPH-Dx with and without silica gel cleanup. Silica gel cleanup resulted in TPH-Dx concentrations of 40% to 70% of the concentration detected without silica gel cleanup.

The soil sample analytical results for TPH and BTEX are presented in **Table 1**. The soil sample analytical data for analysis of VPH/EPH, as well as the associated PAH and VOC results, are presented in **Table 2**. Toxicity adjusted total carcinogenic PAH (cPAH) concentrations are also included in **Table 2**.

Except for TPH-D, TPH as gasoline (TPH-G), benzene, and 1-methylnaphthalene, all of the analyte concentrations were below the selected screening levels (current MTCA Method A cleanup levels for industrial sites or, if there was no Method A cleanup level for a specific analyte, the Method B cleanup level). Detected TPH-D concentrations were typically much greater than TPH-G and TPH as oil (TPH-O) concentrations in the soil samples, and the TPH-G and TPH-O concentrations may be partly due to overlap from the diesel range hydrocarbons.

Figure 6 shows the total TPH concentrations from all soil borings. Where the TPH analysis did not utilize silica gel cleanup, the values presented on Figure 6 are 70% of the detected value, to reflect a conservative reduction in those concentrations that would have occurred had silica gel cleanup been used. The concentration contours shown on **Figure 6** are conceptual and should be considered approximate due to the observed heterogeneity of site soils.

The groundwater sample analytical results for TPH-D, TPH-O, TPH-G, BTEX, and total cPAHs are presented in **Table 3**. Historically, TPH-D analyses on groundwater have typically included silica gel cleanup. Additional groundwater sample analytical data from the 2007 investigation, including results for analysis for non-carcinogenic PAHs, and VOCs are presented in **Table 4** and **Table 5**, respectively. Except for TPH-D, TPH-G, TPH-O, and benzene, all of the analyte concentrations were below the selected screening levels (current MTCA Method A cleanup levels or, if there was no Method A cleanup level for a specific analyte, the Method B cleanup level).

Detected TPH-D concentrations were typically much greater than TPH-G and TPH-O concentrations in the groundwater samples, and the TPH-G and TPH-O concentrations may be partly due to overlap from the diesel range hydrocarbons. **Figure 7** shows the total TPH concentrations, after silica gel cleanup, in groundwater samples collected during the most complete recent sampling event, which was in 2005.

2.4 SITE GEOLOGY AND HYDROGEOLOGY

The site is located within the Columbia River Basin, approximately 600 feet north of the Columbia River. The geologic units identified at or adjacent to the Site include:

- Fill soils: In general, the uppermost soils at the Site are fill soils that range from approximately 2 to 17 feet in thickness. The fill soils generally consist of very loose to very dense fine to medium sand (dredge sands) with a trace to no silt.

- Fine-grained native soils: These soils formed the original surface soils beneath the Site. These soils include silty sands, silts, fine sandy silts, clayey silts, and clays. In general, these soils consist of fluvial silts and fine sandy silts. In some areas, the uppermost fine-grained native soils include silty sands and silts that may have been wind-borne (aeolian) deposits. In some areas, the basal deposit of this unit is a stiff, blue-green clay. These fine-grained native soils are apparently at least 20 feet thick beneath all areas of the Site, and extend above and below the typical (non-flood) stage of the adjacent Columbia River. These soils are consistently reported to contain traces of organic material or woody debris.

- Coarse-grained native soils: These soils include fluvial sands, gravelly sands, and sandy gravels. Site investigations have defined dense to very dense fine to medium sand directly beneath the fine-grained native soils in the vicinity of monitoring well MW-20. Investigations at a neighboring site indicate that the fine to medium sands occur at elevations between mean sea level (0 feet) and approximately -70 feet, and are underlain by at least 20 feet of sandy gravels.

The original (pre-fill) Site topography is not known; however, investigation data suggest that one or more swales were present beneath the Site. The former wastewater infiltration ponds were excavated into fill soils. The bases of the infiltration ponds were generally at or near the base of the fill. After use, the ponds were backfilled with soils that are similar to the dredge sands.

The hydrostratigraphic units defined for this Site include the following:

- Vadose zone: The vadose zone occurs in unsaturated fill soils (fine to medium sands) and underlying unsaturated fine-grained native soils (silty sands, silts, and fine sandy silts).

- Upper saturated zone: The upper saturated zone occurs in saturated fill soils (fine to medium sands). Groundwater elevations in the upper saturated zone are consistently higher than Columbia River elevations (except possibly during significant flood events). The upper saturated zone occurs seasonally beneath the southern and western portions of the site, and continuously beneath the northeastern portion of the site.

- Silt aquitard: The silt aquitard includes saturated native fine-grained soils (silty sands, silts, fine sandy silts, clayey silts, and clays). Groundwater elevations in the silt aquitard are generally higher than Columbia River elevations (except possibly during major flood events). The silt aquitard is interpreted as having a significantly lower hydraulic conductivity than either the overlying dredge sands or the underlying coarse-grained native sands and gravels.

- Lower saturated zone: The lower saturated zone occurs in saturated native coarse-grained soils (fluvial sands, gravelly sands, and sandy gravels) beneath the silt aquitard. Investigation data suggest that groundwater elevations in lower saturated zone sands immediately below the silt aquitard are generally consistent with Columbia River elevations.

Cross sections showing Site geology are illustrated on **Figure 8** and **Figure 9**.

2.5 HYDROGEOLOGIC MODEL

The lower saturated zone is interpreted as being part of the regional flow system within the Columbia River basin. The vadose zone, upper saturated zone, and silt aquitard are interpreted as being part of a local flow system within the regional flow system.

The local flow system is recharged by seasonal precipitation infiltrating into the dredge sands. The infiltrating precipitation accumulates within and above the silt aquitard. The groundwater table beneath the Site occurs within the upper saturated zone and the silt aquitard at depths ranging from approximately 2 to 18 feet below ground surface (bgs). During seasonal high water levels, groundwater within the upper saturated zone generally flows radially from the former wastewater infiltration pond areas through the dredge sands with lesser vertical flow downward through the silt aquitard. As seasonal precipitation rates decrease, the groundwater table in the upper saturated zone falls.

Beneath the southern and western portions of the Site, the water table typically falls below the base of the dredge sands and into the underlying fine-grained native soils. During seasonal low water levels, groundwater in the upper saturated zone beneath the northeastern portion of the Site primarily flows to the north and east through the dredge sands, with lesser vertical discharge through the silt aquitard. However, beneath the western and southern portions of the Site, upper saturated zone flow during seasonal low water levels is entirely within the silt aquitard, and is expected to be primarily southward (towards the Columbia River) and downward. The groundwater monitoring data collected at the Site are presented in **Table 6**.

2.6 PREVIOUS INTERIM REMEDIAL ACTIONS

To recover floating petroleum free product (primarily diesel) that was present in the vicinity of the west and east former wastewater infiltration ponds, Crowley conducted two interim remedial actions at the Site.

In 1985, GeoEngineers installed a groundwater and free product recovery system at the Site. The recovery system consisted of a groundwater recovery trench that was located in the vicinity of the west and east ponds. A groundwater recovery well located in a gravel-filled recovery trench was used to extract groundwater and free product. The recovered liquids were pumped into an oil/water separator to collect the free product, and the water effluent from the separator was forced back into the subsurface via a gravel-filled infiltration trench. The locations of the recovery trench and the infiltration trench are shown on **Figure 3**. The groundwater and free product recovery operations were conducted from 1986 to 1995. The system was deactivated when the floating free product appeared to be no longer present at recoverable levels. A total of approximately 1,425 gallons of free product were recovered by the system. The groundwater and free product recovery operations were detailed in several reports by GeoEngineers, Inc. and Converse Consultants (GeoEngineers, Inc. 1985b; and Converse Consultants, 1995).

In November and December 2000, a second interim remedial action was installed to remediate several areas of petroleum-impacted soil at the site and to recover any remaining localized areas of floating free product. The interim action consisted of the installation and operation of a dual phase extraction system (including a bioventing component). Using a vacuum blower, the system extracted soil vapors, groundwater, and free product from five wells (designated RW-1 through RW-4 and RW-6) that were located within or near the former South Pond and West Pond. The locations of the extraction wells are shown on **Figure 3**.

The extracted vapors were treated with activated carbon prior to discharge to the atmosphere. The extracted liquids were separated and the free product collected in an oil/water separator. The water effluent from the separator was pumped through an activated carbon adsorption system prior to discharge into the infiltration trench described above. The dual phase extraction system operated through February 2003, when it was shut down due to low hydrocarbon recovery rates. To evaluate whether contaminant rebound had occurred during the shut-down period, the system was re-started in December 2004 and operated through December 2005. The system was deactivated when the hydrocarbon vapor recovery rates were too low to justify continued operation and there was no evidence of recovered free product.

The dual-phase extraction system recovered a total of less than 10 gallons of free product. This provided evidence to support that the previous interim action effectively removed the recoverable free product at the site. Based on soil vapor sample analytical results, blower operating hours, and measured airflow rates, the estimated mass of hydrocarbons removed by the soil vapor extraction component of the dual-phase extraction system was approximately 4,000 pounds (500 gallons). Based on the water sample analytical results and the measured volume of extracted groundwater, the estimated mass of hydrocarbons removed by the groundwater extraction component of the system was approximately 690 pounds (88 gallons). Based on measured biorespiration rates, the estimated mass of hydrocarbons removed by bioventing component of the system was approximately 11,000 pounds (1,400 gallons) (SLR, 2007).

Due to the effectiveness of the interim actions, floating free product has not been detected in any of the groundwater monitoring wells at the site since 1999, and benzene has not been detected in any of the soil or groundwater samples collected since the completion of the second interim action. The depth to groundwater and free product thickness data from 1995 through 2005 are presented in **Table 6**. The soil and groundwater sample analytical data are shown in **Table 1** and **Table 3**.

3. NATURE AND EXTENT OF CONTAMINATION

Based on the results of the previous investigations and the previous interim remedial actions, this section details the current nature and extent of the contamination at the Site.

3.1 INDICATOR HAZARDOUS SUBSTANCES

Indicator hazardous substances (IHSs) are the chemicals expected to account for most of the risks at the Site, and cleanup standards must be developed for each IHS in each medium of concern. Based on the previous investigation results, the media of concern at the Site are soil and groundwater. As discussed in Section 2.3, petroleum hydrocarbons, primarily in the diesel range, were detected in soil and groundwater samples at concentrations above the screening levels (MTCA Method A cleanup levels), and these compounds are the predominant contaminants present on Site. With the exception of 1-methylnaphthalene, semi-volatile VOCs (SVOCs) and non-petroleum VOCs did not exceed screening levels (MTCA Method A or Method B cleanup levels) in soil or groundwater samples (**Tables 2, 3, 4, and 5**), which indicates that they contribute a small percentage of the overall threat to human health and the environment (WAC 173-340-703). Based on the investigation results, TPH (combined TPH-G, TPH-D, and TPH-O concentrations) was selected as an IHS for soil and for groundwater.

Soil cleanup levels were calculated by using Ecology's MTCATPH11 spreadsheet, which considers all carcinogenic and non-carcinogenic components of petroleum, including BTEX and PAHs (see Section 4.1). It is not necessary to establish separate cleanup levels for the non-carcinogenic components of petroleum, such as 1-methylnaphthalene, because they would be redundant with the TPH cleanup levels.

In some situations, it can be protective to establish separate cleanup levels for the carcinogenic components of petroleum because small variations in the composition of the petroleum mixture across the Site could result in higher cancer risks than allowed by MTCA. Therefore, benzene and cPAHs were evaluated as possible IHSs. Benzene has not been detected in any of the soil or groundwater samples collected after completion of the previous interim remedial actions at the Site. Because the remedial measures successfully reduced the benzene concentrations to below levels of concern, benzene was not selected as an IHS for soil or groundwater. Because CPAH compounds have never been detected in groundwater, they were not selected as IHSs in groundwater. Because CPAHs have not been detected in soil at concentrations above the MTCA Method A industrial soil cleanup level of 2 mg/kg, they were not selected as IHSs for soil.

Since TPH is the only IHS for the soil and groundwater at the Site, the following sections that describe the nature and extent of contamination will focus solely on TPH.

3.2 SOIL QUALITY

During the previous investigation activities, soil samples have been collected from soil boring locations throughout the Site. The soil sample locations (including monitoring well borings) are shown on **Figure 5.**

The soil sample analytical results show that the contaminant source areas are the three former wastewater infiltration ponds. After completing the interim remedial actions, TPH concentrations in the soil greater than 2,000 mg/kg are located primarily beneath the former West Pond and beneath the northern and central parts of the South Pond. A localized area of TPH concentrations greater than 2,000 mg/kg is also located southwest of the former East Pond (see **Figure 6**). The TPH concentrations typically decrease with distance away from the footprints of the former West and South Ponds, and the concentrations are usually below 100 mg/kg within 20 feet of the edges of the former ponds. The TPH concentrations greater than 2,000 mg/kg typically occur at depths of at least 6 feet bgs and extend downward into the underlying native fine-grained unit. TPH concentrations greater than 2,000 mg/kg have been detected at depths of up to 2 feet below the top of the native fine-grained unit (approximately 17 feet bgs). Soil boring logs and sample analytical results indicate that the TPH concentrations generally decrease with depth after reaching the top of the native fine-grained unit.

3.3 GROUNDWATER QUALITY

During the previous investigations, shallow groundwater samples were collected from all of the monitoring wells and from temporary wells in several of the soil borings located at the site. The groundwater sample locations are shown on **Figure 3.** The groundwater sample analytical results showed that the contaminant source areas are the three former wastewater infiltration ponds. After completing the previous interim remedial actions, TPH concentrations in the groundwater greater than 500 µg/L are located in the southern part of the site (primarily beneath the former West Pond and South Pond) and in the northern part of the Site beneath the former East Pond and to the north of the former East Pond (see **Figure** 7).

The groundwater sample analytical results indicate that the TPH concentrations typically decrease with distance away from the footprints of the former ponds, likely due to natural attenuation. In the southern part of the Site, the TPH concentrations decrease to below 500 µg/L within 40 feet of the edges of the former west and south ponds. In the northern part of the Site, TPH concentrations greater than 500 µg/L extend to the north of the former East Pond. The impacted groundwater beneath the southern part of the Site does not appear to be migrating towards the Columbia River.

4. CLEANUP STANDARDS

4.1 SOIL CLEANUP LEVELS

Soil cleanup levels must consider the following possible endpoints:

- Direct human contact with soil (incidental ingestion)
- Leaching to groundwater
- Residual saturation
- Terrestrial ecological evaluation (TEE)
- In some circumstances, inhalation of soil vapors and dermal contact with soil.

These endpoints are discussed in order below.

4.1.1 Direct Human Contact

The direct contact cleanup level was established using Method C for industrial land use. The Site is zoned for heavy industrial use by the city of Vancouver (Vancouver Municipal Code 20.160.020) and the uses allowed in this zone are consistent with MTCA's definition of industrial land use (WAC 173-340-745). An institutional control in the form of a deed restriction will be applied to ensure that the property remains in industrial use, as required by MTCA (WAC 173-340-440).

The TPH soil cleanup level for direct contact was calculated by using Ecology's MTCATPH11 spreadsheet. To support the MTCATPH11 evaluations, the petroleum fractionation data from eight soil samples collected after completion of the previous interim remedial actions were entered separately into the spreadsheet. The "fractionated" samples were analyzed for VPH, EPH, BTEX, methyl tertiary butyl ether (MTBE), 1,2-dichloroethane (EDC), ethylene dibromide (EDB), n-hexane, and PAHs.

The fractionation data were adjusted to account for constituents never detected on Site and to avoid double counting constituents reported by more than one analytical method (Ecology, 2006). When a fraction was reported by both the VPH and the EPH methods, the higher of the two results was used. The following constituents were considered not to be present, and were assigned values of 0 mg/Kg, because they were not detected in any of the fractionated samples:

- Aliphatic effective carbon chain range (EC) 5-6
- Benzene
- MTBE
- EDB
- EDC

Concentrations of the following constituents were subtracted from the carbon chain ranges indicated to avoid double counting:

- Ethylbenzene and xylenes were subtracted from aromatics EC 8-10
- Naphthalene was subtracted from aromatics EC 10-12
- 1- and 2-methylnaphthalene were subtracted from aromatics EC 12-16
- cPAHs were subtracted from aromatics EC 21-34

n-Hexane was detected in one sample (GPF-2-1207) so it was assumed to be present at half detection limits in each of the other fractionated samples. N-Hexane should be subtracted from aliphatics EC 5-6, but this fraction had been assigned 0 mg/kg because it was not detected in any fractionated sample. The aliphatics EC 5-6 fraction remained unchanged at 0 mg/kg. The adjusted fractionation data for the eight samples are presented in **Table 7**.

The Method C cleanup levels calculated by MTCATPH11 ranged from 22,056 mg/kg (sample GPF 3-1207) to 33,746 mg/kg (sample GPE-6-11). The median of the eight cleanup level values is 30,949 mg/kg.

4.1.2 Leaching to Groundwater

The TPH cleanup level for leaching to groundwater was calculated by using Ecology's MTCATPH11 spreadsheet, assuming a potable groundwater receptor (500 µg/L groundwater cleanup level, discussed in Section 4.2). Each of the eight fractionated samples was evaluated separately after using the data adjustments discussed above for the direct contact evaluation. The leaching to groundwater evaluation was conducted for the unsaturated zone and the default soil parameter values were applied.

Soil cleanup levels were not calculated for the saturated zone because of difficulties demonstrating compliance with soil cleanup levels in the saturated zone. When evaluating results for soil samples in the saturated zone, it is difficult to know whether the concentrations observed reside in the water phase or on the soil phase. An empirical demonstration will be used to demonstrate that soil in the saturated zone is protective of groundwater [WAC 173-340-747(9)]. After the groundwater concentrations decrease to below the groundwater cleanup level, the soil in the saturated zone must be protective of groundwater.

For four of the eight fractionated samples, the leaching evaluation calculated soil cleanup levels ranging from 39 mg/kg (sample GPF-6-1207) to 140 mg/kg (sample GPF-8-1207). For the other four samples, the leaching evaluation returned a result of "100% NAPL." This result means that the composition of the sample is so low in mobility that the spreadsheet would predict no impacts to groundwater even if pure product were present in the soil. For such samples, when concentrations as high as 70,000 mg/kg are tested, the spreadsheet predicts that groundwater would be safe to drink. Concentrations higher than approximately 70,000 mg/kg cannot be tested because the spreadsheet returns an error message that "NAPL is supersaturated" and the calculations are incorrect.

For the purpose of calculating a median value, it was necessary to assign concentrations to the results of "100% NAPL." A conservative value of 10,000 mg/kg was assigned, which is much lower than the highest concentration (70,000 mg/kg) that can be accurately evaluated by the spreadsheet. Using this approach, the median TPH leaching cleanup level for the eight fractionated samples is 5,070 mg/kg.

4.1.3 Residual Saturation

Residual saturation must be considered for organic chemicals that are liquid at ambient temperatures (WAC 173-340-747(10)). Previous interim remedial actions at the site have effectively removed the recoverable free product, and free product has not been observed on site since 1999. This provides an empirical demonstration that residual saturation is no longer a concern at the site (WAC 173-340-747(10)) because:

- Non-aqueous phase liquid (NAPL) is not accumulating on or in groundwater.
- The groundwater has been observed for a sufficiently long period to ensure that NAPL will not begin to accumulate after the interim actions.
- Site conditions will not change in the future in such a way as to promote NAPL accumulation on or in groundwater. In fact, future removal actions will further reduce the likelihood that NAPL could reach groundwater.

As a result of the empirical demonstration, residual saturation was eliminated from further consideration in establishing the soil cleanup levels for TPH.

4.1.4 Terrestrial Ecological Evaluation

SLR conducted a TEE for the Site as required by WAC 173-340-7490. The Site did not meet any of the criteria for exclusion of the TEE [WAC 173-340-7491(1)], and a site-specific TEE was not required because:

- The Site, located in an area of heavy industrial land use, is not located on or directly adjacent to the an area where management or land use plans will maintain or restore native or semi-native vegetation [WAC 173-340-7491(2)(a)(i)].
- Based on a review of the Bald Eagle Buffer Management Zone Map and the Habitat Species Map for the Site area that were provided by the Washington Department of Fish and Wildlife

(WDFW), bald eagles and sandhill cranes are known to use areas located 0.25 to 0.5 miles north of the Site. Threatened and endangered species were not identified on Site or in the immediate vicinity of the Site.

