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Attn: Mr. Paul E. Skyllingstad

Date: June 15, 2000

Company: Department of Ecology

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Address: 300 Desmond Drive, SE
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Project: Remediation Work Plan

Job No: 015.08480

RE: Former Columbia Marine Lines Facility

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Comments: Enclosed please find one copy of the above referenced report. Please feel free to contact Mr. Brian Pletcher, Mr. Steve Hammer or Mr. Brent Brelje.

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cc:

SECOR
International Incorporated

REMEDIATION
WORK PLAN

Former Columbia Marine Lines Facility
6305 Lower River Road
Vancouver, Washington

SECOR Project No. 015.08480

Submitted by:
SECOR International Incorporated
7730 SW Mohawk Street
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Submitted to:
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June 15, 2000

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1.0 INTRODUCTION

A groundwater and soil remediation plan is proposed for the former Columbia Marine Lines facility located at 6305 Lower River Road in Vancouver, Washington. The remedial plan will be implemented by Crowley Marine Services, Inc. (Crowley), formerly Columbia Marine Lines, as an independent cleanup action. The purpose of this work plan is to outline the remedial objectives and techniques and to provide a technical document for review.

Remaining areas of the site that require remediation will be addressed with one of the two following remedial alternatives:

- Bioventing and total fluids extraction
- Excavation and on-site thermal treatment

The proposed bioventing and total fluids extraction system would enhance natural biodegradation through increased oxygen flow to indigenous subsurface microorganisms. If bioventing and total fluids extraction are not selected as the cleanup option, remediation of the site will be accomplished by excavation and on-site thermal treatment of the petroleum-impacted soil.

This work plan presents a brief description of the site, a summary of the results of past soil and groundwater investigations, a discussion of applicable regulatory cleanup standards, a summary of previous pilot test results, and an outline of the proposed remediation plan.

2.0 SITE DESCRIPTION

2.1 PROPERTY DESCRIPTION

The site is located immediately north of the Columbia River and approximately 3 miles west of the city of Vancouver in Section 18, Township 2N, Range 1E, as shown on Figure 1. The site is relatively flat, with the highest point lying at an approximate elevation of 32 feet above mean sea level. The Columbia River is tidally dominated and typically ranges from minus 5 to positive 5 feet above mean sea level.

The majority of the site is sparsely vegetated with grasses and moss. Willows, alders, and brush are present in isolated low-lying areas in the northern portion of the site. Two operating settling ponds occupy a portion of the site to the northwest. The settling ponds are currently operated by Vanalco (formerly operated by ALCOA) as part of the aluminum manufacturing process. Figure 2 is a site plan of the subject property.

2.2 SITE HISTORY

Columbia Marine Lines formerly operated a marine repair facility at the site, and periodically placed barge slop residues from gas-freeing operations in a disposal pit located adjacent to the site on property owned by Vanalco (formerly ALCOA). The pit was approximately 12 to 15 feet deep, 200 feet long, and 125 feet wide and was located approximately 400 feet north of the Columbia River and 300 feet east of Vanalco's settling ponds (Figure 2).

In January 1984, all liquids were removed from the pit, and the pit was filled with dredge sand to prevent accumulation of surface water. On April 3, 1984, Columbia Marine Lines notified Ecology in writing of the past practice and closure of the former pit. Soil and groundwater characterization work was completed, and an interim corrective action was implemented in subsequent years. The interim action consisted of groundwater extraction, non-aqueous phase liquid (NAPL) hydrocarbon removal, and re-infiltration of extracted groundwater. The interim action was conducted from 1986 to 1995 until NAPL was reduced to below recoverable levels.

The former Columbia Marine Lines facility is currently under the ownership of Tidewater Barge Lines. ALCOA owns the property where the former pit was located. There have been no significant changes in the surface features in the vicinity of the former pit area since the initial closure of the pit by filling.

2.3 LAND USE

The current zoning classification for the site and the Vanalco property is industrial. Surrounding land use patterns indicate that the properties will continue to have industrial land uses. Potable water is supplied to the properties by the city of Vancouver. Access to the site is restricted by fencing and site security measures.

3.0 PREVIOUS INVESTIGATIONS

Previous investigations have been conducted at the site to delineate the extent of petroleum-impacted soil in the vicinity of the two former ponds used to store barge slops. During these investigations, several monitoring wells and geoprobe soil borings have been completed at the site. The most recent investigations, conducted in July and September of 1999, focused on the area in the vicinity of the westernmost of the two former ponds. Monitoring well and geoprobe boring locations are shown on Figure 2.

During the 1999 investigations, samples were collected from geoprobe soil borings at the site. Soil samples were collected continuously by the geoprobe, and the lithology of the soils was recorded. Samples were inspected visually for staining and odors, and field screened with a photoionization detector (PID) for the presence of volatile organic hydrocarbons (VOCs). Based on field observations, portions of the soil from the borings were collected and shipped to an analytical laboratory and analyzed for total petroleum hydrocarbons (TPH). The results of the 1999 subsurface investigations are summarized in the following subsections.

3.1 SITE GEOLOGY AND HYDROGEOLOGY

The soils encountered during the 1999 geoprobe subsurface investigation consisted of unconsolidated sands (dredge fill material) and an underlying silty flood plain deposit. The silt was encountered at depths ranging from 12 feet below ground surface (bgs) at geoprobe boring GP-8A to 14.5 feet bgs at geoprobe borings GP-1A, GP-6A, and GP-12A. Saturated soil was encountered within the unconsolidated sands at a depth of approximately 12 feet bgs.

SECOR personnel collected water level data from the existing monitoring wells on October 14, 1999. Static water levels in the wells ranged from 4.85 to 15.43 feet bgs, as measured from the top of each well casing. Based on the calculated groundwater elevations, SECOR estimated the groundwater gradient and flow direction. Groundwater flow in the southern area of the site was oriented in a southwesterly direction toward the Columbia River, at a gradient of 0.03 foot/foot (ft/ft). The groundwater flow direction in the northwestern portion of the site is to the northwest, at a gradient of 0.005 ft/ft. Groundwater elevation data and flow direction are presented on Figure 3. Historical groundwater elevation and analytical data for monitoring wells MW-1 through MW-21 is included in Appendix A.

NAPL hydrocarbon has been encountered in monitoring wells MW-7, MW-8, and MW-19. Since decommissioning pits in 1984, NAPL at the site has been reduced considerably through recovery and/or biodegradation. During initial monitoring after decommissioning the pits, up to 6 feet of NAPL was measured in MW-8. The most recent measurements observed NAPL thickness of 0.18 foot in MW-8 and 0.02 foot in MW-19, and a sheen was encountered on the water surface in monitoring wells MW-1, MW-2, MW-4, MW-5, MW-6, and MW-7. Based on the reduction of the measured NAPL thickness, it appears that most of the residual NAPL has been recovered an/or has degraded.

3.2 GROUNDWATER AND SOIL ANALYTICAL RESULTS

Groundwater sample analytical results are summarized on Figure 4. Groundwater samples were analyzed for TPH-D and TPH-O, and samples containing TPH were treated for reanalysis with the silica gel and acid cleanup method to remove biogenic carbon material that could artificially increase TPH values. Following silica gel cleanup, TPH-D and TPH-O were detected in the groundwater samples collected from monitoring wells MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, MW-16, and MW-19. TPH-D concentrations ranged from 1.2 milligrams per liter (mg/L) in MW-16 to 26 mg/L in MW-7. TPH-O concentrations ranged from 0.68 mg/L in MW-5 to 5.18 mg/L in MW-4. Compliance wells MW-13 and MW-14 were non-detect for TPH-D and TPH-O after silica gel cleanup.

Soil sample analytical results are summarized on Figure 5. Soil samples were analyzed for TPH-D and TPH-O. Samples were collected from above the water table and analyzed for TPH-D ranged from 78.1 milligrams per kilogram (mg/Kg) in boring GP-2A to 32,500 mg/Kg in boring GP-13A. Concentration of TPH-O ranged from 81.7 mg/Kg in boring GP-4A to 863 mg/Kg in boring GP-5A. Silica gel cleanup of soil samples identified possible biogenic interference in the sample from GP-2A.

3.3 FEASIBILITY TEST RESULTS

SECOR conducted an aquifer test in February 1996 to evaluate hydraulic characteristics of the shallow aquifer in the dredge fill. In February 1999, SECOR conducted a bioventing pilot test to evaluate the feasibility of bioventing as a remedial alternative.

3.3.1 Aquifer Testing

Aquifer testing was performed at the site to evaluate hydraulic characteristics of the shallow water-bearing dredge fill. Tests were performed during February 1996 when the aquifer yield was assumed to be greatest. Slug tests were performed on wells MW-1, MW-7, MW-18, and EX-2 to collect data to estimate aquifer transmissivity. A step-drawdown test and a pumping test were conducted on well EX-2. During the time of highest yield, the aquifer sustained a maximum yield of 0.5 gallon per minute (gpm) in a 4-inch diameter groundwater monitoring well. No drawdown was measured in observation well MW-7, 20 feet away from well EX-2. The pump test data indicate a lateral formation transmissivity of 0.0005 square foot per minute (ft^2/min), which is consistent for a silt material.

Given the transmissivity determined through aquifer testing, aggressive capture and recovery of groundwater at the site would require extensive trenching in order to effectively implement a pump and treat corrective action.

3.3.2 Bioventing and Total Fluids Extraction Pilot Test

The pilot test was conducted during the weeks of February 11, February 18 and February 25, 2000 on the shallow sandy fill material in the vicinity of the former west pond. The objective of the bioventing and total fluids extraction pilot test was to evaluate the following site-specific parameters for full-scale remediation system design:

- Rate of Biorespiration
- Soil Vapor Extraction Flow Rate Versus Applied Vacuum
- Radius of Influence
- Total Fluids Recovery Rate

The pilot test results indicate that bioventing and total fluids extraction is a feasible alternative for accelerating natural biodegradation of petroleum hydrocarbons at the site to levels below the regulatory cleanup standards. The full scale design is based on the following design parameters derived from the results of the pilot test.

- *Vacuum Versus Flow Rate:* The design vacuum will be approximately 4 inches of mercury (" Hg), and the design flow rate will be approximately 20 standard cubic feet per minute (scfm) per well.

- *Radius of Influence:* The conservative design radius of influence is 30 feet, based on an induced vacuum radius of influence ranging from 11 to 43 feet. Also, increases in oxygen concentrations in the vadose zone were observed in wells that were 30 to 50 feet from the extraction point.

- *Soil Vapor Concentrations and Air Emissions Estimates:* Low levels of the BTEX compounds, benzene (0.496 mg/m^3), toluene (0.496 mg/m^3), ethylbenzene (0.496 mg/m^3), and xylenes (0.496 mg/m^3) and gasoline range hydrocarbons (20.8 mg/m^3) indicate that the blower discharge should, at least initially, be treated with vapor phase activated carbon.

- *Biodegradation Rates:* Hydrocarbon degradation rates ranging from 3 mg/kg per day to 160 mg/kg per day were observed in monitoring wells during the pilot test.

- *Total Fluids Production:* The average groundwater extraction rate is expected to range between 0.2 gpm and 1 gpm per well.

4.0 CLEANUP STANDARDS

Cleanup standards for the shallow groundwater at the site have been developed pursuant to the Model Toxics Control Act (MTCA) cleanup regulations using an assessment of potentially sensitive receptors and local soil and groundwater quality. The following discussion presents the rationale for the selected cleanup standards.

4.1 REMEDIAL OBJECTIVES

Ecology has established that cleanup of hazardous substance sites shall be conducted with preference given to technologies which minimize the amount of untreated hazardous substances remaining at the site. The site conditions have been evaluated with regard to the preferred technologies presented in WAC 173-34-360(4). Based on an evaluation of the contaminants of concern, the media of concern, the site conditions, and the results of the feasibility pilot testing, bioventing and excavation were selected as technically feasible alternatives for remediation of the site. These alternatives will treat hazardous substances and minimize the amount remaining at the site, as discussed in Sections 5.0 and 6.0 below.

4.2 MODEL TOXICS CONTROL ACT

MTCA requires that remedial actions at a site achieve a cleanup level that protects human health and the environment. The cleanup must comply with MTCA cleanup standards as specified in WAC 173-340-700 et seq.

MTCA provides the primary cleanup standards for the affected media at the site. MTCA authorized Ecology to adopt cleanup standards for remedial actions at hazardous waste sites. These regulations incorporate other federal and state requirements and are considered the primary cleanup standards for soil, groundwater, and surface water cleanup actions in Washington State. The processes for identifying, investigating, and remediating hazardous waste sites are defined, and cleanup levels are set for groundwater, soil, surface water, and air in WAC 173-340 Sections 720 through 750. Additional guidance for conducting cleanups of site contaminated with TPH is provided in the *Interim Interpretive and Policy Statement: Cleanup of Total Petroleum Hydrocarbons (TPH)*, Ecology Publication No. ECY97-600 (Interim TPH Policy), January 20, 1997, discussed below.

