

APPENDIX B

Contaminant Fate and Transport Modeling

FINAL FOCUSED FEASIBILITY STUDY REPORT
South of Runway 18-36 Area
U.S. Navy, Engineering Field Activity, Northwest
Contract No. N44255-02-D-2008
Delivery Order 0037

Appendix B
Revision No.: 0
Date: 05/25/05
Page B-1

No contaminant fate and transport modeling was performed for this site.

APPENDIX C

Human Health and Ecological Risk Assessments

Appendix C contains the complete risk assessment for the South of Runway 18-36 Area. This appendix has been divided into two parts as follows:

- CI: Human Health Risk Assessment
- CII: Ecological Risk Assessment

Sections 4 and 5 of the main report contain summaries of the results of the risk assessments for human health and ecological health, respectively.

APPENDIX CI

Human Health Risk Assessment

CONTENTS

APPENDIX CI: HUMAN HEALTH RISK ASSESSMENT

CI.1.0	INTRODUCTION	CI.1-1
CI.1.1	Site Description.....	CI.1-2
CI.1.2	Source of Contamination	CI.1-4
CI.1.3	Migration Pathways	CI.1-4
CI.2.0	DATA EVALUATION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN	CI.2-1
CI.2.1	Selection of Data Applicable to Human Health.....	CI.2-1
CI.2.2	Chemical Selection Process	CI.2-5
CI.2.3	Results of Screening	CI.2-7
CI.2.4	Summary of Selected COPCs	CI.2-9
CI.3.0	EXPOSURE ASSESSMENT	CI.3-1
CI.3.1	Conceptual Site Model.....	CI.3-1
CI.3.2	Exposure Point Concentrations.....	CI.3-5
CI.3.3	Calculation of Chemical Dose	CI.3-7
CI.4.0	TOXICITY CRITERIA	CI.4-1
CI.4.1	Oral Toxicity Criteria.....	CI.4-1
CI.4.2	Inhalation Toxicity Criteria.....	CI.4-4
CI.4.3	Dermal Toxicity Criteria.....	CI.4-4
CI.5.0	RISK CHARACTERIZATION	CI.5-1
CI.5.1	Methodology for Assessing Noncancer Hazards.....	CI.5-1
CI.5.2	Methodology for Evaluating Cancer Risk	CI.5-2
CI.5.3	Risk Characterization Results for COPCs	CI.5-2
CI.5.4	Summary of Risk Characterization.....	CI.5-5
CI.6.0	CALCULATION OF RISK-BASED CLEANUP LEVELS	CI.6-1
CI.7.0	UNCERTAINTIES IN RISK ASSESSMENT	CI.7-1
CI.7.1	Data Collection and Evaluation	CI.7-1
CI.7.2	Exposure	CI.7-5
CI.7.3	Toxicity Assessment and Risk Hazard Calculations	CI.7-8

CONTENTS (Continued)

CI.7.4	Summary	CI.7-11
CI.8.0	SUMMARY AND CONCLUSIONS	CI.8-1
CI.8.1	Chemical of Potential Concern Selection	CI.8-1
CI.8.2	Exposure Assessment.....	CI.8-2
CI.8.3	Toxicity Assessment	CI.8-3
CI.8.4	Risk Characterization.....	CI.8-3
CI.8.5	Cleanup Levels Discussion	CI.8-4
CI.9.0	REFERENCES	CI.9-1

FIGURES

CI.1-1	Site Location and Vicinity Map	CI.1-5
CI.2-1	Soil and Groundwater Sampling Locations, South of Runway 18-36 Area	CI.2-11
CI.2-2	Human Health Conceptual Site Model, South of Runway 18-36 Area	CI.2-13
CI.3-1	Proposed Future Land Use, South of Runway 18-36 Area.....	CI.3-9
CI.3-2	Human Health Exposure Area, South of Runway 18-36 Area	CI.3-11

TABLES

CI.2-1	Summary of Data Selection for Use in the Risk Assessment	CI.2-14
CI.2-2	Summary of the Number of Samples by Analytical Method.....	CI.2-15
CI.2-3	Chemicals With Sample Quantitation Limits Exceeding Screening Values	CI.2-16
CI.2-4	Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Groundwater	CI.2-17
CI.2-5	South of Runway 18-36 Area Groundwater Frequency and Magnitude of Exceedance for Chemicals With Detected Concentrations Greater Than the Screening Values	CI.2-18
CI.2-6	Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Soil	CI.2-19
CI.2-7	South of Runway 18-36 Area Soil Frequency and Magnitude of Exceedance for Chemicals With Detected Concentrations Greater Than the Screening Values	CI.2-20
CI.2-8	Chemicals Selected as Chemicals of Potential Concern.....	CI.2-21

CONTENTS (Continued)

CI.3-1	Summary of Exposure Point Concentrations (EPCs)	CI.3-13
CI.3-2	Alaska DEC Default Petroleum Compositions.....	CI.3-14
CI.3-3	Construction Worker Exposures to Groundwater, Exposure Assumptions and Intake Equations.....	CI.3-15
CI.3-4	Construction Worker Exposures to Soil, Exposure Assumptions and Intake Equations.....	CI.3-16
CI.3-5	Summary of Volatilization Factor and Particulate Emission Factor Inputs and Equations.....	CI.3-17
CI.4-1	Carcinogenic Toxicity Criteria for the Chemicals of Potential Concern	CI.4-6
CI.4-2	Noncarcinogen Chronic and Subchronic Values Toxicity Criteria for Chemicals of Potential Concern	CI.4-7
CI.5-1	Summary of Total RME Risks and Hazards for the Construction Worker From Groundwater and Soil	CI.5-5
CI.5-2	Summary of RME Risks and Hazards for the Construction Worker From Soil...	CI.5-6
CI.5-3	Summary of Total RME Risks and Hazards for the Construction Worker From Groundwater	CI.5-7

APPENDIX CI: HUMAN HEALTH RISK ASSESSMENT

CI.1.0 INTRODUCTION

The previous sections of the focused feasibility study have identified petroleum compounds in soil and groundwater above regulatory levels at the site from leaks associated with a currently abandoned fuel line that likely transported JP-5. While there were subsurface pipelines running through the area containing a variety of fuel types (see Figure 2-2 in Section 2 of the FFS), the analytical data indicate a predominantly diesel-range petroleum release.

This appendix provides an evaluation of whether potential health risks are present if people encounter these petroleum-impacted materials in their environment. Alaska DEC provides guidance for four methods of determining cleanup levels (beginning with Method 1) that increase in level of effort and site-specificity. Method 4 uses risk assessment to determine site specific cleanup levels (ADEC 2000c). Sufficient site information is available to determine Method 4 cleanup levels and the results are presented in this appendix and summarized in Section 5.

According to Alaska DEC and U.S. Environmental Protection Agency (EPA) guidance, risk assessments are composed of four basic steps. The first step involves an initial screening of the sampling data to select the applicable data set for humans and, within that data set, select chemicals that could be a health concern. Secondly, chemical sources, pathways, receptors, exposure duration and frequency, and routes of exposure are evaluated to quantitatively assess the amount of exposure to the chemicals of potential concern (COPCs). Next, a toxicity assessment is performed, which qualitatively summarizes the carcinogenic and noncarcinogenic effects associated with the COPCs and provides toxicity values that are used to calculate the dose-response relationship. The final step in a human health risk assessment (HHRA) is the risk characterization that integrates the quantitative and qualitative results of the data evaluation, exposure, and toxicity assessment sections. A fifth step is sometimes performed: after the risk characterization step, if there are chemicals found to be a health concern, site-specific alternative cleanup levels (ACLs) are calculated. ACLs were not calculated for this site because no exposure to chemicals at this site posed unacceptable risk to human health.

The accuracy of this assessment depends in part on the quality and representativeness of the available sample, exposure, and toxicological data. Where information is incomplete, conservative assumptions were made so that risk to public health was not underestimated. Section CI.7 presents a discussion of uncertainties in the HHRA. This report was prepared in accordance with current Alaska DEC and EPA guidelines for risk assessment (ADEC 2000a, 2000b, 2000c; USEPA 1989, 1991, 1997a, 1998). The evaluation followed the available science

where appropriate regulatory guidance was not available to accommodate site-specific conditions.

This risk assessment is organized as follows:

- **Section CI.1** contains an introduction, a site description, and describes the source of contamination.
- **Section CI.2** evaluates and selects the data for the risk assessment and selects the COPCs.
- **Section CI.3** provides the conceptual site models, the rationale for the selection/exclusion of exposure pathways, and the inputs used to calculate chemical dose.
- **Section CI.4** describes the oral, inhalation, and dermal toxicity criteria used in the risk and hazard calculations.
- **Section CI.5** provides the methodology used to calculate cancer risks and noncancer hazards.
- **Section CI.6** discusses chemical concentrations in groundwater exceeding Alaska DEC Table C cleanup levels.
- **Section CI.7** discusses the uncertainties in the risk assessment.
- **Section CI.8** provides a summary and presents the conclusions of the risk assessment.

CI.1.1 Site Description

The South of Runway 18-36 Area consists of the lowland area surrounding the southern portion of Runway 18-36. It extends from the East Canal of the airport ditch system on the east to South Sweeper Creek on the west and south to Sweeper Cove (Figure CI.1-1). To the east, this site adjoins another petroleum release site: the Naval Mobile Construction Battalion (NMCB) Building Area, T-1416 Expanded Area. The primary physical features on the site include the southern portion of Runway 18-36, Main Road, the northern end of Transit Road up to the Transit Road Bridge, and the southern portion of the West Canal and the crossover canal of the airport ditch system. The canals that constitute the airport ditch system are engineered structures

used to divert surface water from the vicinity of Runway 18-36. Because the site is within the low-fly zone established for the airfield, no buildings are located within the site boundaries.

Topography at the South of Runway 18-36 Area is flat and low-lying. Elevations in this area are generally less than 15 feet above mean lower low water (MLLW). The dike situated on the eastern shore of South Sweeper Creek constitutes the highest topographic point on the site. Approximately 50 percent of the ground surface within the area north of Main Road is paved with asphalt, concrete, or compacted gravel. The ground surface on the remaining portions of the site is covered with grasses. Due to the high level of disturbance and air traffic, the terrestrial portion of the site does not provide high-quality habitat for wildlife.

South Sweeper Creek, located at the western boundary of the site, receives surface water and groundwater from approximately 30 percent of the Sweeper Cove drainage basin and indirectly receives stormwater runoff and recharge from groundwater in the downtown area. The mouth of South Sweeper Creek forms an estuary where it empties into Sweeper Cove. As a result of the cycling tides, saltwater periodically moves beneath the freshwater flow as a wedge along the bottom of the creek. Salinity infiltration occurs in the South Sweeper Creek and has been traced as far north as the mouth of Yakutat Creek, approximately 4,500 feet upstream from Sweeper Cove (URSG 1999a).

Sweeper Cove is a large saltwater inlet connected to Kuluk Bay. It is a moderately high-energy marine environment with its northern and western shorelines bounding the downtown areas on Adak Island. The original shorelines were altered by construction during World War II. The shoreline is sandy near streams such as South Sweeper Creek. However, the cove is lined with engineered riprap and boulders along the rest of the northern and western shoreline (URSG 1999a).

The West Canal is a steeply sloped, manmade channel lined with tundra grass. The crossover canal is entirely contained in underground culverts that allow water to flow between the East Canal and West Canal. The canals provide drainage and water level control surrounding Runway 18-36. The canals are filled with fresh water year round. Currently, surface water and groundwater that migrates from the site into the canals is transferred into South Sweeper Creek through turbine pumps. Because the engineered drainage canals of the airport ditch system are isolated from South Sweeper Creek, they are not considered wildlife habitat. For this reason, only South Sweeper Creek and Sweeper Cove are considered downgradient points of exposure for the South of Runway 18-36 Area.

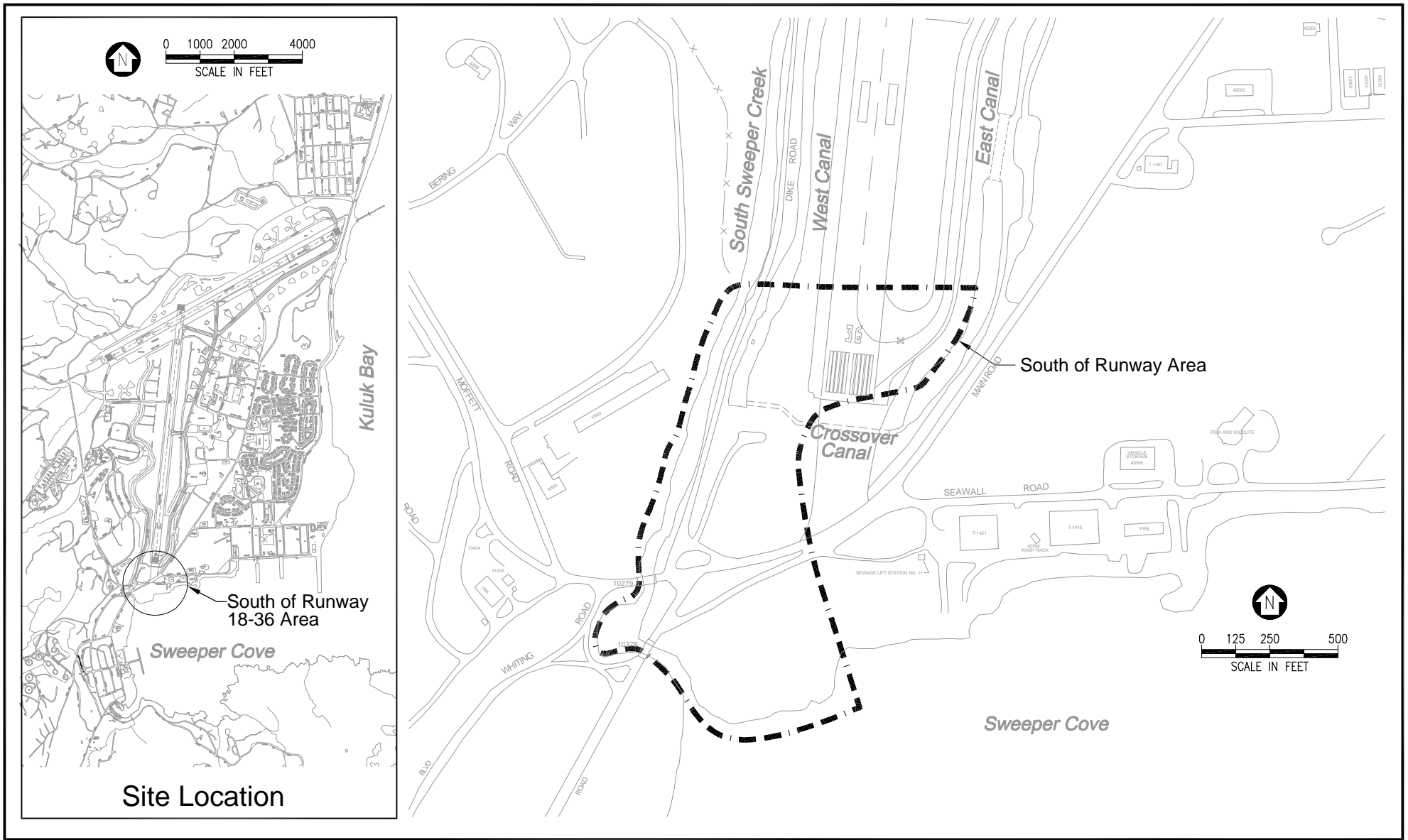
CI.1.2 Source of Contamination

In September 1990, an abandoned fuel line located near the southeast corner of Runway 18-36 was uncovered during the installation of a new fuel line adjacent to Main Road. The abandoned fuel line reportedly was likely the major source of the subsurface fuel release, and residual product was observed in the excavated trench (EMCON 1995). The fuel line was left in place. Subsequent site investigation activities indicated the presence of petroleum hydrocarbons in subsurface soil and groundwater over a large area south of Runway 18-36. Measurable quantities of free-phase petroleum product have been periodically observed in groundwater monitoring wells at the site. Free-product recovery has been ongoing at the site from June 1997 through November 2002. Approximately 210 gallons of free-phase petroleum has been removed at the site during this period.

All known or presumed releases of petroleum hydrocarbons at the South of Runway 18-36 Area have occurred in the subsurface. Petroleum hydrocarbons associated with surface soils at the site have not been reported.

CI.1.3 Migration Pathways

The initial petroleum release was into shallow subsurface soils; the material moved downward into the groundwater (approximately 8 feet below ground surface [bgs]). Groundwater flow direction at the site is radial: south toward Sweeper Cove, west toward South Sweeper Creek, and north toward the crossover canal. Monitoring wells where product has been detected include wells located within 50 feet of South Sweeper Creek. Free-phase petroleum product has been observed entering the South Sweeper Creek on an intermittent basis. Seeps into South Sweeper Creek east of the Transit Road Bridge have produced a petroleum sheen. Booms and other product recovery devices were installed to intercept the seeps. Surface water sampling in October 2001 for volatile organic compounds (VOCs) did not result in any detections. Impacted sediment in the airport ditch system and in South Sweeper Creek have been removed or capped into place to eliminate surface exposure (see Section 3.2).



U.S. NAVY

SCALE: AS SHOWN

**Figure CI.1-1
Site Location and Vicinity
South of Runway 18-36 Area**

Delivery Order 0037
Adak Island, AK
FOCUSED FEASIBILITY
STUDY

CI.2.0 DATA EVALUATION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

The initial step in the risk assessment has two parts: first, the available sampling data and site information are reviewed to select data applicable to human health; and second, chemical concentrations within the data set are evaluated to identify chemicals and affected environmental media (e.g., soil, groundwater) that are potential human health concerns requiring a more detailed assessment.

CI.2.1 Selection of Data Applicable to Human Health

Usually, not all the data available at a particular site are selected for inclusion in the risk assessment because not all are relevant to human health. For example, the quality of the data may be insufficient for the needs of the risk assessment, or the soil data may be from a depth interval for which there would be no human exposures. The data selected for inclusion or exclusion along with the rationale for exclusion in the risk assessments for this site is presented on Table CI.2-1 and Figure CI.2-1 shows the sampling locations of the data selected for inclusion in the risk assessment. A discussion of data issues from the perspective of human health risk assessment is provided in the sections below.

Data Quality and Usability

Optimizing data usability reduces uncertainty in environmental data used in a risk assessment. Data usability and quality issues are discussed below according to U.S. Environmental Protection Agency (EPA) guidelines (1992a), which provide practical guidance on how to obtain an appropriate level of quality of all environmental analytical data. All data have been collected following Navy and EPA requirements, and the data are generally of sufficient quality for use in risk assessment. Where multiple analyses of a sample exist, the highest detected or lowest nondetected value is selected as the single, most valid, analytical result for the sample collected. In addition, analytical results qualified as estimated values (i.e., J qualified results) are treated as valid results.

Data Usability. The four data application questions requiring an answer for risk assessment from EPA's data usability guidance (USEPA 1992a) are as follows:

- **What contamination is present, and at what levels?** Sample numbers and sample locations were chosen based on an understanding of the sources of contamination and potential migratory pathways of chemicals, and according to Alaska DEC regulations for petroleum-contaminated sites (ADEC 2000b). The site characterization performed at this site identified diesel-range organics (DRO),

likely primarily JP-5, as the major source of petroleum compounds. JP-5 has an approximate carbon fraction range of C₉ to C₁₆. Alaska DEC DRO analyses, with an approximate carbon fraction range of C₁₀ to C₂₅, and Alaska DEC gasoline-range organic (GRO) analyses, with an approximate carbon fraction range of C₆ to C₁₀, cover the range of the majority of carbon compounds expected in the groundwater plumes and soils; therefore, these analyses were appropriate to use in evaluating contamination. The most toxic portions of petroleum are the single ring aromatics—benzene, toluene, ethylbenzene, and xylenes (BTEX)—found primarily in the GRO range, and the carcinogenic polycyclic aromatic hydrocarbons (PAHs) found at the heavy end of the DRO range. The carcinogenic PAHs are virtually excluded from JP-5 and would not be expected in any significant amounts at any of the sites with JP-5 sources (ATSDR [Agency Toxics Substances and Disease Registry] 1998). Analyses for BTEX and the PAH compounds were performed separately along with analyses for metals and other analyses for volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs). Table CI.2-2 provides the analytical method and the number of samples (detects and nondetects) analyzed per method for soil and groundwater. The specific numbers of samples available for each potential COPC are discussed further for each site under item 4 of this list.

Free phase petroleum has not been removed to the practicable end point at this site (see Section 3.3). URS estimates that between 1,040 and 5,200 gallons of free product may remain in the central portion of the site (see Figure 3-2). However, risk assessments typically only quantitatively evaluate dissolved concentrations in groundwater. Free-phase petroleum product is generally assumed to present a health risk. The extent of free-phase petroleum product and its potential effect on human exposures was qualitatively addressed in the risk characterization section of the risk assessment.

- **Are site concentrations different from background?** Concentrations of chemicals that occur on site in the absence of site activities are defined as background concentrations. Comparison of site data to background concentrations allows determination of the degree of contamination. Background concentrations are only available for metals. For the organic constituents, background was assumed to be zero. Lead is the only metal evaluated at this site. Thus, lead concentrations in soil and groundwater used for screening were compared against the available Adak Island background values for lead (URS 1995a).

- **Are all exposure pathways and areas identified and examined?** Sufficient site knowledge exists to understand potential current and future exposure pathways, although in some cases the ability to quantify the pathway may be limited. Exposure pathways are identified and discussed in detail in Section CI.3.0. In addition, exposure pathways are illustrated on the CSM in Figure CI.2-2. Data limitations with respect to the potential pathways are discussed further below.
- **Are all exposure areas fully characterized?** Sufficient data exist to characterize exposures to DRO, GRO, and BTEX at the South of Runway 18-36 Area. Soil samples were collected from 1993 to 2001, groundwater samples were collected from 1992 to 2001, sediment samples were collected from 1996 to 1998, and surface water samples were collected from 1993 to 1998. The sampling locations at the South of Runway 18-36 Area are depicted in Figure CI.2-1. Note that surface water and sediment data were not included in the human health risk assessment, because human exposures to surface water and sediment at the South of Runway 18-36 Area are expected to be infrequent, thus insignificant (see further discussion in Section CI.3.1). In addition, no chemicals were detected in surface water or sediment at levels that would be a human health concern (see Tables 3-8 and 3-9). These data were used the ecological evaluation.

There are a sufficient number of groundwater samples taken from 26 sampling locations. An adequate number of soil samples (subsurface) were collected from 66 sampling locations to evaluate a range of chemical concentrations at the site. One surface soil sample was collected (location 850). The soil in the area where this sample was collected has been completely re-worked, and covered with clean fill material (BEESC 2001a). Therefore, this sample is no longer representative of surface conditions at the South of Runway 18-36 Area, but likely more representative of subsurface conditions. Thus, this sample was included in the evaluation of subsurface soil exposures at the site. Although additional surface soil samples were not collected, this does not represent a data gap because the source of contamination was to the subsurface and contaminated surface soil was removed and clean fill material was placed. Thus, there are no on-site exposures to impacted surface soil at South of Runway 18-36 Area.

Data for PAHs are limited to five samples in soil. However, significant amounts of carcinogenic PAHs are unlikely at JP-5 source sites and in support of this, no carcinogenic PAHs were detected in soil (see Table 3-5).

Data Quality: Sample Quantitation Limits. All data have been collected following Navy and EPA requirements; consequently, the data is generally of sufficient quality for use in risk

assessment. Therefore, the focus of this section is to address any sample quantitation limit (SQL) issues that are specifically applicable to human health. SQLs are the laboratory quantitation limit (also referred to as the reporting limit) that is adjusted to reflect sample-specific factors such as dilution, use of a smaller sample aliquot for analysis, or for matrix interference. The method detection limit (MDL) is defined as the minimum concentration of an analyte that can be routinely identified using a specific method. The reporting limit is the minimum level at which an analyte can be accurately and reproducibly quantitated. SQLs are used in risk assessment data evaluations because they “take into account sample characteristics, sample preparation, and analytical adjustments” (USEPA 1989), and they are considered to be the most relevant quantitation limits for evaluating nondetected chemicals.

Some of the SQLs in the data set may not meet risk assessment requirements, i.e., SQLs could be above the screening value of the chemical. If a chemical is not detected in a sample, it could be present at a concentration just below the reported SQL, or it may not be present in the sample at all. If the quantitation limit is below the screening value, the resulting data set provides the risk assessor with a higher degree of certainty in identifying COPCs. SQLs exceeding screening values may be a particular concern for chemicals that are not selected as COPCs because those chemicals could potentially be present at levels that warrant a health concern. For chemicals selected as COPCs, a surrogate concentration of half the SQL is included in the risk calculations for nondetected samples (see Section CI.3), as per EPA (1989) guidance; thus, while the use of half the SQL could either under- or overestimate chemical concentrations, at least an attempt is made to quantify possible risks.

If the chemical is never detected, it will be assumed not to be present. However, if the chemical is detected at least once in any sample, then the range of SQLs will be further evaluated. Any detected chemicals with SQLs greater than their screening values are listed in Table CI.2-3. This table provides the number of “nondetected” values greater than screening values and the total number of nondetected samples for each chemical. If the total number of samples is large relative to the number of non-detects, then detection limits exceeding screening values are of less concern, because the majority of the data set contains detected values. Chemicals with low detection frequency and a high percentage of the non-detected values with SQLs exceeding screening levels represent a greater degree of uncertainty because a larger percentage of the data set could potentially be present above a screening level. The uncertainties surrounding the inadequate SQLs for these compounds and the potential effect on the selection of COPCs and the risk assessment results will be discussed in Section CI.7.

Eight chemicals in groundwater had SQLs greater than the screening values. Of these 8 chemicals, 6 were ultimately selected as COPCs and quantitatively evaluated in the risk assessment. Toluene was not selected as a COPC because none of the detected concentrations exceeded its respective screening value. In addition, the SQL exceeded the screening level in

only one of the 49 nondetected samples. Therefore, toluene is not likely present in concentrations that are a health concern and the SQLs are not a concern. Benzo(a)pyrene was not selected as a COPC because of infrequent detection and infrequent exceedance over its respective screening value. The SQLs associated with this chemical represent a certain degree of uncertainty that is further discussed in the uncertainty section. It should be noted that four of the chemicals with quantitation limits over their screening values had quantitation limits that were very high, in some cases many times greater than the screening values. All four of these high quantitation limits were found in the same sample collected from location, LC6A (OLD 1). This sample had the highest concentration of xylene and the high quantitation limits are likely a function of the laboratory needing to dilute the sample to get accurate xylene concentrations. Including half the SQL as a surrogate concentration for chemical data from this well in the risk assessment adds a level of uncertainty to the exposure point concentrations for the chemicals selected as COPCs and may bias concentrations high.

No detected chemicals in soil had SQLs greater than the screening values.

CI.2.2 Chemical Selection Process

Typically, not all chemicals present at a site pose health risks or contribute significantly to overall site risks. EPA guidelines (USEPA 1989) recommend focusing on a group of “chemicals of potential concern” based on inherent toxicity, site concentration, and behavior of the chemicals in the environment. To identify these COPCs, risk-based screening values are compared to site concentrations of chemicals. If site concentrations of a chemical exceed their respective screening concentrations, then further evaluation of their concentrations is conducted and the chemicals may be retained as COPCs for further evaluation in the risk assessment. EPA Region 9 residential soil preliminary remediation goals (PRGs) and tap water PRGs were used as the risk-based screening values in the COPC screening process (USEPA 2002a). For the petroleum compounds (GRO, DRO, and RRO), one-tenth of the Alaska DEC soil (Method 2, over 40-inch zone) and groundwater cleanup levels were used as the screening values (ADEC 2003). These values are derived using the toxicity criteria of surrogate compounds that represent the toxicity of the aliphatic and aromatic portions of each petroleum compound (ADEC 2001b). For chemicals without screening criteria, screening criteria for surrogate chemicals were used wherever possible, as per Alaska DEC (2001a) guidance.

COPCs were selected for each impacted media at the site. The screening process consisted of the steps listed below, and the results are discussed in Section CI.2.3.

- 1. Determination of the frequency of chemical detection.** EPA guidance allows the elimination of chemicals from the quantitative evaluation if they are detected infrequently and the magnitude of exceedance is not a concern (USEPA 1989). In

this assessment, a frequency of detection of 5 percent was used as a criterion for the elimination of chemicals as COPCs. In other words, if a chemical was detected in fewer than 5 percent of the samples for a particular medium, it was eliminated as a COPC if the magnitude of exceedance was not a concern. It should be noted that for data sets containing fewer than 20 samples, evaluation of the frequency of detection is generally not applicable.

- 2. Comparison of maximum detected chemical concentrations to background.** The term “background” is used here to refer to chemical concentrations that would be expected to occur naturally in the environment without influence from humans. In general, comparison with natural background levels is applicable only to inorganic contaminants because the majority of organic contaminants are not naturally occurring (USEPA 1989). Background values for all VOCs, SVOCs, and total petroleum hydrocarbons (TPHs) are assumed to be zero in this assessment. Background values for metals are site-specific values for Adak Island (URS 1995a).
- 3. Comparison of the maximum detected chemical concentration in a particular medium to the screening value.** If the maximum detected chemical concentration exceeds the screening value (one-tenth EPA Region 9 PRGs for residential exposures for noncarcinogens, and the residential PRG for carcinogens), then Alaska DEC (2001b) recommends the chemical be retained for further evaluation in the risk assessment. In this step of the screening process, all chemicals with a maximum concentration exceeding a screening value are identified. The rationale behind comparing the maximum concentration against one-tenth of a risk-based value is explained by the default assumption that all toxic effects are additive. For example, two or more chemicals that are present at concentrations just below the levels of concern for the individual chemicals could be a health concern if their toxic effects are considered additive. Thus, it is important to select more, rather than fewer, chemicals to evaluate in the risk assessment due to potential cumulative effects. However, in some cases an exceedance of the screening value by a maximum concentration does not represent either an individual or an additive health concern within the context of a particular site, and consequently the chemical could be safely eliminated as a COPC and not affect the outcome of the risk assessment. The following two steps describe the process used to further evaluate the chemicals with maximum concentrations that exceed the screening level.
- 4. Evaluation of the frequency of exceedance over screening levels.** The frequency of exceedance of concentrations above the screening level was also

evaluated. Estimates of risk are calculated using the 95 percent upper confidence limit (95UCL) of the mean concentration for each chemical because the risk calculations are based on an estimate of average exposure concentration over time, not the maximum concentration. Therefore, if only a handful of concentrations of a chemical exceed a screening level, and the magnitude of exceedance is not large, the chemical will not represent a health risk and can potentially be eliminated from the risk evaluation, particularly if the screening level is below a level that is a health concern. Chemicals with few concentrations exceeding their screening level, especially those with screening levels below risk-based levels, may be eliminated from further evaluation. In general, a frequency of exceedance of 10 percent or less was considered acceptable, thus warranting exclusion as a COPC.

- 5. Evaluation of the magnitude of exceedance over screening levels.** If the frequency of exceedance was 10 percent or less, then the magnitude of exceedance was evaluated. A magnitude of exceedance of up to 10 times the screening level was considered potentially acceptable reason for exclusion as a COPC if the screening level was one-tenth of a risk-based value. However, exclusion as a COPC based on frequency and magnitude of exceedance are evaluated on a case-by-case basis depending on the toxicity of the chemical, the specific screening level, and the magnitude of exceedances.

CI.2.3 Results of Screening

This section describes the results of the screening process, including the rationale for selecting or eliminating the chemicals.

Groundwater

Table CI.2-4 summarizes the screening process for groundwater. A total of 20 chemicals were detected in the South of Runway 18-36 Area groundwater and compared to their respective screening values. Of the 20 detected chemicals, 10 had maximum concentrations greater than their respective screening values. These 10 chemicals were further evaluated, according to the steps outlined in Section CI.2.2, for frequency and magnitude of exceedance above screening levels (Table CI.2-5). Eight were selected as COPCs because their frequencies and magnitude of exceedance above screening levels warrant in-depth evaluation in the risk assessment, according to screening Steps 4 and 5. The eight selected chemicals are listed below.

- 2-Methylnaphthalene
- Acetone

- Benzene
- Ethylbenzene
- Naphthalene
- Xylenes
- DRO
- GRO

As summarized in Table CI.2-5, benzo(a)pyrene was not selected because the frequency of chemical detection was equal to 5 percent and the frequency of exceedance above screening levels was less than 10 percent (Steps 1 and 4, respectively). The exclusion of benzo(a)pyrene as a COPC in groundwater is discussed further in the uncertainty section.

Although lead exceeded its screening value in 2 out of 10 samples (20 percent), the maximum detected concentration was only 2 times greater than the screening value. In addition, the lead screening value is based on EPA's tap water action level for lead and is protective of children, the most sensitive population to lead exposures, who drink tap water on a daily basis. At this site, the only complete exposure pathways to groundwater are inhalation and dermal contact during subterranean construction activities (see further discussion in Section 3.1). Lead is not a volatile chemical and is not readily absorbed through the skin. Therefore, construction worker exposures to lead in groundwater would not be significant (USEPA 2003b).

Soil

Table CI.2-6 summarizes the soil screening results for the South of Runway 18-36 Area. A total of 11 chemicals were detected in site soil and compared to their respective screening values. Of the 11 detected chemicals, 7 had maximum concentrations above their respective screening levels. These seven chemicals were further evaluated, according to the steps outlined in Section CI.2.2, for natural background (metals only) and frequency and magnitude of exceedance above screening levels (Table CI.2-7). Four were selected as COPCs because their frequencies and magnitude of exceedance above screening levels warrant in-depth evaluation in the risk assessment, according to screening Steps 4 and 5.

The four selected chemicals are listed below:

- 2-Methylnaphthalene
- Naphthalene
- DRO
- GRO

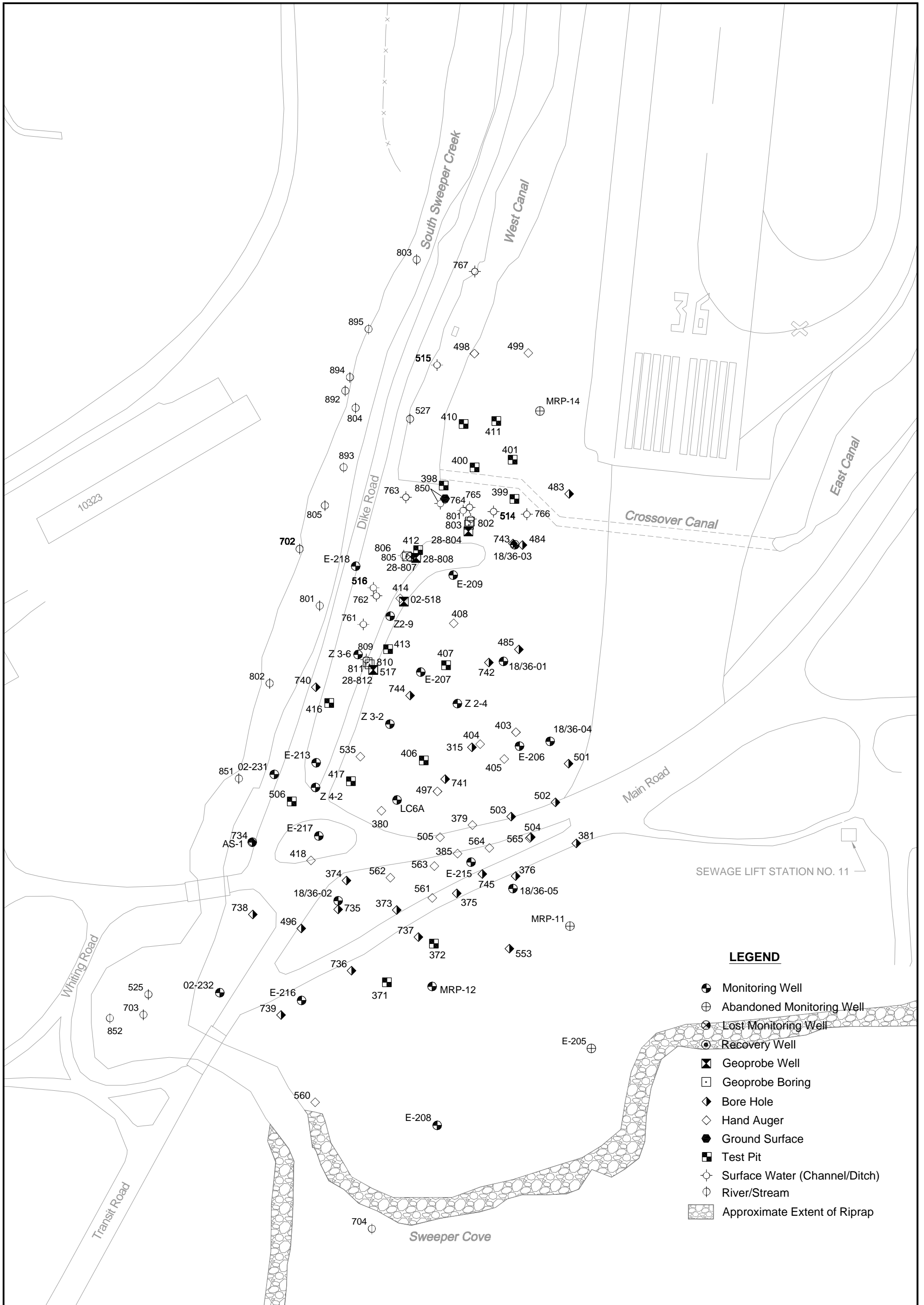
As shown on Table CI.2-7, the three other chemicals were not selected for the following reasons:

- The frequency of chemical detection was less than or equal to 5 percent, as summarized in Table CI.2-7 (Step 1 eliminates benzene)
- The frequency of exceedance above screening was less than or equal to 10 percent, as summarized in Table CI.2-7 (Step 4 eliminates benzene, ethylbenzene, and xylenes).
- The magnitude of exceedance was less than 10, as summarized in Table CI.2-7 (Step 5 eliminates benzene, ethylbenzene, and xylenes).

It should be noted that the soil screening criteria are based on residential exposures, and only worker exposures to soil are evaluated at this site (see Section CI.3.1.1). Workers, even construction workers with high rates of soil contact, have much less exposure to soil than do residents. In addition, the working adult population does not contain sensitive subpopulations, such as children or the elderly, as do residential populations. Therefore, use of the residential soil PRGs in the screening for COPCs is a conservative approach and allows for a certain degree of flexibility in the selection of COPCs. Furthermore, estimates of risk are calculated using an estimate of the average site concentration within the exposure area (generally the 95% UCL of the mean), not the maximum concentrations. Thus, the low frequencies and magnitudes of exceedance above screening values of the eliminated chemicals are likely to result in exposure point concentrations that do not warrant a health concern. The exclusion of these chemicals as COPCs in soil is discussed further in the uncertainty section.

CI.2.4 Summary of Selected COPCs

Table CI.2-8 summarizes the chemicals that were selected for quantitative evaluation by media. Eight chemicals in groundwater and four chemicals in soil were selected as COPCs. Four chemicals were selected as COPCs in both groundwater and soil.



U.S. NAVY

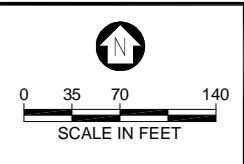
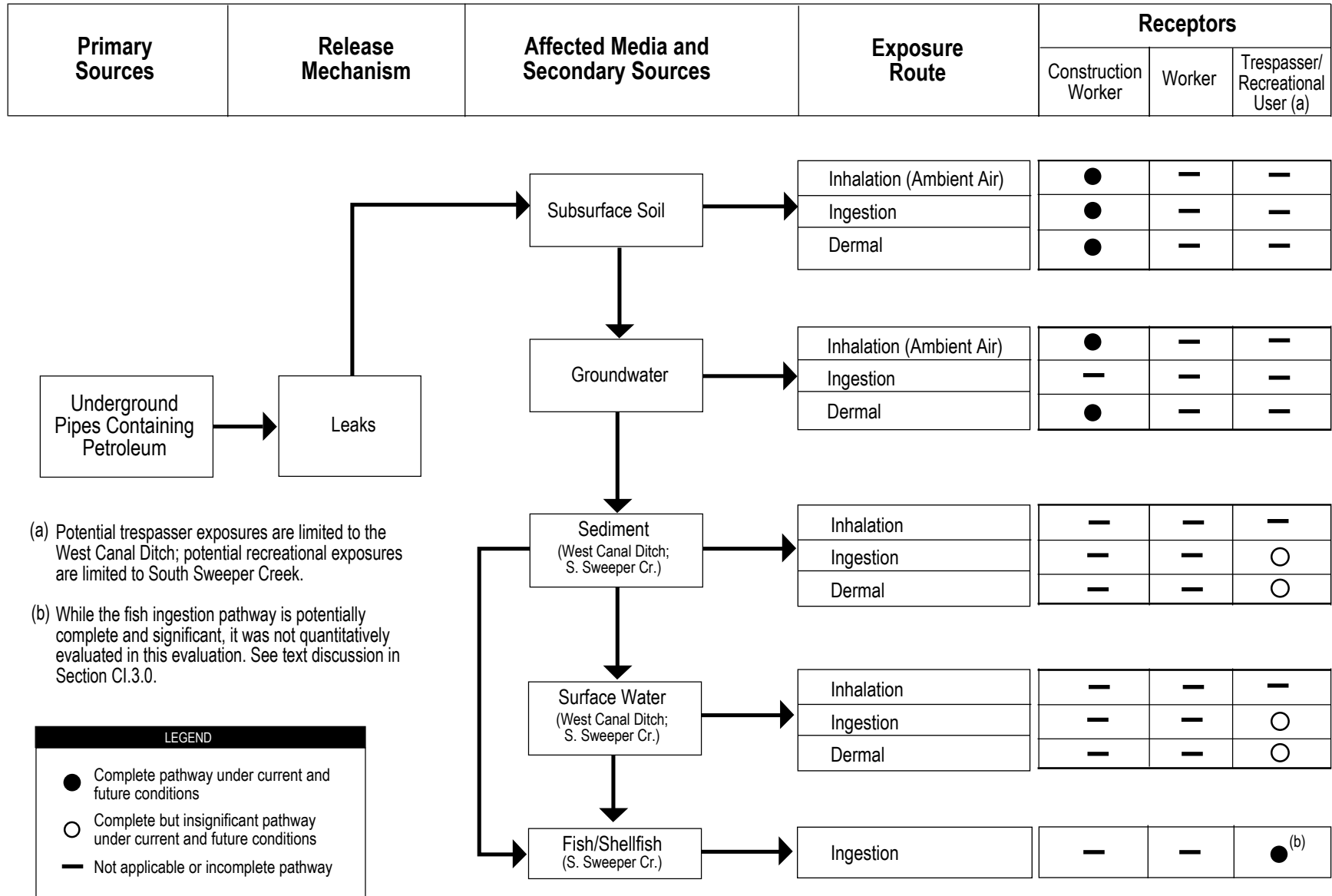


Figure CI.2-1
Soil and Groundwater Sampling Locations
South of Runway 18-36 Area

Delivery Order 0037
 Adak Island, AK
FOCUSED FEASIBILITY
STUDY



**Table CI.2-1
 Summary of Data Selection for Use in the Risk Assessment**

Soil	
Locations of Data Included in the Risk Assessment	
561, 563, 564, 565, 562, 560, 02-231, 02-232, 517, 02-518, 18/36-01, 18/36-04, 18/36-05, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 802, 803, 28-804, 806, 850, 28-807, 28-808, 810, 811, 28-812, 499, 414, 408, 404, 418, 380, 497, 535, 503, 502, 496, 373, 374, 315, 399, 411, 398, 400, 401, 416, 407, 506, 372, E-207, E-208, E-209, E-213, E-215, E-216, E-217, E-218	
Excluded Data	Rationale for Exclusion
Samples collected at depths greater than 15 feet bgs	No direct human exposure to soils collected at depths greater than 15 feet bgs
Samples designated as "field"	Testing does not distinguish between fuel products (e.g., gasoline or diesel)
Groundwater	
Locations of Data Included in the Risk Assessment	
02-231, 02-232, 18/36-01, 18/36-02, 18/36-03, 18/36-04, 18/36-05, 28-804, 28-808, 28-812, E-205, E-206, E-207, E-208, E-209, E-213, E-215, E-216, E-217, E-218, LC6A, MRP-11, MRP-12, MRP-14	
Excluded Data	Rationale for Exclusion
Samples analyzed by Method AK-102-AA and AK-103-AA	Data of unacceptable quality according to ADEC (ADEC 2001e)
Samples analyzed by Method 418.1	Method does not distinguish between fuel products (e.g., gasoline or diesel)
Samples analyzed by Methods EPH and VPH	Usable data, but not compatible with ADEC definitions of TPH carbon fraction ranges
Sediment and Surface Water	
Excluded Data	Rationale for Exclusion
850, 851, 852, 514, 515, 516, 525, 527, 801, 805, 809, 703, 704, 766, 765, 764, 763, 761, 767, 762	These data are not applicable to human health, but will be used in the ecological health evaluation.