The following information was obtained from the Port of Vancouver Columbia Gateway Project Draft Environmental Inpact Statement (Columbia Gateway EIS), dated September 2007, that was prepared by Jones and Stokes, Inc. for the Port of Vancouver (Jones and Stokes, 2007). Bald eagles are reported as nesting approximately one mile north of the Site. Bald eagles are listed as threatened under the Washington State Bald Eagle Protection Act. Sandhill cranes have been seen in the Site area during surveys conducted between November 2003 and March 2004. Sandhill cranes are listed as endangered by the State of Washington. No other threatened or endangered animal species were identified in the Site area.

Bald eagles are not known to "use" (live, feed, or breed) the Site and there are no trees on the site that could be used for perching. The sandhill crane use of the Site area consists of migration stops that focus on shallow lakes and mudflats with little vegetation. Shallow lakes and mudflats do not exist at the Site. Sandhill cranes are not known to "use" the Site; therefore, the Site is not used by any threatened or endangered species [WAC 173-340-7491(2)(a)(ii)].

- Based on a review of the Habitat and Species Map provided by the WDFW for the Site and surrounding area, great blue herons are known to use areas located 0.25 to 0.5 miles north and east of the Site. Priority species were not identified on the Site or in the immediate vicinity of the Site.

  According to the Columbia Gateway EIS, great blue herons have been observed in the Site area and there are rookeries located more than one mile to the northeast of the Site (Jones and Stokes, 2007). Great blue herons primarily use upland pasture land and row cropland in the Site area for foraging. The Columbia Marine Lines Site does not contain any pasture land or row cropland, and great blue herons are not known to use the Site. No other priority animal species or species of concern were identified in the site area [WAC 173-340-7491(2)(a)(ii)].

- According to the Washington Department of Natural Resources Natural Heritage Program, there are no records of significant natural features, rare plants, or high quality native plant communities in the Site area. According to the Columbia Gateway EIS, the Site habitat is "urban and mixed environments". The Site is not occupied by plant species classified as endangered, threatened, or sensitive under Title 79 RCW [WAC 173-340-7491(2)(a)(ii)].

- The area of contamination at the Site is not located on a property that contains at least 10 acres of native vegetation within 500 feet of the area of contamination [WAC 173-340-7491(2)(a)(iii)]. Sparse vegetation and industrial land use preclude the presence of significant native vegetation.

- The Department of Ecology has not determined that the Site may present a risk to significant wildlife populations [WAC 173-340-7491(2)(a)(iv)].

SLR conducted a simplified TEE for the Site (WAC 173-340-7492). The majority of the Site is sparsely vegetated with grasses and mosses, and willows, alders, and brush are present in isolated low-lying areas in the northern portion of the Site. The current and future Site use is industrial. Under the pathways analysis [WAC 173-340-7492 (2)(b)], only potential exposure pathways to wildlife, such as small mammals and birds, need to be considered. The TPH cleanup level for the TEE is 15,000 mg/kg based on industrial/commercial sites (MTCA Table 749-2).

4.1.5 Soil Vapor Pathway

If changes are made to the default exposure parameters in the soil ingestion equations (MTCA Equations 740-1 and 740-2), if changes are made to the default soil parameters in the soil leaching model, or if a soil cleanup level higher than 10,000 mg/kg is proposed for TPH (diesel range), soil cleanup levels must consider the soil vapor pathway (WAC 173-340-740(3)(c)(iv)). Because there were no changes to the default exposure parameters and, as discussed in the summary of this section, because the proposed cleanup level for TPH is less than 10,000 mg/kg, the soil vapor pathway was not evaluated.

4.1.6 Dermal Contact with Soil

The MTCATPH11 spreadsheet used to calculate the TPH cleanup levels for direct human contact uses Equation 740-3, which incorporates both incidental ingestion and dermal contact with soil. Therefore, further evaluation of this pathway is not required.

4.1.7 Summary of Soil Cleanup Levels

The TPH soil cleanup levels discussed in this section include the following:

- Direct contact: 30,949 mg/kg
- Leaching to groundwater: 5,070 mg/kg
- TEE: 15,000 mg/kg

The final soil cleanup level for TPH (combined TPH-G, TPH-D, and TPH-O concentrations) is 5,070 mg/kg based on leaching to potable groundwater. The point of compliance for the soil cleanup level is throughout the site and within the soil column from the ground surface to the top of the groundwater table.

4.2 GROUNDWATER CLEANUP LEVEL

Groundwater cleanup levels must consider protection of drinking water and protection of surface water. The groundwater beneath the Site is considered potable and it is hydraulically connected to the Columbia River, which is also considered potable. Therefore, a MTCA Method A cleanup level for TPH, which is based on protection of drinking water, is the selected groundwater cleanup level for the Site. The Method A TPH groundwater cleanup levels in MTCA Table 720-1 were derived by setting the hazard index (HI) for each of the mixtures (i.e., TPH-G, TPH-D, and TPH-O) to 1.0. Using all three of the Method A cleanup levels would be equivalent to establishing an HI of 3.0, which exceeds the MTCA target of 1.0. Since the hydrocarbons at the site are predominantly in the diesel range and the Method A cleanup level for TPH-D is 500 µg/L, the selected groundwater cleanup level for TPH (combined TPH-G, TPH-D, and TPH-O concentrations) is 500 µg/L. The point of compliance for the groundwater cleanup level is throughout the site.

5. CLEANUP ACTION ALTERNATIVES

This section summarizes the four remedial alternatives that were developed and evaluated for the Site. For each alternative, the key components are described, including conceptual engineering designs.

Components and unit pricing were developed based on prior experience and current vendor information collected specifically for this analysis. These data were used to develop conceptual scenarios and to estimate costs.

The following four alternatives were evaluated:

1. Alternative 1: Excavation and Off-Site Disposal
2. Alternative 2: Excavation and On-Site Treatment
3. Alternative 3: Bioventing
4. Alternative 4: In-Situ Chemical Oxidation

5.1 ALTERNATIVE 1: EXCAVATION AND OFF-SITE DISPOSAL

5.1.1 Excavation and Off-Site Disposal

For Alternative 1, soil containing TPH concentrations above the cleanup level of 5,070 mg/kg would be excavated and transported off-site for disposal. The approximate area to be excavated and the conceptual configuration of the alternative are illustrated on **Figure 10** and **Figure 11**. Impacted soil generally lies beneath 6 to 10 feet of clean soil and extends to a depth of approximately 15 feet bgs. To effectively recover impacted soils, the excavations would extend to depths of approximately one foot below the low seasonal groundwater table (approximately 15 to 17 feet bgs). The excavations would extend laterally until the sidewall sample concentrations are below the cleanup level.

An estimate of 4,800 cubic yards (cy) of clean soil overburden would be removed and stockpiled on site. The actual amount of excavated soil may vary based on the observed conditions in the subsurface. An estimate of 3,400 cy of impacted soil would be excavated and transported off site to a licensed landfill for disposal. The actual amount of soil excavated may vary based on the observed conditions in the subsurface.

Prior to backfilling, the stockpile of clean excavated soil would be sampled to determine the TPH concentrations. The stockpiled soil that contains TPH concentrations below the cleanup level would be used to backfill the excavations. The stockpiled soil that contains TPH concentrations above the cleanup level would be transported off-site for disposal at a licensed landfill. The remainder of the excavations would be backfilled by either re-grading existing site soils or bringing in clean backfill material.

5.1.2 Groundwater Recovery

During excavation, groundwater would be pumped from the open excavations, treated on-site using the existing oil/water separator, bag filters, and activated carbon, and reinjected into the inactive extraction and injection trenches or another injection point. Injection will be completed under either the existing injection permit issued for the bioventing system or a new injection permit, if necessary. The depth to groundwater is expected to be approximately
13 to 14 feet. Assuming that the depth of groundwater above the base of the excavations is 3 feet, the total estimated volume of extracted groundwater is up to 250,000 gallons. Initially, the treated water would be pumped into a temporary storage tank after treatment, and samples of the extracted and treated water would be collected for laboratory analysis . When the treated water has been confirmed to contain TPH concentrations below the groundwater cleanup level, it would be discharged into the designated injection point.

5.1.3 Monitored Natural Attenuation (MNA)

Petroleum hydrocarbon concentrations in groundwater naturally attenuate relatively rapidly once source materials have been removed. The secondary groundwater cleanup component to this alternative is natural attenuation. Up to eight new wells, as necessary to replace wells destroyed during excavations and to provide new wells for monitored natural attenuation, would be installed to monitor the attenuation of dissolved-phase TPH. The new wells would be designed and developed to minimize silt and sediment in samples and limit the potential for artificially inflated TPH concentrations due to the present of silt and sediment in samples.

Monitoring would be conducted on a quarterly basis for the first year, on a semi-annual basis for the second year, and on an annual basis until the TPH concentrations are below the cleanup level. At that time, the sampling will be conducted on a quarterly basis until the concentrations are below the cleanup level for four consecutive quarterly events. For the purpose of this FS, we assumed that MNA monitoring would be conducted for a total of up to 6 years.

5.1.4 Institutional Controls

Institutional controls would be implemented to restrict future use of the property to industrial uses.

5.2 ALTERNATIVE 2: EXCAVATION AND ON-SITE TREATMENT

5.2.1 Excavation and On-Site Treatment

For Alternative 2, soil containing TPH concentrations above the cleanup level of 5,070 mg/kg would be excavated and treated on site by ex-situ bioremediation. The excavation of clean overburden, stockpiling of clean overburden, and excavation impacted soil of would be conducted as described above under Alternative 1.

The excavated soil would be treated on-site via ex-situ bioremediation. Approximately 1- to 2-acre treatment cells would be constructed by removing vegetation, re-grading the area such that it is level, and then placing the contaminated soil on the level ground in 1- to 2-foot thick lifts. The estimated locations of the bioremediation cells are shown on **Figure 11**. These locations are conceptual and the final treatment cell locations will depend on field conditions such as topography and the actual amount of soil removed for bioremediation.

The cells would be graded to have a slight slope inwards from the perimeter of the cell, and silt fencing would be installed around the perimeter of the treatment cells to minimize flow of storm water out of the treatment cells. The soil would be turned and amended with nutrients and water on regular, periodic schedules. Soil may be turned with a plow or other equipment designed to mix and turn the soil at the same time. If 2-foot lifts are used, soil may be turned in lifts. During the dry season, clean water may be transported to the Site for irrigating the soil.

To monitor the progress of the bioremediation, samples of the soil would be collected on at least a quarterly basis. When soil in a cell or portion of a cell contains TPH concentrations below the 5,070 mg/kg cleanup level, operation of the cell or portion of the cell will be stopped and the soil that is below the cleanup level will be backfilled in the excavations.

5.2.2 Groundwater Recovery

Same as Alternative 1.

5.2.3 Monitored Natural Attenuation

Same as Alternative 1.

5.2.4 Institutional Controls

Same as Alternative 1.

5.3 ALTERNATIVE 3: BIOVENTING

For Alternative 3, the areas of the site where TPH concentrations in the soil exceed the site cleanup level would be treated by bioventing methods and the groundwater in those areas would be extracted by dual-phase extraction methods. Bioventing has been conducted at the Site in the past (in conjunction with dual-phase extraction) with positive results. Bioventing would treat the soil by removing volatile organic compounds by soil vapor extraction and by stimulating biodegradation through oxygenation of the subsurface. The extracted groundwater would be treated on site and re-injected.

Approximately 40 new 2-inch diameter bioventing wells would be installed in the impacted areas with a hollow stem auger drill rig. The approximate locations of bioventing wells for a conceptual system under this alternative are shown on **Figure 12**. A pipeline header would be constructed to connect the wells to a vacuum blower system consisting of a vacuum extraction blower and knockout tank. The extracted soil vapors would be forced through vapor-phase carbon units for treatment prior to emission to the atmosphere. The extracted groundwater would be pumped through bag filters and liquid-phase carbon units for treatment prior to reinjection into the inactive extraction trench at the Site.

The system is estimated to require up to 30 months of operation. Operation and maintenance would include monthly sampling of vapor and liquid phase effluents, replacement of spent carbon, monitoring of flow rates, and equipment maintenance, repair, and replacement.

Periodically (quarterly to semi-annually), soil borings would be drilled and sampled by using Geoprobe methods in the zone of system influence to evaluate the effectiveness of the system. The system will be shut down when the soil samples in the compliance borings contain TPH concentrations below the cleanup level.

5.3.1 Monitored Natural Attenuation

Same as Alternative 1, except monitoring is estimated to require up to 12 years.

5.3.2 Institutional Controls

Same as Alternative 1.

5.4 ALTERNATIVE 4: IN-SITU CHEMICAL OXIDATION

In-situ chemical oxidation is a proven technology for destroying organic contaminants in soil. Powerful oxidizing chemicals, such as Fenton's Reagent, are injected into the ground using special tools attached to a Geoprobe rig, and the chemicals react with the organic materials, breaking them down into carbon dioxide and water. However, the oxidizing chemicals would not distinguish between naturally occurring organics and petroleum compounds, and the amount of chemical that would be required to treat soil at the Site, where the soil has high levels of organics, could be very high.

5.4.1 In-Situ Chemical Oxidation

Chemical oxidation would be used to treat soil in areas where the TPH concentrations exceed the soil cleanup level (5,070 mg/kg). The injections would be conducted from depths of the top of impacts (approximately 6 to 10 feet bgs) into the silt, and would thereby treat groundwater as well as soil. Fenton's Reagent would be injected in approximately 80 injection points in the zone of impact during one injection event. The number of points is based on an assumed radius of influence of 8 feet with a 10-percent overlap of radius of influence for each injection point. The approximate locations of the injection points for a conceptual system under this alternative are shown on **Figure 13**.

Approximately 3 months after the initial injection event, drilling and sampling of several Geoprobe borings would be conducted to evaluate the effectiveness of the injections. Following this sampling event, it is likely that additional injections would likely be required. The estimated cost for this alternative assumes 3 injection events, and, hence, 3 confirmation sampling events, would be required. The injections will be discontinued when the soil samples in the confirmation borings contain TPH concentrations below the cleanup level.

5.4.2 Monitored Natural Attenuation

Same as Alternative 3.

5.4.3 Institutional Controls

Same as Alternative 1.

6. EVALUATION OF CLEANUP ACTION ALTERNATIVES

Consistent with MTCA regulations and Ecology guidances, the four remdial alternatives were evaluated for effectiveness, implementability, and relative cost. The criteria are summarized below:

- The **effectiveness** of the alternative at reducing contaminant concentrations to levels protective of human health and the environment. Other factors used to evaluate effectiveness include the permanence of an alternative, the restoration time frame to comply with cleanup standards and applicable state and federal laws, and the consideration of public concerns.
- The technical and practical **implementability** of the alternative.
- The **cost** of the alternative.

Table 8 rates each alternative based on the evaluation criteria. A rating of 1 is the best and a rating of 4 is the worst.

6.1 EFFECTIVENESS

Alternatives 1 and 2 are the most effective alternatives due to the shortest time frame to remediate the soil and groundwater, and a greater likelihood of protectiveness. Depending upon the rate of natural attenuation, Alternative 1 and Alternative 2 are estimated to be completed in 6 years.

Due to the inability to control how airflow and injected oxidizing chemicals move within the subsurface, especially with the presence of fine-grained soils, there is more uncertainty with the effectiveness of Alternative 3 and Alternative 4. The installation of additional bioventing points or oxidizing chemical injection points may have to be conducted to address any areas that are not effectively remediated by the initial efforts. We estimate that Alternatives 3 and 4 would be completed in up to 12 years.

Alternatives 1 and 2 are considered more protective than Alternatives 3 and 4 because soil excavation physically removes the soil contamination (the source of impacted groundwater), while Alternative 3 and Alternative 4 are limited by the heterogeneity of the soil. Alternative 3 is considered more protective than Alternative 4 due to the active groundwater extraction from dual-phase extraction points. All four alternatives include groundwater monitoring to ensure protection of human health and the environment over time (permanence).

6.2 IMPLEMENTABILITY

Because the site is vacant, all four alternatives are relatively easy to implement. The soil excavation component of Alternative 1 and Alternative 2 would be the most difficult to implement. Because Alternative 2 also includes on-site treatment of the excavated soil rather than hauling off-site for disposal, it is considered more difficult to implement than Alternative 1.

Alternative 4 is rated the easiest to implement because it only consists of injection of oxidizing chemicals and groundwater monitoring of natural attenuation. Alternative 3 is rated more difficult to implement than Alternative 4, but it is easier than Alternatives 1 and 2 because it does not include soil excavation.

6.3 COST

Alternative 2 is the least expensive alternative ($740,000), and Alternative 4 ($2,000,000) is the most expensive alternative. The estimated costs for Alternative 1 and Alternative 3 are $970,000 and $1,300,000, respectively. Alternative 3 costs $700,000 less than Alternative 4 and it is considered more protective than Alternative 4.

In comparison with Alternative 1, Alternative 3 is considered disproportionate in cost, particularly when considering the increased effectiveness of the Alternative 1 cleanup. In comparison with Alternative 2, Alternative 1 is considered disproportionate in cost due to the similar effectiveness of both alternatives.

For cost estimating purposes, we assumed that:

- Alternative 1 would include 1 initial year of quarterly groundwater monitoring, 1 year of semiannual monitoring, 3 years of annual monitoring, and 1 final year of quarterly monitoring.
- Alternative 2 would include 1 initial year of quarterly groundwater monitoring, 1 year of semiannual monitoring, 3 years of annual monitoring, and 1 final year of quarterly monitoring.
- Alternative 3 would include 1 initial year of quarterly groundwater monitoring, 1 year of semiannual monitoring, 9 years of annual monitoring, and 1 final year of quarterly monitoring.

- Alternative 4 would include 1 initial year of quarterly groundwater monitoring, 1 year of semiannual monitoring, 9 years of annual monitoring, and 1 final year of quarterly monitoring.

7. RECOMMENDED CLEANUP ACTION

Based on the comparative evaluation of the four alternatives, Alternative 2 is the recommended alternative. Alternative 2 costs $230,000 less than Alternative 1 and it is considered to be equally effective (i.e. it has a similar restoration time and level of protectiveness). Alternative 2 is considered more difficult to implement than Alternatives 3 and 4; however, it costs $570,000 and $1,070,000 less than Alternative 3 and Alternative 4, respectively, and it is considered more effective (lower restoration time and greater level of protectiveness).

Alternative 2 includes groundwater monitoring to evaluate the effectiveness of the remedial action and the rates of natural attenuation. If the average TPH concentrations in the sampled monitoring wells at the Site have not decreased to below the site groundwater cleanup level or by at least 50 percent after three years of post-excavation groundwater monitoring, then we recommend evaluating whether additional groundwater remediation is necessary to address the remaining source areas. A monitoring plan for Alternative 2 that describes the planned excavation soil sampling and the planned groundwater sampling to evaluate monitored natural attenuation is presented in Appendix B.