Under MTCA, site-specific cleanup levels are contingent upon the anticipated future land use of the site. The regulation specifies three "methods" for use in establishing site cleanup levels for specific environmental media. Briefly, these are:

- **Method A** cleanup levels are set by the state of Washington and are delineated in the regulation for a specific subset of chemicals for environmental media. These values can be used as cleanup levels during "routine" site cleanups (e.g., few contaminants at the site, and all contaminants have Method A cleanup levels).
- **Method B** is the standard method for site cleanups under MTCA. Method B cleanup levels involve calculation of media-specific values for a given chemical from specified formulae provided in the regulation. The formulae require input of chemical-specific toxicological parameters, as well as physiological and exposure-based parameters. Parameter values and sources are explicitly stated in the regulation.
- **Method C** is the conditional method for site cleanups under MTCA. MTCA Method C levels involve calculations similar to Method B, with some modification of specific parameter values to meet special conditions associated with the site (i.e., industrial sites).

Consistent with the provisions in MTCA [WAC 173-340-720 (1)(c) and (3)(b)(v) for groundwater cleanup standards], MTCA cleanup levels allow groundwater cleanups based on protecting surface water. Therefore, the proposed groundwater cleanup levels for the site have been based on protection of surface water in the Columbia River.

4.3 CLEANUP CRITERIA

4.3.1 Groundwater

4.3.1.1 Groundwater Cleanup Levels

Cleanup levels for groundwater must protect the highest beneficial use and reasonable maximum exposure expected to occur under both current and potential future site use conditions. Under typical conditions, the highest beneficial use is considered to be as drinking water; however, based on the following criteria, site groundwater is exempt from this consideration per WAC 173-340-720 (1)(a):

1. Shallow site groundwater is not a current source of drinking water

2. Shallow site groundwater is not a viable future drinking water source as a result of the demonstrated low permeability of the aquifer, which did not produce greater than 0.5 gpm sustained flow from EX-2, a 4-inch diameter groundwater monitoring well. Per WAC 173-340-720(1)(a)(ii)(A), groundwater is not a potential future source of drinking water if it is not present in sufficient quantity to yield greater than 0.5 gpm on a sustainable basis.

3. Transport of petroleum constituents from the contaminated groundwater to a current or potential source of drinking water is unlikely due to the following factors per WAC 173-340-720(1)(b):

    - The extent of affected groundwater is limited to the perched aquifer in the region of the former pits.

    - The nearest drinking water supply well is approximately ½ mile from the site and is screened at a depth of 110 feet.

    - Petroleum impacts are present in shallow groundwater. State requirements for drinking water wells (WAC 173-160) require an 18-foot casing, placing a well screen in the unproductive silt, below the zone of petroleum impacts hypothetical drinking water.

    - Transport to a deeper aquifer is improbable because the petroleum compounds are less dense than water and tend to reside at the top of the water table.

    - Transport to a deeper aquifer is improbable due to the lower permeability of the silt layer underlying the sand.

    - Transport to an adjacent aquifer is unlikely, as the groundwater flow has been demonstrated to be to the south towards the Columbia River.

Due to the unsuitability of site groundwater for drinking and domestic uses, proposed groundwater cleanup levels for the site are not based on a drinking water beneficial use. It is proposed that cleanup standards therefore be based on the beneficial use of the Columbia River which is a potential receptor of site groundwater. The highest use of the Columbia River is as drinking water, and to protect the use of the Columbia River as a downstream drinking water source, the MTCA Method A groundwater cleanup level of 1,000 micrograms per liter (μg/L) (parts per billion [ppb]) TPH is proposed for groundwater discharging to the Columbia River.

4.3.1.2 Point of Compliance

The regulatory point of compliance for protection of surface waters is "the point at which hazardous substances are released to surface waters." WAC 173-340-730(6)(a). To provide additional protection to the beneficial uses of the Columbia River, a more protective point of compliance is proposed at downgradient wells MW-13 and MW-14. These wells are located south of the zone of contamination, between it and the Columbia River.

4.3.2 Surface Water

No adverse impact due to site contaminants, such as water quality violations or a visible oil sheen, is allowed on surface water, including the Columbia River. Establishment of the two points of compliance at MW-13 and MW-14 will allow monitoring to verify that this requirement is met.

4.3.3 Soil

Method A cleanup levels are listed in Tables 1, 2, and 3 of WAC 173-340-700. Method A cleanup levels are not site specific. Method A cleanup levels are 200 mg/kg for TPH-D and TPH-O in soil. The Interim TPH policy establishes guidelines for developing Method B and Method C risk-based soil cleanup levels that address the following exposure pathways for potential receptors:

- Direct contact pathway
- Soil to groundwater pathway

To implement the methods for establishing soil cleanup levels for these two pathways, a soil sample was collected for analysis of aliphatic and aromatic hydrocarbon fractions. The sample was collected from GP-3 on May 6, 1999 at a depth of 7 to 8 feet bgs. The analysis breaks TPH down into smaller categories of compounds, called fractions, based on hydrocarbon size, (i.e., the approximate number of carbons in the compound). It also includes analysis of potentially carcinogenic compounds such as benzene and carcinogenic polycyclic aromatic hydrocarbons (c-PAHs). The results of the analysis are presented in the following Table 1:

Table 1. TPH Fraction Analysis
Representative Soil Sample (GP-3 7-8')
Former Columbia Marine Lines Facility

Fraction	**Concentration (mg/kg)**
Aliphatics	**5,915**
EC 5-6	nd
EC>6-8	nd
EC>8-10	94.3
EC>10-12	961
EC>12-16	3,130
EC>16-21	1,730
Aromatics	**1,104**
Benzene	nd
Ethylbenzene	nd
Toluene	Nd
Xylenes	Nd
EC>8-10	Nd
EC>10-12	46.6
EC>12-16	412
EC>16-21	409
EC>21-35	237
Carcinogenic PAHs	0.485
TPH	**7,020**

Laboratory analytical reports and the boring log are included in the *Additional Subsurface Investigation Report*, dated July 9, 1999, prepared by SECOR.

4.3.3.1 Direct Contact Pathway

Under the TPH Interim Policy, Method B and Method C cleanup levels may be established for direct contact with soil at sites with future residential, commercial, or industrial use categories. Residential cleanup levels are the most restrictive.

Due to the limitations of existing risk data for the compounds typically found in petroleum products, two types of cleanup levels must be calculated for the direct contact pathway. The first cleanup level from the Interim TPH policy is for non-carcinogenic petroleum compounds. The second cleanup level from the Interim TPH Policy is for all carcinogenic compounds, including benzene and c-PAHs.

Non-Carcinogenic Compound Cleanup Level

The non-carcinogenic cleanup level is determined by calculating a hazard quotient (HQ). The cleanup level is defined as the level at which the HQ is equal to 1.0. The HQ is dependant on the concentration of the aliphatic and aromatic petroleum hydrocarbon fractions listed in Table 1. For each fraction, an HQ is calculated using the following formula:

$$HQ = \frac{(SC)(SIR)}{(ORfD)(ABW)(1{,}000{,}000 mg/kg)} \qquad [1]$$

Where SC is the soil concentration of the fraction in mg/kg, SIR is the average soil ingestion rate (assumed to be 200 mg/day), the ORfD is the oral reference dose, and ABW is the average body weight of a child receptor (assumed to be 16 kg). EPA defines the ORfD as an estimate of a daily exposure to the human population, including sensitive subgroups, that is likely to be without an appreciable risk of deleterious effects during a lifetime. Doses at or below the ORfD are not likely to be associated with any health risks, and are, therefore, assumed likely to be protective and of little regulatory concern.

Equation [1] may be simplified as follows:

$$HQ = (SC)(Multiplier) \qquad [2]$$

Where:

$$Multiplier = \frac{Factor}{ORfD} \qquad [3]$$

And:

$$Factor_{Residential} = \frac{200 mg/day}{(16 kg)(1{,}000{,}000 mg/kg)} = 1.25e^{-5}/day \qquad [4]$$

$$Factor_{Commercial} = 3.125e^{-6}/day \qquad [5]$$

$$Factor_{Industrial} = 2.86e^{-7}/day \qquad [6]$$

Using these factors, the hazard quotient of the representative soil sample (see Table 1) may be calculated as follows:

Table 2. Representative Sample Hazard Quotient
Direct Contact Pathway Evaluation
Former Columbia Marine Lines Facility

Condition	ORfD (mg/kg-day)	Factor	Multiplier	Soil Conc. (mg/kg)	Hazard Quotient
RESIDENTIAL					
Total Aliphatic	0.06	1.25E-05	2.08E-04	6,254	1.303
Total Aromatic	0.03	1.25E-05	4.17E-04	1,105	0.460
			TOTAL	7,359	1.763
COMMERCIAL					
Total Aliphatic	0.06	3.13E-06	5.21E-05	6,254	0.326
Total Aromatic	0.03	3.13E-06	1.04E-04	1,105	0.115
			TOTAL	7,359	0.441
INDUSTRIAL					
Total Aliphatic	0.06	2.86E-07	4.77E-06	6,254	0.030
Total Aromatic	0.03	2.86E-07	9.53E-06	1,105	0.011
			TOTAL	7,359	0.040

Table 2 indicates that the TPH levels in the representative soil sample are greater than the residential cleanup level, but less than the commercial and industrial cleanup level. It also indicates that 74% of the hazard quotient is produced by the aliphatic fraction and that 26 percent is produced by the aromatic fraction.

Equation 2 may be re-arranged to derive the following formula for calculating the cleanup level by setting the total HQ to 1 (0.74 for the aliphatic fraction and 0.26 for the aromatic fraction) and solving for the corresponding soil concentrations that will produce the hazard quotients:

$$SC = \frac{HQ}{Multiplier} = \frac{1}{\dfrac{Factor}{ORfD}} = \frac{ORfD}{Factor} \qquad [7]$$

Residential, commercial, and industrial cleanup levels for the non-carcinogenic TPH compounds are calculated on the following Table 3:

Table 3. Non-Carcinogenic Cleanup Levels
Direct Contact Pathway Evaluation
Former Columbia Marine Lines Facility

Condition	ORfD (mg/kg-day)	Factor	Multiplier	Hazard Quotient	Cleanup Level (mg/kg)
RESIDENTIAL					
Total Aliphatic	0.06	1.25E-05	2.08E-04	0.74	3,552
Total Aromatic	0.03	1.25E-05	4.17E-04	0.26	624
			TOTAL	1.00	4,176
COMMERCIAL					
Total Aliphatic	0.06	3.13E-06	5.21E-05	0.74	14,208
Total Aromatic	0.03	3.13E-06	1.04E-04	0.26	2,496
			TOTAL	1.00	16,704
INDUSTRIAL					
Total Aliphatic	0.06	2.86E-07	4.77E-06	0.74	155,245
Total Aromatic	0.03	2.86E-07	9.53E-06	0.26	27,273
			TOTAL	1.00	182,517

Carcinogenic Compound Cleanup Levels by TPH Interim Policy

The risk from carcinogenic compounds is calculated and compared to the acceptable risk level assigned by MTCA for residential, commercial, and industrial uses. Of the two carcinogenic groups looked at by the TPH Interim Policy, c-PAHs were detected at a level of 0.485 mg/kg. Benzene was not detected in this sample. It has been detected in groundwater (1996) and was detected in the pilot test soil vapor sample at a level of 0.496 mg/m^3.

The formula for determining the carcinogenic cleanup level is:

$$Risk = \frac{(SC)(OCPF)(SIR)(DUR)}{(ABW)(Life)(1{,}000{,}000 mg/kg)} \qquad [8]$$

Where SC is the soil concentration in mg/kg, OCPF is the oral cancer potency factor (0.029 kg-day/mg for benzene and 7.3 kg-day/mg for all c-PAHs), SIR is the soil ingestion rate of 200 mg/day, DUR is the duration of 6 years, ABW is the average body weight of a child (16 kg), and life is average life span (75 years).

The equation may be simplified as follows:

$$\text{Residential Soils: Risk} = (SC)(OCPF)(1.0e^{-6}) \qquad [9]$$

$$\text{Commercial Soils: Risk} = (SC)(OCPF)(2.5e^{-7}) \qquad [10]$$

$$\text{Industrial Soils: Risk} = (SC)(OCPF)(7.62e^{-8}) \qquad [11]$$

Acceptable risk levels are less than one in a million ($1e^{-6}$) for residential land use and less than one in one hundred thousand ($1e^{-5}$) for commercial and industrial land use. In practice, a soil cleanup level may be calculated by first determining the risk due to the existing c-PAH level, dividing that risk by the acceptable risk, and then multiplying by the existing c-PAH level.