Notes:

ADEC - Alaska Department of Environmental Conservation
 bgs - below ground surface
 EPH - extractable petroleum hydrocarbons
 TPH - total petroleum hydrocarbons
 VPH - volatile petroleum hydrocarbons

**Table CI.2-2
 Summary of the Number of Samples by Analytical Method**

Matrix	Analytical Method^a	South of Runway 18-36
Soil	6000/7000, 6010 - Total Inorganics (Pb only)	34
	8020 - Volatile Organics (BTEX only)	43
	8021 - Volatile Organics (BTEX only)	37
	8270 - Semivolatile Organics	4
	8015 Mod - TPH, Gasoline Range	27
	8100 Mod - TPH, Diesel Range	42
	AK 101 - TPH, Gasoline Range	63
	AK 102 - TPH, Diesel Range	62
Groundwater	6000/7000, 6010 - Total Inorganics (Pb only)	9
	8020 - Volatile Organics (BTEX only)	43
	8021 - Volatile Organics (BTEX only)	15
	8270 - Semivolatile Organics	18
	8270 Mod - Semivolatile Organics	1
	8015 Mod - TPH, Gasoline Range	19
	8100 Mod - TPH, Diesel Range	19
	AK 101 - TPH, Gasoline Range	27
	AK 101 AA - TPH, Gasoline Range	14
	AK 102 - TPH, Diesel Range	28
	V-CLP - Volatile Organics	4

^aSamples analyzed by the following TPH methods are not included in this table: 418.1, AK 102 AA, AK 103 AA, EPH, and VPH. See Tables 2-1 through 2-3.

Notes:

-- This analytical method was not used or matrix was not analyzed for this site.

BTEX - benzene, toluene, ethylbenzene, xylenes

TPH - total petroleum hydrocarbons

Pb - lead

Hg - mercury

**Table CI.2-3
 Chemicals With Sample Quantitation Limits Exceeding Screening Values**

Exposure Medium	Chemical	Units	Range of Sample Quantitation Limits	Screening Value	No. of Nondetections	No. of Nondetects Exceeding Screening Value	Frequency of Exceedance (%)
Groundwater	2-methylnaphthalene	µg/L	2-2.11	0.6	7	7	100 %
	Benzene	µg/L	0.2-500	0.3	48	26	54 %
	Ethylbenzene	µg/L	0.2-10	2.9	29	1	3 %
	Naphthalene	µg/L	0.02-2.11	0.6	10	7	70 %
	Toluene	µg/L	0.2-500	72.3	47	1	2 %
	Benzo(a)pyrene	µg/L	0.02-1	0.009	18	18	100 %
	DRO	µg/L	100-1,000,000	150	16	14	88 %
	GRO	µg/L	5-1,000,000	130	36	9	25 %

Notes:

DRO - diesel-range organics

GRO - gasoline-range organics

µg/L - micrograms of chemical per liter of medium

mg/kg - milligrams of chemical per kilogram of medium

No. - number

Table CI.2-4
South of Runway 18-36 Area Groundwater
Occurrence, Distribution, and Selection of Chemicals of Potential Concern

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Tap Water

CAS Number	Chemical	Minimum Concentration ⁽¹⁾	Minimum Qualifier	Maximum Concentration ⁽¹⁾	Maximum Qualifier	Unit	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Screening Rationale (4)
Volatile Organic Compounds (VOCs)																
91-57-6	2-Methylnaphthalene (5)	0.74	J	143	J	ug/L	E-217	8/15	2 - 2.11	143	0	0.6	1460	AkCL	YES	ASL
67-64-1	Acetone	320	J	320	J	ug/L	LC6A (OLD 1)	1/3	10	320	0	60.8	3650	AkCL	YES	ASL
83-32-9	Acenaphthene	0.04	J	2.47		ug/L	02-231	11/19	0.02 - 2.2	2.47	0	36.5	2200	AkCL	NO	BSL
120-12-7	Anthracene	0.04	J	0.15	J	ug/L	E-207	2/19	0.02 - 2.22	0.15	0	183	11000	AkCL	NO	BSL
71-43-2	Benzene	0.389		39		ug/L	02-231	14/62	0.2 - 500	39	0	0.3 c	5	AkCL	YES	ASL
100-41-4	Ethylbenzene	0.22		97	J	ug/L	LC6A (OLD 1)	33/62	0.2 - 10	97	0	2.9 c	700	AkCL	YES	ASL
86-73-7	Fluorene	0.02	J	8.55		ug/L	02-231	15/19	0.02 - 2.08	8.55	0	24.3	1460	AkCL	NO	BSL
91-20-3	Naphthalene	1.45	J	189	J	ug/L	E-217	9/19	0.02 - 2.11	189	0	0.6	1460	AkCL	YES	ASL
129-00-0	Pyrene	0.03	J	0.08	J	ug/L	LC6A (OLD 1)	4/19	0.02 - 2.22	0.08	0	18.3	1100	AkCL	NO	BSL
108-88-3	Toluene	0.5	J	4.37		ug/L	02-231	15/62	0.2 - 500	4.37	0	72.3	1000	AkCL	NO	BSL
1330-20-7	Xylenes	0.44		580		ug/L	LC6A (OLD 1)	33/62	0.2-2.0	580	0	21	10000	AkCL	YES	ASL
Semivolatile Organic Compounds (SVOCs)																
208-96-8	Acenaphthylene (5)	0.15	J	0.21	J	ug/L	E-209	2/19	0.02 - 2.22	0.21	0	36.5	2200	AkCL	NO	BSL
50-32-8	Benzo(a)pyrene	0.02	J	0.02	J	ug/L	E-217	1/19	0.02 - 1	0.02	0	0.009 c	0.2	AkCL	NO	IFE, IFD
86-74-8	Carbazole	0.11	J	1.58	J	ug/L	E-217	3/8	0.2 - 0.22	1.58	0	3.4	40	AkCL	NO	BSL
218-01-9	Chrysene	0.03	J	0.04	J	ug/L	LC6A (OLD 1)	2/19	0.02 - 2.22	0.04	0	9.2 c	100	AkCL	NO	BSL
206-44-0	Fluoranthene	0.02	J	0.1	J	ug/L	E-205	2/19	0.02 - 2.22	0.1	0	146	1460	AkCL	NO	BSL
85-01-8	Phenanthrene (5)	0.03	J	5.51		ug/L	02-231	9/19	0.02 - 2.2	5.51	0	183	11000	AkCL	NO	BSL
Total Petroleum Hydrocarbons (TPH)																
na	Diesel Range Organics (6)	100		45000		ug/L	LC6A (OLD 1)	37/53	100 - 1000000	45000	0	150	1500	AkCL	YES	ASL
na	Gasoline Range Organics (6)	21		2800		ug/L	02-231	26/61	5 - 1000000	2800	0	130	1300	AkCL	YES	ASL
Metals																
7439-92-1	Lead (7)	1.2	J	33		ug/L	E-207	7/10	1 - 1	33	11.8	15	15	AkCL	NO	LME

Notes:

Chemicals bolded exceeded their screening value.

(1) Minimum/maximum detected concentration

(2) Background is assumed to be zero for SVOCs, TPH, and VOCs.

Lead background was taken from the Background Study Report for Adak Island (U.S. Navy 1995).

(3) Screening values are one-tenth the Region 9 PRG for noncancer or full value for cancer, unless otherwise marked.

4) Rationale Codes

Selection Reason: ASL: above screening level

Deletion Reason: BSL: below screening level

IFE: infrequent exceedance of screening value

IFD: infrequent detection

LME: low magnitude of exceedance

(5) The following surrogate chemicals used for screening values:

Chemical Name	Surrogate Chemical
2-Methylnaphthalene	Naphthalene
Phenanthrene	Anthracene
Acenaphthylene	Acenaphthene

(6) There are no Region 9 PRGs for these chemicals; therefore, one-tenth of the Alaska groundwater cleanup level was used as the screening value.

(7) The screening value is the MCL lead action level.

Definitions:

AkCL- Alaska cleanup level

ARAR/TBC - applicable or relevant and appropriate requirement/to be considered

c - cancer endpoint

CAS - Chemical Abstract Service

COPC - chemical of potential concern

J - estimated concentration

MCL - Maximum contaminant level

ug/L - micrograms per liter

na - not available

PRG - EPA's Region 9 preliminary remediation goal for tap water

SVOC - semivolatile organic compound

TPH - total petroleum hydrocarbon

VOC - volatile organic compound

**Table CI.2-5
 South of Runway 18-36 Area Groundwater
 Frequency and Magnitude of Exceedance for Chemicals
 With Detected Concentrations Greater Than the Screening Values**

Chemical	Maximum Concentration (µg/L)	Screening Concentration (µg/L)	Frequency of Detection	Frequency of Exceedance	Magnitude of Exceedance
Chemicals Not Selected as COPCs					
Benzo(a)pyrene	0.02	0.009	1/19 (5%)	1/19 (5%)	2.2 times screening
Lead	33	15	7/10 (70%)	2/10 (20%)	2.2 times screening
Chemicals Selected as COPCs					
2-Methylnaphthalene	143	0.62	8/15 (53%)	8/15 (53%)	231 times screening
Acetone	320	60.8	1/3 (33%)	1/3 (33%)	5.3 times screening
Benzene	39	0.34	14/62 (23%)	14/62 (23%)	115 times screening
DRO	45,000	150	37/53 (70%)	35/53 (66%)	300 times screening
Ethylbenzene	97	2.9	33/62 (53%)	21/62 (34%)	33 times screening
GRO	2,800	130	26/61 (43%)	18/61 (30%)	22 times screening
Naphthalene	189	0.6	9/19 (47%)	9/19 (47%)	305 times screening
Xylenes	580	21	33/62 (53%)	18/62 (20%)	28 times screening

¹No toxicity criteria are available; therefore, the chemical cannot be quantitatively evaluated.

Notes:

COPC - chemical of potential concern

DRO - diesel-range organics

GRO - gasoline-range organics

µg/L - micrograms per liter

**Table C1.2-6
 South of Runway 18-36 Area Soil
 Occurrence, Distribution, and Selection of Chemicals of Potential Concern**

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Construction Site/Trenching

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Unit	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Screening Rationale (4)
Volatile Organic Compounds (VOCs)																
91-57-6	2-Methylnaphthalene (5)	61		61		mg/kg	02-231	1/4	0.2-4	61	0	5.6	92	AkCL	YES	ASL
71-43-2	Benzene	0.023		1.67	J	mg/kg	734	3/78	0.0095-0.58	1.67	0	0.6 c	6.4	AkCL	NO	IFD, IFE, LME
100-41-4	Ethylbenzene	0.014	J	15.8	J	mg/kg	734	25/78	0.01-0.5	15.8	0	8.92 c	89	AkCL	NO	IFE, LME
86-73-7	Fluorene	10		10		mg/kg	02-231	1/4	0.2-4	10	0	274.7	3300	AkCL	NO	BSL
91-20-3	Naphthalene	14		14		mg/kg	02-231	1/4	0.2-4	14	0	5.6	92	AkCL	YES	ASL
85-01-8	Phenanthrene (5)	10		10		mg/kg	02-231	1/4	0.2-4	10	0	2189.6	24900	AkCL	NO	BSL
108-88-3	Toluene	0.013	J	1.65	J	mg/kg	734	9/78	0.01-1	1.65	0	520	180	AkCL	NO	BSL
1330-20-7	Xylenes	0.023	J	49	J	mg/kg	734	32/78	0.03-0.123	49	0	27.49	81	AkCL	NO	IFE, LME
Total Petroleum Hydrocarbons (TPH)																
na	Diesel-Range Organics (6)	4.44	J	75000		mg/kg	E-209	71/92	4-50	75000	0	825	8250	AkCL	YES	ASL
na	Gasoline-Range Organics (6)	2.86	J	2700		mg/kg	E-209	32/78	0.3-6.15	2700	0	140	1400	AkCL	YES	ASL
Metals																
7439-92-1	Lead (7)	1.3		42.4		mg/kg	506	37/37	—	42.4	10.9	400	400	AkCL	NO	BSL

Notes:

Chemicals bolded exceeded their screening value.

(1) Minimum/maximum detected concentration.

(2) Background is assumed to be zero for SVOCs, TPH, and VOCs.

Lead background was taken from the Background Study Report for Adak Island (U.S. Navy 1995).

(3) Screening values are the Region 9 residential soil PRGs for VOCs and Alaska cleanup values for TPHs (method two, over 40-inch zone).

One-tenth the PRG or cleanup level for noncancer or the full PRG or cleanup level for cancer were used as screening values.

(4) Rationale Codes

Selection Reason: ASL: above screening level

Deletion Reason: BSL: below screening level

IFE: infrequent exceedance of screening value

IFD: infrequent detection

LME: low magnitude of exceedance

(5) The following surrogate chemicals were used for screening values:

Chemical Name	Surrogate Chemical
2-Methylnaphthalene	Naphthalene
Phenanthrene	Anthracene

(6) There are no Region 9 PRGs for these chemicals; therefore, one-tenth of the Alaska soil cleanup level was used as the screening value.

(7) Lead is evaluated differently from other chemicals, and the PRG takes into account additive effects. Therefore, the full value of the PRG is reported on the table.

Definitions: -- compound has 100% detection frequency

AkCL - Alaska cleanup level

ARAR/TBC - applicable or relevant and appropriate requirement/to be considered

c - cancer endpoint

CAS - Chemical Abstract Service

COPC - chemical of potential concern

J - estimated value

mg/kg - milligrams per kilogram

na - not available

PRG - EPA's Region 9 preliminary remediation goal for residential soil

Table CI.2-7
South of Runway 18-36 Area Soil
Frequency and Magnitude of Exceedance for Chemicals With Detected
Concentrations Greater Than the Screening Values

Chemical	Maximum Concentration (mg/kg)	Screening Concentration (mg/kg)	Frequency of Detection	Frequency of Exceedance	Magnitude of Exceedance
Chemicals Not Selected as COPCs					
Benzene	1.67	0.6	3/79 (4%)	2/79 (3%)	2.8 times screening
Ethylbenzene	15.8	8.92	25/79 (32%)	2/79 (3%)	1.8 times screening
Xylenes	49	27.49	32/79 (41%)	2/79 (3%)	1.8 times screening
Chemicals Selected as COPCs					
2-Methylnaphthalene	61	5.6	1/4 (25%)	1/4 (25%)	11 times screening
DRO	75,000	825	72/93 (77%)	32/93 (34%)	91 times screening
GRO	2,700	140	32/79 (41%)	15/79 (19%)	19 times screening
Naphthalene	14	5.6	1/4 (25%)	1/4 (25%)	2.5 times screening

Notes:
 COPC - chemical of potential concern
 DRO - diesel-range organics
 GRO - gasoline-range organics
 mg/kg - milligrams per kilogram

Table CI.2-8
Chemicals Selected as Chemicals of Potential Concern

Chemical	Groundwater	Soil
2-Methylnaphthalene	X	X
Acetone	X	
Benzene	X	
DRO	X	X
Ethylbenzene	X	
GRO	X	X
Naphthalene	X	X
Xylenes	X	

Notes:

DRO - diesel-range organics

GRO - gasoline-range organics

CI.3.0 EXPOSURE ASSESSMENT

This section evaluates sources, pathways, receptors, exposure duration and frequency, and routes of exposure to assess total human exposure to the substances of concern at each site. The goal of this section is to quantify a calculated dose of chemical per body weight per day for each COPC, receptor, and exposure pathway combination. Three elements are required to calculate a dose: first, a CSM must be developed that identifies exposure pathways and populations; second, estimates of media concentrations at the exposure point must be developed; and third, factors must be selected that quantify the amount of exposure. These exposure factors are then combined with the media concentrations to quantify a dose for each chemical.

CI.3.1 Conceptual Site Model

A CSM describes the sources of chemicals at a site, their release and transfer through environmental media (e.g., soil and air), and the points and means by which human populations might contact the chemicals. This section provides a brief description of which environmental media have been impacted by chemical releases, a description of the site's land uses, and a characterization of the exposed populations under both current and future conditions, as is required by EPA and Alaska DEC guidance (USEPA 1989, ADEC 2000a). The goal of the CSM is to provide an understanding of where the site-related chemicals are present and where they may be present in the future so that the populations that could encounter the chemicals can be identified. The pathways of exposure for these populations can then be selected for quantitative evaluation of health risks.

Affected Media and Land Use

The following media have been identified as containing chemicals above risk-based screening levels associated with an abandoned fuel line located near the southeast corner of Runway 18-36:

- Subsurface soil
- Groundwater

Subsurface soil and groundwater contamination is found over a large area South of Runway 18-36. The regional aquifer beneath the site is at an average depth of 8 feet bgs, with a range of 5 to 10 feet bgs. Groundwater is not a drinking water source because of saltwater intrusion. Therefore, risks from groundwater as a drinking water source will not be evaluated in this assessment. Groundwater in the area appears to flow south toward Sweeper Cove and west toward South Sweeper Creek. Nearshore groundwater in the vicinity of Sweeper Cove and South Sweeper Creek is tidally influenced.

Alaska DEC guidance (ADEC 2000a) requires that future land use scenarios be identified in order to estimate future exposures, as well as current exposures. The Adak Reuse Plan (ARC 2000) has been developed by the Adak Reuse Corporation (ARC) to recommend the reuse of existing infrastructure to support a residential population on Adak Island. Therefore, no new infrastructure is hypothesized for the purposes of the risk assessment. The Adak Reuse Plan also includes information about current land ownership and proposed comprehensive land use plans. The report also includes an analysis of zoning controls for the island, capital improvements required to operate a community of the desired size, a strategy for maintaining and acquiring personal property on the island, recommendations and costs for operations and maintenance (O&M), and a strategy for implementing this plan. The Adak Reuse Plan identifies land use at the South of Runway 18-36 Area as aviation and public facilities (Figure CI.3-1). Public facilities reuse is intended to provide for and protect areas of public lands or facilities for public use (ARC 2000). The adjacent property to the east and west of the South of Runway 18-36 Area is classified for commercial reuse. The intent of the commercial land use category is to provide areas for general commercial/institutional activities that are oriented toward serving the commercial needs of the residents.

Selected Populations

Based on the site's current and potential future land use, the following populations are selected for further discussion:

- Current and future adult construction workers
- Future trespassers

There are no buildings located in the exposure area; therefore, building workers will not be evaluated. Future construction workers could be exposed to both subsurface soil and groundwater because groundwater is as shallow as 5 feet bgs in the South of Runway 18-36 Area and exposure might occur during intrusive activities. In addition, future trespassers who might travel from the housing areas are a population of concern for exposure to surface water and sediment in the West Canal Ditch; and recreational users are a population of concern for exposure to surface water, sediment, and fish/shellfish in South Sweeper Creek.

Although surface materials could theoretically migrate off site and affect off-site receptors, there is no contaminated surface soil at this site (see Section 1.1). The groundwater plume is also not affecting any off-site populations (no drinking water use and no off-site buildings occur above any part of the plume). Therefore, no off-site receptors were identified as populations of potential concern at this site.

Identification of Exposure Pathways

Several possible pathways of exposure may exist at this site. An exposure pathway is the mechanism by which a receptor (human) is exposed to chemicals from a source. The following four elements constitute a complete exposure pathway:

- A source and mechanism of chemical release
- A retention or transport medium (e.g., soil)
- A point of potential human contact with the affected medium
- A means of entry into the body (e.g., ingestion) at the contact point

Only complete pathways containing all four elements result in exposures. However, in some circumstances, an exposure pathway may be considered complete (i.e., meet all four elements outlined above), but insignificant. An exposure pathway is considered complete but insignificant if one or more of the following conditions is met (USEPA 1989):

- The exposure resulting from the pathway is much less than that from another pathway involving the same medium.
- The potential magnitude of exposure from the pathway is low or of limited toxicological importance.
- The probability of the exposure occurring is very low and the risks associated with the occurrence are not high.

Only complete and significant pathways of exposure will be quantitatively evaluated in this risk assessment. Complete but insignificant pathways of exposure generally do not require quantitative evaluation, but will be discussed qualitatively. The CSM (see Figure CI.2-2) depicts the complete pathways for this site. In addition, the current and future exposure pathways considered for the characterization of the site are discussed in more detail.

The rationale for selecting pathways for quantitative evaluation and eliminating pathways considered incomplete or relatively insignificant sources of risks are discussed in the following subsections.

Contact With Soil and Groundwater by Construction Workers. It is assumed that construction activities could occur anywhere on the site. Therefore, the construction worker exposure area is defined by the area of contamination as characterized by the data. Figure CI.3-2 depicts the construction worker exposure area, and construction worker EPCs were calculated from the chemical concentrations in the sampling locations within the defined exposure area.

Construction workers would disturb soil if they, for example, constructed a road or installed underground utilities through the area. Therefore, current and future construction workers could be exposed to chemicals in subsurface soil (as deep as 15 feet bgs) by ingestion, dermal contact, and inhalation while performing work that involves soil disturbance. Although significant amounts of dust generation are unlikely because of the wet weather conditions and soils with high moisture content on Adak, this pathway is included in the quantitative evaluation for construction workers because of the active soil disturbance that occurs during construction.

Subsurface soil disturbances during construction activities typically occur as deep as 15 feet bgs (ADEC 2000a) and groundwater is at an average depth of 8 feet bgs. Therefore, construction workers could come into direct contact with chemicals in groundwater while performing work that involves soil disturbance. Construction workers were evaluated for dermal exposure to groundwater and inhalation of volatile chemicals vaporizing into the outdoor air. Because of the possibility of construction work taking place below grade in semi-confined conditions, the vapor inhalation pathway could potentially be significant for construction workers. Semi-confined conditions represent a worst-case vapor inhalation scenario because vapor concentrations would be higher than in outdoor air (see also Section CI.7.0).

Contact With Surface Water and Sediments in the West Canal Ditch by Trespassers.

Groundwater at the facility is hydrologically connected to the airport ditch system, and petroleum compounds have been detected in surface water and sediment of the West Canal Ditch. Consequently, people who might trespass in the ditches during outdoor activities might encounter petroleum compounds. However, the airport runway area is restricted to airport personnel and the general public is not allowed in this area. In addition, the nearest housing area is over half a mile away from the South of Runway 18-36 Area. For this reason, human contact with surface water and sediment would likely be infrequent and of short duration. Therefore, trespass exposures to surface water and sediment from the Ditch, though a potentially complete pathway, are considered limited and insignificant. Consequently, this pathway was not quantified. Note: Recreational exposures to chemicals in surface water and sediment of the Airport Ditch were quantitatively evaluated under a trespass scenario in the risk assessment for the SWMU 62, New Housing Fuel leak site. The SWMU 62 risk assessment results did not find a health risk to children occasionally coming into contact with ditch surface water and sediment.

Contact With Surface Water, Sediments, and Fish/Shellfish in South Sweeper Creek by Recreational Users. Groundwater at the facility is hydrologically connected to South Sweeper Creek, and petroleum compounds have been detected in surface water and sediment. Consequently, child recreational users might encounter petroleum compounds in South Sweeper Creek during outdoor activities. However, the nearest existing housing area is over half a mile away from South Sweeper Creek in the South of Runway 18-36 Area. For this reason, human contact with surface water and sediment would likely be infrequent and of short duration. In

addition, removal actions of impacted sediment in the Creek and control of seeps have resulted in only low levels of petroleum compounds remaining in these media in the Creek (see Section 3.5.3 and Tables 3-8 and 3-9). No detected chemicals in sediment collected from South Sweeper Creek exceeded Alaska DEC soil cleanup levels protective of direct human contact; and no detected chemicals in surface water collected from South Sweeper Creek exceeded Alaska DEC groundwater cleanup levels for protection of drinking water except DRO and benzo(a)pyrene at one location, location 851 (see further discussion in uncertainty section). Therefore, recreational exposures to surface water and sediment from South Sweeper Creek, though a potentially complete pathway, are considered limited. Current concentrations are below levels that would be a health concern; thus, insignificant. Consequently, this pathway was not quantified.

People have been observed fishing and harvesting shellfish at the mouth of South Sweeper Creek where it drains into Sweeper Cove. Therefore, the fish ingestion pathway could represent a potentially complete pathway. However, part of the remedial action for Sweeper Cove is the issuance of a fish advisory which limits the amount of shellfish ingested from Sweeper Cove (U.S. Navy 2004). While the South of Runway 18-36 Area does not have any restrictions on shellfish consumption, shellfish are not expected to be present in the South of Runway 18-36 Area in great numbers. The fish advisory in place for Sweeper Cove is expected to be protective of potential shellfish contamination at the mouth of South Sweeper Creek. Therefore, the fish ingestion pathway was not evaluated for this site, because it is being addressed by the remedial actions in place for Sweeper Cove.

CI.3.2 Exposure Point Concentrations

To calculate a cancer risk or a noncancer hazard, an estimate must be made of the chemical concentration to which an individual may be exposed. According to EPA (USEPA 1992b, 1992c), the concentration term at the exposure point (the EPC) should be an estimate of the average concentration to which an individual would be exposed over a significant part of a lifetime. Because of the uncertainties surrounding the true average, EPCs were calculated using the 95UCL of the arithmetic mean as the appropriate estimate of the average site concentration for a reasonable maximum exposure (RME) scenario (ADEC 2001d). All statistical program printouts and data used in the EPC calculations are included as Attachment CI-1.

The formula used to calculate a 95UCL depends on the distribution of the data, i.e., the “shape” of the curve (USEPA 1992c). A statistical test was performed for each COPC’s data set to determine the best distribution assumption for the data set. A statistical add-in to Microsoft Excel, titled MTCASat 3.0, provided by Washington State Department of Ecology was used to determine distributions (<http://www.ecy.wa.gov/programs/tcp/tools/toolmain.html>). The results of the distribution test indicate whether the data are normally distributed, lognormally distributed, or neither normal nor lognormal. If the data set distribution is normal, MTCASat

3.0 was used to calculate a corresponding 95UCL value. If the MTCASat 3.0 results indicate a lognormal or “neither” distribution of the data set, a one-sided 95UCL was calculated using the bootstrap method as recommended by EPA and Alaska DEC (USEPA 1997b, ADEC 2001d).

The bootstrap method is a nonparametric statistical technique, which can reduce the bias of point estimates and construct approximate confidence intervals for the population mean. Using SYSTAT 9 software, the bootstrap procedure involves drawing repeated samples of size n with replacement from the given set of data. The process is repeated a large number of times, and each time an estimate of the sample mean is calculated. For this risk assessment, the process was repeated 1,000 times, resulting in a new population of sample means. According to the central limit theorem, the arithmetic means obtained from independent, random samples drawn from the same population will be approximately normally distributed, regardless of the distribution of the sampled population, if the sample size is large (ADEC 2001d, USEPA 1999b). When the assumption of normally distributed means is valid, confidence intervals for the mean may be estimated using the t -statistic (USEPA 1999b). Summary statistics were performed on the 1,000 bootstrapped estimates of the mean. The mean and standard deviation of the bootstrapped estimates were then applied to the Student- t equation for estimating the UCL of a normally distributed population, as follows:

$$95\text{UCL} = (\text{mean of bootstrap estimates}) + 1.64 \times (\text{standard deviation of bootstrap estimates})$$

Where, 1.64 is the z value corresponding to an $\alpha = 0.05$.

Statistical tests were not used for data sets with fewer than 10 samples. If the data set has fewer than 10 samples, the maximum concentration was used as the estimate of the EPC for that chemical. As per EPA (1989) and Alaska DEC guidance, half the SQL was used as a surrogate concentration for nondetected samples. A summary of EPCs for construction workers is included on Table CI.3-1.

Calculation of Exposure Point Concentrations for Petroleum Compounds

Alaska DEC recommends the surrogate approach for evaluating petroleum compounds. The surrogate approach involves separation of the fuel mixtures (e.g., DRO) into aliphatic and aromatic carbon-range fractions and the use of surrogate compounds or derived values to represent the toxicity of those fractions. Therefore, EPCs were calculated for each of the aromatic and aliphatic carbon range fractions. The GRO and DRO data were converted into their respective aromatic and aliphatic carbon fractions by multiplying the GRO and DRO EPCs by the Alaska DEC default percentages of aromatic and aliphatic fractions within each carbon fraction range. The Alaska DEC default percentages are listed in Table CI.3-2. The use of

Alaska DEC's default percentages is a conservative approach which is discussed further in the uncertainty section (Section CI-7).

CI.3.3 Calculation of Chemical Dose

This section defines the magnitude, frequency, and duration of exposure for the populations and pathways selected for quantitative evaluation. Doses are calculated assuming RME as defined by EPA and Alaska DEC. All ACLs and cleanup actions are generally determined from RME risks and hazards; therefore, the calculation of central tendency (CT) risks/hazards was not done because it is not necessary information for the focused feasibility study.

The formulas and exposure factors that were used in concert with the EPCs to quantify dose for the complete pathways at the site are presented in Tables CI.3-3 and CI.3-4, which also indicate the source of the factors. Where site-specific factors, rather than accepted defaults, are proposed for use, the rationale for their selection is discussed below. Default exposure factors are discussed in Attachment CI-2.

Exposure Frequency for Construction Workers

EPA (2002c) default values for construction workers assume an exposure duration of one year, during which workers are at a job site in a contaminated area for 250 days (exposure frequency). However, on Adak Island, construction activities are not expected to occur throughout an entire year because of inclement weather patterns. Therefore, a construction worker exposure frequency of 190 days per year was used. This assumes that construction activities will take place in the summer, spring, and fall and cease in the winter. This is based on a 5-day workweek, with 2 weeks of vacation, for 9 months out of a year.

Groundwater Emission Factors for Construction Workers

For volatile chemicals in groundwater that could be inhaled during construction work, an upper-bound volatilization factor (VF) is used and is based on workers in trenches flooded with groundwater off-gassing VOCs. As described earlier, VOCs are defined as chemicals having both a molecular weight of less than 200 g/mole and a Henry's Law constant greater than 10^{-5} atm-m³/mole (USEPA 2002b). A methodology developed by EPA was used to estimate a VF from water (VF_w) (USEPA 1999a). The EPA (1999a) method examines the mass of a chemical that could be transferred from water to air and assumes:

$$VF_w \left(\frac{L}{m^3} \right) = \frac{(k_{lg})}{(k) \left(\frac{u}{L} \right) (H)} \cdot \left(\frac{1000L}{m^3} \right)$$

where:

k_{lg} = A conservative estimate of the overall mass transfer coefficient from the liquid phase to the gas phase of 3.0×10^{-6} meters per second (m/sec) (USEPA 1999a)

L = A maximum trench length of up to 30 meters (USEPA 1999a)

H = an average trench depth of 3 meters (USEPA 1999a)

u = Site-specific average wind speed of 14 miles per hour (mph) (6.26 m/sec) over a year's time (URS 1995b)

k = An air mixing rate between trench air and ambient air of 50 percent; uniform mixing of air occurs in the trench (USEPA 1999a)

On Adak, continuous winds average approximately 14 mph with gusts up to 115 mph (URS 1995b). Adjusting the wind speed results in a VFW of 0.01 liters per cubic meter (L/m^3).

Particulate Emission Factor for Soil

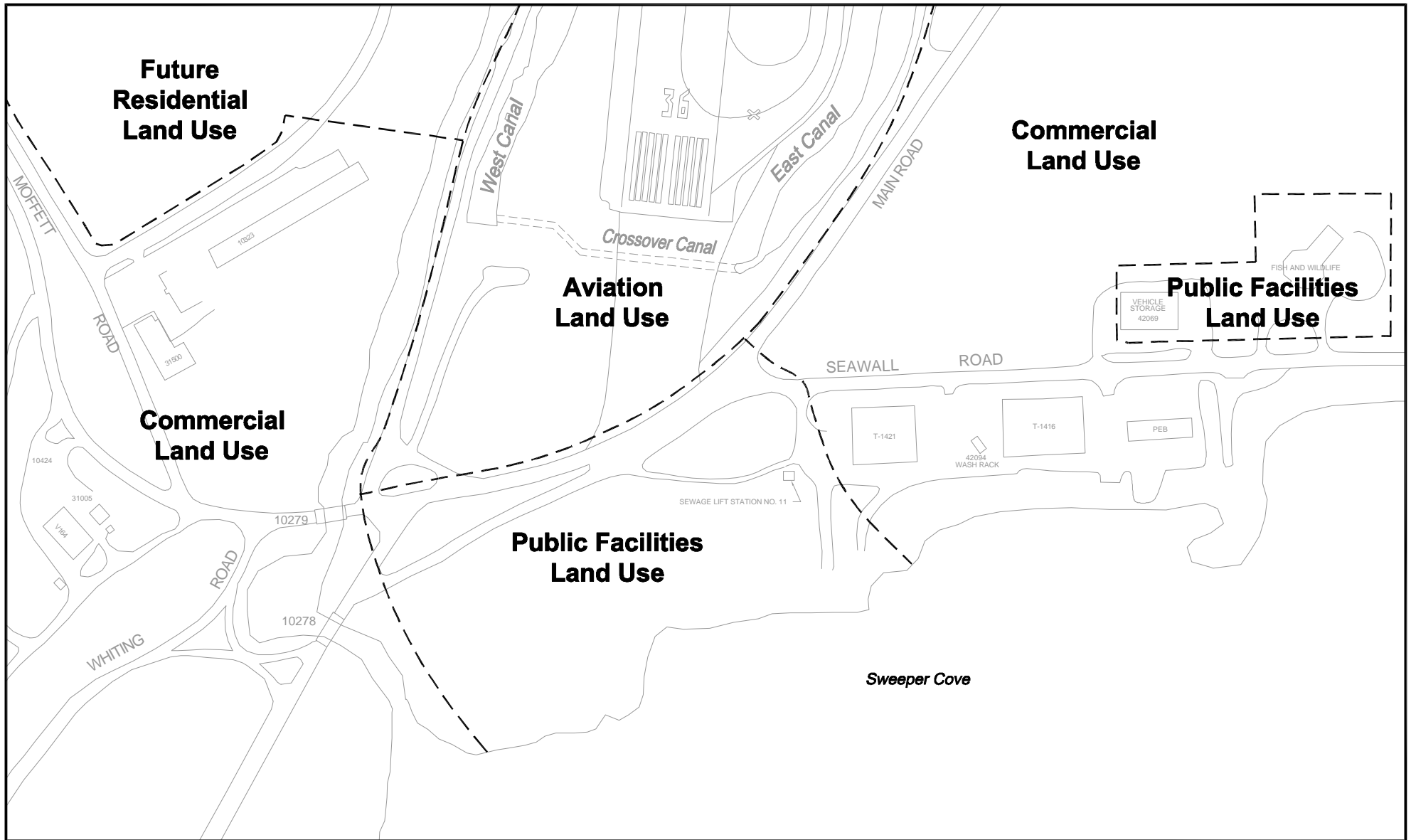
The particulate emission factor (PEF) relates the concentration of chemical in soil with the concentration of dust particles in the air, or "fugitive dust" (USEPA 1996). A site-specific PEF was calculated for the site using the equation from EPA (2002c). The emissions part of the equation is based on the "unlimited reservoir" model from Cowherd et al. (1985) developed to estimate particulate emissions owing to wind erosion (as cited in USEPA 1996). The dispersion part of the equation includes a dispersion coefficient (Q/C_{wind}). The variable, Q/C_{wind} , is dependent on the climatic zone and meteorological conditions at a site. Therefore, site-specific dispersion factors can be calculated that reflect the site location and climate as well as the site size. The Alaska DEC (2002) default Q/C value for the "over 40-inch zone" of 82.72 (g/m^2-s per kg/m^3) was used in the PEF equation. Table CI.3-5 summarizes the inputs for the PEF equation.

The *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA 2002c) also provides a more complicated method for deriving a PEF for a construction scenario, which takes into account the amount of dust thrown into the air from vehicle traffic (e.g., earthmoving equipment). During intrusive construction activities subsurface soil could be moved to the surface. Detailed site-specific information required for input into this PEF equation was not available (i.e., length and width of construction roads, number and average weight of construction vehicles, etc.). The simpler approach for estimating PEF as described above was used instead. If construction activities are planned at this facility in the future, particulate air concentrations should be recalculated using project-specific information.

Volatilization Factor for Soil

The soil-to-air volatilization factor (VF) is used to define the relationship between the concentration of the volatile contaminant in soil and the flux of the volatilized contaminant to air. The VF only applies to volatile chemicals in soil, while the PEF, described above, only applies to nonvolatile chemicals. The *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA 2002c) provides a method for deriving chemical specific VFs that are appropriate for evaluating exposures for subchronic outdoor inhalation of volatiles by construction workers.

The equation used to derive the VFs for the construction worker scenario is Equation 5-14 of the Supplemental Guidance and is shown in Table CI.3-5. The VF equation combines chemical-specific properties with dispersion assumptions. The default subchronic dispersion factor for volatiles factor, Q/C_{sa} , was derived using EPA's SCREEN3 dispersion model for a hypothetical site under a wide range of meteorological conditions. Unlike the Q/C value for the PEF above, the Q/C_{sa} can only be modified to reflect different site sizes; it cannot be modified for climatic zone. The default Q/C_{sa} was used which assumes a 0.5-acre site. The time interval, T, is the total time over which construction occurs in seconds. For the construction worker scenario, a time interval of 3.2×10^7 seconds (1 year x 365 days/year x 24 hours/day x 60 min/hour x 60 sec/min) will be assumed, which is equal to the assumed exposure duration for the construction worker.



U.S. NAVY

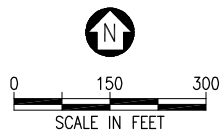
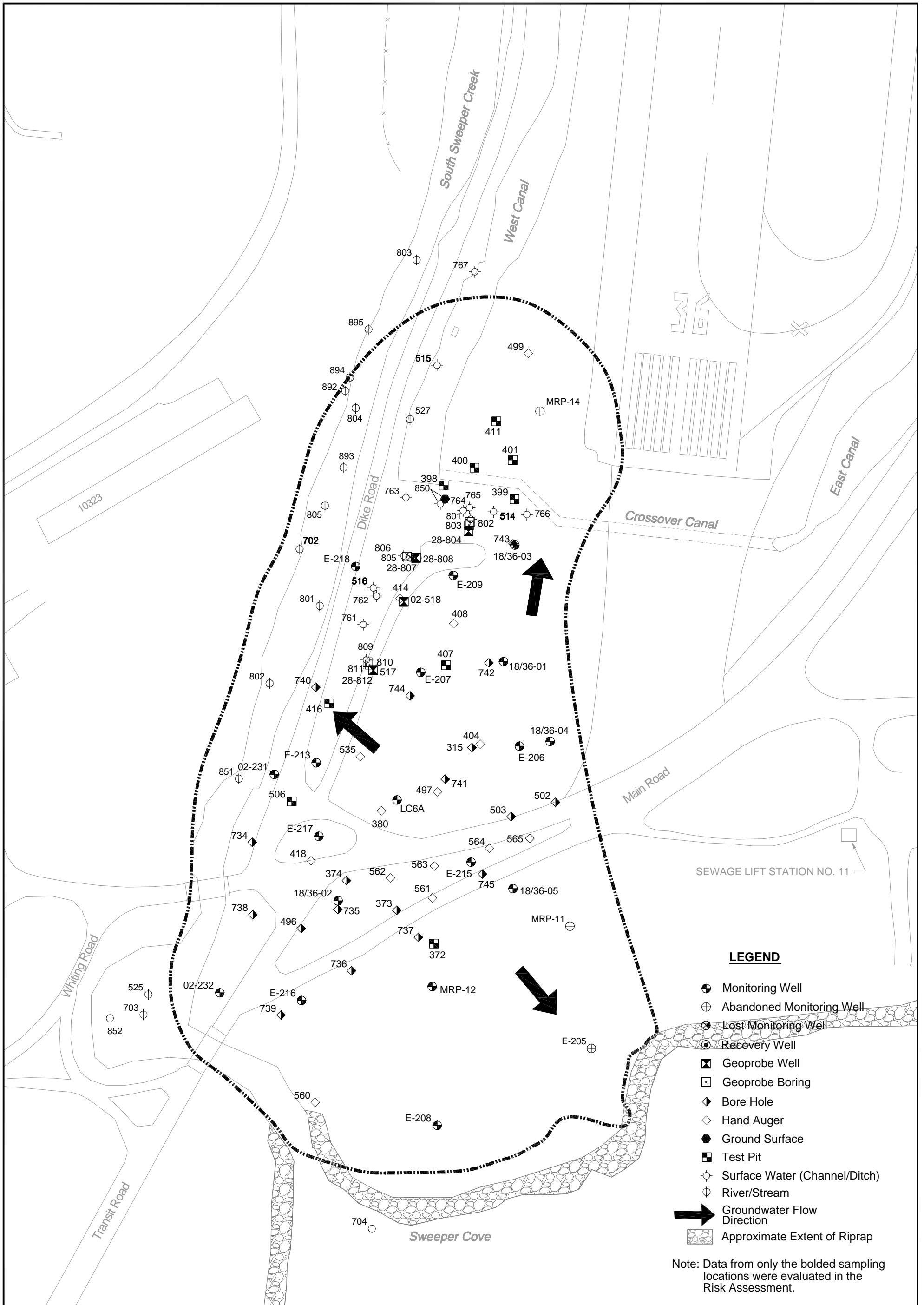


Figure CI.3-1
Proposed Future Land Use
South of Runway 18-36 and NMCB Area

Delivery Order 0037
 Adak Island, AK
 FOCUSED FEASIBILITY
 STUDY



U.S. NAVY

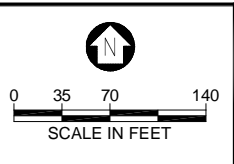


Figure CI.3-2
Human Health Exposure Area
South of Runway 18-36 Area

Delivery Order 0037
 Adak Island, AK
FOCUSED FEASIBILITY
STUDY

**Table CI.3-1
 Summary of Exposure Point Concentrations (EPCs)**

Chemical	Construction Worker Exposures	
	Groundwater µg/L	Soil mg/kg
2-Methylnaphthalene	33.8	61 ^a
Acetone	320 ^a	--
Benzene	14.3	--
Ethylbenzene	12.7	--
Naphthalene	44.6	14 ^a
Xylenes	55.9	--
GRO (C ₆ -C ₈ aliphatics)	15312	238
GRO (C ₆ -C ₈ aromatics)	10937	170
DRO (C ₉ -C ₂₄ aliphatics)	25012	7424
DRO (C ₉ -C ₂₄ aromatics)	12506	3712

Note: All EPCs are the UCL95, unless otherwise noted.

^a A UCL95 cannot be calculated for this chemical because there are fewer than 10 samples in the data set.

Therefore, the maximum detected concentration was used as the EPC.

-- These chemicals were not selected as COPCs in this medium.

DRO - Diesel range organics

GRO - Gasoline range organics

µg/L - microgram per liter

mg/kg - milligram per kilogram

Table CI.3-2
Alaska DEC Default Petroleum Compositions

Carbon Range	Percent Aliphatic	Percent Aromatic
Gasoline-range organics (C ₆ -C ₈)	70%	50%
Diesel-range organics (C ₉ -C ₂₄)	80%	40%
Residual-range organics (>C ₂₄)	90%	30%

Source: ADEC 2000b.

Note that total composition adds up to greater than 100 percent. Alaska DEC (2000b) recommends these percentages because of the uncertainties surrounding actual composition of weathered petroleum products.

