Terminal 91 Tank Farm Site
Feasibility Study
Cleanup Levels

Prepared For:

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ACRONYMS AND ABBREVIATIONS

Acronym	Explanation
ACR	Acute/Chronic Ratio
API	Asian Pacific Islander
AQUIRE	Aquatic Toxicity Information Retrieval
BDR1	Terminal 91 Bridge Document Report 1
CF	Conversion Factor
COPC	Constituents of Potential Concern
CSM	Conceptual Site Model
C_w	Cleanup Level in Water Based on Protection of Sediment
DF	Dilution Factor
Ecology	Washington State Department of Ecology
ECOTOX	Ecotoxicology Database (USEPA)
FAV	Final Acute Value
FCV	Final Chronic Value
foc	Fraction Organic Compound
FS	Feasibility Study
H_{cc}	Henry's Law Constant
HEAST	Health Effects Assessment Summary Table
HQ	Hazard Quotient
IHS	Indicator Hazardous Substances
IQR	Interquartile Range
IRIS	Integrated Risk Information System
K_d	Sediment-Water Partitioning Coefficient
LNAPL	Light Non-Aqueous Phase Liquid
Memo	Memorandum
MTCA	Model Toxics Control Act
NCEA	National Center for Environmental Assessment
ORNL	Oak Ridge National Laboratory
PIONEER	PIONEER Technologies Corporation
Port	Port of Seattle
PQL	Practical Quantitation Limit
PSC	Philip Services Corporation
RAIS	Risk Assessment Information System
RSSL	Residual Soil Saturation Level
Site	Tank Farm Site
SMS	Washington State Sediment Management Standards
SQS	Washington State Sediment Quality Standards (WAC 173-204)
T-91	Terminal 91

ACRONYMS AND ABBREVIATIONS

Acronym	Explanation
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
WAC	Washington Administrative Code

T-91 FEASIBILITY STUDY CLEANUP LEVELS

1.1 Introduction

This memorandum (memo) presents cleanup levels for the Port of Seattle's (Port) Terminal 91 (T-91) Tank Farm Site (Site) that were calculated in accordance with the Feasibility Study (FS) Work Plan[1] (PES et al., 2005), which was approved by the Washington State Department of Ecology (Ecology) (Ecology, 2005). The Site is defined in Agreed Order DE 98HW-N108 as the Tank Farm Lease Parcel and areas where releases of constituents originating from the Tank Farm Lease Parcel operations have come to be located.

The Tank Farm Lease Parcel formerly consisted of three tank yards and associated buildings, and it covers approximately four acres within the T-91 Complex. The T-91 Complex is located along the shore of Elliott Bay at 2001 West Garfield Street in Seattle, Washington, and encompasses approximately 216 acres including adjacent marine waters and upland areas. The tank yards and associated buildings were demolished in 2005, and the Site was paved following demolition activities. The Tank Farm Lease Parcel formerly operated as a dangerous waste treatment and storage facility and as a petroleum terminal. A Site Plan showing the former tank farm features is presented in Figure 1.

This memo is organized as follows:

- **Section 1.2** – Development of Cleanup Standards
- **Section 1.3** – Conceptual Site Model (CSM)
- **Section 1.4** – Identification of Indicator Hazardous Substances
- **Section 1.5** – Calculation of Cleanup Levels

1.2 Development of Cleanup Standards

This section presents the approach for developing cleanup standards for the Site per the requirements of the Model Toxics Control Act (MTCA) Cleanup Regulation Washington Administrative Code (WAC) (WAC 173-340). Cleanup standards, as explained in WAC 173-340-700 (3), consist of the following:

a) Cleanup levels for hazardous substances present at the Site;

b) The location where these cleanup levels must be met (i.e., the point of compliance); and

c) Other regulatory requirements that apply to the Site because of the type of action and/or location of the Site (i.e., applicable state and federal laws).

This memo only addresses item a), cleanup levels for hazardous substances present at the Site. Items b)

[1] This memo also incorporates the results of informal discussions/communications with Ecology regarding the April 2006 Draft Terminal 91 Tank Farm Site Feasibility Study Cleanup Levels Memo (PIONEER Technologies Corporation [PIONEER], 2006). Ecology's informal comments were developed by Damon Delistraty of Ecology and submitted to Galen Tritt of Ecology in a memorandum dated May 26, 2006. Representatives of Ecology, the Port, and the Port's contractors discussed Ecology's comments during multiple conference calls and the results of those discussions are included in this document.

and c) will be integrated with item a) in the FS.

1.3 Conceptual Site Model

The CSM for the Site was presented in Bridge Document Report 1 (BDR1) (Roth Consulting, 2001). Figure 2 presents an updated version of that CSM, as presented in the FS Work Plan, based on current known and planned future Site conditions. Each of the potentially-complete exposure pathways is summarized below. More detailed descriptions of these pathways are presented in BDR1 (Roth Consulting, 2001).

1.3.1 Screening of Soil-Based Exposure Pathways

Based on work performed as part of the Bridge Documents (Roth Consulting, 2001), three potentially complete exposure pathways related to soil were identified: (1) direct contact with soil by utility or construction workers, (2) soil to indoor air, and (3) soil to groundwater (which ultimately may impact aquatic receptors). These pathways were addressed using the following approaches:

Direct Contact with Soil Pathway – Direct soil contact by workers (or trespassers) was not retained as a pathway of concern for the Site because soils are currently covered by pavement or buildings. If any future excavation or underground utility work takes place, workers could potentially be exposed to soil, and direct contact with soil would become a pathway of concern. However, institutional controls and standard worker health and safety procedures will be implemented and should provide adequate protection.

Soil to Indoor Air Pathway – This pathway is currently only potentially applicable at the Site and possibly in areas immediately adjacent to the Site. The FS will identify the boundaries of the area where this pathway is a potential concern based on the available soil data. Previous studies (Soil Vapor Technical Memorandum No. 2 dated June 2003 by Philip Services Corporation [PSC], and Soil Vapor Evaluation Terminal 91: Building M-28, dated September 2004 by PIONEER Technologies Corporation [PIONEER]) have documented that there are no unacceptable current[1] risks. Ecology concurred with the determination of no unacceptable current risks in its letter to the Port dated June 16, 2005. The only potential-future exposures via this pathway would result from Site development activities. The approach for addressing these potential-future exposures will be to implement institutional controls, such as notices on parcel deeds of the potentially-impacted properties, which would require either:

(1) including engineering controls (e.g., vapor barriers, sub-slab venting systems) in Site development plans to mitigate the potential exposure; or

(2) conducting a development-specific evaluation of the soil to indoor air pathway (i.e., develop risk-based cleanup levels for the specific-potential exposures related to the proposed development). If concentrations of indicator hazardous substances (IHSs) exceed the cleanup levels developed under the second option, appropriate supplemental remedial actions will be

[1] Currently there are no unacceptable risks associated with this pathway. However, there is a possibility that the situation may change with future exposures. These future exposures will be managed, if necessary, via institutional/engineering controls.

evaluated and implemented as part of Site development activities. Engineering controls may also be implemented, as appropriate. Calculating cleanup levels at the time of development, if that is the response that is chosen, would allow for the specific location (e.g., northeast corner of the tank farm), nature of the development (e.g., industrial or commercial), and building-specific factors (e.g., slab-on-grade warehouse, ground-level parking) to be accounted for in the cleanup level calculations.

Soil to Groundwater Pathway – As with the soil to indoor air pathway, the soil to groundwater pathway is only potentially applicable to the Site and immediately adjacent areas. This area generally coincides with areas where light non-aqueous phase liquid (LNAPL) have been observed and generally correspond with associated elevated concentrations of constituents of potential concern (COPCs) in groundwater. The FS will address the LNAPL and residual groundwater contamination through evaluation of LNAPL recovery approaches and development of groundwater cleanup levels.

The soil to groundwater pathway will be evaluated empirically in the FS consistent with the requirements of WAC 173-340-747 (see the discussion of residual soil saturation levels [RSSLs] below). If groundwater concentrations are below cleanup levels at the point of compliance or conditional point of compliance, then by definition, the concentrations of IHSs in soil are not causing exceedances of groundwater cleanup levels[1]. Conversely, if groundwater concentrations at the point of compliance exceed cleanup levels, then soil to groundwater cleanup levels will be developed for those constituents at that time.

Soil erosion was not retained as a pathway of concern for the Site because of the extensive paving and coverage by buildings. Stormwater is either discharged to the sanitary sewer or collected in catch basins and discharged via storm drains, which further limits erosion from the Site. This pathway represents a minimum risk, and will not be addressed as part of the FS. As documented in the BDR1 (Roth Consulting, 2001), this Site qualifies for exclusion from a terrestrial ecological evaluation under WAC 173-340-7491(1)(c)(i) and, therefore, terrestrial ecological receptors will not be addressed in the FS. Although the ponding in the short-fill impoundment may offer some limited habitat value (primarily loafing for overwintering or migratory waterfowl), in the short-term, quantification of risks will not be conducted in the FS because the impoundment will be filled or covered. Mitigation for the filling of the pond was addressed as part of the overall mitigation performed for construction of the short fill.

Residual Soil Saturation Levels

As part of the soil-to-groundwater pathway evaluation at the Site, a preliminary range of RSSLs have been developed based on existing site data and empirical evidence consistent with WAC 173-340-747 (9) and (10). The evaluation process included the following steps:

1. Identification of hazardous substances based on historical bulk product handling information and

[1] Soil IHSs may or may not cause future exceedances of groundwater cleanup levels via future leaching to groundwater. However, it should be noted that groundwater has been monitored at this site for over a decade and it is highly unlikely that a significant number of additional constituents will be detected in groundwater at concentrations exceeding CULs as a result of leaching from soil.

documented releases of bulk products. The selected hazardous substances included toluene, gasoline range petroleum hydrocarbons, diesel range petroleum hydrocarbons, and Bunker C (or Fuel Oil No. 6).

2. Compilation of soil physical property data and LNAPL characteristic data to develop preliminary ranges of RSSLs for each selected hazardous substance. Based on site data, the selected soil matrix is described as fine to coarse sand with an average porosity of 0.4 and density of 1.63 g/cm^3.

3. Development of preliminary RSSL ranges for each selected hazardous substance using MTCA four-phase partitioning model spreadsheets for toluene and using published industry references for middle distillate and fuel oil fractions.

Upon completion of these steps, the following preliminary ranges of Site-Specific RSSLs have been developed.

Indicator Hazardous Substance	Preliminary RSSL Range Calculated from Site Data
Toluene	845 mg/kg
Gasoline Range Petroleum Hydrocarbons	3,266 to 5,625 mg/kg
Diesel Range Petroleum Hydrocarbons	7,410 to 14,130 mg/kg
Bunker C (Fuel Oil No. 6)	16,084 to 47,853 mg/kg

Source:

PES Environmental, Inc., 2007. Technical Memorandum and Work Plan Addendum. Data Gaps Investigation. Port of Seattle – Terminal 91 Tank Farm Site and Upland Areas.

These preliminary RSSLs will be reevaluated in the FS based on the results of the Data Gaps Investigation conducted at the Site during 2007 (PES, 2007). This investigation included installation of approximately 93 direct push borings and 11 LNAPL monitoring wells throughout the site, the collection of numerous soil to evaluate the nature of relevant constituents, and monitoring of LNAPL thickness in both existing and newly installed wells.

1.3.2 Screening of Groundwater-Based Exposure Pathways

Based on work performed as part of the Bridge Documents (Roth Consulting, 2001), three potentially-complete exposure pathways related to groundwater were identified: (1) groundwater to indoor air, (2) groundwater to surface water/sediment, and (3) ingestion of groundwater as drinking water. These pathways were addressed using the following approaches:

Groundwater to Indoor Air Pathway – Inhalation of indoor air impacted by vapor intrusion from groundwater does not represent an unacceptable risk to workers at the Site under current conditions (PSC 2001, 2002; PTC 2004). However, this remains a potentially-complete exposure pathway for the Site and may be of concern for future commercial land-use scenarios. Therefore, this pathway was retained for evaluation.

Groundwater to Surface Water/Sediment Pathways – These pathways are the primary pathways of concern for the Site, and will be evaluated in the FS**.** Impacted groundwater from the Site could be released to Elliott Bay via the groundwater to surface water pathway and/or groundwater to sediment pathway and potentially result in exposure to aquatic receptors (i.e., fish or invertebrates) or people consuming seafood collected from the Bay.

Ingestion of Groundwater as Drinking Water Pathway – This is not identified as a pathway of concern for either current or future conditions because groundwater at the Site is not considered potable. The rationale for this determination was presented in BDR1 (Roth Consulting, 2001) and is described below.

- The groundwater does not serve as a current source of drinking water [WAC 173-340-720(2)(a)].

- It is unlikely that hazardous substances originating from the Site will be transported from the contaminated groundwater to groundwater that is a current- or potential-future source of drinking water [WAC 173-340-720(2)(c)].

- There is an extremely low probability that the groundwater will be used for drinking water because of the Site's proximity to surface water that is not suitable as a domestic water supply [WAC 173-340-720(2)(d)]. The Site's groundwater conditions are similar to those at Harbor Island (i.e., shallow groundwater in close proximity to marine waters), which is not considered suitable for drinking water by Ecology WAC 173-340-720(2)(d). The Site also meets the following conditions as specified in WAC 173-340-720(2)(d):
  - There are known or projected points of entry of the groundwater into the surface water [WAC 173-340-720(2)(d)(ii)];
  - The surface water is not classified as a "suitable" domestic water supply source under Chapter 173-201A WAC [WAC 173-340-720(d)(iii)]; and
  - The groundwater is sufficiently hydraulically connected to the surface water so that the groundwater is not practicable to use as a drinking water source [WAC 173-340-720(2)(d)(iv)].

1.3.3 Pathways Associated with Past Impacts to Sediments

An aquatic ecological risk assessment and subsequent development of cleanup levels for sediment may eventually be necessary to evaluate historical releases to sediment through surface water. However, the Port and Ecology have agreed that based on current information, it would not be practicable to address these media under the Agreed Order, and so remedial actions for the submerged lands are being deferred until factors such as source control can be evaluated. Therefore sediment cleanup levels are beyond the scope of this memo.

1.4 Identification of Indicator Hazardous Substances

Cleanup levels were developed for constituents in groundwater that could potentially contribute significantly to human health or ecological risks. Under MTCA, these constituents are considered IHSs. IHSs were identified for the Site according to the guidelines provided in WAC 173-340-703, which allows those constituents that do not contribute significantly to the risk associated with a Site to be eliminated from further consideration in the FS. Constituents that contributed only a small percentage to the risk were identified based on a stepwise process that evaluated:

- The frequency that a specific constituent occurred in groundwater;
- The geographic distribution of detections for that constituent;
- The magnitude of the concentration for that constituent; and
- The constituent's chemical/physical properties (e.g., persistence in the environment, toxicity to humans or aquatic organisms, and the potential to bioaccumulate).

Initially, the frequency of detection for each constituent was calculated for the entire groundwater data set, which was comprised of sampling rounds from 2000 to 2007. Constituents that were never detected were removed from further consideration. Constituents that were detected in less than or equal to five percent of the samples were flagged for potential elimination from further consideration. However, before eliminating a constituent with a low frequency of detection, the locations of the detections were examined. If the detections were geographically clustered (i.e., adjacent to one another), possibly indicating a potential source area, the constituent was retained. High concentrations were identified as concentrations greater than the 75th percentile plus three times the interquartile range (IQR), where the IQR equals the 75th percentile value minus the 25th percentile value (NIST, 2005). Even if the detections were not near one another, they still might be indicative of a source if the concentrations were high. Therefore, constituents that were infrequently detected, but had high concentrations, were retained for further evaluation. If the maximum detected value was greater than the 75th percentile plus three times the IQR, then the constituent was retained for further consideration. Constituents that were detected in more than five percent of the samples were automatically retained as IHSs. See Table 1 for a list of IHSs. Table 2 presents constituents that were not included on the IHS list because of the results of the frequency of detection, IQR, and/or spatial evaluations. Table 3 presents constituents that were not included on the IHS list because they were never detected in groundwater[1].

Methane, nitrate, sulfate, iron, and manganese were also not included as IHSs because they are only being reported to support the Monitored Natural Attenuation Study for the Feasibility Study.

[1] Table 3 presents constituents that have never been detected in groundwater, and does not reflect the possibility of soil contaminants leaching to groundwater in the future that may or may not result in exceedances of groundwater cleanup levels. However, it should be noted that groundwater has been monitored at this site for over a decade and it is highly unlikely that a significant number of additional constituents will be detected in groundwater at concentrations exceeding CULs as a result of leaching from soil.

1.5 Calculation of Cleanup Levels

Cleanup levels were developed for each IHS for the following complete exposure pathways identified in the CSM: (1) groundwater to indoor air, (2) groundwater to surface water, and (3) groundwater to sediment. Groundwater cleanup levels are therefore based on the protection of indoor air, surface water, and sediment quality according to MTCA requirements (WAC 173-340-750, WAC 173-340-730, and WAC 173-204, respectively).

Groundwater cleanup levels were based on the highest beneficial use of groundwater, which was identified as recharge to surface water (Roth Consulting, 2001). As discussed in Section 1.3.2, Site groundwater is not potable and qualifies for consideration of a beneficial use other than drinking water under WAC 173-340-720(2) for the purpose of developing cleanup levels. Discharge of groundwater to surface water must therefore preserve the highest beneficial use of the receiving water (in this case Elliott Bay). The highest beneficial use of Elliott Bay is assumed to be habitat for fish, shellfish, and other aquatic organisms. Cleanup levels must therefore protect aquatic organisms that may be exposed to Site groundwater, and people who may consume seafood from Elliott Bay in the vicinity of the Site.