Using the methods in the Interim TPH Policy, the risk associated with the carcinogenic PAHs, and the associated cleanup levels for carcinogenic PAHs only, are summarized on Table 4, below:

Table 4. Carcinogenic PAH Cleanup Levels
Direct Contact Pathway Evaluation
Former Columbia Marine Lines Facility

Compound	Representative Sample Conc. (mg/kg)	OCPF (kg-day/mg)	Residential Risk	Commercial Risk	Industrial Risk
c-PAHs	0.485	7.3	3.54E-06	8.85E-07	2.70E-07
Total Acceptable Risk			1.00E-06	1.00E-05	1.00E-05

c-PAH Cleanup Level (mg/kg)		0.14	5.48	17.98

It should be noted that the only carcinogenic compound detected on site was chrysene. The *MTCA Cleanup Levels and Risk Calculations (CLARCII) Update*, issued by Ecology in February 1996, includes a Method B cleanup level of 0.137 mg/kg in soils for chrysene, equal to the residential level calculated in Table 4. Because the TPH Interim Policy, which was issued after the CLARCII Update, addresses commercial and industrial risks as well as residential risk, the CLARCII values are believed to be inappropriate.

4.3.3.2 Soil to Groundwater Pathway

The soil to groundwater pathway addresses the following two transport issues:

- Solubilization of Vadose Zone Petroleum
- NAPL Gravity Flow

Solubilization of Vadose Zone Petroleum

Evaluation of the soil to groundwater pathway determines what concentrations may be left in the vadose zone without producing concentrations in the groundwater, via solubilization of vadose zone petroleum and transport into the groundwater, that exceed groundwater cleanup levels. The following four options are presented in the TPH Interim Policy for evaluating the soil to groundwater pathway:

- Option 1: 100 x Groundwater
- Option 2: Soil/Pore Water Partitioning and Groundwater Mixing
- Option 3: Empirical Demonstration
- Option 4: LUST Matrix

Under Option 1, the soil cleanup level may be assumed to be 100 times the groundwater cleanup level. Due to the relative insolubility of the constituents at the site, Option 1 underestimates the amount that may be left in the soil and is not appropriate. Data required for Option 3 is not available for the site. Option 4 is not appropriate because this site is not a leaking underground storage tank (LUST) site.

Option 2 is used to develop the soil to groundwater pathway cleanup level in this document. The soil/pore water partitioning and groundwater mixing method models two mass transport and mixing phenomena using formulas presented in the TPH Interim Policy:

- Equilibrium partitioning (solubilization) of petroleum constituents in the vadose zone into infiltrating water using Raoult's Law
- Simple mass balance mixing of the infiltrating water with groundwater

The soil/pore water partitioning method incorporates the following conservative assumptions:

- Equilibrium soil/water partitioning is instantaneous
- Constituents do not attenuate (i.e. adsorb to soil or degrade either biologically or chemically) in the aquifer
- The source is infinite, homogenous, and extends from the ground surface to the water table
- The receptor well is at the edge of the source and screened within the plume
- Aquifer properties are homogenous and isotropic
- To provide an even more conservative model than presented in the TPH Interim Policy, the evaluation in this document assumes that the infiltrating water will not be diluted by clean groundwater, i.e. a dilution factor of 1 is used rather than the recommended dilution factor of 20 from the TPH Interim Policy. This simplification has the effect of eliminating the mass balance mixing portion of the model.

Due to the interactions between individual chemical components, the solubility in water of a chemical in a mixture is different than for the individual chemical. For a given chemical species in a mixture, equilibrium partitioning is described by Raoult's law, which is:

$$C_{pw} = XS \qquad [12]$$

Where C_{pw} is the concentration in the vadose zone pore water, i.e. the effective solubility of the chemical species; X is the mole fraction of the chemical species in the soil; and S is the solubility of the chemical species in water. The mole fraction is the number of moles of the species in question divided by the total number of moles of all species in the mixture. The mole fraction of an individual chemical species, a, in a mixture of chemical, such as petroleum, is calculated by dividing the number of moles of the individual species by the total number of moles in the mixture. The number of moles present for each species is calculated by dividing the mass of each species by its molecular weight.

$$X = \frac{\dfrac{m_a}{MW_a}}{\sum \dfrac{m_n}{MW_n}} \qquad [13]$$

Where m_a and MW_a are the mass and molecular weight of the species in question, respectively, and m_n and MW_n are the mass and molecular weight of all species in the mixture (including the species in question). Because the model assumes instantaneous equilibrium between the petroleum mixture and the water, the overall solubility of the mixture is determined solely by the mole fraction and solubility of individual components, and it is independent of the actual soil concentration of the mixture. However, it is sensitive to changes in the mixture, i.e. the overall solubility decreases as composition of the mixture increases in heavier fractions, or it would increase if the composition increased in lighter fractions.

Because petroleum is a mixture of many different chemicals of unknown properties, the TPH Interim Policy simplifies the evaluation by presenting molecular weights and solubility data for each of the aliphatic and aromatic petroleum fractions identified in the TPH fraction analysis (see Table 1). Using the TPH fraction values identified in Table 1, equilibrium partitioning of site petroleum compounds is modeled in Table 5.

Table 5. Predicted Groundwater Concentrations
Soil to Groundwater Pathway Evaluation
Former Columbia Marine Lines Facility

Compound	**Soil Conc. (mg/kg)**	**Groundwater Cleanup Calculations**						
		MW_n (g/mol)	**M_n Moles (mmol/kg)**	**X Mol. Frac. (percent)**	**S Solubility (mg/l)**	**C_{pw} Effect. Sol. (mg/l)**	**Dilution Factor**	**Groundwater Concentration (mg/l)**
ALIPHATICS								
EC >8 -10	94	130	0.7	0.02	0.33	0.007	1	0.0068
EC >10 -12	961	160	6.0	0.17	0.026	0.0045	1	0.00446
EC >12 -16	3130	200	15.7	0.45	0.00059	0.00026	1	0.00026
EC >16 - 21	1730	270	6.4	0.18	0.000001	0.0000002	1	0.000000
AROMATICS								
EC >10 - 12	47	130	0.4	0.01	25	0.3	1	0.256
EC >12 - 16	412	150	2.7	0.08	5.8	0.45	1	0.455
EC >16 - 21	409	190	2.2	0.06	0.51	0.031	1	0.0313
EC >21 - 35	237	240	1.0	0.03	0.0066	0.00019	1	0.0002
TOTAL			**35.0**	**1.00**				**0.754**

As shown in Table 5, even with no dilution, due to the relative insolubility of the fractions in the petroleum mixture at the site, the overall solubility of the mixture is less than the 1 mg/L limit for TPH in groundwater; therefore, there is no cleanup level defined by the soil/pore water partitioning method.

Historic groundwater analyses for which TPH concentrations that exceed these predicted values may have been elevated due to biogenic interference or the presence of small amounts of free product in the sample. Future groundwater samples will be collected in a manner to minimize interference by free product.

NAPL Gravity Flow

NAPL petroleum that is present in the vadose zone at levels above the residual saturation level may flow downwards toward the water table, coming into direct contact with groundwater. Residual saturation is defined as the amount of liquid that will remain in the soil after it has been completely drained, i.e. how much will remain in soil pores and adsorbed to particles and that will not further drain by gravity.

Literature Review

Laboratory residual saturation values for different types of petroleum products from several literature sources are summarized in Cohen and Mercer (1993). Residual saturation values reported in Cohen and Mercer for middle distillates range from 12,625 mg/kg in fine to medium sand, such as the soil found in upper site layers, to 17,000 in silt to fine sand, such the soil found beneath the sand. Literature residual saturation values for fuel oils range from 21,250 mg/kg in the fine to medium sand to 34,000 in silt to fine sand.

Further literature review suggests that residual saturation is inversely proportional to grain size and moisture content, i.e. it increases with decreasing grain size and decreases with increasing moisture content. Most studies did not addressed moisture content, and the two studies that did address moisture content (Hoag and Marley, 1986, and Ostendorf, et. al. 1991) focused on gasoline residual levels, which are not applicable to the product at the site. Ostendorf did find that field gasoline residual levels in a portion of the plume downgradient from the source were significantly lower than laboratory residual saturation levels, but this result is of questionable applicability to the Crowley site because the product at the site is not gasoline and the area of concern is at the source, not significantly down gradient.

Site Data

Site hydrocarbons have been identified as a "highly weathered diesel fuel oil" (North Creek Analytical, Inc., 1999). Residual saturation values for the hydrocarbon at the site are thus likely to be comparable to those observed for fuel oils in the literature.

Site-specific residual saturation values may be inferred from soil data collected at the site. A sample collected from GP-3 on May 7, 1999, from a depth of 3-4 feet bgs contained 14,000 mg/kg TPH. The sample collected from GP-3 at a depth of 7-8 feet bgs contained only 7,600 mg/kg TPH. These soils are fine to medium-grained sands. Considering the 15 year age of the hydrocarbon release, this evidence indicates that the residual saturation level of the hydrocarbon product at the site is likely greater than 14,000 mg/kg in the fine to medium grained sand of the upper soil layer. This level is consistent with values published for fuel oil in the literature, i.e. greater than 20,000 mg/kg for fine to medium grained sand.

4.3.4 Summary of Identified Cleanup Levels

4.3.4.1 Groundwater Cleanup Levels

A groundwater cleanup level of 1 mg/L is proposed for the points of compliance, MW-13 and MW-14.

4.3.4.2 Soil Cleanup Levels

Commercial cleanup levels calculated for the direct contact pathway are 16,700 mg/kg for non-carcinogenic TPH and 5.48 mg/kg for c-PAHs. Based on literature data and analytical results from site soils, residual saturation values for site soils are likely greater than 20,000 mg/kg. Therefore a soil cleanup level of 16,700 mg/kg is recommended.

4.4 COMPARISON OF SITE CONCENTRATIONS TO CLEANUP LEVELS

Site soil TPH concentrations at two of the soil borings from the geoprobe investigation in 1999 exceeded the proposed soil clean up level of 16,700 for the direct contact pathway (32,500 mg/kg at GP-13A from 10.5 feet bgs and 17,200 mg/kg at GP-10A from 13 feet bgs). Figure 6 shows an outline of the approximate extent of soil TPH levels above the 16,700 mg/kg cleanup level.

Site soil TPH fractions found in the vadose zone are relatively insoluble and appear to be protective of groundwater via the soil to groundwater pathway, based on the soil/pore water partitioning and groundwater mixing method presented in the Interim TPH guidance.

TPH groundwater concentrations, following silica gel and acid cleanup to remove biogenic material, are below the 1 mg/L Method A cleanup level at the points of compliance, MW-13 and MW-14.

4.5 PROPOSED CLEANUP ACTIONS

The following two potential cleanup actions are proposed:

- In-Situ Bioventing
- Excavation and Treatment

The in-situ bioventing remediation strategy has been selected based on the results of the bioventing pilot test, summarized in Section 5.0 of this report and discussed in detail in the Dual Phase Extraction and Bioventing Pilot Test Report. The bioventing remedy may be implemented as discussed in Section 5.0 of this report. Excavation and treatment is discussed in Section 6.0 of the plan. Cost estimates for both options are presented in Section 7.0.

5.0 BIOVENTING REMEDIATION PLAN

5.1 BIOVENTING DESIGN PHILOSOPHY

Based on the favorable pilot test results, bioventing has been selected as the remedial action for the site. The goal of the system is to reduce soil TPH below the target cleanup value of 16,700 mg/kg. This value is achievable through natural biodegradation of the contaminants by indigenous organisms. Because the prime factor that has limited natural biodegradation at the site is lack of oxygen, the addition of oxygen through bioventing will accelerate reduction of petroleum compound concentrations to levels below the cleanup standards.

The following key parameters have been considered in the design of the proposed remediation plan:

- Radius of influence of each bioventing well
- Anticipated air flow rate from each well
- Petroleum hydrocarbon concentrations in extracted air
- Anticipated water flow rate from each well
- Petroleum hydrocarbon concentrations in extracted water

Using a conservative design radius of influence per remediation well of 30 feet, bioventing will be implemented at approximately 5 wells as shown on Figure 6. Hydrocarbon degradation as a result of bioventing will be monitored to evaluate the effectiveness of the full scale bioventing system. Compliance monitoring will be conducted per the procedures presented in the *Compliance Monitoring Plan*, to be developed per WAC 173-340-410 following acceptance of this Work Plan.

To monitor the points of compliance, quarterly groundwater monitoring at MW-13 and MW-14 is proposed. The results will be tabulated and summarized in brief summary reports following each sampling event.