Note:

DEC - State of Alaska Department of Environmental Conservation

**Table CI.3-3
 Construction Worker Exposures to Groundwater,
 Exposure Assumptions and Intake Equations**

Equations:

Chemical intake (mg/kg-day) = CW * SIF

$$SIF_{\text{derm}} = \frac{CF1 \cdot CF2 \cdot SA \cdot EF \cdot ET \cdot ED \cdot PC}{BW \cdot AT}$$

$$SIF_{\text{inh}} = \frac{CF1 \cdot InhR \cdot EF \cdot ED \cdot VFw}{BW \cdot AT}$$

Where:

SIF_{derm} (L-mg/ug-kg-day) = summary intake factor for dermal contact with groundwater
 SIF_{inh} (L-mg/ug-kg-day) = summary intake factor for inhalation of groundwater vapors

Parameter	Definition	Value	Units	Source
CW	Chemical concentration in groundwater	chemical specific	ug/L	analytical data
CF1	Conversion factor	1.00E-03	mg/ug	not applicable
CF2	Conversion factor	1.00E-03	L/cm ³	not applicable
SA	Skin surface area	3300	cm ²	default value, USEPA 2002c
PC	Dermal permeability constant	chemical specific	cm/hr	USEPA 2003b
InhR	Inhalation rate	20	m ³ /day	default value, USEPA 2002c
VFw	Volatilization factor for water	0.01	L/m ³	site-specific, USEPA 1999a
EF	Exposure frequency	190	days/year	site-specific
ET	Exposure time	8	hours/day	site-specific
ED	Exposure duration	1	years	site-specific
BW	Body weight	70	kg	default value, USEPA 2002c
ATnc	Averaging time (noncarcinogen)	ED x 365 days/year	days	default value, USEPA 2002c
ATca	Averaging time (carcinogen)	25,550	days	default value, USEPA 2002c

Notes:

- cm² - centimeters squared
- cm³ - cubic centimeters
- hr - hour
- kg - kilograms
- L - liters
- m³ - cubic meters
- mg - milligrams
- ug - micrograms

**Table CI.3-4
 Construction Worker Exposures to Soil,
 Exposure Assumptions and Intake Equations**

Equations:

Chemical intake (mg/kg-day) = CS * SIF

$$SIF_{ing} = \frac{IR \cdot CF \cdot EF \cdot ED}{BW \cdot AT}$$

$$SIF_{derm} = \frac{CF \cdot SA \cdot AF \cdot ABS \cdot EF \cdot ED}{BW \cdot AT}$$

$$SIF_{inh} = \frac{InhR \cdot EF \cdot ED \cdot (1/PEF)}{BW \cdot AT}$$

Where:

SIF_{ing} (day⁻¹) = summary intake factor for ingestion of soil
 SIF_{derm} (day⁻¹) = summary intake factor for dermal contact with soil
 SIF_{inh} (day⁻¹) = summary intake factor for inhalation of fugitive dust

Parameter	Definition	Value	Units	Source
CS	Chemical concentration in soil	chemical specific	mg/kg	analytical data
IR	Ingestion rate	330	mg/day	default value, USEPA 2002c
CF	Conversion factor	1.00E-06	kg/mg	not applicable
SA	Surface area	3300	cm ²	default value, USEPA 2002c
AF	Soil to skin adherence factor	0.3	mg/cm ² -day	default value, USEPA 2002c
ABS	Absorption factor	chemical specific	unitless	USEPA 2003b
InhR	Inhalation rate	20	m ³ /day	default value, USEPA 2002c
PEF	Particulate emission factor	5.09E+08	m ³ /kg	site-specific, USEPA 2002c
EF	Exposure frequency	190	days/year	site-specific
ED	Exposure duration	1	years	default value, USEPA 2002c
BW	Body weight	70	kg	default value, USEPA 2002c
ATnc	Averaging time (noncarcinogen)	ED x 365 days/year	days	default value, USEPA 2002c
ATca	Averaging time (carcinogen)	25,550	days	default value, USEPA 2002c

Notes:

- cm² - centimeters squared
- kg - kilograms
- m³ - cubic meters
- mg - milligrams

**Table CI.3-5
 Summary of Volatilization Factor and Particulate
 Emission Factor Inputs and Equations**

Parameter	Definition (units)	Value	Source
$D_A = \{[(q_a^{10/3} \times D_i \times H') + (q_w^{10/3} \times D_w)]/n^2\} / \{p_b k_{oc} f_{oc} + q_w + q_a H'\}$			
q_a	Air-filled soil porosity (L_{air}/L_{soil})	0.28	Default value (USEPA 2002c)
D_i	Diffusivity in air (cm^2/s)	Chemical specific	Table 37 page 137 of USEPA 1996
H'	Henry's Law constant (unitless)	Chemical specific	Table 36 page 134 of USEPA 1996
q_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15	Default value (USEPA 2002c)
D_w	Diffusivity in water (cm^2/s)	Chemical specific	Table 37 page 137 of USEPA 1996
n	Total soil porosity (L_{pore}/L_{soil})	0.43	$1-(p_b/p_s)$
p_b	Dry soil bulk density (g/cm^3)	1.5	Default value (USEPA 2002c)
p_s	Soil particle density (g/cm^3)	2.65	Default value (USEPA 2002c)
k_{oc}	Soil organic carbon-water partition coefficient (cm^3/g)	Chemical specific	Table 39 page 143 of USEPA 1996. The larger of the calculated K_{oc} or measured K_{oc} was used.
f_{oc}	Organic carbon content (g/g)	0.006	Default value (USEPA 2002c)
$VF = Q/C \times (1/F_D)^* \times [(3.14 \times D_A \times T)^{1/2} / (2 \times p_b \times D_A)] \times 10^{-4}$ * The F_D factor is only used with the Q/C_{sa} dispersion coefficient			
$Q/C_{vol} [Q/C_{sa}]$	Dispersion coefficient for volatiles [subchronic dispersion coefficient] (g/m^2 -s per kg/m^3)	82.72 [14.31]	Alaska DEC default value for "over 40-inch zone" (2002). Value in brackets is the EPA's subchronic dispersion coefficient default from Exhibit D-3 (2002c).
F_D	Dispersion correction factor (unitless) The F_D factor is only used with the Q/C_{sa} dispersion coefficient.	0.19	Default value (USEPA 2002c)
T (on-site worker)	Exposure interval (s)	9.5×10^8	Default value (USEPA 2002c)
T (construction worker)	Exposure interval (s)	$3.2E+07$	Total time over which construction occurs; site specific.
p_b	Dry soil bulk density (g/cm^3)	1.5	Default value (USEPA 2002c)

Table CI.3-5 (Continued)
Summary of Volatilization Factor and Particulate
Emission Factor Inputs and Equations

Parameter	Definition (units)	Value	Source
PEF = [Q/C_{wind} x 3600] / [0.036 x (1-V) x (U_m/U_t)³ x F(x)]			
Q/C _{wind}	Dispersion coefficient for fugitive dust (g/m ² -s per kg/m ³)	82.72	Alaska DEC default value for "over 40-inch zone" (2002).
V	Fraction of vegetative cover (unitless)	0.5	Default value (USEPA 2002c) ⁽¹⁾
U _m	Mean annual windspeed (m/s)	6.24	Site specific
U _t	Equivalent threshold value of windspeed at 7 m (m/s)	11.32	Default value (USEPA 2002c)
F(x)	Function dependent on U _m /U _t	0.194	Default value (USEPA 2002c)
PEF	Particulate emission factor (m ³ /kg)	5.09E+08	Calculated

⁽¹⁾ Although the default value is listed here, this value is representative of the area evaluated.

Notes:

- g - gram
- m³/kg - cubic meter per kilogram
- m/s - meter per second
- g/m²-s - gram per square meter; second

CI.4.0 TOXICITY CRITERIA

The purpose of the toxicity assessment is to weigh the available and relevant evidence regarding the potential for chemicals to cause adverse health effects in exposed individuals and to provide a quantitative estimate of the relationship between the magnitude of exposure and the likelihood of adverse effects (USEPA 1989). A fundamental principle of toxicology is that the dose determines the severity of the effect. Accordingly, the toxicity criteria describe the quantitative relationship between the dose of a chemical and the type and incidence of the toxic effect. This relationship is referred to as the dose-response. The types of toxicity criteria are described in the following subsections. Tables CI.4-1 and CI.4-2 present toxicity criteria used in this assessment. Attachment CI-3 contains discussions of the specific criteria and associated health effects for each COPC.

CI.4.1 Oral Toxicity Criteria

A dose-response evaluation is the process of quantitatively evaluating toxicity information and characterizing the relationship between the dose of the chemical and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity criteria are derived that can be used to estimate the potential for adverse health effects as a function of exposure to the chemical. Toxicity values are combined with the summary intake factors listed on Tables CI.3-3 and CI.3-4 and are used to calculate human risks for various exposure scenarios. Exposure to chemicals can result in cancer or noncancer effects, which are characterized separately. Essential dose-response criteria are the EPA slope factor (SF) values for assessing cancer risks and the EPA-verified reference dose (RfD) values for evaluating noncancer effects. These criteria are from the EPA's on-line database, Integrated Risk Information System (IRIS) (USEPA 2003a). Where IRIS criteria were not available, other EPA sources of toxicity criteria were investigated as described in Attachment CI-3 for individual chemicals.

Cancer Effects

The cancer SF (expressed as $(\text{mg}/\text{kg}\text{-day})^{-1}$) expresses excess cancer risk as a function of dose. The dose-response model is based on high- to low-dose extrapolation, and assumes that there is no lower threshold for the initiation of toxic effects. Specifically, cancer effects observed at high doses in laboratory animals or from occupational or epidemiological studies are extrapolated, using mathematical models, to low doses common to environmental exposures. These models are essentially linear at low doses, such that no dose is without some risk of cancer. The cancer SFs for each of the COPCs are presented on Table CI.4-1.

Noncancer Effects

Chronic RfDs are defined as an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without appreciable risk of noncancer effects during a lifetime of exposure (USEPA 1989). Chronic RfDs are specifically developed to be protective for long-term exposure to a chemical and are generally used to evaluate the potential noncancer effects associated with exposure periods of 7 years to a lifetime. RfDs are expressed as mg/kg-day and are calculated using lifetime average body weight and intake assumptions. The noncancer toxicity criteria is presented in Table CI.4-2.

RfD values are derived from experimental data on the no-observed-adverse-effect level (NOAEL) or lowest-observed-adverse-effect level (LOAEL) in animals or humans. The NOAEL is the highest tested chemical dose given to animals or humans that has not been associated with any adverse health effects. The LOAEL is the lowest chemical dose at which health effects have been reported. RfDs are calculated by dividing the NOAEL or LOAEL by a total uncertainty factor (UF), which represents a combination of individual factors for various sources of uncertainty associated with the database for a particular chemical or with the extrapolation of animal data to humans. IRIS also assigns a level of confidence in the RfD. The level of confidence is rated as either high, medium, or low based on confidence in the study and confidence in the database. RfDs for subchronic, rather than chronic, exposures have been developed for some chemicals.

For the construction worker scenario evaluated in this assessment, EPA guidance (2002c) recommends evaluating construction exposures over a 1-year duration. A 1-year timeframe is defined by EPA (USEPA 1989) as a subchronic exposure (i.e., lasting between 2 weeks and 7 years). RfDs are designed to be protective over a lifetime and reflect the safe dose level for chronic, rather than subchronic exposures. Therefore, according to EPA (see Section 5.3.1 of USEPA 2002c), construction worker non-cancer hazards should be evaluated using subchronic RfDs (cancer risks are not affected because all cancer risks are evaluated based on lifetime exposure). EPA's *Health Effects Assessment Summary Tables* (HEAST) (USEPA 1997c) is the only published EPA source of subchronic criteria; however, subchronic criteria have been calculated by EPA since 1997 for specific chemicals. The Agency for Toxic Substances and Disease Registry (ATSDR) has minimum risk levels (MRLs) for intermediate exposures (defined as >14 – 364 days). However, these MRLs do not necessarily use the same information as EPA RfDs and don't always correspond to EPA values. Therefore, they are difficult to use with EPA toxicity criteria as they often do not represent an "apples to apples" comparison with EPA criteria.

In EPA's methodology used to derive chronic RfDs, UFs (UFs) are applied to the no-observed-adverse-effect-level (NOAEL) or lowest-observed-adverse-effect-level (LOAEL) of the critical

research study. These UFs are used to address the uncertainties/variabilities that are present in the data set for each individual chemical (see Section 4.4.5 of USEPA 2002d). The UFs (up to 5) are assigned values of either 10 or 3, these values are multiplied together, and then the critical study NOAEL or LOAEL is divided by the total UF (see Section 4.4.5 of USEPA 2002d). In general, EPA has estimated subchronic criteria from chronic criteria by removing the UF of 10 to account for the use of a subchronic study to estimate chronic exposure; therefore, the vast majority of the subchronic criteria presented in HEAST are an order of magnitude larger than their corresponding chronic values.

In this assessment, subchronic criteria were used to evaluate construction worker exposures. The subchronic criteria were obtained from the following sources. The subchronic toxicity values selected for use in the risk assessment were submitted to EPA's National Center for Environmental Assessment (NCEA) by Alaska DEC. Alaska DEC approved the use of those subchronic toxicity criteria following approval from NCEA.

1. HEAST. Subchronic criteria from HEAST were used if the chronic RfD has not been updated since 1997 (i.e., the subchronic criteria is based on the same critical study as the chronic criteria).
2. IRIS. Where the chronic criteria have been updated since 1997 and are in IRIS, the IRIS file was reviewed. If a UF was used to decrease a chronic value to account for subchronic to chronic exposure, that UF was removed to obtain a subchronic criteria. In addition, if the NOAEL or LOAEL was adjusted from a 5-day exposure to a 7-day exposure, that adjustment was removed to reflect the worker population of concern (see Sections 4.4.2 and 4.4.3 in USEPA 2002d).
3. National Center for Environmental Assessment (NCEA). Where the source of the chronic criteria is the NCEA (this information is listed on EPA's Region 9 PRG list), the backup documentation that NCEA used to derive the chronic criteria was reviewed to evaluate whether sufficient information was provided to make an adjustment to the chronic value as described above under bullet number two.

Where information is insufficient to derive a subchronic value, the chronic RfD was used to evaluate hazards, as was the case for the petroleum fraction toxicity criteria. The petroleum fraction toxicity criteria values presented in Alaska DEC guidance were not adjusted because of their status in State guidance and because of insufficient information on how those values were derived. Table CI.4-2 summarizes the chronic RfDs, the subchronic RfDs, as well as the sources and methods used to derive the subchronic criteria for each COPC.

CI.4.2 Inhalation Toxicity Criteria

The criteria for inhalation are reference concentrations (RfCs) expressed in milligrams of chemical per cubic meter of air (mg/m^3) for noncarcinogens and unit risk factors (URFs) expressed in cubic meters of air per microgram of chemical ($\text{m}^3/\mu\text{g}$) for carcinogenic exposures. RfCs and URFs are developed in the same manner as RfDs and SFs except they include, as part of their development, a default inhalation rate assumption of 20 m^3 of air inhaled per day. Because the default inhalation rate is not applicable to all the receptors in this risk assessment, RfCs and URFs were converted into reference doses for inhalation (RfD_i) and inhalation slope factors (SF_i) according to the protocols presented by EPA (1989, 2003a). The conversions are as follows:

$$\text{RfD}_i (\text{mg}/\text{kg}\text{-day}) = \text{RfC} (\text{mg}/\text{m}^3) \times 20 (\text{m}^3/\text{day}) \times 1 / 70 (\text{kg})$$

$$\text{SF}_i (\text{kg}\text{-day}/\text{mg}) = \text{URF} (\text{m}^3/\mu\text{g}) \times 1 / 20 (\text{day}/\text{m}^3) \times 70 (\text{kg}) \times 10^3 (\mu\text{g}/\text{mg})$$

Subchronic inhalation RfDs were developed in the same manner as the oral subchronic RfDs described in Section CI.4.1 to evaluate construction worker inhalation exposures. Chemical-specific information is provided in Attachment CI-3.

CI.4.3 Dermal Toxicity Criteria

Most oral RfDs and slope factors are expressed as an administered dose, i.e., the amount of substance taken into the body by swallowing. In contrast, exposure estimates for the dermal route of exposure are expressed as an absorbed dose, i.e., the amount of chemical that is actually absorbed through the skin. Because dermal toxicity criteria are not readily available, oral toxicity values are used in conjunction with an absorption correction factor to adjust for the difference in administered to absorbed dose. The dermal absorption correction factor inversely affects the toxicity criteria.

For example, assume a chemical has an oral (administered) RfD of $10 \text{ mg}/\text{kg}\text{-day}$. If 100 percent of the administered safe dose is absorbed, then the absorbed dose will be equal to $10 \text{ mg}/\text{kg}\text{-day}$. If only 50 percent of the administered safe dose is absorbed, then the absorbed safe dose is 50 percent less, or $5 \text{ mg}/\text{kg}\text{-day}$. Therefore, essentially only half of the amount of chemical that is actually swallowed will cause adverse effects, because only half is actually absorbed into the body. EPA recommends absorption correction factors for a limited amount of inorganic chemicals in Exhibit 4-1 of the Part E, Supplemental Guidance for Dermal Risk Assessment (USEPA 2003b). For those chemicals that do not appear on the table, the recommendation is to assume 100 percent absorption (USEPA 2003b). In other words, the dermal toxicity criteria would not differ from the oral toxicity criteria.

In this instance, none of the selected COPCs have recommended absorption correction factors. Therefore, the default assumption of 100 percent absorption was used. Assuming 100 percent absorption is a non-conservative approach (USEPA 1989). However, for organics, review of current literature indicates that organic chemicals are generally well absorbed (greater than 50 percent) across the GI tract (USEPA 2003b). Therefore, the assumption of 100 percent absorption for organic chemicals is reasonable.

**Table CI.4-1
 Carcinogenic Toxicity Criteria for the Chemicals of Potential Concern**

Chemical	Oral Cancer: Slope Factor (mg/kg-day) ⁻¹	Inhalation Cancer: Slope Factor (mg/kg-day) ⁻¹	Tumor Type	EPA Cancer Classification ^a	Reference
2-Methylnaphthalene	None	None	NA	Not classified	NA
Acetone	None	None	NA	EPA Group D carcinogen	USEPA 2003a
Benzene	0.055	0.029	Leukemia (human)	EPA Group A carcinogen	USEPA 2003a
Ethylbenzene	None	0.0039	Renal and testicular cancer (male rates)	EPA Group D carcinogen ^b	USEPA 2002a
Naphthalene	None	None	NA	EPA Group D carcinogen	USEPA 2002a
Xylenes	None	None	NA	EPA Group D carcinogen	USEPA 2002a
DRO aliphatics	None	None	NA	Not classified	ADEC 2000a
DRO aromatics	None	None	NA	Not classified	ADEC 2000a
GRO aliphatic	None	None	NA	Not classified	ADEC 2000a
GRO aromatics	None	None	NA	Not classified	ADEC 2000a

Notes:

^aEPA's Weight-of-Evidence Classification System:

- Group A - human carcinogen (sufficient evidence in humans)
- Group B1 - probable human carcinogen (limited human data available)
- Group B2 - probable human carcinogen (sufficient evidence in animals, inadequate or no evidence in humans)
- Group C - possible human carcinogen (limited evidence in animals)
- Group D - not classifiable as to human carcinogenicity

^bThe IRIS file has not been updated yet to reflect the carcinogenicity of ethylbenzene. Therefore, the cancer classification will likely change.

mg/kg-day - milligram per kilogram per day

NA - not applicable

SF - slope factor

**Table CI.4-2
 Noncarcinogenic Chronic and Subchronic Toxicity Criteria for the Chemicals of Potential Concern**

Chemical	Chronic RfD (mg/kg-day)	Toxic Endpoint	Critical Study	Chronic RfD UF ^a	RfD Source	Adjustment from Chronic to Subchronic	Subchronic RfD (mg/kg-day)	EPA Subchronic Source ^b
Inhalation Exposures								
2-Methylnaphthalene	none ^c	--	--	--	NCEA-S-1400 (April 2003)	insufficient information	--	
Acetone	none ^d	Inhalation hazards will not be quantified, uncertainties will be discussed.	--	--	--	insufficient information	--	
Benzene	0.009	Decreased lymphocyte count	subchronic human occupational	300	IRIS	no adjustment for subchronic warranted, primary study is already occupational	0.009	
Ethylbenzene	0.29	Developmental toxicity	subchronic female rats	300	IRIS	Based on developmental effects during gestational exposures. No subchronic to chronic UF used; therefore, no subchronic value proposed.	0.29	
Naphthalene	0.00086	Nasal effects	chronic mouse	3,000	IRIS	remove adjustment from 5 to 7 days ^e	0.0043	
Xylenes	0.029	Hyperactivity, decreased body weight, and increased mortality	subchronic male rats	300	IRIS	remove UF of 3 for subchronic to chronic	0.09	
DRO aliphatics	0.29	hepatic and hematological changes	NA	NA	ADEC 2000a	The petroleum fraction RfD values presented in ADEC guidance were not adjusted because of their status in State guidance and because of insufficient information on how those values were derived.	0.29	
DRO aromatics	0.06	Decreased body weight	NA	NA	ADEC 2000a		0.06	
GRO aliphatics	5.3	Neurotoxicity	NA	NA	ADEC 2000a		5.3	
GRO aromatics	0.11	Hepatotoxicity and nephrotoxicity	NA	NA	ADEC 2000a		0.11	
Oral Exposures								
2-Methylnaphthalene	0.009	pulmonary alveolar proteinosis	chronic male mice	1,000	NCEA-S-1400 (April 2003)	no adjustment for subchronic warranted because no UF applied for subchronic to chronic.	0.009	
Acetone	0.1	Nephropathy	subchronic rat	1,000	IRIS	remove UF of 10 for subchronic to chronic	1	HEAST
Benzene	0.004	Decreased lymphocyte count	subchronic human occupational	300	IRIS	no adjustment for subchronic warranted, primary study is already occupational	0.004	
Ethylbenzene	0.10	Liver and kidney toxicity	subchronic mouse	1,000	IRIS	remove UF of 10 for subchronic to chronic	1	
Naphthalene	0.02	Decreased body weight	subchronic rat	3,000	IRIS	remove UF of 10 for subchronic to chronic	0.2	
Xylenes	0.2	Hyperactivity, decreased body weight, and increased mortality	chronic rat	1,000	IRIS	remove adjustment from 5 to 7 days ^e	0.25	
DRO aliphatics	0.1	hepatic and hematological changes	NA	NA	ADEC 2000a	The petroleum fraction RfD values presented in ADEC guidance were not adjusted because of their status in State guidance and because of insufficient information on how those values were derived.	0.1	
DRO aromatics	0.04	Decreased body weight	NA	NA	ADEC 2000a		0.04	
GRO aliphatics	5.00	Neurotoxicity	NA	NA	ADEC 2000a		5.00	
GRO aromatics	0.2	Hepatotoxicity and nephrotoxicity	NA	NA	ADEC 2000a		0.2	

Notes

^aEPA indicates that there are generally 5 areas of uncertainty where an application of a UF may be warranted:

- 1 variation between species (applied when extrapolating from animal to human)
- 2 variation within species (applied to account for differences in human response and sensitive subpopulations)
- 3 use of a subchronic study to evaluate chronic exposure
- 4 use of a LOAEL, rather than a NOAEL
- 5 deficiencies in the data base

^b If a subchronic value was obtained from a published source, rather than calculated, the source is listed in this column.

^c No inhalation criteria are available for this chemical and NCEA specifically states the route-to-route extrapolation from oral to inhalation is not recommended for this chemical (NCEA-S-1400, April 2003).

^d No inhalation criteria are available for this chemical.

^e EPA adjusted the 5-day per week exposure of the NOAEL to a 7-day NOAEL to account for continuous exposure (chronic), rather than subchronic, exposures.

IRIS: EPA's Integrated Risk Information System (on-line data base) (USEPA 2003a)

LOAEL: lowest-observed-adverse-effect-level

NCEA: EPA's National Center for Environmental Assessment

NOAEL: no-observed-adverse-effect-level

RfD: Reference Dose

UF: Uncertainty factor

CI.5.0 RISK CHARACTERIZATION

Risk characterization is the summarizing step of risk assessment (USEPA 1989; ADEC 2000a). In the risk characterization, the toxicity values (RfDs and SFs) are applied in conjunction with the concentrations of COPCs and intake assumptions to estimate cancer risks and health hazards other than cancer.

Noncancer health hazards and cancer risks were calculated for RME exposure conditions. RME hazard/risk estimates are based on the maximum exposure that is reasonably expected to occur at a site. Intake parameter values were selected so that the combination of all parameters resulted in an estimate of the RME for a particular exposure pathway. By design, the estimated RME is higher than that expected to be experienced by most of the exposed population.

CI.5.1 Methodology for Assessing Noncancer Hazards

The potential for adverse health effects other than cancer (noncancer effects) was characterized by dividing estimated chemical intakes by chemical-specific RfDs. The resulting ratio is the hazard quotient (HQ), derived as follows:

$$HQ = \frac{\text{Chemical Intake (mg/kg-day)}}{\text{RfD (mg/kg-day)}}$$

EPA (1989) risk assessment guidelines consider the additive effects associated with simultaneous exposure to several chemicals by specifying that all HQs initially be summed across exposure pathways and chemicals to estimate the total hazard index. This summation conservatively assumes that the toxic effects of all chemicals would be additive, or in other words, that all chemicals cause the same toxic effect and act by the same mechanism. Alaska DEC (2000c) risk assessment guidelines require that noncarcinogenic effects of the TPH compounds (i.e., DRO and GRO) be evaluated separately from the non-TPH compounds. Therefore, in the summarizing step of the risk characterization section, a HI is presented for each, the non-TPH compounds and the TPH compounds.

If the total HI is less than or equal to 1, multiple-pathway exposures to COPCs at the site are considered unlikely to result in an adverse effect. If the total HI is greater than 1, further evaluation of exposure assumptions and toxicity, including consideration of specific affected target organs and the mechanisms of toxic actions of COPCs, is warranted to ascertain whether the cumulative exposure would in fact be likely to harm exposed individuals.

CI.5.2 Methodology for Evaluating Cancer Risk

The potential for carcinogenic effects are evaluated by estimating the probability of developing cancer over a lifetime based on exposure assumptions and chemical-specific toxicity criteria. The increased likelihood of cancer due to exposure to a particular chemical is defined as the excess cancer risk (i.e., in excess of a background cancer risk of one chance in three [0.3 or 3×10^{-1}] for every American female, and one chance in two [0.5 or 5×10^{-1}] for every American male, of eventually developing cancer [ACS (American Cancer Society) 2001]). Excess lifetime cancer risk is estimated by multiplying the estimated chemical intake by the cancer SF, as follows.

$$\text{Cancer Risk} = \text{Chemical Intake (mg/kg-day)} \times \text{SF (mg/kg-day)}^{-1}$$

This formula applies to cancer risks lower than 1×10^{-2} (1 in 100). All cancer risks in this assessment were lower than 1×10^{-2} .

The risks resulting from exposure to multiple carcinogens are assumed to be additive. The total cancer risk is estimated by summing the estimated risks for each COPC and for each exposure pathway. Alaska DEC's target acceptable excess cancer risk is 1×10^{-5} , although, under certain site conditions, the State may approve a risk level as acceptable that is at the upper end of EPA's target risk range (1×10^{-4}).

CI.5.3 Risk Characterization Results for COPCs

Total RME risks and hazards are summarized on Table CI.5-1. Note that all final risk and hazard estimates are presented to one significant figure only, as recommended by EPA (USEPA 1989). Therefore, an HQ of 1 could range between 0.95 and 1.4, and a risk of 2×10^{-5} could range between 1.5×10^{-5} and 2.4×10^{-5} . Details of the calculations with risks and hazards presented to two significant figures can be found in Attachment CI-4. The risks and hazards for each exposure scenario are discussed in the following subsections.

Risks and Hazards for Construction Workers

The construction worker scenario was evaluated to estimate potential exposures to workers in the event that construction activities did take place, disturbing subsurface soil. No construction activities are currently planned for the South of Runway 18-36 Area. Risks and hazards from construction activities within the site were evaluated for current and future construction workers and are summarized on Table CI.5-1. Construction workers could be exposed to soil through incidental ingestion, dermal contact, and inhalation of vapors and dusts. The risks and hazards from exposures to soil through each pathway are summarized on Table CI.5-2. Exposures to

groundwater could occur through dermal contact with the water and through inhalation of volatiles. The risks and hazards from exposures to groundwater through each pathway are summarized on Table CI.5-3.

As discussed in Section CI.5.1, noncancer hazards were evaluated separately for non-TPH compounds and TPH compounds. The total RME non-TPH hazard indices of 0.09, TPH hazard indices of 0.9, and cancer risk of 4×10^{-8} from combined exposures to soil and groundwater were all below Alaska DEC's target health goals of 1 and 1×10^{-5} for hazards and cancer risks, respectively. The following summarizes the contribution to total risks and hazards from each media.

- Only two COPCs in groundwater were evaluated for cancer risks: benzene and ethylbenzene. RME cancer risks from groundwater were 4×10^{-8} , almost three orders of magnitude below the acceptable cancer risk level (Table CI.5-3).
- The non-TPH HI from soil of 0.06 contributed 64 percent to the total non-TPH HI (Table CI.5-2). The non-TPH HI from groundwater was 0.03 (Table CI.5-3).
- The TPH HI from soil of 0.7 contributed 83 percent to the total TPH HI (Table CI.5-2). The TPH HI from groundwater was 0.2 (Table CI.5-3).

Potential Risks from Exposures to Residual Free Product

Risks and hazards to free product cannot be quantified using standard risk assessment techniques. In general, if free product is encountered in sufficient amounts, this could constitute a hazard and the presence of free product is generally assumed to present a situation where precautions should be taken to prevent/minimize/manage exposure. The potential extent of remaining free product at the site was presented on Figure 3-2 and discussed in detail in Section 3.3 of the RI/FS. Measurable amounts of free product have been observed in 11 wells since August 2004 (E-207, E-209, E-213, E-215, E-216, E-217, 02-231, 18/36-01, 18/36-02, 18/36-03, and 28-12)).

Because depth to groundwater is on average less than 15 feet bgs, construction workers could potentially come in contact with free product while performing subterranean activities. Notwithstanding, construction worker exposures may not be a health concern for the following reasons:

- The amount of free product remaining is relatively localized in extent. While the thickness of residual free product measured in these wells ranges from less than one inch to nearly 1 foot, the thickness of light non-aqueous phase liquid

(LNAPL) measured directly in a monitoring well is not representative of the true or formation thickness, but is an apparent thickness greater than the actual formation thickness. Thus the actual thickness of LNAPL in the aquifer is less than that measured in the monitoring wells (Testa and Winegardner, 1991; Fetter 1998).

- The concentrations of volatile compounds present in the free product are unlikely to represent an inhalation health risk for construction workers. While volatile COPCs were identified in groundwater, health risks from exposure to volatile compounds in groundwater were 2 orders of magnitude less than the target health goals for construction workers, even under the assumption that workers are standing in a flooded trench (see Table CI.5-3). While it is possible that concentrations of volatiles could be higher in free product than groundwater, the free product on Adak Island has been subject to weathering processes for decades. The lighter, more volatile compounds present in free product are more water-soluble and are more likely to volatilize into the soil gas than the heavier components of free product. Thus, the lighter, more volatile compounds will likely have either dissolved in groundwater or dissipated through soil gas over the years. Therefore, it is not likely that present concentrations of volatile chemicals in free product are greater than those detected in groundwater. Free product volatile concentrations would have to be more than 2 orders of magnitude greater than concentrations in groundwater before a health risk would be possible.
- Actual excavation or construction at this site is unlikely. The site has all existing utilities for continued use in the future.

Free product is also migrating toward South Sweeper Creek. Therefore, recreational users of the creek could potentially come into contact with free product while engaged in outdoor activities, if the product intercept device fails. However, recreational exposures to surface water and sediment along the creek were considered an insignificant pathway based on infrequent exposures and exposures of only short duration. This assumption would still apply if sediment concentrations increased due to the potential presence of free product in surface water. Therefore, the presence of free product in surface water is not likely to present a health concern for recreational exposures in South Sweeper Creek. However, Alaska DEC surface water criteria state that no contamination which could cause a sheen on surface water is permitted. Therefore, while the presence of free product in South Sweeper Creek would not likely present a health concern for intermittent recreational exposures, Alaska DEC surface water criteria would be exceeded.

CI.5.4 Summary of Risk Characterization

The results of the risk characterization indicate that no chemicals in soil or groundwater present a health concern for future construction worker exposures. If a construction project should disturb soil in the limited area of remaining free product, workers should take appropriate precautions to minimize and/or prevent any health hazards arising from free product exposure.

**Table CI.5-1
 Summary of Total RME Risks and Hazards for the Construction Worker
 From Groundwater and Soil**

Chemicals of Potential Concern	Total		Groundwater		Soil	
	HI	CR	HI	CR	HI	CR
2-Methylnaphthalene	0.02	NA	b	NA	0.02	NA
Acetone	b	NA	b	NA	a	a
Benzene	0.01	4E-08	0.01	4E-08	a	a
Ethylbenzene	0.0002	1E-09	0.0002	1E-09	a	a
Naphthalene	0.062	NA	0.02	NA	0.04	NA
Xylenes	0.003	NA	0.003	NA	a	a
Non-TPH Total Hazard/Risk	0.09	4E-08	0.03	4E-08	0.06	--
DRO aliphatics	0.2	NA	b	NA	0.2	NA
DRO aromatics	0.3	NA	b	NA	0.3	NA
GRO aliphatics	0.02	NA	0.004	NA	0.02	NA
GRO aromatics	0.3	NA	0.1	NA	0.2	NA
TPH Total Hazard/Risk	0.9	NA	0.2	NA	0.7	NA

^aChemical was not selected as a COPC in this media

^bToxicity criteria are not available to quantify exposures to this media.

Notes:

CR - cancer risk

DRO - diesel-range organics

GRO - gasoline-range organics

HI - hazard index

NA - not applicable; these chemicals are not considered carcinogenic by this pathway.

NE - not evaluated

RME - reasonable maximum exposure

TPH - total petroleum hydrocarbon

-- - no value

**Table CI.5-2
 Summary of RME Hazards for the Construction Worker From Soil¹**

Chemicals of Potential Concern	Total	Ingestion	Dermal	Inhalation
	HI	HQ	HQ	HQ
2-Methylnaphthalene	0.02	0.02	--	--
Naphthalene	0.04	0.0002	--	0.04
Non-TPH Total Hazard	0.06	0.02	--	0.0440
DRO aliphatics	0.2	0.2	0.05	0.000007
DRO aromatics	0.3	0.2	0.07	0.00002
GRO aliphatics	0.02	0.0001	--	0.02
GRO aromatics	0.2	0.002	--	0.2
TPH Total Hazard	0.7	0.4	0.1	0.2

¹No chemicals selected as COPCs in soil are associated with carcinogenic effects. Therefore, this table presents only the noncancer hazards from exposures to soil.

Notes:

COPCs - chemicals of potential concern

DRO - diesel-range organics

GRO - gasoline-range organics

HI - hazard index

HQ - hazard quotient

RME - reasonable maximum exposure

TPH - total petroleum hydrocarbon

-- - not evaluated; toxicity criteria are not available to quantify exposures by this pathway.

**Table CI.5-3
 Summary of Total RME Risks and Hazards for the
 Construction Worker From Groundwater**

Chemicals of Potential Concern	Total		Dermal		Inhalation	
	HI	CR	HI	CR	HI	CR
2-Methylnaphthalene	b	NA	b	NA	b	NA
Acetone	b	NA	b	NA	b	NA
Benzene	0.01	4E-08	0.01	3E-08	0.002	9E-09
Ethylbenzene	0.0002	1E-09	0.0001	NA	0.00007	1E-09
Naphthalene	0.02	NA	0.002	NA	0.02	NA
Xylenes	0.003	NA	0.002	NA	0.0009	NA
Non-TPH Total Hazard/Risk	0.03	4E-08	0.02	3E-08	0.02	1E-08
DRO aliphatics	b	NA	b	NA	a	NA
DRO aromatics	b	NA	b	NA	a	NA
GRO aliphatics	0.004	NA	b	NA	0.004	NA
GRO aromatics	0.1	NA	b	NA	0.1	NA
TPH Total Hazard/Risk	0.2	NA	b	NA	0.2	NA

Notes:

CR - cancer risk

DRO - diesel-range organics

GRO - gasoline-range organics

HI - hazard index

NA - not applicable; these chemicals are not considered carcinogenic by this pathway.

RME - reasonable maximum exposure

a - Chemical is not considered volatile; Pathway is only complete for volatile chemicals.

b - Toxicity criteria are not available to quantify exposures by this pathway.

CI.6.0 CALCULATION OF RISK-BASED CLEANUP LEVELS

If chemicals at a site exceed target health goals, then site-specific cleanup levels can be calculated to provide information to risk managers. Alaska DEC allows site-specific cleanup levels to be calculated, rather than using the State's default values for soil and groundwater (18 AAC 75.340 and 18 AAC 75.345, respectively). Because no chemicals exceeded target health goals or contributed to exceedances above target health goals, site-specific ACLs do not need to be calculated for this site.

However, recent monitoring well results were compared to the proposed groundwater cleanup levels as discussed in Section 3.6.1 of the FFS (10 times Alaska DEC's Table C cleanup levels as per Alaska DEC (18 AAC 75.345[b][2]) guidance for non-potable groundwater). Out of the 26 groundwater wells sampled at the site, only well 02-231 had one DRO concentration (15,500 µg/L) exceeding 10 times the Table C cleanup levels (15,000 µg/L) in the latest round (10/15/01) of groundwater sampling. The extent of groundwater contamination exceeding the proposed groundwater cleanup levels is depicted on Figure 4-2 of the FFS.

CI.7.0 UNCERTAINTIES IN RISK ASSESSMENT

The purpose of the uncertainty section is to describe, in a qualitative way, where there are major uncertainties in the risk assessment process that could affect the conclusions of the risk assessment. Estimating and evaluating health risk from exposure to environmental chemicals is a complex process with inherent uncertainties. Uncertainty reflects limitations in knowledge, and simplifying assumptions must be made in order to quantify health risks.

The section is organized according to uncertainties relating to (1) the data and selection of COPCs, (2) the assumptions about exposure, (3) the assumptions about toxicity, and (4) the characterization of health risks.

There are uncertainties regarding the quantification of health risks in terms of a number of assumptions about both exposure and toxicity, including both site-specific and general uncertainties. Based on anticipation of uncertainty when quantifying exposure and toxicity, the health risks and hazards presented in this risk assessment are more likely to indicate that chemicals are exceeding target risk goals, although health risks may actually be negligible. Risk assessment methodology is less likely to indicate that chemicals are not a health risk when they actually are. This process is necessary to ensure the protection of public health and the environment.

Uncertainty in the risk assessment produces the potential for two kinds of errors. The first potential, or Type I, error is the identification of a specific chemical, area, or activity as a health concern when, in fact, it is not a concern (false positive conclusion). The second potential, or Type II, error is the elimination of a chemical, area, or activity from further consideration when, in fact, there should be a concern (false negative conclusion). In the risk assessment, uncertainties were handled conservatively (i.e., health protective choices were preferentially made). This strategy is more likely to produce false positive errors than false negative errors.

The following sections provide additional detail regarding uncertainties in the estimations of health risks.

The following sections provide details regarding uncertainties in the estimations of health risks.

CI.7.1 Data Collection and Evaluation

The data evaluation process addresses whether (1) chemicals are potentially present in various environmental media at levels of health concern, (2) site concentrations are different from background, and (3) sufficient samples have been collected to fully characterize each exposure pathway.

Groundwater Data

Some of the available groundwater petroleum data were not selected for use in the risk assessment. The following are three general categories of petroleum analysis any of which may be used under certain circumstances:

- Method that tests for all petroleum hydrocarbons (e.g., Standard Method 418.1)
- Method that tests for specific carbon fraction ranges representing fuel types like gasoline (e.g., AK-101 and 8100 modified)
- Method that tests for specific carbon fraction ranges as well as aliphatic and aromatic fractions (e.g., AK-101-AA and VPH).

In June 2001, Alaska DEC restricted the use of Methods AK-102-AA and AK-103-AA due to “uncertainties surrounding the repeatability, accuracy, and precision” of these methods since their use began in 1999 (ADEC 2001e). Because this restriction was issued during the time frame when water samples were collected from the site and analyzed by AK-102-AA and AK-103-AA, these data were not included in the this risk assessment. Additionally, results reported from the use of Method 418.1 are not useable because the method does not distinguish between fuel products (e.g., gasoline or diesel).

The majority of the available data are from methods that test for specific carbon fraction ranges representing gasoline range and diesel-range organics, GRO and DRO, respectively. These methods are well documented and use of the data generated by these methods is acceptable. However, due to variability between laboratories and how they quantify GRO versus DRO (i.e., which carbon ranges they report), there is uncertainty in the amount of GRO versus DRO in samples collected from the same location but analyzed by different laboratories at different times. Results may be biased either high or low for GRO and DRO.

Groundwater samples were collected from 26 locations across the entire site and multiple times. Therefore, sufficient samples are available to adequately characterize groundwater.

Soil Data

Soil samples were collected from 66 locations across the entire site and locations with visible signs of contamination were preferentially sampled. Therefore, sufficient samples are available to adequately characterize soil and concentrations are likely biased high.

Selection of COPCs

Three chemicals in soil and two chemicals in groundwater were not selected as COPCs although their maximum concentrations slightly exceeded screening values. As described in Section CI.2.0, if quantified these chemicals would not exceed Alaska DEC target health goals for the following reasons:

- The screening values used to select chemicals are based on residential exposures, site populations are industrial.
- The screening values used are an order of magnitude lower than Alaska DEC target health goals (screening levels represent 1 in a million risks for carcinogens and a hazard quotient of 0.1 for non-cancer chemicals).
- Groundwater screening levels are especially protective because the screening levels assume domestic use of groundwater with exposures through ingestion, inhalation, and dermal contact.
- Only inhalation and dermal contact are complete pathways at the site for construction workers.

95UCLs calculated for the non-selected chemicals would therefore represent health risks below one in a million and a hazard of 0.1 for residential exposures, and even lower levels for workers. The chemicals that were not selected as COPCs in soil and groundwater are discussed in greater detail below.

Lead and benzo(a)pyrene, were screened out of groundwater based on infrequent exceedance and/or low magnitude of exceedance of their screening values (See Table CI.2-5). These two chemicals are discussed separately:

- Lead exceeded its screening value in only 2 out of 10 samples (20 percent), and the maximum detected concentration was only 2 times greater than the screening value. The lead screening value is based on EPA's tap water action level for lead and is protective of children, the most sensitive population to lead exposures, who drink tap water on a daily basis. At this site, the only complete exposure pathways to groundwater are inhalation and dermal contact during subterranean construction activities. Lead is not considered a volatile chemical and is not readily absorbed through the skin. Therefore, exclusion of lead as a COPC does not affect the conclusions of the risk assessment.

- Benzo(a)pyrene was detected in only 1 out of 19 samples (5 percent) and the single detection only slightly exceeded the screening value by a factor of 2. Therefore, benzo(a)pyrene was excluded as a COPC based on infrequent detection, infrequent exceedance, and low magnitude of exceedance, according to the steps outlined in Section CI.2.2. However, benzo(a)pyrene was the only chemical with SQLs exceeding its screening value that was not selected as a COPC (Table CI-3). As shown on Table CI-3, 100 percent of the SQLs for the nondetected results exceeded the screening value. However, the screening values are based on residential tap water use, including ingestion, inhalation, and dermal contact with groundwater. The only complete exposure pathway to groundwater at this site is through dermal contact and inhalation during construction activities. Exposures that are expected to be less intensive than through residential tap water use. For a construction worker exposure scenario, these screening values are overly health protective. Because benzo(a)pyrene was detected only once out of 19 samples at a concentration that only slightly exceeds the residential tap water PRG, benzo(a)pyrene is not likely present in concentrations that are a health concern for construction worker exposures. In addition, the likely source of most of the contamination at this site is JP-5. The carcinogenic PAHs are virtually excluded from JP-5 and are not expected to be present in any significant amounts at JP-5 source sites, as further indicated by the fact that none of the other carcinogenic PAHs were ever detected in groundwater at this site. Therefore, while exclusion of benzo(a)pyrene as a COPC in groundwater represents a certain degree of uncertainty, it is not likely present in concentrations that are a health concern for construction worker exposures. Its exclusion is not likely to affect the conclusions of the risk assessment.

Three chemicals were screened out of soil based on infrequent detection, infrequent exceedance, and/or low magnitude of exceedance over their screening values (See Table CI.2-7). Benzene was detected in only 4 percent of the samples; and it only slightly exceeded its screening value in only 2 percent of the samples (2.8 times greater than the screening value). Ethylbenzene and xylenes both slightly exceeded their respective screening values in only 2 percent of the samples. The screening values are based on residential soil use. For a construction worker exposure scenario, these screening values are likely overly health protective. Therefore, these three chemicals are not likely present in concentrations that are a health concern for construction worker exposures; and their exclusion as COPCs is not likely to affect the conclusions of the risk assessment.

CI.7.2 Exposure

For estimating the RME, UCL₉₅ values, or upper-bound estimates of national averages are generally used for exposure assumptions. The intent of RME, as discussed by the EPA Deputy Administrator and the Risk Assessment Council (Habicht 1992), is to present risks as a range from central tendency to high-end risk (“above the 90th percentile of the population distribution”). This descriptor is intended to estimate the risks that are expected to occur in small but definable ‘high end’ segments of the subject population” (Habicht 1992). EPA makes a distinction between scenarios that are possible, but highly improbable, and those that are conservative, but more likely to occur within a population, with the latter being favored in risk assessment. RME calculations thus overestimate risk for the majority of a hypothetical population even though all assumptions may not be at their maximum.

Recreational Pathway

Recreational exposures to chemicals in sediments and surface water of South Sweeper Creek, while potentially complete, were not quantitatively evaluated in the risk assessment, because this pathway was considered insignificant as discussed in Section CI.3.1. Activities at this area are expected to be limited, because the nearest housing area is over half a mile away from South Sweeper Creek in the South of Runway 18-36 Area. For this reason, human contact with surface water and sediment in the Creek would likely be infrequent and of short duration. In addition, the concentrations of detected chemicals in surface water and sediment collected from South Sweeper Creek are below levels that would likely be a health concern for this pathway. The detected concentrations in sediment were compared to the Alaska DEC residential soil cleanup levels protective of direct human contact, a pathway that is expected to result in greater exposures than the recreational exposures to sediment expected at the creek. No chemicals detected in sediment collected from South Sweeper Creek were present in concentrations greater than the Alaska DEC soil cleanup levels. Likewise, detected concentrations in surface water were compared to the Alaska DEC groundwater cleanup levels protective of drinking water, also a pathway that is expected to result in greater exposures than the recreational exposures to surface water expected at the creek. Only DRO and benzo(a)pyrene in surface water collected from one location (location 851) exceeded the drinking water criteria. These two exceedances in surface water over the drinking water criteria are not expected to represent a health concern for recreational exposures because recreational visitors are not expected to ingest significant amounts of contaminated surface water from the creek. Therefore, concentrations in surface water and sediment of South Sweeper Creek are not present in concentrations that warrant a health concern for recreational exposures; and any exposures would be infrequent and of short duration.