As described in Section 1.3.1, cleanup levels were not developed for the direct contact with soil, soil to indoor air, and soil to groundwater pathways as part of the FS. These potential pathways are only a concern in primary-source location(s), such as the Tank Farm Lease Parcel, which is generally co-located with areas where LNAPL has been observed. Vapors from the areas of LNAPL will be addressed through development of groundwater to indoor air cleanup levels (Section 1.5.1). Furthermore, as part of the selected cleanup action, the Port intends to require that vapor intrusion mitigation systems be installed for new buildings constructed where LNAPL has been observed, in order to mitigate or eliminate vapor intrusion. If future soil vapor sampling is required, then soil vapor cleanup levels protective of indoor air exposures will be developed and used to evaluate the data. These cleanup levels will be developed, as the groundwater to indoor air cleanup levels were developed for this memo, by first calculating indoor air cleanup levels per WAC 173-340-750. Soil vapor cleanup levels will then be calculated by dividing the indoor air cleanup levels by the appropriate soil vapor to indoor air attenuation factor. The attenuation factors will be calculated using the United States Environmental Protection Agency's (USEPA's) Johnson and Ettinger model or another approach approved by Ecology.

1.5.1 Groundwater Cleanup Levels Based on Protection of Indoor Air

Groundwater cleanup levels that are protective of indoor air quality were calculated to address the groundwater to indoor air pathway. MTCA Method C (WAC 173-340-750 (4)) cleanup levels for indoor air were derived using equations 750-1 (for noncarcinogens) and 750-2 (for carcinogens) from WAC 173-340-750. Groundwater cleanup levels were then calculated by dividing the indoor air cleanup levels by groundwater to indoor air attenuation factors that were developed based on the USEPA's Johnson and Ettinger Model (http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm). The input parameters used to calculate the groundwater cleanup levels based on protection of indoor air are summarized below:

- Exposure parameters, which describe the exposure patterns of the receptors (e.g., exposure frequency, exposure duration, inhalation rate, body weight, and averaging time), are presented in Table 4.

- Johnson and Ettinger vapor intrusion model input parameters are presented in Table 5 and Table 6.

- Toxicity values (i.e., reference doses and carcinogenic potency factors) are presented in Table 7. Per WAC 173-340-708 (7) & (8), toxicity values were obtained from the following sources (listed in order of preference):

    1. Integrated Risk Information System (IRIS) database
    2. Health Effects Assessment Summary Tables (HEAST)
    3. USEPA National Center for Environmental Assessment (NCEA)

A hazard quotient (HQ) of one was used for calculating noncarcinogenic cleanup levels. The target risk used for calculating carcinogenic cleanup levels was 1E-05. Groundwater cleanup levels based on protection of indoor air are presented in Table 10.

1.5.2 Groundwater Cleanup Levels Based on Protection of Surface Water and Sediment

Groundwater cleanup levels were developed to protect people who may consume seafood from Elliott Bay (including Asian Pacific Islander [API] Fisher) in the vicinity of the Site, and aquatic organisms that may be exposed to surface water and sediment in Elliott Bay that may be potentially impacted by groundwater from the Site, in accordance with WAC 173-340-730.

Groundwater cleanup levels can be determined from surface water cleanup levels, assuming no dilution from groundwater to surface water (WAC 173-340-730[6][b]). MTCA Method B cleanup levels for surface water (WAC 173-340-730 [3][b][iii]), based on protection of human health, were derived using equations 730-1 (for noncarcinogens) and 730-2 (for carcinogens) In addition, modified exposure parameters were used for the API Fisher population, per the MTCA Science Advisory Board Meeting, September 2006 (Ecology, 2006). The input parameters used to calculate the groundwater cleanup levels based on protection of surface water (i.e., people who consume seafood) are summarized below:

- Toxicity values are presented in Table 7. The toxicity values were selected using the precedence presented in Section 1.5.1.

- Exposure parameters are presented in Table 8.

- Bioconcentration factors are presented in Table 9.

An HQ of one was used for calculating the noncarcinogenic cleanup levels. The target risk used for calculating carcinogenic cleanup levels was 1E-06. Groundwater cleanup levels developed to protect people who may consume seafood from Elliott Bay are presented in Table 10.

Table 11 presents groundwater cleanup levels (based on the protection of ecological receptors) which were calculated per WAC 173-340-730 (3)(b)(i) and (ii). These cleanup levels were identified based on:

- Washington State Water Quality Standards (WAC 173-201A).
- Federal Ambient Water Quality Criteria (Section 304 CWA).
- National Toxics Rule (40 CFR 131).
- Environmental Effects. Where there were no existing standards or criteria for IHSs, groundwater cleanup levels were derived from concentrations that would likely result in no or minimal adverse effects to aquatic organisms (including benthic invertebrates). The sources that were investigated for effects data included:
    - USEPA's Ecotoxicology (ECOTOX) database. The ECOTOX database compiles information from three effects databases, including AQUIRE (Aquatic Toxicity Information Retrieval).
    - United States Department of Energy's Risk Assessment Information System (RAIS), which includes ecological benchmarks for water and sediment.
    - Oak Ridge National Laboratory (ORNL) ecological benchmarks are compiled from various databases and documents. Several methods, based on USEPA guidance and methods for deriving ambient water quality criteria, are used to develop individual benchmark values for screening contaminants in water at hazardous waste sites.
    - United States Geological Survey (USGS) aquatic toxicity benchmarks for volatile organic chemicals (data drawn from AQUIRE).

The ECOTOX database reports results for a given constituent from numerous studies and endpoints for both marine and freshwater aquatic species. This database was the primary source of effects data for developing groundwater cleanup levels when standards or criteria were not available from Washington State Water Quality Standards (WAC 173-201A), Federal Ambient Water Quality Criteria (Section 304 CWA), or National Toxics Rule (40 CFR 131). The effects data used to derive ecological cleanup levels presented in this memo are presented in Appendix A.

Groundwater cleanup levels based on environmental effects data reported in the ECOTOX database were derived using methods similar to the USEPA's ambient water quality screening levels (i.e., Tier II criteria) (USEPA, 1985). The USEPA uses the relationship between available acute and chronic effects data to derive a risk-based screening level when data are insufficient to develop national effects-based water quality criteria. The basic approach is to calculate the fifth percentile of all the acute effects values for a given constituent across all species, life stages, and endpoints to represent a final acute value (FAV). A final chronic value (FCV) is then calculated from the FAV by dividing it by the Acute/Chronic Ratio (ACR), which is the ratio of the geometric mean of the acute effects concentrations to the geometric mean

of the concentrations associated with chronic responses.

This approach was modified for derivation of the T-91 groundwater cleanup levels to address those constituents with little or no available chronic effects data. Where there were too few data for a given constituent to calculate an ACR, the geometric mean of all ACRs used to derive groundwater cleanup levels for groundwater (i.e., all constituents combined) was used.

Data from the ECOTOX database were screened prior to deriving potential groundwater cleanup levels as follows.

- Initially, all aquatic species were selected from the database; however, protozoans, other microorganisms, amphibians, phytoplankton, and other aquatic plants were ultimately not included because of their lack of association with sediment or, in the case of amphibians, association with marine habitats. In addition, the relevance of protozoans, microorganisms, and plankton to the protection of sediment quality is unknown.
- Then data for endpoints associated with survival, growth, or reproduction were selected from the reported endpoints. Endpoints associated with genetic, enzymatic, physiological, metabolic, or behavioral alterations were not included because the relevance to the protection of aquatic populations is unknown.

All remaining freshwater and marine species and associated endpoints were then combined into one data set for each constituent because there was little difference in the types of effects exhibited, or the range of concentrations associated with those effects between these environments. Combining these data provided a more robust data set for developing potential groundwater cleanup levels. Data for each constituent were sorted to represent either acute or chronic responses according to USEPA guidelines (USEPA, 1999). All test durations less than four days were assumed to represent acute effects for any species. Data were considered to represent chronic conditions for invertebrates when the test duration was greater than four days for invertebrates and 14 days for fish (the subchronic definition was included in chronic response). The reported data were converted to the same units (ug/L) to ensure data comparability. Where only the minimum and maximum effects data were reported, the geometric mean of the minimum and maximum value was calculated.

With the exception of USEPA-lead studies, which were assumed to be of high quality, the effects data set available for each constituent was also statistically evaluated to identify unusual or extreme values, which were identified as values exceeding the 75^{th} percentile plus three times the IQR. The original study cited for the extreme values was examined to determine the applicability (actual endpoint measured, constituent form, methodology, etc.) of the data for use in deriving a cleanup level. If test results were not appropriate or the documentation was not available, data were omitted from the final data set. Concentrations that exceeded the solubility limit for a given constituent were also excluded from the final data set.

If the ECOTOX database did not contain any effects data associated with survival, growth, or reproduction (or only one or two studies were available), then screening levels derived by RAIS, ORNL, or USGS were used. Where there were no existing standards or water quality effects screening levels,

groundwater cleanup levels were calculated from the Washington State Sediment Management Standards (SMS) Sediment Quality Standards (SQS) (WAC 173-204), assuming partitioning between sediment and water.

The SQS represent concentrations in sediment that result in no adverse effects to benthic invertebrates and are assumed to represent no significant health risks to water column organisms. Cleanup levels for groundwater were calculated from these standards, which are considered protective of aquatic organisms, using Equation 747-1 in WAC 173-340-747. The following input parameters were used in the calculations.

Non Organic Carbon Normalized SQS: $C_w = SQS / \{ [Kd + (\theta_w / \rho b)] * DF * CF \}$

Organic Carbon Normalized SQS: $C_w = (SQS * foc) / \{ [(K_{oc} * foc) + (\theta_w / \rho_b)] * DF * CF \}$

Parameter	Value	Rationale
C_w = Cleanup Level in Water Based on Protection of Sediment (ug/L)	--	Constituent-specific value calculated using equation 747-1 (above).
SQS[1] = Sediment Quality Standard (mg/kg)	--	Constituent-specific value from WAC 173-204.
K_d = Sediment-Water Partitioning Coefficient (L/kg sediment)	--	Constituent-specific value – See Table 9 in the February 2008 Terminal 91 Tank Farm Site Feasibility Study Cleanup Levels Memo.
K_{oc} = Sediment Organic Carbon-Water Partitioning Coefficient (L/kg organic carbon)	--	Constituent-specific value – See Table 9 in the February 2008 Terminal 91 Tank Farm Site Feasibility Study Cleanup Levels Memo.
foc = Fraction Organic Carbon (g organic carbon/g sediment)	0.01	This value was identified in Ecology's March 26, 2006 Informal Comment (#16) on the April 2006 Draft Terminal 91 Tank Farm Site Feasibility Study Cleanup Levels Memo.
θ_w = Water-Filled Sediment Porosity (ml water/ml sediment)	0.8	This value was suggested in Ecology's March 26, 2006 Informal Comment (#12) on the April 2006 Draft Terminal 91 Tank Farm Site Feasibility Study Cleanup Levels Memo.
ρ_b = Dry Sediment Bulk Density (kg sediment/L sediment)	1.3	This value was suggested in Ecology's March 26, 2006 Informal Comment (#12) on the April 2006 Draft Terminal 91 Tank Farm Site Feasibility Study Cleanup Levels Memo.
DF = Dilution Factor (unitless)	1	MTCA Default Per Equation 747-1 in WAC 173-340-747 and footnotes for Saturated Conditions.
CF = Conversion Factor (mg/ug)	0.001	Conversion factor for micrograms to milligrams.

Note: θ_a = Air-Filled Sediment Porosity (ml air/ml sediment) is assumed to be 0 for saturated conditions in the sediment.
In instances where the K_d was not available it was calculated via the following equation: $K_d = K_{oc} * foc$.
[1] Units for non organic carbon (OC) normalized SQS = mg/kg sediment. Units for OC normalized SQS = mg/kg sediment OC.

Potential cleanup levels resulting from the process described in Section 1.5.2 are reported in Table 11. Existing water quality standards and criteria are compiled in this table, along with the effects-based levels derived from the ECOTOX database or other effects compilations for aquatic organisms.

Uncertainties in Deriving Cleanup Levels Protective of Ecological Receptors from the Literature

While state water quality standards and national water quality criteria have met rigorous scientific and regulatory thresholds prior to promulgation or publication, the remaining effects levels proposed as cleanup levels have a high degree of uncertainty associated with them. AWQC have not been developed

for a number of IHSs because there are too few studies meeting all of the requirements of the AWQC derivation process (e.g., number of taxonomic groups, endpoints, data quality, etc). Numerous studies retrieved from the ECOTOX database reported effects and calculated LC50s and other thresholds based on nominal concentrations, leaving the actual exposure concentration unquantified. Given the volatile nature of many of the IHSs, loss of the chemical during the experiment would be expected due to volatilization, although most researchers did not appear to investigate or quantify the rate of loss. In the few studies that did address this issue, losses of 50 to 90 percent were reported. Thus, the reported concentrations for many volatile constituents likely over-estimate the actual exposure concentration.

Derivation of a cleanup level for groundwater from the SMS is also uncertain. No site-specific data regarding sediment characteristics (e.g., total organic carbon or sediment density or porosity) are available. Partitioning coefficients reported in the literature tend to inaccurately predict the actual partitioning between sediment and water in an aquatic ecosystem, in part, because the laboratory studies from which partitioning coefficients are derived cannot account for all of the factors that affect chemical behavior.

Issues of uncertainty as they may affect selection of cleanup levels will be addressed in the FS.

1.5.3 Potential Feasibility Study Cleanup Levels

Potential FS cleanup levels were calculated based on the information presented in this memo and are presented in Table 10 for human health-related cleanup levels and Table 11 for ecological-related cleanup levels. Per WAC 173-340-705(4) and 173-340-706(4), cleanup levels that are based on protection of human health may be adjusted downward to address cumulative exposure to multiple hazardous substances or pathways. In such cases, the adjustment will be made to ensure that the cumulative noncarcinogenic risks do not exceed one and the cumulative carcinogenic risks do not exceed one in 100,000.

Final FS cleanup levels will be selected from the cleanup levels presented in Tables 10 and 11. The resulting FS cleanup levels will be adjusted so that they are not less than the practical quantitation limit (PQL) or background groundwater concentrations for the Site per WAC 173-340-730(5)(c) and 173-340-750(5)(c). PQLs will be identified in consultation with Ecology per WAC 173-340-707. Area background groundwater concentrations for the T-91 Site were submitted to Ecology in January 2007 (PIONEER, 2007). Ecology approved the area background concentrations in a letter from Galen Tritt (Ecology) to Ms. Susan Roth (Roth Consulting) dated October 24, 2007 (Ecology, 2007).

1.6 References

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Tables

Table 1: Indicator Hazardous Substances List

CAS Number	Indicator Hazardous Substances (IHS)	Class	Number of Samples Analyzed	Number of Detected Results	Frequency of Detection (%)	Minimum Detected Result (ug/L)	Maximum Detected Result (ug/L)	Keep as IHS Based On the Frequency of Detection? (> 5%)	Keep as IHS Based On the Maximum Detected Results? (Maximum > 75th Percentile + 3 x Interquartile Range [IQR])[1]	Keep as IHS Based on Spatial Evaluation?	Rationale for Spatial Evaluation
7440-38-2	Arsenic	Inorganic	492	412	83.74	0.063	89.2	Yes	--	--	--
7440-39-3	Barium	Inorganic	46	32	69.57	10.6	344	Yes - Per Request from Ecology	--	--	--
7440-47-3	Chromium	Inorganic	492	283	57.52	0.6	61.8	Yes	--	--	--
7439-92-1	Lead	Inorganic	492	84	17.07	1	33.1	Yes	--	--	--
7439-97-6	Mercury	Inorganic	383	34	8.88	0.00557	2.03	Yes	--	--	--
7782-49-2	Selenium	Inorganic	46	26	56.52	1.1	10.2	Yes - Per Request from Ecology	--	--	--
7440-22-4	Silver	Inorganic	46	2	4.08	1.25	1.35	Yes - Per Request from Ecology	--	--	--
7440-66-6	Zinc	Inorganic	492	195	39.63	4	1470	Yes	--	--	--
68334-30-5	Diesel	Petroleum	518	181	34.94	260	19800	Yes	--	--	--
86290-81-5	Gasoline	Petroleum	518	241	46.53	50.6	7010	Yes	--	--	--
541-73-1	1,3-dichlorobenzene	Semi-Volatile	496	9	1.81	2.68	5.84	No	No	Yes	All 9 detections occurred at CP_107. The first detect was on 3/08/2002 and the most recent was on 9/21/2006. Concentrations ranged from 2.68 ug/L to 5.84 ug/L.
90-12-0	1-methylnaphthalene	Semi-Volatile	238	87	36.55	0.0485	189	Yes	--	--	--
105-67-9	2,4-dimethylphenol	Semi-Volatile	454	12	2.64	2.9	161	No	No	Yes	Detected at CP_106A [3/3/2004], CP_108A [10/5/2004], CP_GP12 [3/29/2005, 9/21/2005, 12/14/2005, 6/27/2005, 3/29/2006, 6/07/2006, 9/21/2006, 12/28/2006, 3/13/2007, 9/17/2007]. Concentrations ranged from 2.9 ug/L to 161 ug/L.
121-14-2	2,4-dinitrotoluene	Semi-Volatile	464	7	1.51	13	15.2	No	No	Yes	Detected at CP_114 [9/28/2005], CP_GP03A [9/28/2005], CP_GP05 [9/27/2005], CP_GP06 [10/24/2003], CP_GP08 [9/29/2005], CP_GP10 [9/29/2005], CP_GP11 [9/27/2005]. Concentrations ranged from 13 ug/L to 15.2 ug/L.
91-57-6	2-methylnaphthalene	Semi-Volatile	500	62	12.4	0.0486	69.25	Yes	--	--	--
95-48-7	2-methylphenol	Semi-Volatile	454	5	1.1	7	29	No	No	Yes	Detected at CP-GP12 on 6/27/2005, 9/21/2005, 12/14/2005, 3/13/2007, and 9/17/2007. Concentrations ranged from 7.0 ug/L to 29 ug/L.
106-44-5	4-methylphenol	Semi-Volatile	65	3	4.62	1.1	20	No	No	Yes	All 3 detections occurred at CP_G12 (12/28/2006, 3/13/2007, 9/17/2007). Concentrations ranged from 1.1 ug/L to 20.0 ug/L.
83-32-9	Acenaphthene	Semi-Volatile	500	261	52.2	0.011	115	Yes	--	--	--
208-96-8	Acenaphthylene	Semi-Volatile	494	93	18.83	0.017	4.72	Yes	--	--	--
120-12-7	Anthracene	Semi-Volatile	500	154	30.8	0.011	6.12	Yes	--	--	--
56-55-3	Benzo(a)anthracene	Semi-Volatile	499	36	7.21	0.011	1.21	Yes	--	--	--
50-32-8	Benzo(a)pyrene	Semi-Volatile	499	40	8.02	0.012	1.985	Yes	--	--	--
205-99-2	Benzo(b)fluoranthene	Semi-Volatile	499	43	8.62	0.02	3.96	Yes	--	--	--
UNK-009	Benzo(b,k)fluoranthene	Semi-Volatile	19	1	5.26	0.112	0.112	Yes	--	--	--
191-24-2	Benzo(g,h,i)perylene	Semi-Volatile	500	30	6	0.011	1.09	Yes	--	--	--
207-08-9	Benzo(k)fluoranthene	Semi-Volatile	499	42	8.42	0.01	8.11	Yes	--	--	--
65-85-0	Benzoic Acid	Semi-Volatile	454	12	2.64	9.76	22.4	No	No	Yes	Detected at CP_108A (10/05/04, 09/28/05, 09/18/06), CP_103A (03/04/04 & 09/18/06), CP_106B (10/23/03 & 03/03/04), CP_107 (03/10/04), CP_108B (09/20/05), CP_GP06 (10/24/03), PNO_MW06A (10/06/04), PNO_MW06B (10/06/04). Concentrations ranged from 9.76 ug/L to 22.4 ug/L.
86-74-8	Carbazole	Semi-Volatile	371	5	1.35	7.6	52.7	No	Yes	--	--
218-01-9	Chrysene	Semi-Volatile	499	42	8.42	0.01	1.6	Yes	--	--	--
53-70-3	Dibenz(a,h)anthracene	Semi-Volatile	499	23	4.61	0.059	1.58	No	Yes	--	--