Based on the results of the pilot test, SECOR anticipates that petroleum hydrocarbon levels in soil and groundwater will be below the cleanup levels within 6 to 12 months of operation. Consequently, as dictated by actual system operating data, groundwater and soil confirmation sampling will be conducted to evaluate remediation progress following 6 to 12 months of operation of the system. A confirmation sampling and analysis work plan will be developed for inclusion in the *Compliance Monitoring Plan*. Should results indicate that soil and groundwater cleanup levels have been met, site closure will be requested.

5.2 BIOVENTING WELLS AND PIPE NETWORK

The proposed remediation wells will be installed as shown on Figure 7. Three extraction points, RW-1, RW-2, and RW-3, will utilize existing wells MW-7, MW-8, and MW-19, respectively. Extraction points RW-4 and RW-5 will be new 2-inch wells. The new extraction wells will be 2-inch diameter wells installed to a total depth of 15 feet. The wells will be screened from 8 to 15 feet bgs.

A total fluids remediation well head will be constructed at each remediation well, as illustrated on the process and instrumentation diagram (Figure 8). A 2-inch to 4-inch bushing and short section of 4-inch PVC will be connected at the top of the 2-inch casing, and a 4-inch well seal installed at the top of the 4-inch PVC section. The well seal is designed to seal around a 1-inch flexible PVC hose, called a stinger, through which vapor and water will be extracted from the well. The depth of the bottom of the stinger in the well will be adjustable, so that it can be lowered or raised to follow the water surface in the well. Groundwater and petroleum fluids at the water surface will be extracted by entrainment into the high velocity soil vapor stream flowing into the stinger. At the top of each well, the stinger will be connected to an individual HDPE extraction line coming from the manifold at the extraction blower. A ball valve will be provided at the connection for throttling flow from the well. A ¼-inch female Swagelok quick connect fitting will also be installed at each well head. The Swagelok fitting can be used as a pressure indicating port or sample port by plugging the appropriate equipment into the fitting.

The well seal also has two ½-inch NPT threaded connections. A ½-inch brass ball valve will be connected to one of the connections to provide a dilution point for introduction of air into the well casing, facilitating water removal in case the formation provides less air flow than expected. The other ½-inch connection will be plugged, but it may be used with the ejector pumping system if groundwater production is higher than expected (see Section 6.3). To use it with the ejector system, a section of ½-inch PVC pipe or copper tubing will be inserted into the well and threaded into the bottom of the well seal. The bottom of the tube will be set at a depth of within approximately 6 inches to 12 inches. At the top of the well seal, ½-inch pipe or tubing will be plumbed to a venturi ejector, which will provide vacuum to pump water from the well as described in Section 6.3.

5.3 BIOVENTING EXTRACTION EQUIPMENT

Figure 8 presents the process and instrumentation diagram for the proposed system. In addition to the wells and wellheads, the proposed system includes the following equipment:

- Extraction manifold
- Moisture separation drum
- Vacuum blower
- Oil/water separation tank
- Liquid phase carbon filter
- Vapor phase carbon filter

The HDPE extraction lines will be connected to a 3-inch PVC extraction manifold. Each line will be equipped with a ball valve, Swagelok port, and anemometer port at the extraction manifold. The anemometer port is a ½" threaded hole in the pipe that is normally plugged, but into which a hot wire anemometer may be inserted to measure air flow rate.

The 3-inch PVC manifold will be connected to a modified 55-gallon drum used as a moisture separation tank. The drum will be equipped with a tangential inlet by which the incoming air flow is directed around the inner walls of the drum, enhancing moisture separation. The moisture separator will be equipped with an air dilution valve to allow for adjustment of the vacuum level applied to the wells. Groundwater that accumulates in the moisture separator will be pumped to the oil/water separation tank by a ½-horsepower (hp) submersible sump pump installed in the moisture separator. The submersible pump will be powered by 110-V power supplied from a duplex outlet at the electrical panel.

Each extraction well is expected to operate at an air flow rate of approximately 20 scfm and a vacuum of approximately 4" Hg. The total flow from the 5 wells is expected to be near 125 scfm. To accommodate back pressure from the vapor phase carbon units and friction losses in the extraction pipe and moisture separator, the proposed blower has been sized to provide greater than 125 scfm at 5" Hg vacuum. The proposed blower is a Rotron EN 707 5.5 horsepower, 230-volt, 1-phase blower. It will be equipped with a vacuum relief valve, motor starter, and hand switch.

The blower will be wired to the pilot test electrical panel by a certified electrician. Exhaust from the blower will be discharged to the atmosphere through activated carbon and a 10-foot tall, 3-inch diameter, schedule 40 PVC discharge stack. A ½-inch threaded port in the stack will be used as a sample port and for measuring air flow using a hot wire anemometer.

Water pumped out of the moisture separator drum will discharge to an existing approximately 1000-gallon oil/water separation tank (See Figure 9). Water will discharge from the tank by gravity through a 2-inch discharge line to a 55-gallon drum of activated carbon. Treated water discharged from the carbon drum will flow into the existing infiltration trench. The trench location is shown on Figure 7. The trench design is shown on Figure 10.

5.4 BIOVENTING PERMITTING

The Southwest Washington Air Pollution Control Authority (SWAPCA) has stated that it will not require a permit for discharge from the remediation system if the discharge is controlled by carbon; therefore the facility will not require an air permit. An injection well permit will be required.

6.0 EXCAVATION AND TREATMENT

The excavation and treatment remedial alternative will consist of excavation of contaminated soil, onsite thermal treatment, and replacement of the treated soil back into the excavation after it has been demonstrated to be below cleanup levels. The areas to be excavated are illustrated on Figure 6, and include the area around boring GP-13A and GP-10A. Additionally, MW-7, MW-8, and MW-19 would be removed and impacted soil, including free product, removed. The wells would be replaced with new monitoring wells in the backfilled soil.

Groundwater monitoring at the points of compliance will continue for four quarters after excavation to confirm that groundwater TPH levels remain below 1 mg/L.

7.0 BIBLIOGRAPHY

Additional Subsurface Investigation Report. SECOR International Incorporated. July 9, 1999

Case Narrative. North Creek Analytical, Inc. November 16, 1999.

Cohen, R.M. and J.W. Mercer. *DNAPL Site Evaluation*. 1993. CRC Press. Boca Raton, FL: S.K. Smoley

Dual Phase Extraction And Bioventing Pilot Test Report. SECOR International Incorporated. March 17, 2000

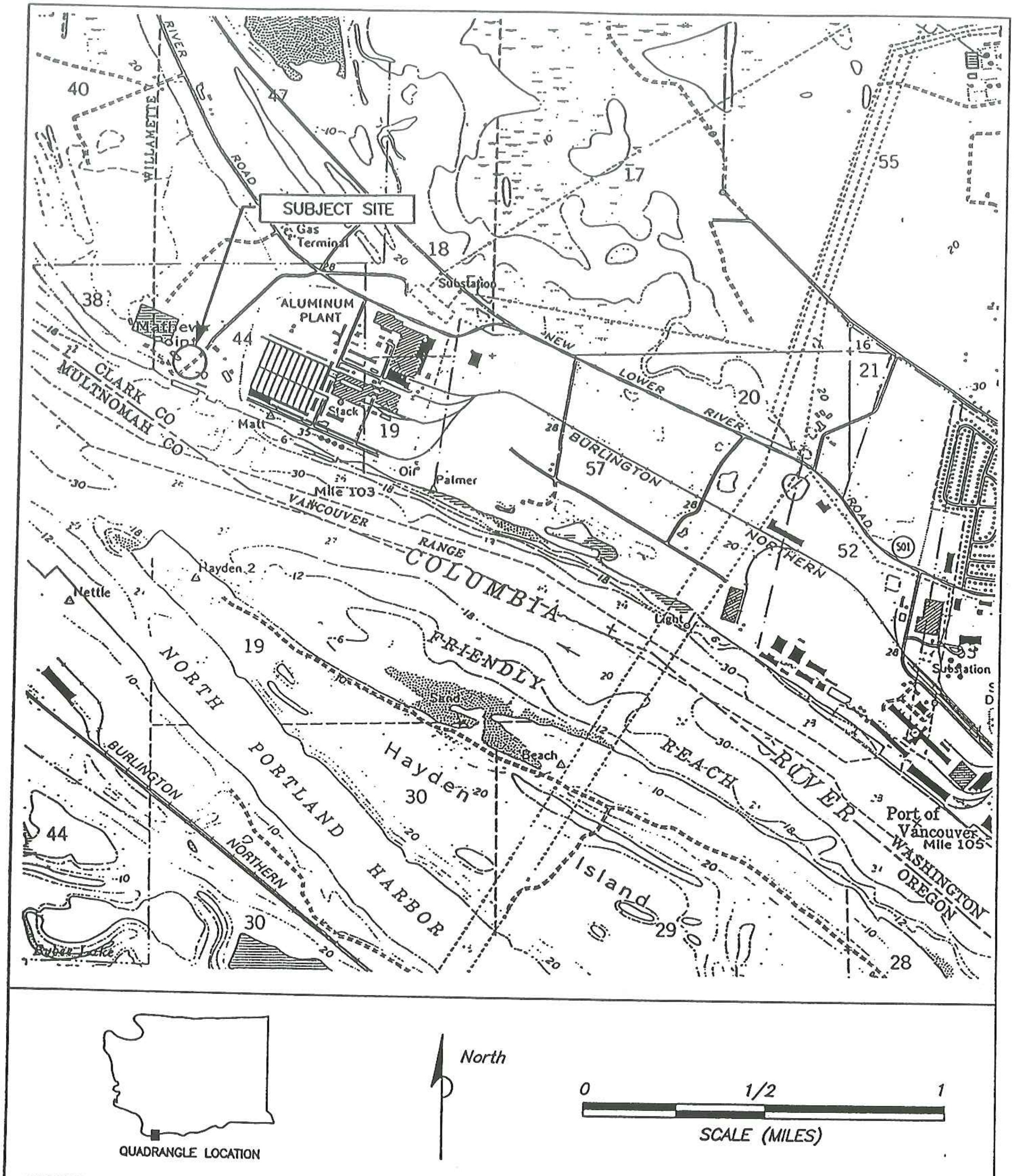
Hoag, G.E. and M.C. Marley. Gasoline Residual Saturation in Unsaturated Uniform Aquifer Materials. Journal of Environmental Engineering. ASCE. 112(3):586-604.

Interim Interpretive and Policy Statement – Cleanup of Total Petroleum Hydrocarbons (TPH). Washington State Department of Ecology. January 1997.

Model Toxics Control Act Cleanup Levels and Risk Calculations (CLARCII) Update. Washington State Department of Ecology. February 1996.

Ostendorf, D.W. et al. Field Sampling of Residual Aviation Gasoline in Sandy Soil. Groundwater Monitoring and Remediation. Spring 1991. p. 107-120.

Subsurface Investigation Report, SECOR International Incorporated. December 3, 1999.



REFERENCE: USGS 7.5 MINUTE QUADRANGLE; VANCOUVER, WASHINGTON.