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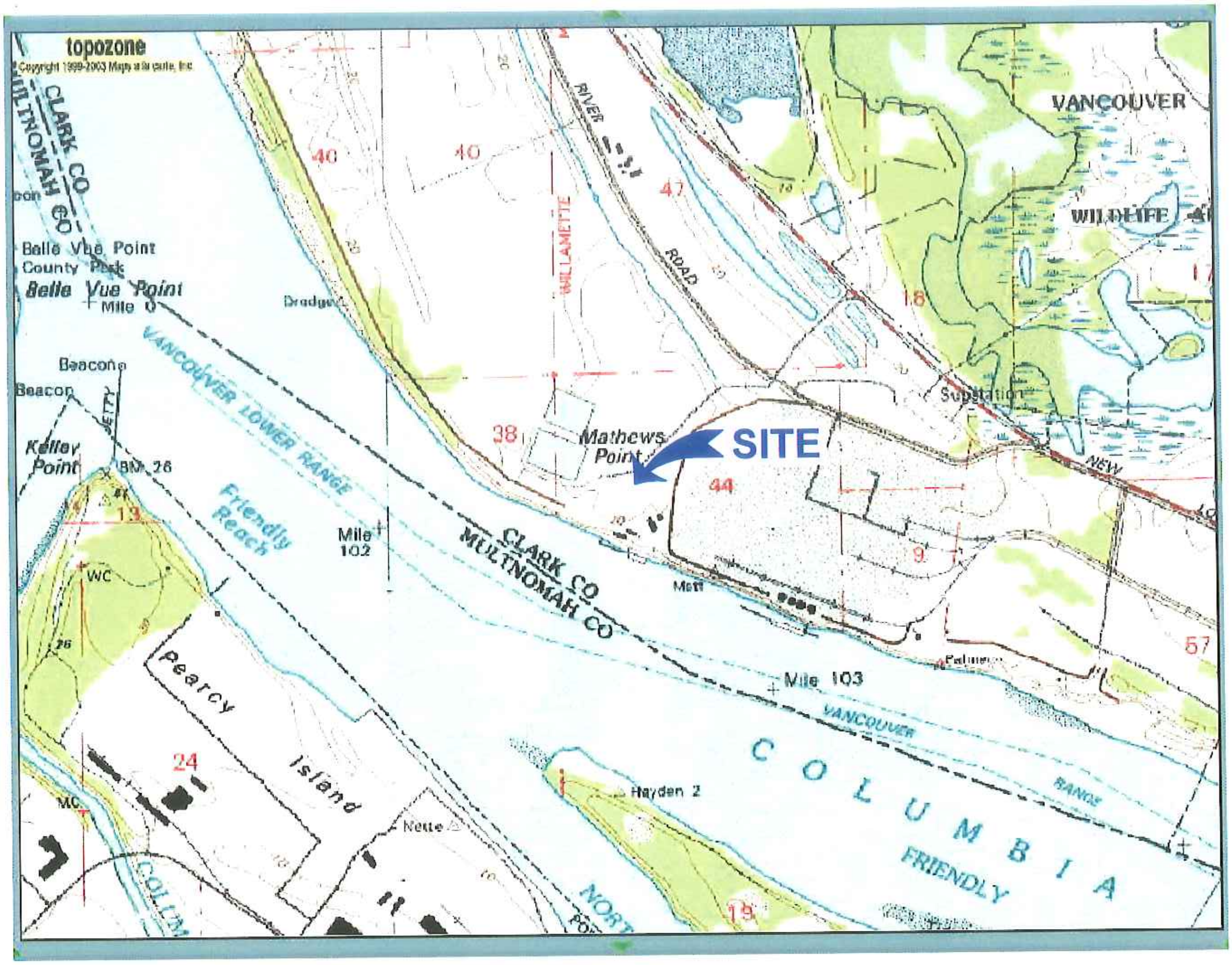
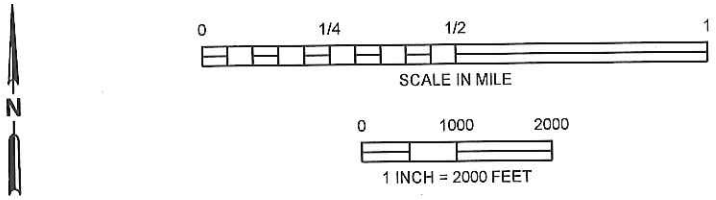
FIGURES





REFERENCE: USGS 7.5 MINUTE QUADRANGLE; VANCOUVER, WASHINGTON; 1990

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FIGURE 1
FORMER COLUMBIA MARINE
LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
SITE LOCATION MAP

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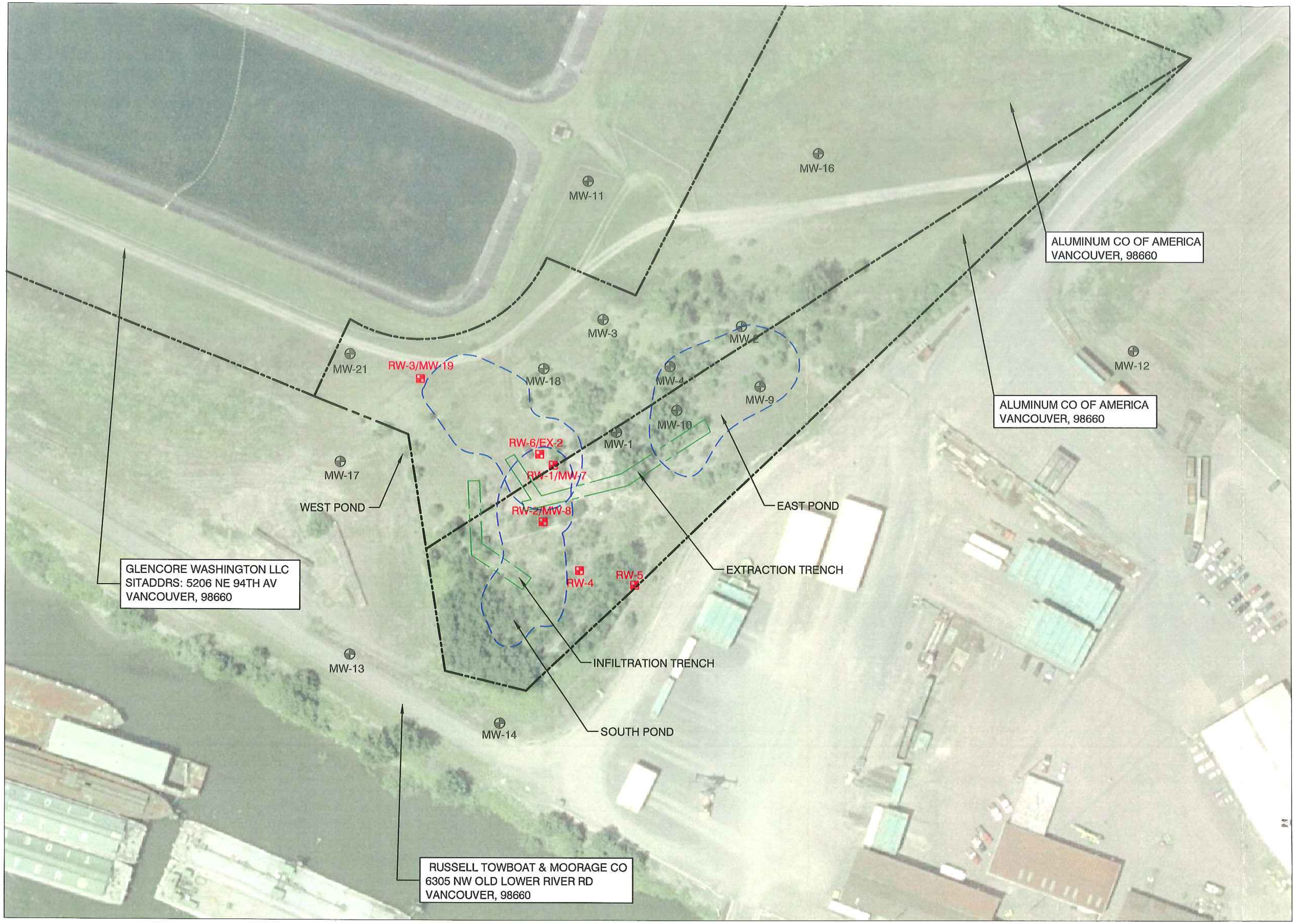
FIGURE 2
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
SITE VICINITY MAP



LEGEND

⊕	GROUNDWATER MONITORING WELL
▣	EXTRACTION WELL
- · - ·	APPROXIMATE PROPERTY LINES
◌	HISTORICAL EXTENTS OF PONDS

NOTES:

EXTENT OF EAST POND FROM 1971 AND 1980 AERIAL PHOTOGRAPHS

EXTENT OF WEST POND FROM HISTORICAL SITE TOPOGRAPHIC MAP AND 1968 AERIAL PHOTOGRAPH

EXTENT OF SOUTH POND FROM 1963 AND 1964 AERIAL PHOTOGRAPHS

N

0 100 200

SCALE IN FEET

NOTE:PROPERTY LINES ARE APPROXIMATE. PROPERTY LINES AND OWNERSHIP INFORMATION ARE BASED ON INFORMATION AVAILABLE ON THE CLARK COUNTY INTERNET WEB SITE.

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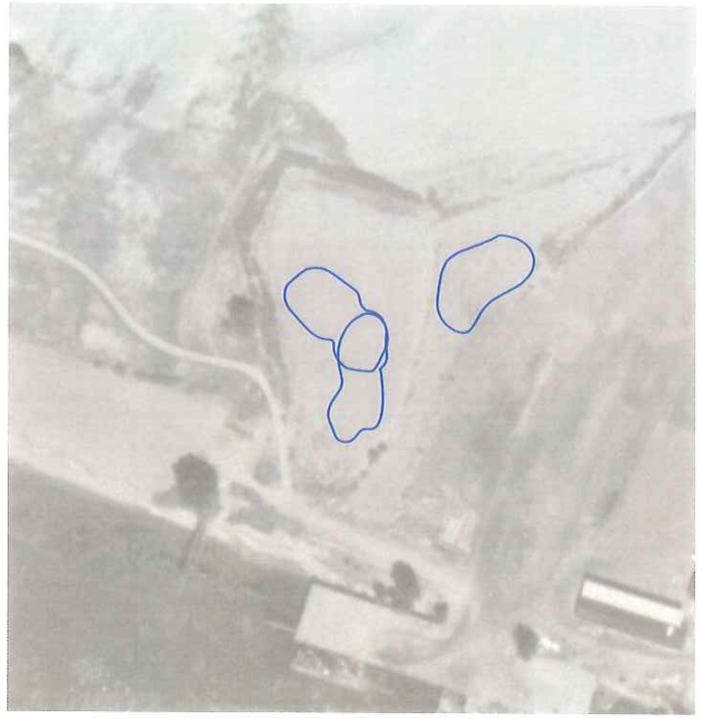
FIGURE 3
FORMER COLUMBIA MARINE
LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
SITE PLAN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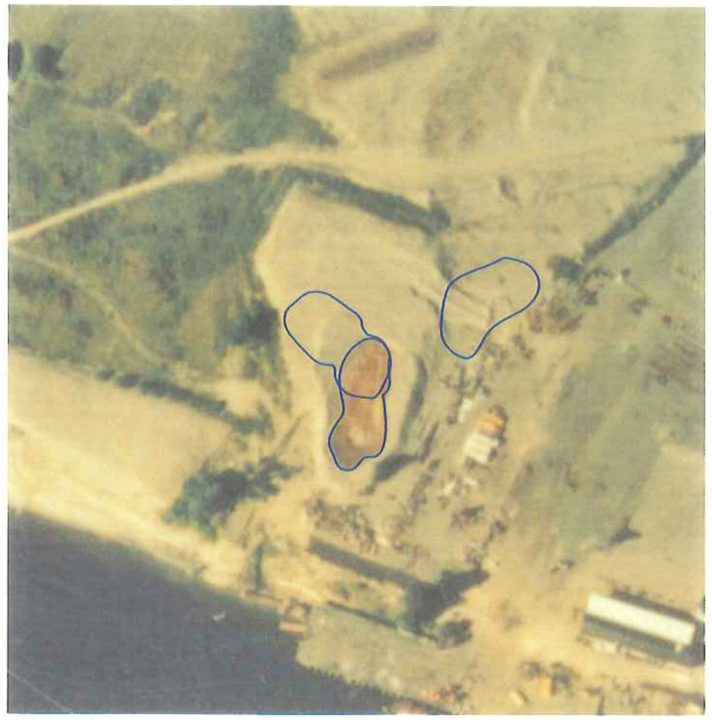
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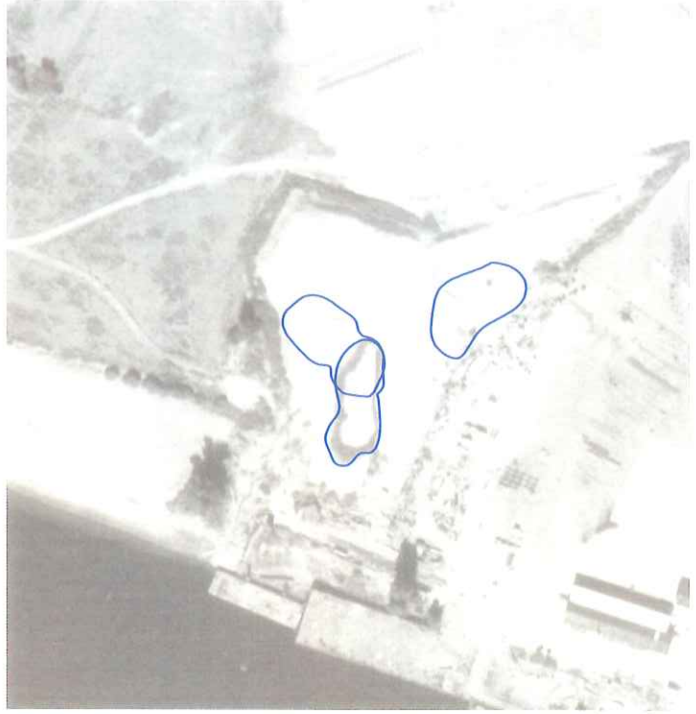
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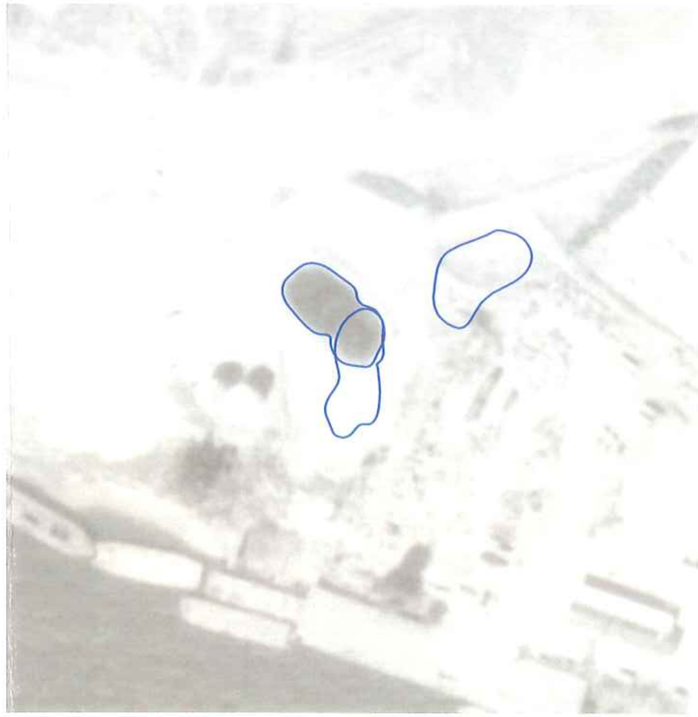
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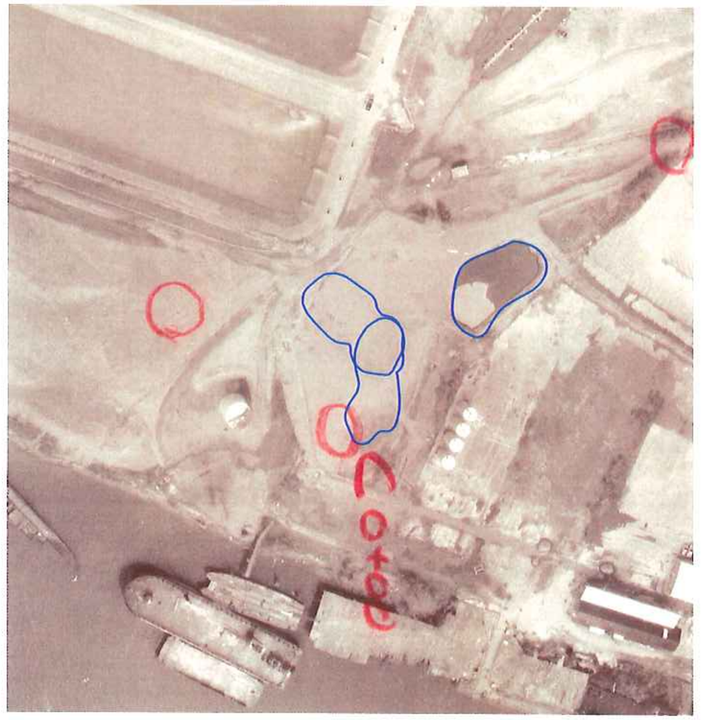

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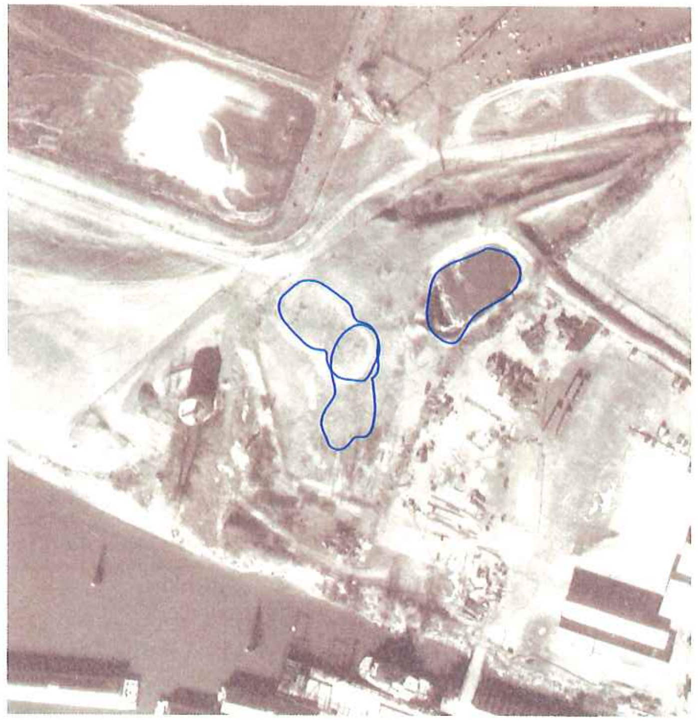
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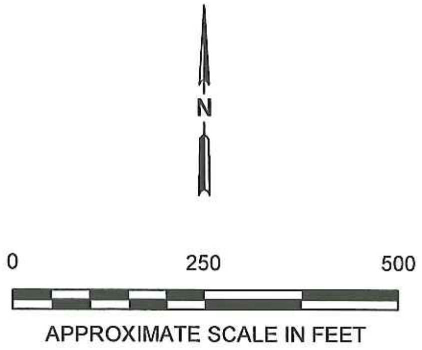

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FIGURE 4
FORMER COLUMBIA MARINE
LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
HISTORICAL AERIAL PHOTOGRAPHS

LEGEND

- ● GROUNDWATER MONITORING WELL
- 🟥 EXTRACTION WELL
- ● GEOPROBE BORING (MAY 1999)
- ● GEOPROBE BORING (SEPTEMBER 1999)
- ● GEOPROBE BORING (JANUARY 2002)
- ● GEOPROBE BORING (MAY 2005)
- ● GEOPROBE BORING (AUGUST 2007)
- ◯ APPROX. LOCATIONS OF FORMER PONDS