Table 1: Indicator Hazardous Substances List

CAS Number	Indicator Hazardous Substances (IHS)	Class	Number of Samples Analyzed	Number of Detected Results	Frequency of Detection (%)	Minimum Detected Result (ug/L)	Maximum Detected Result (ug/L)	Keep as IHS Based On the Frequency of Detection? (> 5%)	Keep as IHS Based On the Maximum Detected Results? (Maximum > 75th Percentile + 3 x Interquartile Range [IQR])[1]	Keep as IHS Based on Spatial Evaluation?	Rationale for Spatial Evaluation
132-64-9	Dibenzofuran	Semi-Volatile	465	14	3.01	0.82	37.1	No	No	Yes	Detected at CP_108A [2/25/2000 & 10/4/2000], CP_GP12 [3/29/2005, 9/21/2005, 12/14/2005, 6/27/2005, 3/29/2006, 12/28/2006, 3/13/2007, 9/17/2007], SHFLL_W10 [2/29/2000, 9/22/2006, 3/15/2007, 9/18/2007]. Concentrations ranged from 0.8 ug/L to 37.1 ug/L. Highest concentration detections are located to the east at well CP_GP12.
206-44-0	Fluoranthene	Semi-Volatile	500	167	33.4	0.02	23.4	Yes	--	--	--
86-73-7	Fluorene	Semi-Volatile	499	174	34.87	0.018	45.9	Yes	--	--	--
67-72-1	Hexachloroethane	Semi-Volatile	465	5	1.08	6.78	27.6	No	Yes	--	--
193-39-5	Indeno(1,2,3-cd)pyrene	Semi-Volatile	499	42	8.42	0.013	1.99	Yes	--	--	--
CRESOLS34	Methylphenol, P-, M-	Semi-Volatile	326	2	0.61	28.4	44.35	No	No	Yes	Both detects occurred at CP_GP12. First detect was in 6/2005 and then 12/2005. Concentrations ranged from 28.4 ug/L to 44.4 ug/L. These 2 hits were separated by a nondetect in 9/21/05 (DL = 4.85 ug/L).
91-20-3	Naphthalene	Semi-Volatile	500	144	28.8	0.011	525	Yes	--	--	--
85-01-8	Phenanthrene	Semi-Volatile	500	164	32.8	0.011	55.25	Yes	--	--	--
129-00-0	Pyrene	Semi-Volatile	500	203	40.6	0.013	16.2	Yes	--	--	--
75-34-3	1,1-dichloroethane	Volatile	490	14	2.86	0.794	5.03	No	No	Yes	Six of the 14 detections were at CP-104A [2/28/2000, 3/1/2001, 3/7/2003, 3/9/2004, 10/4/2000, 10/3/2001] . The other 8 were at CP_104B [2/28/2000, 3/1/2001, 3/7/2003, 3/9/2004, 10/4/2000, 10/28/2003, 10/11/2002, 10/3/2001]. Concentrations ranged from 0.8 ug/L to 5 ug/L. The wells are located close together.
95-63-6	1,2,4-trimethylbenzene	Volatile	471	13	2.76	0.679	2.825	No	No	Yes	Detected at CP_103A [3/5/2003, 10/6/2000, 3/6/2002], CP_104A [10/4/2000, 3/7/2002], CP_108A [3/5/2003, 3/5/2002], CP_GP02 [3/8/2004, 12/12/2005], CP_GP12 [3/29/2005, 6/27/2005, 10/16/2002, 9/21/2006]. Concentrations ranged from 0.68 ug/L to 2.83 ug/L. Detections were scattered around the site. Each well had more than one hit (13 hits @ 5 wells). CP-GP12 didn't have a detection until 2005 - but had the highest detection of 2.83 on 6/27/05.
106-46-7	1,4-dichlorobenzene	Volatile	496	8	1.61	5.14	11.9	No	No	Yes	All 8 detections occurred at CP_107. The first detect was on 3/08/2002 and the most recent was on 9/21/2006. Concentrations ranged from 5.1 ug/L to 11.9 ug/L.
67-64-1	Acetone	Volatile	490	9	1.84	5.4	31.8	No	Yes	--	--
71-43-2	Benzene	Volatile	518	68	13.13	0.55	114	Yes	--	--	--
104-51-8	Butylbenzene,n-	Volatile	375	66	17.6	0.73	8.82	Yes	--	--	--
108-90-7	Chlorobenzene	Volatile	490	4	0.82	1.2	1.79	No	No	Yes	Detected at CP_W210. First detect was in 3/30/2005 and the last was 9/18/2007. Concentrations ranged from 1.2 ug/L to 1.79 ug/L.
75-00-3	Chloroethane	Volatile	490	60	12.24	1	20.2	Yes	--	--	--
156-59-2	Cis-1,2-dichloroethene	Volatile	490	11	2.24	0.356	2	No	No	Yes	Detected at CP_106A [2/25/2000, 3/6/2003, 3/3/2004, 10/23/2003, 10/6/2004, 10/14/2002, 3/7/2002, 10/2/2001], CP_104A [2/28/2000 AND 10/4/2000], CP_113 [2/28/2000]. Concentrations ranged from 0.36 ug/L to 2 ug/L.
100-41-4	Ethylbenzene	Volatile	518	29	5.6	0.232	380	Yes	--	--	--
98-82-8	Cumene	Volatile	375	101	26.93	0.564	35.1	Yes	--	--	--
103-65-1	n-Propylbenzene	Volatile	375	80	21.33	0.514	46	Yes	--	--	--
135-98-8	Sec-butylbenzene	Volatile	375	99	26.4	0.54	11.2	Yes	--	--	--
98-06-6	Tert-butylbenzene	Volatile	375	17	4.53	0.626	1.56	No	No	Yes	Detected at CP_103A [03/31/2006], CP_104A [10/04/2000, 10/11/2004], CP_108A [10/04/2000, 03/31/2006], CP_112 [10/04/2000, 10/29/2003, 03/10/2004, 10/12/2004], CP_113 [10/05/2000, 10/28/2003, 03/05/2004, 10/12/2004], CP_203B [03/04/2004, 03/29/2006], PNO_MW06A.[10/06/2004, 03/28/2005]. Concentrations ranged from 0.63 ug/L to 1.56 ug/L.
108-88-3	Toluene	Volatile	518	35	6.76	0.196	10	Yes	--	--	--

Table 1: Indicator Hazardous Substances List

CAS Number	Indicator Hazardous Substances (IHS)	Class	Number of Samples Analyzed	Number of Detected Results	Frequency of Detection (%)	Minimum Detected Result (ug/L)	Maximum Detected Result (ug/L)	Keep as IHS Based On the Frequency of Detection? (> 5%)	Keep as IHS Based On the Maximum Detected Results? (Maximum > 75th Percentile + 3 x Interquartile Range [IQR])[1]	Keep as IHS Based on Spatial Evaluation?	Rationale for Spatial Evaluation
75-01-4	Vinyl Chloride	Volatile	490	27	5.51	0.276	4.43	Yes	--	--	--
1330-20-7	Xylenes (total)	Volatile	457	19	4.16	0.659	188.5	No	Yes	--	--

Notes:

-- = Not calculated/evaluated
% = Percent
[1] = IQR was calculated using detected results only
IHS = Indicator Hazardous Substances
IQR = Interquartile range (75th percentile minus the 25th percentile)
n/a = Not applicable – Could not calculate IQR because not enough detected results were available
ug/L = Micrograms per liter

Table 2: Constituents Not Included On the IHS List Because of the Frequency of Detection Evaluation, Interquartile Range Evaluation, and/or Spatial Evaluation

CAS Number	Indicator Hazardous Substances (IHS)	Class	Number of Samples Analyzed	Number of Detected Results	Frequency of Detection (%)	Minimum Detected Result (ug/L)	Maximum Detected Result (ug/L)	Keep as IHS Based On the Frequency of Detection? (> 5%)	Keep as IHS Based On the Maximum Detected Results? (Maximum > 3 x Interquartile Range [IQR])[1]	Keep as IHS Based on Spatial Evaluation?	Rationale for Spatial Evaluation
PHCLUB	Phc As Lube Oil	Petroleum	435	12	2.76	94.6	1050	No	No	No	Detected at CP_103A [10/6/2000], CP_103B [10/6/2000, 10/11/2002], CP_108A [2/28/2001, 3/5/2002], CP_108B [3/5/2002], CP_111 [3/6/2002], CP_114 [3/5/2002], CP_115B [3/5/2002], CP_121 [10/6/2000], PNO_MW103 [3/4/2003], SHFLL_W10 [10/6/2000]. Concentrations ranged from 94.6 ug/L to 1050 ug/L. Detections were scattered around the site. However, the majority were found at CP_103 A & B and CP_108A & B, which are close together. There was one detection at PNO_MW103, which is located away from the other wells with detections. Since 10/6/2000, 14 consecutive rounds of nondetects at CP_103A (DL = 1 ug/L).
11097-69-1	Aroclor-1254	Polychlorinated Biphenyl	461	1	0.22	0.021	0.021	No	No	No	Only detected one time.
11096-82-5	Aroclor-1260	Polychlorinated Biphenyl	461	2	0.43	0.427	0.815	No	No	No	Detected at two different wells (CP_103A and CP_108A). Both were detected in 2006. Concentrations ranged from 0.427 ug/L to 0.815 ug/L.
120-82-1	1,2,4-trichlorobenzene	Semi-Volatile	496	2	0.4	1.18	3.04	No	No	No	Detected at two different wells (CP_103A and CP_108A). Both detects observed in 10/2001. All nondetects since then. Concentrations ranged from 1.2 ug/L to 3.04 ug/L.
95-50-1	1,2-dichlorobenzene	Semi-Volatile	496	7	1.41	0.132	1.22	No	No	No	Detected at CP_104A [2/28/2000], and CP_107 {3/10/2004, 3/30/2005, 9/22/2005, 10/8/2004). Concentrations ranged from 0.13 ug/L to 1.22 ug/L.
51-28-5	2,4-dinitrophenol	Semi-Volatile	454	3	0.66	11.4	15.4	No	No	No	Detected at CP-108A [10/05/2004], PNO_MW06A [10/06/2004], and PNO-MW06B [10/06/2004]. Concentrations ranged from 11.4 ug/L to 15.4 ug/L.
606-20-2	2,6-dinitrotoluene	Semi-Volatile	464	2	0.43	7.09	16	No	No	No	Detected at two different wells CP_108A [10/5/2004] and CP_GP01A [9/29/2005]. All nondetects since then. Concentrations ranged from 7.1 ug/L to 16 ug/L.
91-94-1	3,3'-dichlorobenzidine	Semi-Volatile	452	1	0.22	4.79	4.79	No	No	No	Only detected one time.
534-52-1	4,6-dinitro-2-methylphenol	Semi-Volatile	454	4	0.88	6.67	9.1	No	No	No	Detected at CP_108A [10/05/2004], CP_108B [10/05/2004], PNO_MW06A [10/06/2004], PNO_MW06B [10/06/2004]. Concentrations ranged from 6.7 ug/L to 9.1 ug/L.
59-50-7	4-chloro-3-methylphenol	Semi-Volatile	454	1	0.22	16.8	16.8	No	No	No	Only detected one time.
100-02-7	4-nitrophenol	Semi-Volatile	454	3	0.66	4.92	10.7	No	No	No	Detected at CP-108A [10/05/2004], PNO_MW06A [10/06/2004], and PNO-MW06B [10/06/2004]. Concentrations ranged from 5 ug/L to 10.7 ug/L.
117-81-7	Bis(2-ethylhexyl)phthalate	Semi-Volatile	465	7	1.51	1.1	84.8	No	No	No	Detected at CP_W210 [03/15/2007], CP_103A [03/05/2003], CP_111 [03/07/2003], CP_115B [09/19/2006], CP_GP07 [03/19/2007], CP_GP09 [09/13/2007], and CP_GP11 [09/13/2007]. Concentrations ranged from 1.1 ug/L to 84.8 ug/L. All concentrations detected in 2007 were less than or equal to 2.6 ug/L.
84-66-2	Diethyl Phthalate	Semi-Volatile	465	2	0.43	1.7	4.96	No	No	No	Detected at two different wells (CP_111 [9/18/2007] and CP_113 [3/07/2002]). Concentrations ranged from 1.7 ug/L to 4.96 ug/L.
131-11-3	Dimethyl Phthalate	Semi-Volatile	465	1	0.22	5.66	5.66	No	No	No	Only detected one time.
84-74-2	Di-n-butylphthalate	Semi-Volatile	465	2	0.43	5.11	8.11	No	No	No	Detected at two different wells (CP_105B and CP_205B). Both detects observed in 10/2003. All nondetects since then. Concentrations ranged from 5.1 ug/L to 8.1 ug/L.
117-84-0	Di-n-octylphthalate	Semi-Volatile	465	1	0.22	12.5	12.5	No	No	No	Only detected one time.
87-86-5	Pentachlorophenol	Semi-Volatile	454	5	1.1	2.71	7.52	No	No	No	Detected at CP-103B [2/25/2000], CP_108B [9/20/2005], CP_GP02 [3/08/2004], CP_GP05 [9/27/2005], and CP-GP11 [6/07/2006]. Concentrations ranged from 2.7 ug/L to 7.5 ug/L. These results slightly exceed the most common DL observed in the dataset for PCP of 4 ug/L.
108-95-2	Phenol	Semi-Volatile	454	1	0.22	1.3	1.3	No	No	No	Only detected one time.

Table 2: Constituents Not Included On the IHS List Because of the Frequency of Detection Evaluation, Interquartile Range Evaluation, and/or Spatial Evaluation

CAS Number	Indicator Hazardous Substances (IHS)	Class	Number of Samples Analyzed	Number of Detected Results	Frequency of Detection (%)	Minimum Detected Result (ug/L)	Maximum Detected Result (ug/L)	Keep as IHS Based On the Frequency of Detection? (> 5%)	Keep as IHS Based On the Maximum Detected Results? (Maximum > 3 x Interquartile Range [IQR])[1]	Keep as IHS Based on Spatial Evaluation?	Rationale for Spatial Evaluation
79-00-5	1,1,2-trichloroethane	Volatile	490	1	0.2	1.1	1.1	No	No	No	Only detected one time.
108-67-8	1,3,5-trimethylbenzene	Volatile	375	1	0.27	1.3	1.3	No	No	No	Only detected one time.
78-93-3	2-butanone	Volatile	490	1	0.2	16.2	16.2	No	No	No	Only detected one time.
75-15-0	Carbon Disulfide	Volatile	490	4	0.82	0.228	16.9	No	No	No	Detected at CP-104B [10/11/2004], CP_115B [2/29/2000], CP-205B [10/12/2004], and CP_108B [9/20/2007] . Concentrations ranged from 0.23 ug/L to 16.9 ug/L. All nondetects before and after these detected results.
67-66-3	Chloroform	Volatile	490	7	1.43	0.326	8.74	No	No	No	Detected at CP_103A [2/28/2000, 3/4/2004, and 3/31/2006], CP_106A [2/25/2000 & 3/2/2001], CP_108A [2/25/2000], CP_GP10 [6/27/2005]. Concentrations ranged from 0.33 ug/L to 8.7 ug/L. Between 3/4/2004 and 3/30/2006, 4 consecutive rounds of nondetects at CP_103A (DL = 1 ug/L). The detect on 3/31/2006 was 1.17 ug/L (slightly above the DL = 1). Since 3/2/2001, 13 consecutive rounds of nondetects at CP_106A.
75-71-8	Dichlorodifluoromethane	Volatile	422	2	0.47	0.426	3.33	No	No	No	Detected at two different wells (CP_104A [2/28/2000] and CP_107A [3/10/2004]). All nondetects since then. Concentrations ranged from 0.43 ug/L to 3.33 ug/L.
110-54-3	Hexane	Volatile	384	10	2.6	3.54	26.3	No	No	No	Detected at CP_104A [10/28/2003], CP_106A [10/23/2003, 10/6/2004], CP_112 [3/10/2004, 10/29/2003], CP_113 [10/28/2003], CP_203B [10/28/2003], SHFLL_W10 [10/16/2002, 3/12/2003], CP_W210 [10/27/2003]. Concentrations ranged from 3.5 ug/L to 26.3 ug/L. Detections were spread across the site. With the exception of well SHFLL_W10, which was last sampled in 2003, the last samples collected at each of these wells were nondetects. There were no detections after 2004.
99-87-6	P-isopropyltoluene	Volatile	375	3	0.8	1.71	4.305	No	No	No	Detected at (CP-104A [10/04/2000], CP_113 [3/05/2004], and CP_GP12 [3/29/2005]). Concentrations ranged from 1.7 ug/L to 4.3 ug/L.
127-18-4	Tetrachloroethene (Tetrachloroethylene)	Volatile	490	2	0.41	0.418	0.562	No	No	No	Detected at two different wells (CP_106A and CP_121). Both were detected in 2000. All nondetects since then. Concentrations ranged from 0.418 ug/L to 0.56 ug/L.
79-01-6	Trichloroethylene (Trichloroethene)	Volatile	490	4	0.82	0.516	1.71	No	No	No	Detected at CP-106A on 2/25/2000, 3/2/2001, and 3/7/2002. One detect occured at CP_121 on 2/29/2000. Concentrations ranged from 0.52 ug/L to 1.7 ug/L. All results for TCE at CP-106A have been nondetects since last detection in 3/7/2002. Detection limit for these samples was very good 1 ug/L.