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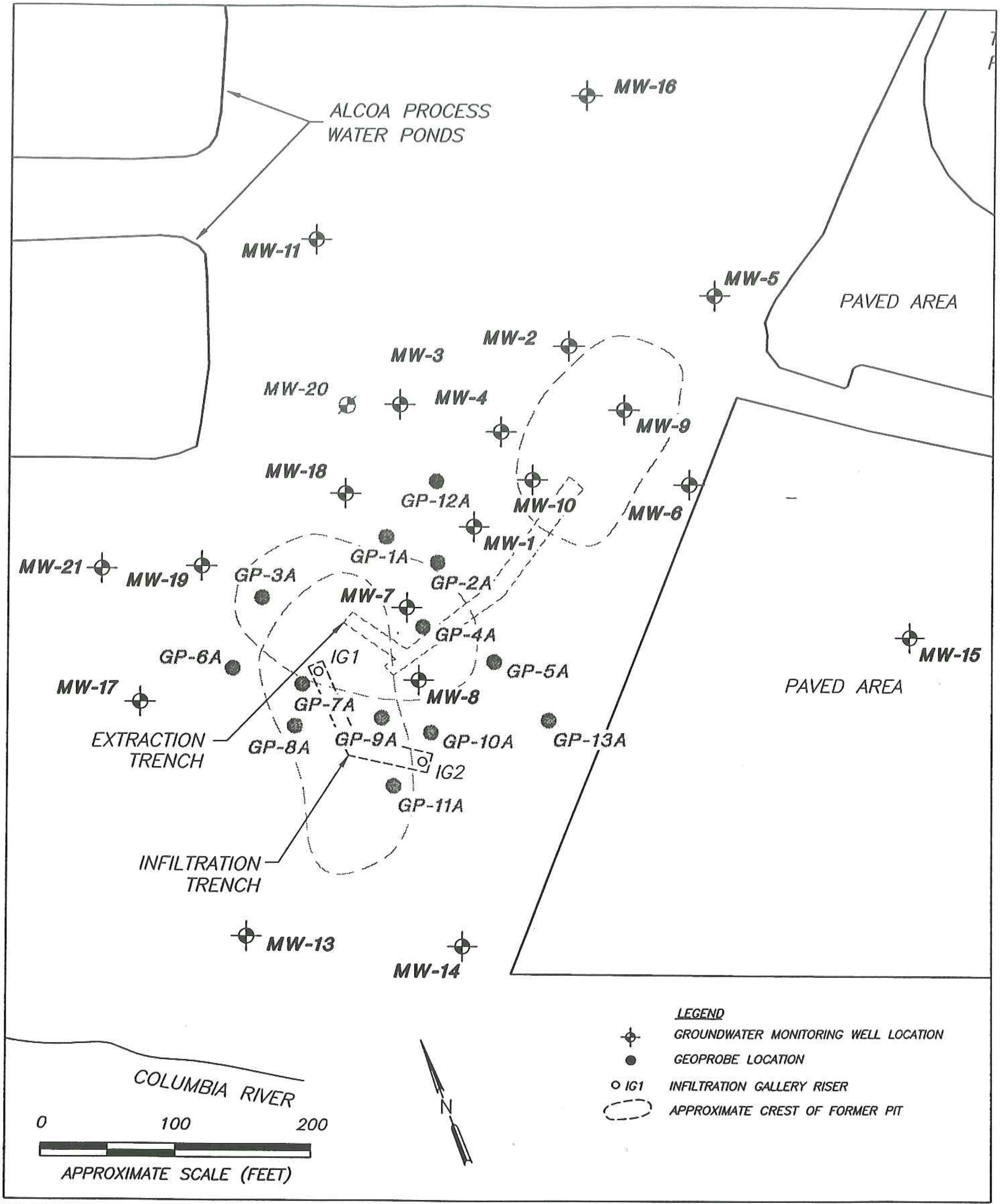
SITE LOCATION MAP
FORMER COLUMBIA MARINE LINES FACILITY
VANCOUVER, WASHINGTON

FIGURE:
1

JOB#: 00255-003-01 APPR: RGA DWN: DJM DATE: 12/2/97

DWG: CR003088

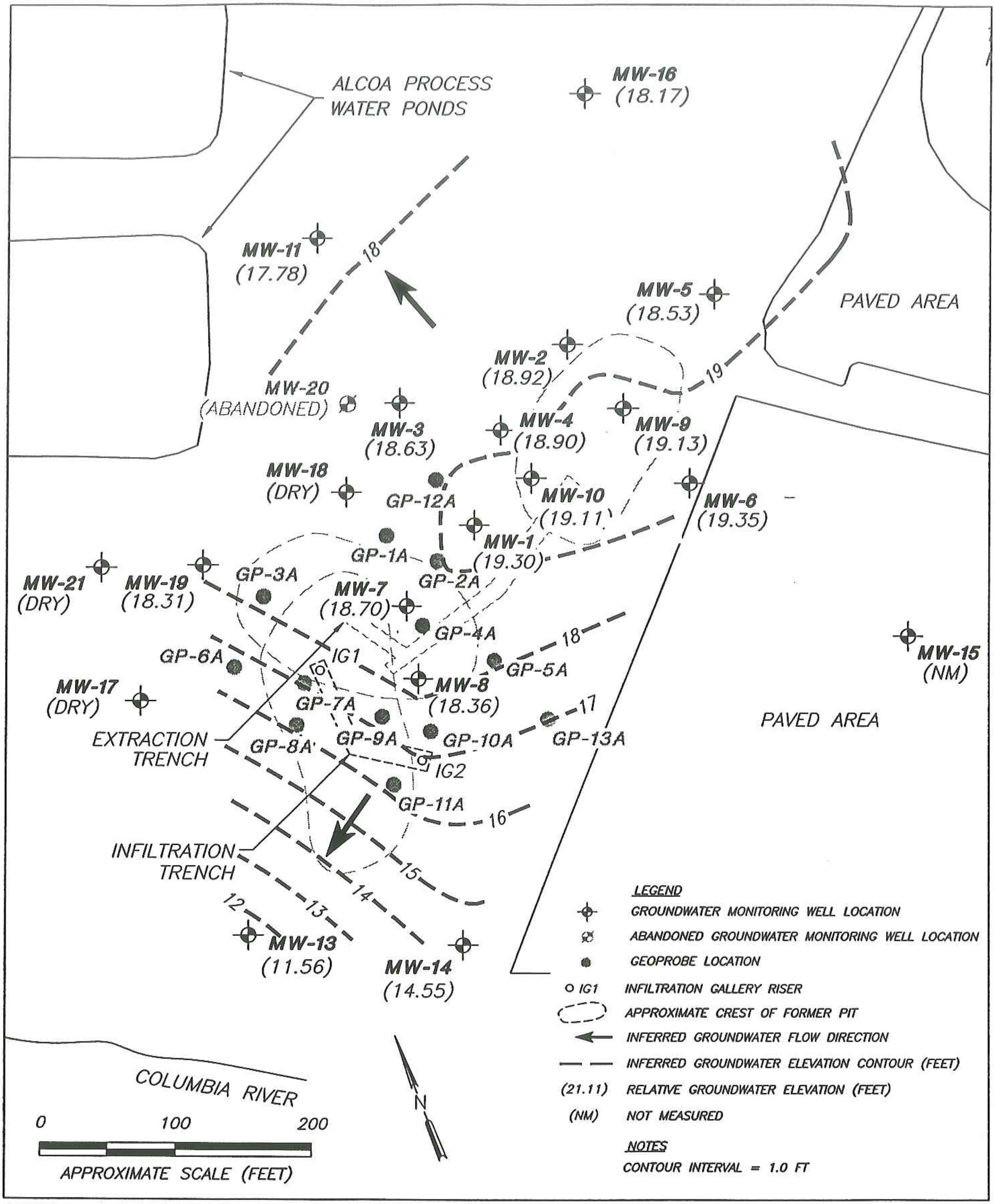


SECOR International Incorporated 015	**SITE PLAN** **FORMER COLUMBIA MARINE LINES FACILITY** **6305 LOWER RIVER ROAD** **VANCOUVER, WASHINGTON**	FIGURE: 2

JOB#: **015.08480.500** APPR: SRH DWN: **KSM** DATE: **4/12/00**

F:/FILES/PORTLAND/CROWLEY

DWG: 15-8480-512SP



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International Incorporated
015

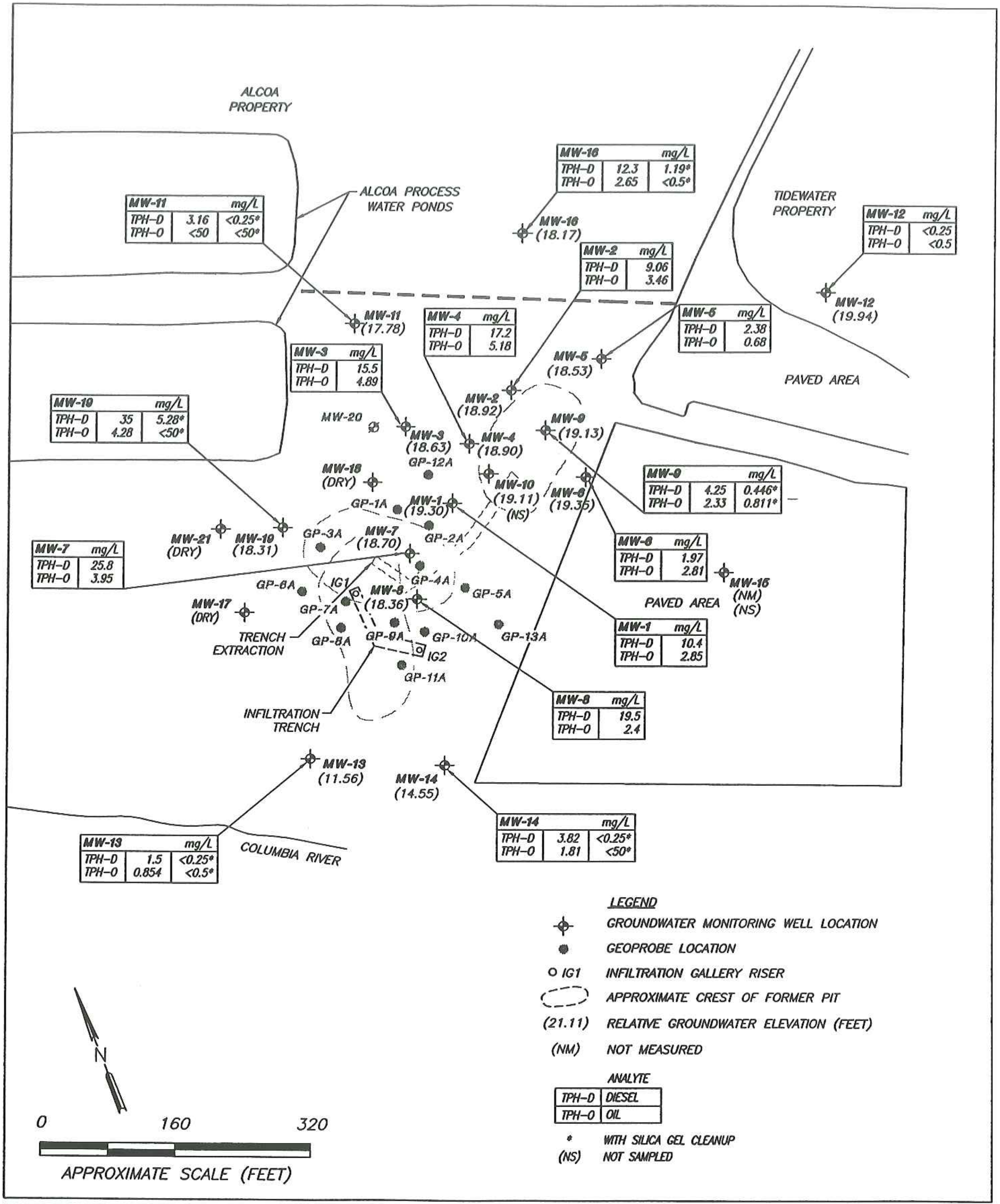
GROUNDWATER ELEVATION CONTOUR MAP
(10/14/99)
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON

FIGURE:
3

JOB#: 015.08480.500 APPR: SRH DWN: KSM DATE: 4/12/00

F:/FILES/PORTLAND/CROWLEY

DWG: 15-8480-53-1099



SECOR
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015

GROUNDWATER ANALYTICAL RESULTS
(10/14/99)
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON

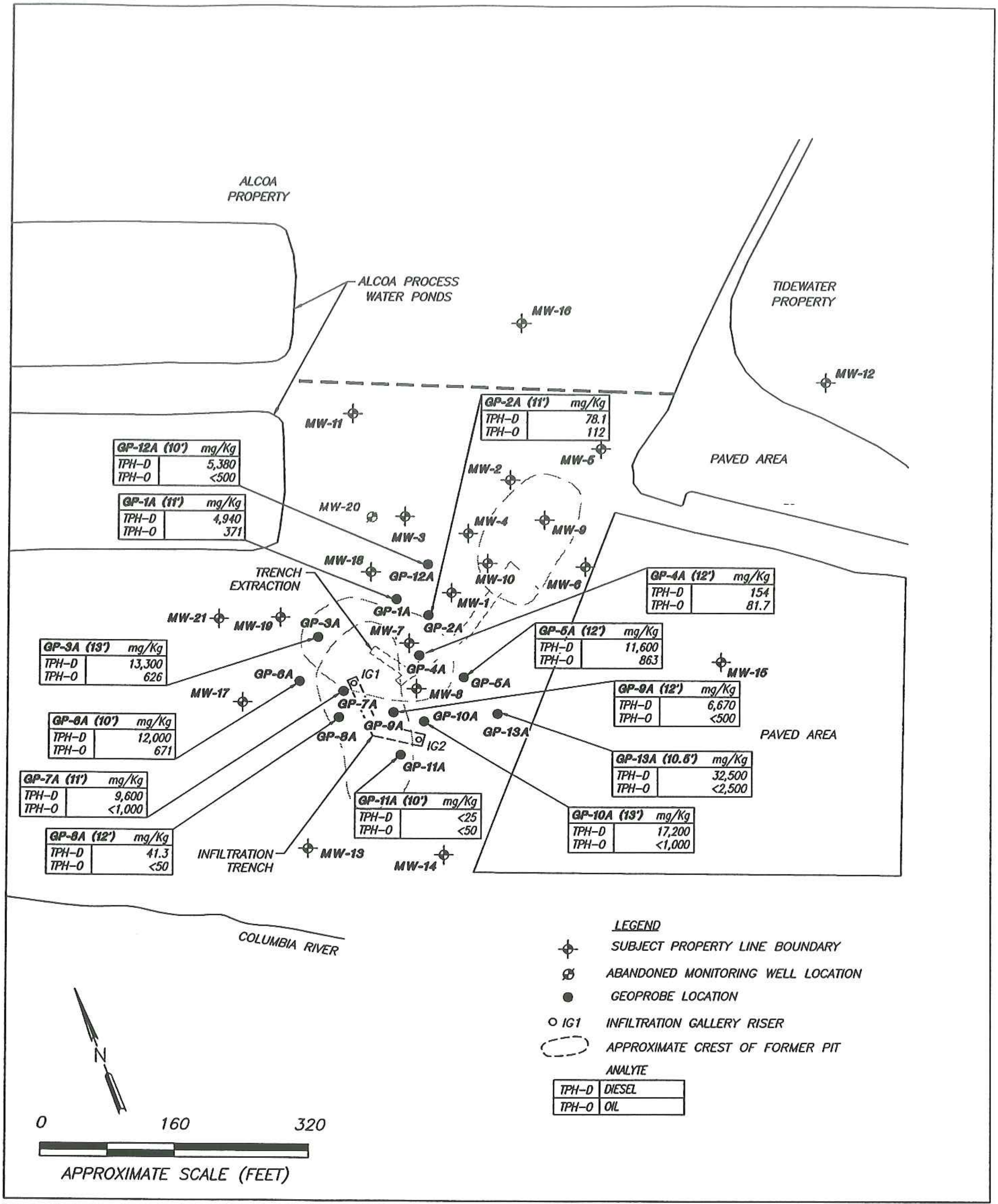
FIGURE:

4

JOB#: 015.08480.500 APPR: SRN DWN: KSM DATE: 4/12/00

F:/FILES/PORTLAND/CROWLEY

DWG: 15-8480-54A-1099



GP-2A (11')	mg/Kg
TPH-D	78.1
TPH-O	112

GP-12A (10')	mg/Kg
TPH-D	5,380
TPH-O	<500

GP-1A (11')	mg/Kg
TPH-D	4,940
TPH-O	371

GP-4A (12')	mg/Kg
TPH-D	154
TPH-O	81.7

GP-5A (12')	mg/Kg
TPH-D	11,600
TPH-O	863

GP-3A (13')	mg/Kg
TPH-D	13,300
TPH-O	626

GP-9A (12')	mg/Kg
TPH-D	6,670
TPH-O	<500

GP-6A (10')	mg/Kg
TPH-D	12,000
TPH-O	671

GP-13A (10.5')	mg/Kg
TPH-D	32,500
TPH-O	<2,500

GP-7A (11')	mg/Kg
TPH-D	9,600
TPH-O	<1,000

GP-11A (10')	mg/Kg
TPH-D	<25
TPH-O	<50

GP-10A (13')	mg/Kg
TPH-D	17,200
TPH-O	<1,000

GP-8A (12')	mg/Kg
TPH-D	41.3
TPH-O	<50

TPH-D	DIESEL
TPH-O	OIL

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015

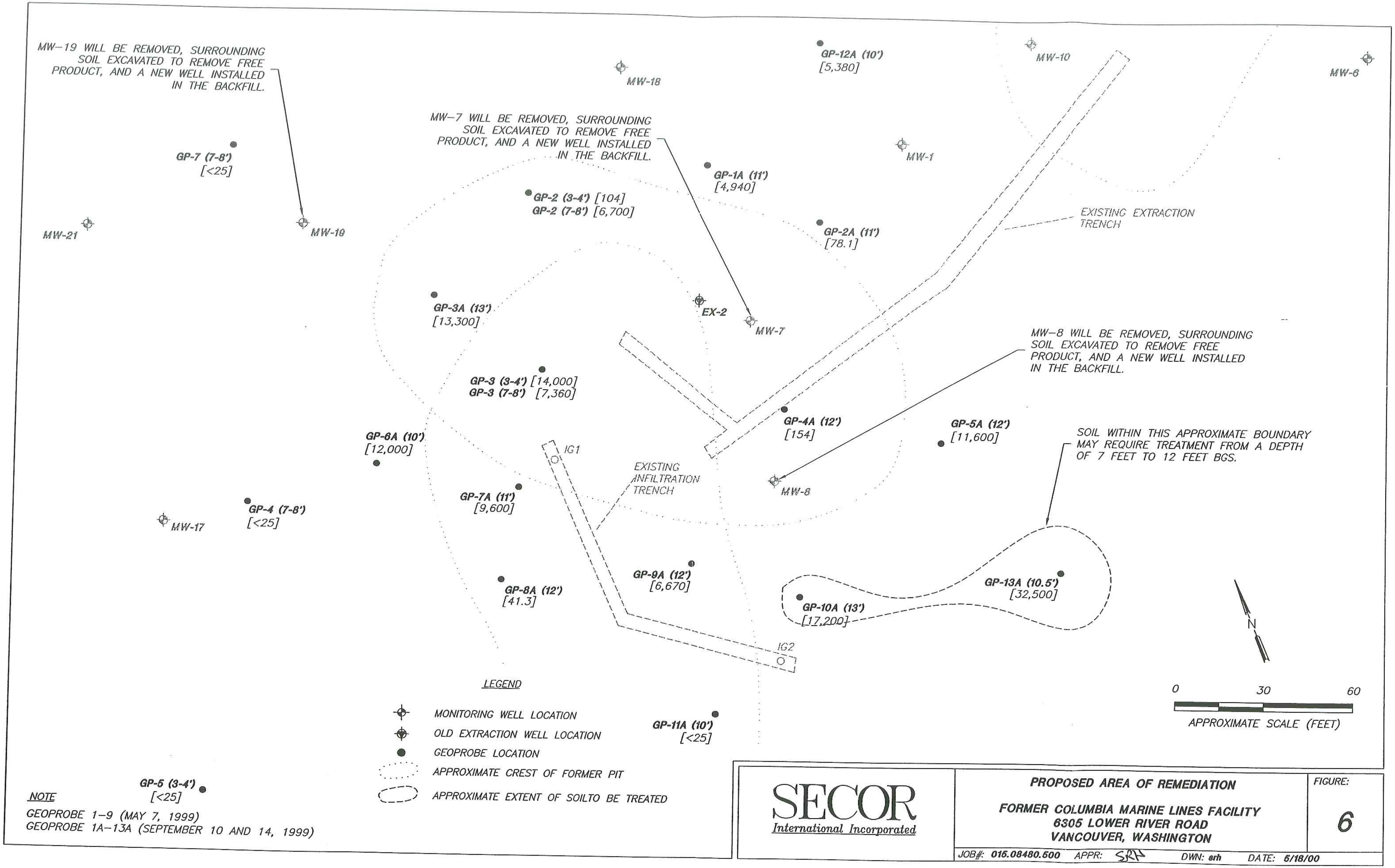
GEOPROBE SOIL ANALYTICAL RESULTS
(SEPTEMBER 10 AND 14, 1999)
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON

FIGURE:
5

JOB#: 015.08480.500 APPR: SRH DWN: KSM DATE: 4/12/00

F:/FILES/PORTLAND/CROWLEY

DWG: 15-8480-55A-999



LEGEND

- ⌖ MONITORING WELL LOCATION
- ⌖ OLD EXTRACTION WELL LOCATION
- ● GEOPROBE LOCATION
- ⋯ APPROXIMATE CREST OF FORMER PIT
- ⬭ APPROXIMATE EXTENT OF SOILTO BE TREATED

NOTE

GEOPROBE 1–9 (MAY 7, 1999)
GEOPROBE 1A–13A (SEPTEMBER 10 AND 14, 1999)

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PROPOSED AREA OF REMEDIATION

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

FIGURE:
6

JOB#: **015.08480.500** APPR: SRH DWN: **srh** DATE: **5/18/00**

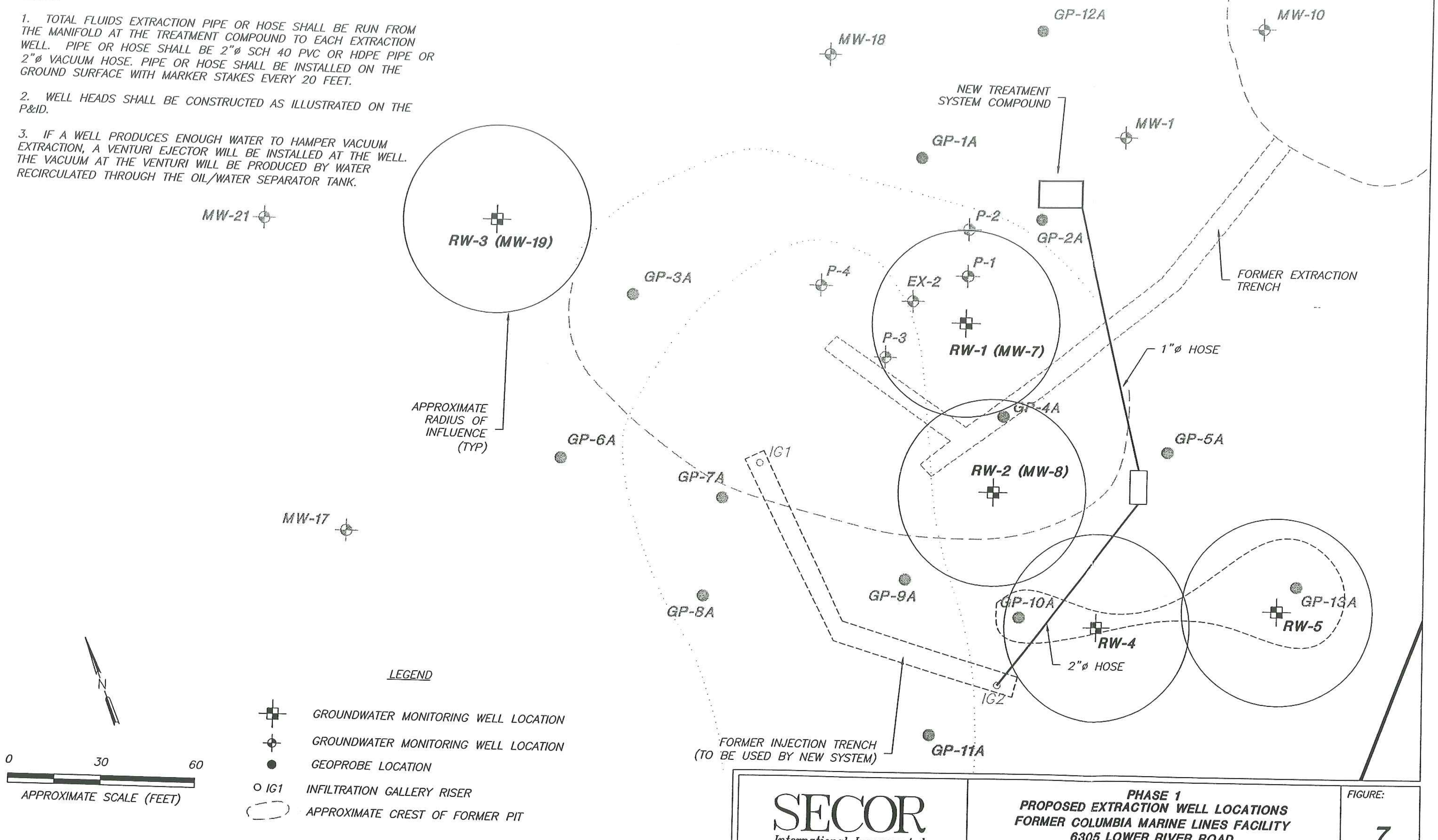
DWG: 15–8480–509

NOTES:

1. TOTAL FLUIDS EXTRACTION PIPE OR HOSE SHALL BE RUN FROM THE MANIFOLD AT THE TREATMENT COMPOUND TO EACH EXTRACTION WELL. PIPE OR HOSE SHALL BE 2"ø SCH 40 PVC OR HDPE PIPE OR 2"ø VACUUM HOSE. PIPE OR HOSE SHALL BE INSTALLED ON THE GROUND SURFACE WITH MARKER STAKES EVERY 20 FEET.

2. WELL HEADS SHALL BE CONSTRUCTED AS ILLUSTRATED ON THE P&ID.

3. IF A WELL PRODUCES ENOUGH WATER TO HAMPER VACUUM EXTRACTION, A VENTURI EJECTOR WILL BE INSTALLED AT THE WELL. THE VACUUM AT THE VENTURI WILL BE PRODUCED BY WATER RECIRCULATED THROUGH THE OIL/WATER SEPARATOR TANK.