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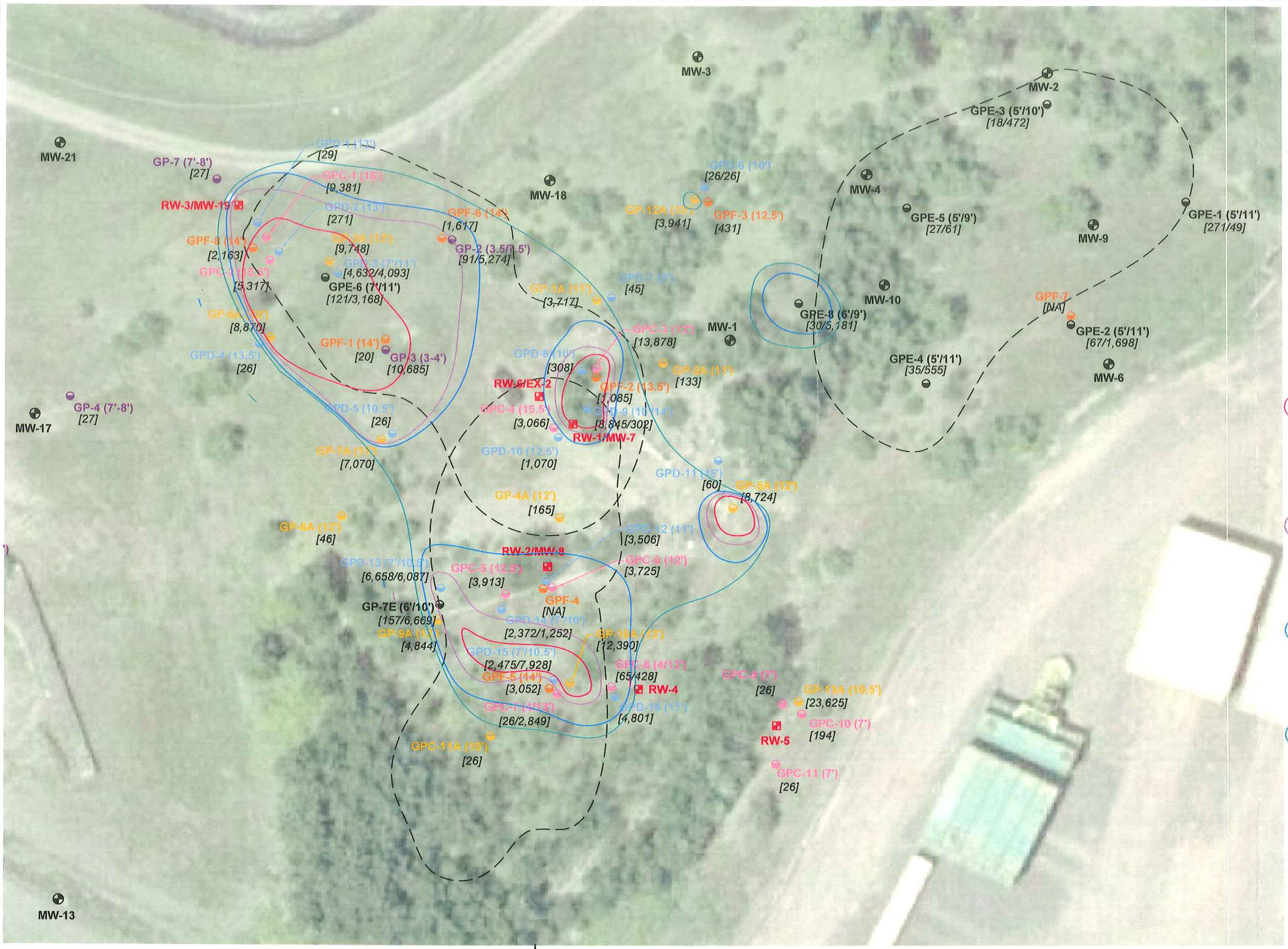
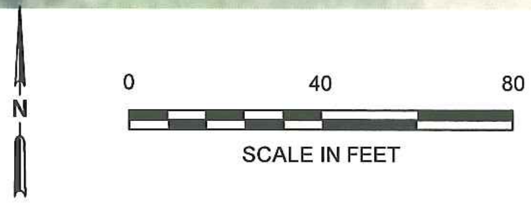
FIGURE 5
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
SITE PLAN WITH GEOPROBE AND CROSS SECTION LOCATIONS





LEGEND

⊕ GROUNDWATER MONITORING WELL

▣ EXTRACTION WELL

● GEOPROBE BORING (MAY 1999)

● GEOPROBE BORING (SEPTEMBER 1999)
(LOCATIONS OUITSIDE OF BIOVENTING INFLUENCE)

● GEOPROBE BORING (JANUARY 2002)

● GEOPROBE BORING (MAY 2005)

● GEOPROBE BORING (AUGUST 2007)

[5,380] TPH ANALYTICAL RESULTS (mg/Kg)

APPROX. LOCATIONS OF FORMER PONDS

APPROX. EXTENT OF SOIL THAT MAY HAVE TPH-DX EXCEEDING 8,000 MG/KG
VOLUME OF CLEAN SOIL REMOVED = 2,700 CY
VOLUME OF IMPACTED SOIL REMOVED = 1,300 CY
SEE FIGURE 4, FIGURE 5, AND FIGURE 6

APPROX. EXTENT OF SOIL THAT MAY HAVE TPH-DX EXCEEDING 6,000 MG/KG
VOLUME OF CLEAN SOIL REMOVED = 4,400 CY
VOLUME OF IMPACTED SOIL REMOVED = 2,800 CY
SEE FIGURE 4, FIGURE 5, AND FIGURE 6

APPROX. EXTENT OF SOIL THAT MAY HAVE TPH-DX EXCEEDING 4,000 MG/KG
VOLUME OF CLEAN SOIL REMOVED = 5,500 CY
VOLUME OF IMPACTED SOIL REMOVED = 4,200 CY
SEE FIGURE 4, FIGURE 5, AND FIGURE 6

APPROX. EXTENT OF SOIL THAT MAY HAVE TPH-DX EXCEEDING 2,000 MG/KG
VOLUME OF CLEAN SOIL REMOVED = 7,700 CY
VOLUME OF IMPACTED SOIL REMOVED = 6,900 CY

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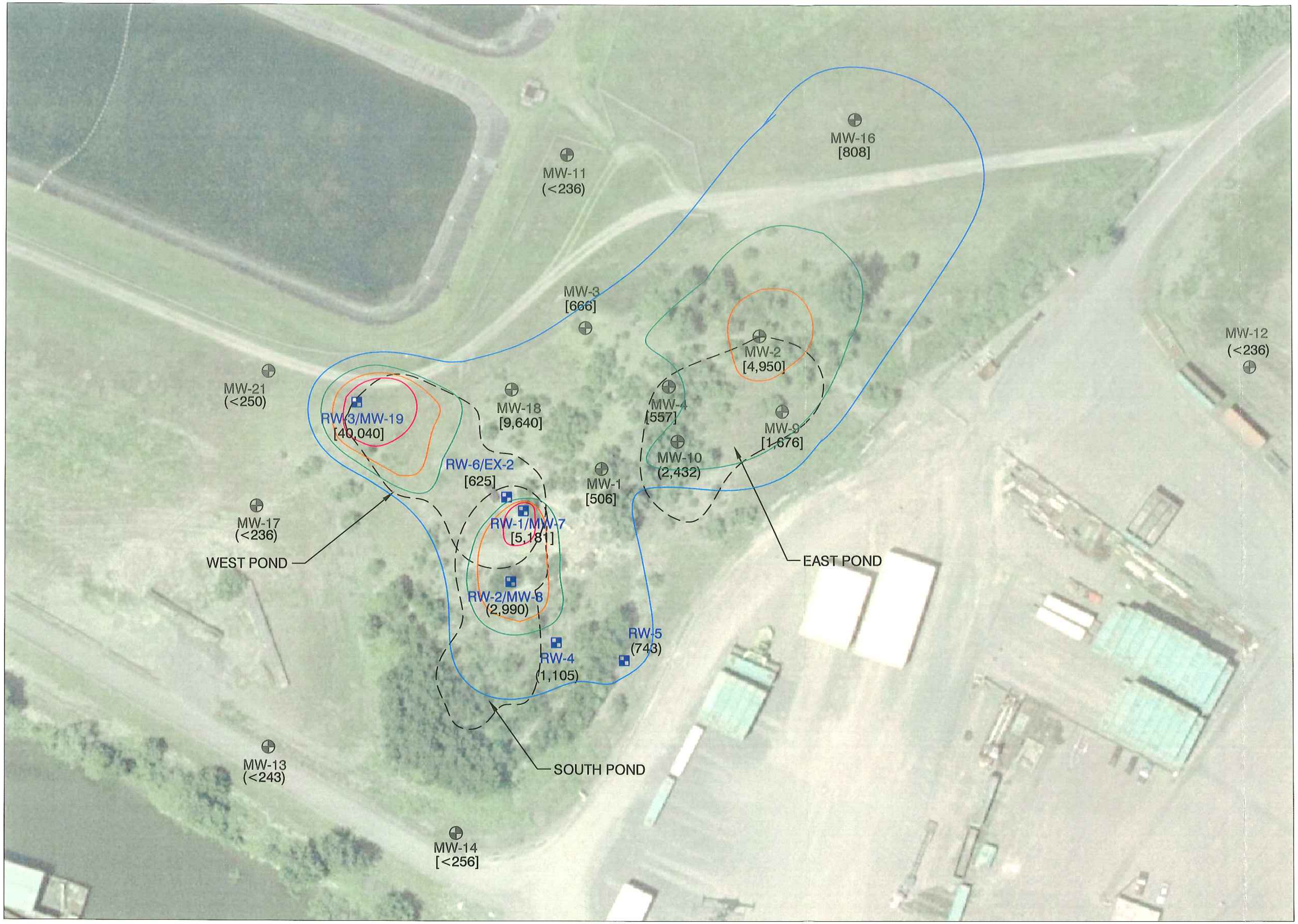
FIGURE 6
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
SILICA GEL ADJUSTED SOIL TPH-DX DATA
AND CONCENTRATION CONTOURS



LEGEND

⊕ GROUNDWATER MONITORING WELL

▪ EXTRACTION WELL

(428) TPH CONCENTRATION (μg/L)

HISTORICAL EXTENTS OF PONDS

APPROXIMATE EXTENT OF GROUNDWATER WITH > 500 μg/L TPH

APPROXIMATE EXTENT OF GROUNDWATER WITH > 1,000 μg/L TPH

APPROXIMATE EXTENT OF GROUNDWATER WITH > 2,000 μg/L TPH

APPROXIMATE EXTENT OF GROUNDWATER WITH > 5,000 μg/L TPH

NOTES:

EXTENT OF EAST POND FROM 1971 AND 1980 AERIAL PHOTOGRAPHS

EXTENT OF WEST POND FROM HISTORICAL SITE TOPOGRAPHIC MAP AND 1968 AERIAL PHOTOGRAPH

EXTENT OF SOUTH POND FROM 1963 AND 1964 AERIAL PHOTOGRAPHS

IF A WELL WAS DRY IN OCTOBER 2005 A PREVIOUS GROUNDWATER SAMPLE RESULT FOR THAT WELL WAS INDLUDED ON THIS FIGURE.

N

0 80 160

SCALE IN FEET

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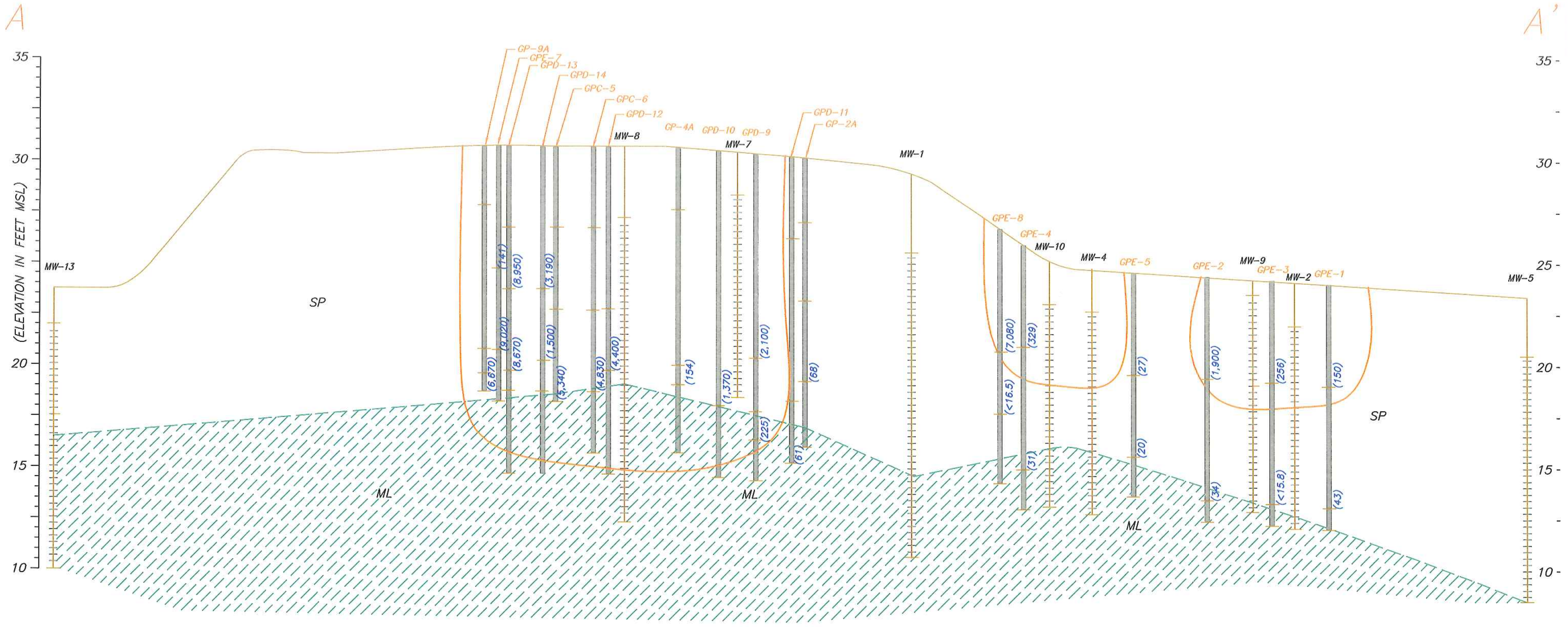
FIGURE 7
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
TPH CONCENTRATIONS IN GROUNDWATER
OCTOBER 2005



LEGEND

- - APPROXIMATE CONTACT

— APPROXIMATE EXTENT OF TPH-Dx> 100mg/kg

SP	SAND
ML	SILT

NOTES

VERTICAL SCALE: 1"=5'

HORIZONTAL SCALE: 1"=40'

WELL ID

SCREENED INTERVAL

MONITORING WELL

GEOPROBE BORING ID #

(SOIL TPH-Dx DIESEL RESULTS IN mg/kg)

GEOPROBE BORING

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FIGURE 8
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
CROSS-SECTION A-A'

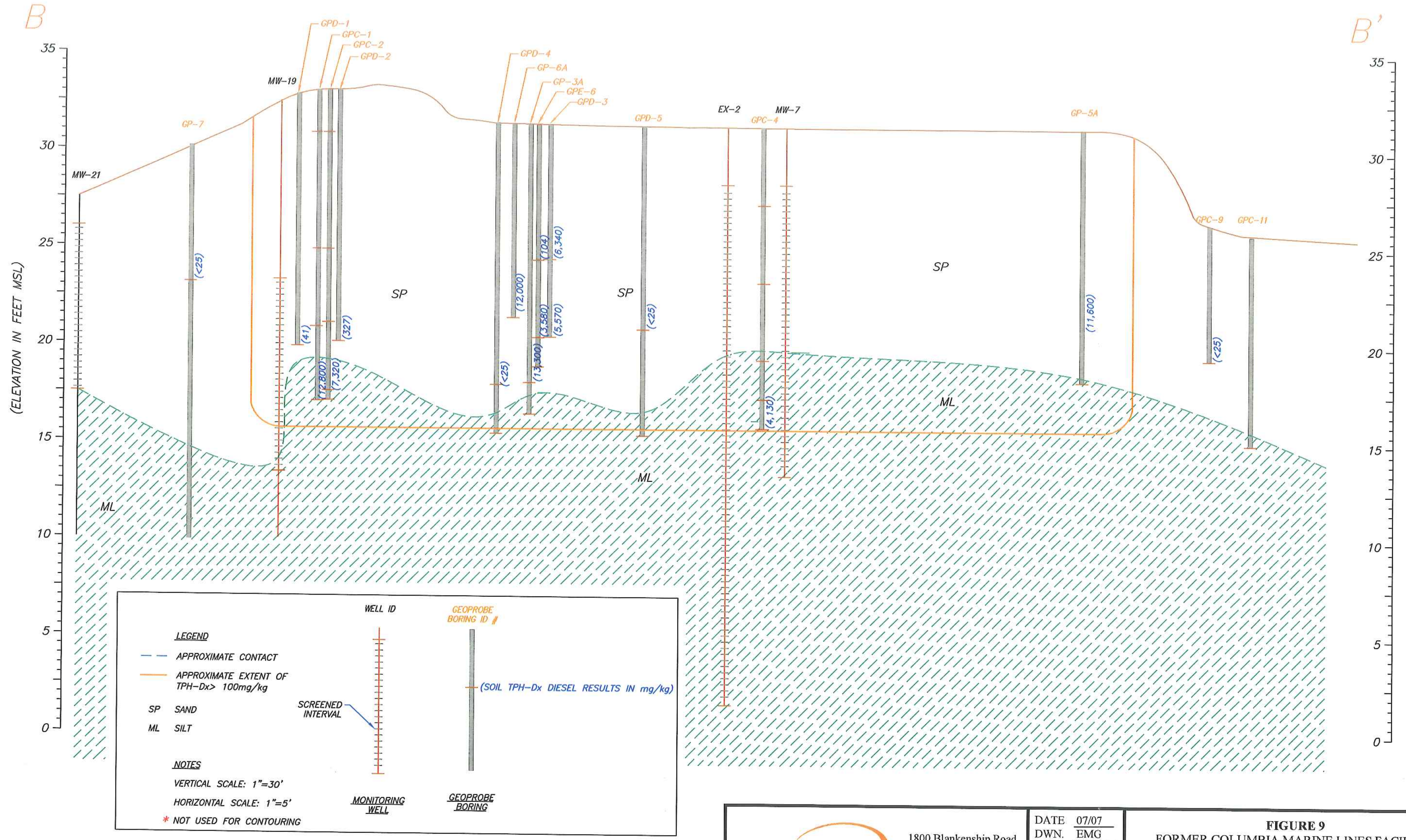

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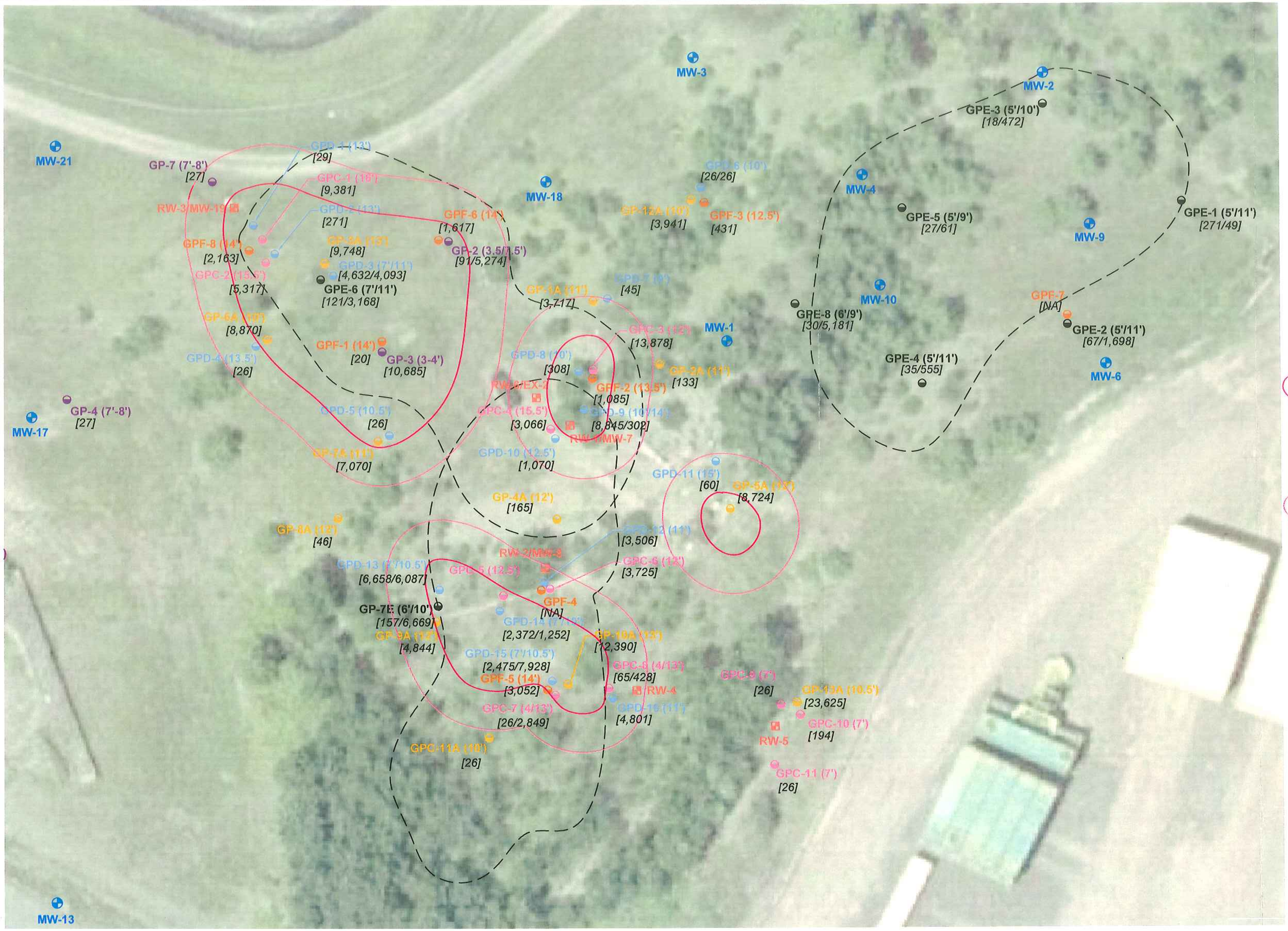
FIGURE 9
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
CROSS-SECTION B-B'