Notes:

-- = Not calculated/evaluated
% = Percent
[1] = IQR was calculated using detected results only
IHS = Indicator Hazardous Substances
IQR = Interquartile range (75^{th} percentile minus the 25^{th} percentile)
n/a = Not applicable – Could not calculate IQR because not enough detected results were available
ug/L = Micrograms per liter

Table 3: Constituents Not Included On the IHS List Because They Were Never Detected in Groundwater

CAS Number	Constituent	Class	Number of Samples Analyzed	Number of Detected Results	Frequency of Detection (%)	IHS?
3812-32-6	Carbonate	Conventional	1	0	0	No
14280-30-9	Hydroxide	Conventional	1	0	0	No
7440-43-9	Cadmium	Inorganic	46	0	0	No
12674-11-2	Aroclor-1016	Polychlorinated Biphenyl	461	0	0	No
11104-28-2	Aroclor-1221	Polychlorinated Biphenyl	461	0	0	No
11141-16-5	Aroclor-1232	Polychlorinated Biphenyl	461	0	0	No
53469-21-9	Aroclor-1242	Polychlorinated Biphenyl	461	0	0	No
12672-29-6	Aroclor-1248	Polychlorinated Biphenyl	461	0	0	No
37324-23-5	Aroclor-1262	Polychlorinated Biphenyl	461	0	0	No
11100-14-4	Aroclor-1268	Polychlorinated Biphenyl	461	0	0	No
108-60-1	2,2'-Oxybis(1-Chloropropane)	Semi-Volatile	65	0	0	No
95-95-4	2,4,5-trichlorophenol	Semi-Volatile	454	0	0	No
88-06-2	2,4,6-trichlorophenol	Semi-Volatile	454	0	0	No
120-83-2	2,4-dichlorophenol	Semi-Volatile	454	0	0	No
91-58-7	2-chloronaphthalene	Semi-Volatile	465	0	0	No
95-57-8	2-chlorophenol	Semi-Volatile	454	0	0	No
88-74-4	2-nitroaniline	Semi-Volatile	465	0	0	No
88-75-5	2-nitrophenol	Semi-Volatile	454	0	0	No
99-09-2	3-nitroaniline	Semi-Volatile	465	0	0	No
101-55-3	4-bromophenyl Phenyl Ether	Semi-Volatile	465	0	0	No
7005-72-3	4-chlorophenyl Phenyl Ether	Semi-Volatile	465	0	0	No
62-53-3	Aniline	Semi-Volatile	372	0	0	No
100-51-6	Benzyl Alcohol	Semi-Volatile	454	0	0	No
85-68-7	Benzyl Butyl Phthalate	Semi-Volatile	465	0	0	No
111-91-1	Bis(2-chloroethoxy)methane	Semi-Volatile	465	0	0	No
111-44-4	Bis(2-chloroethylether)	Semi-Volatile	465	0	0	No
39638-32-9	Bis(2-chloroisopropyl)ether	Semi-Volatile	400	0	0	No
1319-77-3	Cresols	Semi-Volatile	63	0	0	No
87-68-3	Hexachloro-1,3-butadiene	Semi-Volatile	465	0	0	No
118-74-1	Hexachlorobenzene	Semi-Volatile	465	0	0	No
77-47-4	Hexachlorocyclopentadiene	Semi-Volatile	465	0	0	No
78-59-1	Isophorone	Semi-Volatile	465	0	0	No
98-95-3	Nitrobenzene	Semi-Volatile	465	0	0	No
621-64-7	N-nitroso-di-n-propylamine	Semi-Volatile	465	0	0	No
86-30-6	N-nitrosodiphenylamine	Semi-Volatile	465	0	0	No
106-47-8	P-chloroaniline	Semi-Volatile	465	0	0	No
100-01-6	P-nitroaniline	Semi-Volatile	452	0	0	No
PHCHRO	Phc As Heavy/residual Range Organic Compounds	Petroleum	18	0	0	No
PHCMO	Phc as Motor Oil	Petroleum	65	0	0	No
630-20-6	1,1,1,2-tetrachloroethane	Volatile	38	0	0	No
71-55-6	1,1,1-trichloroethane	Volatile	490	0	0	No
79-34-5	1,1,2,2-tetrachloroethane	Volatile	490	0	0	No
75-35-4	1,1-dichloroethylene (1,1-dichloroethene)	Volatile	490	0	0	No
563-58-6	1,1-dichloropropylene(1,1-dichloropropene)	Volatile	38	0	0	No
87-61-6	1,2,3-trichlorobenzene	Volatile	19	0	0	No
96-18-4	1,2,3-trichloropropane	Volatile	19	0	0	No
96-12-8	1,2-dibromo-3-chloropropane (dbcp)	Volatile	27	0	0	No

Table 3: Constituents Not Included On the IHS List Because They Were Never Detected in Groundwater

CAS Number	Constituent	Class	Number of Samples Analyzed	Number of Detected Results	Frequency of Detection (%)	IHS?
106-93-4	1,2-dibromoethane	Volatile	27	0	0	No
107-06-2	1,2-dichloroethane	Volatile	490	0	0	No
78-87-5	1,2-dichloropropane	Volatile	490	0	0	No
142-28-9	1,3-dichloropropane	Volatile	38	0	0	No
594-20-7	2,2-dichloropropane	Volatile	38	0	0	No
110-75-8	2-chloroethyl Vinyl Ether	Volatile	409	0	0	No
95-49-8	2-chlorotoluene	Volatile	19	0	0	No
591-78-6	2-hexanone	Volatile	490	0	0	No
106-43-4	4-chlorotoluene	Volatile	19	0	0	No
108-10-1	4-methyl-2-pentanone	Volatile	490	0	0	No
108-86-1	Bromobenzene	Volatile	19	0	0	No
75-27-4	Bromodichloromethane	Volatile	490	0	0	No
74-83-9	Bromomethane	Volatile	490	0	0	No
56-23-5	Carbon Tetrachloride	Volatile	490	0	0	No
76-13-1	Chlorinated Fluorocarbon (freon 113)	Volatile	471	0	0	No
74-97-5	Chlorobromomethane (bromochloromethane)	Volatile	19	0	0	No
124-48-1	Chlorodibromomethane (Dibromochloromethane)	Volatile	490	0	0	No
74-87-3	Chloromethane	Volatile	490	0	0	No
10061-01-5	Cis-1,3-dichloropropene	Volatile	490	0	0	No
74-95-3	Dibromomethane	Volatile	19	0	0	No
75-09-2	Dichloromethane (Methylene Chloride)	Volatile	490	0	0	No
1634-04-4	Methyl-tert-butyl Ether	Volatile	384	0	0	No
100-42-5	Styrene (monomer)	Volatile	490	0	0	No
156-60-5	Trans-1,2-dichloroethene	Volatile	490	0	0	No
10061-02-6	Trans-1,3-dichloropropene	Volatile	490	0	0	No
75-25-2	Tribromomethane (Bromoform)	Volatile	490	0	0	No
75-69-4	Trichlorofluoromethane	Volatile	490	0	0	No
108-05-4	Vinyl Acetate	Volatile	471	0	0	No

Notes:

IHS = Indicator Hazardous Substances

Table 4: MTCA Equations and Parameters Used to Calculate Groundwater Cleanup Levels to Protect Indoor Air Quality based on Vapor Intrusion from Groundwater

Non-Carcinogenic Cleanup Level (ug/L)			$\frac{RfD \times ABW \times UCF \times HQ \times AT}{BR \times ABS \times ED \times EF} \times \frac{1}{alpha}$	
Carcinogenic Cleanup Level (ug/L)			$\frac{RISK \times ABW \times AT \times UCF}{CPF \times BR \times ABS \times ED \times EF} \times \frac{1}{alpha}$	
			Non-Carcinogen	**Carcinogen**
			750-1	**750-2**
Parameter	**Abbreviation**	**Units**	**Method C**	**Method C**
Reference dose	RfD	mg/kg-day	Constituent-specific (see Table 7)	
Average body weight	ABW	kg	70	70
Unit conversion factor	UCF	ug/mg	1000	1,000
Air inhalation intake rate	BR	m^3/day	20	20
Inhalation absorption fraction	ABS	unitless	1	1
Hazard quotient	HQ	unitless	1	N/A
Averaging time	AT	years	6	75
Exposure duration	ED	years	6	30
Exposure frequency	EF	unitless	1	1
Acceptable cancer risk level	RISK	unitless	N/A	1E-05
Carcinogenic potency factor	CPF	kg-day/mg	Constituent-specific (see Table 7)	
Groundwater to indoor air attenuation factor	alpha	ug/m^3 / ug/L	Constituent-specific (see Table 6)	

Notes:

Reference Dose is as specified in WAC 173-340-708(7) (mg/kg-day)
750-1 and 750-2 are Equations and input parameters defined in WAC 173-340-750
MTCA = Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC Amended February 12, 2001

Table 5: Site-Specific Johnson and Ettinger Model Input Parameters Used to Calculate Groundwater Cleanup Levels Based on the Protection of Indoor Air

Parameter	Abbreviation	Commercial Building	Reference
Average soil/groundwater Temperature (oC)	TS	15	Site-Specific for Western Washington
Depth Below Grade to Bottom of Enclosed Floor Space (cm)	LF	15	JEM Default (Slab on Grade)
Depth Below Grade to Water Table (cm)	LWT	304.8	Site-Specific (10 feet)
Thickness of Soil Stratum (cm)	hA	304.8	Site-Specific (10 feet)
SCS Soil Type	E38	Sand	Site-Specific
Sand Vapor Permeability (cm^2)	kV	1E-08	JEM Default for Sand
Soil Dry Bulk Density (g/cm^3)	ρbA	1.66	JEM Default for Sand
Total Soil Porosity (unitless)	nA	0.375	JEM Default for Sand
Soil Water Filled Porosity (cm^3/cm^3)	θwA	0.054	JEM Default for Sand
Enclosed Floor Space Thickness (cm)	Lcrack	10	JEM Default for Residential Building. Conservatively assumed same value for Commercial Building.
Soil to Building Pressure Differential ($g/cm\text{-}s^2$)	ΔP	40	JEM Default for Residential Building. Conservatively assumed same value for Commercial Building.
Enclosed Floor Space Length (cm)	LB	1000	JEM Default for Residential Building. Conservatively assumed same value for Commercial Building.
Enclosed Floor Space Width (cm)	WB	1000	JEM Default for Residential Building. Conservatively assumed same value for Commercial Building.
Enclosed Floor Space Height (cm)	HB	244	JEM Default (Slab on Grade)
Floor-wall Seam Crack Width (cm)	w	0.1	JEM Default for Residential Building. Conservatively assumed same value for Commercial Building.
Indoor Air Exchange Rate (1/hour)	ER	1.0	JEM Default for Residential Building. Assumed slightly higher building air exchange rate for Commercial Building due to presence of an active ventilation system.
Average Vapor Flow Rate into Building (L/minute)	Qsoil	5	JEM Default for Residential Building. Conservatively assumed same value for Commercial Building.

Notes:

Source: United States Environmental Protection Agency's (USEPA's) Johnson and Ettinger Model [Version 3.1; 02/04]

Table 6: Constituent-Specific Input Parameters Used to Calculate Groundwater Cleanup Levels Based on the Protection of Indoor Air

CAS Number	Indicator Hazardous Substances (HIS)	Class	Commercial Building Groundwater to Indoor Air Attenuation Factor (ug/m3 / ug/L)	Koc (cm^3/g)	Diffusivity in Air (cm^2/s)	Diffusivity in Water (cm^2/s)	Pure Component Solubility (mg/L)	Henry's Law Constant (unitless)	Henry's Law Constant (atm-m^3/mol) @ 25 ^oC	Normal Boiling Point (^oK)	Critical Temperature (^oK)	Enthalpy of Vaporization at the Normal Boiling Point (cal/mol)
7440-38-2	Arsenic	Inorganic	--	--	--	--	--	--	--	--	--	--
7440-39-3	Barium	Inorganic	--	--	--	--	--	--	--	--	--	--
7440-47-3	Chromium	Inorganic	--	--	--	--	--	--	--	--	--	--
7439-92-1	Lead	Inorganic	--	--	--	--	--	--	--	--	--	--
7439-97-6	Mercury	Inorganic	1.32E-02	5.20E+01	3.07E-02	6.30E-06	2.00E+01	4.40E-01	1.07E-02	6.30E+02	1.75E+03	1.41E+04
7782-49-2	Selenium	Inorganic	--	--	--	--	--	--	--	--	--	--
7440-22-4	Silver	Inorganic	--	--	--	--	--	--	--	--	--	--
7440-66-6	Zinc	Inorganic	--	--	--	--	--	--	--	--	--	--
68334-30-5	Diesel	Petroleum	--	--	--	--	--	--	--	--	--	--
86290-81-5	Gasoline	Petroleum	--	--	--	--	--	--	--	--	--	--
541-73-1	1,3-dichlorobenzene	Semi-Volatile	1.10E-02	1.98E+03	6.92E-02	7.86E-06	1.34E+02	1.27E-01	3.09E-03	4.46E+02	6.84E+02	9.23E+03
90-12-0	1-methynphthalene	Semi-Volatile	1.07E-03	2.81E+03	5.22E-02	7.75E-06	2.46E+01	2.12E-02	5.17E-04	5.14E+02	7.61E+02	1.26E+04
105-67-9	2,4-dimethylphenol	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
121-14-2	2,4-dinitrotoluene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
91-57-6	2-methylnaphthalene	Semi-Volatile	1.07E-03	2.81E+03	5.22E-02	7.75E-06	2.46E+01	2.12E-02	5.17E-04	5.14E+02	7.61E+02	1.26E+04
95-48-7	2-methylphenol	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
106-44-5	4-methylphenol	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
83-32-9	Acenaphthene	Semi-Volatile	3.33E-04	7.08E+03	4.21E-02	7.69E-06	3.57E+00	6.34E-03	1.55E-04	5.51E+02	8.03E+02	1.22E+04
208-96-8	Acenaphthylene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
120-12-7	Anthracene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
56-55-3	Benzo(a)anthracene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
50-32-8	Benzo(a)pyrene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
205-99-2	Benzo(b)fluoranthene	Semi-Volatile	8.28E-05	1.23E+06	2.26E-02	5.56E-06	1.50E-03	4.54E-03	1.11E-04	7.16E+02	9.69E+02	1.70E+04
UNK-009	Benzo(b,k)fluoranthene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
191-24-2	Benzo(ghi)perylene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
207-08-9	Benzo(k)fluoranthene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
65-85-0	Benzoic acid	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
86-74-8	Carbazole	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
218-01-9	Chrysene	Semi-Volatile	8.52E-05	3.98E+05	2.48E-02	6.21E-06	6.30E-03	3.87E-03	9.44E-05	7.14E+02	9.79E+02	1.65E+04
53-70-3	Dibenzo(a,h)anthracene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
132-64-9	Dibenzofuran	Semi-Volatile	1.52E-07	5.15E+03	2.38E-02	6.00E-06	3.10E+00	5.15E-04	1.26E-05	5.60E+02	8.24E+02	6.64E+04
206-44-0	Fluoranthene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
86-73-7	Fluorene	Semi-Volatile	1.46E-04	1.38E+04	3.63E-02	7.88E-06	1.98E+00	2.60E-03	6.34E-05	5.70E+02	8.70E+02	1.27E+04
67-72-1	Hexachloroethane	Semi-Volatile	7.05E-04	1.78E+03	2.50E-03	6.80E-06	5.00E+01	1.59E-01	3.88E-03	4.58E+02	6.95E+02	9.51E+03
193-39-5	Indeno(1,2,3-cd)pyrene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--

Table 6: Constituent-Specific Input Parameters Used to Calculate Groundwater Cleanup Levels Based on the Protection of Indoor Air