In addition, because people have been observed fishing and harvesting shellfish at the mouth of South Sweeper Creek where it drains into Sweeper Cove, the fish ingestion pathway could represent a potentially complete pathway to recreational users of South Sweeper Creek. However this pathway was not quantitatively evaluated in the risk assessment. Part of the remedial action for Sweeper Cove is the issuance of a fish advisory which limits the amount of shellfish ingested from Sweeper Cove (U.S. Navy 2004). While the South of Runway 18-36 Area does not have any restrictions on shellfish consumption, shellfish are not expected to be present in the South of Runway 18-36 Area in great numbers. The fish advisory in place for Sweeper Cove is expected to be protective of potential shellfish contamination at the mouth of South Sweeper Creek. Therefore, the fish ingestion pathway was not evaluated for this site, because it is being addressed by the remedial actions in place for Sweeper Cove.

Percentage Assumptions for Petroleum Products

Construction worker hazards for the TPH compounds are likely overestimated because EPCs for the petroleum fractions were calculated using Alaska DEC's default percent compositions for the different fuel fractions, as per Alaska DEC guidance (ADEC 2000b). Alaska DEC's default percent compositions are not fuel type specific and are very conservative. As discussed previously, the fuel released in the South of Runway 18-36 Area is likely predominantly JP-5. Because of variability in the percent composition of petroleum fuels depending on the fuel source and its weathering in the environment, site-specific information is likely the most applicable for risk assessment purposes (ATSDR 1999; TPHCWG 1999). Weathering of petroleum fuels likely reduces the percent content of the volatile aromatic portions (the most toxic portions of gasoline).

The generic, Alaska DEC (ADEC 2000b) default percent composition for GRO aromatics (the more toxic portion of GRO) is 50 percent, representative of the maximum amount of aromatics found in fresh product (ATSDR 1999). The actual amount of aromatics present at the site is likely much less than 50 percent, based on observed concentrations of the BTEX compounds which can make up to 20 percent of the content of fresh fuel (ATSDR 1999).

The generic, Alaska DEC default percent composition for DRO aromatics is 40 percent, likely a large overestimation of the aromatic content of the diesel source at this site, JP-5. Fresh JP-5 has a typical aromatic percentage range of 10 percent to 25 percent (ATSDR 1998; TPHCWG 1999, AFCEE [Air Force Center for Environmental Excellence] 1999b). While weathering in the environment produces many changes, a significant increase in the overall aromatic fraction relative to the overall aliphatic fraction has not been seen in the literature, although the available data are limited. Aromatic/aliphatic fractions were either very similar to fresh material or the aromatic percent showed a decrease (Robb 1999, Wang et al 1998, AFCEE 1999a, Dror et al. 2001). Therefore, it is unlikely that the aromatic percentage of weathered JP-5 would

significantly increase from the original maximum aromatic content of the fresh material and would potentially be lower than the original percentage (lowering of the original percentage was noted in Robb 1999 and AFCEE 1999a).

Exposure to Free Product

Free product recovery has been conducted at the South of Runway 18-36 Area intermittently from September 1997 through November 2004. As discussed in Section 3.3 of the FFS and CI.5.3, measurable thicknesses of free product have been observed in 11 monitoring wells at the South of Runway 18 site during groundwater monitoring activities conducted since August 2004. While exposures to free product cannot be quantitatively evaluated in risk assessments, exposures to free product are considered to represent an unacceptable health risk, as discussed in Section C1.5.3. Therefore, in the event that free product is encountered, the appropriate measures should be taken to minimize contact and exposure. Because depth to groundwater is on average less than 15 feet bgs, construction workers could potentially come in contact with free product while performing subterranean activities. Free product is also migrating toward South Sweeper Creek. Therefore, recreational users of the creek could potentially come in contact with free product while engaged in outdoor activities, if the product intercept device fails. However, recreational exposures to surface water and sediment along the creek were considered an insignificant pathway based on infrequent exposures and exposures of only short duration. This assumption would still apply if sediment concentrations increased due to the potential presence of free product in surface water. Therefore, the presence of free product in surface water is not likely to present a health concern for recreational exposures in South Sweeper Creek. However, Alaska DEC surface water criteria state that no contamination which could cause a sheen on surface water is permitted. Therefore, while the presence of free product in South Sweeper Creek would not likely present a health concern for intermittent recreational exposures, Alaska DEC surface water criteria would be exceeded.

Exposure Assumptions

Intake rates of soil included an assumption that ingestion of soil of 330 mg/day for construction workers. This value for construction workers is the 95th percentile ingestion rate from a mass-balance study conducted with 10 adults who were followed over a 4-week period (280 subject-days). The average and median amounts of soil ingested in the study were 10 mg/day and 1 mg/day, respectively (Stanek et al. 1997). Because of the small population and the large variability in the data, the 95th percentile value is highly uncertain.

The assumption of a 70-year averaging time used in EPA RME assumptions tends to overestimate carcinogenic risks, which are prorated over the lifetime. The current life

expectancy in the United States is actually 75.7 years (Bureau of the Census 1994). Thus, 75.7 years should be used in the risk calculations rather than the default 70-year value.

Individuals within a population may have higher exposure rates than assumed by the separate exposure assumptions. However, the RME values used represent the maximum exposures that could reasonably be expected to occur in the population.

Construction workers' dermal exposures to groundwater were slightly overestimated for all COPCs. EPA's dermal guidance recommends different formulas for estimating dermal absorption for chemicals in water depending on whether the chemical is inorganic and/or highly ionizable, or whether the chemical is organic (USEPA 2003b). The formula for inorganic dermal absorption is much simpler than the organic one and the simpler inorganic formula was used in this assessment. Because of the relatively short and infrequent exposure of construction workers to groundwater the more complex modeling effort was not considered warranted for this project. As a check, the more complex modeling was used to evaluate dermal exposures. For all COPCs, using the organic compounds' dermal formula provides slightly lower hazards and risks: however, the results of the hazards and risk estimates were unchanged to one significant figure. Therefore, the inorganic dermal formula used in the calculations for this assessment slightly overestimated hazards and risks, but the use of the dermal organic formula would not affect the risk assessment results.

CI.7.3 Toxicity Assessment and Risk Hazard Calculations

Toxicity values have been developed by the EPA from the available toxicological data. These values frequently involve high-to-low-dose extrapolations and are often derived from animal rather than human data. In addition, there may be few studies available for a particular chemical. As the unknowns increase, the uncertainty of the value increases. Uncertainty is addressed by reducing RfDs using UFs and by deriving SF using a conservative model. The greater the uncertainty, the greater the UFs and tendency to overestimate the toxicity.

Toxicity Values for Petroleum Compounds

DRO, GRO, and RRO were selected as chemicals of potential concern in soil, and DRO and GRO were also selected for groundwater. There are no toxicity criteria that represent exposures to the whole mixtures of the petroleum groups; thus, there is a higher than usual degree of uncertainty surrounding the toxicity criteria used in this assessment to estimate hazards from DRO, GRO, and RRO. In addition, there are no subchronic toxicity criteria for the petroleum compounds with which to evaluate construction worker exposures. Two groups have pioneered similar approaches to estimating the toxicity of petroleum: the Massachusetts Department of Environmental Protection (MDEP) and the Total Petroleum Hydrocarbon Criteria Working

Group (TPHCWG). Both these groups recommend analyzing the fractions of petroleum present and evaluating the toxicity of the fractions based on a compound (or compounds) that falls within the fraction that is anticipated to adequately represent the toxicity of the entire fraction. However, the groups do not select the same surrogate compounds for each of the fractions, nor do their fraction definitions entirely agree.

The surrogate approach is recommended by Alaska DEC (2000b) guidance, which selected the surrogates recommended by the TPHCWG for the aliphatic and aromatic portions of the petroleum groups. Alaska DEC defines GRO as containing carbon chain lengths from C₆ to C₁₀, and DRO as containing carbon chain lengths from C₁₀ to C₂₅. MDEP and the TPHCWG only recommend noncancer toxicity criteria for the petroleum groups. Carcinogenic effects are not evaluated for the petroleum ranges. Rather, the individual carcinogenic compounds present in petroleum (e.g., benzene and the carcinogenic PAHs) are evaluated separately. Note, while Alaska DEC recommends the use of both the oral and inhalation toxicity criteria recommended by the TPHCWG, the following discussions are limited to the variances in the available oral toxicity criteria for the TPH compounds. A discussion of the inhalation toxicity criteria used in this assessment is provided in Attachment CI-3.

Aliphatic DRO. The TPHCWG oral RfD recommended for the aliphatic portion of the DRO range is 0.1 mg/kg-day and is derived from several studies of petroleum mixtures containing branched, straight, and cyclic alkanes within the carbon range of C₇ to C₁₈. EPA's review of TPHCWG and MDEP's proposed surrogates found the selection of 0.1 mg/kg-day for aliphatic DRO compounds a reasonable one and likely to overestimate the toxicity of this fuel (USEPA 2000b). Note that if the RfD recommended by MDEP of 0.6 mg/kg-day (as used in this report) had been used instead (MDEP 1994), the conclusions of the risk assessment would not change (hazards would still be below target health goals).

Aromatic DRO. The majority of the possible RfDs for the aromatic fraction of DRO compounds are in the 10⁻² range. TPHCWG recommended 0.04 mg/kg-day (TPHCWG 1999, 1999b), MDEP recommended 0.03 mg/kg-day (MDEP 1994), and EPA selected 0.05 mg/kg-day (USEPA 2000b) as the best estimate. Because Alaska DEC guidance recommends using the TPHCWG values, an RfD of 0.04 mg/kg-day was used in this assessment to evaluate the aromatic fraction of DRO. Calculating hazards with one of the RfDs recommended by the other two groups discussed here would not significantly change the results of the risk assessment.

Aliphatic GRO. The TPHCWG proposes two alternatives for oral RfDs for the aliphatic portion of the GRO range. The first is to use the n-hexane RfD (0.06 mg/kg-day) for the n-hexane portion of the fraction and to use the n-heptane RfD (2 mg/kg-day) for the remainder of the fraction; the second alternative is to use an RfD derived for commercial hexane (5 mg/kg-day) if n-hexane makes up less than 53 percent of the fraction, and revert back to the first alternative if

n-hexane comprises more than 53 percent of the fraction. MDEP, on the other hand, adopted the RfD for n-hexane (0.06 mg/kg-day) as the RfD protective of exposures to the aliphatic portion of this carbon fraction range. EPA's review of these RfDs recommends the use of MDEP's approach as a more conservative approach. EPA concluded that TPHCWG's RfD for commercial hexane is not appropriate for use in EPA risk assessments (USEPA 2000b). In spite of EPA's reviews of the RfDs, Alaska DEC recommends the use of TPHCWG's RfD for commercial hexane. Had MDEP's RfD of 0.06 mg/kg-day been used in the quantitation of hazards for the aliphatic portion of the GRO carbon fraction range, TPH hazards would increase from 1.45 to 1.5 for the construction worker.

Aromatic GRO. MDEP assesses the aromatic portion of the GRO carbon fraction range on the basis of the four individual indicator compounds that constitute this fraction: benzene, toluene, ethylbenzene and xylene, rather than choosing one RfD to represent the entire fraction. TPHCWG chose the RfD of 0.2 mg/kg-day for toluene to represent the noncarcinogenic effects of this fraction. Toluene is likely the most toxic noncarcinogenic compound of these four indicator compounds and is considered to be a conservative approach for evaluating noncarcinogenic effects. Alaska DEC recommends the use of TPHCWG's RfD of 0.2 mg/kg-day in the evaluation of hazards.

The toxicity information is almost exclusively based on fresh, unweathered materials. Understanding the composition of the original petroleum product is important; however, once petroleum products are released into the environment they become subject to weathering (e.g., biodegradation, volatilization, leaching), which can have a substantial effect on the original composition, and thus potentially also on its toxicity.

The Agency for Toxic Substances and Disease Registry (ATSDR) in their toxicity profile for TPH (ATSDR 1999) states that:

The longer the release is exposed to the environment, the greater the change in chemical character...After extensive weathering, detailed knowledge of the original bulk product is often less valuable than current site-specific information on a more focused set of hydrocarbon components, for example TPH fractions.

Therefore, weathering adds a further area of uncertainty into the assessment of petroleum toxicity.

Chemicals for Which Risks/Hazards Could Not Be Calculated Due to Lack of Information

Hazards are potentially underestimated for construction worker exposures to groundwater because of lack of available toxicity information for 2-methylnaphthalene, acetone, GRO, and

DRO. No quantitative information are available indicating how much of these compounds are absorbed through the skin (i.e., permeability constants). In addition, while 2-methylnaphthalene and acetone are considered volatile, inhalation toxicity criteria are not available for these two chemicals to quantify inhalation exposures. The effects that this lack of information could potentially have on the conclusions of the risk assessment are discussed separately for 2-methylnaphthalene and acetone relative to the effects on the total non-TPH HI and for GRO and DRO relative to the total TPH hazard index.

As discussed above, neither dermal nor inhalation toxicity criteria are available for 2-methylnaphthalene and acetone. Therefore, exposures to these chemicals in groundwater were not quantified at all. However, hazards from dermal exposures for the 4 other non-TPH COPCs in groundwater ranged from 0.0001 to 0.01, four to two orders of magnitude below the target health goal of 1. Given the average concentration of these two chemicals in groundwater and their relative toxicity, if dermal hazards could be quantified for these chemicals, they would not likely be greater than those calculated for the other chemicals. Thus, dermal hazards would still be expected to be well below the target health goal of 1. In addition, if the oral RfDs were used as surrogates to evaluate inhalation hazards for 2-methylnaphthalen and acetone, inhalation hazards would only slightly increase from 0.02 to 0.03, still well below the target health goal of 1. Thus, the lack of toxicity criteria for these chemicals is not likely to affect the conclusions of the risk assessment with respect to the non-TPH compounds in groundwater.

For the TPH compounds, dermal toxicity criteria are not available for DRO and GRO to quantify dermal exposures. Therefore, the TPH HI is potentially underestimated for construction worker exposures to groundwater. GRO meets EPA's definition of a volatile chemical. Thus, GRO in groundwater was evaluated for inhalation exposures. Yet, weathered DRO does not meet the definition of a volatile chemical. Therefore, exposure to DRO in groundwater was not quantified at all. The total TPH HI for groundwater exposures was 0.2, slightly below the target health goal of 1. Not evaluating DRO and GRO for dermal exposures in groundwater could potentially increase hazards nearer to the target health goal. The lack of dermal toxicity criteria for these chemicals remains an area of uncertainty.

CI.7.4 Summary

Every aspect of the risk assessment contains multiple sources of uncertainty. Simplifying assumptions are often made so that health risks can be estimated quantitatively. Because the exact amount of uncertainty cannot be quantified, the risk assessment is intended to overestimate rather than underestimate probable risk. The results of this assessment therefore, are likely to be protective of health despite the inherent uncertainties in the process.

CI.8.0 SUMMARY AND CONCLUSIONS

The previous sections of the focused feasibility study have identified petroleum compounds in soil and groundwater above regulatory levels at the site from leaks associated with an abandoned fuel line, likely transporting JP-5. This appendix provides an evaluation of whether potential health risks are present if people encounter these petroleum-impacted materials in their environment. Alaska DEC provides guidance for four methods of determining cleanup levels (beginning with Method 1) that increase in level of effort and site-specificity. Method 4 uses risk assessment to determine site specific cleanup levels (ADEC 2000c).

CI.8.1 Chemical of Potential Concern Selection

The first step in a human health risk assessment is an evaluation of the data in order to select chemicals of potential concern (COPCs) for human health. Of the total available data, the following were selected as applicable to human health:

- Groundwater data from impacted monitoring wells.
- Soil data from samples collected to a depth of 15 feet. Alaska DEC excludes soil deeper than 15 feet from human health risk assessments because humans would generally not encounter material this deep. Alaska DEC defines surface soil as 0 to 2 feet bgs (ADEC 2000a). The source of contamination was to the subsurface; thus, there are no on-site exposures to impacted surface soil at South of Runway 18-36.

EPA's Region 9 PRGs dated October 2002, and Alaska total petroleum hydrocarbon (TPH) cleanup levels were used as screening values (USEPA 2002a; ADEC 2003). Chemical concentrations in groundwater and soil were compared to one-tenth of the PRG or cleanup level for noncarcinogens and the full value for carcinogens. Screening values represent concentrations below which there is no health concern. If the maximum concentration of a chemical was less than the screening value, the chemical was eliminated from the risk assessment because it would not be a health concern. Chemicals with concentrations greater than the screening values were evaluated further in terms of their frequency of detection, magnitude of exceedance of screening levels, and toxicity. Several COPCs were selected for in-depth evaluation in the assessment based on their toxicity and the frequency and magnitude with which their concentrations exceeded the screening levels. Eight chemicals were selected as COPCs in groundwater:

- 2-Methylnaphthalene
- Acetone
- Benzene

- Ethylbenzene
- Naphthalene
- Xylenes
- DRO
- GRO

The following four chemicals were selected as COPCs in soil:

- 2-Methylnaphthalene
- Naphthalene
- DRO
- GRO

CI.8.2 Exposure Assessment

Once COPCs are selected, the second step in risk assessment is an evaluation of the exposure pathways by which people could encounter chemicals. The exposure assessment identifies the populations potentially exposed to chemicals at the site, the means by which exposure occurs, and the amount of chemical received from each exposure medium (i.e., the dose). Only complete exposure pathways are quantitatively evaluated. Complete pathways consist of four elements: (1) a source and mechanism of chemical release, (2) a retention or transport medium (e.g., groundwater), (3) a point of potential human contact with the affected medium, and (4) a means of entry into the body at the contact point. Figure CI.2-2 presents the CSM, which depicts the complete pathways for this site.

The South of Runway 18-36 Area is zoned for commercial land use. Thus, no residential populations would be exposed to chemicals at the site. Because there is no impacted surface soil and chemicals in groundwater are moving away from the residential areas, off-site populations would not be exposed to chemicals migrating from the site to the residential areas. Children trespassing on the site or playing in South Sweeper Creek or the Airport Ditches are not expected to be exposed because the airport runway area is restricted to airport personnel only and current concentrations of petroleum in surface water and sediment do not exceed Alaska DEC cleanup levels for human health. Current and future exposures to chemicals in soil and groundwater at the South of Runway 18-36 Area were therefore evaluated for potential construction workers who could be involved in tasks requiring subsurface intrusion. The following exposure pathways were selected for quantitative evaluation under current and future conditions:

- Construction workers potentially disturbing soil in the course of construction activity could be exposed through incidental ingestion, dermal contact, and inhalation of chemicals in soil (to a depth of 15 feet).
- Construction workers conducting intrusive subsurface work could be exposed to chemicals in shallow groundwater (less than 15 feet bgs) through dermal contact and inhalation of volatile chemicals.

Ingestion of groundwater is an incomplete pathway for all receptors. As discussed in Section CI.3.1, groundwater is not suitable as a drinking water source due to salt water intrusion.

CI.8.3 Toxicity Assessment

The third step in risk assessment is an evaluation of the toxicity of the COPCs by an assessment of the relationship between the dose of a chemical and the occurrence of toxic effects. Chemical toxicity criteria, which are based on this relationship, consider both cancer effects and effects other than cancer (noncancer effects). The toxicity criteria are required in order to quantify the potential health risks due to the COPCs. Benzene and ethylbenzene were evaluated for cancer effects, and the other chemicals (where toxicity information exists) were evaluated for noncancer effects.

CI.8.4 Risk Characterization

The last step in human health risk assessment is a characterization of the health risks. The exposure factors, media concentrations, and toxicity criteria are combined to calculate health risks. Health risks are calculated differently for chemicals that cause cancer and for chemicals that cause noncancer effects. The calculation of cancer risk assumes that no level of the chemical is without some risk, whereas for chemicals with noncancer effects, a “threshold” dose exists. Risks (for cancer) and hazards (for noncancer effects) are calculated for the reasonable maximum exposure (RME) for each pathway, a calculation that overestimates risks for the majority of the population in order to ensure that public health is protected. Cancer risk estimates represent the potential for cancer effects by estimating the probability of developing cancer over a lifetime due to site exposures. Noncancer hazards assume there is a level of chemical intake that is not associated with an adverse health effect even in sensitive individuals.

Cancer risks for the construction worker scenario were 4×10^{-8} , and the non-TPH and TPH hazard indices were 0.09 and 0.9, respectively. These values do not exceed the Alaska DEC target health goals of no more than a 1×10^{-5} chance of developing cancer and a hazard quotient for noncarcinogenic chemicals that does not exceed 1. Therefore, neither groundwater nor soil

were not found to be a health risk for construction workers, and no actions are necessary to protect public health from chemicals in soil or groundwater at the South of Runway 18-36 Area.

Free product recovery has been conducted at the South of Runway 18-36 Area intermittently from September 1997 through November 2004 and is still on-going. While exposures to free product cannot be quantitatively evaluated in risk assessments, exposures to free product are considered to represent an unacceptable health risk. Therefore, in the event that free product is encountered by construction workers performing subterranean activities or recreational users of South Sweeper Creek, the appropriate measures should be taken to minimize contact and exposure.

CI.8.5 Cleanup Levels Discussion

If chemicals at a site exceed target health goals, then site-specific cleanup levels can be calculated to provide information to risk managers. Alaska DEC allows site-specific cleanup levels to be calculated, rather than using the State's default values for soil and groundwater (18 AAC 75.340 and 18 AAC 75.345, respectively). Because no chemicals exceeded target health goals or contributed to exceedances above target health goals, site-specific ACLs do not need to be calculated for this site.

However, recent monitoring well results were compared to the proposed groundwater cleanup levels as discussed in Section 3.6.1 of the FFS (10 times Alaska DEC's Table C cleanup levels as per Alaska DEC (18 AAC 75.345[b][2]) guidance for non-potable groundwater). Out of the 26 groundwater wells sampled at the site, none had any concentrations of petroleum related chemicals exceeding this criteria in the latest round of groundwater monitoring. In addition, only three wells (02-231, E-217, and LC6A) had DRO concentrations exceeding 10 times the Table C cleanup levels (15,000 µg/L) in any round of groundwater sampling. See Figure 4-2 of the FFS.

CI.9.0 REFERENCES

- Adak Reuse Corporation (ARC). 2000. *Economic Reuse Study, Phase II: Engineering Analysis, Adak Naval Air Facility*. Prepared by ASCG Incorporated. September 14, 2000.
- Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological Profile for Total Petroleum Hydrocarbons (TPH). U.S. Department of Health and Human Services. September 1999.
- . 1998. Toxicological Profile for Jet Fuels (JP-5 and JP-8). U.S. Department of Health and Human Services. August 1998.
- Air Force Center for Environmental Excellence (AFCEE). 1999a. Light Nonaqueous-Phase Liquid Weathering at Various Fuel Release Sites. Prepared by Parsons Engineering Science, Denver, Colorado. September 1999.
- . 1999b. Petroleum Fuels: Basic Composition and Properties Fact Sheet. TI#19206. February 26. <http://www.afcee.brooks.af.mil/pro-act/fact/feb99a.asp>
- Alaska Department of Environmental Conservation (ADEC). 2003. *Oil and Other Hazardous Substances Pollution Control*. Division of Spill Prevention and Response, Contaminated Sites Remediation Program. January 30, 2003.
- . 2002. *Cleanup Levels Guidance*. Division of Spill Prevention and Response, Contaminated Sites Remediation Program. November 7, 2002.
- . 2001b. Technical Memorandum – 01-003. *Screening Procedures for COPCs Under Method Four*. January 16, 2001.
- . 2001a. Technical Memorandum – 01-007. *Calculated Cleanup Levels for Compounds Without Tabular Values in Site Cleanup Rules*. December 18, 2001.
- . 2001d. Technical Memorandum – 01-004. *Use of the Bootstrap Method in Calculating the Concentration Term for Estimating Risk and Hazard*. January 24, 2001.
- . 2001e. Technical Memorandum – 01-006, Version 1.1. *Requirements for Using AK-102-AA and AK-103-AA During the 2001 Field Season*. June 25, 2001.
- . 2000a. *Risk Assessment Procedures Manual*. June 8, 2000.

- . 2000b. *Guidance for Cleanup of Petroleum Contaminated Sites*. September 2000.
- . 2000c. *Guidance on Calculating Cumulative Risk*. Final Draft. December 2000.
- American Cancer Society (ACS). 2001. *Cancer Facts and Figures - 2001*. The Society, New York.
- Bristol Environmental and Engineering Services Corporation (BEESC). 2001a. *Completion Report, Airport Ditch Culvert Installation, Naval Air Facility, Adak Island, Alaska*. Prepared for U.S. Navy by BEESC, Anchorage, Alaska. October 30, 2001.
- Bureau of the Census. 1994. Personal Communication. Data from the Statistical Abstract of the United States. Government Printing Office. Seattle, WA. August 4.
- Dror I, Z Gerstl, and B Yaron. 2001. Temporal changes in kerosene content and composition in field soil as a result of leaching. *Journal of Contaminant Hydrology*, (48) 305-323.
- EMCON. 1995. *Tank Farm A Release Investigation Report, Naval Air Facility, Adak, Alaska*. Bothell, Washington. April 4, 1995.
- Fetter CW. 1998. *Contaminant Hydrogeology*, Second Edition, July
- Habicht, H. 1992. *Guidance on Risk Characterization for Risk Managers and Risk Assessors*. U.S. Environmental Protection Agency, Office of the Administrator, Washington, D.C. February 26, 1992.
- Massachusetts Department of Environmental Protection (MDEP), Bureau of Waste Site Cleanup. 1994. *Interim Final Petroleum Report: Development of Health-Based Alternative to the Total Petroleum Hydrocarbon (TPH) Parameter*. Prepared by Office of Research and Standards Massachusetts Department of Environmental Protection and ABB Environmental Services, Inc. August 1994.
- Robb, S. 1999. Calculation of TPH Human Health Direct Contact Cleanup Levels Using Default Compositions. Toxics Cleanup Program, Department of Ecology, Washington State. February.
- Stanek, E.J., E.J. Calabrese, R. Barnes, and P. Pekow. 1997. Soil Ingestion in Adults - Results of a Second Pilot Study. *Ecotoxicology and Environmental Safety*. 36: 249-257.
- Testa SM and DL Winegardner. 1991. Restoration of Petroleum-Contaminated Aquifers

- Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). 1999. *Human Health Risk-Based Evaluation of Petroleum Release Sites: Implementing the Working Group Approach*. Vol. 5. Amherst Scientific Publishers, Amherst, Massachusetts. June 1999.
- URS. 1995a. *Final Background Study Report for the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract N62474-89-D-9295, Naval Air Facility, Adak, Alaska*. Prepared for Engineering Field Activity, Northwest, Naval Facilities Engineering Command. Seattle, Washington. March 31, 1995.
- . 1995b. *Final Groundwater Study Report for the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract N62474-89-D-9295, Naval Air Facility, Adak, Alaska*. Prepared for Engineering Field Activity, Northwest, Naval Facilities Engineering Command. Seattle, Washington. March 31, 1995.
- URS Greiner, Inc. (URSG). 1999a. *Final Site Summary Report for Free-Product Petroleum Sites, Adak Naval Complex, Adak Island, Alaska, (2 volumes)*. Prepared for Engineering Field Activity, Northwest, Seattle, Washington. March 1, 1999.
- U.S. Environmental Protection Agency (USEPA). 2003a. Integrated Risk Information System (IRIS) Online Database (<http://www.epa.gov/iris/index.html>). May 2003.
- . 2003b. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim*. March 2003.
- . 2002a. *U.S. EPA Region 9 Preliminary Remedial Goal (PRG) Table and Supplemental Information*. October 2002.
- . 2002b. *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*. OSWER EPA530-F-02-052. November 2002.
- . 2002c. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*. OSWER 9355.4-24. December 2002.
- . 2002d. *A Review of the Reference Dose and Reference Concentration Processes*. Final Report. EPA/630/P-02/002F. December 2002.

- . 2000b. *Risk Assessment Issue Paper for: Approaches to and Provisional Guidance for Risk Assessment of Total Petroleum Hydrocarbons*. Superfund Technical Support Center. National Center for Environmental Assessment. Cincinnati, Ohio. October 12.
- . 1999a. *Derivation of a Volatilization Factor to Estimate Upper Bound Exposure Point Concentration for Workers in Trenches Flooded with Groundwater Off-Gassing Volatile Organic Chemicals*. Region 8. Ref: 8EPR-PS. July 29, 1999.
- . 1999b. *Risk Assessment Guidance for Superfund, Volume 3 Part A: Process for conducting Probabilistic Risk Assessment – Appendix D: Estimating Uncertainty in the Mean Concentration*. Office of Solid Waste and Emergency Response, Draft. (<http://www.epa.gov/superfund/pubs.htm>) December 1999.
- . 1998. *EPA Region 10 Interim Final Guidance: Developing Risk-based Cleanup Levels at Resource Conservation and Recovery Act Sites in Region 10*. EPA 910/R-98-001. January 1998.
- . 1997a. *Exposure Factors Handbook*. Volumes I–III. An Update to Exposure Factors Handbook EPA/600/8-89/043 May 1989. EPA/600/P-95-002Fa. August 1997a.
- . 1997b. *The Lognormal Distribution in Environmental Applications*. EPA Technology Support Center Issue. EPA/600/R-97/006. Office of Research and Development, Office of Solid Waste and Emergency Response. December 1997.
- . 1997c. *Health Effects Assessment Summary Tables*. EPA 540/R-97-036. Office of Research and Development, Office of Emergency and Remedial Response. July 1997.
- . 1996. *Soil Screening Guidance: Technical Background Document*. EPA/540/R-95/128. Office of Solid Waste and Emergency Response. May 1996.
- . 1992a. *Final Guidance for Data Usability in Risk Assessment*. Office of Solid Waste and Emergency Response. Washington, D.C.
- . 1992b. “Guidelines for Exposure Assessment.” Notice. *Federal Register* 57(104):22888-22938.
- . 1992c. *Supplemental Guidance to RAGS: Calculating the Concentration Term*. Publication: 9285.7-081. Office of Solid Waste and Emergency Response. Washington, D.C. May.

- . 1991. *Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual*. Supplemental Guidance: Standard Default Exposure Factors. Interim Final. OSWER Directive: 9285.6-03. March 25, 1991.
- . 1989. *Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual*. Part A. Interim Final. EPA 540/1-89/002. U.S. EPA Office of Emergency and Remedial Response. Washington, D.C.
- Wang Z, M Fingas, S Blekinsopp, G Segy, M Landriault, L Sigouin, J Foght, K Semple, DWS Westlake. 1998. Comparison of oil composition changes due to biodegradation and physical weathering in different oils. *Journal of Chromatography A* (809) 89-107.
- U.S. Navy. 2004. *Final Institutional Control Management Plan Revision 1, Former Adak Naval Complex, Adak Island, Alaska*. Prepared by Engineering Field Activity, Northwest. Poulsbo, Washington. April 2004.

ATTACHMENT CI-1

Distribution Checks and Statistical Summaries of Data Used to Calculate EPCs

**95UCL CALCULATIONS FOR SOUTH OF RUNWAY 18-36
 Groundwater**

Chemical	Units	Mean ¹	StdDev ¹	95UCL ²
Acetone ³	ug/L			320.0
Benzene	ug/L	7.405	4.199	14.3
Ethylbenzene	ug/L	8.82	2.353	12.7
Naphthalene	ug/L	25.795	11.483	44.6
2-Methylnaphthalene	ug/L	18.48	9.367	33.8
Xylene	ug/L	37.52	11.219	55.9
DRO ⁴	ug/L	14781.76	10050.47	31264.5
C9-C24 Aliphatic	ug/L			25011.6
C9-C24 Aromatic	ug/L			12505.8
GRO ⁴	ug/L	8583.861	8103.602	21873.8
C6-C8 Aliphatic	ug/L			15311.6
C6-C8 Aromatic	ug/L			10936.9

RME - Reasonable maximum exposure

EPC - Exposure point concentration

¹These are the bootstrap estimates from the Systat outputs below.

²The 95th percent upper confidence limit (95UCL) is calculated using the z-statistic of 1.64 for $\alpha = 0.05$.

³A UCL95 cannot be calculated for this chemical because there are fewer than 10 samples in the data set. Therefore, the maximum detected concentration will be used as the EPC.

⁴The aliphatic and aromatic fractions for DRO and GRO were calculated

SYSTATv.9 OUTPUT

BZ	
N of cases	1000
Minimum	0.279
Maximum	23.654
Mean	7.405
Standard Dev	4.199

DRO	
N of cases	1000
Minimum	2187.286
Maximum	55540.1
Mean	14781.76
Standard Dev	10050.47

EBZ	
N of cases	1000
Minimum	2.886
Maximum	17.765
Mean	8.82
Standard Dev	2.353

GRO	
N of cases	1000
Minimum	133.267
Maximum	40627.67
Mean	8583.861
Standard Dev	8103.602

NAPH	
N of cases	1000
Minimum	2.293
Maximum	64.913
Mean	25.795
Standard Dev	11.483

METHNAPH	
N of cases	1000
Minimum	1.023
Maximum	70.701
Mean	18.48
Standard Dev	9.367

XYL	
N of cases	1000
Minimum	10.615
Maximum	83.067
Mean	37.52
Standard Dev	11.219

South of Runway - Construction Worker Groundwater

Acetone

<u>ug/L</u>	<u>Loc Cross Ref.</u>
5	LC6A (OLD 1)
5	LC6A (OLD 1)
320	LC6A (OLD 1)

Number of samples		Uncensored values	
Uncensored	3	Mean	110.00
Censored		Lognormal mean	357.26
Detection limit or PQL		Std. devn.	181.865335
Method detection limit		Median	5
TOTAL	3	Min.	5
		Max.	320
Lognormal distribution? r-squared is:		Normal distribution? r-squared is:	
Recommendations: Reject lognormal distribution. W value is 0.75. This is less than the tabled value of 0.767 Reject normal distribution. W value is 0.75. This is less than the tabled value of 0.767			
UCL (based on t-statistic) is 416.6			

South of Runway - Construction Worker Groundwater

Benzene

ug/L	Loc Cross Ref.	ug/L	Loc Cross Ref.
0.5	E-205	0.1	MRP-12
0.5	E-205	33.4	02-231
0.5	E-206	0.1	02-232
0.1	E-206	0.1	18/36-01
0.5	E-207	1.69	18/36-02
0.5	E-207	0.1	18/36-03
0.5	E-208	0.1	18/36-04
0.5	E-208	0.1	18/36-05
0.1	E-208	0.1	E-206
0.1	E-208	0.1	E-208
5	E-209	0.389	E-213
0.5	E-213	0.516	E-215
0.5	E-215	30.1	E-217
0.5	E-215	0.1	E-218
0.5	E-216	0.5	MRP-14
0.5	E-216	33	02-231
0.1	E-216		
16	E-217		
5.7	E-217		
0.5	E-218		
0.1	E-218		
0.1	E-218		
0.1	E-218		
0.1	E-218		
0.1	E-218		
5	LC6A (OLD 1)		
5	LC6A (OLD 1)		
250	LC6A (OLD 1)		
0.5	LC6A (OLD 1)		
8.1	LC6A (OLD 1)		
2.6	LC6A (OLD 1)		
0.5	MRP-11		
0.5	MRP-12		
0.5	MRP-12		
0.1	MRP-14		
35	02-231		
24	02-231		
39	02-231		
0.2	02-232		
0.1	02-232		
0.1	02-232		
0.1	02-232		
0.5	28-804		
0.5	28-808		
0.5	28-812		
1.69	LC6A (OLD 1)		

Number of samples		Uncensored values	
Uncensored	62	Mean	8.21
Censored		Lognormal mean	4.67
Detection limit or PQL		Std. devn.	32.6932961
Method detection limit		Median	0.5
TOTAL	62	Min.	0.1
		Max.	250
Lognormal distribution?		Normal distribution?	
r-squared is:		r-squared is:	
Recommendations:			
Reject lognormal distribution.			
Y value is -5.8859. This lies outside the tabled values of 1.1272 and -2.6896			
Reject normal distribution.			
Y value is -44.6048. This lies outside the tabled values of 1.1272 and -2.6896			
UCL (based on t-statistic) is 15.1482289325246			

South of Runway - Construction Worker Groundwater

Ethylbenzene

ug/L	Loc Cross Ref.	ug/L	Loc Cross Ref.
0.5	E-205	0.25	MRP-12
0.5	E-205	47.3	02-231
0.5	E-206	0.25	02-232
0.1	E-206	0.25	18/36-01
7.6	E-207	52.3	18/36-02
9.4	E-207	0.25	18/36-03
0.5	E-208	0.25	18/36-04
0.5	E-208	0.25	18/36-05
0.1	E-208	0.25	E-206
0.1	E-208	0.25	E-208
5	E-209	3.56	E-213
3.4	E-213	2.72	E-215
2.3	E-215	48.9	E-217
1.2	E-215	0.25	E-218
0.9	E-216	0.5	MRP-14
1.2	E-216	34	02-231
0.9	E-216		
13	E-217		
9.3	E-217		
0.5	E-218		
0.1	E-218		
0.22	E-218		
0.1	E-218		
0.1	E-218		
0.59	E-218		
22	LC6A (OLD 1)		
16	LC6A (OLD 1)		
97	LC6A (OLD 1)		
15	LC6A (OLD 1)		
12	LC6A (OLD 1)		
13	LC6A (OLD 1)		
0.5	MRP-11		
0.5	MRP-12		
0.5	MRP-12		
0.1	MRP-14		
63	02-231		
60	02-231		
52	02-231		
0.6	02-232		
0.51	02-232		
0.1	02-232		
0.46	02-232		
0.5	28-804		
1.6	28-808		
4.4	28-812		
12	LC6A (OLD 1)		

Number of samples		Uncensored values	
Uncensored	62	Mean	10.03
Censored		Lognormal mean	12.47
Detection limit or PQL		Std. devn.	19.78578056
Method detection limit		Median	0.55
TOTAL	62	Min.	0.1
		Max.	97
Lognormal distribution?		Normal distribution?	
r-squared is:		r-squared is:	
Recommendations:			
Assume lognormal distribution.			
Y value is -0.5093. This lies within the tabled values of 1.1272 and -2.6896			
UCL (based on t-statistic) is 14.229145204784			

South of Runway - Construction Worker Groundwater

Naphthalene

ug/L	Loc Cross Ref.			
1.04	E-205			
0.01	E-206			
43.2	E-207			
1.03	E-208			
1.055	E-209			
1.02	E-213			
1.45	E-215			
1	E-216			
189	E-217			
0.01	E-218			
26	LC6A (OLD 1)			
70	LC6A (OLD 1)			
1.02	MRP-11			
1.04	MRP-12			
0.01	MRP-14			
132	02-231			
2.97	28-804			
4.06	28-808			
20.4	28-812			
		Number of samples	Uncensored values	
		Uncensored	19	Mean
		Censored		Lognormal mean
		Detection limit or PQL		Std. devn.
		Method detection limit		Median
		TOTAL	19	Min.
				Max.
		Lognormal distribution?	Normal distribution?	
		r-squared is:	r-squared is:	
		Recommendations:		
		Reject lognormal distribution.		
		W value is 0.8917. This is less than the tabled value of 0.901		
		Reject normal distribution.		
		W value is 0.5809. This is less than the tabled value of 0.901		
		UCL (based on t-statistic) is 46.6802366481777		

South of Runway - Construction Worker Groundwater
 2-Methylnaphthalene

ug/L	Loc Cross Ref.				
1.04	E-205				
40.1	E-207				
1.03	E-208				
1.055	E-209				
1.02	E-213				
0.88	E-215				
1	E-216				
143	E-217				
14.7	LC6A (OLD 1)				
41	LC6A (OLD 1)				
1.02	MRP-11				
1.04	MRP-12				
3.41	28-804				
0.74	28-808				
23.9	28-812				
		Number of samples	Uncensored values		
		Uncensored	15	Mean	18.33
		Censored		Lognormal mean	18.84
		Detection limit or PQL		Std. devn.	37.32711999
		Method detection limit		Median	1.04
		TOTAL	15	Min.	0.74
				Max.	143
		Lognormal distribution?	Normal distribution?		
		r-squared is:	r-squared is:		
		Recommendations:			
		Reject lognormal distribution.			
		W value is 0.7673. This is less than the tabled value of 0.881			
		Reject normal distribution.			
		W value is 0.5401. This is less than the tabled value of 0.881			
		UCL (based on t-statistic) is 35.3012026714179			

South of Runway - Construction Worker Groundwater

Xylenes

ug/L	Loc Cross Ref.	ug/L	Loc Cross Ref.
1	E-205	0.1	02-232
0.5	E-205	0.44	02-232
1	E-206	0.5	28-804
0.2	E-206	5.2	28-808
31	E-207	8.4	28-812
61	E-207	43.5	LC6A (OLD 1)
1	E-208	0.5	MRP-12
0.5	E-208	157	02-231
0.1	E-208	0.5	02-232
0.1	E-208	0.5	18/36-01
14	E-209	56.3	18/36-02
9.5	E-213	0.5	18/36-03
7.8	E-215	0.5	18/36-04
2.5	E-215	0.5	18/36-05
3.1	E-216	0.5	E-206
3	E-216	0.5	E-208
1.3	E-216	5.59	E-213
88	E-217	6.5	E-215
35	E-217	172	E-217
1	E-218	0.5	E-218
0.2	E-218	1	MRP-14
0.69	E-218	150	02-231
0.1	E-218		
0.1	E-218		
1.1	E-218		
80	LC6A (OLD 1)		
66	LC6A (OLD 1)		
580	LC6A (OLD 1)		
57	LC6A (OLD 1)		
44	LC6A (OLD 1)		
48	LC6A (OLD 1)		
0.5	MRP-11		
1	MRP-12		
0.5	MRP-12		
0.2	MRP-14		
262	02-231		
222	02-231		
220	02-231		
0.4	02-232		
0.95	02-232		

Number of samples Uncensored 62 Censored Detection limit or PQL Method detection limit TOTAL 62	Uncensored values Mean 39.64 Lognormal mean 68.45 Std. devn. 92.29127362 Median 1 Min. 0.1 Max. 580
Lognormal distribution? r-squared is:	Normal distribution? r-squared is:
Recommendations: Assume lognormal distribution. Y value is -0.6363. This lies within the tabled values of 1.1272 and -2.6896	
UCL (based on t-statistic) is 59.2182572484837	

South of Runway - Construction Worker Groundwater

DRO

ug/L	Loc Cross Ref.																																
125	E-205	<table border="1"> <tr> <td>Number of samples</td> <td></td> <td>Uncensored values</td> <td></td> </tr> <tr> <td>Uncensored</td> <td>53</td> <td>Mean</td> <td>14223.08</td> </tr> <tr> <td>Censored</td> <td></td> <td>Lognormal mean</td> <td>11616.99</td> </tr> <tr> <td>Detection limit or PQL</td> <td></td> <td>Std. devn.</td> <td>68562.66522</td> </tr> <tr> <td>Method detection limit</td> <td></td> <td>Median</td> <td>1780</td> </tr> <tr> <td>TOTAL</td> <td>53</td> <td>Min.</td> <td>50</td> </tr> <tr> <td></td> <td></td> <td>Max.</td> <td>500000</td> </tr> </table>				Number of samples		Uncensored values		Uncensored	53	Mean	14223.08	Censored		Lognormal mean	11616.99	Detection limit or PQL		Std. devn.	68562.66522	Method detection limit		Median	1780	TOTAL	53	Min.	50			Max.	500000
Number of samples						Uncensored values																											
Uncensored	53					Mean	14223.08																										
Censored						Lognormal mean	11616.99																										
Detection limit or PQL						Std. devn.	68562.66522																										
Method detection limit						Median	1780																										
TOTAL	53					Min.	50																										
						Max.	500000																										
125	E-205																																
125	E-206																																
200	E-206																																
1800	E-207																																
1900	E-207																																
125	E-208																																
125	E-208																																
700	E-209																																
2000	E-213	<table border="1"> <tr> <td>Lognormal distribution?</td> <td>Normal distribution?</td> </tr> <tr> <td>r-squared is:</td> <td>r-squared is:</td> </tr> <tr> <td colspan="2">Recommendations:</td> </tr> <tr> <td colspan="2">Assume lognormal distribution.</td> </tr> <tr> <td colspan="2">Y value is -0.4194. This lies within the tabled values of 1.0611 and -2.7396</td> </tr> <tr> <td colspan="2">UCL (based on t-statistic) is 30009.2024928189</td> </tr> </table>				Lognormal distribution?	Normal distribution?	r-squared is:	r-squared is:	Recommendations:		Assume lognormal distribution.		Y value is -0.4194. This lies within the tabled values of 1.0611 and -2.7396		UCL (based on t-statistic) is 30009.2024928189																	
Lognormal distribution?	Normal distribution?																																
r-squared is:	r-squared is:																																
Recommendations:																																	
Assume lognormal distribution.																																	
Y value is -0.4194. This lies within the tabled values of 1.0611 and -2.7396																																	
UCL (based on t-statistic) is 30009.2024928189																																	
4600	E-215																																
2100	E-215																																
5600	E-216																																
8200	E-216																																
27000	E-217																																
28000	E-217																																
3600	E-217																																
125	E-218																																
200	E-218																																
500000	LC6A (OLD 1)																																
45000	LC6A (OLD 1)																																
13000	LC6A (OLD 1)																																
4300	LC6A (OLD 1)																																
125	MRP-11																																
125	MRP-12																																
125	MRP-12																																
100	MRP-14																																
1300	28-804																																
7100	28-808																																
1300	28-812																																
4130	LC6A (OLD 1)																																
169	MRP-12																																
23800	02-231																																
15500	02-231																																
1780	02-232																																
2310	18/36-01																																
5200	18/36-02																																
50	18/36-03																																
57	18/36-04																																
605	18/36-05																																
776	E-206																																
129	E-208																																
4840	E-213																																
1910	E-215																																
11000	E-217																																
267	E-218																																
125	MRP-14																																
2800	02-232																																
14000	02-231																																
85	E-218																																
80	MRP-12																																
5000	E-216																																
85	E-208																																

South of Runway - Construction Worker Groundwater

GRO

<u>ug/L</u>	<u>Loc Cross Ref.</u>	<u>ug/L</u>	<u>Loc Cross Ref.</u>
125	E-205	25	02-232
50	E-205	25	18/36-01
125	E-206	474	18/36-02
2.5	E-206	25	18/36-03
520	E-207	25	18/36-04
50	E-207	25	18/36-05
125	E-208	25	E-206
50	E-208	25	E-208
10	E-208	186	E-213
10	E-208	82.7	E-215
500	E-209	766	E-217
150	E-213	25	E-218
350	E-215	125	MRP-14
50	E-215	910	02-231
125	E-216		
50	E-216		
51	E-216		
2300	E-217		
280	E-217		
810	E-217		
125	E-218		
2.5	E-218		
21	E-218		
10	E-218		
10	E-218		
35	E-218		
500000	LC6A (OLD 1)		
770	LC6A (OLD 1)		
180	LC6A (OLD 1)		
470	LC6A (OLD 1)		
50	MRP-11		
125	MRP-12		
50	MRP-12		
2.5	MRP-14		
2400	02-231		
2200	02-231		
2800	02-231		
26	02-232		
28	02-232		
24	02-232		
38	02-232		
50	28-804		
50	28-808		
50	28-812		
338	LC6A (OLD 1)		
25	MRP-12		
1690	02-231		

Number of samples	Uncensored values		
Uncensored	61	Mean	8525.36
Censored		Lognormal mean	759.85
Detection limit or PQL		Std. devn.	63978.79648
Method detection limit		Median	50
TOTAL	61	Min.	2.5
		Max.	500000
Lognormal distribution?	Normal distribution?		
r-squared is:	r-squared is:		
Recommendations:			
Reject lognormal distribution.			
Y value is -5.0447. This lies outside the tabled values of 1.1211 and -2.6943			
Reject normal distribution.			
Y value is -56.4447. This lies outside the tabled values of 1.1211 and -2.6943			
UCL (based on t-statistic) is 22213.603536571			

**95UCL CALCULATIONS FORSOUTH OF RUNWAY 18-36
 Soil**

Chemical	Units	Mean ¹	StdDev ¹	95UCL ²
Naphthalene ³	mg/kg			14.0
2-Methylnaphthalene ³	mg/kg			61.0
DRO ⁴	mg/kg	6830.353	1493.558	9279.79
C9-C24 Aliphatic	mg/kg			7423.8
C9-C24 Aromatic	mg/kg			3711.9
GRO ⁴	mg/kg	235.339	63.515	339.5
C6-C8 Aliphatic	mg/kg			238
C6-C8 Aromatic	mg/kg			169.8

RME - Reasonable maximum exposure

EPC - Exposure point concentration

¹These are the bootstrap estimates from the Systat outputs below.