LEGEND

● GROUNDWATER MONITORING WELL

▨ EXTRACTION WELL

● GEOPROBE BORING (MAY 1999)

● GEOPROBE BORING (SEPTEMBER 1999)

● GEOPROBE BORING (JANUARY 2002)

● GEOPROBE BORING (MAY 2005)

● GEOPROBE BORING (AUGUST 2007)

TPH ANALYTICAL RESULTS (MG/KG)

APPROX. LOCATIONS OF FORMER PONDS

APPROX. EXTENT OF SOIL THAT MAY HAVE TPH EXCEEDING 5,070 MG/KG

ESTIMATED VOLUME OF CLEAN SOIL REMOVED = 4,800 CY

ESTIMATED VOLUME OF IMPACTED SOIL REMOVED = 3,400 CY

APPROX. EXTENT OF TOP OF EXCAVATION WITH 1:1 SIDE SLOPE

N

0 40 80

SCALE IN FEET

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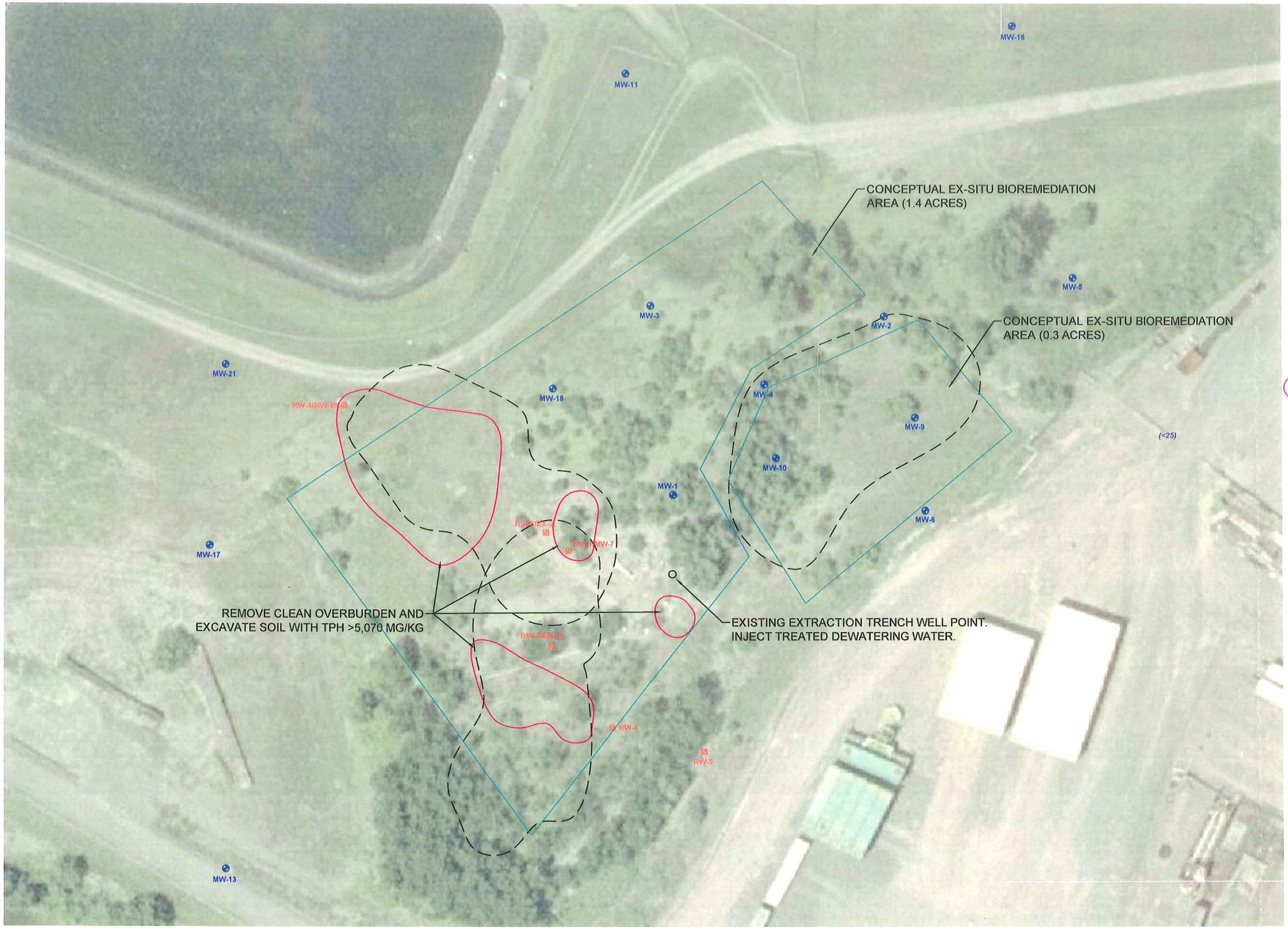
FIGURE 10
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
APPROXIMATE EXTENTS OF TPH CONCENTRATIONS IN SOIL EXCEEDING 5,070 MG/KG



LEGEND

- ● GROUNDWATER MONITORING WELL
- ▨ EXTRACTION WELL
- GEOPROBE BORING (MAY 1999)
- GEOPROBE BORING (SEPTEMBER 1999)
- GEOPROBE BORING (JANUARY 2002)
- GEOPROBE BORING (MAY 2005)
- GEOPROBE BORING (AUGUST 2007)
- TPH-D ANALYTICAL RESULTS (mg/Kg)
- APPROX. LOCATIONS OF FORMER PONDS
- APPROX. EXTENT OF SOIL THAT MAY HAVE TPH-DX EXCEEDING 5,070 MG/KG

VOLUME OF CLEAN SOIL REMOVED = 2,900 CY
VOLUME OF IMPACTED SOIL REMOVED = 3,300 CY

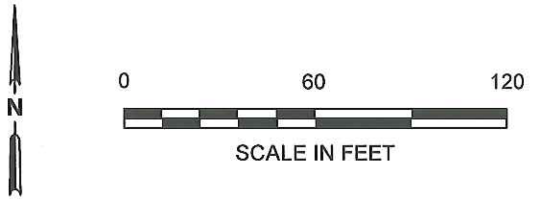


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FIGURE 11
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
CONCEPTUAL CLEANUP ACTION
ALTERNATIVE 1 AND ALTERNATIVE 2

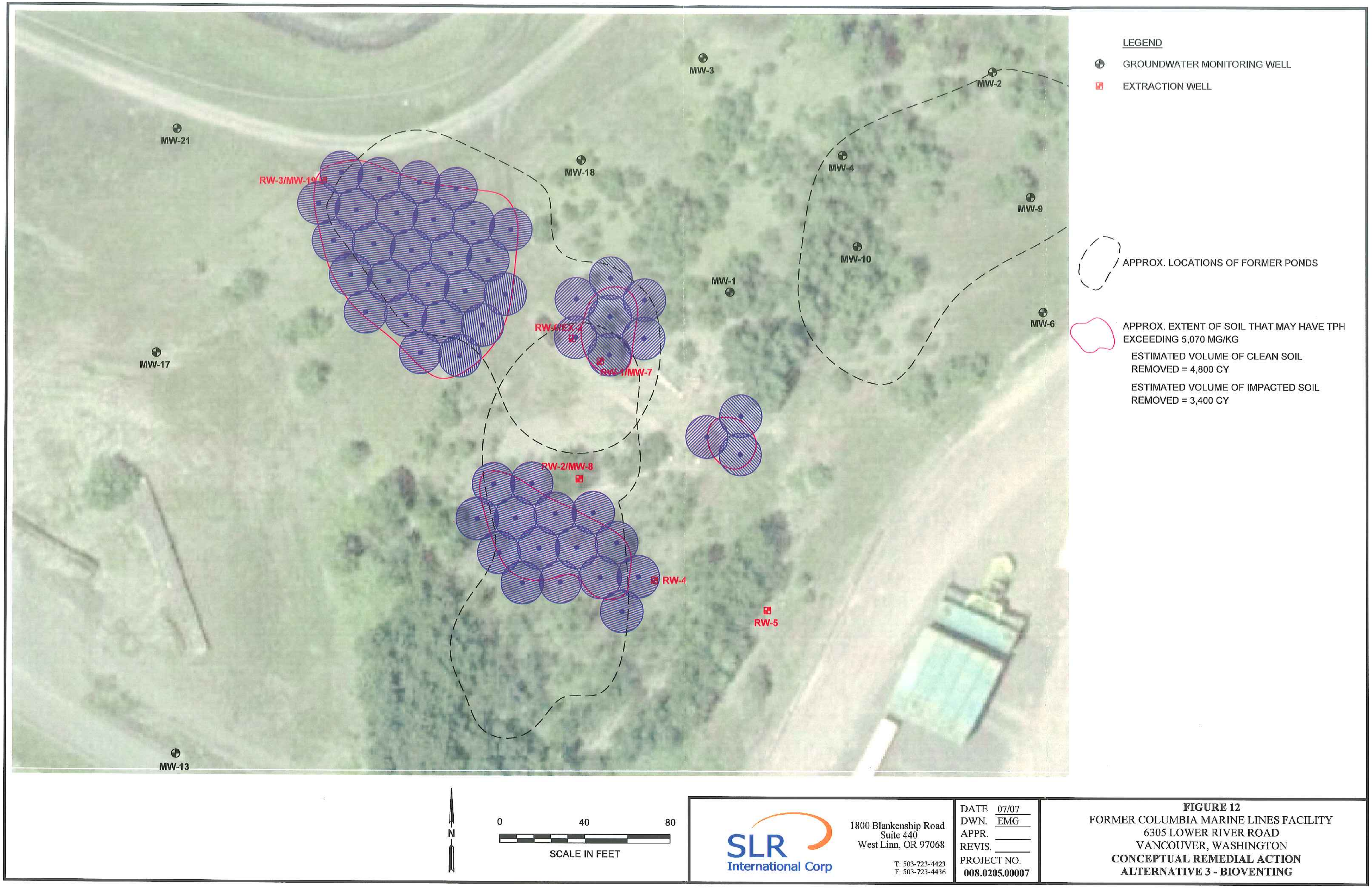

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FIGURE 12
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
CONCEPTUAL REMEDIAL ACTION
ALTERNATIVE 3 - BIOVENTING

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FIGURE 13
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
CONCEPTUAL REMEDIAL ACTION
ALTERNATIVE 4 - CHEMICAL OXIDATION

TABLES

Table 1. Soil Sample Analytical Data - TPH and BTEX
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Depth (feet bgs)	Sample Date	TPH-Gx	TPH-Dx Without Silica Gel Cleanup		TPH-Dx With Silica Gel Cleanup			Adjusted Diesel Concentration After Removing Biogenic Interference[a] (mg/kg)	BTEX (mg/kg)			
			Gasoline (mg/kg)	Diesel (mg/kg)	Heavy Oil (mg/kg)	Diesel (mg/kg)	Percent Reduction in Diesel Concentration after Silica Gel Cleanup	Heavy Oil (mg/kg)		Benzene	Toluene	Ethyl-benzene	Total Xylenes
Screening Levels[b]			**100**	**2,000**	**2,000**	**2,000**		**2,000**	**2,000**	**0.03**	**7**	**6**	**9**
GP1	2.5 - 3.0	5/6/1999	5.29	<25	<50	--	--	--	NA	<0.05	<0.05	<0.05	<0.05
GP2	3 - 4	5/6/1999	<2.5	104	<50	--	--	--	73	<0.05	<0.05	<0.05	<0.05
	7 - 8	5/6/1999	**584**	**6,700**	<500	--	--	--	**4,690**	<0.05	<0.05	<0.05	<0.05
GP3	3 - 4	5/6/1999	13.7	**14,000**	<2500	--	--	--	**9,800**	<0.05	<0.05	<0.05	<0.05
	7 - 8	5/6/1999	EPH/VPH Analysis Performed			--	--	--	NA	<1.0	<1.0	<1.0	<1.0
GP4	3 - 4	5/6/1999	<2.5	<25	<50	--	--	--	NA	<0.05	<0.05	<0.05	<0.05
GP5	3 - 4	5/6/1999	<2.5	<25	<50	--	--	--	NA	<0.05	<0.05	<0.05	<0.05
GP6	7 - 8	5/6/1999	<2.5	<25	<50	--	--	--	NA	<0.05	<0.05	<0.05	<0.05
GP7	7 - 8	5/6/1999	<2.5	<25	<50	--	--	--	NA	<0.05	<0.05	<0.05	<0.05
GP8	3 - 4	5/6/1999	<2.5	<25	<50	--	--	--	NA	<0.05	<0.05	<0.05	<0.05
GP9	3 - 4	5/6/1999	<2.5	<25	<50	--	--	--	NA	<0.05	<0.05	<0.05	<0.05
GP1A	11.0	9/10/1999	--	**4,940**	371	--	--	--	**3,458**	--	--	--	--
GP2A	11.0	9/10/1999	--	78	112	68	100	--	68	--	--	--	--
GP3A	13.0	9/10/1999	--	**13,300**	626	**13,500**	476	--	**13,500**	--	--	--	--
GP4A	12.0	9/10/1999	--	154	82	138	53	--	138	--	--	--	--
GP5A	12.0	9/10/1999	--	**11,600**	863	**11,200**	581	--	**11,200**	--	--	--	--
GP6A	10.0	9/14/1999	--	**12,000**	671	--	--	--	**8,400**	--	--	--	--
GP7A	11.0	9/14/1999	--	**9,600**	<1000	--	--	--	**6,720**	--	--	--	--
GP8A	12.0	9/10/1999	--	41	<50	--	--	--	29	--	--	--	--
GP9A	12.0	9/10/1999	--	**6,670**	<500	--	--	--	**4,669**	--	--	--	--
GP10A	13.0	9/10/1999	--	**17,200**	<1000	**17,400**	<500	--	**17,400**	--	--	--	--
GP11A	10.0	9/14/1999	--	<25	<50	--	--	--	NA	--	--	--	--
GP12A	10.0	9/14/1999	--	**5,380**	<500	--	--	--	**3,766**	--	--	--	--
GP13A	10.5	9/14/1999	--	**32,500**	<2500	--	--	--	**22,750**	--	--	--	--
GPC1	16.0	1/31/2002	--	**12,800**	602	--	--	--	**8,960**	--	--	--	--
GPC2	15.5	1/31/2002	--	**7,320**	275	--	--	--	**5,124**	--	--	--	--
GPC3	11.5-12.0	1/31/2002	--	**19,200**	625	--	--	--	**13,440**	--	--	--	--
GPC4	15-15.5	1/31/2002	--	**4,130**	<500	--	--	--	**2,891**	--	--	--	--
GPC5	12.0-12.5	1/31/2002	--	**5,340**	<500	--	--	--	**3,738**	--	--	--	--
GPC6	11.5-12.0	1/31/2002	--	**4,830**	492	--	--	--	**3,381**	--	--	--	--
GPC7	3.5-4.0	1/31/2002	--	<25	<50	--	--	--	NA	--	--	--	--
	12-12.5	1/31/2002	--	**3,820**	<500	--	--	--	**2,674**	--	--	--	--
GPC8	3.5-4.0	1/31/2002	--	68	<50	--	--	--	48	--	--	--	--
	12.5-13.0	1/31/2002	--	586	<50	--	--	--	410	--	--	--	--
GPC9	6.5-7.0	1/31/2002	--	<25	<50	--	--	--	NA	--	--	--	--
GPC10	6.5-7.0	1/31/2002	--	207	71	--	--	--	145	--	--	--	--
GPC11	6.5-7.0	1/31/2002	--	<25	<50	--	--	--	NA	--	--	--	--
GPD1	13.0	5/10/2005	--	41	<0.5	--	--	--	29	--	--	--	--
GPD2	13.0	5/10/2005	--	327	61	--	--	--	229	--	--	--	--
GPD3	7.0	5/10/2005	--	**6,340**	277	--	--	--	**4,438**	--	--	--	--
	11.0	5/10/2005	--	**5,570**	277	--	--	--	**3,899**	--	--	--	--
GPD4	13.5	5/10/2005	--	<25	<50	--	--	--	NA	--	--	--	--
GPD5	10.5	5/10/2005	--	<25	<50	--	--	--	NA	--	--	--	--
GPD6	7.0	5/10/2005	--	<25	<50	--	--	--	NA	--	--	--	--
	10.0	5/10/2005	--	<25	<50	--	--	--	NA	--	--	--	--
GPD7	9.0	5/10/2005	--	39	<50	--	--	--	27	--	--	--	--
GPD8	10.0	5/10/2005	--	415	<50	--	--	--	291	--	--	--	--
GPD9	10.0	5/10/2005	--	**12,100**	536	--	--	--	**8,470**	--	--	--	--
	14.0	5/10/2005	--	225	207	--	--	--	158	--	--	--	--
GPD10	12.5	5/10/2005	--	1,370	158	--	--	--	959	--	--	--	--
GPD11	15.0	5/10/2005	--	61	<50	--	--	--	43	--	--	--	--
GPD12	11.0	5/10/2005	--	**4,400**	609	--	--	--	**3,080**	--	--	--	--
GPD13	7.0	5/10/2005	**241**	**8,950**	320	--	--	--	**6,265**	<0.093	<0.093	0.15	0.821
	10.5	5/10/2005	--	**8,670**	<50	--	--	--	**6,069**	--	--	--	--
GPD14	7.0	5/10/2005	--	**3,190**	199	--	--	--	**2,233**	--	--	--	--
	10.0	5/10/2005	--	1,500	289	--	--	--	1,050	--	--	--	--
GPD15	7.0	5/10/2005	60.1	**3,450**	<50	--	--	--	**2,415**	<0.0861	<0.0861	<0.0861	<0.0861
	10.5	5/10/2005	--	**11,200**	<250	--	--	--	**7,840**	--	--	--	--
GPD16	11.0	5/10/2005	--	**6,620**	238	--	--	--	**4,634**	--	--	--	--
GPE-1	5.0	8/24/2007	<5.73	150	234	--	--	--	105	--	--	--	--
	11.0	8/24/2007	10.2	43	<32.8	--	--	--	30	<0.00201	<0.00201	<0.00535	<0.0134
GPE-2	5.0	8/24/2007	45.7	34	<31.0	--	--	--	24	--	--	--	--

Table 1. Soil Sample Analytical Data - TPH and BTEX
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