CAS Number	Indicator Hazardous Substances (HIS)	Class	Commercial Building Groundwater to Indoor Air Attenuation Factor (ug/m3 / ug/L)	Koc (cm^3/g)	Diffusivity in Air (cm^2/s)	Diffusivity in Water (cm^2/s)	Pure Component Solubility (mg/L)	Henry's Law Constant (unitless)	Henry's Law Constant (atm-m^3/mol) @ 25 ^oC	Normal Boiling Point (^oK)	Critical Temperature (^oK)	Enthalpy of Vaporization at the Normal Boiling Point (cal/mol)
CRESOLS34	Methylphenol, P-, M-	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
91-20-3	Naphthalene	Semi-Volatile	1.40E-03	2.00E+03	5.90E-02	7.50E-06	3.10E+01	1.98E-02	4.82E-04	4.91E+02	7.48E+02	1.04E+04
85-01-8	Phenanthrene	Semi-Volatile	--	--	--	--	--	--	--	--	--	--
129-00-0	Pyrene	Semi-Volatile	1.71E-05	1.05E+05	2.72E-02	7.24E-06	1.35E+00	4.50E-04	1.10E-05	6.68E+02	9.36E+02	1.44E+04
75-34-3	1,1-dichloroethane	Volatile	2.86E-02	3.16E+01	7.42E-02	1.05E-05	5.06E+03	2.30E-01	5.61E-03	3.31E+02	5.23E+02	6.90E+03
95-63-6	1,2,4-trimethylbenzene	Volatile	1.86E-02	1.35E+03	6.06E-02	7.92E-06	5.70E+01	2.52E-01	6.14E-03	4.42E+02	6.49E+02	9.37E+03
106-46-7	1,4-dichlorobenzene	Volatile	8.47E-03	6.17E+02	6.90E-02	7.90E-06	7.90E+01	9.82E-02	2.39E-03	4.47E+02	6.85E+02	9.27E+03
67-64-1	Acetone	Volatile	3.84E-04	5.75E-01	1.24E-01	1.14E-05	1.00E+06	1.59E-03	3.87E-05	3.29E+02	5.08E+02	6.96E+03
71-43-2	Benzene	Volatile	3.06E-02	5.89E+01	8.80E-02	9.80E-06	1.79E+03	2.27E-01	5.54E-03	3.53E+02	5.62E+02	7.34E+03
108-90-7	Chlorobenzene	Volatile	1.53E-02	2.19E+02	7.30E-02	8.70E-06	4.72E+02	1.51E-01	3.69E-03	4.05E+02	6.32E+02	8.41E+03
75-00-3	Chloroethane	Volatile	1.26E-01	4.40E+00	2.71E-01	1.15E-05	5.68E+03	3.61E-01	8.80E-03	2.85E+02	4.60E+02	5.88E+03
156-59-2	Cis-1,2-dichloroethylene	Volatile	2.02E-02	3.55E+01	7.36E-02	1.13E-05	3.50E+03	1.67E-01	4.07E-03	3.34E+02	5.44E+02	7.19E+03
98-82-8	Cumene	Volatile	4.31E-02	4.89E+02	6.50E-02	7.10E-06	6.13E+01	4.74E+01	1.46E-02	4.26E+02	6.31E+02	1.03E+04
100-41-4	Ethylbenzene	Volatile	3.22E-02	3.63E+02	7.50E-02	7.80E-06	1.69E+02	3.22E-01	7.86E-03	4.09E+02	6.17E+02	8.50E+03
104-51-8	N-butylbenzene	Volatile	3.71E-02	1.11E+03	5.70E-02	8.12E-06	2.00E+00	5.38E-01	1.31E-02	4.56E+02	6.61E+02	9.29E+03
103-65-1	Propylbenzene	Volatile	3.28E-02	5.62E+02	6.01E-02	7.83E-06	6.00E+01	4.37E-01	1.07E-02	4.32E+02	6.30E+02	9.12E+03
135-98-8	Sec-butylbenzene	Volatile	2.65E-05	9.66E+02	5.70E-02	8.12E-06	3.94E+00	5.68E-01	1.39E-02	4.47E+02	6.79E+02	8.87E+04
98-06-6	Tert-butylbenzene	Volatile	4.05E-02	7.71E+02	5.65E-02	8.02E-06	2.95E+01	4.87E-01	1.19E-02	4.42E+02	1.22E+03	8.98E+03
108-88-3	Toluene	Volatile	3.33E-02	1.82E+02	8.70E-02	8.60E-06	5.26E+02	2.72E-01	6.62E-03	3.84E+02	5.92E+02	7.93E+03
75-01-4	Vinyl Chloride	Volatile	2.22E-01	1.86E+01	1.06E-01	1.23E-05	8.80E+03	1.10E+00	2.69E-02	2.59E+02	4.32E+02	5.25E+03
1330-20-7	Xylene (total)	Volatile	3.17E-02	3.89E+02	7.69E-02	8.44E-06	1.85E+02	3.13E-01	7.64E-03	4.12E+02	6.16E+02	8.53E+03

Notes:

-- = No value was available
Source: United States Environmental Protection Agency's (USEPA's) Johnson and Ettinger Model [Version 3.1; 02/04]

Table 7: Toxicity Values Used to Calculate MTCA Cleanup Levels Based on the Protection of Human Health

CAS Number	Indicator Hazardous Substances (IHS)	Class	Inhalation Cancer Potency Factor (iCPF) (mg/kg-day)$^{-1}$	iCPF Source	Inhalation Reference Dose (mg/kg-day)	iRfD Source	Oral Cancer Potency Factor (oCPF) (mg/kg-day)$^{-1}$	oCPF Source	Oral Reference Dose (mg/kg-day)	oRfD Source
7440-38-2	Arsenic	Inorganic	1.51E+01	IRIS (4th Quarter) 2007	--	No Value on IRIS 07, HEAST 97, or NCEA	1.50E+00	IRIS (4th Quarter) 2007	3.00E-04	IRIS (4th Quarter) 2007
7440-39-3	Barium	Inorganic	--	No Value on IRIS 07, HEAST 97, or NCEA	1.43E-04	IRIS (4th Quarter) 2007	--	No Value on IRIS 07, HEAST 97, or NCEA	2.00E-01	IRIS (4th Quarter) 2007
7440-47-3	Chromium	Inorganic	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	1.50E+00	IRIS (4th Quarter) 2007- as Chromium III
7439-92-1	Lead	Inorganic	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA
7439-97-6	Mercury	Inorganic	--	No Value on IRIS 07, HEAST 97, or NCEA	8.57E-05	IRIS (4th Quarter) 2007	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA
7782-49-2	Selenium	Inorganic	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	5.00E-03	IRIS (4th Quarter) 2007
7440-22-4	Silver	Inorganic	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	5.00E-03	IRIS (4th Quarter) 2007
7440-66-6	Zinc	Inorganic	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	3.00E-01	IRIS (4th Quarter) 2007
68334-30-5	Diesel	Petroleum	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA
86290-81-5	Gasoline	Petroleum	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA
541-73-1	1,3-dichlorobenzene	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	3.00E-03	NCEA Value from EPA Reg III RBCTable
90-12-0	1-methylnaphthalene	Semi-Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	3.00E-04	Ecology Memo (11/10/04) to Marcia Bailey
105-67-9	2,4-dimethylphenol	Semi-Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	2.00E-02	IRIS (4th Quarter) 2007
121-14-2	2,4-dinitrotoluene	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	2.00E-03	IRIS (4th Quarter) 2007
91-57-6	2-methylnaphthalene	Semi-Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	4.00E-03	Ecology Memo (11/10/04) to Marcia Bailey
95-48-7	2-methylphenol	Semi-Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	5.00E-02	IRIS (4th Quarter) 2007
106-44-5	4-methylphenol	Semi-Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	5.00E-03	IRIS (4th Quarter) 2007
83-32-9	Acenaphthene	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	6.00E-02	IRIS (4th Quarter) 2007
208-96-8	Acenaphthylene	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97
120-12-7	Anthracene	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	3.00E-01	IRIS (4th Quarter) 2007
56-55-3	Benzo(a)anthracene	Semi-Volatile	3.10E-01	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA	7.30E-01	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA
50-32-8	Benzo(a)pyrene	Semi-Volatile	3.10E+00	NCEA Value from EPA Reg III RBCTable	--	No Value on IRIS 07, HEAST 97, or NCEA	7.30E+00	IRIS (4th Quarter) 2007	--	No Value on IRIS 07, HEAST 97, or NCEA
205-99-2	Benzo(b)fluoranthene	Semi-Volatile	3.10E-01	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA	7.30E-01	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA
UNK-009	Benzo(b,k)fluoranthene	Semi-Volatile	3.10E-01	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA	7.30E-01	MTCA, 2007 - TEFs for PAHs-Benzo(b)fluoranthene	--	No Value on IRIS 07, HEAST 97, or NCEA
191-24-2	Benzo(ghi)perylene	Semi-Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA
207-08-9	Benzo(k)fluoranthene	Semi-Volatile	3.10E-02	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA	7.30E-01	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA
65-85-0	Benzoic acid	Semi-Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	4.00E+00	IRIS (4th Quarter) 2007
86-74-8	Carbazole	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	2.00E-02	HEAST1 (Tables 1 & 3), 1997	--	No Value on IRIS 07 or HEAST 97
218-01-9	Chrysene	Semi-Volatile	3.10E-02	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA	7.30E-02	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA

Table 7: Toxicity Values Used to Calculate MTCA Cleanup Levels Based on the Protection of Human Health

CAS Number	Indicator Hazardous Substances (IHS)	Class	Inhalation Cancer Potency Factor (iCPF) (mg/kg-day)$^{-1}$	iCPF Source	Inhalation Reference Dose (mg/kg-day)	iRfD Source	Oral Cancer Potency Factor (oCPF) (mg/kg-day)$^{-1}$	oCPF Source	Oral Reference Dose (mg/kg-day)	oRfD Source
53-70-3	Dibenzo(a,h)anthracene	Semi-Volatile	3.10E-01	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA	7.30E-01	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA
132-64-9	Dibenzofuran	Semi-Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	4.00E-03	NCEA value provided by Marcia Bailey
206-44-0	Fluoranthene	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	4.00E-02	IRIS (4th Quarter) 2007
86-73-7	Fluorene	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	4.00E-02	IRIS (4th Quarter) 2007
67-72-1	Hexachloroethane	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	1.40E-02	IRIS (4th Quarter) 2007	1.00E-03	IRIS (4th Quarter) 2007
193-39-5	Indeno(1,2,3-cd)pyrene	Semi-Volatile	3.10E-01	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA	7.30E-01	MTCA, 2007 - TEFs for PAHs	--	No Value on IRIS 07, HEAST 97, or NCEA
CRESOLS34	Methylphenol, P-, M-	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97
91-20-3	Naphthalene	Semi-Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	8.57E-04	IRIS (4th Quarter) 2007	--	No Value on IRIS 07, HEAST 97, or NCEA	2.00E-02	IRIS (4th Quarter) 2007
85-01-8	Phenanthrene	Semi-Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA
129-00-0	Pyrene	Semi-Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	3.00E-02	IRIS (4th Quarter) 2007
75-34-3	1,1-dichloroethane	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	1.43E-01	HEAST2 (Table 2), 1997	--	No Value on IRIS 07, HEAST 97, or NCEA	1.00E-01	HEAST1 (Tables 1 & 3), 1997
95-63-6	1,2,4-trimethylbenzene	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	1.70E-03	NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	5.00E-02	NCEA
106-46-7	1,4-dichlorobenzene	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	2.29E-01	IRIS (4th Quarter) 2007	2.40E-02	HEAST1 (Tables 1 & 3), 1997	--	No Value on IRIS 07, HEAST 97, or NCEA
67-64-1	Acetone	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	--	No Value on IRIS 07, HEAST 97, or NCEA	9.00E-01	IRIS (4th Quarter) 2007
71-43-2	Benzene	Volatile	2.73E-02	IRIS (4th Quarter) 2007	8.57E-03	IRIS (4th Quarter) 2007	5.50E-02	IRIS (4th Quarter) 2007	4.00E-03	IRIS (4th Quarter) 2007
104-51-8	Butylbenzene,n-	Volatile	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97	--	No Value on IRIS 07 or HEAST 97
108-90-7	Chlorobenzene	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	5.71E-03	HEAST2 (Table 2), 1997	--	No Value on IRIS 07, HEAST 97, or NCEA	2.00E-02	IRIS (4th Quarter) 2007
75-00-3	Chloroethane	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	2.86E+00	IRIS (4th Quarter) 2007	2.90E-03	NCEA Value from EPA Reg IX PRG Table	4.00E-01	NCEA Value from EPA Reg IX PRG Table
156-59-2	cis-1,2-dichloroethylene	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	1.00E-02	NTV - Surrogate Toxicity Value	--	No Value on IRIS 07, HEAST 97, or NCEA	1.00E-02	HEAST1 (Tables 1 & 3), 1997
98-82-8	Cumene	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	1.14E-01	IRIS (4th Quarter) 2007	--	No Value on IRIS 07, HEAST 97, or NCEA	1.00E-01	IRIS (4th Quarter) 2007
100-41-4	Ethylbenzene	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	2.86E-01	IRIS (4th Quarter) 2007	--	No Value on IRIS 07, HEAST 97, or NCEA	1.00E-01	IRIS (4th Quarter) 2007
103-65-1	Propylbenzene	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	4.00E-02	NCEA Value from EPA Reg IX PRG Table	--	No Value on IRIS 07, HEAST 97, or NCEA	4.00E-02	NCEA Value from EPA Reg IX PRG Table
135-98-8	Sec-Butylbenzene	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	4.00E-02	NCEA Value from EPA Reg IX PRG Table	--	No Value on IRIS 07, HEAST 97, or NCEA	4.00E-02	NCEA Value from EPA Reg IX PRG Table
98-06-6	Tert-butylbenzene	Volatile	--	No Value on IRIS 07 or HEAST 97	4.00E-02	NCEA Value from EPA Reg IX PRG Table	--	No Value on IRIS 07, HEAST 97, or NCEA	4.00E-02	NCEA Value from EPA Reg IX PRG Table
108-88-3	Toluene	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	1.43E+00	IRIS (4th Quarter) 2007	--	No Value on IRIS 07, HEAST 97, or NCEA	8.00E-02	IRIS (4th Quarter) 2007
75-01-4	Vinyl Chloride	Volatile	3.08E-02	IRIS (4th Quarter) 2007	2.86E-02	IRIS (4th Quarter) 2007	1.40E+00	IRIS (4th Quarter) 2007	3.00E-03	IRIS (4th Quarter) 2007
1330-20-7	Xylene (total)	Volatile	--	No Value on IRIS 07, HEAST 97, or NCEA	2.86E-02	IRIS (4th Quarter) 2007	--	No Value on IRIS 07, HEAST 97, or NCEA	2.00E-01	IRIS (4th Quarter) 2007

Notes:

-- = No toxicity value was available
No Value = No Value on IRIS 06, HEAST 97, or NCEA
mg/kg-day = microgram/kilogram per day
HEAST = Health Effects Assessment Summary Tables
IRIS = Integrated Risk Information System

MTCA = Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC Amended February 12, 2001
NCEA = National Center for Environmental Assessment

Table 8: MTCA Equations and Parameters Used to Calculate Groundwater Cleanup Levels to Protect Surface Water Quality based on the Groundwater to Surface Water Pathway

Non-Carcinogenic Cleanup Level (ug/L)		*RfD x ABW x UCF1 x UCF2 x HQ x AT / BCF x FCR x FDF x ED*		
Carcinogenic Cleanup Level (ug/L)		*RISK x ABW x AT x UCF1 x UCF2 / CPF x BCF x FCR x FDF x ED*		
Parameter	**Abbreviation**	**Units**	**Non-Carcinogen 730-1 Method B**	**Carcinogen 730-2 Method B**
Reference dose	RfD	mg/kg-day	Constituent-specific (see Table 7)	
Average body weight	ABW	kg	70 (63)*	70 (63)*
Unit conversion factor	UCF1	ug/mg	1,000	1,000
Unit conversion factor	UCF2	grams/L	1,000	1,000
Bioconcentration factor	BCF	L/kg	Constituent-specific (see Table 9)	
Hazard quotient	HQ	unitless	1	N/A
Averaging time	AT	years	30	75
Exposure duration	ED	years	30	30
Fish consumption rate	FCR	grams/day	54 (57)*	54 (57)*
Fish diet fraction	FDF	unitless	0.5 (1.0)*	0.5 (1.0)*
Acceptable cancer risk level	RISK	unitless	N/A	1E-06
Carcinogenic potency factor	CPF	kg-day/mg	Constituent-specific (see Table 7)	

Notes:

Reference Dose is as specified in WAC 173-340-708(7) (mg/kg-day)
730-1 and 730-2 are Equations and input parameters defined in WAC 173-340-730
MTCA = Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC Amended February 12, 2001
* Numbers presented in parentheses represent modified exposure parameters for the Asian Pacific Islander per the MTCA Science Advisory Board Meeting, September 15, 2006.