²The 95th percent upper confidence limit (95UCL) is calculated using the z-statistic of 1.64 for $\alpha = 0.05$.

³A UCL95 cannot be calculated for this chemical because there are fewer than 10 samples in the data set. Therefore, the maximum detected concentration will be used as the EPC.

⁴The aliphatic and aromatic fractions for DRO and GRO were calculated using ADEC's default TPH compositions of 80% aliphatic and 40% aromatic and 70% aliphatic and 50% aromatic for DRO and GRO, respectively.

SYSTATv.9 OUTPUT

DRO	
N of cases	1000
Minimum	3163.107
Maximum	11661.65
Mean	6830.353
Standard Dev	1493.558

GRO	
N of cases	1000
Minimum	51.628
Maximum	474.469
Mean	235.339
Standard Dev	63.515

South of Runway - Construction Worker Soil

Naphthalene

<u>mg/kg</u>	<u>Loc Cross Ref.</u>				
1	02-231	Number of samples		Uncensored values	
14	02-231	Uncensored	4	Mean	4.28
2	02-232	Censored		Lognormal mean	10.36
0.1	02-232	Detection limit or PQL		Std. devn.	6.529612035
		Method detection limit		Median	1.5
		TOTAL	4	Min.	0.1
				Max.	14
Lognormal distribution? Normal distribution?					
r-squared is:			r-squared is:		
Recommendations: Assume lognormal distribution. W value is 0.9882. This exceeds the tabled value of 0.748					
UCL (based on t-statistic) is 11.9570885596925					

South of Runway - Construction Worker Soil
 2-Methylnaphthalene

<u>mg/kg</u>	<u>Loc Cross Ref.</u>				
1	02-231	Number of samples		Uncensored values	
61	02-231	Uncensored	4	Mean	16.03
2	02-232	Censored		Lognormal mean	63.11
0.1	02-232	Detection limit or PQL		Std. devn.	29.99337427
		Method detection limit		Median	1.5
		TOTAL	4	Min.	0.1
				Max.	61
		Lognormal distribution?	Normal distribution?		
		r-squared is:	r-squared is:		
Recommendations: Assume lognormal distribution. W value is 0.969. This exceeds the tabled value of 0.748					
UCL (based on t-statistic) is 51.3122048266879					

South of Runway - Construction Worker Soil

DRO

<u>mg/kg</u>	<u>Loc Cross Ref.</u>	<u>mg/kg</u>	<u>Loc Cross Ref.</u>
5700	416	59.2	737
30	411	15.5	737
11	401	6220	736
15	372	7240	736
126	506	14.8	736
99	499	237	736
23000	414	10400	735
22000	408	4	735
37000	407	4	735
200	400	1150	734
12	399	4	18/36-05
250	398	4	18/36-04
5	02-518	5.08	18/36-01
5	02-518	18000	535
50	565	5.7	535
50	564	16000	503
47	563	10	502
36	562	6300	497
50	561	7200	497
130	560	6.7	497
8.4	02-517	10	496
12000	28-812	140	418
5100	28-811	10	404
520	28-810	2700	380
4.9	28-808	8	380
4.7	28-807	27	374
4.9	28-806	1600	373
16000	28-804	310	02-232
25000	28-803	27000	02-232
59000	28-802	40000	02-231
5.43	745	6750	02-231
110	745	17000	315
3110	745	24	315
297	744	10	E-218
4820	744	110	E-217 (AMW-217)
16000	744	33	E-216
13	744	10	E-215
44.6	744	130	E-213 (AMW-213)
4	743	75000	E-209 (AMW-209)
4	743	190	E-208
5.08	742	13000	E-207 (AMW-207)
5.79	742	9100	850
58.3	742		
5.14	741		
940	741		
11.9	741		
17300	740		
4.44	739		
6.65	738		
17000	738		
4	737		

Number of samples	Uncensored values		
Uncensored	93	Mean	5723.12
Censored		Lognormal mean	32701.07
Detection limit or PQL		Std. devn.	12487.373
Method detection limit		Median	58.75
TOTAL	93	Min.	4
		Max.	75000
Lognormal distribution? Normal distribution?			
r-squared is:		r-squared is:	
Recommendations:			
Assume lognormal distribution.			
Y value is -0.4061. This lies within the tabled values of 1.275 and -2.5744			
UCL (based on t-statistic) is 7853.14352114708			

South of Runway - Construction Worker Soil

GRO

mg/kg	Loc Cross Ref.	mg/kg	Loc Cross Ref.
4.4	416	539	734
2.5	411	39.5	734
2.5	401	143	734
2.5	372	2680	734
2.5	506	2.5	18/36-05
2.5	499	1.995	18/36-04
86	414	1.595	18/36-01
150	408	990	535
14	407	2.5	535
2.5	400	200	503
2.5	399	2.5	502
2.5	398	480	497
0.15	02-518	460	497
0.15	02-518	2.5	496
1.5	02-517	2.5	418
1.625	745	2.5	404
1.45	745	69	380
17.1	745	2.5	374
1.49	744	21	373
39.6	744	2.5	02-232
152	744	16	02-232
1.825	744	110	02-231
1.85	744	350	02-231
1.865	743	1600	315
2.27	743	2.5	315
1.405	742	2.5	E-218
1.695	742	5.3	E-217 (AMW-217)
1.67	742	2.5	E-216
1.665	741	2.5	E-215
6.7	741	2.5	E-213 (AMW-213)
1.235	741	2700	E-209 (AMW-209)
355	740	52	E-208
1.975	739	970	E-207 (AMW-207)
3.075	738	2.45	850
876	738		
2.5	737		
1.59	737		
1.185	737		
58	736		
78.9	736		
2.5	736		
2.86	736		
121	735		
1.36	735		
1.635	735		

Number of samples		Uncensored values	
Uncensored	79	Mean	170.67
Censored		Lognormal mean	167.53
Detection limit or PQL		Std. devn.	490.6135696
Method detection limit		Median	2.5
TOTAL	79	Min.	0.15
		Max.	2700
Lognormal distribution?		Normal distribution?	
r-squared is:		r-squared is:	
Recommendations:			
Reject lognormal distribution.			
Y value is -5.9061. This lies outside the tabled values of 1.216 and -2.6208			
Reject normal distribution.			
Y value is -37.5937. This lies outside the tabled values of 1.216 and -2.6208			
UCL (based on t-statistic) is 265.443174941468			

ATTACHMENT CI-2
Default Exposure Factors

ATTACHMENT CI-2 Default Exposure Factors

The following default exposure factors were used in the human health risk assessment for the South of Runway 18-36 Area site. Site-specific exposure factors are discussed in Section CI.3.3.

General Exposure Factors

Body Weight. An adult body weight of 70 kilograms (kg) was used. This is the average body weight for adult men and women combined, rounded to 70 kg (ADEC 1999; USEPA 1989).

Averaging Time. For carcinogens, an averaging time of 70 years (equivalent to a lifetime), or 25,550 days, was used (USEPA 1989). For noncarcinogens, an averaging time equal to the exposure duration (1 year, or 365 days, for construction worker) was used (ADEC 1999; USEPA 1989).

Construction Worker Exposure Factors

The following default exposure factors were used in the evaluation of the construction worker scenario. The default exposure factors are the recommended values in EPA's *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (2002c).

Inhalation Rate. The recommended construction worker inhalation rate of 20 m³/day was selected for soil and groundwater exposure (USEPA 2002c). According to the Exposure Factors Handbook (USEPA 1997a), an inhalation rate for adults engaged in light activities is 1 m³/hour, 1.6 m³/hour for those engaged in moderate activities, and a rate 2.5 m³/hour for those engaged in heavy activities outdoors. In a construction scenario, this value of 20 m³/day equates to an inhalation rate of 2.5 m³/hour for 8 hours/day, which is likely an overestimate. For example, while the definitions of heavy activities are somewhat subjective, EPA (1997a) states representative "heavy" activities include vigorous physical exercise (i.e., fast running) and climbing stairs carrying a load.

Soil Ingestion Rate. An RME soil ingestion rate of 330 mg/day for a construction worker was selected as recommended in the *Supplemental Soil Screening Guidance* (USEPA 2002c). This value is the upper-percentile adult ingestion rate from a soil ingestion mass-balance study conducted by Stanek et al. (1997) of adults engaged in routine day-to-day activities over a 4-week period. However, this estimate, as stated by the authors, is highly uncertain due to the small size of the study.

Skin Surface Area. For construction workers, an exposed skin surface area of 3,300 cm² was used as recommended in EPA's supplemental Soil Screening Guidance (USEPA 2002c); this corresponds to exposure to head, forearms, and hands.

Adherence Factor. A soil to skin adherence factor of 0.3 mg/cm²-event was used for the construction worker soil exposure scenario (USEPA 2003b). This value in EPA's Soil Screening Guidance is based on studies by Kissel et al. (1996 and 1998) and Holmes et al. (1999) where data suggest that (1) soil properties influence adherence, (2) soil adherence varies considerable across different parts of the body, and (3) soil adherence varies with activity (USEPA 2002c). The adherence factor of 0.3 mg/cm² represents the 95th percentile for construction workers.

Dermal Absorption Factor. The dermal absorption factor represents the fraction of a chemical that is absorbed through the skin via contact with soil. EPA recommends evaluating the dermal pathway for those chemicals where dermal absorption data are available (USEPA 2003b). Therefore, diesel was evaluated for the dermal pathway using a dermal absorption factor of 0.1 (ADEC 1999; USEPA 2003b).

Dermal Permeability Constant. The dermal permeability constant reflects the movement of a specific chemical from water across the skin and into the blood stream (USEPA 1989). Dermal permeability constants were obtained from EPA's *Dermal Risk Assessment Guidance* (USEPA 2003b). Dermal permeability constants are not available for the following COPCs: 2-methylnaphthalene, DRO, and GRO. Therefore, dermal exposures cannot be evaluated for these chemicals in groundwater. See further discussion in Section CI.7.

ATTACHMENT CI-3
Chemical Toxicity Profiles for Human Health

FINAL FOCUSED FEASIBILITY STUDY REPORT
South of Runway 18-36 Area
U.S. Navy, Engineering Field Activity, Northwest
Contract No. N44255-02-D-2008
Delivery Order 0037

Attachment CI-3
Revision No.: 0
Date: 05/25/05
Page iii

ATTACHMENT CI-3 Chemical Toxicity Profiles

Toxic effects of the chemicals of potential concern are presented in this Appendix. In general, the information has been summarized from the latest available Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Environmental Protection Agency (EPA) Integrated Risk Information System (IRIS), and Oak Ridge National Laboratory Toxicity Values online databases.

CONTENTS

1.0	PETROLEUM HYDROCARBONS.....	1
1.1	GRO (ALASKA DEC carbon chain length C6–C10)	2
1.1.1	Aliphatic Fraction Toxicity Criteria.....	2
1.1.2	Aromatic Fraction Toxicity Criteria	2
1.2	DRO (ALASKA DEC carbon chain length C10–C25)	2
1.2.1	Aliphatic Fraction Toxicity Criteria.....	3
1.2.2	Aromatic Fraction Toxicity Criteria	3
2.0	ACETONE	7
3.0	BENZENE.....	8
4.0	ETHYLBENZENE.....	10
5.0	2-METHYLNAPHTHALENE.....	12
6.0	NAPHTHALENE.....	13
7.0	XYLENES	15

TABLE

1	Fractions, Surrogates and Toxicity Reference Doses for Total Petroleum Hydrocarbon Compounds (ADEC 2000).....	6
---	---	---

1.0 PETROLEUM HYDROCARBONS

Petroleum products are complex mixtures of hundreds of different hydrocarbon compounds. These mixtures can roughly be divided into four categories based on the boiling point (i.e., the distillation fraction) of the individual hydrocarbons and the length of the carbon chains. These four categories are (1) gasoline, where the majority of the hydrocarbons have carbon chain lengths ranging from 5 carbons to 10 carbons (C_5 to C_{10}), (2) the middle distillates (e.g., kerosene, diesel, jet fuels, and lighter fuel oils [C_8 to C_{18}]), (3) heavy fuel oils and lubricating oils (C_{19} to C_{45}), and (4) asphaltics (C_{30+}) (API 1989; Sullivan and Johnson 1993).

Total petroleum hydrocarbons (TPH) are defined by the analytical method used to evaluate them, i.e., concentrations of TPH will differ depending on the type of analysis. The current recommended approach for assessing petroleum toxicity is to identify the original source and analyze the environmental samples by methods that test for specific carbon fraction ranges as well as aliphatic and aromatic fractions (TPHCWG 1999a, b). These divisions were selected based on both the similarity of behavior in the environment (i.e., fate and transport characteristics) and toxicity. If these data are available, then surrogate compounds for which toxicity information is available can be selected for each fraction and the mixture can be evaluated. The surrogate approach involves the separation of the petroleum mixtures into aliphatic and aromatic equivalent carbon-range fractions (i.e., EC5 to EC8) and the use of surrogate compounds or derived values to represent the toxicity of those fractions (ADEC 2000). Alaska DEC recommends the toxicity criteria selected by the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) for sites in Alaska (ADEC 2000). The State's carbon chain lengths for their recommended divisions of petroleum compounds, i.e., gasoline-range organics (GRO), diesel-range organics (DRO), and residual-range organics (RRO), are not identical to the fractions proposed by the TPHCWG on which TPHCWG based their toxicity studies. It is not known if the relatively slight differences in carbon chain length fractions would have an impact on toxicity. The surrogate compounds and toxicity criteria for the various aliphatic and aromatic carbon-range fractions developed by the TPHCWG and recommended by the Alaska DEC guidance are summarized on Table 1. Only noncancer toxicity criteria are available for the petroleum groups. Carcinogenic effects are not evaluated for the petroleum ranges. Rather, the individual carcinogenic compounds present in petroleum (i.e., benzene) are evaluated separately.

A discussion of the surrogate compounds and toxicity criteria used to evaluate petroleum compounds at this site (GRO and DRO) is provided below. The criteria used are based on two of the State's three categories of petroleum fuels, GRO, DRO, and RRO.

1.1 GRO (ALASKA DEC CARBON CHAIN LENGTH C6–C10)

Gasoline (unweathered) is a complex mixture of over 200 petroleum-derived chemicals consisting primarily of aliphatic hydrocarbons (up to 62 percent; MDEP 1994), and to a lesser extent of aromatic hydrocarbons, and polycyclic aromatic hydrocarbons (PAHs). Additives or octane enhancers are frequently added to gasoline. The range of gasoline hydrocarbons is typically from C₄ to C₁₂ (State of California 1989) with the majority of the compounds within C₅ to C₁₀. In the absence of benzene (discussed separately) and potentially ethylbenzene (see discussion in Section 8.6), gasoline is unlikely to be carcinogenic and its primary toxic effects are related to central nervous system depression (ATSDR 1999). Long-term effects from exposure to weathered product in the environment are not known. For fresh product, intermittent gasoline vapor exposure is common among gas station attendants and mechanics and appears to result in generally little to no toxic effect (Andrews and Snyder 1991).

1.1.1 Aliphatic Fraction Toxicity Criteria

Both the oral RfD of 5 mg/kg-day and the RfC of 18 mg/m³ that TPHCWG recommends for the C₅ to C₈ fraction (note that Alaska DEC's GRO analyses span a different chain length group than this) are based on studies of exposure to commercial hexane (<53 percent) by rodents (TPHCWG 1999a, 1999b). The inhalation value was derived from several rodent studies applying a NOAEL of 3,000 ppm (adjusted to 1,840 mg/m³) and an uncertainty factor of 100 (for animal to human extrapolation and intrahuman variability). The oral RfD was calculated using the inhalation RfC (assuming an inhalation rate for a 70kg human of 20 m³/day and 100% absorption). The critical effect for the both oral and inhalation RfC is neurotoxicity.

1.1.2 Aromatic Fraction Toxicity Criteria

TPHCWG's recommended reference dose (RfD) and reference concentration (RfC) for this group (C₅ to C₈) are based on EPA's criteria for toluene of 0.2 mg/kg-day and 0.4 mg/m³ for the oral and inhalation values, respectively. The toluene criteria are based on a rat study that reported changes in liver and kidney weights (USEPA 2002).

1.2 DRO (ALASKA DEC CARBON CHAIN LENGTH C10–C25)

Unweathered diesel has toxic effects similar to gasoline, although diesel is less volatile, and less toxic. Like gasoline, diesel is a complex mixture of aliphatic and aromatic hydrocarbons. Generally diesel fuels contain 80 to 90 percent aliphatic hydrocarbons and 10 to 20 percent aromatic hydrocarbons (ATSDR 1999). Central nervous system depression appears to be the

principal toxic effect in humans from inhalation of diesel vapors, but limited evidence indicates there might be other systemic problems (ATSDR 1999).

1.2.1 Aliphatic Fraction Toxicity Criteria

The Alaska DEC DRO carbon chain length range does not exactly match the carbon chain length fraction upon which the TPHCWG toxicity criteria are based. Alaska DEC guidance recommends using the TPHCWG value for DRO as the closest match available. The TPHCWG oral RfD recommended for the aliphatic portion of the C₉ – C₁₆ fraction (closest to Alaska's DRO range) is 0.1 mg/kg-day and is derived from several studies of petroleum mixtures containing branched, straight, and cyclic alkanes, and JP-8 within the carbon range of C₇–C₁₈. The studies noted above were also used to derive TPHCWG's recommended RfC of 1 mg/m³. The studies are mostly unpublished from industry research using rodents (TPHCWG 1999b). EPA's review of TPHCWG's proposed surrogates found the selection of 0.1 mg/kg-day for aliphatic DRO compounds a reasonable one and likely to overestimate the toxicity of this fuel (USEPA 2000).

1.2.2 Aromatic Fraction Toxicity Criteria

There are a number of aromatic compounds in this C₉ – C₁₆ carbon range for which EPA has derived RfDs. The majority of the possible RfDs for individual constituents in this TPH fraction are in the 10⁻² range. TPHGWC recommended 0.04 mg/kg-day as an RfD for this fraction range, the EPA's RfD for fluorene and fluoranthene (TPHCWG 1999a,b). The same study was used to derive the RfDs for these two compounds, a subchronic mouse study (USEPA 2002). EPA's confidence in the RfD is rated as low and they assign an uncertainty factor of 3,000 to the RfD. TPHCWG's recommended RfC of 0.2 mg/m³ is derived from a rodent study where mice were exposed to high flash aromatic naphthalene which is composed primarily of C₉ compounds (TPHCWG 1999b; ATSDR 1999).

REFERENCES

- Agency for Toxic Substances and Disease Registry (ATSDR). 1999. *Toxicological Profile for Total Petroleum Hydrocarbons (TPH)*. U.S. Department of Health and Human Services. September.
- Alaska Department of Environmental Conservation (ADEC). 2000. *Guidance for Cleanup of Petroleum Contaminated Sites*. Division of Spill Prevention and Response, Contaminated Sites Remediation Program. September
- American Petroleum Institute (API). 1989. *A guide to the assessment and remediation of underground petroleum releases*. API Publication 1629, Second Edition. August.
- Andrews L. and Snyder R. 1991. Toxic effects of solvents and vapors. In: MO Amdur, J Doull, and CD Klaassen, eds. *Casarett and Doull's Toxicology: The Basic Science Of Poisons*, 4th ed. Ch. 20, pages 681-722. Pergamon, New York, NY.
- California, State of, Leaking Underground Fuel Tank Field Manual Task Force. 1989. *Leaking Underground Fuel Tank Field Manual: Guidelines For Site Assessment, Cleanup, And Underground Storage Tank Closure*. October.
- Massachusetts Department of Environmental Protection (MDEP). 1994. *Interim Final Petroleum Report: Development of Health-Based Alternative to the Total Petroleum Hydrocarbon (TPH) Parameter*. Office of Research and Standards. August.
- Sullivan, Brian, and Sidney Johnson. 1993. 'Oil' you need to know about crude oil. *Soils*. May.
- Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). 1999a. *Human Health Risk-Based Evaluation of Petroleum Release Sites: Implementing the Working Group Approach. Volume 5*. Amherst Scientific Publishers, Amherst, MA. June.
- Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). 1999b. *Human Health Risk-Based Evaluation of Petroleum Release Sites: Implementing the Working Group Approach. Volume 3*. Amherst Scientific Publishers, Amherst, MA. June.
- U.S. Environmental Protection Agency (USEPA). 2002. Integrated Risk Information System (IRIS) Online Database. September.

FINAL FOCUSED FEASIBILITY STUDY REPORT
South of Runway 18-36 Area
U.S. Navy, Engineering Field Activity, Northwest
Contract No. N44255-02-D-2008
Delivery Order 0037

Attachment CI-3
Revision No.: 0
Date: 05/25/05
Page 5

———. 2000. *Risk Assessment Issue Paper for: Approaches to and Provisional Guidance for Risk Assessment of Total Petroleum Hydrocarbons*. Superfund Technical Support Center. National Center for Environmental Assessment. Cincinnati, Ohio. October 12.

Table 1
Fractions, Surrogates and Toxicity Reference Doses for
Total Petroleum Hydrocarbon Compounds (ADEC 2000)

Alaska DEC Compound and Carbon-Range Fraction	TPHCWG Surrogate Compound for Alaska DEC Carbon Ranges	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m ³)
Aliphatics			
GRO (C ₆ – C ₁₀)	Commercial hexane	5.0	18.4
DRO (C ₁₀ – C ₂₅)	Several studies with compounds ranging from C ₇ – C ₁₈ and JP-8	0.1	1.0
Aromatics			
GRO (C ₆ – C ₁₀)	Toluene	0.2	0.4
DRO (C ₁₀ – C ₂₅)	Fluorene, fluoranthene (oral); naphtha (inhalation)	0.04	0.2

Notes:

DEC - Department of Environmental Conservation
 DRO - diesel-range organics
 GRO - gasoline-range organics
 JP-8 - jet petroleum No. 8
 mg/kg - milligram per kilogram per day
 mg/m³ - milligrams per cubic meter
 NA - none available
 RfC - reference concentration
 RfD - reference dose
 TPHCWG - Total Petroleum Hydrocarbon Criteria Working Group

2.0 ACETONE

Acetone has a long history of industrial use as a solvent (USEPA 2003a) and as an intermediate in chemical production (ATSDR 1994). The potential for human exposure via inhalation, dermal, and oral routes is great under occupational situations (ATSDR 1994).

The EPA reports an oral RfD of 0.9 mg/kg-day and an inhalation RfD is not established for acetone (USEPA 2003). The principle study for the oral value is a subchronic drinking water study in rats where the toxic endpoint was nephropathy (kidney). However, the oral RfD was not evaluated in the construction worker exposure scenario because acetone was a COPC only in groundwater and the groundwater ingestion pathway is not complete.

To date there are no epidemiological studies demonstrating an association between exposure to acetone and increased risk of cancer (USEPA 2003).

REFERENCES

- Agency for Toxic Substances and Disease Registry (ATSDR). 1994. Toxicological Profile for Acetone. U.S. Department of Health and Human Services. May 1994.
- U.S. Environmental Protection Agency (USEPA). 2003. Integrated Risk Information System (IRIS) Online Database (<http://www.epa.gov/iris/index.html>). May 2003.

3.0 BENZENE

Benzene is widely used as an industrial solvent, an intermediate in chemical synthesis of commercial products, and a component of gasoline (USEPA 1998b). The potential for human exposure via inhalation, dermal, and oral routes is great under environmental and occupational situations (USEPA 1998b).

The EPA reports an oral RfD for benzene of 0.004 mg/kg-day and an inhalation RfD 0.0086 mg/kg-day (USEPA 2003). The critical study for both the oral and inhalation values was a human occupational study where the toxic endpoint was decreased lymphocyte counts. EPA assigned an uncertainty factor of 300 to both the oral and inhalation values, of which a factor of 3 was for subchronic-to-chronic adjustment. EPA's confidence in the chronic oral and inhalation RfDs is medium. No adjustment was made to the chronic RfDs to evaluate the construction worker exposure scenario.

Under the proposed revised carcinogen risk assessment guidelines (USEPA 1996), benzene is characterized as a known human carcinogen for all routes of exposure based upon convincing human evidence from occupational epidemiological studies as well as supporting evidence from animal studies (USEPA 2003). Significantly increased risk of leukemia, primarily acute myelogenous leukemia (AML), have been reported in benzene-exposed workers in the chemical industry, shoemaking and oil refineries (USEPA 2003). EPA's IRIS file on benzene summarizes several key studies that support the weight of evidence classification that exposure to benzene is causally related to an increase in the risk of cancer, specifically leukemia. Included in these studies are the effects of benzene exposure among 28,500 Turkish shoe industry workers; a retrospective cohort mortality study where leukemogenic effects of benzene exposure in 748 white male workers in a rubber products manufacturing plant were examined; and two cohort studies by where an extension and elaboration for the initial analysis done for the rubber plant workers was performed (USEPA 2003). These studies were selected by the EPA as the critical studies for dose-response analysis and for the quantitative estimation of cancer risk to humans (USEPA 2003).

The true cancer risk from exposure to inhaled benzene cannot be ascertained because of uncertainties in the low-dose exposure scenarios and lack of clear understanding of the mode of action. Therefore, *“a range of estimates of risk is recommended, each having equal scientific plausibility. The range estimates are maximum likelihood values (i.e., best statistical estimates) and were derived from observable dose responses using a linear extrapolation model to estimate low environmental exposure risks...The use of a linear model is a default public health protective approach and an argument both for and against recognizing supra- and sublinear relationships at low doses and non-threshold or threshold modes of action on exposure to benzene. Therefore,*

the risk could be either higher or lower” (USEPA 2003). Thus, the inhalation unit risk estimate for benzene is reported as a range, from 2.2E-06 to 7.8E-06 per ug/m³. The inhalation slope factor can then be derived by applying standard inhalation exposure parameters, an air intake of 20 m³/day and an adult body weight of 70 kg. The benzene slope factor range is calculated as 0.0077 to 0.0273 (mg/kg-day)⁻¹. Risks from benzene inhalation evaluated in this assessment used the higher (more health protective) slope factor of 0.0273 (mg/kg-day)⁻¹. The oral SF for benzene is 0.0055 (mg/kg-day)⁻¹. This value is reported on the EPA’s Region IX PRG tables and is based on human data.

REFERENCES

- Rothman, N., G.L. Li, M. Dosemeci, W.E. Bechtold, G.E. Marti, Y.Z. Wang, M. Linet, L.Q. Xi, W. Lu, M.T. Smith, N. Titenko-Holland, L.P. Zhang, W. Blot, S.N. Yin, and R.B. Hayes. 1996. Hematotoxicity among Chinese workers heavily exposed to benzene. *Am. J. Ind. Med.* 29: 236-246.
- U.S. Environmental Protection Agency (USEPA). 1996. *Proposed guidelines for carcinogenic risk assessment*. Office of Research and Development. EPA/600/P-92/003C. April.
- . 1998a. *Carcinogenic Effects of Benzene: An Update*. EPA/600/P-67/001F. National Center for Environmental Assessment – Washington Office, Office of Research and Development. April 1998.
- . 1998b. *Toxicological Review of Benzene (NonCancer Effects)*. DRAFT. The National Center for Environmental Assessment-Washington Division, Office of Research and Development. September 1998.
- . 2003. *Integrated Risk Information System (IRIS) Online Database*. June.

4.0 ETHYLBENZENE

Ethylbenzene is a colorless liquid that smells like gasoline and has an odor threshold of approximately 2 parts per million (ppm) in air. Ethylbenzene is used primarily in the production of styrene, but is also used as a solvent, a component of asphalt and naphtha, and in fuels (gasoline contains about 2 percent ethylbenzene by weight). Consumer products containing ethylbenzene include pesticides, carpet glues, varnishes and paints, and tobacco products. Acute inhalation exposure of humans to high levels of ethylbenzene has been documented to irritate the eyes and throat and adversely affect the central nervous system (CNS). CNS effects include dizziness, headaches, confusion, and weakness. There are no reliable data on toxic effects in humans following ingestion of or dermal contact with ethylbenzene. Whether or not chronic exposure to ethylbenzene affects human health is not known because little information is available.

EPA has established an oral RfD for ethylbenzene of 0.1 mg/kg-day, based on a study reporting histopathologic changes in liver and kidney tissue in female rats following exposure to 408 or 680 mg/kg ethylbenzene for 5 days/week for 182 days (Wolf et al. 1956). The oral RfD was calculated by applying an uncertainty factor of 1000 (to account for both intraspecies and interspecies variability to the toxicity of ethylbenzene in lieu of specific data, and extrapolation of a subchronic effect level to its chronic equivalent) and a modifying factor of 1 to the reported NOAEL of 136 mg/kg/day. The overall confidence in the RfD is rated low because rats of only one sex were tested and the experiment was not of chronic duration (USEPA 2003). For the construction worker scenario, the uncertainty factor of 10 for subchronic to chronic extrapolation was removed from the oral RfD. A subchronic oral RfD of 1 mg/kg-day was used to evaluate hazards to the construction worker population.

EPA has established an inhalation RfC for ethylbenzene of 1 mg/m³, based on a study reporting reduced numbers of live kits per litter in rabbits and developmental abnormalities in rats with chronic inhalation exposure to ethylbenzene at concentrations as low as 434 mg/m³ (Andrew et al. 1981). The inhalation RfC was calculated by applying an uncertainty factor of 300 (to protect unusually sensitive individuals, adjust for interspecies conversion, and adjust for the absence of multigenerational reproductive and chronic studies) and a modifying factor of 1 to the reported LOAEL of 434 mg/m³. The overall confidence in the RfC is rated low due to the relative lack of information on the potential for maternal toxicity and developmental effects (USEPA 2003). No adjustment was made to the inhalation RfC to evaluate subchronic construction worker exposures, because there was no uncertainty factor specifically for subchronic to chronic extrapolation to remove. Therefore, the chronic inhalation RfC of 1 mg/m³ (or inhalation RfD of 0.29 mg/kg-day) was used to evaluate hazards to construction workers.

The IRIS record for ethylbenzene classifies the chemical as Group D—not classifiable as to its human carcinogenicity—due to lack of animal bioassays and human studies. No association between increased cancer incidence in humans and exposure to ethylbenzene has been reported in current literature. However, recently one animal study has provided clear evidence of carcinogenicity in male rats exposed to 750 ppm ethylbenzene for up to 2 years, citing the incidence of renal and testicular lesions. Evidence for female rats and male and female B6C3F1 mice is suggestive, but not conclusive (NTP 1996). The National Toxicology Program (NTP) and EPA have recently reviewed the 1996 NTP study and have concluded that there is “clear evidence” of the carcinogenicity of ethylbenzene in animals by the inhalation route (NTP 1999; USEPA 1999). USEPA has calculated an inhalation unit risk from the male rat data of $1.16 \text{ (ug/m}^3\text{)}^{-1}$ corresponding to an inhalation slope factor of $3.85 \times 10^{-3} \text{ (mg/kg-day)}^{-1}$ (USEPA 1999). This slope factor has been incorporated into the latest versions of EPA Region 9’s PRG list and EPA Region 3’s Risk-Based-Concentration list, both of which have been published as revised versions this year and are available on their respective websites.

REFERENCES

- Andrew, F.D., R.L. Buschbom, W.C. Cannon, R.A. Miller, L.F. Montgomery, D.W. Phelps, et al. 1981. Teratologic assessment of ethylbenzene and 2-ethoxyethanol. Battelle Pacific Northwest Laboratory, Richland, WA. PB 83-208074., 108.
- National Toxicology Program (NTP). 1999. NTP Technical Report on the Toxicology and carcinogenesis studies of ethylbenzene in F344/N rats and B6C3F1 mice. NTP publication No. 99-3956. January.
- . 1996. Toxicology and carcinogenesis studies of ethylbenzene in F344/N rats and B6C3F1 mice. Inhalation studies TR-466.
- U.S. Environmental Protection Agency (USEPA). 2003. Integrated Risk Information System (IRIS) Online Database. June.
- . 1999. Risk Assessment Issue Paper for: Derivation of an Inhalation Unit Risk for Ethylbenzene. Superfund Technical Support Center, National Center for Environmental Assessment, Cincinnati, Ohio.
- Wolf, M.A., V.K. Rowe, D.D. McCollister, R.L. Hollingsworth and F. Oyen. 1956. Toxicological studies of certain alkylated benzenes and benzene. Arch. Ind. Health. 14: 387-398.

5.0 2-METHYLNAPHTHALENE

2-Methylnaphthalene, also called beta methylnaphthalene, is a naphthalene-related compound. It is a solid like naphthalene. 2-Methylnaphthalene has an odor threshold in air of 10 parts per billion (ppb), which remains approximately the same when water is applied. Along with naphthalene, it is present in cigarette smoke, wood smoke, fossil fuels, tar, and asphalt, and at some hazardous waste sites. Products containing 2-methylnaphthalene include dyes, resins, and vitamin K (ATSDR 2000).

EPA has established an oral RfD for 2-methylnaphthalene of 0.009 mg/kg-day, based on a study reporting increased incidence of pulmonary alveolar proteinosis in lung tissue of mice following exposure to 50.3 or 54.3 mg/kg-day 2-methylnaphthalene for 81 weeks (Murata et al. 1997). The oral RfD was calculated by applying an uncertainty factor of 1000 (a factor of 10 each to account for both intraspecies and interspecies variability to the toxicity of 2-methylnaphthalene, and a third factor of 10 to account for deficiencies in the database and a modifying factor of 1. The overall confidence in the RfD is rated low because of confidence in the database (USEPA 2003). Because no uncertainty factor was applied for subchronic-to-chronic exposures, the chronic value was not adjusted to derive a subchronic value for the construction worker scenario.

No inhalation RfD is available for this chemical and EPA specifically states that route-to-route extrapolation is not appropriate because there is limited evidence which suggests that the toxicity associated with the toxic endpoint (pulmonary alveolar proteinosis) may vary with route of exposure (USEPA 2003).

In addition, there is a lack of evidence for human carcinogenicity of 2-methylnaphthalene. The EPA considers the data as inadequate to assess the human carcinogenic potential (USEPA 2003).

REFERENCES

- Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological Profiles on CD-ROM, Version 3:1.
- Lorber M. 1972. Hematoxicity of synergized pyrethrin insecticides and related chemicals in intact, totally and subtotally splenectomized dogs. *Acta Hepato-Gastroenterol* 19:66-78.
- U.S. Environmental Protection Agency (USEPA). 2003. Toxicological Review of 2-Methylnaphthalene. In Support of Summary Information on the Integrated Risk Information System (IRIS). April 2003.

6.0 NAPHTHALENE

Naphthalene is a white solid that evaporates easily. Naphthalene has an odor threshold in air of 84 ppb; that threshold is lowered to 21 ppb when water is applied. Naphthalene is present in cigarette smoke, wood smoke, fossil fuels, tar, and asphalt, and at some hazardous waste sites. Products containing naphthalene include moth repellents, toilet deodorant blocks, dyes, resins, leather tanning agents, and the insecticide, carbaryl (ATSDR 2000).

In humans, exposure to high concentrations of naphthalene is known to cause hemolytic anemia, nausea, vomiting, diarrhea, blood in the urine, and a yellow color to the skin. In animals, ingestion of naphthalene has been shown to cause rats to develop cataracts, and chronic inhalation has been shown to cause respiratory inflammation and irritation in mice. Evidence of naphthalene-induced reproductive toxicity is inconclusive. Evidence that naphthalene is a carcinogen is also inconclusive: female mice with daily lifetime exposures to naphthalene developed lung cancer, but a significant association between tumor development and naphthalene exposure was not established (ATSDR 2000).

EPA has established an oral RfD for naphthalene of 0.02 mg/kg-day, based on a study reporting decreased mean terminal body weight in rats exposed to 142.9 and 285.7 mg/kg-day naphthalene, 5 days/week for 13 weeks (BCL 1980). The oral RfD was calculated by applying an uncertainty factor of 3,000 (to account for interspecies extrapolation, intraspecies extrapolation to protect sensitive human populations, subchronic to chronic extrapolation, and database deficiencies) and a modifying factor of 1 to the reported NOAEL of 71.4 mg/kg-day. The overall confidence in the RfD is rated low because of inadequate chronic oral data for naphthalene; the lack of any dose-response data for naphthalene-induced hemolytic anemia; and the lack of two-generation reproductive toxicity studies (USEPA 2003). For the construction worker scenario, the uncertainty factor of 10 for subchronic to chronic extrapolation was removed and a subchronic oral RfD of 0.2 mg/kg-day was used to evaluate hazards to the construction population.

EPA has established an inhalation RfD for naphthalene of 0.00086 mg/kg-day, based on a study reporting hyperplasia and metaplasia in respiratory and olfactory epithelium, respectively, in mice exposed to naphthalene concentrations as low as 9.3 mg/m³ (USEPA 2003). The inhalation RfD was calculated by applying an uncertainty factor of 3,000 (to account for interspecies extrapolation, protection of sensitive individuals, and extrapolation from a LOAEL to a NOAEL) and a modifying factor of 3 (to account for database deficiencies) to the reported LOAEL of 9.3 mg/m³. The overall confidence in the RfD is rated low to medium (USEPA 2003). In calculating the inhalation RfD, EPA adjusted the NOAEL for a 7-day exposure from the actual 5-day exposures that occurred during the critical study (USEPA 2003). For the construction

worker scenario, that adjustment was removed and a subchronic inhalation RfD of 0.0043 mg/kg-day) was used in the risk calculations.

EPA has determined that the human carcinogenic potential of naphthalene cannot be determined (Group D) due to the lack of human carcinogenicity data and inadequate animal data. However, there is suggestive evidence that naphthalene is carcinogenic in animals. One study reported observations of benign respiratory tumors and one carcinoma in female mice only exposed to naphthalene by inhalation (NTP 1992). Additional support includes increase in respiratory tumors associated with exposure to 1-methylnaphthalene (Murata 1993).

REFERENCES

- Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological Profiles on CD-ROM, Version 3:1.
- Battelle's Columbus Laboratories (BCL). 1980. Unpublished subchronic toxicity study: Naphthalene (C52904), Fischer 344 rats. Prepared by Battelle Laboratories under NTP Subcontract No. 76-34-106002.
- Murata, T., A. Denda, and H. Maruyama. 1993. Chronic toxicity and carcinogenicity studies of 1-methylnaphthalene in B6C3F1 mice. *Fundam. Appl. Toxicol.* 21:44-51.
- National Toxicology Program (NTP). 1992. Toxicology and carcinogenesis studies of naphthalene in B6C3F1 mice (inhalation studies). Technical Report Series No. 410. NIH Publication No. 92-3141.
- U.S. Environmental Protection Agency (USEPA). 2003. Integrated Risk Information System (IRIS) Online Database. June 2003.

7.0 XYLENES

Xylene is primarily synthesized from petroleum, although it also occurs naturally in petroleum and coal tar, and is formed during forest fires. It is a colorless, flammable liquid with an odor threshold of approximately 0.08-3.7 ppm. Xylene is one of the top 30 chemicals produced in the U.S. in terms of volume. It is used as a solvent, cleaning agent, and paint thinner. Xylene is also used as a component of materials manufactured in the chemical, plastics, and synthetic fiber industries. Isomers of xylene are used in the manufacture of certain polymers (ATSDR 2000).

In humans, acute exposure to high concentrations of xylene is known to cause irritation of the skin, eyes, nose, and throat; difficulty in breathing; impaired function of the lungs; delayed response to a visual stimulus; impaired memory; stomach discomfort; and possible changes in the liver and kidneys. Both acute and chronic exposure to high concentrations of xylene can also cause a number of effects on the nervous system, such as headaches, lack of muscle coordination, dizziness, confusion, and loss of balance. Most of the information on long-term exposure to xylene is from studies of workers employed in industries that make or use xylene. Animal studies indicate that exposure to high concentrations of xylene can cause harmful effects on the liver, kidneys, lungs, heart, and nervous system. Studies of unborn animals have reported dose-dependent developmental toxicity (i.e., increased numbers of deaths, decreased weight, skeletal changes, delayed skeletal development). In many instances, the same xylene concentrations cause deleterious health effects in the mothers (ATSDR 2000).

EPA has recently re-evaluated the toxicity of mixed xylenes and has revised its previous oral RfD for xylenes to 0.2 mg/kg-day (USEPA 2003). EPA has applied an uncertainty factor of 1,000 to the study NOAEL to account for intra and inter species differences (factor of 10 each), and a factor of 10 for data base uncertainties. In calculating the oral RfD, EPA adjusted the NOAEL for a 7-day exposure from the actual 5-day exposures that occurred during the critical study (USEPA 2003). For the construction worker scenario, the adjustment was removed, giving a subchronic oral RfD of 0.25 mg/kg-day.

The recent re-evaluation also has established a reference concentration for xylenes of 0.1 mg/m³, equivalent to an inhalation RfD of 0.029 mg/kg-day. An uncertainty factor of 300 was applied to the study NOAEL as follows: factor of three applied for interspecies differences, factor of three for subchronic-to-chronic adjustments, a factor of 10 for human variability. For the construction worker scenario, the factor of three for subchronic to chronic extrapolation was removed, giving a subchronic inhalation RfD of 0.09 mg/kg-day.

The critical endpoint for both the RfD and the RfC is neurotoxicity.

EPA has determined that the human carcinogenic potential of xylene cannot be determined (Group D) due to the lack of human carcinogenicity data and inadequate animal data. The NTP study (1986) used to derive the original oral RfD reported no evidence of carcinogenicity (i.e., neoplastic lesions, etc.) in rats exposed orally to 0, 250, 500, or 1,000 mg/kg-day xylene via gavage. However, Maltoni et al. (1985) reported higher incidences (versus controls) of malignant tumors in male and female rats treated by gavage with xylene in olive oil at 500 mg/kg-day, 5 days/week for 104 weeks. Berenblum (1941) reported that “undiluted” xylene applied at weekly intervals produced one tumor-bearing animal out of 40 after 25 weeks in skin-painting experiments in mice.