			TPH-Gx	TPH-Dx Without Silica Gel Cleanup		TPH-Dx With Silica Gel Cleanup			Adjusted Diesel Concentration After Removing Biogenic Interference[a] (mg/kg)	BTEX (mg/kg)			
Sample Location	Depth (feet bgs)	Sample Date	Gasoline (mg/kg)	Diesel (mg/kg)	Heavy Oil (mg/kg)	Diesel (mg/kg)	Percent Reduction in Diesel Concentration after Silica Gel Cleanup	Heavy Oil (mg/kg)		Benzene	Toluene	Ethyl-benzene	Total Xylenes
Screening Levels[b]			**100**	**2,000**	**2,000**	**2,000**		**2,000**	**2,000**	**0.03**	**7**	**6**	**9**
	11.0	8/24/2007	6.18	1,900	520	--	--	--	1,330	<0.00172	<0.00172	<0.00458	<0.0114
GPE-3	5.0	8/24/2007	<3.94	<15.8	<31.7	--	--	--	NA	--	--	--	--
	10.0	8/24/2007	<4.17	256	416	--	--	--	179	--	--	--	--
GPE-4	5.0	8/24/2007	<4.26	31	<33.2	--	--	--	21	--	--	--	--
	11.0	8/24/2007	<4.21	329	462	--	--	--	230	<0.00148	<0.00148	<0.00395	<0.00987
GPE-5	5.0	8/24/2007	<4.09	20	<32.1	--	--	--	14	--	--	--	--
	9.0	8/24/2007	<4.14	27	58	--	--	--	19	--	--	--	--
GPE-6	7.0	8/24/2007	<4.19	104	66	--	--	--	73	--	--	--	--
	11.0	8/24/2007	**753**	**3,580**	192	--	--	--	**2,506**	<0.00202	<0.00202	<0.0054	<0.0135
GPE-7	6.0	8/24/2007	<3.93	141	81.4	--	--	--	99	--	--	--	--
	10.0	8/24/2007	**173**	**9,020**	<668	--	--	--	**6,314**	<0.00249	<0.00249	<0.00663	<0.0166
GPE-8	6.0	8/24/2007	18.1	<16.5	<33.1	--	--	--	NA	--	--	--	--
	9.0	8/24/2007	<5.15	**7,080**	<637	--	--	--	**4,956**	--	--	--	--
GPF-1	14.0	12/20/2007	--	22	6.9	8.6	61%	<5	15	<0.00032	<0.0012	0.00049	0.0016
GPF-2	13.5	12/21/2007	--	1,500	<100	940	37%	<100	1,050	<0.00032	0.0029	0.0017	0.0047
GPF-3	12.5	12/22/2007	--	590	<50	220	63%	<50	413	<0.015	<0.056	<0.010	<0.021
GPF-5	14.0	12/23/2007	--	**4,000**	360	**2,700**	32%	<250	**2,800**	<0.00032	<0.0012	<0.00023	<0.00046
GPF-6	14.0	12/24/2007	--	**2,100**	210	920	56%	<50	920	<0.180	<0.690	<0.130	<0.26
GPF-8	14.0	12/25/2007	--	**2,900**	190	1,300	55%	<50	1,300	<0.016	<0.059	0.014	<0.022

Notes:

[a] Based on the reduction in diesel concentrations after silica gel cleanup, the diesel concentrations without silica gel cleanup were conservatively reduced by 30% to account for naturally occuring biogenic interference.

[b] Chapter 173-340 WAC, Model Toxics Control Act (MTCA) Cleanup Regulation, Method A Cleanup Levels for Industrial Sites. Amended February 12, 2001.

[c] Since benzene has not been detected in soil samples, the MTCA Method A clenaup level of 100 mg/kg was used as the screening level for TPH as gasoline.

Bold - Indicates that the compound was detected at a concentration that exceeded the screening level.

mg/kg = milligrams per kilogram.

-- = Not analyzed.

< = Not detected at or above the indicated detection limit.

NA = Not applicable.

Diesel =TPH as diesel analysis by Washington DOE Method WTPH-D or by Northwest Method NWTPH-Dx with silica gel cleanup analysis based on possible biogenic intererence.

Heavy Oil = Analysis based on possible biogenic intererence.

BTEX = Analyzed by EPA Method 8260B. Prior to 2007 the method is unknown.

Table 2. Soil Sample Analytical Results - EPH/VPH, VOCs, and PAHs from 2007 Investigation
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Analytical Method	Chemical	Sample ID								Screening Level[a] (mg/kg)
		GPE-6-11 (mg/kg)	GPE-7-10 (mg/kg)	GPF-1-1207 (mg/kg)	GPF-2-1207 (mg/kg)	GPF-3-1207 (mg/kg)	GPF-5-1207 (mg/kg)	GPF-6-1207 (mg/kg)	GPF-8-1207 (mg/kg)	
EPH WDOE	AL_EC>8-10	38.4	121	73	24	1.2	7.7	29	14	NA
EPH WDOE	AL_EC>10-12	347	753	520	200	19	91	170	160	NA
EPH WDOE	AL_EC>12-16	1350	2560	1400	550	180	590	400	460	NA
EPH WDOE	AL_EC>16-21	971	1610	620	320	140	420	170	160	NA
EPH WDOE	AL_EC>21-34	165	224	80	66	42	47	24	33	NA
EPH WDOE	AR_EC>8-10	<6.80	<13.3	1.25	1.75	1.2	1.2	4.1	1.2	NA
EPH WDOE	AR_EC>10-12	19	42.8	49	160	1.2	8.8	160	24	NA
EPH WDOE	AR_EC>12-16	151	301	320	840	3.4	150	660	120	NA
EPH WDOE	AR_EC>16-21	331	561	420	1500	41	340	800	120	NA
EPH WDOE	AR_EC>21-34	70.2	112	60	420	25	35	130	24	NA
VPH WDOE	AL_EC>5-6	<13.2	<82.7	6	10.5	4.8	6	4.8	5.5	NA
VPH WDOE	AL_EC>6-8	<13.2	<82.7	51	10.5	4.8	6	110	5.5	NA
VPH WDOE	AL_EC>8-10	19	<82.7	73	10.5	4.8	6	95	5.5	NA
VPH WDOE	AL_EC>10-12	47.8	62.3	190	10.5	4.8	6	160	35	NA
VPH WDOE	AR_EC>8-10	<13.2	<82.7	220	35	4.8	47	340	54	NA
VPH WDOE	AR_EC>10-12	93.2	108	540	98	4.8	350	790	150	NA
VPH WDOE	AR_EC>12-13	186	244	410	90	4.8	350	360	120	NA
VOC 8260B	Benzene	<0.00202	<0.00249	<0.00032	<0.00032	<0.015	<0.00032	<0.180	<0.016	0.03
VOC 8260B	Toluene	<0.00202	<0.00249	<0.0012	0.0029	<0.056	<0.0012	<0.690	<0.059	7
VOC 8260B	Ethylbenzene	<0.00540	<0.0063	0.00049	0.0017	<0.010	<0.00023	<0.130	0.014	6
VOC 8260B	Xylenes	<0.0135	<0.0166	0.0016	0.0047	<0.021	<0.00046	<0.26	<0.022	9
PAH 8270M-SIM	Naphthalene	<0.719	<2.48	0.01	1.0	0.16	0.16	0.46	0.086	5
PAH 8270M-SIM	1-Methyl Naphthalene	10.6	36.1	0.23	17	1.3	7.2	7.8	3.8	24
PAH 8270M-SIM	2-Methyl Naphthalene	6.43	<0.354	<0.0012	1.8	0.077	0.08	0.06	0.044	32
VOC 8260B	n-Hexane	0.0159	<0.00829	<0.0033	0.011	<0.15	<0.0033	<1.9	<0.16	4800
VOC 8260B	MTBE	<0.00135	<0.00166	<0.00028	<0.0028	<0.013	<0.00028	<0.16	<0.014	0.1
VOC 8260B	Ethylene Dibromide (EDB)	<0.00675	<0.00829	--	--	--	--	--	--	NA
VOC 8260B	1,2 Dichloroethane	<0.00169	<0.00207	<0.00053	<0.00053	<0.024	<0.00053	<0.300	<0.026	NA
PAH 8270M-SIM	Benzo(a)anthracene	0.449	0.529	0.0084	0.29	0.084	0.13	0.048	0.033	NA
PAH 8270M-SIM	Benzo(b)fluoranthene	0.292	<0.354	0.0054	0.18	0.084	0.091	0.028	<0.011	NA
PAH 8270M-SIM	Benzo(k)fluoranthene	0.183	<0.354	0.0015	0.053	0.023	0.032	0.0073	<0.0047	NA
PAH 8270M-SIM	Benzo(a)pyrene	0.272	<0.354	0.0031	0.14	0.06	0.066	0.021	0.012	NA
PAH 8270M-SIM	Chrysene	0.727	0.803	0.01	0.44	0.098	0.16	0.074	0.042	NA
PAH 8270M-SIM	Dibenzo(a,h)anthracene	<0.180	<0.354	<0.00093	<0.019	0.015	<0.019	<0.0093	<0.0093	NA
PAH 8270M-SIM	Indeno(1,2,3-cd)pyrene	<0.180	<0.354	0.0016	0.064	0.031	0.031	<0.011	<0.011	NA
PAH 8270M-SIM	Acenaphthene	0.526	1.39	0.019	0.83	0.043	1.1	0.38	0.2	4800
PAH 8270M-SIM	Acenaphthylene	<0.360	<1.06	0.004	0.18	0.0083	0.23	0.084	0.042	4800
PAH 8270M-SIM	Anthracene	0.858	0.984	0.012	0.74	0.074	1.4	0.24	0.15	100000

Table 2. Soil Sample Analytical Results - EPH/VPH, VOCs, and PAHs from 2007 Investigation
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Analytical Method	Chemical	Sample ID								Screening Level[a] (mg/kg)
		GPE-6-11 (mg/kg)	GPE-7-10 (mg/kg)	GPF-1-1207 (mg/kg)	GPF-2-1207 (mg/kg)	GPF-3-1207 (mg/kg)	GPF-5-1207 (mg/kg)	GPF-6-1207 (mg/kg)	GPF-8-1207 (mg/kg)	
PAH 8270M-SIM	Benzo(ghi)perylene	<0.180	<0.354	0.0023	0.092	0.04	0.044	0.016	<0.011	0.23
PAH 8270M-SIM	Fluoranthene	0.599	1.14	0.05	0.92	0.22	0.42	0.13	0.052	3200
PAH 8270M-SIM	Fluorene	1.48	4.43	0.026	1.8	0.059	1.9	0.72	0.31	3200
PAH 8270M-SIM	Phenanthrene	4.54	10.7	0.05	3.5	0.12	4.9	1.2	0.63	100000
PAH 8270M-SIM	Pyrene	0.883	1.38	0.047	0.99	0.24	0.64	0.18	0.12	2400
VOC 8260B	Acetone	0.102	--	--	--	--	--	--	--	8000
VOC 8260B	Carbon Disulfide	0.00517	--	--	--	--	--	--	--	720
VOC 8260B	2-Butanone	0.0216	--	--	--	--	--	--	--	34000
VOC 8260B	n-Butylbenzene	0.327	--	--	--	--	--	--	--	240
VOC 8260B	sec-Butylbenzene	0.193	--	--	--	--	--	--	--	220
VOC 8260B	tert-Butylbenzene	0.0146	--	--	--	--	--	--	--	390
VOC 8260B	Isopropylbenzene	0.252	--	--	--	--	--	--	--	240
VOC 8260B	n-Propylbenzene	0.426	--	--	--	--	--	--	--	240
PAH 8270M-SIM	Toxicity Adjusted Total cPAHs	0.38967	0.30873	0.0049365	0.20402	0.08468	0.09695	0.031085	0.01752	2

Notes:

Table 2 only includes the VOC and PAH compounds that were detected in at least one of the samples.

[a] Chapter 173-340 WAC, Model Toxics Control Act (MTCA) Cleanup Regulation, Method A Cleanup Levels for Industrial Sites and Method B Cleanup Levels. Amended February 12, 20C

Bold - Indicates the compound was detected at a concentration exceeding the screening level.

mg/kg = milligrams per kilogram.

NA = Not applicable.

-- = Not analyzed.

VPH = Volatile petroleum hydrocarbon.

EPH = Extractable petroleum hydrocarbon.

VOC = Volatile organic compound.

PAH = Polycyclic aromatic hydrocarbons.

cPAH = Carcinogenic PAHs.

Table 3. Groundwater Sample Analytical Data - TPH, BTEX, and cPAHs
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	**Sample Date**	**Silica Gel Cleanup (TPH-Dx)**	**TPH-Dx (µg/L)**		**TPH-Gx (µg/L)**	**BTEX (µg/L)**				**Total cPAHs (µg/L)**
			Diesel	**Heavy Oil**	**Gasoline**	**Benzene**	**Toluene**	**Ethyl-benzene**	**Total Xylenes**	
Screening Level			**500**	**500**	**800**	**5**	**1,000**	**700**	**1,000**	**0.1[d]**
MW-1	11/8/1983	No	--	--	--	<20	<20	<20	--	--
	12/13/1984	No	--	--	--	<5	<5	<5	<5	--
	11/13/1995	No	**12,000**	<5,000	<80	<0.50	<0.50	<0.50	<0.50	ND
	10/29/1998	No	**5,430**	**1,230**	233	<0.50	<0.50	<0.50	<1.0	--
	10/14/1999	No	**10,400**	**2,850**	--	--	--	--	--	--
	10/20/2000	No	**8,140**	**1,060**	269	<0.50	<0.50	<0.50	<1.0	--
	10/20/2000	Yes	**1,980**	<500	--	--	--	--	--	--
	6/28/2001	Yes	**796**	<625	392	<0.5	<0.5	<0.5	<1.0	--
	2/12/2002	Yes	271	<500	--	--	--	--	--	--
	5/13/2005	Yes	<250	<500	--	--	--	--	--	--
	10/20/2005	Yes	268	<476	--	--	--	--	--	--
	8/30/2007	No	**5,600**	**1,250**	<80	<1.00	<1.00	<1.00	<3.00	ND
MW-2	11/8/1983	No	--	--	--	**510**	450	100	770	--
	12/14/1984	No	--	--	--	**74**	83	<5.0	122	
	2/5/1986	No	--	--	--	**69**	390	110	900	--
	8/28/1990	No	**26,400**	--	<50	<100	<100	<100	566	--
	8/2/1994	No	**10,000**	--	**3,100**	**6**	3	35	110	ND
	11/13/1995	No	**40,000**	**7,400**	**4,000**	2	2	22	110	--
	8/1/1996	No	**4,700**	--	<80	2	1	20	44	--
	10/29/1998	No	**9,030**	<2,500	**3220**	<0.50	1	<0.50	6	--
	10/14/1999	No	**9,060**	**3,460**	--	--	--	--	--	--
	10/20/2000	No	**7,740**	**1,610**	**862**	2	<0.50	<0.50	<1.0	--
	10/20/2000	Yes	**2,480**	**747**	--	--	--	--	--	--
	6/28/2001	Yes	**8,400**	**2,240**	**900**	1	1	1	3	--
	2/12/2002	Yes	**5,700**	**1,750**	--	--	--	--	--	--
	5/13/2005	Yes	**2,070**	**836**	--	--	--	--	--	--
	10/20/2005	Yes	**3,760**	**1,190**	--	--	--	--	--	--
	8/30/2007	No	**9,390**	**2,850**	180	<1.00	<1.00	<1.00	<3.00	ND
MW- 3	11/8/1983	No	--	--	--	**95**	64	15	90	--
	12/17/1984	No	--	--	--	<1	<1	<1	--	--
	11/13/1995	No	**4,600**	<5,000	290	<0.50	<0.50	<0.50	<0.50	--
	10/30/1998	No	**11,400**	**4,100**	282	<0.50	2	<0.50	<1.0	--
	10/14/1999	No	**15,500**	**4,890**	--	--	--	--	--	--
	6/28/2001	Yes	**1,560**	**<588**	529	<0.5	<0.5	<0.5	1	--
	2/12/2002	Yes	435	<500	--	--	--	--	--	--
	5/13/2005	Yes	**710**	<500	--	--	--	--	--	--
	10/20/2005	Yes	428	<476	--	--	--	--	--	--
	8/30/2007	No	**9,390**	**3,920**	<80	<1.00	<1.00	<1.00	<3.00	--
MW-4	11/8/1983	No	--	--	--	**700**	150	110	800	--
	12/12/1984	No	--	--	--	<1	<1	<1	<1	--
	11/13/1995	No	**7,800**	<5000	390	3	1	1	7	--
	8/1/1996	No	**11,000**	--	380	2	5	<0.50	<1.0	--
	10/29/1998	No	**11,200**	**2,920**	**1,120**	<0.50	1	<0.50	<1.0	--
	10/14/1999	No	**17,200**	**5,180**	--	--	--	--	--	--
	5/13/2005	Yes	**965**	<500	--	--	--	--	--	--
	10/20/2005	Yes	319	<476	--	--	--	--	--	--
	8/30/2007	No	**15,600**	**3,330**	87.6	--	--	--	--	--

Table 3. Groundwater Sample Analytical Data - TPH, BTEX, and cPAHs
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Dx (µg/L)		TPH-Gx (µg/L)	BTEX (µg/L)				Total cPAHs (µg/L)
			Diesel	Heavy Oil	Gasoline	Benzene	Toluene	Ethyl-benzene	Total Xylenes	
Screening Level			500	500	800	5	1,000	700	1,000	0.1^d
MW-5	11/8/1983	No	--	--	--	35	<2	<2	--	--
	12/17/1984	No	--	--	--	<20	380	<20	--	--
	11/13/1995	No	**2,600**	**770**	<80	<0.50	<0.50	<0.50	<0.50	--
	10/14/1999	No	**2,380**	**680**	--	--	--	--	--	--
	Unable to locate - possibly destroyed									
MW-6	12/12/1984	No	--	--	--	<1	<1	<1	<1	--
	11/13/1995	No	**48,000**	<5,000	740	<0.50	<0.50	<0.50	<0.50	--
	10/30/1998	No	**27,000**	**6,790**	<80	<0.50	<0.50	<0.50	<1.0	--
	10/14/1999	No	**19,700**	**2,810**	--	--	--	--	--	--
	10/20/2000	No	**30,200**	**2,360**	**936**	<0.50	<0.50	<0.50	<1.0	--
	10/20/2000	Yes	**13,500**	**1,390**	--	--	--	--	--	--
	6/28/2001	Yes	**5,660**	**822**	212	<0.50	<0.50	<0.50	<1.0	--
	2/12/2002	Yes	**31,500**	**3,380**	--	--	--	--	--	--
	Unable to locate - possibly destroyed									
MW-7	11/8/1983	No	--	--	--	<20	<20	<20	--	--
	8/2/1994	No	**7,700**	--	**1,600**	<2.5	<2.5	<2.5	<2.5	ND
	11/13/1995	No	**43,000**	<5,000	**1,800**	2	1	<1.0	<1.0	--
	10/30/1998	No	DET	ND	DET	--	--	--	--	--
	8/24/1999	No	**35,800**	<10,000	--	--	--	--	--	--
	8/24/1999	Yes	**28,900**	<5,000	--	--	--	--	--	--
	10/14/1999	No	**25,800**	**3,950**	--	--	--	--	--	--
	10/20/2000	No	**61,800**	<10,000	**2,110**	<2.5	<2.5	<2.5	<5.0	--
	10/20/2000	Yes	**76,100**	<5,000	--	--	--	--	--	--
	2/12/2002	Yes	**1,590**	<500	--	--	--	--	--	--
	5/13/2005	Yes	**1,450**	<500	<80	<0.50	<0.50	<0.50	<1.0	--
	10/21/2005	Yes	**4,540**	<481	<800	<5.00	<5.00	<5.00	<10.0	--
MW-8	11/8/1983	No	--	--	--	**208**	<2	<2	--	--
	11/13/1995	No	**490,000**	**41,000**	**5,400**	2	2	2	5	--
	10/30/1998	No	DET	DET	DET	--	--	--	--	--
	10/14/1999	No	**19,500**	**2,400**	--	--	--	--	--	--
	2/12/2002	Yes	**2,990**	<500	--	--	--	--	--	--
MW-9	12/13/1984	No	--	--	--	<1	<1	<1	<1	--
	11/13/1995	No	**880**	**630**	<80	<0.50	<0.50	<0.50	<0.50	--
	10/30/1998	No	**5,760**	**2,030**	<80	<0.50	<0.50	<0.50	<1.0	--
	10/14/1999	No	**4,250**	**2,330**	--	--	--	--	--	--
	10/14/1999	Yes	446	**811**	--	--	--	--	--	--
	5/13/2005	Yes	498	<500	--	--	--	--	--	--
	10/20/2005	Yes	**824**	**852**	--	--	--	--	--	--
MW-10	11/13/1995	No	<250	<500	760	1	1	1	2	--
	5/13/2005	Yes	**522**	**1,910**	--	--	--	--	--	--
MW-11	12/17/1984	No	--	--	--	<1	<1	<1	--	--
	8/2/1994	No	<500	--	<200	<0.50	<0.50	<0.50	1	ND
	11/13/1995	No	**11,000**	<5000	<80	<0.50	<0.50	<0.50	<0.50	--
	10/29/1998	No	**3,160**	**698**	<80	<0.50	<0.50	<0.50	<1.0	--
	10/14/1999	No	**3,160**	<500	--	--	--	--	--	--
	10/14/1999	Yes	<250	<500	--	--	--	--	--	--
	5/13/2005	Yes	<250	<500	--	--	--	--	--	--
	10/21/2005	Yes	<236	<472	--	--	--	--	--	--
MW-12	12/18/1984	No	--	--	--	<1	<1	<1	--	--
	11/13/1995	No	<250	<500	<80	<0.50	<0.50	<0.50	<0.50	--
	8/1/1996	No	<250	--	<80	<0.50	<0.50	<0.50	<1	--
	10/29/1998	No	<250	<500	<80	<0.50	<0.50	<0.50	<1.0	--
	10/14/1999	No	<250	<500	--	--	--	--	--	--
	5/13/2005	Yes	<250	<500	--	--	--	--	--	--
	10/20/2005	Yes	<236	<472	--	--	--	--	--	--
	8/30/2007	No	<238	<476	<80	--	--	--	--	--