Table 9: Constituent-Specific Properties Used to Calculate Human Health and Ecological Groundwater Cleanup Levels Based on Protection of Surface Water

CAS Number	Indicator Hazardous Substances (IHS)	Class	Bioconcentration Factor (BCF) (L/kg)	BCF Source	Koc (L/kg)	kd (L/kg)	Koc Surrogate Chemical Data Used
7440-38-2	Arsenic	Inorganic	44	AWQC	--	29	
7440-39-3	Barium	Inorganic	1	RAIS	--	41	
7440-47-3	Chromium	Inorganic	16	AWQC	--	--	
7439-92-1	Lead	Inorganic	3.2	RAIS	--	10000	
7439-97-6	Mercury	Inorganic	3.2	RAIS		52	
7782-49-2	Selenium	Inorganic	200	RAIS	--	5	
7440-22-4	Silver	Inorganic	5	RAIS	--	8.3	
7440-66-6	Zinc	Inorganic	47	AWQC	--	62	
68334-30-5	Diesel	Petroleum	--		--	--	
86290-81-5	Gasoline	Petroleum	--		--	--	
541-73-1	1,3-dichlorobenzene	Semi-Volatile	100	RAIS	434	--	
90-12-0	1-methylnaphthalene	Semi-Volatile	10.5	Surrogate naphthalene	3038	--	
105-67-9	2,4-dimethylphenol	Semi-Volatile	93.8	AWQC	209	--	
121-14-2	2,4-dinitrotoluene	Semi-Volatile	3.8	MTCA CLARC	363.8	--	
91-57-6	2-methylnaphthalene	Semi-Volatile	10.5	Surrogate naphthalene	2976	--	Naphthalene
95-48-7	2-methylphenol	Semi-Volatile	6.3	RAIS	91.2	--	2.4-Dimethylphenol
106-44-5	4-methylphenol	Semi-Volatile	6.2	RAIS	434	--	
83-32-9	Acenaphthene	Semi-Volatile	242	AWQC	7080	--	
208-96-8	Acenaphthylene	Semi-Volatile	220	RAIS	6123	--	
120-12-7	Anthracene	Semi-Volatile	30	MTCA CLARC	20400	--	
56-55-3	Benzo(a)anthracene	Semi-Volatile	30	AWQC	398000	--	
50-32-8	Benzo(a)pyrene	Semi-Volatile	30	AWQC	1020000	--	
205-99-2	Benzo(b)fluoranthene	Semi-Volatile	30	AWQC	1230000	--	
UNK-009	Benzo(b,k)fluoranthene	Semi-Volatile	30	AWQC	1230000	--	Benzo(b)fluoranthene
191-24-2	Benzo(ghi)perylene	Semi-Volatile	30	Surrogate pyrene	2680000	--	
207-08-9	Benzo(k)fluoranthene	Semi-Volatile	30	AWQC	1230000	--	
65-85-0	Benzoic acid	Semi-Volatile	15.8	USEPA 1998: Combustor Facility Guidance	0.6	--	
86-74-8	Carbazole	Semi-Volatile	150	RAIS	3390	--	
218-01-9	Chrysene	Semi-Volatile	30	AWQC	398000	--	
53-70-3	Dibenzo(a,h)anthracene	Semi-Volatile	30	AWQC	3800000	--	

Table 9: Constituent-Specific Properties Used to Calculate Human Health and Ecological Groundwater Cleanup Levels Based on Protection of Surface Water

CAS Number	Indicator Hazardous Substances (IHS)	Class	Bioconcentration Factor (BCF) (L/kg)	BCF Source	Koc (L/kg)	kd (L/kg)	Koc Surrogate Chemical Data Used
132-64-9	Dibenzofuran	Semi-Volatile	300	RAIS	11300	--	
206-44-0	Fluoranthene	Semi-Volatile	1150	AWQC	107000	--	
86-73-7	Fluorene	Semi-Volatile	30	AWQC	13800	--	
67-72-1	Hexachloroethane	Semi-Volatile	87	MTCA CLARC	224.7	--	
193-39-5	Indeno(1,2,3-cd)pyrene	Semi-Volatile	30	AWQC	3470000	--	
CRESOLS34	Methylphenol, P-, M-	Semi-Volatile	6.4	RAIS	434	--	
91-20-3	Naphthalene	Semi-Volatile	10.5	AWQC	2000	--	
85-01-8	Phenanthrene	Semi-Volatile	0.0033	USEPA 1998: Combustor Facility Guidance	20800	--	
129-00-0	Pyrene	Semi-Volatile	30	AWQC	105000	--	Benzo(a)anthracene & chrysene
75-34-3	1,1-dichloroethane	Volatile	4.8	RAIS	31.6	--	
95-63-6	1,2,4-trimethylbenzene	Volatile	86	RAIS	3700	--	
106-46-7	1,4-dichlorobenzene	Volatile	55.6	AWQC	617	--	
67-64-1	Acetone	Volatile	3.2	RAIS	0.575	--	
71-43-2	Benzene	Volatile	5.2	AWQC	58.6	--	
108-90-7	Chlorobenzene	Volatile	10.3	AWQC	219	--	
75-00-3	Chloroethane	Volatile	2.5	RAIS	15	--	
156-59-2	Cis-1,2-dichloroethylene	Volatile	8.1	RAIS	35.5	--	trans-1,2-Dichloroethene
98-82-8	Cumene	Volatile	130	RAIS	817.2	--	m-Xylene
100-41-4	Ethylbenzene	Volatile	37.5	AWQC	363	--	
104-51-8	N-butylbenzene	Volatile	291	Surrogate t-butylbenzene	1110	--	Ethylbenzene
103-65-1	Propylbenzene	Volatile	38	HSDB	2800	--	Ethylbenzene
135-98-8	Sec-butylbenzene	Volatile	291	Surrogate t-butylbenzene	966	--	Ethylbenzene
98-06-6	Tert-butylbenzene	Volatile	291	HSDB	771	--	
108-88-3	Toluene	Volatile	10.7	AWQC	182	--	
75-01-4	Vinyl Chloride	Volatile	1.17	AWQC	18.6	--	
1330-20-7	Xylene (total)	Volatile	190	RAIS	410	--	

Notes:

-- = No value was available

L/kg = liters per kilogram
AWQC = U.S. Ambient Water Quality Criteria (Section 304 of the Clean Water Act)
HSDB = Hazardous Substances Database (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB)
MTCA CLARC = MTCA Cleanup Levels and Risk Calculations (https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx)
RAIS = Risk Assessment Information System (http://risk.lsd.ornl.gov/index.shtml)

Table 10: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Human Health

			Method B	Method B	API Fisher	API Fisher	Method C	Method C
			MTCA Method B - 730-2	MTCA Method B - 730-1	MTCA Method B - 730-2 Modified	MTCA Method B - 730-1 Modified	MTCA Method C - 750-2	MTCA Method C - 750-1
			Ingestion of Fish	Ingestion of Fish	Ingestion of Fish	Ingestion of Fish	Inhalation of Indoor Air	Inhalation of Indoor Air
			SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	Groundwater	Groundwater
			CR Goal = 1E-06	HQ Goal = 1	CR Goal = 1E-06	HQ Goal = 1	CR Goal = 1E-05	HQ Goal = 1
Cas_No	Indicator Hazardous Substance	Class	Cancer (ug/L)	NonCancer (ug/L)	Cancer (ug/L)	NonCancer (ug/L)	Cancer (ug/L)	NonCancer (ug/L)
7440-38-2	Arsenic	Inorganic	9.82E-02	1.77E+01	4.19E-02	7.54E+00	No Alpha	No Alpha
7440-39-3	Barium	Inorganic	No SF	1.30E+05	No SF	5.53E+04	No Alpha	No Alpha
7440-47-3	Chromium	Inorganic	No SF	2.43E+05	No SF	1.04E+05	No Alpha	No Alpha
7439-92-1	Lead	Inorganic	No SF	No RfD	No SF	No RfD	No Alpha	No Alpha
7439-97-6	Mercury	Inorganic	No SF	No RfD	No SF	No RfD	No SF	2.28E+01
7782-49-2	Selenium	Inorganic	No SF	6.48E+01	No SF	2.76E+01	No Alpha	No Alpha
7440-22-4	Silver	Inorganic	No SF	2.59E+03	No SF	1.11E+03	No Alpha	No Alpha
7440-66-6	Zinc	Inorganic	No SF	1.65E+04	No SF	7.05E+03	No Alpha	No Alpha
68334-30-5	Diesel	Petroleum	No BCF	No BCF	No BCF	No BCF	No Alpha	No Alpha
86290-81-5	Gasoline	Petroleum	No BCF	No BCF	No BCF	No BCF	No Alpha	No Alpha
541-73-1	1,3-dichlorobenzene	Semi-Volatile	No SF	7.78E+01	No SF	3.32E+01	No SF	No RfD
90-12-0	1-methylnaphthalene	Semi-Volatile	No SF	7.41E+01	No SF	3.16E+01	No SF	No RfD
105-67-9	2,4-dimethylphenol	Semi-Volatile	No SF	5.53E+02	No SF	2.36E+02	No Alpha	No Alpha
121-14-2	2,4-dinitrotoluene	Semi-Volatile	No SF	1.36E+03	No SF	5.82E+02	No Alpha	No Alpha
91-57-6	2-methylnaphthalene	Semi-Volatile	No SF	9.88E+02	No SF	4.21E+02	No SF	No RfD
95-48-7	2-methylphenol	Semi-Volatile	No SF	2.06E+04	No SF	8.77E+03	No Alpha	No Alpha
106-44-5	4-methylphenol	Semi-Volatile	No SF	2.09E+03	No SF	8.91E+02	No Alpha	No Alpha
83-32-9	Acenaphthene	Semi-Volatile	No SF	6.43E+02	No SF	2.74E+02	No SF	No RfD
208-96-8	Acenaphthylene	Semi-Volatile	No SF	No RfD	No SF	No RfD	No Alpha	No Alpha
120-12-7	Anthracene	Semi-Volatile	No SF	2.59E+04	No SF	1.11E+04	No Alpha	No Alpha
56-55-3	Benzo(a)anthracene	Semi-Volatile	2.96E-01	No RfD	1.26E-01	No RfD	No Alpha	No Alpha
50-32-8	Benzo(a)pyrene	Semi-Volatile	2.96E-02	No RfD	1.26E-02	No RfD	No Alpha	No Alpha
205-99-2	Benzo(b)fluoranthene	Semi-Volatile	2.96E-01	No RfD	1.26E-01	No RfD	3.41E+03	No RfD
UNK-009	Benzo(b,k)fluoranthene	Semi-Volatile	2.96E-01	No RfD	1.26E-01	No RfD	3.41E+03	No RfD
191-24-2	Benzo(g,h,i)perylene	Semi-Volatile	No SF	No RfD	No SF	No RfD	No Alpha	No Alpha
207-08-9	Benzo(k)fluoranthene	Semi-Volatile	2.96E-01	No RfD	1.26E-01	No RfD	No Alpha	No Alpha
65-85-0	Benzoic Acid	Semi-Volatile	No SF	6.56E+05	No SF	2.80E+05	No Alpha	No Alpha
86-74-8	Carbazole	Semi-Volatile	2.16E+00	No RfD	9.21E-01	No RfD	No Alpha	No Alpha
218-01-9	Chrysene	Semi-Volatile	2.96E+00	No RfD	1.26E+00	No RfD	3.31E+04	No RfD
53-70-3	Dibenz(a,h)anthracene	Semi-Volatile	2.96E-01	No RfD	1.26E-01	No RfD	No Alpha	No Alpha
132-64-9	Dibenzofuran	Semi-Volatile	No SF	3.46E+01	No SF	1.47E+01	No SF	No RfD
206-44-0	Fluoranthene	Semi-Volatile	No SF	9.02E+01	No SF	3.84E+01	No Alpha	No Alpha
86-73-7	Fluorene	Semi-Volatile	No SF	3.46E+03	No SF	1.47E+03	No SF	No RfD
67-72-1	Hexachloroethane	Semi-Volatile	5.32E+00	2.98E+01	2.27E+00	1.27E+01	No SF	No RfD
193-39-5	Indeno(1,2,3-cd)pyrene	Semi-Volatile	2.96E-01	No RfD	1.26E-01	No RfD	No Alpha	No Alpha

Table 10: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Human Health

			Method B	Method B	API Fisher	API Fisher	Method C	Method C
			MTCA Method B - 730-2	MTCA Method B - 730-1	MTCA Method B - 730-2 Modified	MTCA Method B - 730-1 Modified	MTCA Method C - 750-2	MTCA Method C - 750-1
			Ingestion of Fish	Ingestion of Fish	Ingestion of Fish	Ingestion of Fish	Inhalation of Indoor Air	Inhalation of Indoor Air
			SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	Groundwater	Groundwater
			CR Goal = 1E-06	HQ Goal = 1	CR Goal = 1E-06	HQ Goal = 1	CR Goal = 1E-05	HQ Goal = 1
Cas_No	Indicator Hazardous Substance	Class	Cancer (ug/L)	NonCancer (ug/L)	Cancer (ug/L)	NonCancer (ug/L)	Cancer (ug/L)	NonCancer (ug/L)
CRESOLS34	Methylphenol, P-, M-	Semi-Volatile	No SF	No RfD	No SF	No RfD	No Alpha	No Alpha
91-20-3	Naphthalene	Semi-Volatile	No SF	4.94E+03	No SF	2.11E+03	No SF	2.14E+03
85-01-8	Phenanthrene	Semi-Volatile	No SF	No RfD	No SF	No RfD	No Alpha	No Alpha
129-00-0	Pyrene	Semi-Volatile	No SF	2.59E+03	No SF	1.11E+03	No SF	No RfD
75-34-3	1,1-dichloroethane	Volatile	No SF	5.40E+04	No SF	2.30E+04	No SF	1.75E+04
95-63-6	1,2,4-trimethylbenzene	Volatile	No SF	1.51E+03	No SF	6.43E+02	No SF	3.20E+02
106-46-7	1,4-dichlorobenzene	Volatile	4.86E+00	No RfD	2.07E+00	No RfD	No SF	9.45E+04
67-64-1	Acetone	Volatile	No SF	7.29E+05	No SF	3.11E+05	No SF	No RfD
71-43-2	Benzene	Volatile	2.27E+01	1.99E+03	9.66E+00	8.50E+02	1.05E+02	9.81E+02
104-51-8	Butylbenzene,n-	Volatile	No SF	No RfD	No SF	No RfD	No SF	No RfD
108-90-7	Chlorobenzene	Volatile	No SF	5.03E+03	No SF	2.15E+03	No SF	1.31E+03
75-00-3	Chloroethane	Volatile	8.94E+02	4.15E+05	3.81E+02	1.77E+05	No SF	7.95E+04
156-59-2	Cis-1,2-dichloroethene	Volatile	No SF	3.20E+03	No SF	1.36E+03	No SF	1.73E+03
100-41-4	Ethylbenzene	Volatile	No SF	6.91E+03	No SF	2.95E+03	No SF	3.10E+04
98-82-8	Cumene	Volatile	No SF	1.99E+03	No SF	8.50E+02	No SF	9.27E+03
103-65-1	n-Propylbenzene	Volatile	No SF	2.73E+03	No SF	1.16E+03	No SF	4.27E+03
135-98-8	Sec-butylbenzene	Volatile	No SF	3.56E+02	No SF	1.52E+02	No SF	5.29E+06
98-06-6	Tert-butylbenzene	Volatile	No SF	3.56E+02	No SF	1.52E+02	No SF	3.46E+03
108-88-3	Toluene	Volatile	No SF	1.94E+04	No SF	8.26E+03	No SF	1.50E+05
75-01-4	Vinyl Chloride	Volatile	3.96E+00	6.65E+03	1.69E+00	2.83E+03	1.28E+01	4.50E+02
1330-20-7	Xylene (total)	Volatile	No SF	2.73E+03	No SF	1.16E+03	No SF	3.15E+03

Notes:

Final FS CULs = These are the most stringent applicable CULs and are the initial CULs that will be considered in the Feasibility Study (FS). As such, they may be adjusted upward or downward based on area background concentrations, practical quantitation limits, or other information, as appropriate, in the FS.

-- = No value was available

API Fisher = Asian Pacific Islander Fisherman

AWQC = Federal Ambient Water Quality Criteria (Section 304 of the Clean Water Act)

CR = Cancer Risk

CUL = Cleanup Level

HQ = Hazard Quotient

MTCA = Model Toxics Control Act (WAC 173-340)

No BCF = No bioconcentration factor was available to calculate the cleanup level

No Alpha = No groundwater to indoor air volatilization factor was available to calculate the cleanup level

No RfD = No Reference Dose was available to calculate the cleanup level

No SF = No Slope Factor was available to calculate the cleanup level

[1] Used as surrogate cleanup levels for surface water because surface water TPH cleanup levels are not available.