REFERENCES

- Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological Profiles on CD-ROM, Version 3:1.
- Berenblum, I. 1941. The cocarcinogenic action of croton resin. *Cancer Res.* 1: 44-48.
- Maltoni, C., B. Conti, G. Cotti and F. Belpoggi. 1985. Experimental studies on benzene carcinogenicity at the Bologna Institute of Oncology: Current results and ongoing research. *Am. J. Ind. Med.* 7: 415-446.
- National Toxicology Program (NTP). 1986. NTP Technical Report on the Toxicology and Carcinogenesis of Xylenes (mixed) (60.2% m-xylene, 13.6% p-xylene, 17.0 ethylbenzene and 9.1% o-xylene) (CAS No. 1330-20-7) in F344/N rats and B6C3F1 mice (gavage studies). U.S. DHHS, PHS, NIH, NTP, Research Triangle Park, NC. NTP TR 327, NIH Publ. No. 86-2583.
- U.S. Environmental Protection Agency (USEPA). 2003. Toxicological Review of Xylenes. EPA 635/R-03/001. January 2003.

ATTACHMENT CI-4
Risk Calculation Spreadsheets

Table CI-1
Inhalation of Groundwater Vapors during Construction Activities
Current/Future

Exposure Medium: Groundwater **Noncancer Hazard = CS x SIFnc / RfD**
Exposure Point: Construction site groundwater **Cancer Risk = CS x SIFc x CSF**
Receptor Population: Construction Workers
Receptor Age: Adults

Parameter	Units	RME Value
Chemical Concentration in Tap Water (CW)	ug/L	chem-specific
Inhalation Rate of Air (Inh)	m ³ /day	20
Exposure Frequency (EF)	days/year	190
Exposure Duration (ED)	years	1
Volatilization Factor for water (VFw)	L/m ³	0.01
Conversion Factor (CF)	mg/ug	1.0E-03
Body Weight (BW)	kg	70
Averaging Time (noncancer) (ATnc)	days	365
Averaging Time (cancer) (ATc)	days	25550
SIFnc = ((Inh* VFw* EF* ED* CF) / (BW* ATnc))	L-mg/ug-kg-d	1.49E-06
SIFc = ((Inh*VFw*EF*ED*CF)/(BW*ATc))	L-mg/ug-kg-d	2.12E-08

Chemical	RfD-I (mg/kg-d)	CSF-I (mg/kg-d) ⁻¹
2-Methylnaphthalene	--	--
Acetone	--	--
Benzene	9.0E-03	2.9E-02
Ethylbenzene	2.9E-01	3.9E-03
Naphthalene	4.3E-03	--
Xylenes	9.0E-02	--
C9-C24 aliphatics	2.9E-01	--
C9-C24 aromatics	6.0E-02	--
C6-C8 aliphatics	5.3E+00	--
C6-C8 aromatics	1.1E-01	--

Construction Site Groundwater	Reasonable Maximum Exposure				
	CW ug/L	Intake nc (mg/kg-d)	Intake c (mg/kg-d)	Hazard Quotient	Cancer Risk
2-Methylnaphthalene	33.8	5.03E-05	7.18E-07	--	--
Acetone	320	4.76E-04	6.80E-06	--	--
Benzene	14.3	2.13E-05	3.04E-07	0.002	8.8E-09
Ethylbenzene	12.7	1.89E-05	2.70E-07	0.000065	1.0E-09
Naphthalene	44.6	6.63E-05	9.48E-07	0.015	--
Xylenes	55.9	8.31E-05	1.19E-06	0.0009	--
C9-C24 aliphatics	(a)	--	--	--	--
C9-C24 aromatics	(a)	--	--	--	--
C6-C8 aliphatics	15312	2.28E-02	3.25E-04	0.0043	--
C6-C8 aromatics	10937	1.63E-02	2.32E-04	0.15	--
Non TPH Compounds Total				0.02	9.8E-09
TPH Compounds Total				0.15	0.0E+00

(a) - This chemical is not considered volatile. The inhalation pathway is only complete for volatile chemicals.

Summary of inhalation and dermal hazards and risks:

Non TPH Compounds Total	0.03	4.3E-08
TPH Compounds Total	0.15	0.0E+00

Table CI-2
Dermal Contact with Groundwater during Construction Activities
Future

Exposure Medium: Groundwater **Noncancer Hazard = CW x SIFnc x PC / RfD**
Exposure Point: Groundwater **Cancer Risk = CW x SIFc x PC x CSF**
Receptor Population: Construction Worker
Receptor Age: Adults

Parameter	Units	RME Value
Chemical Concentration in Water (CW)	ug/L	chem-specific
Exposure Time (ET)	hours/event	8
Exposure Frequency (EF)	events/year	190
Exposure Duration (ED)	years	1
Surface Area Available for Contact (SA) (PC)	cm ²	3,300
Conversion Factor 1 (CF1)	L/cm ³	1.0E-03
Conversion Factor 2 (CF2)	mg/ug	1.0E-03
Dermal Absorption (Absd)	unitless	chem-specific
Body Weight (BW)	kg	70
Averaging Time (noncancer) (ATnc)	days	365
Averaging Time (cancer) (ATc)	days	25,550
SIFnc = ((EF*ED*SA*ET*CF1*CF2)/(BW*ATnc))	hr-L-mg/cm-ug-kg-d	1.96E-04
SIFc = ((EF*ED*SA*ET*CF1*CF2)/(BW*ATc))	hr-L-mg/cm-ug-kg-d	2.80E-06

Chemical	RfD-D (mg/kg-d)	CSF-D (mg/kg-d) ⁻¹	PC
2-Methylnaphthalene	0.009	--	--
Acetone	1.0E-01	--	--
Benzene	4.0E-03	5.5E-02	1.5E-02
Ethylbenzene	1.0E+00	--	4.9E-02
Naphthalene	2.0E-01	--	4.7E-02
Xylenes	2.5E-01	--	5.3E-02
C9-C24 aliphatics	1.0E-01	--	--
C9-C24 aromatics	4.0E-02	--	--
C6-C8 aliphatics	5.0E+00	--	--
C6-C8 aromatics	2.0E-01	--	--

Construction Site Groundwater	Reasonable Maximum Exposure				
	CW (ug/L)	Intake nc (mg/kg-d)	Intake c (mg/kg-d)	Hazard Quotient	Cancer Risk
2-Methylnaphthalene	33.8	--	--	--	--
Acetone	320	--	--	--	--
Benzene	14.3	4.21E-05	6.02E-07	0.011	3.3E-08
Ethylbenzene	13	1.22E-04	1.75E-06	0.0001	--
Naphthalene	44.6	4.12E-04	5.88E-06	0.002	--
Xylenes	55.9	5.82E-04	8.31E-06	0.00233	--
C9-C24 aliphatics	25012	--	--	--	--
C9-C24 aromatics	12506	--	--	--	--
C6-C8 aliphatics	15312	--	--	--	--
C6-C8 aromatics	10937	--	--	--	--
Non TPH Compounds Total				0.02	3.3E-08
TPH Compounds Total				0.00	0.0E+00

Table CI-3
Incidental Ingestion of Construction Site Soil
Current/Future

Exposure Medium: Soil **Noncancer Hazard = CS x SIFnc x ABSo / RfD**
Receptor Population: Construction Worker **Cancer Risk = CS x SIFc x ABSo x CSF**
Receptor Age: Adults
Exposure Point: Construction Site Soil

Parameter	Units	RME Value
Chemical Concentration in Soil (CS)	mg/kg	chem-specific
Ingestion Rate of Soil (IR-S)	mg/day	330
Exposure Frequency (EF)	days/year	190
Exposure Duration (ED)	years	1
Conversion Factor (CF)	kg/mg	1.0E-06
Body Weight (BW)	kg	70
Averaging Time (noncancer) (ATnc)	days	365
Averaging Time (cancer) (ATc)	days	25,550
SIFnc = ((IR-S*EF*ED*CF)/(BW*ATnc))		2.45E-06
SIFc = ((IR-S*EF*ED*CF)/(BW*ATc))		3.51E-08

Chemical	RfD-O (mg/kg-d)	CSF-O (mg/kg-d) ⁻¹	ABSo unitless
2-Methylnaphthalene	0.009	--	1
Naphthalene	2.0E-01	--	1
C9-C24 aliphatics	1.0E-01	--	1
C9-C24 aromatics	4.0E-02	--	1
C6-C8 aliphatics	5.0E+00	--	1
C6-C8 aromatics	2.0E-01	--	1

Construction Soil	Reasonable Maximum Exposure				
	CS (mg/kg)	Intake nc (mg/kg-d)	Intake c (mg/kg-d)	Hazard Quotient	Cancer Risk
2-Methylnaphthalene	61	1.50E-04	2.14E-06	0.0166	--
Naphthalene	14	3.44E-05	4.91E-07	0.0002	--
C9-C24 aliphatics	7424	1.82E-02	2.60E-04	0.18	--
C9-C24 aromatics	3712	9.11E-03	1.30E-04	0.23	--
C6-C8 aliphatics	238	5.84E-04	8.34E-06	0.00012	--
C6-C8 aromatics	170	4.17E-04	5.96E-06	0.0021	--
Non TPH Compounds Total				0.02	0.0E+00
TPH Compounds Total				0.41	0.0E+00

Summary of ingestion, dermal, and inhalation hazards and risks:

Non TPH Compounds Total	0.06	0.0E+00
TPH Compounds Total	0.74	0.0E+00

Table CI-4
Dermal Contact with Construction Site Soil
Current/Future

Exposure Medium: Soil **Noncancer Hazard = CS x SIFnc x Absd/ RfD**
Receptor Population: Construction Worker **Cancer Risk = CS x SIFc x Absd x CSF**
Receptor Age: Adults
Exposure Point: Construction Site Soil

Parameter	Units	RME Value
Chemical Concentration in Soil (CS)	mg/kg	chem-specific
Adherence Factor (AF)	mg/cm ² -event	0.3
Exposure Frequency (EF)	events/year	190
Exposure Duration (ED)	years	1
Surface Area Available for Contact (SA)	cm ²	3,300
Conversion Factor (CF)	kg/mg	1.0E-06
Dermal Absorption (AbsD)	unitless	chem-specific
Body Weight (BW)	kg	70
Averaging Time (noncancer) (ATnc)	days	365
Averaging Time (cancer) (ATc)	days	25,550
SIFnc = ((EF*ED*SA*AF*CF)/(BW*ATnc))		7.36E-06
SIFc = ((EF*ED*SA*AF*CF)/(BW*ATc))		1.05E-07

Chemical	RfD-D (mg/kg-d)	CSF-D (mg/kg-d) ⁻¹	AbsD
2-Methylnaphthalene	0.009	--	--
Naphthalene	2.0E-01	--	--
C9-C24 aliphatics	1.0E-01	--	1.0E-01
C9-C24 aromatics	4.0E-02	--	1.0E-01
C6-C8 aliphatics	5.0E+00	--	--
C6-C8 aromatics	2.0E-01	--	--

Construction Site Soil	Reasonable Maximum Exposure				
	CS (mg/kg)	Intake nc (mg/kg-d)	Intake c (mg/kg-d)	Hazard Quotient	Cancer Risk
2-Methylnaphthalene	61	--	--	--	--
Naphthalene	14	--	--	--	--
C9-C24 aliphatics	7424	5.47E-03	7.81E-05	0.055	--
C9-C24 aromatics	3712	2.73E-03	3.90E-05	0.068	--
C6-C8 aliphatics	238	--	--	--	--
C6-C8 aromatics	170	--	--	--	--
Non TPH Compounds Total				0.00	0.0E+00
TPH Compounds Total				0.12	0.0E+00

Table CI-5
Inhalation of Fugitive Dust or Volatiles from soil
Current/Future

Exposure Medium: Soil **Noncancer Hazard = (CS x SIFnc) / (RfD x PEF(or VF))**
Receptor Population: Construction Site Workers **Cancer Risk = CS x SIFc x CSF / PEF(or VF)**
Receptor Age: Adults
Exposure Point: Soil

Parameter	Units	RME Value
Chemical Concentration in Soil (Csoil)	mg/kg	chem-specific
Inhalation Rate of Air (Inh)	m ³ /day	20
Exposure Frequency (EF)	days/year	190
Exposure Duration (ED)	years	1
Body Weight (BW)	kg	70
Averaging Time (noncancer) (ATnc)	days	365
Averaging Time (cancer) (ATc)	days	25,550
SIFnc = ((Inh*EF*ED)/(BW*ATnc))		1.49E-01
SIFc = ((Inh*EF*ED)/(BW*ATc))		2.12E-03

Chemical	RfD-I (mg/kg-d)	CSF-I (mg/kg-d) ⁻¹	PEF/VF m ³ /kg
2-Methylnaphthalene	--	--	2.5E+04
Naphthalene	4.3E-03	--	1.1E+04
C9-C24 aliphatics	2.9E-01	--	5.1E+08
C9-C24 aromatics	6.0E-02	--	5.1E+08
C6-C8 aliphatics	5.3E+00	--	4.1E+02
C6-C8 aromatics	1.1E-01	--	1.2E+03

Construction Site Soil	Reasonable Maximum Exposure				
	Csoil mg/kg	Intake nc (mg/kg-d)	Intake c (mg/kg-d)	Hazard Quotient	Cancer Risk
2-Methylnaphthalene	61	3.61E-04	5.15E-06	--	--
Naphthalene	14	1.89E-04	2.70E-06	0.04	--
C9-C24 aliphatics	7424	2.17E-06	3.10E-08	0.0000075	--
C9-C24 aromatics	3712	1.08E-06	1.55E-08	0.000018	--
C6-C8 aliphatics	238	8.59E-02	1.23E-03	0.016	--
C6-C8 aromatics	170	2.12E-02	3.04E-04	0.19	--
Non TPH Compounds Total				0.04	0.0E+00
TPH Compounds Total				0.21	0.0E+00

APPENDIX CII

Ecological Risk Assessment

CONTENTS

APPENDIX CII: ECOLOGICAL RISK ASSESSMENT

CII.1.0	INTRODUCTION	CII.1-1
CII.2.0	PROBLEM FORMULATION	CII.2-1
CII.2.1	Ecological Setting of the South Runway Area	CII.2-1
CII.2.2	Conclusion of the Preliminary (Screening Level) Problem Formulation.....	CII.2-5
CII.2.3	Target Ecological Receptors	CII.2-6
CII.2.4	Assessment Endpoints and Measures of Ecological Effects..	CII.2-7
CII.3.0	DATA EVALUATION	CII.3-1
CII.4.0	SELECTION OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN (COPECS).....	CII.4-1
CII.4.1	Soil COPECS.....	CII.4-2
CII.4.2	Surface Water COPECS	CII.4-3
CII.4.3	Sediment COPECS	CII.4-3
CII.4.4	Conclusion of the Screening Level Ecological Risk Assessment.....	CII.4-4
CII.5.0	ANALYSIS.....	CII.5-1
CII.5.1	Measures of Exposure (Exposure Assessment)	CII.5-1
CII.5.2	Measures of Effect (Toxicity Assessment)	CII.5-2
CII.5.2.1	Calculation of Aquatic Biota Risk-Based Screening Concentrations for Petroleum Alkanes, BTEX and PAH Compounds	CII.5-2
CII.5.2.2	Derivation of Ecological Risk-Based Screening Concentrations for the Protection of Wildlife from Petroleum Constituents in Soil.....	CII.5-8
CII.5.3	Soil RBSC Calculation	CII.5-14
CII.6.0	RISK CHARACTERIZATION	CII.6-1
CII.6.1	Aquatic Life Risks From Contaminated Surface Waters.....	CII.6-1
CII.6.2	Benthic Biota Risks from Contaminated Sediment	CII.6-2
CII.6.3	Conclusions of the Risk Characterization Phase	CII.6-3

CONTENTS (Continued)

CII.7.0 UNCERTAINTIES ASSOCIATED WITH THE ECOLOGICAL
RISK ASSESSMENT CII.7-1
CII.7.1 Components of Uncertainty CII.7-1
CII.7.2 General Sources of Uncertainty CII.7-2
CII.7.3 Specific Sources of Uncertainty..... CII.7-3
CII.7.4 Summary of Ecological Evaluation of the South of
Runway 18-36 Area CII.7-7

CII.8 LITERATURE CITED CII.8-1

ATTACHMENTS

- CII-1 Ecological Checklist
- CII-2 Data Used in Ecological Risk Assessment

FIGURES

CII.1-1 Ecological Conceptual Site Model South of Runway 18-36 Area CII.1-3

CONTENTS (Continued)

TABLES

CII.2-1	Assessment Endpoints and Measures of Effect for the Ecological Risk Assessment of the South of Runway 18-36 Area	CII.2-8
CII.4-1	Results of the Screening Level Ecological Risk Assessment to Identify COPECs in Soil at the South of Runway 18-36 Area.....	CII.4-5
CII.4-2	Results of the Screening Level Ecological Risk Assessment to Identify COPECs in Surface Water at the South of Runway 18-36 Area	CII.4-6
CII.4-3	Results of the Screening Level Ecological Risk Assessment to Identify COPECs in Sediment at the South of Runway 18-36 Area.....	CII.4-7
CII.5-1	Summary Statistics and Exposure Point Concentrations (EPC = 95% UCL) for COPECs at the South Runway Area to Which Ecological Receptors are Exposed.....	CII.5-16
CII.5-2	Tissue Residues of Alkanes, Cycloalkanes and BTEX Chemicals Associated with Adverse Effects in Aquatic Biota	CII.5-17
CII.5-3	Calculation of Ecological RBSC's for Petroleum Components in Water and Sediment Using a No Effect Tissue Residue Approach RBSC Development Methodology	CII.5-19
CII.5-4	AQUIRE Toxicity Data for Aliphatic Petroleum Constituents	CII.5-20
CII.5-5	Exposure Factors for the Norway Rat.....	CII.5-25
CII.5-6	Toxicity of Aliphatic Hydrocarbons to Mammals.....	CII.5-26
CII.5-7	Mammalian Oral Toxicity Data for Aromatic Hydrocarbons.....	CII.5-27
CII.5-8	Avian oral Toxicity Data for Aromatic Hydrocarbons.....	CII.5-30
CII.5-9	Ecological RBSCs for Protection of Wildlife Exposed to Petroleum Contaminants in Soil.....	CII.5-31
CII.6-1	Results of the Baseline Ecological Risk Assessment to Identify COCs in Surface Water at the South of Runway 18-36 Area.....	CII.6-5
CII.6-2	Results of the Baseline Ecological Risk Assessment to Identify COCs in Sediment at the South of Runway 18-36 Area.....	CII.6-6
CII.7-1	General Factors Associated With Uncertainty and Variability in the Ecological Risk Assessment	CII.7-10
CII.7-2	Comparison of RBSCs Used to Identify COPECs in Sediment at the South of Runway 18-36 Area	CII.7-12
CII.7-3	Calculation of Hazards Associated with Ingestion of Surface Water at the South of Runway 18-36 Area	CII.7-13

APPENDIX CII: ECOLOGICAL RISK ASSESSMENT

This appendix presents the findings of the ecological risk assessment of the South of Runway 18-36 Area (the South Runway Area), Adak Island, Alaska. The risk assessment described in this section is deliberately limited to the evaluation of risks associated with petroleum product releases. This limitation places bounds on the chemicals of potential ecological concern (COPECs) evaluated during the risk assessment, but has no effect on the risk assessment procedures used or guidance followed during this risk assessment.

The risk assessment procedures utilized follow current Alaska Department of Environmental Conservation (Alaska DEC) (ADEC 2000) and U.S. Environmental Protection Agency (EPA) (USEPA 1997a, 1997b) ecological risk assessment guidance. Very little ecological toxicity data (i.e., toxicity reference values) are available for petroleum mixtures such as total petroleum hydrocarbons (TPH), gasoline range organics (GRO), diesel range organics (DRO) or residual range organics (RRO). To develop toxicity reference values (TRVs) for petroleum mixtures in soil, surface water and sediment for this risk assessment, procedures previously developed (URS 1996a, 1996b, 1996c) to derive soil TRVs for wildlife and aquatic receptors, as part of the Remedial Investigations on Adak have been updated with more recent toxicological literature.

CII.1.0 INTRODUCTION

Under Alaska DEC (2000) risk assessment guidance, the first stage of an ecological risk assessment at a given site is to determine whether a detailed ecological risk assessment of that site is required. A detailed ecological risk assessment of a given site is required whenever the potential for an ecological threat from exposure to chemicals detected on site exists. In this risk assessment, the decision on whether to perform a detailed ecological risk assessment, or not, was made during the problem formulation stage of the risk assessment process. Before a decision can be made on the need for a detailed ecological risk assessment of a given site, a determination is made regarding the following:

1. The presence of sensitive environments, critical habitats, or sensitive species at a site; and
2. The presence of complete exposure pathways which result in the exposure of ecological receptors to site contaminants

If it is determined that no sensitive environments, critical habitats or sensitive species are present at a given site, and complete exposure pathways cannot be identified, Alaska DEC (2000) guidance permits the ecological risk assessment process for that site to be terminated. If sensitive environments are present, and/or if complete exposure pathways are identified, the detailed ecological risk assessment process must continue with an ecological effects evaluation of onsite chemicals. This initial decision as to whether or not a detailed ecological risk assessment is required is made at what Alaska DEC (2000) terms Ecological Scientific/Management Decision Point #1. Before this decision can be made, Alaska DEC requires the development of an ecological conceptual site model (CSM) to define exposure pathways, if any, of ecological receptors to site contaminants. Alaska DEC also requires completion of a series of ecological checklists, found in Appendix B of the Alaska DEC Risk Assessment Procedures Manual (2000). These ecological checklists are used to document the environmental setting of and potential ecological receptors at a site.

The CSM (Figure CII.1-1) and Alaska DEC (2000) ecological checklists (Attachment CII-1), along with descriptions of the ecological setting, ecological receptors, and fate and transport of contaminants in soil, groundwater, surface water and sediment at the South Runway Area, are presented in the problem formulation section of the ecological risk assessment.

CII.2.0 PROBLEM FORMULATION

This section describes the ecological setting of the South Runway Area, ecological receptors at the site, and the environmental fate and transport of site contaminants. These discussions culminate with the development of an ecological CSM (Figure CII.1-1), and completion of Alaska DEC (2000) ecological checklists (Attachment CII-1) that document the environmental setting of the South Runway Area. The problem formulation stage of the risk assessment concludes with Ecological Scientific/Management Decision Point #1: the decision as to whether or not a significant ecological threat may be posed to receptors by site contaminants. The outcome of the problem formulation stage of the ecological risk assessment is to either 1) proceed with the ecological effects evaluation portion of the risk assessment, or 2) to terminate the ecological risk assessment, depending on whether or not a potential ecological threat is identified.

CII.2.1 Ecological Setting of the South Runway Area

The South Runway Area consists of the lowland area surrounding and immediately south of the southern portion of runway 18-36 (Figure 2-1). The northern portion of the site (e.g., north of the Crossover Canal of the airport ditch system) extends from the East Canal of the airport ditch system on the east to South Sweeper Creek on the west. The southern portion of the site (i.e., south of the Crossover Canal of the airport ditch system) extends from the western boundary of the Naval Mobile Construction Battalion (NMCB) Building Area, T-1416 Expanded Area (another large petroleum release site) on the east to South Sweeper Creek on the west. The entire site extends from the southern portion of runway 18-36 in the north to Sweeper Cove and the inlet of South Sweeper Creek in the south.

The primary physical features on the site include: the southern portion of runway 18-36, Main Road, the northern end of Transit Road up to the Transit Road Bridge, and the southern portions of both the East and West Canals and the Crossover Canal of the airport ditch system. Because the site is within the low-fly zone established for the airfield, no buildings are located within the site boundaries.

The environmental setting of the South Runway Area has been summarized using the Alaska DEC (2000) ecological checklists. The ecological checklists for the site are contained in Attachment CII-1 of this document, and their contents described in more detail in the rest of this section. Adak Island is within the Aleutian Islands ecoregion of Alaska DEC (1999).

Topography at the South Runway Area is flat and low-lying, generally less than 15 feet above mean lower low water (MLLW). The site occupies an area of approximately 20 acres that include disturbed commercial-industrial areas and undisturbed grass-covered areas.

The disturbed area north of Main Road is paved with asphalt, cement, or compacted gravel. Limited areas of ruderal vegetation (i.e., native tundra meadow, hydroseeded grasses) are present. This area does not provide good habitat for wildlife because of the lack of suitable vegetation and the high level of disturbance and air traffic.

The shoreline of Sweeper Cove is also disturbed, being covered with large boulders (i.e., riprap) placed there to protect the shoreline from erosion. The rocky nature of the shoreline does not encourage growth of typical beach vegetation. However, gulls, upland birds (i.e., snow bunting), and marine invertebrates have been noted along the shoreline. Gulls, seabirds, harbor seals, sea otters, fish, and invertebrates use the nearshore marine habitat and nearby ledges (USFWS 1995).

The northern portion of the site containing the East, West, and Crossover Canals (man-made diversionary structures) is also disturbed. However, the aboveground sections of the canals are lined with grasses and other soft-stemmed plants. Wildlife in the canals includes waterfowl (i.e., mallard duck, green-winged teal) and sparse populations of aquatic invertebrates (USFWS 1995). The canals are also believed to be sparsely populated by aquatic invertebrates. Because the canals are physically isolated from South Sweeper Creek by pump turbines and tide gates, they are not believed to provide habitat for fish (BEESC 2001a). Because the engineered drainage canals of the airport ditch system are isolated from South Sweeper Creek, they are not considered state-regulated waterways and are therefore not considered habitat for this risk assessment.

The relatively undisturbed area of the site between the Main Road and Sweeper Cove is dominated by grasses and other soft-stemmed plants that provide high-quality habitat for wildlife. Terrestrial invertebrates and songbirds, such as the Lapland longspur and snow bunting, are present in the area. Of the introduced mammal species on Adak, the Norway rat is likely to forage on or around the site (USFWS 1995). Caribou are not found within the South Runway Area.

As previously stated, South Sweeper Creek forms the western boundary of the South Runway Area and empties into Sweeper Cove at the southwestern boundary of the site. The banks of the Creek are undisturbed areas that provide high-quality habitat for a variety of water-tolerant plants, aquatic invertebrates, several species of fish (i.e., pink and Coho salmon, Dolly Varden trout, three-spine stickleback, sculpin), and waterfowl (USFWS 1995).

None of the listed threatened or endangered species on Adak (e.g., Aleutian shield fern, Aleutian Canada goose, Steller's sea lion) are found within or in close proximity to the South Runway Area. However, Sweeper Creek is a migratory pathway and feeding area for anadromous runs of Dolly Varden. In addition, the estuarine portion of South Sweeper Creek and the nearshore areas

of Sweeper Cove provide high-quality habitat for intertidal invertebrates (i.e., blue mussel). Therefore, Sweeper Creek and the coastal areas of Sweeper Cove are considered Alaska State-Sensitive Environments under Alaska DEC (2000) risk assessment guidelines.

CII.2.1.1 Soil Environment

As noted earlier, much of the South Runway Area is dominated by grasses and other vegetation that provide high-quality habitat. Potential ecological receptors onsite would include birds, mammals, invertebrates, and plants.

There are no standard definitions of the depth of soil to which ecological receptors are exposed. This absence of a standard definition of surface soil in ecological risk assessment requires a site specific definition of surface soil to be made prior to sorting available site data for use in exposure point calculation. Amundsen (1985) observed root and rhizome depths of tundra grasses on Amchitka Island to not exceed 5 feet below ground surface (bgs). It is conceivable that soil invertebrates and wildlife burrowing underneath the South Runway Area from open areas could potentially come into contact with contaminants in the soil near the bottom of a 0 – 5 feet bgs biologically active zone. The burrowing depth of the only terrestrial mammal likely found at the site, the Norway rat, is 12 – 36 inches (Zeiner et al. 1990). Earthworms are rare to nonexistent at Adak sites covered with gravel (URS 1996d), and their burrowing depth in soil on Adak is unknown.

Ecology (2001) defines soil from 0 to 6 feet bgs as the biologically active zone. This definition is based on the assumption that 6 feet bgs is: the soil depth below which soil invertebrates are unlikely to occur, the maximum burrowing depth of animals, and the maximum depth to which plant roots occur. For the purposes of this risk assessment, Ecology's definition of the biologically active zone in soil was selected as a conservative working definition of the soil environment within which ecological receptors might reasonably be present.

Site-specific data has confirmed that contaminants exist within the biologically active zone of onsite soils. As there are no structural or other limitations that physically inhibit ecological receptors from entering the South Runway Area, wildlife species may come into contact with contaminated soils onsite. The CSM for the site (Figure CII.1-1) describes where wildlife receptors can contact soil as a potentially complete exposure pathway to site contaminants.

CII.2.1.2 Groundwater

Groundwater is present beneath the South Runway Area at depths between 5 to 10 feet bgs. Groundwater in the area is complex and controlled to a large extent by the water level in the East

and West Canals. In general, groundwater flow is toward the nearest surface water body: East Canal, West Canal, South Sweeper Creek, or Sweeper Cove.

Wildlife that dwell above the ground surface are not likely to come into direct contact with groundwater at the South Runway Area due to the depth of the water table and extensive paving of the site. Groundwater beneath the site may be present near/at the bottom of the biologically active zone in soil (e.g., 0 to 6 feet below ground surface as defined in Ecology [2001]). Therefore, plant roots, soil invertebrates, and burrowing wildlife could potentially come into direct contact with groundwater at the site. However, the frequency and duration of direct exposure of onsite ecological receptors to contaminants in groundwater is expected to be minor or insignificant. Minor or insignificant exposure routes are not quantitatively evaluated in the risk assessment for the site.

CII.2.1.3 Surface Water

South Sweeper Creek and the coastal areas of Sweeper Cove are known to provide high quality habitat for several plant, invertebrate, bird, fish, and mammal species. In addition, both are considered State-Sensitive Environments in accordance with Alaska DEC (2000). Site-specific data has confirmed that detectable concentrations of contaminants exist in South Sweeper Creek. Therefore, ecological receptors may come into contact with contaminated surface water in South Sweeper Creek and/or the coastal areas of Sweeper Cove. The CSM for the site (Figure CII.1-1) documents the scenarios where aquatic receptors can be exposed to site contaminants via contact with fresh (i.e., South Sweeper Creek) and marine (i.e., Sweeper Cove) surface water as potentially complete exposure pathways.

It is also possible that terrestrial wildlife could come into contact with site contaminants that may be present in South Sweeper Creek and the coastal areas of Sweeper Cove. However, these exposure pathways are considered minor or insignificant due to the minimal frequency and duration of exposure that terrestrial receptors might have to potentially contaminated surface water on site. In the CSM for the site (Figure CII.1-1), pathways for exposure of terrestrial ecological receptors to site contaminants in surface water are shown as potentially complete, but are considered minor or insignificant. Minor or insignificant exposure routes are not quantitatively evaluated in the risk assessment for the site.

CII.2.1.4 Sediment

For sediment, the biologically active zone was defined as the 0-10 centimeter (cm) stratum below the sediment-water interface. This selection is based on the results of several investigations (Thoms et al. 1995, Boudreau 1994, McCall and Tevesz 1982), all of whom observed that the bioturbation zone of either freshwater or marine sediments (Thoms et al. 1995

evaluated both types of sediment) is within the top 10 cm of sediment 80% or more of the time it has been measured.

As previously stated, South Sweeper Creek and the coastal areas of Sweeper Cove are known to provide high-quality habitat for several plant, invertebrate, bird, fish, and mammal species. Site-specific data has confirmed that detectable concentrations of contaminants exist within the biologically active zone of South Sweeper Creek sediments. Therefore, ecological receptors may come into contact with contaminants in sediments in South Sweeper Creek and the coastal areas of Sweeper Cove. The CSM for the site (Figure CII.1-1), indicates the scenarios where aquatic receptors can be exposed to site contaminants via contact with freshwater (i.e., South Sweeper Creek) and estuarine (i.e., the interface between South Sweeper Creek and the nearshore marine areas of Sweeper Cove) sediments as potentially complete exposure pathways.

It is also possible that terrestrial wildlife could come into contact with site contaminants that may be present in sediments in South Sweeper Creek and the coastal areas of Sweeper Cove. However, these exposure pathways are considered minor or insignificant due to the minimal frequency and duration of exposure that terrestrial receptors might have to potentially contaminated surface water onsite. In the CSM for the site (Figure CII.1-1), pathways for exposure of terrestrial ecological receptors to site contaminants in surface water sediments are shown as potentially complete, but are considered minor or insignificant. Minor or insignificant exposure routes are not quantitatively evaluated in the risk assessment for the site.

CII.2.2 Conclusion of the Preliminary (Screening Level) Problem Formulation

Once the CSM and Alaska DEC (2000) ecological checklists have been completed, Alaska DEC (2000) guidance permits a determination of whether or not a significant ecological threat associated with exposure to onsite contaminants exists at a site. Termed Ecological Scientific/Management Decision Point #1 by Alaska DEC, the decision as to whether or not to proceed with the ecological effects evaluation portion of the risk assessment is dependent on the answer to the questions listed below.

South Sweeper Creek and the coastal areas of Sweeper Cove were identified as State-Sensitive Environments within the South Runway Area because they provide migratory pathway and feeding areas for anadromous runs of Dolly Varden and high-quality habitat for shellfish. In addition, several complete exposure pathways have been identified for the site. As shown in the CSM for the South Runway Area (Figure CII.1-1), complete exposure pathways have been identified for terrestrial ecological receptors exposed to contaminants in surface soil and aquatic receptors exposed to site contaminants in fresh and marine surface water and sediments. Both of

<i>Ecological Scientific/Management Decision Point #1^a</i>
<p>– Are sensitive environments identified? Yes? Proceed with ecological risk assessment Go to effects evaluation No? End ecological risk assessment unless the following question is answered yes ANSWER FOR THE SOUTH RUNWAY AREA: YES</p>
<p>– Are completed exposure pathways identified? Yes? Proceed with ecological risk assessment Go to effects evaluation ANSWER FOR THE SOUTH RUNWAY AREA: YES</p>

Note:

- a) The numbers used to describe Ecological Scientific/Management Decision Points (SMDP) in this text are those given in Alaska DEC (2000), which results in the appearance that some SMDPs were omitted in this text. All SMDPs appropriate to this site were evaluated, but not all SMDPs in Alaska DEC (2000) were needed for the South Runway Area.

these scenarios warrant quantitative risk assessment. Other minor or insignificant exposure pathways are also present, none of which result in any ecologically significant exposure to contaminants onsite, and none of which require quantitative evaluation.

Based on the assessment of the ecological characteristics of the site and potential exposure scenarios, a potential ecological threat exists to ecological receptors from petroleum release products at the South Runway Area. An ecological effects evaluation that quantitatively describes the potential ecological risk associated with exposure to site contaminants is presented in the following sections.

CII.2.3 Target Ecological Receptors

Ecological risk assessments do not normally evaluate risks to all species present at a site. The large number of species present at most sites makes this impractical. Instead, one or more target ecological receptors are selected as representative species, and risks to the target receptors are evaluated. Representative species can be defined in one or more contexts, including species which are sensitive to the adverse effects of contaminants, representatives of larger species assemblages, functional groups or trophic levels, or species which can be easily sampled at a site.

For terrestrial wildlife, two target ecological receptors, the Norway rat (*Rattus norvegicus*) and the Lapland longspur (*Calcarius lapponicus*) have been selected as target ecological receptors

for exposure to soil contaminants. Norway rat is one of only two upland mammal species on Adak (the other being caribou), and is the only one likely to be present at the South Runway Area. Lapland longspur is a common summer nesting bird throughout Adak. It feeds on a mixture of seeds and other plant material in upland areas, and is somewhat more insectivorous in wetland areas. In previous ecological risk evaluations using the Lapland longspur on Adak (URS 1997), it was assumed that 2% of its diet consisted of incidentally ingested soil.

For aquatic species, the Dolly Varden (*Salvelinus malma*), a fish in the same genus as the brook trout (*S. fontinalis*), which is widely used in aquatic toxicology testing, has been selected as a target ecological receptor for exposure to surface water contaminants. Dolly Varden are common on Adak, and exist as both landlocked freshwater populations, and as anadromous populations. Benthic macroinvertebrates as a group are also selected as a target ecological receptor, which are exposed to sediment contaminants.

CII.2.4 Assessment Endpoints and Measures of Ecological Effects

Assessment endpoints are explicit expressions of environmental values to be protected (USEPA 1998). With relatively few exceptions, assessment endpoints cannot be directly quantified in the field. Instead, one or more measures of ecological effect are evaluated for each target receptor. A measure of ecological effect is defined as a measurable ecological characteristic that is related to the valued characteristics selected as assessment endpoints (Suter et al. 2000). Ecological effect measures in this ecological risk assessment are measurable environmental concentrations of COPECs that can be related to the environmental values which are to be protected. Discussed in more detail in Section CII.5 (Analysis) of this document, ecological effect measures describe the effects elicited by a COPEC, links them to the assessment endpoints, and evaluates how they change with changes in COPEC concentrations in the environment. The relationships between measures of effect and the assessment endpoints in this ecological risk assessment have been derived in laboratory toxicity tests, and are described in more detail in Section CII.5. The assessment endpoints, measures of ecological effect and the linkage between the measures of effect and the assessment endpoints are presented in Table CII.2-1.

**Table CII.2-1
 Assessment Endpoints and Measures of Effect for the Ecological Risk Assessment
 of the South of Runway 18-36 Area**

Assessment Endpoint	Measure of Effect	Linkage Between Measure of Effect and Assessment Endpoint
Survival, reproduction, and growth of fish	Comparison of measured COPEC concentrations in surface water to protective water quality guidelines ^a	Water quality guidelines represent COPEC concentrations in surface water which adversely affect 5% or fewer of aquatic genera under chronic exposure conditions, or result in less than a 20% reduction in recruit abundance
Survival, reproduction, and growth of benthic macroinvertebrates	Comparison of measured COPEC concentrations in sediment to sediment quality guidelines protective of benthic biota	Sediment quality guidelines represent COPEC concentrations in surficial sediments which have no or minimal adverse effects on benthic species under chronic exposure conditions
Survival, reproduction, and health of avian and mammalian wildlife	Comparison of measured COPEC concentrations in surface soil to soil RBSCs derived from ingested dose (dietary) benchmarks for wildlife	Benchmarks represent no observed adverse effect levels (NOAEL's) for COPEC's in the diet of wildlife where the combined concentration in surface soil and that bioaccumulated in prey species has no effect on wildlife receptors

^a Depending on the fish species, sediment contamination may present a complete exposure route. However, fish are mobile and unlikely to remain in a given area (e.g., the Dolly Varden selected as the indicator species is anadromous). Therefore, the potential impacts from sediment contamination were assessed using benthic macroinvertebrates and are likely to be protective of fish.

CII.3.0 DATA EVALUATION

All available site-specific analytical data for groundwater, soil, marine and fresh surface water, and marine and freshwater sediment samples collected at the South Runway Area were compiled and evaluated. The raw data set is included in Attachment CII-2 of this report. The data set was reduced by the following strategy, which reduced the available data set for the South Runway Area considerably:

- Groundwater samples were excluded because no exposure of ecological receptors to onsite groundwater was established during Problem Formulation;
- Soil samples begun greater than 6 feet below ground surface were excluded because they are below the biologically active zone in soil, which precludes exposure of ecological receptors;
- Sediment samples begun greater than 10 cm below the water-sediment interface were excluded because they are below the biologically active zone in sediment, which precludes exposure of ecological receptors;
- At locations where duplicate samples were taken (during the same sampling event for quality control purposes), the lower sample result was excluded;
- At locations sampled on different dates, only the most recent sample data were retained (see Section CII.7.3.5);
- Any samples collected and analyzed prior to January 1, 1997 were excluded.

Note that in 1996, two sediment samples collected from South Sweeper Creek adjacent to the South Runway Area were analyzed for PCBs. However, the presence of PCBs in sediment in the area of South Sweeper Creek adjacent to South Runway is likely not associated with South of Runway 18-36 Area, because there is no historical indication that PCBs were ever used or disposed of at the site. Therefore, soils were not tested for PCBs at this site. The presence of PCBs in sediment from South Sweeper Creek was addressed through a large sediment removal action under CERCLA, and a final remedy is in place for PCBs in South Sweeper Creek as specified in the Record of Decision (ROD) for Operable Unit A (OU A) (U.S. Navy, USEPA, and Alaska DEC 2000). Thus, the presence of PCBs in sediments will not be evaluated in the ecological evaluation.

The detailed justification for this data evaluation and screening procedure, and references to support this approach are presented later in this section.

Summary statistics were prepared for the remaining data set, including:

- Maximum detected concentration (MDC) for each contaminant in each medium;
- Minimum detected concentration for each contaminant in each medium;
- Number of detects for each contaminant in each medium;
- Mean detected concentration for each contaminant in each medium; and
- 95% Upper Confidence Limit on the mean (95%UCL) for each contaminant in each medium.

Each of the MDCs were used in the preliminary risk screen; 95%UCLs were used in the baseline risk characterization if a sufficient number of samples were available to permit the calculation of a 95%UCL, and if the 95%UCL was smaller than the MDC.

All available site-specific analytical data for groundwater, soil, marine and fresh surface water, and marine and freshwater sediment samples collected at the South Runway Area since January 1, 1997, were compiled and evaluated. Surface soil, surface water and sediment data collected from the South Runway Area prior to this date were evaluated for their ecological risk potential in another document (URS 1996e), and are not re-evaluated in this report.

All remaining surface water data of suitable quality were retained for analysis in the ecological risk assessment. Soil and sediment data were further evaluated to determine if the data represented contaminants to which ecological receptors could be exposed. This was done by defining a biologically active zone for both surface soil and sediment. For soil, all data from the data set collected deeper than 6 feet bgs was eliminated. This was based on the rationale presented in Section CII.2.1.1 for plants, soil invertebrates, and burrowing or foraging animals to have a reasonable chance of coming into contact with subsurface soil contaminants. For sediment, the biologically active zone was defined as the 0-10 cm stratum below the sediment-water interface, based on the rationale given in Section CII.2.1.4.

The data set was further reduced by excluding samples where the reported contaminant concentration was below the lower limit of detection. Although non-detected analytes whose

detection limits are higher than risk-based screening concentrations have a potential to pose ecological risk, this potential, if any, cannot be quantified.

Several of the sediment and soil analytical results were reported as the sum of various combinations of PAH and/or BTEX compounds. The PAH summed results were low molecular weight PAHs (LPAH), high molecular weight PAHs (HPAH), and non-carcinogenic PAHs (NCPAH). In this ecological risk assessment, risks are assessed by evaluation of each individual detected PAH compound, not by evaluating the sum of the concentration of various groupings of several individual PAH compounds. Therefore, LPAH, HPAH and NCPAH analytical results were not evaluated and were excluded from the data set. In the same manner, individual BTEX compounds are evaluated for their potential ecological risks; the sum of the concentration of all BTEX compounds is not evaluated. Therefore, total BTEX analytical results were not evaluated and were excluded from the data set.

Following data evaluation, summary statistics for the remaining data were calculated. These statistics include the arithmetic mean, minimum, and maximum concentrations, and the 95% upper confidence limit (95%UCL) of the mean concentration. The summary statistics are presented in tables in Section CII.4 during the selection of chemicals of potential ecological concern.

CII.4.0 SELECTION OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN (COPECS)

This section presents the results of a screening level ecological risk assessment of surface soils, sediment and surface water at or in the vicinity of the South Runway Area. The purpose of this section is to identify the combinations of complete exposure pathways to ecological receptors and site chemical concentrations that potentially pose unacceptable ecological risks to receptors. Chemicals identified as having a potential to pose unacceptable ecological risks to one or more receptors will be termed chemicals of potential ecological concern (COPECS). Potential ecological risks from identified COPECS will be evaluated in more detail in the baseline ecological risk characterization section of this document.

Chemicals which are not identified as having a potential to pose unacceptable ecological risks to target receptors in this screening level ecological risk assessment will not be identified as COPECS. Chemicals not believed to have the potential to pose significant ecological risks will not be evaluated further during the baseline ecological risk characterization.

Identification of a chemical as a COPEC does not necessarily mean that the chemical poses unacceptable risks to ecological receptors. Identification of a chemical as a COPEC does mean, however, that the potential for unacceptable ecological risk under the assumed exposure conditions of this screening level ecological risk assessment cannot be discounted. In addition to chemicals which are identified as COPECS, chemicals for which risk-based screening concentrations (RBSCs) cannot be identified will be presented as having an unknown potential to pose ecological risk. Chemicals with an unknown potential for risk will be retained as COPECS for discussion in the baseline ecological risk characterization phase of the assessment.

This screening level ecological risk assessment utilizes the hazard quotient approach to identify COPECS, as shown in Equation 1.

Equation 1:

$$HQ = \frac{MDC}{RBSC}$$

Where: HQ = hazard quotient

MDC = maximum detected chemical concentration in an environmental medium

RBSC = risk-based screening concentration

Chemicals with hazard quotients greater than or equal to 1.0 will be retained as COPECs. Chemicals with hazard quotients less than 1.0 will be considered to have an insufficient potential to pose ecological risks to warrant further evaluation. The sources and derivation of the RBSCs used in this screening level ecological risk assessment are presented in Section CII.5.2 and CII.5.3 of this report.