Table 3. Groundwater Sample Analytical Data - TPH, BTEX, and cPAHs
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Dx (µg/L)		TPH-Gx (µg/L)	BTEX (µg/L)				Total cPAHs (µg/L)
			Diesel	Heavy Oil	Gasoline	Benzene	Toluene	Ethyl-benzene	Total Xylenes	
Screening Level			**500**	**500**	**800**	**5**	**1,000**	**700**	**1,000**	**0.1^d**
MW-13	12/19/1984	No	--	--	--	<1	<1	<1	--	--
	2/5/1986	No	--	--	--	<1	<1	<1	<2	--
	8/28/1990	No	<50	--	<50	<100	<100	<100	<100	--
	8/2/1994	No	**1,200**	--	<200	<0.50	<0.50	<0.50	<0.50	ND
	11/13/1995	No	**1,400**	<500	<80	<0.50	<0.50	<0.50	<0.50	--
	8/1/1996	No	**900**	--	<80	<0.50	<0.50	<0.50	<1	--
	10/30/1997	No	**1,530**	**750**	<80	<0.50	<0.50	<0.50	<1	--
	10/14/1999	No	**1,500**	**854**	--	--	--	--	--	--
	10/14/1999	Yes	<250	<500	--	--	--	--	--	--
	6/28/2001	Yes	<250	<500	<80	<0.50	<0.50	<0.50	<1.0	--
	2/12/2002	Yes	<250	<500	--	--	--	--	--	--
	5/13/2005	Yes	<250	<500	--	--	--	--	--	--
	10/20/2005	Yes	<238	<476	--	--	--	--	--	--
	9/13/2007	Yes	<243	<485	--	--	--	--	--	--
MW-14	12/19/1984	No	--	--	--	<1	<1	<1	--	--
	11/13/1995	No	**1,000**	<500	<80	<0.50	<0.50	<0.50	<0.50	--
	8/1/1996	No	**1,800**	--	<80	<0.50	<0.50	<0.50	<1	--
	10/30/1997	No	<250	<500	<80	<0.50	<0.50	<0.50	<1	--
	10/14/1999	No	**3,820**	**1,810**	--	--	--	--	--	--
	10/14/1999	Yes	<250	<500	--	--	--	--	--	--
	6/28/2001	Yes	<294	**<588**	108	<0.50	<0.50	<0.50	<1.0	--
	2/12/2002	Yes	<250	<500	--	--	--	--	--	--
	5/13/2005	Yes	<250	<500	--	--	--	--	--	--
	10/20/2005	Yes	<250	<500	--	--	--	--	--	--
MW-15	2/5/1986	No	--	--	--	<1	<1	<1	<2	--
	8/2/1994	No	<500	--	<200	<0.50	<0.50	<0.50	<0.50	ND
	Unable to locate - possibly destroyed									
MW-16	2/5/1986	No	--	--	--	93	<10	<10	240	--
	8/28/1990	No	**4,910**	--	**1,000**	<100	<100	<100	445	--
	8/2/1994	No	**11,000**	--	**1,100**	2	0.73	0.74	4.8	ND
	11/13/1995	No	**10,000**	**2,100**	**900**	1	1	53	8	--
	8/1/1996	No	<500	--	740	<0.50	2	<0.50	3	--
	10/30/1997	No	**9,010**	**2,700**	**1,220**	<0.50	<0.50	8	4	--
	10/29/1998	No	**11,600**	**2,590**	482	<0.50	4	<0.50	<1.0	--
	8/24/1999	No	**9,900**	**2,130**	--	--	--	--	--	--
	8/24/1999	Yes	**842**	<500	--	--	--	--	--	--
	10/14/1999	No	**12,300**	**2,650**	--	--	--	--	--	--
	10/14/1999	Yes	**1,190**	<500	--	--	--	--	--	--
	10/20/2000	No	**13,200**	**1,530**	463	<0.50	5	<0.50	<1.0	--
	10/20/2000	Yes	**1,510**	<500	--	--	--	--	--	--
	6/28/2001	Yes	**1,800**	<500	361	<0.50	1	<0.50	<1.0	--
	5/13/2005	Yes	**1,220**	<500	--	--	--	--	--	--
	10/21/2005	Yes	**572**	<472	--	--	--	--	--	--
	8/31/2007	No	**12,700**	**2,800**	116	<1.00	<1.00	<1.00	<3.00	ND

Table 3. Groundwater Sample Analytical Data - TPH, BTEX, and cPAHs
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Dx (µg/L)		TPH-Gx (µg/L)	BTEX (µg/L)				Total cPAHs (µg/L)
			Diesel	Heavy Oil	Gasoline	Benzene	Toluene	Ethyl-benzene	Total Xylenes	
Screening Level			500	500	800	5	1,000	700	1,000	0.1[d]
MW-17	2/5/1986	No	--	--	--	<1	<1	<1	<2	--
	5/13/2005	Yes	<250	<500	--	--	--	--	--	--
	10/20/2005	Yes	<236	<472	--	--	--	--	--	--
	8/30/2007	No	<236	<472	<80	--	--	--	--	--
MW-18	11/13/1995	No	**4,900**	**2,100**	<80	<0.50	<0.50	<0.50	<0.50	--
	8/1/1996	No	**9,600**	--	<80	<0.50	1	1	<1.0	--
MW-19	12/5/1986	No	--	--	--	**140**	<10	30	<20	--
	8/28/1990	No	**35,200**	--	<50	<100	<100	<100	<100	--
	11/13/1995	No	**69,000**	<25,000	**4,300**	<2.5	<2.5	<2.5	<2.5	--
	10/30/1997	No	**21,600**	**3,180**	**2,860**	<0.50	<0.50	<0.50	1	--
	10/30/1998	No	DET	DET	DET[b]	--	--	--	--	--
	10/14/1999	No	**35,000**	**4,280**	--	--	--	--	--	--
	10/14/1999	Yes	**5,280**	<500	--	--	--	--	--	--
	2/12/2002	Yes	**19,800**	<5,000	--	--	--	--	--	--
	5/13/2005	Yes	**9,990**	**1,260**	390	<0.50	<0.50	<0.50	<1.0	--
	10/21/2005	Yes	**35,500**	**4,140**	<800	<5.00	<5.00	<5.00	<10.0	--
	8/31/2007	No	**30,700**	**4,680**	--	--	--	--	--	--
MW-20	2/5/1986	No	--	--	--	<1	<1	<1	<2	--
	11/13/1995	No	**870**	**730**	<80	<0.50	<0.50	<0.50	<0.50	--
	10/30/1998	No	<250	<500	<80	<0.50	<0.50	<0.50	<1.0	--
	10/20/2000	No	**14,500**	**1,340**	294	<0.50	1	<0.50	<1.0	--
	10/20/2000	Yes	**878**	<500	--	--	--	--	--	--
	Well Abandoned									
MW-21	2/5/1986	No	--	--	--	<1	<1	<1	<2	--
	5/13/2005	Yes	<250	<500	--	--	--	--	--	--
RW-4	10/20/2000	No	**10,400**	**1,020**	782	<0.50	1	1	<1.0	--
	10/20/2000	Yes	<250	<500	--	--	--	--	--	--
	6/28/2001	Yes	**806**	<588	550	<0.50	1	<0.50	<0.50	--
	2/12/2002	No	**2,430**	<500	--					
	5/13/2005	Yes	**2,280**	<500	--	--	--	--	--	--
	10/21/2005	Yes	**867**	<476	--	--	--	--	--	--
	8/30/2007	No	**16,400**	**2,090**	--	--	--	--	--	--
RW-5	10/20/2000	No	**12,700**	**2,720**	491	<0.50	<0.50	<0.50	<0.50	--
	10/20/2000	Yes	**696**	<500	--	--	--	--	--	--
	6/28/2001	Yes	**29,000**	**1,580**	**2,010**	<0.5	<0.5	1	2	--
	2/12/2002	Yes	405	<500	--	--	--	--	--	--
	5/13/2005	Yes	**2,120**	<500	--	--	--	--	--	--
	10/20/2005	Yes	**502**	<481	--	--	--	--	--	--
EX-2	2/3/1996	No	**13,000**	**2,500**	**5,300**	1	1	1	2	--
	6/28/2001	Yes	**2,020**	<500	**1,580**	<0.50	1	1	3	--
	2/12/2002	Yes	**1,040**	<500	--	--	--	--	--	--
	5/13/2005	Yes	**1,060**	<500	--	--	--	--	--	--
	10/20/2005	Yes	384	<481	--	--	--	--	--	--
	8/31/2007		**11,600**	**1,270**	104	<1.0	<1.0	<1.0	<3.0	--
GP1	5/7/1999	No	335	<500	<80	<0.5	<0.5	<0.5	<1.0	--
GP2	5/7/1999	No	**17,900**	<500	**2,710**	<2.50	6	<2.50	<5.0	--
GP3	5/7/1999	No	**13,100**	<500	**2,780**	<0.5	1	<0.5	<1.0	--
GP4	5/7/1999	No	486	<500	<80	<0.5	<0.5	<0.5	<1.0	--
GP5	5/7/1999	No	**1,970**	<500	<80	<0.5	<0.5	<0.5	<1.0	--
GP6	5/7/1999	No	<250	<500	<80	<0.5	<0.5	<0.5	<1.0	--
GP7	5/7/1999	No	**11,800**	<500	<80	<0.5	<0.5	<0.5	<1.0	--
GP8	5/7/1999	No	**15,200**	<500	479	<0.5	<0.5	<0.5	<1.0	--
GP9	5/7/1999	No	**4,930**	<500	<80	<0.5	<0.5	<0.5	<1.0	--

Table 3. Groundwater Sample Analytical Data - TPH, BTEX, and cPAHs
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Dx (µg/L)		TPH-Gx (µg/L)	BTEX (µg/L)				Total cPAHs (µg/L)
			Diesel	Heavy Oil	Gasoline	Benzene	Toluene	Ethyl-benzene	Total Xylenes	
Screening Level			**500**	**500**	**800**	**5**	**1,000**	**700**	**1,000**	**0.1**[d]
GPE-1-GW	8/24/2007	No	**2,830**	714	199	<1.00	<1.00	<1.00	<3.00	**9.89**
GPE-2-GW	8/24/2007	No	**1,170**	<490	<80	<1.00	<1.00	<1.00	<3.00	**0.780**
GPE-3-GW	8/24/2007	No	**5,590**	**1,660**	162	--	--	--	--	--

Notes:

[a] Chapter 173-340 WAC, Model Toxics Control Act (MTCA) Cleanup Regulation, Method A Cleanup Levels. Amended February 12, 200

[b] Detected (DET) hydrocarbons in gasoline range appear to be due to overlap of diesel-range hydrocarbon

Bold - Indicates the compound was detected at a concentration exceeding the screening level.

µg/l = micrograms per liter.

NA = Not applicable.

-- = Not analyzed or not sampled.

DET = Detected as being presenrt by TPH-HCID

ND = Not detected above laboratory method reporting limit (MRL).

TPH-G = Total petroleum hydrocarbons as gasoline analysis by Washington DOE Method WTPH-G.

TPH-D = TPH as diesel and heavy oil analysis by Washington DOE Method WTPH-D (extended) with silica gel cleanup analysis based on possible biogenic intererence.

BTEX = Benzene, toluene, ethylbenzene, and total xylene analysis by EPA Method 8020.

PAHs = Polynuclear aromatic hydrocarbon analysis by EPA Method 8310.

Analytical methods prior to 1995 include Hydrocarbon Scan by EPA Methods 3510/Modified 8015, and Oil and Grease by EPA Method 413.1.

Table 4. Groundwater Sample Analytical Results - Non-Carcinogenic PAHs
2007 Investigation
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample ID	Analysis	Date	Analytical Results in µg/l					
			Acenaphthene	Fluoranthene	Fluorene	1-Methylnaphthalene	Phenanthrene	Pyrene
Screening Levels[a]			960	640	640	2.4	NE	480
MW 2	SVOC	7/11/2007	0.64	<0.189	1.38	NA	<0.189	<0.189
MW 3	SVOC	7/11/2007	0.119	0.622	0.433	NA	<0.0962	0.446
MW 7	SVOC	7/11/2007	<0.556	<0.556	<0.556	NA	<0.556	<0.556
MW 19	SVOC	7/12/2007	4.17	<1.94	3.48	NA	5.02	3.32
MW 2	SVOC	8/30/2007	<4.76	<19.0	5.1	NA	<19.0	<19.0
MW 1	PAH	8/30/2007	<0.189	<0.0943	<0.0943	<0.0943	NA	<0.0943
MW 2	PAH	8/30/2007	1.06	<0.472	2.43	**19.9**	NA	<0.472
MW 16	PAH	8/31/2007	1.33	1.35	2.22	1.07	NA	0.977

Notes:

[a] Chapter 173-340 WAC, Model Toxics Control Act (MTCA) Cleanup Regulation, Method B cleanup levels. Amended February 12, 2001. Method B cleanup levels used because Method A cleanup levels are not established for these compounds.

Bold - Indicates the compound was detected at a concentration exceeding the screening level.

µg/l = Micrograms per liter.

NE = Not established.

SVOCs = Semi-volatile organic compounds analyzed by EPA Method 8260B.

PAHs = Polynuclear aromatic hydrocarbons analyzed by EPA Method 8270C-SIM.

Table 5. Groundwater Sample Analytical Results - VOCs (Except BTEX)
2007 Investigation
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample ID	Date	Analytical Results in µg/l					
		Acetone	Chloroethane	Isopropylbenzene	n-Butylbenzene	n-Propylbenzene	sec-Butylbenzene
Screening Levels[a]		800	15	NE	NE	NE	NE
MW 2	7/11/2007	<25	<1	<2	<5	<1	<1
MW 3	7/11/2007	<50	<2	<4	<10	<2	<2
MW 7	7/11/2007	<50	<2	<4	<10	<2	<2
MW 19	7/12/2007	36.3	<1	7.39	<5	8.94	1.2
MW 1	8/30/2007	<20	1.17	<1	<1	<1	<1
MW 2	8/30/2007	<20	1.59	<1	1.04	<1	<1
MW 16	8/31/2007	26	1.14	1.82	<1	2.08	<1

Notes:

[a] Chapter 173-340 WAC, Model Toxics Control Act (MTCA) Cleanup Regulation, Method B cleanup levels. Amended February 12, 2001. Method B cleanup levels used because Method A cleanup levels are not established for these compounds.

µg/l = Micrograms per liter.

NE = Not established.

VOCs = Volatile organic compounds analyzed by EPA Method 8260B.

Table 5 only includes the VOC compounds (other than BTEX) that were detected above the method reporting limits. BTEX concentrations are presented in Table 3.

Table 6. Groundwater Monitoring Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Measurement Date	Depth to Groundwater (feet)	Free Product Thickness (feet)	Groundwater Elevation (feet)
MW-1	11/13/1995	9.19	0.00	22.47
31.66	8/1/1996	10.23	0.00	21.43
	10/30/1997	9.54	0.00	22.12
	10/29/1998	12.26	0.00	19.40
	5/7/1999	9.51	0.00	22.15
31.69	10/14/1999	12.39	0.00	19.27
	6/28/2001	11.80	0.00	19.89
	2/12/2002	9.65	0.00	22.04
	5/13/2005	10.09	0.00	21.60
	10/20/2005	13.49	0.00	18.20
MW-2	11/13/1995	12.95	0.00	21.02
33.97	8/1/1996	13.75	0.00	20.22
	10/30/1997	13.55	0.00	20.42
	10/29/1998	14.92	0.00	19.05
	5/7/1999	12.79	0.00	21.18
33.98	10/14/1999	15.06	0.00	18.92
	6/28/2001	14.93	0.00	19.05
	2/12/2002	12.28	0.00	21.70
	5/13/2005	14.61	0.00	19.37
	10/20/2005	16.27	0.00	17.71
MW- 3	11/13/1995	11.24	0.00	19.66
30.90	8/1/1996	11.11	0.00	19.79
	10/30/1997	11.23	0.00	19.67
	10/30/1998	12.28	0.00	18.62
	5/7/1999	9.98	0.00	20.92
30.96	10/14/1999	12.33	0.00	18.63
	6/28/2001	12.27	0.00	18.69
	2/12/2002	9.42	0.00	21.54
	5/13/2005	11.83	0.00	19.13
	10/20/2005	13.50	0.00	17.46
MW-4	11/13/1995	8.27	0.00	20.15
28.42	8/1/1996	8.40	0.00	20.02
	10/30/1997	8.45	0.00	19.97
	10/29/1998	9.65	0.00	18.77
	5/7/1999	7.26	0.00	21.16
28.64	10/14/1999	9.74	0.00	18.90
	6/28/2001	10.68	0.00	17.96
	2/12/2002	6.68	0.00	21.96
	5/13/2005	8.12	0.00	20.52
	10/20/2005	10.88	0.00	17.76
MW-5	11/13/1995	3.07	0.00	20.30
23.37	8/1/1996	3.60	0.00	19.77
	5/7/1999	2.45	0.00	20.92
23.38	10/14/1999	4.85	0.00	18.53
	Unable to locate - possibly destroyed.			
MW-6	11/13/1995	5.23	0.00	20.91
26.14	8/1/1996	5.50	0.00	20.64
	10/30/1998	5.44	0.00	20.70
	5/7/1999	3.18	0.00	22.96
24.76	10/14/1999	5.41	0.00	20.73
	6/28/2001	5.28	0.00	19.48
	2/12/2002	2.87	0.00	21.89
	Unable to locate - possibly destroyed.			