Table 10: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Human Health

Cas_No	Indicator Hazardous Substance	Class	AWQC Federal Human Health Consumption of Organisms Only SurfaceWater (ug/L)	AWQC Federal Organoleptic Effect Criteria SurfaceWater (ug/L)	MTCA Method A Table 720-1 Values Petroleum Related MTCA Method A Table 720-1 Values Groundwater[1] (ug/L)
7440-38-2	Arsenic	Inorganic	1.40E-01	--	--
7440-39-3	Barium	Inorganic	--	--	--
7440-47-3	Chromium	Inorganic	--	--	--
7439-92-1	Lead	Inorganic	--	--	--
7439-97-6	Mercury	Inorganic	3.00E-01	--	--
7782-49-2	Selenium	Inorganic	4.20E+03	--	--
7440-22-4	Silver	Inorganic	--	--	--
7440-66-6	Zinc	Inorganic	2.60E+04	5.00E+03	--
68334-30-5	Diesel	Petroleum	--	--	5.00E+02
86290-81-5	Gasoline	Petroleum	--	--	8.00E+02
541-73-1	1,3-dichlorobenzene	Semi-Volatile	9.60E+02	--	--
90-12-0	1-methylnaphthalene	Semi-Volatile	--	--	--
105-67-9	2,4-dimethylphenol	Semi-Volatile	8.50E+02	4.00E+02	--
121-14-2	2,4-dinitrotoluene	Semi-Volatile	3.40E+00	--	--
91-57-6	2-methylnaphthalene	Semi-Volatile	--	--	--
95-48-7	2-methylphenol	Semi-Volatile	--	--	--
106-44-5	4-methylphenol	Semi-Volatile	--	--	--
83-32-9	Acenaphthene	Semi-Volatile	9.90E+02	2.00E+01	--
208-96-8	Acenaphthylene	Semi-Volatile	--	--	--
120-12-7	Anthracene	Semi-Volatile	4.00E+04	--	--
56-55-3	Benzo(a)anthracene	Semi-Volatile	1.80E-02	--	--
50-32-8	Benzo(a)pyrene	Semi-Volatile	1.80E-02	--	--
205-99-2	Benzo(b)fluoranthene	Semi-Volatile	1.80E-02	--	--
UNK-009	Benzo(b,k)fluoranthene	Semi-Volatile	--	--	--
191-24-2	Benzo(g,h,i)perylene	Semi-Volatile	--	--	--
207-08-9	Benzo(k)fluoranthene	Semi-Volatile	1.80E-02	--	--
65-85-0	Benzoic Acid	Semi-Volatile	--	--	--
86-74-8	Carbazole	Semi-Volatile	--	--	--
218-01-9	Chrysene	Semi-Volatile	1.80E-02	--	--
53-70-3	Dibenz(a,h)anthracene	Semi-Volatile	1.80E-02	--	--
132-64-9	Dibenzofuran	Semi-Volatile	--	--	--
206-44-0	Fluoranthene	Semi-Volatile	1.40E+02	--	--
86-73-7	Fluorene	Semi-Volatile	5.30E+03	--	--
67-72-1	Hexachloroethane	Semi-Volatile	3.30E+00	--	--
193-39-5	Indeno(1,2,3-cd)pyrene	Semi-Volatile	1.80E-02	--	--

Table 10: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Human Health

Cas_No	Indicator Hazardous Substance	Class	AWQC Federal Human Health Consumption of Organisms Only SurfaceWater (ug/L)	AWQC Federal Organoleptic Effect Criteria SurfaceWater (ug/L)	MTCA Method A Table 720-1 Values Petroleum Related MTCA Method A Table 720-1 Values Groundwater[1] (ug/L)
CRESOLS34	Methylphenol, P-, M-	Semi-Volatile	--	--	--
91-20-3	Naphthalene	Semi-Volatile	--	--	--
85-01-8	Phenanthrene	Semi-Volatile	--	--	--
129-00-0	Pyrene	Semi-Volatile	4.00E+03	--	--
75-34-3	1,1-dichloroethane	Volatile	--	--	--
95-63-6	1,2,4-trimethylbenzene	Volatile	--	--	--
106-46-7	1,4-dichlorobenzene	Volatile	1.90E+02	--	--
67-64-1	Acetone	Volatile	--	--	--
71-43-2	Benzene	Volatile	5.10E+01	--	
104-51-8	Butylbenzene,n-	Volatile	--	--	--
108-90-7	Chlorobenzene	Volatile	1.60E+03	2.00E+01	--
75-00-3	Chloroethane	Volatile	--	--	--
156-59-2	Cis-1,2-dichloroethene	Volatile	--	--	--
100-41-4	Ethylbenzene	Volatile	2.10E+03	--	--
98-82-8	Cumene	Volatile	--	--	--
103-65-1	n-Propylbenzene	Volatile	--	--	--
135-98-8	Sec-butylbenzene	Volatile	--	--	--
98-06-6	Tert-butylbenzene	Volatile	--	--	--
108-88-3	Toluene	Volatile	1.50E+04	--	--
75-01-4	Vinyl Chloride	Volatile	2.40E+00	--	--
1330-20-7	Xylene (total)	Volatile	--	--	--

Notes:

Final FS CULs = These are the most stringent applicable CULs and are the initial CULs that will be considered in the Feasibility Study (FS). As such, they may be adjusted upward or downward based on area background concentrations, practical quantitation limits, or other information, as appropriate, in the FS.

-- = No value was available

API Fisher = Asian Pacific Islander Fisherman

AWQC = Federal Ambient Water Quality Criteria (Section 304 of the Clean Water Act)

CR = Cancer Risk

CUL = Cleanup Level

HQ = Hazard Quotient

MTCA = Model Toxics Control Act (WAC 173-340)

No BCF = No bioconcentration factor was available to calculate the cleanup level

No Alpha = No groundwater to indoor air volatilization factor was available to calculate the cleanup level

No RfD = No Reference Dose was available to calculate the cleanup level

No SF = No Slope Factor was available to calculate the cleanup level

[1] Used as surrogate cleanup levels for surface water because surface water TPH cleanup levels are not available.

Table 11: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Ecological Receptors

			AWQC	AWQC	AWQC	AWQC	WA State	WA State	WA State	WA State
			Federal	Federal	Federal	Federal	WAC 173-201A	WAC 173-201A	WAC 173-201A	WAC 173-201A
			FreshWater CMC	Freshwater CCC	Saltwater CMC	Saltwater CCC	Freshwater Acute	Freshwater Chronic	Marine Acute	Marine Chronic
			SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater
Cas_No	Indicator Hazardous Substance	Class	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
7440-38-2	Arsenic	Inorganic	3.40E+02	1.50E+02	6.90E+01	3.60E+01	3.60E+02	1.90E+02	6.90E+01	3.60E+01
7440-39-3	Barium	Inorganic	--	--	--	--	--	--	--	--
7440-47-3	Chromium	Inorganic	5.70E+02	7.40E+01	--	--	--	--	--	--
7439-92-1	Lead	Inorganic	6.50E+01	2.50E+00	2.10E+02	8.10E+00	--	--	2.10E+02	8.10E+00
7439-97-6	Mercury	Inorganic	1.40E+00	7.70E-01	1.80E+00	9.40E-01	2.10E+00	1.20E-02	1.80E+00	2.50E-02
7782-49-2	Selenium	Inorganic	--	5.00E+00	2.90E+02	7.10E+01	2.00E+01	5.00E+00	2.90E+02	7.10E+01
7440-22-4	Silver	Inorganic	3.20E+00	--	1.90E+00	--	--	--	1.90E+00	--
7440-66-6	Zinc	Inorganic	1.20E+02	1.20E+02	9.00E+01	8.10E+01	--	--	9.00E+01	8.10E+01
68334-30-5	Diesel	Petroleum	--	--	--	--	--	--	--	--
86290-81-5	Gasoline	Petroleum	--	--	--	--	--	--	--	--
541-73-1	1,3-dichlorobenzene	Semi-Volatile	--	--	--	--	--	--	--	--
90-12-0	1-methylnaphthalene	Semi-Volatile	--	--	--	--	--	--	--	--
105-67-9	2,4-dimethylphenol	Semi-Volatile	--	--	--	--	--	--	--	--
121-14-2	2,4-dinitrotoluene	Semi-Volatile	--	--	--	--	--	--	--	--
91-57-6	2-methylnaphthalene	Semi-Volatile	--	--	--	--	--	--	--	--
95-48-7	2-methylphenol	Semi-Volatile	--	--	--	--	--	--	--	--
106-44-5	4-methylphenol	Semi-Volatile	--	--	--	--	--	--	--	--
83-32-9	Acenaphthene	Semi-Volatile	--	--	--	--	--	--	--	--
208-96-8	Acenaphthylene	Semi-Volatile	--	--	--	--	--	--	--	--
120-12-7	Anthracene	Semi-Volatile	--	--	--	--	--	--	--	--
56-55-3	Benzo(a)anthracene	Semi-Volatile	--	--	--	--	--	--	--	--
50-32-8	Benzo(a)pyrene	Semi-Volatile	--	--	--	--	--	--	--	--
205-99-2	Benzo(b)fluoranthene	Semi-Volatile	--	--	--	--	--	--	--	--
UNK-009	Benzo(b,k)fluoranthene	Semi-Volatile	--	--	--	--	--	--	--	--
191-24-2	Benzo(g,h,i)perylene	Semi-Volatile	--	--	--	--	--	--	--	--
207-08-9	Benzo(k)fluoranthene	Semi-Volatile	--	--	--	--	--	--	--	--
65-85-0	Benzoic Acid	Semi-Volatile	--	--	--	--	--	--	--	--
86-74-8	Carbazole	Semi-Volatile	--	--	--	--	--	--	--	--
218-01-9	Chrysene	Semi-Volatile	--	--	--	--	--	--	--	--
53-70-3	Dibenz(a,h)anthracene	Semi-Volatile	--	--	--	--	--	--	--	--

Table 11: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Ecological Receptors

			AWQC	AWQC	AWQC	AWQC	WA State	WA State	WA State	WA State
			Federal	Federal	Federal	Federal	WAC 173-201A	WAC 173-201A	WAC 173-201A	WAC 173-201A
			FreshWater CMC	Freshwater CCC	Saltwater CMC	Saltwater CCC	Freshwater Acute	Freshwater Chronic	Marine Acute	Marine Chronic
			SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater
Cas_No	Indicator Hazardous Substance	Class	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
132-64-9	Dibenzofuran	Semi-Volatile	--	--	--	--	--	--	--	--
206-44-0	Fluoranthene	Semi-Volatile	--	--	--	--	--	--	--	--
86-73-7	Fluorene	Semi-Volatile	--	--	--	--	--	--	--	--
67-72-1	Hexachloroethane	Semi-Volatile	--	--	--	--	--	--	--	--
193-39-5	Indeno(1,2,3-cd)pyrene	Semi-Volatile	--	--	--	--	--	--	--	--
CRESOLS34	Methylphenol, P-, M-	Semi-Volatile	--	--	--	--	--	--	--	--
91-20-3	Naphthalene	Semi-Volatile	--	--	--	--	--	--	--	--
85-01-8	Phenanthrene	Semi-Volatile	--	--	--	--	--	--	--	--
129-00-0	Pyrene	Semi-Volatile	--	--	--	--	--	--	--	--
75-34-3	1,1-dichloroethane	Volatile	--	--	--	--	--	--	--	--
95-63-6	1,2,4-trimethylbenzene	Volatile	--	--	--	--	--	--	--	--
106-46-7	1,4-dichlorobenzene	Volatile	--	--	--	--	--	--	--	--
67-64-1	Acetone	Volatile	--	--	--	--	--	--	--	--
71-43-2	Benzene	Volatile	--	--	--	--	--	--	--	--
104-51-8	Butylbenzene,n-	Volatile	--	--	--	--	--	--	--	--
108-90-7	Chlorobenzene	Volatile	--	--	--	--	--	--	--	--
75-00-3	Chloroethane	Volatile	--	--	--	--	--	--	--	--
156-59-2	Cis-1,2-dichloroethene	Volatile	--	--	--	--	--	--	--	--
100-41-4	Ethylbenzene	Volatile	--	--	--	--	--	--	--	--
98-82-8	Cumene	Volatile	--	--	--	--	--	--	--	--
103-65-1	n-Propylbenzene	Volatile	--	--	--	--	--	--	--	--

Table 11: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Ecological Receptors

Cas_No	Indicator Hazardous Substance	Class	AWQC Federal FreshWater CMC SurfaceWater (ug/L)	AWQC Federal Freshwater CCC SurfaceWater (ug/L)	AWQC Federal Saltwater CMC SurfaceWater (ug/L)	AWQC Federal Saltwater CCC SurfaceWater (ug/L)	WA State WAC 173-201A Freshwater Acute SurfaceWater (ug/L)	WA State WAC 173-201A Freshwater Chronic SurfaceWater (ug/L)	WA State WAC 173-201A Marine Acute SurfaceWater (ug/L)	WA State WAC 173-201A Marine Chronic SurfaceWater (ug/L)
135-98-8	Sec-butylbenzene	Volatile	--	--	--	--	--	--	--	--
98-06-6	Tert-butylbenzene	Volatile	--	--	--	--	--	--	--	--
108-88-3	Toluene	Volatile	--	--	--	--	--	--	--	--
75-01-4	Vinyl Chloride	Volatile	--	--	--	--	--	--	--	--
1330-20-7	Xylene (total)	Volatile	--	--	--	--	--	--	--	--

Notes:

Final FS CULs = These are the most stringent applicable CULs and are the initial CULs that will be considered in the Feasibility Study (FS). As such, they may be adjusted upward or downward based on area background concentrations, practical quantitation limits, or other information, as appropriate, in the FS.

-- = No value was available

AWQC = Federal Ambient Water Quality Criteria (Section 304 of the Clean Water Act)

CCC = Criteria Continuous Concentration

CMC = Criteria Maximum Concentration

CUL = Cleanup Level

Eco = Ecological

ECOTOX = U.S. EPA Ecotoxicity Database - available on-line at http://www.epa.gov/ecotox/

MTCA = Model Toxics Control Act (WAC 173-340)

NC = not calculated because a promulgated Federal or State surface water standard or a risk-based ecological cleanup level was available.

No BCF = No bioconcentration factor was available to calculate the cleanup level

ORNL = Oak Ridge Nation Laboratory Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota - http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html and go to screening benchmark reports

RA = Risk Assessment

RAIS = Risk Assessment Information System - available online at http://risk.lsd.ornl.gov/index.shtml

State AWQC = WAC 173-201A - Water Quality Standards for Surface Waters of the State of Washington

USGS 1999 = United States Geological Survey - Selection Procedure and Salient Information for Volatile Organic Compounds Emphasized in National Water Quality

[1] Risk-based ecological cleanup levels were only calculated if a promulgated Federal or State surfacewater standard was not available.

Table 11: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Ecological Receptors

			AWQC	AWQC	AWQC	AWQC	WA State	WA State	WA State	WA State
			Federal	Federal	Federal	Federal	WAC 173-201A	WAC 173-201A	WAC 173-201A	WAC 173-201A
			FreshWater CMC	Freshwater CCC	Saltwater CMC	Saltwater CCC	Freshwater Acute	Freshwater Chronic	Marine Acute	Marine Chronic
			SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater
Cas_No	Indicator Hazardous Substance	Class	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)

[2] Surface water cleanup levels were calculated based on sediment standards presented in WAC 173-204 using Equation 747-1 in WAC 173-340-747 only if a a promulgated Federal or State surface water standard was not available and an risk-based ecological cleanup level was not available.

Table 11: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Ecological Receptors

			Eco RA	Eco RA	Eco RA	WA State	WA State	WA State	WA State
			Ecological	Ecological	Ecological	WA State WAC 173-204	WA State WAC 173-204	WA State WAC 173-204	WA State WAC 173-204
			Ecolgical Risk Assessment Value[1]	Basis of Ecological Risk Assessment Value	Comment on Ecological Risk Assessment Value	Based on Table 1 Marine Sediment Quality Standards (173 204-320) mg/kg Dry Weight[2]	Based on Table 1 Marine Sediment Quality Standards (173 204-320) mg/kg Dry Weight (Organic Carbon Normalized)[2]	Based on Table III Cleanup Screening Levels Criteria (173-204-520) mg/kg Dry Weight[2]	Based on Table III Cleanup Screening Levels Criteria (173-204-520) mg/kg Dry Weight (Organic Carbon Normalized)[2]
			SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater
Cas_No	Indicator Hazardous Substance	Class	(ug/L)	Source	Comment	(ug/L)	(ug/L)	(ug/L)	(ug/L)
7440-38-2	Arsenic	Inorganic	NC	--	--	NC	NC	NC	NC
7440-39-3	Barium	Inorganic	5.70E+03	ECOTOX	--	NC	NC	NC	NC
7440-47-3	Chromium	Inorganic	NC	--	--	NC	NC	NC	NC
7439-92-1	Lead	Inorganic	NC	--	--	NC	NC	NC	NC
7439-97-6	Mercury	Inorganic	NC	--	--	NC	NC	NC	NC
7782-49-2	Selenium	Inorganic	NC	--	--	NC	NC	NC	NC
7440-22-4	Silver	Inorganic	NC	--	--	NC	NC	NC	NC
7440-66-6	Zinc	Inorganic	NC	--	--	NC	NC	NC	NC
68334-30-5	Diesel	Petroleum	--	--	--	--	--	--	--
86290-81-5	Gasoline	Petroleum	--	--	--	--	--	--	--
541-73-1	1,3-dichlorobenzene	Semi-Volatile	2.06E+02	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
90-12-0	1-methylnaphthalene	Semi-Volatile	1.19E+03	ECOTOX	--	NC	NC	NC	NC
105-67-9	2,4-dimethylphenol	Semi-Volatile	3.97E+02	ECOTOX	--	NC	NC	NC	NC
121-14-2	2,4-dinitrotoluene	Semi-Volatile	3.07E+02	ECOTOX	--	NC	NC	NC	NC
91-57-6	2-methylnaphthalene	Semi-Volatile	3.73E+02	ECOTOX	--	NC	NC	NC	NC
95-48-7	2-methylphenol	Semi-Volatile	4.02E+03	ECOTOX; cresol as surrogate	--	NC	NC	NC	NC
106-44-5	4-methylphenol	Semi-Volatile	1.83E+03	ECOTOX; cresol as surrogate	--	NC	NC	NC	NC
83-32-9	Acenaphthene	Semi-Volatile	3.40E+01	ECOTOX	--	NC	NC	NC	NC
208-96-8	Acenaphthylene	Semi-Volatile	--	--	--	--	1.07E+01	--	1.07E+01
120-12-7	Anthracene	Semi-Volatile	2.68E+00	ECOTOX	--	NC	NC	NC	NC
56-55-3	Benzo(a)anthracene	Semi-Volatile	--	--	--	--	2.76E-01	--	6.78E-01
50-32-8	Benzo(a)pyrene	Semi-Volatile	1.10E-01	ECOTOX	--	NC	NC	NC	NC
205-99-2	Benzo(b)fluoranthene	Semi-Volatile	--	--	--	--	1.87E-01	--	3.66E-01
UNK-009	Benzo(b,k)fluoranthene	Semi-Volatile	--	--	--	--	1.87E-01	--	3.66E-01
191-24-2	Benzo(g,h,i)perylene	Semi-Volatile	--	--	--	--	1.16E-02	--	2.91E-02
207-08-9	Benzo(k)fluoranthene	Semi-Volatile	--	--	--	--	1.87E-01	--	3.66E-01
65-85-0	Benzoic Acid	Semi-Volatile	2.95E+03	ECOTOX	--	NC	NC	NC	NC
86-74-8	Carbazole	Semi-Volatile	2.99E+02	ECOTOX	--	NC	NC	NC	NC
218-01-9	Chrysene	Semi-Volatile	1.56E+03	ECOTOX	--	NC	NC	NC	NC
53-70-3	Dibenz(a,h)anthracene	Semi-Volatile	--	--	--	--	3.16E-03	--	8.68E-03

Table 11: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Ecological Receptors