Detailed derivations of the RBSCs used in this ecological risk assessment are presented in Section CII.5.2. The sources and derivation of the sediment and surface water RBSCs used in the hazard quotient calculations are presented in Section CII.5.2.1. RBSCs for GRO, DRO and RRO were derived using a tissue residue approach described in detail in Section CII.5.2.1. Sediment RBSCs for other chemicals were compiled from Washington sediment management standards (Ecology 1995) or USEPA (1999a, 1993) equilibrium partitioning approaches to sediment quality criteria development, using USEPA (2002, 1991) water quality criteria or State of Alaska water quality standards as input to the calculations. Surface water and sediment RBSCs for BTEX chemicals and PAH compounds were derived following procedures presented in the preliminary source evaluation (PSE-2) guidance for evaluating sites at NAF Adak (URS 1996a). See the discussion in the uncertainty section, Section CII.7.3.1 for how other types of sediment RBSCs might impact COPEC selection. PAH water quality RBSCs were the input values of USEPA (1999a, Table 3-4 of the source document) into their current sediment criteria development methodology using equilibrium partitioning (USEPA 1999a). The PSE-2 guidelines were derived from Alaska water quality standards, USEPA ambient water quality criteria, Washington sediment management standards, and USEPA (1999a, 1993) equilibrium partitioning approaches to deriving sediment quality criteria.

Soil RBSC sources and derivation are presented in detail in Section CII.5.2.2 and summarized in Table CII.5-9. The soil RBSCs were derived from mammalian ingested dose data compiled from a number of sources, which were then used as input into a soil RBSC derivation methodology presented in Ecology (2001). The RBSCs derived in Sections CII.5.2.1 and CII.5.2.2 are used in both the screening level and baseline ecological risk assessment.

To maximize the likelihood that all detected chemicals with a potential to pose unacceptable ecological risks are retained for more detailed evaluation, the maximum detected concentration for each analyte was compared to the RBSC during the screening level risk assessment. The results of the screening level ecological risk assessment to identify COPECs are presented in Table CII.4-1 for soil, Table CII.4-2 for surface water, and Table CII.4-3 for marine sediment.

CII.4.1 Soil COPECs

For soil, no chemical concentrations exceeded their associated RBSCs for any chemical with an RBSC (Table CII.4-1). Nor were there any detected chemicals in soil without RBSCs. Based on

these results, no chemicals associated with UST sites at the South Runway Area pose significant ecological risks to receptors. Risks to receptors from exposure to soil at the South Runway Area will not be further evaluated in this risk assessment.

CII.4.2 Surface Water COPECs

Two chemicals detected at least once in surface water samples at the South Runway Area had maximum detected concentrations which exceeded their respective RBSCs (Table CII.4-2). These two chemicals will be passed forward for further evaluation in the baseline ecological risk assessment:

- Indeno(1,2,3-cd)pyrene (hazard quotient = 1.1)
- GRO (hazard quotient = 5.7)

Both of the maximum detected values for the COPECs listed above were in the same sample (02-851; see Figure 3-5), collected August 5, 1998. This would seem to indicate a release of some sort at or near this sample location that produced analytical results which may not be representative of surface water in general.

A hazard quotient could not be calculated for one other chemical detected in on-site surface water, the DRO fraction of TPH. Although DRO has an RBSC, it was detected in surface water at the South Runway Area at concentration that exceeds its maximum water solubility. Because a hazard quotient could not be calculated for DRO, it will, therefore, be passed forward for further evaluation in the baseline ecological risk assessment.

CII.4.3 Sediment COPECs

Four chemicals detected at least once in sediment samples at the South Runway Area had maximum detected concentrations that exceeded their respective RBSCs (Table CII.4-3). These four chemicals will be passed forward for further evaluation in the baseline ecological risk assessment:

- 2-Methylnaphthalene (hazard quotient = 6.4)
- Phenanthrene (hazard quotient = 6.2)
- DRO (hazard quotient = 13.2)
- GRO (hazard quotient = 2.3)

All detected sediment chemicals had RBSCs available. Therefore, no chemicals without RBSCs need to be passed through to the baseline ecological risk assessment.

CII.4.4 Conclusion of the Screening Level Ecological Risk Assessment

Once the screening level risk calculations have been completed, Alaska DEC (2000) guidance permits a determination of whether or not exposure to on-site contaminants might pose an unacceptable risk to ecological receptors (based on the comparison of the maximum detected concentrations of contaminants onsite to their respective risk-based screening criteria). Termed Ecological Scientific/Management Decision Point #2 by Alaska DEC, the decision as to whether or not to proceed with a quantitative ecological risk assessment is dependent on the answers to the questions listed below.

<i>Ecological Scientific/Management Decision Point #2</i>	
Are all chemical concentrations below ecological benchmarks?	
No?	Proceed with ecological risk assessment
Yes?	End ecological risk assessment unless the answer to the next question is yes
<i>ANSWER FOR THE SOUTH RUNWAY AREA: NO</i>	
Do COPECs have a tendency to bioaccumulate and/or biomagnify?	
Yes?	Proceed with ecological risk assessment
<i>ANSWER FOR THE SOUTH RUNWAY AREA: NO</i>	

The hazard quotients developed for contaminants at the South Runway Area show that the maximum detected concentrations for some surface water and sediment contaminants in South Sweeper Creek exceed conservative ecological RBSCs (i.e., some hazard quotients exceed 1.0). In addition, a hazard quotient could not be calculated for DRO in surface water, as the maximum detected concentration of DRO exceeds its maximum solubility in water. Therefore, the potential risks of DRO could not be quantified. Risks from chemicals without hazard quotients are considered an uncertainty in this risk assessment, and all such chemicals are considered to be COPECs. None of the petroleum-related contaminants detected onsite have the tendency to biomagnify.

Potential unacceptable risks exists to ecological receptors associated with petroleum release products in surface water and sediments of South Sweeper Creek in the vicinity of the South Runway Area. Therefore, a baseline ecological risk assessment is warranted for this site.

**Table CII.4-1
 Results of the Screening Level Ecological Risk Assessment to Identify COPECs in
 Soil at the South of Runway 18-36 Area**

Chemical	Maximum Detected Concentration (mg/kg)	RBSC (mg/kg)	Hazard Quotient	Poses Potential Ecological Risk?	Rationale
TPH - Diesel range organics	9,100	20,100	0.5	NO	Site chemical concentration lower than RBSC
TPH - Gasoline range organics	2.86	1840	0.002	NO	Site chemical concentration lower than RBSC

Notes:

COPEC - Contaminant of potential ecological concern

mg/kg - milligrams contaminant per kilogram of soil

RBSC - Risk-based screening concentration

TPH - Total petroleum hydrocarbons

**Table CII.4-2
 Results of the Screening Level Ecological Risk Assessment to Identify COPECs in
 Surface Water at the South of Runway 18-36 Area**

Chemical	Maximum Detected Concentration (µg/L)	RBSC (µg/L)	Hazard Quotient	Poses Potential Ecological Risk?	Rationale
2-Methylnaphthalene	1.5	72	0.02	NO	Site chemical concentration lower than RBSC
Benzo(a)anthracene	0.84	2.2	0.4	NO	Site chemical concentration lower than RBSC
Benzo(a)pyrene	0.34	0.96	0.4	NO	Site chemical concentration lower than RBSC
Benzo(b)fluoranthene	0.5	0.68	0.7	NO	Site chemical concentration lower than RBSC
Benzo(g,h,i)perylene	0.33	0.44	0.8	NO	Site chemical concentration lower than RBSC
Benzo(k)fluoranthene	0.27	0.64	0.4	NO	Site chemical concentration lower than RBSC
Chrysene	1.5	2	0.8	NO	Site chemical concentration lower than RBSC
Ethylbenzene	1.5	6400	0.0002	NO	Site chemical concentration lower than RBSC
Fluorene	3.5	39.3	0.09	NO	Site chemical concentration lower than RBSC
Indeno(1,2,3-cd)pyrene	0.32	0.28	1.1	YES	Site chemical concentration exceeds RBSC
Toluene	1.1	3500	0.0003	NO	Site chemical concentration lower than RBSC
TPH - Diesel range organics	79000	0.014	NC	UNKNOWN	RBSC cannot be used to quantify risks when concentration of diesel-range organics is in excess of maximum water solubility
TPH - Gasoline range organics	650	114	5.7	YES	Site chemical concentration exceeds RBSC
Xylenes	5.7	332	0.02	NO	Site chemical concentration lower than RBSC

Notes:

COPEC - Contaminant of potential ecological concern

NC - not calculated

µg/L - micrograms contaminant per liter of water

RBSC - Risk-based screening concentration

TPH - Total petroleum hydrocarbons

**Table CII.4-3
 Results of the Screening Level Ecological Risk Assessment to Identify COPECs in
 Sediment at the South of Runway 18-36 Area**

Chemical	Maximum Detected Concentration (mg/kg)	RBSC (mg/kg)	Hazard Quotient	Poses Potential Ecological Risk?	Rationale
2-Methylnaphthalene	0.13	0.0202	6.4	YES	Site chemical concentration exceeds RBSC
Ethylbenzene	0.03	14	0.002	NO	Site chemical concentration lower than RBSC
Fluoranthene	0.05	0.6	0.08	NO	Site chemical concentration greater than RBSC
Naphthalene	0.13	0.99	0.1	NO	Site chemical concentration greater than RBSC
Phenanthrene	1.4	0.225	6.2	YES	Site chemical concentration exceeds RBSC
Pyrene	0.03	0.35	0.09	NO	Site chemical concentration greater than RBSC
Toluene	0.07	4.6	0.01	NO	Site chemical concentration lower than RBSC
TPH - Diesel range organics	1200	90.6	13.2	YES	Site chemical concentration exceeds RBSC
TPH - Gasoline range organics	28	12.2	2.3	YES	Site chemical concentration exceeds RBSC
Xylenes	0.2	0.79	0.3	NO	Site chemical concentration lower than RBSC

Notes:

COPEC - Contaminant of potential ecological concern
 mg/kg - milligrams contaminant per kilogram of sediment
 RBSC - Risk-based screening concentration
 TPH - Total petroleum hydrocarbons

CII.5.0 ANALYSIS

The analysis phase of the ecological risk assessment process evaluates the two primary components of risk (exposure and effects), and their relationships to each other and ecological characteristics of a site. The products of the analysis phase are measures of exposure, which in this ecological risk assessment are measured contaminant concentrations used to quantify the exposure of ecological receptors to site contaminants, and measures of effect, which describe dose-response relationships, examine causality, and discuss the relationship between measures of effect and assessment endpoints.

CII.5.1 Measures of Exposure (Exposure Assessment)

The screening level ecological risk assessment in Section CII.4 eliminated all chemicals in soil as posing potential ecological risks (Table CII.4-1). Four chemicals detected in sediment samples exceeded their associated RBSCs, and were passed forward to the baseline risk assessment (Table CII.4-3). In surface water, three chemicals (two chemicals that exceeded their associated RBSCs, and one chemical with no screening level RBSC) were passed forward to this baseline risk assessment (Table CII.4-2).

To account for the spatial and temporal variation of chemical concentrations at the South Runway, exposure point concentrations (EPCs) for each COPEC were defined. Exposure point concentrations in this ecological risk assessment are defined as either the 95% upper confidence limit (95%UCL) of the arithmetic mean COPEC concentration for chemicals where a 95%UCL could be calculated (i.e. more than one detected value), or are defined as the maximum detected concentration for chemicals where only one detected result is available. For chemicals whose calculated 95%UCL is greater than the maximum detected concentration, the maximum detected concentration was used as the EPC so as not to overstate any potential site risks.

The EPCs for indeno(1,2,3-cd)pyrene, DRO and GRO, the three COPECs detected in surface water, are the MDCs, as those contaminants were only detected in one sample (02-851; see Figure 3-5).

Only one of the four sediment COPECs, DRO, has sufficient data to permit calculation of a 95%UCL for use as an EPC. The 95%UCL for DRO was greater than the MDC. Therefore, the MDC for DRO in sediment as used as the EPC so as not to overstate any potential site risks. The other three COPECs, 2-methylnaphthalene, phenanthrene and GRO, were only detected in one sample each. The EPCs for these COPECs in sediment are the MDCs.

Summary statistics and EPCs for the COPECs in all media at the South Runway Area are presented in Table CII.5-1. The bolded values in Table CII.5-1 will be used as EPCs in the baseline ecological risk assessment.

CII.5.2 Measures of Effect (Toxicity Assessment)

The exposure point concentrations for COPECs will be compared to the measures of ecological effect described in this section. Measures of ecological effect (formerly termed the toxicity assessment portion of an ecological risk assessment) define concentrations of COPECs in environmental media that can result in adverse effects to ecological receptors. These concentrations are termed risk-based screening concentrations (RBSCs) in this risk assessment. RBSCs represent chemical concentrations in environmental media that may pose unacceptable ecological risks to receptors if they are exposed to site chemicals at concentrations greater than or equal to the RBSC.

CII.5.2.1 Calculation of Aquatic Biota Risk-Based Screening Concentrations for Petroleum Alkanes, BTEX and PAH Compounds

Petroleum Alkane Mixture RBSC Derivation

Promulgated ecological screening level toxicity reference values (TRVs) or risk based screening concentrations (RBSCs) for petroleum alkane mixtures are unavailable. This lack is the reason for the extensive discussion of the petroleum alkane RBSC derivation methodology in this toxicity assessment. The only efforts to date to derive petroleum alkane TRVs (Michelsen 1997, URS 1996c, Golder Associates 1995) have all utilized a tissue residue approach. These three efforts, performed originally for sites in Washington, Alaska and British Columbia, respectively, have more similarities than differences in their methodologies. All are limited to some extent by the limited amount of publically available petroleum alkane toxicity data in the scientific literature.

The tissue residue approach starts with a critical body residue of a toxicant, then in essence runs a bioaccumulation model backwards to calculate the maximum chemical concentration in water or sediment which does not result in exceedance of the critical body residue (CBR). These maximum media concentrations which do not result in exceedance of a CBR are the TRVs or RBSCs used to evaluate ecological risks from media concentrations of gasoline range organics (alkanes, alkenes and cycloalkanes with a carbon chain length between C₆ and C₁₀), diesel range organics (C₁₀ to C₂₅) and residual range organics (>C₂₅).

Petroleum alkanes, alkenes and cycloalkanes are considered to elicit their toxicity to aquatic life by a mode of toxic action termed narcosis (Schultz 1997, Snyder 1987). Narcotic chemicals do

not have a specific site or organ in the body where they elicit their toxicity. Instead, they are believed to elicit their toxic effects after dissolution of the chemical in the lipid layer of membranes, resulting in an increased volume fraction of the chemical in tissue and disruption of cellular function (Franks and Lieb 1978). Symptoms of narcotic toxicity include decreased nervous system activity, lethargy, loss of equilibrium and ultimately death. Narcotic toxicity is reversible if the environmental concentration of the chemical is reduced below that required to elicit toxicity. Narcosis is perhaps better known as the mode of toxic action of anaesthetics used in medicine.

As is the case with nearly all chemicals, narcotic chemicals must first be accumulated in the tissues of an aquatic species to a concentration which elicits the toxic response. Toxicity does not occur until the chemical concentration in tissues exceeds a critical body residue. Critical body residues in a number of aquatic species for a number of narcotic chemicals have been measured. These studies (summarized in McCarty and Mackay 1993, Van Wezel and Opperhuizen 1995) have observed that when expressed on a molar concentration basis, the critical body residue of narcotic chemicals associated with mortality is constant within a narrow range of 2 - 8 millimoles per kilogram (mmol/kg) whole body, wet weight.

Limited information is available regarding narcotic chemical residues associated with chronic toxicity, defined here as any adverse effect other than mortality. What information is available indicates that chronic toxicity begins to occur at tissue residues approximately an order of magnitude lower (0.2 - 0.8 mmol/kg) than the lethal body burden of 2 - 8 mmol/kg. A database of tissue residues associated with adverse toxic effects in aquatic biota (Bridges and Lutz 1999, Shephard 1998) contains some information on petroleum alkane residues associated with toxicity. The data indicates that alkane toxicity begins to occur at around 0.24 mmol/kg, within the range of critical body residues predicted to be associated with chronic toxicity. Table CII.5-2 provides a summary of the residue-effects literature for alkanes and BTEX chemicals in aquatic biota.

Narcotic toxicity is often referred to as "baseline toxicity", as narcosis corresponds to the minimal level of toxicity exerted by any chemical. Chemicals with specific modes of toxic action are more toxic (i.e. require lower body burdens to elicit toxicity) than would be expected on the basis of narcotic toxicity.

The toxicity of mixtures of narcotic chemicals has been found to be strictly additive (Deneer et al. 1988, Hermens et al. 1984), implying that the composition of a mixture of narcotic chemicals causing toxicity is not important. Toxicity from a mixture of narcotic chemicals, such as petroleum alkanes, alkenes and cycloalkanes occurs when the sum of individual chemical molar concentrations of the mixture in tissue exceeds the critical body residue. This additivity of

individual narcotic chemical toxicity is what permits derivation of risk-based screening concentrations (RBSCs) for petroleum alkane mixtures, all of whose individual components elicit their toxicity via narcosis.

Starting with a critical body residue of petroleum alkanes (0.24 mmol/kg) believed to be a threshold for chronic toxicity, a one compartment first order kinetic (1CFOK) toxicological model (Shephard 1998) has been used to predict the concentration of alkanes in water required for an aquatic animal to bioconcentrate the critical body residue of 0.24 mmol/kg. The approach is based on the concentration of freely dissolved chemical in water. The differential equation form of the 1CFOK model used to calculate waterborne chemical concentrations of alkanes that will result in bioconcentration of 0.24 mmol/kg petroleum alkanes is given in Equation 2.

Equation 2:

$$\frac{dC_a}{dt} = (k_u \times C_w) - (k_e \times C_a)$$

where: C_a = chemical concentration in an animal (mg/kg)
t = time (hours)
 C_w = chemical concentration in water (mg/L)
 k_u = chemical uptake rate constant (L/kg/hour)
 k_e = chemical elimination rate constant (hour⁻¹)

If the chemical concentration in water is assumed to be constant, Equation 2 may be exactly integrated to yield Equation 3.

Equation 3:

$$C_a = C_w \times \frac{k_u}{k_e} \times (1 - e^{-k_e t}) + (C_{a(t=0)}) e^{-k_e t}$$

where all terms are defined as per Equation 2. For an animal being modeled, which has not been exposed to a chemical at the start of an experiment, $C_{a(t=0)}$ equals zero, and the last term of Equation 3 drops out of the integrated form of the 1CFOK model. If it is assumed that the animal has been exposed to the chemical in water for a sufficiently long period to establish steady state between the chemical concentration in the animal and the water, Equation 3 reduces to Equation 4.

Equation 4:

$$C_a = C_w \times \frac{k_u}{k_e}$$

The term k_u / k_e in Equation 4 is the bioconcentration factor (BCF) of the chemical into the animal from the water, and has units of L/kg. If the animal accumulated its body burden of alkanes from multiple sources (e.g. water and diet), the term k_u / k_e becomes a bioaccumulation factor. Alkane bioaccumulation factors (Chapman and Connell 1986) for a benthic deposit feeding gastropod (*Strombus luhuanus*) were used to derive ecological RBSC's for petroleum alkanes in sediment. For water, reexpressing k_u / k_e as a BCF and rearranging Equation 4 to solve for C_w yields Equation 5, which is the equation used to calculate the ecological RBSC for alkanes/cycloalkanes in water.

Equation 5:

$$C_w = \frac{C_a}{BCF}$$

Bioconcentration factors for petroleum alkanes were derived from the logarithm of the octanol-water partition coefficient ($\log K_{OW}$) of individual petroleum compounds. For RBSCs which encompass a range of alkane carbon chain lengths, a $\log K_{OW}$ for the compound at the center of the range was chosen. Bioconcentration factors and $\log K_{OW}$ were related to each other using Equation 6, the regression equation used by U.S. EPA in the derivation of national ambient water quality criteria (USEPA 1980).

Equation 6:

$$\log BCF = (0.85 \times \log K_{ow}) - 0.70$$

Compilations of $\log K_{OW}$ values for alkanes, particularly the longer carbon chain length alkanes are not readily available. Alkane $\log K_{OW}$ values were derived by combining available information from U.S. EPA and the Alaska DEC. The derivation of the K_{ow} values for the various alkane/cycloalkane size classes starts with Equation 7, which is the regression used by the EPA (1993) to convert K_{ow} values to the organic carbon-water partition coefficient (K_{OC}) needed to derive sediment quality criteria for hydrophobic organic chemicals.

Equation 7:

$$\log K_{OC} = 0.00028 + (0.983 \times \log K_{ow})$$

Where: K_{OC} = organic carbon - water partition coefficient

The State of Alaska (ADEC 1996) has derived Equation 8, which relates K_{OC} and carbon chain length for petroleum alkanes.

Equation 8:

$$\log K_{OC} = (0.45 \times N_C) + 0.43$$

Where: N_C = number of carbons in the alkane (i.e. $N_C = 8$ for octane)

Substituting Equation 8 into Equation 7 and solving for $\log K_{OW}$ yields Equation 9, which was used to derive $\log K_{OW}$ values for determination of bioconcentration factors (Equation 6).

Equation 9:

$$\log K_{ow} = \frac{(0.45 \times N_C) + 0.43}{0.983} - 0.00028$$

Results of the RBSC calculations (Equation 5) are presented in Table CII.5-3.

Some of the petroleum alkane RBSCs (Table CII.5-3) at first glance appear to represent low concentrations in water. As stated earlier, the toxicological model used to derive the RBSCs is based on freely dissolved chemical concentrations in water. Chemicals associated with suspended particulates are not available for uptake by biota in the model used. Potential impacts to ecological risk due to the model's inability to account for suspended particulates are discussed in Section CI.7.3. To compare the predicted RBSCs to the maximum water solubility of the alkane fraction, Equation 10 (ADEC 1996) was used to estimate water solubility of petroleum alkanes.

Equation 10:

$$\log S = 4.5 - (0.55 \times N_C)$$

Where: S = water solubility, mg/L

Using a no adverse effect tissue residue of 0.24 mmol/kg, the narcosis model predicts that alkanes with a carbon chain length greater than C_{16-17} would have to exceed their maximum water solubility before any chronic toxicity could be elicited (Tables CII.5-3 and CII.5-4). As the narcotic toxicological model is based on the concentration of freely dissolved alkanes, the approach used to derive ecological RBSC's does not apply for alkanes with carbon chain lengths greater than C_{16-17} . Toxicity of the heavier alkanes to aquatic life in the water column requires a supersaturated solution (in essence, an oil sheen, slick or spill) before toxicity would be observed.

In supersaturated solutions, toxicity is more likely to occur from physical toxicity or changes in the environment, such as suffocation or habitat degradation. These processes do not result from narcosis; thus, narcosis is not predicted to be the toxic mode of action to aquatic biota for alkanes in surface water with a carbon chain length greater than C_{16-17} . Surface water RBSC's therefore have not been calculated for alkane fractions heavier than C_{16-17} , as the narcotic mode of toxic action is not responsible for any observed adverse effects of alkanes heavier than C_{16-17} . Any detected concentrations of diesel range or residual range alkanes in surface waters which are greater than their maximum water solubility are assumed to represent either material surface adsorbed on particulate matter, which should have limited bioavailability and toxicity to aquatic life, or represent free product, which may pose unacceptable risks to aquatic biota. As the available analytical data do not permit a distinction between particulate sorbed and free product alkanes, any detected diesel range or residual range organics at concentrations in excess of their maximum solubility are assumed to pose potential risks to ecological receptors. Unfortunately, the potential for these toxicological risks cannot be quantified given the current state of the art. The potential for risks from supersaturated solutions of diesel range and residual range organics will be discussed in the uncertainty section of the risk assessment.

Additional details of the procedures used to derive RBSCs for petroleum alkane mixtures are provided in Shephard and Webb (1998) and Shephard and McCarty (1997). Although the literature on water and sediment concentrations of petroleum alkanes associated with toxicity to aquatic life is limited, the existing data support the RBSC derivation methodology used in this risk assessment. Additional support for the utility of the basic approach of this RBSC development approach is found in Dyer et al. (2000), who found that RBSCs, although not specifically petroleum alkane RBSCs, derived by the methodology described herein overpredict adverse effects to field populations of fish. In the initial stages of risk assessment, overprediction of toxicity (i.e. a conservative risk assessment) is generally desired.

Finally, a search of the USEPA AQUIRE database for petroleum alkane toxicity in water to aquatic life is presented as Table CII.5-4. None of the adverse effect concentrations in

Table CII.5-4 are lower than the alkane mixture RBSCs, providing additional support for the ecological protectiveness of the alkane RBSCs derived in this section.

Sources of RBSCs for BTEX and PAH Compounds

Most surface water and sediment RBSCs for BTEX chemicals and PAH compounds were derived following procedures presented in the PSE-2 guidance for evaluating sites at NAF Adak (URS 1996a). The PSE-2 guidelines were derived from Alaska water quality standards, USEPA ambient water quality criteria (USEPA 2002, 1991), Washington sediment management standards (Ecology 1995), and USEPA (1999b, 1993) equilibrium partitioning approaches to deriving sediment quality criteria.

CII.5.2.2 Derivation of Ecological Risk-Based Screening Concentrations for the Protection of Wildlife from Petroleum Constituents in Soil

This portion of the toxicity assessment derives a set of ecological risk-based screening concentrations (RBSCs) for evaluating potential risks to avian and mammalian receptors from their direct exposure to and ingestion of the major toxic constituents of petroleum released into soil. Petroleum products can affect organisms directly and indirectly. Direct effects include physical processes, such as oiling of fur and feathers, and toxicological effects, which can range from biochemical and cellular alterations to mortality. Indirect effects include habitat alteration and nutrient cycle disruptions.

The general approach used to develop the soil screening RBSCs is the same as that used to develop RBSCs for the preliminary source evaluation (PSE) of potentially contaminated sites on NAF Adak (URS 1996a). The approach uses a food chain model to back calculate to a soil RBSC. As this approach has previously been accepted by remedial project managers from the U.S. Navy, USEPA and Alaska DEC for assessing risks at CERCLA sites on Adak (URS 1997), the same approach was chosen to calculate RBSCs at petroleum contaminated sites.

This section describes the RBSC development approach for the development of soil RBSCs and presents the results of the RBSC calculations. The three steps in the derivation of the soil RBSCs are:

1. **Identification of ecological receptors exposed to TPH in soil** – describes what components of the terrestrial ecosystem on Adak could be exposed to soil-borne chemicals, selects an appropriate target receptor species from which to derive RBSCs, and provides exposure factors for RBSC calculation.

2. **Toxicity reference value (TRV) identification** – describes how toxicity values for the individual toxic constituents of petroleum were selected.
3. **Soil RBSC Calculation** – describes how RBSCs were calculated and provides the results.

Identification of Ecological Receptors Exposed to TPH in Soil

The first step in the development of a food chain for deriving ecological soil RBSCs is to identify ecological receptors that could be exposed to soil-borne contaminants. Then, a target ecological receptor species is selected on which to base a food chain model which is protective of a broad group of receptors. Chemicals associated with soil can contact and potentially impact a variety of ecological receptors, including the following:

- ***Soil-dwelling invertebrates***, exposed through direct dermal uptake, ingestion of soil, and consumption of plants and animals that have accumulated chemicals from the soil
- ***Plants***, exposed primarily through direct uptake by roots and translocation to other tissues
- ***Birds and mammals***, exposed through the direct ingestion of soil and consumption of plants and animals that have accumulated chemicals from the soil

The approaches for assessing ecological risks to terrestrial receptors on Adak were originally defined in several earlier workplans and reports (URS 1996a, 1996b, 1996c, 1995). A consistent feature of all these workplans was the definition of a set of assessment endpoints which were explicit expressions of environmental values to be protected. These workplans and reports were developed in concert with the Navy, USEPA, U.S. Fish and Wildlife Service (USFWS), Alaska DEC, and the Aleutian Island Biological Technical Assistance Group (BTAG). They represent a consensus of the various agencies and advisory groups on a sound technical basis for the development of ecological soil RBSCs for contaminated sites, including petroleum contaminated sites.

Three assessment endpoints were identified in URS (1995) for the lowland maritime tundra, the dominant habitat in undisturbed to slightly disturbed sites in the vicinity of downtown Adak. All three assessment endpoints were based on maintenance of bird population abundances that use the maritime tundra habitat on the northern half of Adak for nesting and foraging. Bird species

included in the assessment endpoints were the Lapland longspur, rock ptarmigan and peregrine falcon.

All three of the assessment endpoints focus on the protection of avian species, which are the most readily observable large terrestrial animals on Adak, and which represent important ecosystem components. Unfortunately, the available ecotoxicological data for evaluating petroleum chemical effects on birds are limited. Avian TRVs were available for only 14 of the 22 toxic petroleum constituents evaluated in the Tiered Approach to Risk Assessment (TARA) studies of petroleum sites on Adak (URS 1996c). No avian toxicity reference values are available for alkanes and cycloalkanes, benzene, toluene or ethylbenzene. Because it is not possible to derive ecological soil RBSCs for many of the toxic petroleum components, including some of the most abundant components by weight in petroleum mixtures by using an avian species model, an alternative approach is required.

Ecotoxicological data are available for all 22 toxic components of petroleum identified in URS (1996c) for mammalian species. Therefore, a mammal was chosen as the target ecological receptor on which to base the calculation of ecological soil RBSCs. There are two terrestrial species of mammals that inhabit Adak Island: caribou (*Rangifer tarandus*) and Norway rat (*Rattus norvegicus*). This list does not include resident marine mammals that spend some time on land, such as sea otters. Both species are recent introductions that adversely affect the native organisms on Adak. The caribou forage over great distances and would not be expected to be exposed in any significant degree to soil-borne chemicals on many of the small petroleum sites on Adak. The Norway rat has a home range of approximately 5.7 acres (2.3 hectares) and would potentially be exposed to localized areas of contamination. Therefore, the Norway rat is selected as a surrogate species on which to develop ecological soil RBSCs.

It is assumed that RBSCs developed for the Norway rat will be protective of avian species of interest. Although avian TRVs for alkanes are unavailable, several available avian TRVs for PAHs and BTEX compounds indicate that birds may be less sensitive to these two classes of compounds than are mammals.

Rats forage largely on leafy vegetation, dig up root stocks, and prey on a variety of animals, including birds and their eggs. Availability of food is probably the major determinant of the rat diet. Of 82 rats collected on Amchitka Island, over 50 percent had greater than 50 percent by volume plant material in their stomachs, and over 20 percent of the Amchitka rats had greater than 90 percent plant material in their stomachs (URS 1994). Because the amount of chemical accumulating in birds cannot be easily calculated based solely upon soil chemical concentrations, it is assumed for the purposes of calculating RBSCs that the rat's diet consists entirely of plant material.

Exposure factors for the Norway rat, to be used in calculating soil RBSCs, are shown in Table CII.5-5.

Toxicity Reference Value Identification

The second step in developing ecological RBSCs for soil contaminants was to identify a set of toxicity reference values (TRVs). A TRV represents a dose (milligrams of chemical per kilogram of body weight per day) below which adverse ecological effects are unlikely to occur.

A literature review and database search was performed to identify relevant toxicological information. The following data sources were reviewed:

- Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profiles
- Registry of Toxic Effects of Chemical Substances database (RTECS)
- Hazardous Substance Database (HSDB)
- Integrated Risk Information System database (IRIS)
- Oil and Hazardous Materials / Technical Assistance Database (OHM / TAD)
- Chemical Evaluation Search and Retrieval System (CESARS)
- TERRETOX database
- Various scientific publications

The ATSDR toxicological profiles can be obtained in both a printed format and a commercially available CD-ROM. The CD-ROM version of the ATSDR toxicological profiles was used during the literature review. RTECS is an online database published by the National Institute of Occupational Safety and Health (NIOSH). HSDB is maintained online as part of the National Library of Medicine's TOXNET database. IRIS, Oil and Hazardous Materials/Technical Assistance Database (OHM/TAD) and TERRETOX are online databases maintained by the U.S. Environmental Protection Agency. CESARS is an online database jointly maintained by the Michigan Department of Natural Resources and the Ontario Ministry of the Environment.

Quantitative dose-response information that represented either the highest no observed adverse effect level (NOAEL) or the lowest observed adverse effect level (LOAEL) was selected from the compiled toxicological literature to represent the TRV. A variety of toxic endpoints are available in the literature, but preference was given to selection of TRVs which define effects on ecologically significant endpoints such as reproduction or development.

Relatively little mammalian, and no avian toxicity data are available for petroleum alkanes. A substantial amount of PAH and BTEX toxicity data are available for mammals, but only a limited amount of avian PAH and BTEX toxicity data are available. A preponderance of the available mammalian alkane toxicity data (Table CII.5-6), mammalian PAH and BTEX toxicity data (Table CII.5-7), and avian PAH and BTEX toxicity data (Table CII.5-8) were originally identified in the RTECS database of the National Institute of Occupational Safety and Health (NIOSH), available on the Internet at <http://ccinfoweb.ccohs.ca/rtecs/search.html>.

No avian or mammalian toxicity data were identified in the literature review which exposed animals to TPH fractions which correspond to the Alaska DEC definition of gasoline range organics (C₆ – C₁₀), diesel range organics (C₁₀ – C₂₅) or residual range organics (C₂₅ – C₃₆) carbon chain lengths. In order to derive soil RBSCs for wildlife for GRO, DRO and RRO, the procedures described in Massachusetts Department of Environmental Protection (MDEP [2001]) for adjusting available n-hexane reference doses (RfDs) were followed so that they serve as surrogate RfDs for the toxic petroleum fractions evaluated by MDEP (2001). MDEP (2001) assigns an oral human health RfD of 0.06 mg/kg/day as a RfD to the C₅ – C₈ carbon chain length alkanes and cycloalkanes, based on a study of n-hexane toxicity to rats reported in USEPA (1992). MDEP (2001) then uses an RfD of 0.6 mg/kg/day (10 times the n-hexane RfD) as a surrogate for C₉ – C₁₈ alkanes and cycloalkanes, and an RfD of 6.0 mg/kg/day (100 times the n-hexane RfD) as a surrogate for C₁₈ – C₃₂ alkanes and cycloalkanes. The adjustments to the n-hexane derived RfD were made because MDEP believes that alkane toxicity is related to carbon chain length, with the longer chain alkanes exhibiting lower toxicity than shorter chain alkanes such as n-hexane.

The MDEP n-hexane RfD is based on a chronic oral LOAEL of 570 mg/kg/day for a rat after a 90-day exposure. Adverse effects included neuropathy, testicular atrophy and decreased weight gain. The effects on growth and possible effects on reproduction make this RfD an ecologically relevant endpoint for wildlife. USEPA (1992) modified the 570 mg/kg/day oral LOAEL rat TRV to a human NOAEL by dividing it by an UF (UF) of 10,000, then rounding the result to one significant figure.

It was assumed that the MDEP (2001) defined three carbon chain length groups of alkanes are sufficiently similar to the Alaska DEC definitions of GRO, DRO, and RRO that the human

health RfD adjustment approach used by MDEP (2001) can also be applied to wildlife RBSCs. The n-hexane rat LOAEL of 570 mg/kg/day has therefore been used as a surrogate RBSC for all alkanes and cycloalkanes in the Alaska DEC GRO carbon chain length group of C₆ – C₁₀. Without the application of any UFs, a GRO TRV of 18,400 mg/kg can be calculated. The final values for the petroleum fraction TRVs used in this ecological risk assessment incorporate UFs, which are discussed in the next several paragraphs. The complete set of alkane/cycloalkane soil RBSCs for use at the South Runway site are presented in Table CII.5-9, which also presents the wildlife TRVs used for BTEX compounds in the derivation of soil RBSCs. The derivation of the BTEX wildlife ingested dose TRVs and soil RBSCs is presented in the next several paragraphs, as is the application of UFs to the ecological TRVs.

Using the proposed new MDEP (2002) adjustment factors of 1.67 times the GRO TRV for the DRO TRV calculation, and 33.3 times the GRO TRV for the RRO TRV with the rat hexane (GRO surrogate) TRV of 570 mg/kg/day, a soil RBSC of 201,481 mg/kg DRO, which should be protective of wildlife, can be calculated. Although not a COPEC at the South Runway site, the concentration of RRO in soil required to elicit toxicity to wildlife exceeds 1,000,000 mg/kg (calculated to be 19,618,605 mg/kg RRO in soil before application of UFs), implying that no concentration of RRO alone in soil could elicit toxicity to wildlife under the assumed exposure conditions.

The Norway rat-based TRVs for TPH fractions discussed in the preceding paragraphs were calculated without the use of UFs. Alaska DEC (2000) ecological risk assessment guidance permits the use of selected UFs for adjusting TRVs to be protective of species other than the species for which the TRV was originally developed. The TPH fraction TRVs presented in the previous paragraph have been adjusted downward by a UF of 10 to calculate the final TPH fraction RBSCs presented in Table CII.5-9. This UF of 10 is the product of an UF of 5 to convert a LOAEL to a NOAEL, and an UF of 2 to adjust for differences in population level effects between the laboratory test species and the target ecological receptors for the South Runway site. It should be noted that the use of this UF still results in the RRO soil screening RBSC being in excess of 1,000,000 mg/kg, still implying that no concentration of RRO alone in soil will elicit toxicity to wildlife under the assumed exposure scenario.

BTEX TRVs chosen for use in soil RBSC derivations are presented in Table CII.5-7 and are all based on mammalian TRVs. Only one avian TRV exists for a BTEX compound (xylene) (Table CII.5-8), and it is substantially higher than the mammalian TRV selected for use in soil RBSC derivation. The BTEX TRVs were all based on chronic NOAEL toxicity data from the literature, so the UF of 2 that was applied only adjusts for differences in population level effects between the laboratory test species and the target ecological receptors.

Available mammalian and avian PAH and BTEX TRVs are presented in Tables CII.5-7 and CII.5-8, respectively. In order to provide for the development of conservative RBSCs for PAH compounds, the lowest TRV identified for any individual PAH was selected as the basis for the rat ingested dose TRV for most PAH compounds. The lowest TRV for effects on survival, reproduction and growth of any avian or mammalian species is a benzo(a)pyrene reproductive TRV of 10 mg/kg/day for mice observed by Mackenzie and Angevine (1981). This benzo(a)pyrene TRV was used to derive soil RBSCs for all PAHs except naphthalene. The UF of 20 used to derive the soil RBSCs for PAHs is the product of an UF of 2 to adjust for differences in the genera of the laboratory test animal and the target ecological receptor, an UF of 5 to adjust a chronic LOAEL to a NOAEL, and an UF of 2 to adjust for differences in population level effects between the laboratory test species and the target ecological receptors. Several avian and mammalian TRVs for naphthalene are available in the literature. A rat chronic NOAEL for growth study was selected as the source of the naphthalene TRV.

Lack of avian toxicity data associated with exposure to PAHs in the available literature is a limiting factor, and many of the studies that do exist are of relatively low quality or are simply not useful for risk assessment. For instance, in the Brunstrom study (1991), a mixture of primarily high molecular weight (HMW) PAHs was injected into the air sacs of chicken eggs. This dosing method, simulating an acute exposure, is not applicable to the actual route of exposure that a bird embryo would experience under natural conditions, i.e., chemical transport via the maternal parent. In actuality, factors including the steric hindrance of HMW PAHs and the ability of most avian species to readily metabolize and eliminate PAHs would preclude the magnitude of exposure simulated in the Brunstrom study. In fact, in the discussion section of this study, the authors note that the high rate of biotransformation of PAHs results in PAH concentrations in organisms at high trophic levels that are generally low. Thus, it is doubtful that avian eggs could reach concentrations high enough to induce embryo mortality. Given these conditions, deriving TRVs from this study was not deemed appropriate.

CII.5.3 Soil RBSC Calculation

Ecological RBSCs for petroleum components in soil were calculated using Equation 11.

Equation 11:

$$\text{Soil RBSC (mg / kg)} = \frac{TRV}{I_s + (BCF \times I_p)}$$

Where: Soil RBSC = risk-based screening concentration (mg chemical / kg soil)

TRV = toxicity reference value (mg chemical / kg body weight / day)

I_s = soil ingestion rate (kg soil / kg body weight / day)

BCF = soil to plant bioconcentration factor (unitless)
 I_p = plant ingestion rate (kg dry weight plants / kg body weight / day)

Soil to plant bioconcentration factors were derived by using Equation 12, developed by Travis and Arms (1988).

Equation 12:

$$\log(\text{Soil to plant BCF}) = 1.588 - (0.578 \times \log K_{ow})$$

Where: K_{ow} = octanol – water partition coefficient

The final set of ecological RBSCs for soil contaminants is presented in Table CII.5-9. RBSCs were calculated assuming a hazard quotient of 1.0.

Since the home range of a Norway rat is estimated to be 5.7 acres and the areal extent of surficial soil contamination at some of the petroleum sites may be less than 5.7 acres, the actual exposure of the rat to site contaminants will be a proportion equal to the area of the site divided by the home range of the rat. Therefore, for sites with an areal extent of surficial soil contamination less than 5.7 acres, a site-specific, area-weighted exposure modifier will be used to derive baseline ecological risk assessment RBSCs for sites less than 5.7 acres in area. This adjustment to Equation 11 is shown in Equation 13.

Equation 13:

$$\text{Soil RBSC (mg/kg)} = \frac{TRV}{I_S + (BCF \times I_P)} \times \frac{\text{Home range area (acres or hectares)}^*}{\text{Site area (acres or hectares)}}$$

* - Home range adjustment applied only if receptor home range is larger than the contaminated site area

The adjustment in Equation 13 assumes that 100% of the petroleum ingested by the rat comes from a contaminated site, while none of it comes from the portion of the home range which is not contaminated with petroleum products. The South Runway Area extends over 15 acres, which is larger than the 5.7 acre home range of the Norway rat. Therefore, no area use adjustment factors will be made to RBSCs in this risk assessment.