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PHASE 1
PROPOSED EXTRACTION WELL LOCATIONS
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON

FIGURE:
7

JOB#: 016.08480.500 APPR: SRH DWN: SRH DATE: 5/16/00

F:/FILES/PORTLAND/

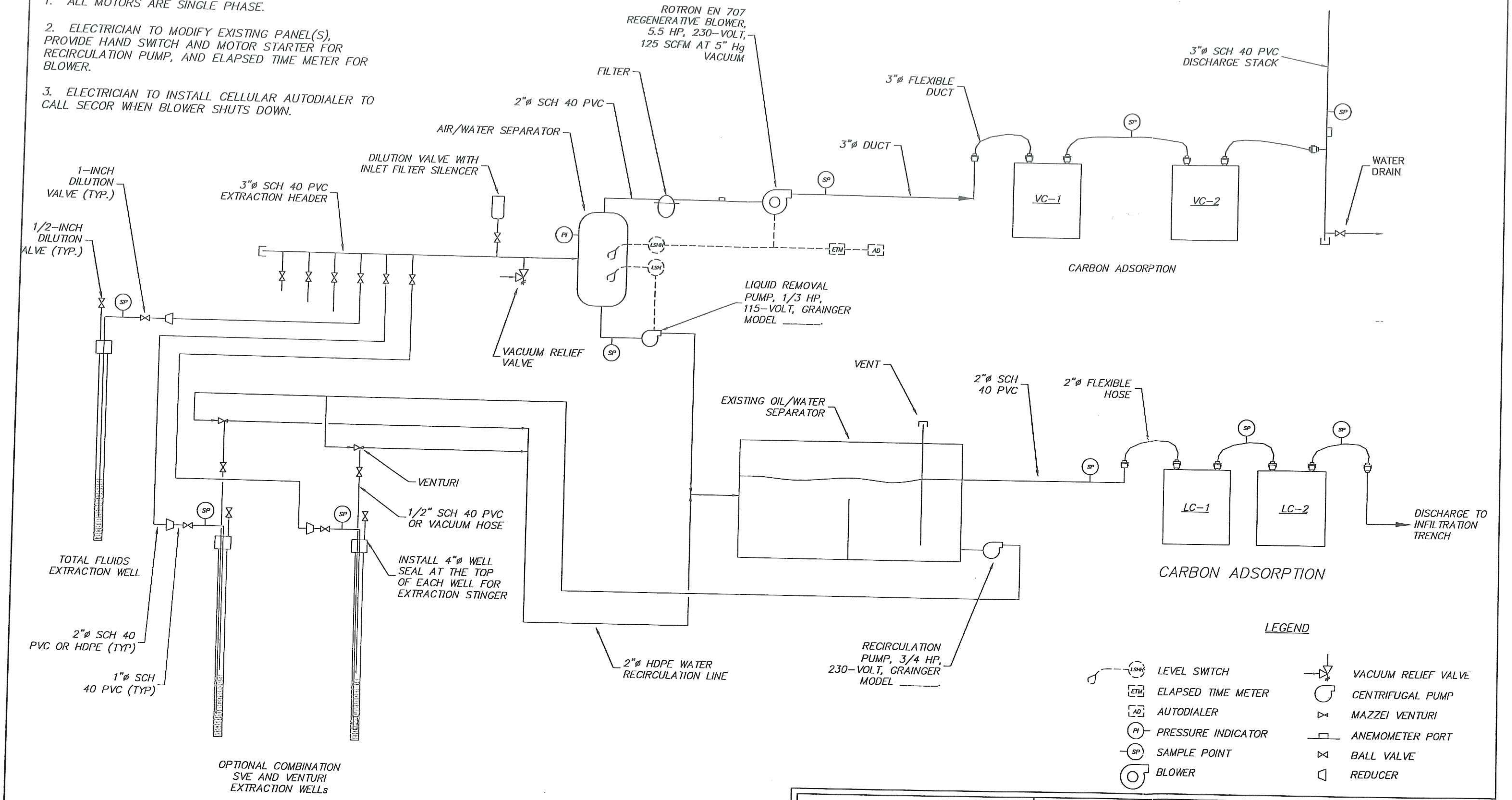
DWG: 15-8480-505.DWG

NOTES:

1. ALL MOTORS ARE SINGLE PHASE.

2. ELECTRICIAN TO MODIFY EXISTING PANEL(S), PROVIDE HAND SWITCH AND MOTOR STARTER FOR RECIRCULATION PUMP, AND ELAPSED TIME METER FOR BLOWER.

3. ELECTRICIAN TO INSTALL CELLULAR AUTODIALER TO CALL SECOR WHEN BLOWER SHUTS DOWN.



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PROPOSED PROCESS AND INSTRUMENTATION DIAGRAM
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON

FIGURE:
8

JOB#: **015.08480.500** APPR: SRH DWN: **SRH** DATE: **04/12/00**

F:/FILES/PORTLAND/CROWLEY

DWG: 15-8480-507.DWG

APPENDIX A
HISTORIC GROUNDWATER DATA

Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	TPH-G (mg/L)	TPH-D (mg/L)		BTEX (µg/L)				HVOCs (µg/L)	PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
			Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes					
MW-1	11/08/1983	--	--	--	<20	<20	<20	--	--	--	--	--	--
31.66	12/13/1984	--	--	--	<5	<5	<5	<5	--	--	--	--	--
	11/13/1995	<0.08	12	<5.0	<0.50	<0.50	<0.50	<0.50	ND	ND	9.19	0.00	22.47
	08/01/1996	--	--	--	--	--	--	--	--	--	10.23	0.00	21.43
	10/30/1997	--	--	--	--	--	--	--	--	--	9.54	0.00	22.12
	10/29/1998	0.233	5.43	1.23	<0.50	<0.50	<0.50	<1.0	--	--	12.26	0.00	19.40
	05/07/1999	--	--	--	--	--	--	--	--	--	9.51	0.00	22.15
31.69	10/14/1999	--	10.4	2.85	--	--	--	--	--	--	12.39	0.00	19.30
MW-2	11/08/1983	--	--	--	510	450	100	770	--	--	--	--	--
33.97	02/05/1986	--	--	--	69	390	110	900	--	--	--	--	--
	08/28/1990	<0.05	26.4	--	<100	<100	<100	566	--	--	--	--	--
	08/02/1994	3.1	10	--	6.3	3	35	110	--	ND	--	--	--
	11/13/1995	4	40	7.4	1.7	2.3	22	110	--	--	12.95	0.00	21.02
	08/01/1996	<0.08	4.7	--	2.3	1	20	44	--	--	13.75	0.00	20.22
	10/30/1997	--	--	--	--	--	--	--	--	--	13.55	0.00	20.42
	10/29/1998	3.22	9.03	<2.50	<0.50	0.641	<0.50	6.21	--	--	14.92	0.00	19.05
	05/07/1999	--	--	--	--	--	--	--	--	--	12.79	0.00	21.18
33.98	10/14/1999	--	9.06	3.46	--	--	--	--	--	--	15.06	0.00	18.92
MW- 3	11/08/1983	--	--	--	95	64	15	90	--	--	--	--	--
30.90	12/17/1984	--	--	--	<1	<1	<1	--	--	--	--	--	--
	11/13/1995	0.29	4.6	<5.0	<0.50	<0.50	<0.50	<0.50	--	--	11.24	0.00	19.66
	08/01/1996	--	--	--	--	--	--	--	--	--	11.11	0.00	19.79
	10/30/1997	--	--	--	--	--	--	--	--	--	11.23	0.00	19.67
	10/30/1998	0.28	11.4	4.1	<0.50	1.55	<0.50	<1.0	--	--	12.28	0.00	18.62
	05/07/1999	--	--	--	--	--	--	--	--	--	9.98	0.00	20.92
30.96	10/14/1999	--	15.5	4.89	--	--	--	--	--	--	12.33	0.00	18.63

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Sample Location/ TOC Elevation (feet)	Sample Date	TPH-G (mg/L)	TPH-D (mg/L)		BTEX (µg/L)				HVOCs (µg/L)	PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
			Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes					
MW-4	11/08/1983	--	--	--	700	150	110	800	--	--	--	--	--
28.42	12/12/1984	--	--	--	<1	<1	<1	<1	--	--	--	--	--
	11/13/1995	0.39	7.8	<5.0	3	1.4	1.1	6.7	--	--	8.27	0.00	20.15
	08/01/1996	0.38	11	--	1.6	5	<0.50	<1.0	--	--	8.40	0.00	20.02
	10/30/1997	--	--	--	--	--	--	--	--	--	8.45	0.00	19.97
	10/29/1998	1.12	11.2	2.92	<0.50	1	<0.50	<1.0	--	--	9.65	0.00	18.77
	05/07/1999	--	--	--	--	--	--	--	--	--	7.26	0.00	21.16
28.64	10/14/1999	--	17.2	5.18	--	--	--	--	--	--	9.74	0.00	18.90
MW-5	11/08/1983	--	--	--	35	<2	<2	--	--	--	--	--	--
23.37	12/17/1984	--	--	--	<20	380	<20	--	--	--	--	--	--
	11/13/1995	<0.08	2.6	0.77	<0.50	<0.50	<0.50	<0.50	--	--	3.07	0.00	20.30
	08/01/1996	--	--	--	--	--	--	--	--	--	3.60	0.00	19.77
	10/29/1998	--	--	--	--	--	--	--	--	--	--	--	--
	05/07/1999	--	--	--	--	--	--	--	--	--	2.45	0.00	20.92
23.38	10/14/1999	--	2.38	0.68	--	--	--	--	--	--	4.85	0.00	18.53
MW-6	12/12/1984	--	--	--	<1	<1	<1	<1	--	--	--	--	--
26.14	11/13/1995	0.74	48	<5.0	<0.50	<0.50	<0.50	<0.50	--	--	5.23	0.00	20.91
	08/01/1996	--	--	--	--	--	--	--	--	--	5.50	0.00	20.64
	10/30/1998	<0.08	27	6.79	<0.50	<0.50	<0.50	<1.0	--	--	5.44	0.00	20.70
	05/07/1999	--	--	--	--	--	--	--	--	--	3.18	0.00	22.96
24.76	10/14/1999	--	19.7	2.81	--	--	--	--	--	--	5.41	0.00	19.35

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Sample Location/ TOC Elevation (feet)	Sample Date	TPH-G (mg/L)	TPH-D (mg/L)		BTEX (µg/L)				HVOCs (µg/L)	PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
			Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes					
MW-7	11/08/1983	--	--	--	<20	<20	<20	--	--	--	--	--	--
33.36	08/02/1994	1.6	7.7	--	<2.5	<2.5	<2.5	<2.5	--	ND	--	--	--
	11/13/1995	1.8	43	<5.0	1.6	1.2	<1.0	<1.0	--	--	12.54	0.00	20.82
	08/01/1996	--	--	--	--	--	--	--	--	--	13.55	0.62	20.31
	10/30/1997	--	--	--	--	--	--	--	--	--	13.24	0.17	20.26
	10/30/1998	DET[a]	DET	ND	--	--	--	--	--	--	14.51	0.07	18.91
	05/07/1999	--	--	--	--	--	--	--	--	--	11.82	0.02	21.56
	08/24/1999	--	35.8	<10	--	--	--	--	DET/ND[b]	--	--	--	--
With Silica Gel Cleanup		--	28.9	<5.0	--	--	--	--	--	--	--	--	--
33.40	10/14/1999	--	25.8	3.95	--	--	--	--	--	--	14.70	0.00	18.70
MW-8	11/08/1983	--	--	--	208	<2	<2	--	--	--	--	--	--
33.49	11/13/1995	5.4	490	41	2	1.5	1.9	5	--	--	12.90	0.50	20.99
	08/01/1996	--	--	--	--	--	--	--	--	--	12.98	0.15	20.63
	10/30/1997	--	--	--	--	--	--	--	--	--	13.20	0.21	20.46
	10/30/1998	DET[a]	DET	DET	--	--	--	--	--	--	14.94	0.14	18.66
	05/07/1999	--	--	--	--	--	--	--	--	--	12.05	0.37	21.74
33.53	10/14/1999	--	19.5	2.4	--	--	--	--	--	--	15.31	0.18	18.36
MW-9	12/13/1984	--	--	--	<1	<1	<1	<1	--	--	--	--	--
26.36	11/13/1995	<0.08	0.88	0.63	<0.50	<0.50	<0.50	<0.50	--	--	4.25	0.00	22.11
	08/01/1996	--	--	--	--	--	--	--	--	--	5.81	0.00	20.55
	10/30/1997	--	--	--	--	--	--	--	--	--	1.87	0.00	24.49
	10/30/1998	<0.08	5.76	2.3	<0.50	<0.50	<0.50	<1.0	--	--	6.31	0.00	20.05
	05/07/1999	--	--	--	--	--	--	--	--	--	5.02	0.00	21.34
26.38	10/14/1999	--	4.25	2.33	--	--	--	--	--	--	7.25	0.00	19.13
With Silica Gel Cleanup		--	0.446	0.811	--	--	--	--	--	--	--	--	--