			Eco RA	Eco RA	Eco RA	WA State	WA State	WA State	WA State
			Ecological	Ecological	Ecological	WA State WAC 173-204	WA State WAC 173-204	WA State WAC 173-204	WA State WAC 173-204
			Ecolgical Risk Assessment Value[1]	Basis of Ecological Risk Assessment Value	Comment on Ecological Risk Assessment Value	Based on Table 1 Marine Sediment Quality Standards (173 204-320) mg/kg Dry Weight (Organic Carbon Normalized)[2]	Based on Table 1 Marine Sediment Quality Standards (173 204-320) mg/kg Dry Weight (Organic Carbon Normalized)[2]	Based on Table III Cleanup Screening Levels Criteria (173-204-520) mg/kg Dry Weight[2]	Based on Table III Cleanup Screening Levels Criteria (173-204-520) mg/kg Dry Weight (Organic Carbon Normalized)[2]
			SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater
Cas_No	Indicator Hazardous Substance	Class	(ug/L)	Source	Comment	(ug/L)	(ug/L)	(ug/L)	(ug/L)
132-64-9	Dibenzofuran	Semi-Volatile	2.68E+02	ECOTOX	--	NC	NC	NC	NC
206-44-0	Fluoranthene	Semi-Volatile	4.10E+00	ECOTOX	--	NC	NC	NC	NC
86-73-7	Fluorene	Semi-Volatile	7.80E+01	ECOTOX	--	NC	NC	NC	NC
67-72-1	Hexachloroethane	Semi-Volatile	3.90E+02	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
193-39-5	Indeno(1,2,3-cd)pyrene	Semi-Volatile	--	--	--	--	9.80E-03	--	2.54E-02
CRESOLS34	Methylphenol, P-, M-	Semi-Volatile	1.25E+03	ECOTOX	--	NC	NC	NC	NC
91-20-3	Naphthalene	Semi-Volatile	9.70E+01	ECOTOX	--	NC	NC	NC	NC
85-01-8	Phenanthrene	Semi-Volatile	2.20E+01	ECOTOX	--	NC	NC	NC	NC
129-00-0	Pyrene	Semi-Volatile	3.50E+01	ECOTOX	--	NC	NC	NC	NC
75-34-3	1,1-dichloroethane	Volatile	2.80E+03	ORNL; lowest chronic value	--	NC	NC	NC	NC
95-63-6	1,2,4-trimethylbenzene	Volatile	3.03E+03	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
106-46-7	1,4-dichlorobenzene	Volatile	1.62E+02	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
67-64-1	Acetone	Volatile	6.67E+02	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
71-43-2	Benzene	Volatile	2.42E+03	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
104-51-8	Butylbenzene,n-	Volatile	1.53E+02	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
108-90-7	Chlorobenzene	Volatile	5.60E+01	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
75-00-3	Chloroethane	Volatile	2.30E+05	USGS 1997;Table 3	--	NC	NC	NC	NC
156-59-2	Cis-1,2-dichloroethene	Volatile	1.16E+04	USGS 1997;Table 3	--	NC	NC	NC	NC
100-41-4	Ethylbenzene	Volatile	1.32E+02	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
98-82-8	Cumene	Volatile	4.13E+02	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
103-65-1	n-Propylbenzene	Volatile	3.01E+02	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC

Table 11: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Ecological Receptors

			Eco RA	Eco RA	Eco RA	WA State	WA State	WA State	WA State
			Ecological	Ecological	Ecological	WA State WAC 173-204	WA State WAC 173-204	WA State WAC 173-204	WA State WAC 173-204
			Ecolgical Risk Assessment Value[1]	Basis of Ecological Risk Assessment Value	Comment on Ecological Risk Assessment Value	Based on Table 1 Marine Sediment Quality Standards (173 204-320) mg/kg Dry Weight[2]	Based on Table 1 Marine Sediment Quality Standards (173 204-320) mg/kg Dry Weight (Organic Carbon Normalized)[2]	Based on Table III Cleanup Screening Levels Criteria (173-204-520) mg/kg Dry Weight[2]	Based on Table III Cleanup Screening Levels Criteria (173-204-520) mg/kg Dry Weight (Organic Carbon Normalized)[2]
			SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater	SurfaceWater
Cas_No	Indicator Hazardous Substance	Class	(ug/L)	Source	Comment	(ug/L)	(ug/L)	(ug/L)	(ug/L)
135-98-8	Sec-butylbenzene	Volatile	1.53E+02	ECOTOX; n-butylbenzene as surrogate	Value is Highly Uncertain	NC	NC	NC	NC
98-06-6	Tert-butylbenzene	Volatile	7.31E+03	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
108-88-3	Toluene	Volatile	3.40E+03	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC
75-01-4	Vinyl Chloride	Volatile	9.30E+02	RAIS	--	NC	NC	NC	NC
1330-20-7	Xylene (total)	Volatile	1.85E+03	ECOTOX	Value is Highly Uncertain	NC	NC	NC	NC

Notes:

Final FS CULs = These are the most stringent applicable CULs and are the initial CULs that will be considered in the Feasibility Study (FS). As such, they may be adjusted upward or downward based on area background concentrations, practical quantitation limits, or other information, as appropriate, in the FS.

-- = No value was available

AWQC = Federal Ambient Water Quality Criteria (Section 304 of the Clean Water Act)

CCC = Criteria Continuous Concentration

CMC = Criteria Maximum Concentration

CUL = Cleanup Level

Eco = Ecological

ECOTOX = U.S. EPA Ecotoxicity Database - available on-line at http://www.epa.gov/ecotox/

MTCA = Model Toxics Control Act (WAC 173-340)

NC = not calculated because a promulgated Federal or State surface water standard or a risk-based ecological cleanup level was available.

No BCF = No bioconcentration factor was available to calculate the cleanup level

ORNL = Oak Ridge Nation Laboratory Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota - http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html and go to screening benchmark reports

RA = Risk Assessment

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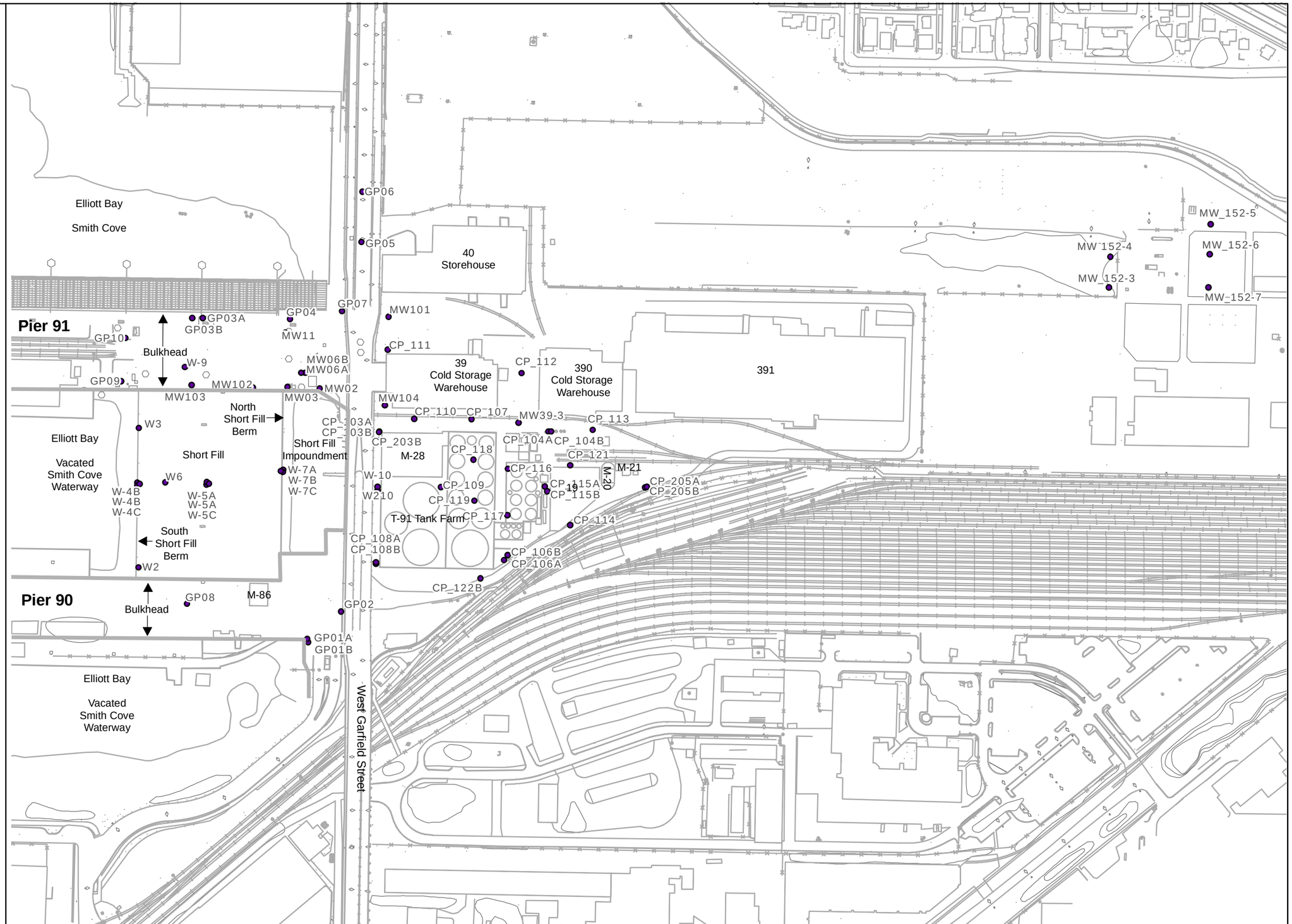
[1] Risk-based ecological cleanup levels were only calculated if a promulgated Federal or State surfacewater standard was not available.

Table 11: Terminal 91 Tank Farm - Feasibility Study Cleanup Levels Based on Protection of Ecological Receptors

Cas_No	Indicator Hazardous Substance	Class	Eco RA Ecological Ecological Risk Assessment Value[1] SurfaceWater (ug/L)	Eco RA Ecological Basis of Ecological Risk Assessment Value SurfaceWater Source	Eco RA Ecological Comment on Ecological Risk Assessment Value SurfaceWater Comment	WA State WA State WAC 173-204 Based on Table 1 Marine Sediment Quality Standards (173 204-320) mg/kg Dry Weight[2] SurfaceWater (ug/L)	WA State WA State WAC 173-204 Based on Table 1 Marine Sediment Quality Standards (173 204-320) mg/kg Dry Weight (Organic Carbon Normalized)[2] SurfaceWater (ug/L)	WA State WA State WAC 173-204 Based on Table III Cleanup Screening Levels Criteria (173-204-520) mg/kg Dry Weight[2] SurfaceWater (ug/L)	WA State WA State WAC 173-204 Based on Table III Cleanup Screening Levels Criteria (173-204-520) mg/kg Dry Weight (Organic Carbon Normalized)[2] SurfaceWater (ug/L)

[2] Surface water cleanup levels were calculated based on sediment standards presented in WAC 173-204 using Equation 747-1 in WAC 173-340-747 only if a a promulgated Federal or State surface water standard was not available and an risk-based ecological cleanup level was not available.

Figures



Notes:

The tank farm is shown for illustrative purposes only. The tank farm was demolished and paved in 2005.

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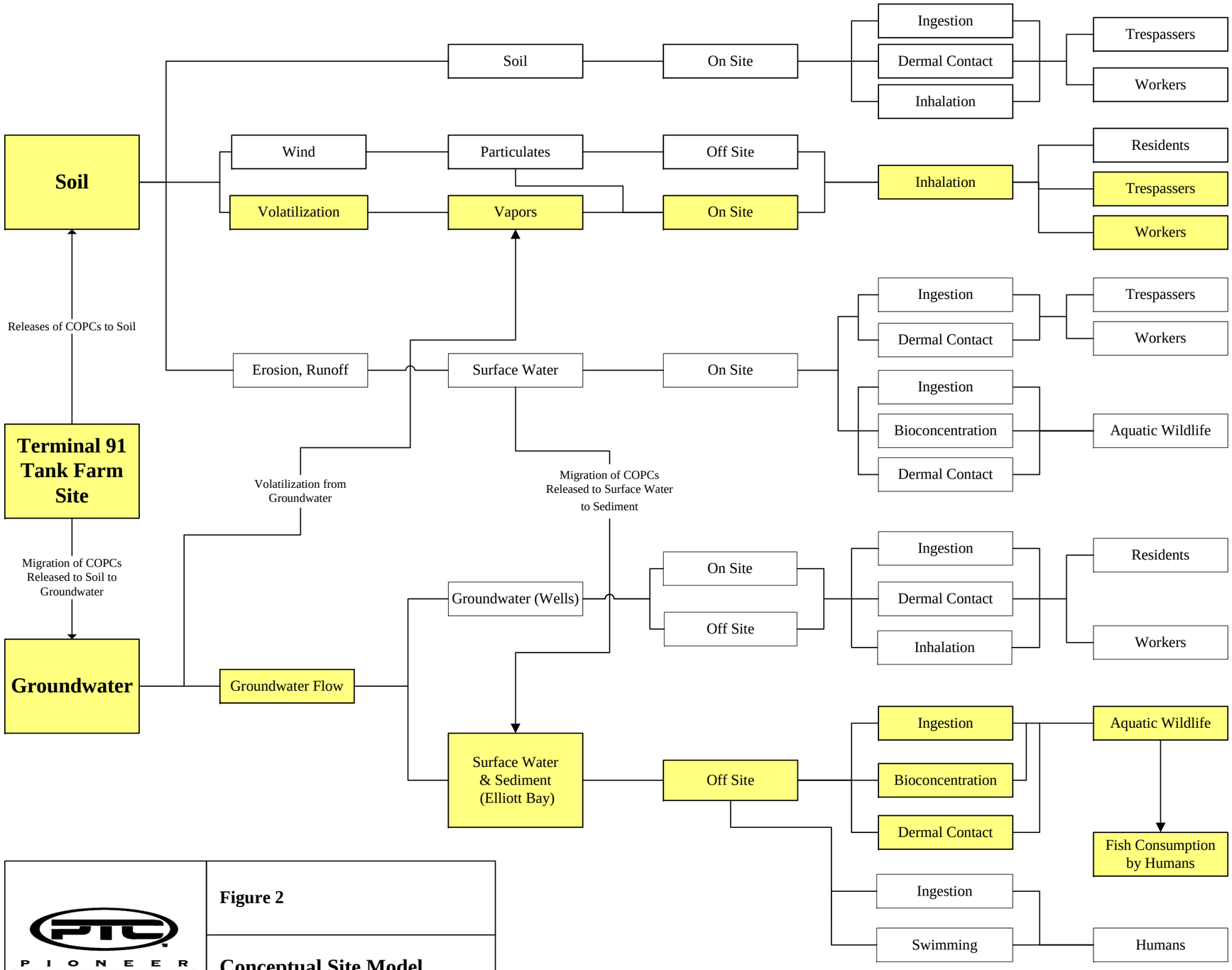
Site Plan

Terminal 91 Tank Farm Site

Seattle, Washington

DRAWN BY:	PROJECT NO.:
BR	**5500.001**
DATE:	FIGURE NO.:
May 2008	1



Primary and Secondary Sources	Transport Mechanism	Exposure Medium	Exposure Point	Exposure Route	Potential Receptor	Complete Pathway?	Rationale
Soil		Soil	On Site	Ingestion, Dermal Contact, Inhalation	Trespassers	No	The site is almost completely paved or is covered by buildings. As an institutional control, the Port of Seattle will not demolish the pavement. Occasional workers (such as trench utility workers) with the potential to encounter impacted soil in trenches will be notified prior to those activities.
					Workers	No	
	Wind	Particulates	Off Site	Inhalation	Residents	No	Inhalation of particulates is not a complete exposure pathway for off-site or on-site receptors because the site is almost completely paved or is covered by buildings. Inhalation of indoor air impacted by vapor intrusion from soil and/or vapor intrusion from groundwater is a potentially-complete exposure pathway for on-site current/future trespassers and for on-site current/future workers.
	Volatilization	Vapors	On Site		Trespassers	**Yes**	
					Workers	**Yes**	
	Erosion, Runoff	Surface Water	On Site	Ingestion, Dermal Contact	Trespassers	No	The site is almost completely paved or is covered by buildings, which minimizes erosion of soils. Storm water is either discharged to the sanitary sewer or collected in catch basins and discharged via storm drains, which further limits erosion from the site. The only surface water impoundment near the site is the short fill impoundment. The Port of Seattle plans to fill or cover the impoundment. As an institutional control, the Port of Seattle will not demolish the pavement.
					Workers	No	
				Ingestion, Bioconcentration, Dermal Contact	Aquatic Wildlife	No	
Groundwater	Groundwater Flow	Groundwater (Wells)	On Site, Off Site	Ingestion, Dermal Contact, Inhalation	Residents	No	Groundwater flows directly into Elliott Bay. There are no residents on or downgradient of the site. As an institutional control, the Port of Seattle will institute restrictive covenants to make this site permanently unavailable for drinking water use.
					Workers	No	No drinking water source is available on site. As an institutional control, the Port of Seattle will institute restrictive covenants to make this site permanently unavailable for drinking water use. Workers with the potential to encounter groundwater in trenches will be notified prior to those activities.
		Surface Water & Sediment (Elliott Bay)	Off Site	Ingestion, Bioconcentration, Dermal Contact	Aquatic Wildlife	**Yes**	Impacted groundwater/surface water may reach Elliott Bay and be taken up by aquatic wildlife in surface water and/or sediment.
					Fish Consumption by Humans	**Yes**	Impacted groundwater/surface water may reach Elliott Bay and be taken up by aquatic wildlife in surface water and/or sediment which are then consumed by humans.
				Ingestion, Swimming	Humans	No	Elliott Bay is too saline to use as a drinking water supply. Due to the industrial nature of the site vicinity, recreational uses such as swimming are unlikely.

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Figure 2

Conceptual Site Model
Terminal 91 Tank Farm Site

File: T91TankFarmCSW_033105.VSD

Appendix A