Table 6. Groundwater Monitoring Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Measurement Date	Depth to Groundwater (feet)	Free Product Thickness (feet)	Groundwater Elevation (feet)
MW-7	11/13/1995	12.54	0.00	20.82
33.36	8/1/1996	13.55	0.62	20.31
	10/30/1997	13.24	0.17	20.26
	10/30/1998	14.51	0.07	18.91
	5/7/1999	11.82	0.02	21.56
33.40	10/14/1999	14.70	0.00	18.70
	6/28/2001	15.41	0.00	17.99
	5/13/2005	13.84	0.00	19.56
	10/21/2005	15.42	0.00	17.98
MW-8	11/13/1995	12.90	0.50	20.99
33.49	8/1/1996	12.98	0.15	20.63
	10/30/1997	13.20	0.21	20.46
	10/30/1998	14.94	0.14	18.66
	5/7/1999	12.05	0.37	21.74
33.53	10/14/1999	15.31	0.18	18.36
	6/28/2001	15.99	0.00	17.54
	5/13/2005	13.77	0.00	19.76
	10/21/2005	15.45	0.00	18.08
MW-9	11/13/1995	4.25	0.00	22.11
26.36	8/1/1996	5.81	0.00	20.55
	10/30/1997	1.87	0.00	24.49
	10/30/1998	6.31	0.00	20.05
	5/7/1999	5.02	0.00	21.34
26.38	10/14/1999	7.25	0.00	19.13
	6/28/2001	6.87	0.00	19.51
	2/11/2002	4.41	0.00	21.97
	5/13/2005	5.74	0.00	20.64
	10/20/2005	8.44	0.00	17.94
MW-10	11/13/1995	5.09	0.00	20.80
25.89	8/1/1996	5.62	0.00	20.27
	10/30/1997	5.64	0.00	20.25
	10/30/1998	DRY	DRY	DRY
	5/7/1999	4.53	0.00	21.36
25.92	10/14/1999	6.81	0.00	19.11
	6/28/2001	7.04	0.00	18.88
	2/11/2002	4.01	0.00	21.91
	5/13/2005	5.46	0.00	20.46
	10/20/2005	DRY	DRY	DRY
MW-11	11/13/1995	6.57	0.00	19.32
25.89	8/1/1996	6.71	0.00	19.18
	10/30/1997	6.75	0.00	19.14
	10/29/1998	8.12	0.00	17.77
	5/7/1999	5.49	0.00	20.40
25.90	10/14/1999	8.12	0.00	17.78
	6/28/2001	3.90	0.00	22.00
	2/11/2002	4.91	0.00	20.99
	5/13/2005	6.21	0.00	19.69
	10/21/2005	9.26	0.00	16.64

Table 6. Groundwater Monitoring Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Measurement Date	Depth to Groundwater (feet)	Free Product Thickness (feet)	Groundwater Elevation (feet)
MW-12	11/13/1995	6.07	0.00	22.10
28.17	8/1/1996	7.15	0.00	21.02
	10/30/1997	6.61	0.00	21.56
	10/29/1998	8.01	0.00	20.16
	5/7/1999	6.36	0.00	21.81
28.28	10/14/1999	8.34	0.00	19.94
	6/28/2001	8.24	0.00	20.04
	2/11/2002	5.76	0.00	22.52
	5/13/2005	6.61	0.00	21.67
	10/20/2005	9.41	0.00	18.87
MW-13	11/13/1995	10.60	0.00	12.18
22.78	8/1/1996	10.70	0.00	12.08
	10/30/1997	10.48	0.00	12.30
	5/7/1999	9.60	0.00	13.18
22.75	10/14/1999	11.19	0.00	11.56
	6/28/2001	11.18	0.00	11.57
	2/12/2002	9.33	0.00	13.42
	5/13/2005	9.91	0.00	12.84
	10/20/2005	11.72	0.00	11.03
	9/13/2007	11.72	0.00	11.03
MW-14	11/13/1995	8.08	0.00	18.17
26.25	8/1/1996	9.15	0.00	17.10
	10/30/1997	8.89	0.00	17.36
	5/7/1999	8.03	0.00	18.22
26.28	10/14/1999	11.73	0.00	14.55
	6/28/2001	11.95	0.00	14.33
	2/12/2002	6.56	0.00	19.72
	5/13/2005	7.85	0.00	18.43
	10/20/2005	9.56	0.00	16.72
MW-15	2/11/2002	--	--	--
26.24	Unable to locate - possibly destroyed.			
MW-16	11/13/1995	9.94	0.00	21.19
31.13	8/1/1996	10.36	0.00	20.77
	10/30/1997	10.26	0.00	20.87
	10/29/1998	11.43	0.00	19.70
	5/7/1999	9.33	0.00	21.80
29.67	10/14/1999	11.50	0.00	18.17
	6/28/2001	11.35	0.00	18.32
	2/11/2002	8.60	0.00	21.07
	5/13/2005	9.87	0.00	19.80
	10/21/2005	12.65	0.00	17.02
MW-17	11/13/1995	DRY	DRY	DRY
33.94	8/1/1996	14.62	0.00	19.32
	10/30/1997	15.61	0.00	18.33
	10/29/1998	DRY	DRY	DRY
	5/7/1999	13.42	0.00	20.52
33.97	10/14/1999	DRY	DRY	DRY
	6/28/2001	DRY	DRY	DRY
	2/11/2002	12.68	0.00	21.29
	5/13/2005	14.64	0.00	19.33
	10/20/2005	17.74	0.00	16.23

Table 6. Groundwater Monitoring Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Measurement Date	Depth to Groundwater (feet)	Free Product Thickness (feet)	Groundwater Elevation (feet)
MW-18	11/13/1995	8.47	0.00	24.72
33.19	8/1/1996	9.96	0.00	23.23
	10/30/1997	DRY	DRY	DRY
	10/29/1998	DRY	DRY	DRY
	5/7/1999	DRY	DRY	DRY
33.24	10/14/1999	DRY	DRY	DRY
	6/28/2001	DRY	DRY	DRY
	2/11/2002	DRY	DRY	DRY
	5/13/2005	DRY	DRY	DRY
	10/20/2005	DRY	DRY	DRY
MW-19	11/13/1995	14.77	0.00	18.90
33.67	8/1/1996	14.24	0.00	19.43
	10/30/1997	14.47	0.00	19.20
	10/30/1998	16.11	0.75	18.16
	5/7/1999	12.95	0.00	20.72
33.72	10/14/1999	15.43	0.02	18.31
	6/28/2001	15.85	0.00	17.87
	5/13/2005	14.08	0.00	19.64
	10/21/2005	16.93	0.00	16.79
MW-20	11/13/1995	21.99	0.00	8.37
30.36	8/1/1996	22.66	0.00	7.70
	10/30/1997	23.72	0.00	6.64
	10/30/1998	27.70	0.00	2.66
	5/7/1999	19.30	0.00	11.06
	Well Abandoned			
MW-21	11/13/1995	DRY	DRY	DRY
30.06	8/1/1996	10.65	0.00	19.41
	10/30/1997	11.50	0.00	18.56
	10/29/1998	DRY	DRY	DRY
	5/7/1999	9.57	0.00	20.49
30.08	10/14/1999	DRY	DRY	DRY
	6/28/2001	DRY	DRY	DRY
	2/11/2002	7.15	0.00	22.93
	5/13/2005	8.91	0.00	21.17
	10/20/2005	DRY	DRY	DRY
RW-4	6/28/2001	16.27	0.00	--
	2/12/2002	12.38	0.00	--
	5/13/2005	14.28	0.00	--
	10/21/2005	16.40	0.00	--
RW-5	6/28/2001	9.42	0.00	--
	2/12/2002	6.7	0.00	--
	5/13/2005	8.12	0.00	--
	10/20/2005	9.74	0.00	--
P-1 29.35	11/13/1995	9.74	0.00	19.61
P-2 25.22	11/13/1995	4.35	0.00	20.87
EX-1 32.3	11/13/1995	14.72	0.00	17.58
EX-2	6/28/2001	14.52	0.00	19.01
33.53	2/12/2002	11.59	0.00	21.94
	5/13/2005	13.40	0.00	20.13
	10/20/2005	15.21	0.00	18.32
GP1	5/7/1999	5.05	0.00	21.50
GP2	5/7/1999	10.3	0.00	21.94
GP3	5/7/1999	10.9	0.00	21.19

Table 6. Groundwater Monitoring Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Measurement Date	Depth to Groundwater (feet)	Free Product Thickness (feet)	Groundwater Elevation (feet)
GP4	5/7/1999	10.2	0.00	20.55
GP5	5/7/1999	6.86	0.00	20.11
GP6	5/7/1999	8.89	0.00	18.28
GP7	5/7/1999	10.5	0.00	20.37
GP8	5/7/1999	7.71	0.00	21.66
GP9	5/7/1999	8.06	0.00	21.60

Note:
-- = Top of casing elevation not known.

Table 7. MTCATPH11 Spreadsheet Input Values
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Fraction/Constituent		West Pond Area					South Pond Area		Between East & West Ponds
		GPE-6-11 (mg/kg)	GPF-6-1207 (mg/kg)	GPF-1-1207 (mg/kg)	GPF-2-1207 (mg/kg)	GPF-8-1207 (mg/kg)	GPF-5-1207 (mg/kg)	GPE-7-10 (mg/kg)	GPF-3-1207 (mg/kg)
Aliphatic	EC>5-6	0	0	0	0	0	0	0	0
	EC>6-8	6.6	110	51	10.5	5.5	6	41.35	4.8
	EC>8-10	38.4	95	73	24	14	7.7	121	4.8
	EC>10-12	347	170	520	200	160	91	753	19
	EC>12-16	1350	400	1400	550	460	590	2560	180
	EC>16-21	971	170	620	320	160	420	1610	140
	EC>21-34	165	24	80	66	33	47	224	42
Aromatic	EC>8-10	6.59	339.81	220.00	34.99	53.98	47.00	41.34	4.78
	EC>10-12	92.84	789.54	539.99	159.00	149.91	349.84	106.76	4.64
	EC>12-16	168.97	652.14	409.77	821.20	116.16	342.72	264.72	3.42
	EC>16-21	331	800	420	1500	120	340	561	41
	EC>21-34	68.10	129.81	59.97	418.82	23.90	34.48	109.78	24.61
BTEX	Benzene	0	0	0	0	0	0	0	0
	Toluene	0.0010	0.35	0.0006	0.0029	0.0295	0.00060	0.0012	0.028
	Ethylbenzene	0.0027	0.065	0.0005	0.0017	0.014	0.00012	0.0032	0.0050
	Total xylenes	0.0068	0.13	0.0016	0.0047	0.011	0.00023	0.0083	0.011
Constituents	Naphthalene	0.36	0.46	0.01	1	0.086	0.16	1.24	0.16
	1-Methylnaphthalene	10.6	7.8	0.23	17	3.8	7.2	36.1	1.3
	2-Methylnaphthalene	6.43	0.06	0.0006	1.8	0.044	0.08	0.18	0.077
	n-Hexane	0.016	0.95	0.0017	0.011	0.08	0.0017	0.0041	0.075
Additives	MTBE	0	0	0	0	0	0	0	0
	EDB	0	0	0	0	0	0	0	0
	EDC	0	0	0	0	0	0	0	0
CPAHs	Benzo(a)anthracene	0.45	0.048	0.0084	0.29	0.033	0.13	0.53	0.084
	Benzo(b)fluoranthene	0.29	0.028	0.0054	0.18	0.0055	0.091	0.18	0.084
	Benzo(k)fluoranthene	0.18	0.0073	0.0015	0.053	0.00235	0.032	0.18	0.023
	Benzo(a)pyrene	0.27	0.021	0.0031	0.14	0.012	0.066	0.18	0.06
	Chrysene	0.73	0.074	0.01	0.44	0.042	0.16	0.80	0.098
	Dibenzo(a,h)anthracene	0.09	0.0047	0.0005	0.0095	0.0047	0.0095	0.18	0.015
	Indeno(1,2,3-cd)pyrene	0.09	0.0055	0.0016	0.064	0.0055	0.031	0.18	0.031
Total		3565.02	3690.30	4394.00	4125.51	1300.61	2283.70	6432.71	471.10

Note:
MTBE, EDB, EDC, benzene, and aliphatic EC>5-6 were not detected in any of the fractionated soil samples so they were assigned concentrations of 0 milligrams per kilogram (mg/kg) for all of the samples. All other fractions and constituents were detected in at least one of the samples so they were assigned values of half of the detection limits for undetected results. Adjustments were made to avoid double-counting of individual constituents, as discussed in the User's Guide to the MTCATPH10 spreadsheet.

Table 8. Summary of Remedial Alternatives Evaluation
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

	Evaluation Criteria					
	Effectiveness				Implementability	Cost
Remedial Alternatives	**Protectiveness**	**Permanence**	**Restoration Time Frame**	**Consideration of Public Concerns**	**Technical and Administrative Implementability**	**Cost**
Alternative 1 - Excavation and Off-Site Disposal	1	1	1	TBD	2	2
Alternative 2 - Excavation and On-Site Treatment	1	1	1	TBD	3	1
Alternative 3 - Bioventing	3	1	3	TBD	4	3
Alternative 4 - In-Situ Chemical Oxidation	4	1	4	TBD	1	4

Notes: TBD = To be determined.
Scale Definition: 1 = best, 4 = worst

APPENDIX B

COMPLIANCE MONITORING PLAN

Appendix B – Compliance Monitoring Plan

This appendix discusses a conceptual compliance monitoring for the selected remedial action. Details of the compliance monitoring plan will be further defined in the Corrective Action Plan (CAP) that will be prepared after finalization of this Focused RI/FS Report.

B.1 CONFIRMATION SOIL SAMPLING

The lateral and vertical extents of each soil excavation will be based on soil sample analytical results; however, the vertical extent of any excavation will not extend below 1 to 2 feet below the groundwater table. During the excavation activities, SLR International Corp (SLR) personnel will screen the excavated soil for the presence of petroleum hydrocarbons by using visual appearance and field screening methods to be determined in the CAP (likely either colorimetric petroleum dectection kits – e.g., Hanby or PetroFlag kit – or an on-site mobile laboratory). When the excavated soil contains limited visible evidence of contamination (e.g., light staining, no sheen) and TPH-D concentrations below 5,070 mg/kg (as indicated by colorimetric field methods or the mobile laboratory), then SLR personnel will inform the excavation contractor to discontinue excavating at that location, and a confirmation soil sample will be collected for laboratory analysis.

SLR personnel will collect confirmation soil samples from excavation sidewalls and, where the excavation has been halted above the saturated zone and capillary fringe, from the bottom of the excavation. (Where the excavation extends below the water table, confirmation soil samples will not be collected from the bottom of the excavation.)

Confirmation sampling will be conducted systematically. Prior to beginning excavation, SLR will establish a grid over the entire site. The anchor point for the grid will be marked. The X-axis coordinates will be named using letters (starting with "A") and the Y-axis coordinates will be named using numbers (starting with "1"). The grid nodes will be surveyed at intervals equal to or less than 25 feet (each grid cell will cover an area of up to 625 square feet), and where accessible, labeled flags and wooden stakes will be used to mark and identify the grid nodes.

Because the soil is a loose sand, the excavation sidewalls will be sloped, likely on a 1 to 1 basis. Excavation sidewall samples will be discrete samples collected on up to approximately 25-foot centers along the perimeter of the excavation. Each sidewall sample will be collected in the area closest to the center of the applicable grid cell. The depth of sidewall samples will be based on the depth of the excavation and the observed depth of impacted soil.

For any portion of an excavation that does not extend to a depth below the groundwater table, excavation floor samples will be collected from the center of each applicable grid cell.

The excavation soil samples will be submitted to a Washington Department of Ecology (Ecology)-accredited laboratory for quantitative chemical analysis. All of the samples will be analyzed for TPH-D and TPH-O by Ecology Method NWTPH-Dx (after silica gel cleanup), and for TPH-G by Ecology Method NWTPH-Gx.

If a sidewall sample contains a TPH concentration that exceeds the site cleanup level, then the wall of the sampled grid cell will be extended laterally by up to 5 feet and re-sampled. If a floor sample contains a TPH concentrations that exceed the site cleanup level, then the floor of the excavation will be deepened by up to 2 feet and re-sampled if the excavation depth is still above the groundwater table. Each excavation will not be completed until the sidewall and possibly floor samples contain TPH concentrations below the soil cleanup level.

B.2 GROUNDWATER TREATMENT SYSTEM SAMPLING

Groundwater recovered from open excavations will be pumped through a groundwater treatment system that will consist of an oil/water separator tank, bag filters, carbon filters in series. Initially, the effluent from the carbon filtration system will be pumped into a temporary storage tank. On a daily basis for at least the first three days of groundwater recovery operations, SLR personnel will collect groundwater samples from the influent to the separator, the influent to the carbon filtration system, and the effluent from the carbon filtration system. The samples will be submitted to an Ecology-accredited laboratory for analysis of TPH-D and TPH-O by Ecology Method NWTPH-Dx (after silica gel cleanup), and TPH-G by Ecology Method NWTPH-Gx.

If the effluent sample from the carbon filtration system contains a TPH concentration below the site groundwater cleanup level, then the water will be pumped into the inactive groundwater injection trench, the inactive groundwater recovery trench, or another approved injection point for reinfiltration to the subsurface. If the effluent sample from the carbon filtration system contains a TPH concentration greater than the groundwater cleanup level, then the water in the storage tank will be pumped into the separator tank and re-treated. If the system effluent samples from three consecutive days of operation contain TPH concentrations below the groundwater cleanup level, then treatment system sampling frequency will be reduced to once per week and the treated water will be directly infiltrated into the subsurface (the storage tank will be bypassed).

B.3 NATURAL ATTENUATION MONITORING

After backfilling the excavations, new monitoring wells will likely be installed, per the groundwater monitoring plan to be developed for the CAP. After installation of the wells, groundwater monitoring will be conducted at the site to evaluate the performance of the excavation activities and to monitor the natural attenuation of the remaining groundwater contamination. To evaluate natural attenuation of groundwater contamination, Ecology recommends monitoring the groundwater conditions (contaminant and geochemical indicator concentrations) within established groundwater flow paths. Within each flow path, groundwater samples should be collected from: an upgradient non-impacted (background) well (if available), a well located within the source area, two wells near the contaminated plume center line that contain concentrations greater than cleanup levels, and a non-impacted downgradient well. Groundwater flow paths and the wells to be monitored will be identified in the CAP.

The groundwater monitoring will follow Ecology's Guidance on Remediation of Petroleum-Contaminated Groundwater by Natural Attenuation, dated July 2005. Groundwater monitoring will be conducted on a quarterly basis for the first year, on a semiannual basis for the second year, and then on an annual basis until the TPH concentrations in all of the wells are below the site cleanup level for two consecutive annual events. Groundwater monitoring would then be conducted on a quarterly basis to determine if the concentrations are below the site cleanup level for four consecutive quarters. If the concentrations are below the site cleanup level for four consecutive quarters, then the monitoring would be discontinued. If concentrations exceed the site cleanup level, then the monitoring program will be continued. SLR would determine the sampling frequency based on the analytical results.

The semiannual sampling event will be conducted during a period of high seasonal groundwater elevations and a period of low seasonal groundwater elevations. The annual events will be conducted during the period of year that has the greatest average groundwater concentrations in the on-site wells.

During each monitoring event, SLR will measure the depths to groundwater all of the groundwater monitoring wells to evaluate the flow directions. If sufficient water is present in the wells to be sampled, the wells will be purged by using a peristaltic pump or disposable bailers. During purging, field instruments will be used to measure dissolved oxygen, redox potential, pH, specific conductivity, temperature, and dissolved ferrous iron. The groundwater samples will be submitted to an Ecology-accredited laboratory for quantitative chemical analysis. The samples will be analyzed for TPH-D and TPH-O by Ecology Method NWTPH-Dx (after silica gel cleanup), for TPH-G by Ecology Method NWTPH-Gx, for sulfate by EPA Method 375.2, nitrate by EPA Method 353.2, dissolved manganese by EPA Method 200.8, alkalinity by EPA Method 310.1, and for dissolved methane by EPA Method RSK 175. If the laboratory determines that the detected TPH-G and/or TPH-O concentrations in the sample from a well are due to overlap from diesel-range hydrocarbons, then future analysis of TPH-G and/or TPH-O will be discontinued from that well.

After completing the quarterly sampling events during the first year of monitoring, SLR will model the analytical data in accordance with the Ecology's Natural Attenuation Analysis Tool Package for Petroleum-Contaminated Groundwater. The modeling results will be used to evaluate if the groundwater plumes are shrinking, stable, or expanding, to calculate the attenuation rates, and to identify the wells that would be sampled during the subsequent monitoring events.

After two years of groundwater monitoring, the groundwater concentrations will be evaluated to assess the affects of the remediation activities on the groundwater conditions. Benchmarks for this evaluation will be discussed in the CAP.