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Sample Location/ TOC Elevation (feet)	Sample Date	TPH-G (mg/L)	TPH-D (mg/L)		BTEX (µg/L)				HVOCs (µg/L)	PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
			Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes					
MW-10	11/13/1995	0.76	<0.25	<5.0	1.1	1	1.2	1.5	--	--	5.09	0.00	20.80
25.89	08/01/1996	--	--	--	--	--	--	--	--	--	5.62	0.00	20.27
	10/30/1997	--	--	--	--	--	--	--	--	--	5.64	0.00	20.25
	10/30/1998	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	05/07/1999	--	--	--	--	--	--	--	--	--	4.53	0.00	21.36
25.92	10/14/1999	--	--	--	--	--	--	--	--	--	6.81	0.00	19.11
MW-11	12/17/1984	--	--	--	<1	<1	<1	--	--	--	--	--	--
25.89	08/02/1994	<0.20	<0.50	--	<0.50	<0.50	<0.50	1	--	ND	--	--	--
	11/13/1995	<0.08	11	<5.0	<0.50	<0.50	<0.50	<0.50	--	--	6.57	0.00	19.32
	08/01/1996	--	--	--	--	--	--	--	--	--	6.71	0.00	19.18
	10/30/1997	--	--	--	--	--	--	--	--	--	6.75	0.00	19.14
	10/29/1998	<0.08	3.16	0.7	<0.50	<0.50	<0.50	<1.0	--	--	8.12	0.00	17.77
	05/07/1999	--	--	--	--	--	--	--	--	--	5.49	0.00	20.40
25.90	10/14/1999	--	3.16	<0.50	--	--	--	--	--	--	8.12	0.00	17.78
With Silica Gel Cleanup		--	<0.25	<0.50	--	--	--	--	--	--	--	--	--
MW-12	12/18/1984	--	--	--	<1	<1	<1	--	--	--	--	--	--
28.17	11/13/1995	<0.08	<0.25	<0.50	<0.50	<0.50	<0.50	<0.50	--	--	6.07	0.00	22.10
	08/01/1996	<0.08	<0.25	--	<0.50	<0.50	<0.50	<1	--	--	7.15	0.00	21.02
	10/30/1997	--	--	--	--	--	--	--	--	--	6.61	0.00	21.56
	10/29/1998	<0.08	<0.25	<0.50	<0.50	<0.50	<0.50	<1.0	--	--	8.01	0.00	20.16
	05/07/1999	--	--	--	--	--	--	--	--	--	6.36	0.00	21.81
28.28	10/14/1999	--	<0.25	<0.50	--	--	--	--	--	--	8.34	0.00	19.94

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Sample Location/ TOC Elevation (feet)	Sample Date	TPH-G (mg/L)	TPH-D (mg/L)		BTEX (µg/L)				HVOCs (µg/L)	PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
			Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes					
MW-13	12/19/1984	--	--	--	<1	<1	<1	<2	--	--	--	--	--
22.78	02/05/1986	--	--	--	<1	<1	<1	<2	--	--	--	--	--
	08/28/1990	<0.05	<0.05	--	<100	<100	<100	<100	--	--	--	--	--
	08/02/1994	<0.20	1.2	--	<0.50	<0.50	<0.50	<0.50	--	ND	--	--	--
	11/13/1995	<0.08	1.4	<0.50	<0.50	<0.50	<0.50	<0.50	--	--	10.60	0.00	12.18
	08/01/1996	<0.08	0.9	--	<0.50	<0.50	<0.50	<1	--	--	10.70	0.00	12.08
	10/30/1997	<0.08	1.53	0.75	<0.50	<0.50	<0.50	<1	--	--	10.48	0.00	12.30
	10/29/1998	--	--	--	--	--	--	--	--	--	--	--	--
	05/07/1999	--	--	--	--	--	--	--	--	--	9.60	0.00	13.18
22.75	10/14/1999	--	1.5	0.854	--	--	--	--	--	--	11.19	0.00	11.56
With Silica Gel Cleanup		--	<0.25	<0.50	--	--	--	--	--	--	--	--	--
MW-14	12/19/1984	--	--	--	<1	<1	<1	--	--	--	--	--	--
26.25	11/13/1995	<0.08	1	<0.50	<0.50	<0.50	<0.50	<0.50	--	--	8.08	0.00	18.17
	08/01/1996	<0.08	1.8	--	<0.50	<0.50	<0.50	<1	--	--	9.15	0.00	17.10
	10/30/1997	<0.08	<0.25	<0.50	<0.50	<0.50	<0.50	<1	--	--	8.89	0.00	17.36
	10/29/1998	--	--	--	--	--	--	--	--	--	--	--	--
	05/07/1999	--	--	--	--	--	--	--	--	--	8.03	0.00	18.22
26.28	10/14/1999	--	3.82	1.81	--	--	--	--	--	--	11.73	0.00	14.55
With Silica Gel Cleanup		--	<0.25	<0.50	--	--	--	--	--	--	--	--	--
MW-15	02/05/1986	--	--	--	<1	<1	<1	<2	--	--	--	--	--
26.24	08/02/1994	<0.20	<0.50	--	<0.50	<0.50	<0.50	<0.50	--	ND	--	--	--
	11/13/1995	--	--	--	--	--	--	--	--	--	--	--	--
	08/01/1996	--	--	--	--	--	--	--	--	--	--	--	--
	05/07/1999	--	--	--	--	--	--	--	--	--	--	--	--
	10/14/1999	--	--	--	--	--	--	--	--	--	--	--	--

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Sample Location/ TOC Elevation (feet)	Sample Date	TPH-G (mg/L)	TPH-D (mg/L)		BTEX (µg/L)				HVOCs (µg/L)	PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
			Diesel	Heavy Oil	Benzene	Toluene	Ethyl- benzene	Total Xylenes					
MW-16	02/05/1986	--	--	--	93	<10	<10	240	--	--	--	--	--
31.13	08/28/1990	1	4.91	--	<100	<100	<100	445	--	--	--	--	--
	08/02/1994	1.1^c	11^c	--	2.0^c	0.73^c	0.74^c	4.8^c	--	11^c	--	--	--
	11/13/1995	0.9	10	2.1	1	1.3	53	8	--	--	9.94	0.00	21.19
	08/01/2009	0.74	<0.50	--	<0.50	2.2	<0.50	3	--	--	10.36	0.00	20.77
	10/30/1997	1.22	9.01	2.7	<0.50	<0.50	7.86	4	--	--	10.26	0.00	20.87
	10/29/1998	0.482	11.6	2.59	<0.50	3.73	<0.50	<1.0	--	--	11.43	0.00	19.70
	05/07/1999	--	--	--	--	--	--	--	--	--	9.33	0.00	21.80
	08/24/1999	--	9.9	2.13	--	--	--	--	--	--	--	--	--
With Silica Gel Cleanup		--	0.842	<0.50	--	--	--	--	--	--	--	--	--
29.67	10/14/1999	--	12.3	2.65	--	--	--	--	--	--	11.50	0.00	18.17
With Silica Gel Cleanup		--	1.19	<0.50	--	--	--	--	--	--	--	--	--
MW-17	02/05/1986	--	--	--	<1	<1	<1	<2	--	--	--	--	--
33.94	11/13/1995	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	08/01/1996	--	--	--	--	--	--	--	--	--	14.62	0.00	19.32
	10/30/1997	--	--	--	--	--	--	--	--	--	15.61	0.00	18.33
	10/29/1998	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	05/07/1999	--	--	--	--	--	--	--	--	--	13.42	0.00	20.52
33.97	10/14/1999	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY
MW-18	11/13/1995	<0.08	4.9	2.1	<0.50	<0.50	<0.50	<0.50	--	--	8.47	0.00	24.72
33.19	08/01/1996	<0.08	9.6	--	<0.50	1.1	0.82	<1.0	--	--	9.96	0.00	23.23
	10/30/1997	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	10/29/1998	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	05/07/1999	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY
33.24	10/14/1999	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY

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Sample Location/ TOC Elevation (feet)	Sample Date	TPH-G (mg/L)	TPH-D (mg/L)		BTEX (µg/L)				HVOCs (µg/L)	PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
			Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes					
MW-19	12/05/1986	--	--	--	140	<10	30	<20	--	--	--	--	--
33.67	08/28/1990	<0.05	35.2	--	<100	<100	<100	<100	--	--	--	--	--
	11/13/1995	4.3	69	<25	<2.5	<2.5	<2.5	<2.5	--	--	14.77	0.00	18.90
	08/01/1996	--	--	--	--	--	--	--	--	--	14.24	0.00	19.43
	10/30/1997	2.86	21.6	3.18	<0.50	<0.50	<0.50	1.45	--	--	14.47	0.00	19.20
	10/30/1998	DET^a	DET	DET	--	--	--	--	--	--	16.11	0.75	18.16
	05/07/1999	--	--	--	--	--	--	--	--	--	12.95	0.00	20.72
33.72	10/14/1999	--	35	4.28	--	--	--	--	--	--	15.43	0.02	18.31
With Silica Gel Cleanup		--	5.28	<0.50	--	--	--	--	--	--	--	--	--
MW-20	02/05/1986	--	--	--	<1	<1	<1	<2	--	--	--	--	--
30.36	11/13/1995	<0.08	0.87	0.73	<0.50	<0.50	<0.50	<0.50	ND	--	21.99	0.00	8.37
	08/01/1996	--	--	--	--	--	--	--	--	--	22.66	0.00	7.70
	10/30/1997	--	--	--	--	--	--	--	--	--	23.72	0.00	6.64
	10/30/1998	<0.08	<0.25	<0.50	<0.50	<0.50	<0.50	<1.0	--	--	27.70	0.00	2.66
	05/07/1999	--	--	--	--	--	--	--	--	--	19.30	0.00	11.06
	Well Abandoned 09/09/99.												
MW-21	02/05/1986	--	--	--	<1	<1	<1	<2	--	--	--	--	--
30.06	11/13/1995	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	08/01/1996	--	--	--	--	--	--	--	--	--	10.65	0.00	19.41
	10/30/1997	--	--	--	--	--	--	--	--	--	11.50	0.00	18.56
	10/29/1998	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	05/07/1999	--	--	--	--	--	--	--	--	--	9.57	0.00	20.49
30.08	10/14/1999	--	--	--	--	--	--	--	--	--	DRY	DRY	DRY
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

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			Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes					
EX-1 32.30	11/13/1995	--	--	--	--	--	--	--	--	--	14.72	0.00	17.58
EX-2 33.53	02/03/1996	5.3	13	2.5	1.4	1.3	0.54	2.4	--	--	--	--	--
PMX-5 26.70	08/02/1994	<0.2	1.3	--	<0.5	<0.5	<0.5	<0.5	--	ND	--	--	--
MTCA Method A Cleanup Levels		1	1		5	40	30	20	Various	0.1^d			

TOC = Top of casing elevation relative to assigned benchmark.
TPH-G = Total petroleum hydrocarbons as gasoline analysis by Washington DOE Method WTPH-G; results in milligrams per liter (mg/L).
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; results in mg/L.
BTEX = Benzene, toluene, ethylbenzene, and total xylene analysis by EPA Method 8020; results in micrograms per liter (µg/L).
HVOCs = Halogenated volatile organic compound analysis by EPA Method 8010/8260B; results in µg/L.
PAHs = Polynuclear aromatic hydrocarbon analysis by EPA Method 8310; results in µg/L.
DTW = Depth to water below top of casing.
LHT = Liquid hydrocarbon thickness.
WTE = Water table elevation.
-- = Not measured, not analyzed, or not sampled.
ND = Not detected above laboratory method reporting limit (MRL).
a = Detected (DET) hydrocarbons in gasoline range appear to be due to overlap of diesel-range hydrocarbons.
b = Isopropylbenzene was detected 8.18 µg/L, and n-Propylbenzene was detected at 10.9 µg/L. All other HVOCs were ND.
c = Results include higher of 08/02/94 MW-16 or blind duplicate listed as "MW-30." Fluorene was detected at 11 µg/L in MW-30; all other PAH results were below laboratory MRLs.
d = Model Toxics Control Act (MTCA) Method A cleanup level for carcinogenic PAHs.

Analytical methods prior to 1995 include Hydrocarbon Scan by EPA Methods 3510/Modified 8015, and Oil and Grease by EPA Method 413.1.
Note: Water elevation corrected if liquid hydrocarbon present; corrected water level elevation = TOC - DTW + (LHT x 0.8).