**Table CII.5-1
 Summary Statistics and Exposure Point Concentrations (EPC = 95%UCL) for COPECs
 at the South Runway Area to Which Ecological Receptors are Exposed**

Analyte	Media	Number of samples	Maximum detected concentration	Minimum detected concentration	Mean concentration	95% UCL concentration
Indeno(1,2,3-cd) pyrene	Surface water	1	0.32 µg/L	0.32 µg/L	0.32 µg/L	NA
TPH – Diesel range organics	Surface water	1	79,000 µg/L	79,000 µg/L	79,000 µg/L	NA
TPH – Gasoline range organics	Surface water	1	650 µg/L	650 µg/L	650 µg/L	NA
2-Methyl naphthalene	Sediment	1	0.13 mg/kg	0.13 mg/kg	0.13 mg/kg	NA
Phenanthrene	Sediment	1	1.4 mg/kg	1.4 mg/kg	1.4 mg/kg	NA
TPH – Diesel range organics	Sediment	2	1,200 mg/kg	330 mg/kg	765 mg/kg	3,511 mg/kg
TPH – Gasoline range organics	Sediment	1	28 mg/kg	28 mg/kg	28 mg/kg	NA

Notes:
 COPC - chemical of potential concern
 EPC - exposure point concentration
 µg/L - microgram per liter
 NA - not analyzed
 mg/kg - milligram per kilogram
 TPH - total petroleum hydrocarbon
 UCL95 - 95% upper confidence limit on the mean

**Table CII.5-2
 Tissue Residues of Alkanes, Cycloalkanes and BTEX Chemicals Associated with Adverse Effects in Aquatic Biota**

Chemical	Effect Concentration mg/kg	Molecular Weight	Effect Concentration mmol/kg	Species	Effect	Reference	Footnotes
Benzene	0.50	78.1	0.0064	Golden ide (<i>Leuciscus idus</i>)	No effect on survivorship in 3 days	Freitag et al. 1985	3
	1.4	78.1	0.018	Pacific herring (<i>Clupea harengus</i>)	Decreased survival of larvae	Struhsaker 1977	3
	4.3	78.1	0.055	Goldfish (<i>Carassius auratus</i>)	No effect on survivorship in bioconcentration experiment	Ogata et al. 1984	3
	234	78.1	3.0	Cladoceran (<i>Daphnia magna</i>)	Lethal body burden	Pawlisz and Peters 1995	3
	310	78.1	4.0	Green algae (<i>Selenastrum capricornutum</i>)	50% reduction in growth over 8 days	Herman et al. 1991	1, 3, 5
	409	78.1	5.2	Rainbow trout (<i>Oncorhynchus mykiss</i>)	Threshold for induction of serum sorbitol dehydrogenase	Kaiser et al. 1984	3
	1950	78.1	25.0	Rainbow trout (<i>Oncorhynchus mykiss</i>)	50% mortality	Kaiser et al. 1984	3
	2015	78.1	25.8	Rainbow trout (<i>Oncorhynchus mykiss</i>)	50% mortality in 96 hours	Hodson et al. 1984	3
n-Butylcyclohexane	40	139.25	0.29	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1991	3
Cyclooctane	32	112.2	0.29	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1991	3
n-Decane	165	142.3	1.16	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1991	3
Docosane	0.50	310.6	0.0016	Golden ide (<i>Leuciscus idus</i>)	No effect on survivorship in 3 days	Freitag et al. 1985	3
n-Dodecane	2.5	170.3	0.015	Golden ide (<i>Leuciscus idus</i>)	No effect on survivorship in 3 days	Freitag et al. 1985	3
	>203	170.3	>1.19	Blue mussel (<i>Mytilus edulis</i>)	Minimal reduction in feeding rate	Donkin et al. 1991	3
Dodecylcyclohexane	718	252.5	2.8	Rainbow trout (<i>Oncorhynchus mykiss</i>)	Reduced growth over 9 months	Cravedi and Tulliez 1982	3
Ethylbenzene	0.37	106.2	0.0035	Manila clam (<i>Tapes semidecussata</i>)	Increased mucus production, decreased feces production	Nunes and Benville 1979	4
	15.5	106.2	0.15	Goldfish (<i>Carassius auratus</i>)	No effect on survivorship in bioconcentration experiment	Ogata et al. 1984	3
	210	106.2	2.0	Green algae (<i>Selenastrum capricornutum</i>)	50% reduction in growth over 8 days	Herman et al. 1991	1, 3, 5
Heptadecane	1200	240.5	5.0	Blue mussel (<i>Mytilus edulis</i>)	No effect on survivorship after 24 hours	Lee et al. 1972	1, 3
Hexadecane	5.7	226.4	0.025	Quahog (<i>Mercenaria mercenaria</i>)	No effect on survival or filtering rate in 8 hours	Boehm and Quinn 1976	4
Methylcyclohexane	500	97.2	5.1	Flagfish (<i>Jordanella floridae</i>)	Low end of lethal body burden range after 87 day exposure	Jenkins et al. 1977	3
n-Nonane	35	128.25	0.27	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1991	3
n-Octane	10	114.2	0.088	Spiny dogfish (<i>Squalus acanthias</i>)	No effect on mortality in 24 hours	Guarino and Arnold 1979	3
	24.6	114.2	0.22	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1989	3
	39	114.2	0.34	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1991	3
l-Phenyldecane	>78	218.39	>0.36	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1991	3
l-Phenylheptane	35	186.29	0.19	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1991	3
l-Phenylotane	82	200.32	0.41	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1991	3
l-Phenylpentane	94	158.24	0.59	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1991	3
Pristane	556	268.5	2.1	Rainbow trout (<i>Oncorhynchus mykiss</i>)	Reduced growth over 9 months	Cravedi and Tulliez 1982	3
Toluene	2.0	92.1	0.022	Blue mussel (<i>Mytilus edulis</i>)	No effect on survivorship	Lee et al. 1972	1, 3
	2.0	92.1	0.022	Manila clam (<i>Tapes semidecussata</i>)	Increased mucus production, decreased feces production	Nunes and Benville 1979	4
	2.4	92.1	0.026	Dolly Varden (<i>Salvelinus malma</i>)	No effect on survival in 24 hours	Varanasi et al. 1989	3
	4.5	92.1	0.049	Golden ide (<i>Leuciscus idus</i>)	No effect on survivorship in 3 days	Freitag et al. 1985	3
	8.3	92.1	0.090	Goldfish (<i>Carassius auratus</i>)	No effect on survivorship in bioconcentration experiment	Ogata et al. 1984	3
	15.6	92.1	0.17	Blue mussel (<i>Mytilus edulis</i>)	50% reduction in feeding rate	Donkin et al. 1989	3

Table CII.5-2 (Continued)
Tissue Residues of Alkanes, Cycloalkanes and BTEX Chemicals Associated with Adverse Effects in Aquatic Biota

Chemical	Effect Concentration mg/kg	Molecular Weight	Effect Concentration mmol/kg	Species	Effect	Reference	Footnotes
Toluene (cont.)	221	92.1	2.4	Cladoceran (<i>Daphnia magna</i>)	Lethal body burden	Pawlisz and Peters 1995	3
	252	92.1	2.7	Green algae (<i>Selenastrum capricornutum</i>)	50% reduction in growth over 8 days	Herman et al. 1991	1, 3, 5
	1012	92.1	11.0	Rainbow trout (<i>Oncorhynchus mykiss</i>)	Median lethal dose	Hodson et al. 1988	3
n-Undecane	>69		>0.44	Blue mussel (<i>Mytilus edulis</i>)	Minimal reduction in feeding rate	Donkin et al. 1991	3
m-Xylene	0.90	106.2	0.0085	Manila clam (<i>Tapes semidecussata</i>)	Increased mucus production, decreased feces production	Nunes and Benville 1979	4
	14.8	106.2	0.14	Goldfish (<i>Carassius auratus</i>)	No effect on survivorship in bioconcentration experiment	Ogata et al. 1984	3
	200	106.2	1.9	Green algae (<i>Selenastrum capricornutum</i>)	50% reduction in growth over 8 days	Herman et al. 1991	1, 3, 5
o-Xylene	0.87	106.2	0.0082	Manila clam (<i>Tapes semidecussata</i>)	Increased mucus production, decreased feces production	Nunes and Benville 1979	4
	14.1	106.2	0.13	Goldfish (<i>Carassius auratus</i>)	No effect on survivorship in bioconcentration experiment	Ogata et al. 1984	3
	207	106.2	1.9	Green algae (<i>Selenastrum capricornutum</i>)	50% reduction in growth over 8 days	Herman et al. 1991	1, 3, 5
p-Xylene	14.8	106.2	0.14	Goldfish (<i>Carassius auratus</i>)	No effect on survivorship in bioconcentration experiment	Ogata et al. 1984	3
	199	106.2	1.9	Green algae (<i>Selenastrum capricornutum</i>)	50% reduction in growth over 8 days	Herman et al. 1991	1, 3, 5

N.C. - not calculated.

- 1 - Dry weight concentration converted to wet weight concentration using water content given in citation, or by assuming 80% water content (Dillon 1984) if no water content given in citation.
- 2 - Field survey, co-occurrence of multiple contaminants with listed contaminant
- 3 - Laboratory toxicity test, single contaminant
- 4 - Laboratory toxicity test, co-occurrence of multiple contaminants with listed contaminant
- 5 - Tissue residue estimated from chart or graph
- 6 - Outdoor microcosm or artificial stream test, single contaminant
- 7 - Outdoor microcosm or artificial stream test, co-occurrence of multiple contaminants

Notes:

mg/kg - milligram per kilogram

mmol/kg - millimoles per kilogram

BTEX - benzene, toluene, ethylbenzene, and total xylenes

Table CII.5-3
Calculation of Ecological RBSC's for Petroleum Components in Water and Sediment Using a No Effect Tissue Residue Approach RBSC Development Methodology

Chemical	Molecular Weight	Median carbon chain length	BCF ^(a)	log Koc ^(b)	log Kow ^(c)	----- Toxic tissue residues -----				Estimated maximum water solubility (µg/L)	Water RBSC ^(f,j) µg/L	Freshwater		----- Marine -----	
						Acute mmol/kg ^(d)	NOEC ^(e) mmol/kg	Acute mg/kg	NOEC mg/kg			Sediment RBSC mg/kg ^(g)	Sediment RBSC mg/kg OC ^(h)	Sediment RBSC mg/kg ^(g)	Sediment RBSC mg/kg OC
C6 - C10 alkanes/cycloalkanes	114	8	240	4.03	4.10	6	0.24	684	27.4	1259	114	12.2	1219	12.2	1219
C10 - C25 alkanes/cycloalkanes	240	17	764072	8.08	8.22	6	0.24	1440	57.6	0.014	0.014	90.6	9063	90.6	9063
C25 - C36 alkanes/cycloalkanes	436	31	2.1E+11	14.38	14.63	6	0.24	2616	104.6	2.8E-10	NA	1172	117207	1172	117207
Benzene	78	---	---	5.2	1.76	6	0.08	468	6.2	---	1060	0.60	60	0.60	60
Toluene	92	---	---	10.7	2.12	6	0.08	552	7.4	---	3500	10.5	1050	4.6	459
Ethylbenzene	106	---	---	37.5	2.34	6	0.08	636	8.5	---	6400	14	1414	14	1414
Xylenes	106	---	---	41.4	2.41	6	0.08	636	8.5	---	332	0.79	79	0.86	86
Naphthalene	128	---	---	---	---	---	---	---	---	---	193	0.99	99	0.99	99
Acenaphthylene	152	---	---	---	---	---	---	---	---	---	307	0.66	66	0.66	66
Acenaphthene	154	---	---	---	---	---	---	---	---	---	56	0.15	N.C. ⁽ⁱ⁾	0.16	16
Fluorene	166	---	---	---	---	---	---	---	---	---	39.3	0.035	N.C.	0.23	23
Phenanthrene	178	---	---	---	---	---	---	---	---	---	19.1	0.225	N.C.	1	100
Fluoranthene	202	---	---	---	---	---	---	---	---	---	7.1	0.6	N.C.	1.6	160
Pyrene	202	---	---	---	---	---	---	---	---	---	10.1	0.35	N.C.	10	1000
Anthracene	178	---	---	---	---	---	---	---	---	---	20.7	0.085	N.C.	2.2	220
Chrysene	228	---	---	---	---	---	---	---	---	---	2.0	0.4	N.C.	1.1	110
Indeno(1,2,3-cd)pyrene	276	---	---	---	---	---	---	---	---	---	0.28	0.34	34	0.34	34
Benzo(a)pyrene	252	---	---	---	---	---	---	---	---	---	0.96	0.4	N.C.	0.99	99
Benzo(a)anthracene	228	---	---	---	---	---	---	---	---	---	2.2	1.1	110	1.1	110
Benzo(b)fluoranthene	252	---	---	---	---	---	---	---	---	---	0.68	2.3	230	2.3	230
Benzo(k)fluoranthene	252	---	---	---	---	---	---	---	---	---	0.64	2.3	230	2.3	230
Dibenz(a,h)anthracene	278	---	---	---	---	---	---	---	---	---	0.28	0.06	N.C.	0.12	12
2-Methylnaphthalene	142	---	---	---	---	---	---	---	---	---	72	0.0202	N.C.	0.0202	N.C.
Benzo(g,h,i)perylene	276	---	---	---	---	---	---	---	---	---	0.44	0.31	31	0.31	31
3/4-Methylphenol ^k	108	---	---	---	---	---	---	---	---	---	62	0.67	N.C.	0.67	N.C.
Phenol	94	---	---	---	---	---	---	---	---	---	2560	0.42	N.C.	0.42	N.C.

a - BCF is the bioconcentration factor, the ratio between a chemical concentration in tissue and water, L/kg
 b - Koc = organic carbon-water partition coefficient
 c - Kow = octanol-water partition coefficient
 d - mmol/kg = millimoles/kilogram
 e - NOEC = No Effect Concentration
 f - RBSC = Risk Based Screening Concentration
 g - Bulk sediment RBSC's in this column based on an assumed 1% organic carbon content of sediment
 h - mg/kg OC = mg chemical/kg organic carbon in sediment
 i - N.C. = Not Calculable, as the PSE-2 RBSC value is not based on a carbon normalized chemical concentration
 j - NA = Not Applicable, RBSC would have to exceed maximum water solubility of these fractions
 k - Water RBSC from Ohio aquatic life criteria, sediment RBSC based on Washington sediment management standard for 4-methylphenol

Table CII.5-4
AQUIRE Toxicity Data for Aliphatic Petroleum Constituents

Chemical	EC #	Species	Duration (days)	Type of Effect	Endpoint	Concentration	Units	Reference
Cyclododecane	12	Daphnia pulex	2	Immobility	EC ₅₀	21,000	µg/L	Passino and Smith 1987
Decane	10	Sheepshead minnow	1	Mortality	LC ₅₀	>500,000	µg/L	Heitmuller et al. 1981
Decane	10	Sheepshead minnow	2	Mortality	LC ₅₀	>500,000	µg/L	Heitmuller et al. 1981
Decane	10	Sheepshead minnow	3	Mortality	LC ₅₀	>500,000	µg/L	Heitmuller et al. 1981
Decane	10	Sheepshead minnow	4	Mortality	LC ₅₀	>500,000	µg/L	Heitmuller et al. 1981
Decane	10	Sheepshead minnow	4	Mortality	NOEC	500,000	µg/L	Heitmuller et al. 1981
Decane	10	Daphnia magna	2	Mortality	NR	1,300	µg/L	LeBlanc 1980
Decane	10	Daphnia magna	2	Immobility	EC ₅₀	0.2	mmol/m ³	Bobra et al. 1983
Decane	10	Daphnia magna	1	Mortality	LC ₅₀	23,000	µg/L	LeBlanc 1980
Decane	10	Daphnia magna	2	Mortality	LC ₅₀	18,000	µg/L	LeBlanc 1980
Decane	10	Opossum shrimp	4	Mortality	LC ₅₀	500,000	µg/L	USEPA 1978
Decane	10	Diatom	0.38	Photosynthesis	EC ₅₀	5	µg/L	Brooks et al. 1977
Decane	10	Diatom	4	Photosynthesis	EC ₅₀	>500,000	µg/L	USEPA 1978
Heptadecane	17	Blue mussel	1	Tissue residue	NR	1,000-8,000	µg/L	Lee et al. 1972
Heptane	7	Algae	0.33	Photosynthesis	EC ₅₀	1,500	µg/L	Brooks et al. 1977
Heptane	7	Oligochaete	4	Mortality	LC ₅₀	2,500,000	µg/L	Ghatak et al. 1988
Heptane	7	Chironomid	4	Immobility	LC ₅₀	838,000	µg/L	Das and Konar 1988

Table CII.5-4 (Continued)
AQUIRE Toxicity Data for Aliphatic Petroleum Constituents

Chemical	EC #	Species	Duration (days)	Type of Effect	Endpoint	Concentration	Units	Reference
Heptane	7	Pacific oyster	2	Mortality	NR	3,400,000	µg/L	Legore 1974
Heptane	7	Daphnia magna	4	Immobility	EC ₅₀	82,500	µg/L	Das and Konar 1988
Heptane	7	Daphnia magna	1	Mortality	LC ₅₀	>10,000	µg/L	Bringmann and Kuhn 1977
Heptane	7	Mosquitofish	4	Mortality	NR	5,600,000	µg/L	Wallen et al. 1957
Heptane	7	Mosquitofish	1	Mortality	LC ₅₀	4,924,000	µg/L	Wallen et al. 1957
Heptane	7	Mosquitofish	2	Mortality	LC ₅₀	4,924,000	µg/L	Wallen et al. 1957
Heptane	7	Mosquitofish	4	Mortality	LC ₅₀	4,924,000	µg/L	Wallen et al. 1957
Heptane	7	Coho salmon	4	Mortality	NR	100,000	µg/L	Morrow et al. 1975
Heptane	7	Mozambique tilapia	4	Mortality	LC ₅₀	375,000	µg/L	Ghatak et al. 1988
Heptane	7	Snail	4	Immobility	EC ₅₀	472,000	µg/L	Das and Konar 1988
Hexane	6	Blue-green algae	10-14	Growth	EC ₅₀	2.31	percent	Stratton 1987
Hexane	6	Blue-green algae	10-14	Growth	EC ₅₀	1.70	percent	Stratton 1987
Hexane	6	Blue-green algae	10-14	Growth	EC ₅₀	2.18	percent	Stratton 1987
Hexane	6	Blue-green algae	10-14	Growth	EC ₅₀	6.58	percent	Stratton 1987
Hexane	6	Brine shrimp	1	Immobility	EC ₅₀	1,510	µg/L	Foster and Tullis 1985
Hexane	6	Brine shrimp	1	Immobility	EC ₅₀	1,800	µg/L	Foster and Tullis 1985
Hexane	6	Brine shrimp	1	Mortality	LC ₅₀	41	mmol/m ³	Abernathy et al. 1986

Table CII.5-4 (Continued)
AQUIRE Toxicity Data for Aliphatic Petroleum Constituents

Chemical	EC #	Species	Duration (days)	Type of Effect	Endpoint	Concentration	Units	Reference
Hexane	6	Rotifer	1	Mortality	LC ₅₀	68,000	µg/L	Snell et al. 1991
Hexane	6	Rotifer	1	Mortality	LC ₅₀	68,300	µg/L	Ferrando and Andreu-Molinar 1992
Hexane	6	Rotifer	1	Mortality	LC ₅₀	154,300	µg/L	Ferrando and Andreu-Molinar 1992
Hexane	6	Oligochaete	4	Mortality	LC ₅₀	3,286,500	µg/L	Ghatak et al. 1988
Hexane	6	Green algae	0.13	Photosynthesis	EC ₅₀	94	mmol/m ³	Hutchinson et al. 1980
Hexane	6	Green algae	10-14	Growth	EC ₅₀	2.66	percent	Stratton and Smith 1988
Hexane	6	Green algae	0.13	Photosynthesis	EC ₅₀	149	mmol/m ³	Hutchinson et al. 1980
Hexane	6	Pacific oyster	2	Mortality	NR	3,300,000	µg/L	Legore 1974
Hexane	6	Daphnia magna	2	Immobility	EC ₅₀	45	mmol/m ³	Bobra et al. 1983
Hexane	6	Daphnia magna	1	NR	EC ₅₀	>1,000,000	µg/L	Bringmann and Kuhn 1982
Hexane	6	Daphnia magna	1	Mortality	LC ₅₀	>50,000	µg/L	Bringmann and Kuhn 1977
Hexane	6	American lobster	0.001-0.003	Mortality	LC ₁₀₀	9,500	µg/L	Idoniboye-Obu 1979
Hexane	6	American lobster	0.13-0.42	Mortality	LC ₁₀₀	9,500	µg/L	Idoniboye-Obu 1979

Table CII.5-4 (Continued)
AQUIRE Toxicity Data for Aliphatic Petroleum Constituents

Chemical	EC #	Species	Duration (days)	Type of Effect	Endpoint	Concentration	Units	Reference
Hexane	6	Blue-green algae	10-14	Growth	EC ₅₀	8	percent	Stratton 1987
Hexane	6	Coho salmon	4	Mortality	NR	100,000	µg/L	Morrow et al. 1975
Hexane	6	Madaka	1	Mortality	LC ₅₀	>1,000,000	µg/L	Tsuji et al. 1986
Hexane	6	Madaka	2	Mortality	LC ₅₀	>1,000,000	µg/L	Tsuji et al. 1986
Hexane	6	Fathead minnow	4	Mortality	LC ₅₀	2,500	µg/L	Geiger et al. 1990
Hexane	6	Diatom	0.33	Photosynthesis	EC ₅₀	300	µg/L	Brooks et al. 1977
Hexane	6	Ciliate	1	Mortality	NR	105	mmol/m ³	Rogerson et al. 1983
Hexane	6	Mozambique tilapia	4	Mortality	LC ₅₀	113,000	µg/L	Ghatak et al. 1988
Octane	8	Brine shrimp	1	Mortality	LC ₅₀	3.5	mmol/m ³	Abernathy et al. 1986
Octane	8	Pacific oyster	2	Mortality	NR	3,500,000	µg/L	Legore 1974
Octane	8	Daphnia magna	2	Immobility	EC ₅₀	3.3	mmol/m ³	Bobra et al. 1983
Octane	8	Blue mussel	<0.07	Food consumption	EC ₅₀	120	µg/L	Donkin et al. 1989
Octane	8	Coho salmon	4	Mortality	NR	100,000	µg/L	Morrow et al. 1975
Octane	8	Diatom	0.38	Photosynthesis	EC ₅₀	1	µg/L	Brooks et al. 1977
Octane	8	Spiny dogfish	3	Mortality	NR	10	mg/kg	Guarino et al. 1976
Octane	8	Ciliate	1	Mortality	NR	3.9	mmol/m ³	Rogerson et al. 1983

FINAL FOCUSED FEASIBILITY STUDY REPORT
South of Runway 18-36 Area
U.S. Navy, Engineering Field Activity, Northwest
Contract No. N44255-02-D-2008
Delivery Order 0037

Appendix CII.0
Revision No.: 0
Date: 05/25/05
Page CII.5-24

Table CII.5-4 (Continued)
AQUIRE Toxicity Data for Aliphatic Petroleum Constituents

Notes:

ug/L - microgram per liter

mmol/m³ - millimoles per cubic meter

Table CII.5-5
Exposure Factors for the Norway Rat

Body Weight (kg)	Home Range (acres)	Soil Ingestion Rate (kg/kg BW/day)	Food Ingestion Rate (kg DW/kg BW/day)
0.4 ^a	5.7 ^b	0.0009 ^c	0.045 ^d

^aChapman and Feldhamer (1982)

^bCalculated following Swihart et al. (1988) as home range (hectares) = $8.51 \times \text{body mass (kg)}^{1.42}$

^cAssumed to be 2.0% of diet from USEPA (1994) for the white-footed mouse

^dCalculated following USEPA (1994) as food ingestion (g DW/day) = $0.621 \times \text{weight (g)}^{0.564}$

BW = body weight

DW = dry weight

kg - kilogram

**Table CII.5-6
 Toxicity of Aliphatic Hydrocarbons to Mammals**

Chemical	Species	Conc.	Units	Effect	Endpoint	Route	Reference
Isobutane	Rat	10,000	mg/kg	weight loss	LD ₅₀	oral	RTECS
n-Pentane	Rat	10,000	mg/kg	renal	LDLO	oral	RTECS
n-Hexane	Rat	25,000	mg/kg	mortality	LD ₅₀	oral	RTECS
n-Hexane	Rat	14,400	mg/kg	mortality	LD ₅₀	oral	OHM/TAD
n-Hexane	Rat	40,000	mg/kg	Weight loss, decreased weight gain	TDLO	oral	RTECS
n-Hexane	Rat	570	mg/kg/day	Decreased weight gain, atrophy of testes, neuropathy	LOAEL	gavage	Krasavage et al. 1980
n-Hexane	Mouse	238,000	mg/kg	fetotoxicity	TDLO	oral	RTECS
Cyclohexane	Mouse	813	mg/kg	mortality	LDLO	oral	OHM/TAD
3-Methylhexane	Rat	10000	mg/kg	renal	LOAEL	oral	RTECS
n-Heptane	Rat	260,000	mg/kg	Weight loss, decreased weight gain	LDLO	oral	RTECS
n-Butylcyclohexane	Rabbit	530	mg/kg	Mortality	LD ₅₀	oral	RTECS
n-Butylcyclohexane	Rat	330	mg/kg	Mortality	LD ₅₀	oral	RTECS
n-Nonane	Mouse	90,000	mg/kg	Changes in organ weights	LDLO	oral	RTECS
2-Methylundecane	Rat	5000	mg/kg	mortality	LD ₅₀	oral	RTECS
n-Octadecane	Rat	4640	mg/kg	Mortality	LD ₅₀	oral	RTECS

LD₅₀ - lethal dose of 50 percent of exposed test animals
 LDLO - lowest published lethal dose
 LOAEL - lowest observable adverse effect level
 mg/kg - milligram per kilogram

OHM/TAD - Oil and Hazardous Materials/Technical Assistance Database
 RTECS - Registry of Toxic Effects of Contaminant Substances
 TDLO - lowest published toxic dose

**Table CII.5-7
 Mammalian Oral Toxicity Data for Aromatic Hydrocarbons**

Chemical	Species	Conc.	Units	Effect	Endpoint	Duration	Reference
Benzene	Rat	100	mg/kg/day	Growth	LOAEL	103 weeks	Huff et al. 1989
Benzene	Rat	50	mg/kg/day	Growth	NOAEL	103 weeks	Huff et al. 1989
Benzene	Mouse	4700	mg/kg	Survival	LD ₅₀		RTECS
Benzene	Dog	2000	mg/kg	Survival	LDLO		RTECS
Benzene	Mouse	6500	mg/kg	Reduced weight of offspring	TDLO		RTECS
Toluene	Mouse	1299	mg/kg	Reduced fetal weight	LOAEL		CESARS
Toluene	Mouse	2500	mg/kg	Reproduction	NOAEL	13 weeks	ATSDR
Toluene	Rat	590	mg/kg	Body weight changes	NOAEL		CESARS
Ethylbenzene	Rat	4728	mg/kg	Mortality	LD ₅₀	1 dose	ATSDR
Ethylbenzene	Rat	408	mg/kg	Liver and kidney weight increases	LOAEL		CESARS
Ethylbenzene	Rat	97	mg/kg/day	Liver and kidney weight increases	NOAEL	182 days	Wolf et al. 1956
m-Xylene	Rat	800	mg/kg	Reproductive effects	NOAEL	13 weeks	ATSDR
p-Xylene	Rat	800	mg/kg	Reproductive effects	NOAEL	13 weeks	ATSDR
p-Xylene	Mouse	2060	mg/kg/day	Reproductive, fetotoxic, developmental abnormalities	LOAEL	15 days	Marks et al. 1982
p-Xylene	Mouse	1020	mg/kg/day	Reproductive, fetotoxic, developmental abnormalities	NOAEL	15 days	Marks et al. 1982
p-Xylene	Rat	179	mg/kg/day	Mortality, decreased body weight	NOAEL	103 weeks	IRIS
o-Xylene	Rat	1000	mg/kg	Systemic effects	NOAEL	10 days	ATSDR
1,3,5-Trimethylbenzene	Rat	54000	mg/kg	Weight loss, decreased weight gain	TDLO	90 days	RTECS
Naphthalene	Rat	1780	mg/kg	Mortality	LD ₅₀	NDA	Eisler 2000
Naphthalene	Rat	41	mg/kg	Mortality	NOAEL	23 months	ATSDR
Naphthalene	Rat	36	mg/kg	Body weight	NOAEL		CESARS
Naphthalene	Rat	490	mg/kg	Survival	LD ₅₀		RTECS
Naphthalene	Mouse	316	mg/kg	Survival	LD ₅₀		RTECS

Table CII.5-7 (Continued)
Mammalian Oral Toxicity Data for Aromatic Hydrocarbons

Chemical	Species	Conc.	Units	Effect	Endpoint	Duration	Reference
Naphthalene	Dog	400	mg/kg	Mortality	LDLO		RTECS
Naphthalene	Cat	1000	mg/kg	Mortality	LDLO		RTECS
Naphthalene	Rabbit	3000	mg/kg	Mortality	LDLO		RTECS
Naphthalene	Mouse	2400	mg/kg	Reproductive, reduced viability of offspring	TDLO		RTECS
Naphthalene	Rat	4500	mg/kg	Reproductive, fetotoxic	TDLO		RTECS
2-Methylnaphthalene	Rat	1630	mg/kg	Mortality	LD ₅₀		RTECS
1-Methylnaphthalene	Rat	1840	mg/kg	Mortality	LD ₅₀		RTECS
Acenaphthylene	Mouse	1760	mg/kg	Mortality	LD ₅₀		RTECS
Acenaphthene	Mouse	1760	mg/kg	Nervous system	LD ₅₀		RTECS
Acenaphthene	Mouse	175	mg/kg	Hepatotoxicity	NOAEL	90 days	IRIS
Fluorene	Mouse	250	mg/kg	Hematological	LOAEL	13 weeks	IRIS
Fluorene	Mouse	125	mg/kg	Hematological	NOAEL	13 weeks	IRIS
Phenanthrene	Mouse	700	mg/kg	Mortality	LD ₅₀		RTECS
Phenanthrene	Mouse/Rat	700	mg/kg	Mortality	LD ₅₀	1 dose	Eisler 2000
Phenanthrene	Rat	100	mg/kg	Enzyme activity	LOAEL		CESARS
Anthracene	Mouse	1000	mg/kg	Adverse effects	NOAEL	90 days	IRIS
Pyrene	Mouse	800	mg/kg	Mortality	LD ₅₀		RTECS
Pyrene	Rat	2700	mg/kg	Mortality	LD ₅₀		RTECS
Pyrene	Mouse	75	mg/kg	Kidney weight/Nephropathy	NOAEL	13 weeks	IRIS
Fluoranthene	Rat	2000	mg/kg	Mortality	LD ₅₀	NDA	Eisler 2000
Fluoranthene	Mouse	125	mg/kg	Liver weight/Nephropathy	NOAEL	13 weeks	IRIS
Benzo(a)anthracene	Rat	2	mg/kg	Carcinogenicity	LOAEL		Eisler 2000
Benzo(a)anthracene	Rat	150	mg/kg	Systemic	NOAEL	4 days	ATSDR
Benzo(b)fluoranthene	Rat	40	mg/kg	Carcinogenicity	LOAEL		Eisler 2000
Benzo(a)pyrene	Rat	50	mg/kg	Mortality	LD ₅₀	NDA	Eisler 2000

Table CII.5-7 (Continued)
Mammalian Oral Toxicity Data for Aromatic Hydrocarbons

Chemical	Species	Conc.	Units	Effect	Endpoint	Duration	Reference
Benzo(a)pyrene	Mouse	120	mg/kg/day	Aplastic anemia	LOAEL	6 months	ATSDR
Benzo(a)pyrene	Mouse	10	mg/kg/day	Reproduction	LOAEL	gestation	Mackenzie and Angevine 1981

LD₅₀ – lethal dose to 50% of exposed test animals

LDLO – lowest published lethal dose

LOAEL – lowest observed adverse effect level

mg/kg - milligram per kilogram

NOAEL – no observed adverse effect level

TDLO – lowest published toxic dose

**Table CII.5-8
 Avian Oral Toxicity Data for Aromatic Hydrocarbons**

Chemical	Species	Conc.	Units	Effect	Endpoint	Duration	Reference
p-Xylene	Japanese quail	719	mg/kg	Overt toxicity	NOAEL	1 dose	Hill and Camardese 1986
Naphthalene	Mallard	4000 ^a	mg/kg	Systemic toxicity; liver weight and blood flow	LOAEL	7 months	Eisler 2000
Acenaphthene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Fluorene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Phenanthrene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Anthracene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Pyrene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Fluoranthene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Benzo(a)anthracene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Chrysene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Benzo(b)fluoranthene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Benzo(k)fluoranthene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Benzo(a)pyrene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Dibenz(a,h)anthracene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Benzo(ghi)perylene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980
Indeno (1,2,3-cd) pyrene	Mallard	407	mg/kg	Increased hepatic stress	LOAEL	7 months	Patton and Dieter 1980

^a – Exposed to a mixture of naphthalenes, naphthenese, and phenanthrene

LOAEL – lowest observed adverse effect level

mg/kg - milligram per kilogram

NOAEL – no observed adverse effect level

**Table CII.5-9
 Ecological RBSCs for Protection of Wildlife Exposed to Petroleum Contaminants in Soil**

Chemical	TRV (mammal) mg/kg/day	Log K _{OW}	Plant BCF	Uncertainty Factor	Soil RBSC (mg/kg)
C ₆ – C ₁₀ alkanes/cycloalkanes (Gasoline range organics)	570 ^a	3.05	0.668	10	1,840
C ₁₀ – C ₂₅ alkanes/cycloalkanes (Diesel range organics)	952 ^a	4.6	0.085	10	20,100
C ₂₅ – C ₃₆ alkanes/cycloalkanes (Residual range organics)	18,981 ^a	5.88	0.0015	10	>1,000,000
Benzene	50	2.13	2.274	2	240
Toluene	590	2.73	1.023	2	6,280
Ethylbenzene	97	3.15	0.585	2	1,780
Xylenes	179	3.26	0.505	2	3,780
1,3,5-Trimethylbenzene	54,000	3.42	0.409	10	280,000
2-Methylnaphthalene	10	3.86	0.227	20	450
Naphthalene	36	4.7	0.074	2	4,240
Acenaphthylene	10	3.7	0.281	20	37
Acenaphthene	10	4.0	0.189	20	53
Fluorene	10	4.2	0.145	20	67
Phenanthrene	10	4.46	0.102	20	90
Fluoranthene	10	4.9	0.057	20	145
Pyrene	10	4.88	0.059	20	140
Anthracene	10	4.45	0.104	20	90
Chrysene	10	5.61	0.022	20	260
Indeno(1,2,3-cd)pyrene	10	6.5	0.007	20	415
Benzo(a)pyrene	10	6.06	0.012	20	345
Benzo(a)anthracene	10	5.6	0.022	20	260
Benzo(b)fluoranthene	10	6.06	0.012	20	345
Benzo(k)fluoranthene	10	6.06	0.012	20	345
Benzo(g,h,i)perylene	10	7.23	0.003	20	490
Dibenz(a,h)anthracene	10	6.8	0.005	20	450

a – Derived from n-hexane TRV. See text for explanation of derivation methodology.

Notes:

BCF- bioconcentration factor

K_{ow} - octanol-water partition coefficient

mg/kg - milligram per kilogram

RBS - risk-based screening concentration

CII.6.0 RISK CHARACTERIZATION

This section quantifies ecological risks to target ecological receptors from the COPECs identified in Section CII.4. This section combines the results of the measures of exposure (exposure assessment) and measures of ecological effects (toxicity assessment) to provide an estimate of ecological risks from contaminants in surface soil and sediment at the South Runway Area. The procedure used to quantify risks is the hazard quotient approach, calculated through the use of Equation 14 below.

Equation 14:

$$HQ = \frac{EPC}{RBSC}$$

Where: HQ = hazard quotient
EPC = exposure point concentration
RBSC = risk-based screening concentration

Equation 14 is merely Equation 1 used in the screening level ecological risk assessment with the maximum detected concentration used as the numerator in Equation 1 replaced with the exposure point concentration in Equation 14. Hazard quotients less than one are indicative of environmental concentrations of COPEC's which do not pose unacceptable levels of risk to ecological receptors. Hazard quotients greater than one are interpreted as indicating an unacceptable risk to ecological receptors, with the magnitude of the risk increasing as the hazard quotient increases.

However, the magnitude of a hazard quotient which exceeds one cannot be directly related to the extent of an adverse effect on a given species for a given chemical. This is because the chemical concentration used as the exposure point concentration (the numerator of the hazard quotient, the maximum detected concentration of a chemical in each media for this site) is a point value, and thus the probability of an adverse effect when the EPC is compared to a dose-response curve will differ for every species. The difference is due to variation in the shape and location on the concentration axis of the dose-response curve for each target ecological receptor (Wentzel et al. 1996).

CII.6.1 Aquatic Life Risks From Contaminated Surface Waters

Risks to aquatic receptors from surface water are presented in Table CII.6-1. The hazard quotient of 1.14 for indeno(1,2,3-cd)pyrene indicates a potential risk to aquatic receptors from

for indeno(1,2,3-cd)pyrene in surface water. The GRO fraction of TPH also has a potential to pose ecological risk to aquatic life, with a hazard quotient of 5.7.

The EPC for the DRO fraction of TPH is substantially higher (79,000 µg/L) than the estimated water solubility of DRO (estimated to be 0.014 µg/L as shown in Table CII.5-3). The petroleum alkane RBSCs based on the narcosis model are not designed to evaluate risks to aquatic life in supersaturated solutions of water. Therefore, risks to aquatic life from DRO dissolved in surface waters of the South Runway Area could not be quantified. Table CII.5-4 in the toxicity assessment does, however, present the results of some toxicity tests with two alkanes, cyclododecane (C₁₂) and decane (C₁₀), both compounds with carbon chain lengths at the lower end of the DRO range. These toxicity studies with various aquatic species utilize carrier solvents to permit suspension of the alkanes in solution, with subsequent exposure of the test species to supersaturated concentrations of the alkanes in water.

Daphnia sp. mortality LC₅₀s for decane and cyclododecane range between 18,000 to 23,000 µg/L. A decane concentration of 500,000 µg/L or greater is required to elicit effects on survival in two marine species, the sheepshead minnow (*Cyprinodon variegatus*) and opossum shrimp (*Americamysis bahia*). DRO alkane toxicity information to diatoms is contradictory, with a decane EC₅₀ for photosynthetic activity of 5 µg/L in one study, and a no effect concentration of 500,000 µg/L in a second study with decane. Information with two species of *Daphnia* (*D. magna* and *D. pulex*) does provide some information that adverse effects of alkanes with carbon chain lengths within the range of diesel-range organics (C₁₀ to C₂₅) can cause toxicity to aquatic life. Therefore, the South Runway Area DRO exposure point concentration of 79,000 µg/L does have the potential to pose adverse ecological risks to aquatic species, based on the results of toxicity tests.

Based on hazard quotient calculations and the results of toxicity tests with alkanes with carbon chain lengths within the range of that of diesel-range organics, the following three chemicals are identified as chemicals of concern for ecological receptors in freshwater and estuarine surface waters of South Sweeper Creek in the vicinity of the South Runway Area:

- Indeno(1,2,3-cd)pyrene
- TPH – diesel-range organics
- TPH – gasoline-range organics

CII.6.2 Benthic Biota Risks from Contaminated Sediment

Risks to benthic biota from sediment COPECs are presented in Table CII.6-2. Four chemicals in sediment were previously identified as COPECs (see Section CII.4.3). All four COPECs were

found to have hazard quotients greater than 1.0 following baseline risk characterization, ranging from 2.3 (GRO) to 13.2 (DRO), and are identified as COCs to ecological receptors exposed to freshwater and marine sediments.

The following chemicals in freshwater and estuarine sediment in South Sweeper Creek in the vicinity of the South Runway Area have the potential to pose unacceptable ecological risks to benthic biota:

- 2-Methylnaphthalene
- Phenanthrene
- GRO
- DRO

CII.6.3 Conclusions of the Risk Characterization Phase

Once the baseline risk calculations have been completed, Alaska DEC (2000) risk guidance reaches Ecological Scientific/Management Decision Point #7. Decision Point #7 results in a determination of whether the site poses no ecological risks, at which point the risk assessment process can be terminated, or whether risk management decisions are required for a site. The determination as to whether to conclude the ecological risk assessment process or to proceed to risk management is dependent on the answers to the questions listed below.

<i>Ecological Scientific/Management Decision Point #7</i>
Are ecological receptors at the site expected to be exposed to contaminants at levels capable of causing harm to the overall ecosystem? Or to a particular valued species within that ecosystem? Now or in the future? Yes? Calculate alternative cleanup levels or go to 4.3.7 (Risk management) No? End of ecological risk assessment.
<i>ANSWER FOR THE SOUTH RUNWAY AREA: YES</i>

The hazard quotients developed for contaminants at the South Runway Area show that detected concentrations for indeno(1,2,3-cd)pyrene, DRO and GRO in surface water of South Sweeper Creek, and 2-methylnaphthalene, phenanthrene, DRO and GRO in sediments of South Sweeper Creek exceed acceptable ecological benchmarks (i.e., some hazard quotients exceed 1.0).

Therefore, there is a potential for unacceptable risk to ecological receptors in freshwater and estuarine areas of South Sweeper Creek associated with petroleum release products from the South of Runway 18-36 Area site.

CII.6.4 Cleanup Levels Discussion

Alaska State Regulations do not establish cleanup levels for sediment (ADEC 2004). Therefore, the RBSCs derived for sediment were selected as the risk-based cleanup levels for chemicals identified as COCs in sediment: 0.02 mg/kg for 2-methylnaphthalene, 0.225 mg/kg for phenanthrene, 90.6 mg/kg for TPH-DRO, and 12.2 mg/kg for TPH-GRO.

For surface water, as discussed in Section 3.6.1 of the FFS, the water quality standards established by Alaska regulation 18 AAC 70 specifies that “Total Aqueous hydrocarbons (TAqH) in the water column may not exceed 15 µg/L. Total aromatic hydrocarbons (TAH) in the water column may not exceed 10 µg/L. There may be no concentrations of petroleum hydrocarbons, animal fats, or vegetable oils in shoreline or bottom sediments that cause deleterious effects to aquatic life. Surface waters and adjoining shorelines must be virtually free from floating oil, film, sheen, or discoloration” [18 AAC 70.020(b)(17)(A)(i), 18 AAC 70.020(b)(17)(B)(ii), 18 AAC 70.020(b)(17)(C)]. These water quality criteria are the cleanup levels for surface water of South Sweeper Creek in the vicinity of the South of Runway 18-36 Area.

Alaska State Regulations do not establish cleanup levels for individual chemicals, TPH-DRO, and TPH-GRO in surface water. Therefore, in addition, the RBSCs derived for surface water were selected as the risk-based cleanup levels for the individual chemicals that were identified as COCs in surface water of South Sweeper Creek: 0.28 µg/L for indeno(1,2,3-cd)pyrene, 0.014 µg/L for TPH-DRO, and 114 µg/L for TPH GRO. These are additional cleanup levels and do not replace the surface water quality criteria applicable to the site, as described in the previous paragraph. Note, the risk-based cleanup level for TPH-DRO of 0.014 µg/L is based on the maximum solubility of the chemical. The presence of TPH-DRO at concentrations greater than this solubility could produce a sheen on the surface waters of South Sweeper Creek. Thus, the risk-based cleanup level for TPH-DRO meets the Alaska water quality standard 18 AAC 70.020(b)(17)(C).

**Table CII.6-1
 Results of the Baseline Ecological Risk Assessment to Identify COCs in
 Surface Water at the South of Runway 18-36 Area**

Chemical	Exposure Point Concentration (µg/L)	RBSC (µg/L)	Hazard Quotient	Poses Potential Ecological Risk?	Rationale
Indeno(1,2,3-cd)pyrene	0.32	0.28	1.14	YES	Site chemical concentration exceeds RBSC
TPH - Diesel range organics	79,000	0.014	NC	UNKNOWN	RBSC not available to quantify risks when DRO concentration is in excess of maximum water solubility
TPH - Gasoline range organics	650	114	5.7	YES	Site chemical concentration exceeds RBSC

Notes:

COC - Contaminant of concern

NC - not calculated

µg/L - micrograms contaminant per liter of water

RBSC - Risk-based screening concentration

TPH - Total petroleum hydrocarbons

**Table CII.6-2
 Results of the Baseline Ecological Risk Assessment to Identify COCs in
 Sediment at the South of Runway 18-36 Area**

Chemical	Exposure Point Concentration (mg/kg)	RBSC (mg/kg)	Hazard Quotient	Poses Potential Ecological Risk?	Rationale
2-Methylnaphthalene	0.13	0.0202	6.4	YES	Site chemical concentration exceeds RBSC
Phenanthrene	1.4	0.225	6.2	YES	Site chemical concentration exceeds RBSC
TPH - Diesel range organics	1200	90.6	13.2	YES	Site chemical concentration exceeds RBSC
TPH - Gasoline range organics	28	12.2	2.3	YES	Site chemical concentration exceeds RBSC

Notes:

COC - Contaminant of concern

mg/kg - milligrams contaminant per kilogram of sediment

RBSC - Risk-based screening concentration

TPH - Total petroleum hydrocarbons

CII.7.0 UNCERTAINTIES ASSOCIATED WITH THE ECOLOGICAL RISK ASSESSMENT

Limitations associated with any risk assessment have a number of components, including degree of success in meeting objectives, the range of conditions over which conclusions can be applied, and the certainty with which conclusions can be drawn. The conclusions of a risk assessment are useful only once they have been placed in perspective relative to the uncertainties associated with the evaluation. The purpose of this section is to provide that perspective.

CII.7.1 Components of Uncertainty

Uncertainty in risk estimation has both qualitative and quantitative components. Where possible, quantitative uncertainty analyses provide objective measures of the relative confidence in conclusions and applications. Both qualitative and in some cases quantitative evaluations of uncertainty are presented in this section.

For practical purposes, uncertainty has two primary components: uncertainty and variability. True uncertainty is indicative of an area where risk assessors have a lack or absence of knowledge of an environmental parameter. Lack of knowledge of the ingested dose of a mixture of diesel range organics which reduces survival of any species of bird is an uncertainty encountered in this risk assessment. Variability refers to observed differences attributable to heterogeneity or diversity in a population or exposure parameter. Differences in COPEC concentrations at different locations within a site is an example of variability. Statistical theory indicates that true variability of a parameter is fixed, but that the estimate of variability can be improved by additional measurements or study.

Uncertainty surrounding risk assessment conclusions has important implications for risk management. However, "uncertainty" is not a single, generally applicable parameter. Uncertainty surrounding a risk estimate or application has a number of components, including parameter variability, calculation error and simplification, and the underlying reality of exposure assumptions and pathways. It is important to understand that uncertainty includes both real variation (reflecting actual, mechanistic biological response ranges and variability in ecosystem conditions) and error. Thus, because biological systems are inherently uncertain and variable, some component of variability in risk estimation is due to the reality of ecological systems, while another component is due to error or uncertainty introduced by the overall analytical process. Error is the component which can be minimized by additional information and knowledge, because this encompasses undesirable uncertainty that has been introduced by the assessment process. However, it is critically important to understand ecosystem variability because this represents an important component of the ecosystem within which risk management decisions must be made.

CII.7.2 General Sources of Uncertainty

Uncertainties surrounding estimates of ecological risk are intrinsically greater than those associated with human health risk assessments, due to the multiplicity of potential receptor species, a general lack of knowledge regarding their life histories and behaviors, and the unknowns of toxicological sensitivities among the receptor species. The generic RBSCs and TRVs used in this assessment are intended to provide conservative benchmarks for screening potential exposures. It is important to note that no one approach to TRV derivation is adequate for all sites and chemicals. The TRVs used in this ecological risk assessment are all chemical-specific and as such cannot address the additive, antagonistic, or synergistic effects of the mixtures of chemicals typically found in the environment. Further, they do not take into account the site-specific conditions regulating chemical exposure and bioavailability, the potential toxicity of other chemicals that were not quantified, the nature and structure of the habitats and ecosystems present at the site, or the pervasive influence of anthropogenic changes in the environment. Anthropogenic influences can be both chemical (e.g. groundwater transport of chemicals from the site to Sweeper Cove) and physical (e.g. buildings and infrastructure on the site) in nature.

A qualitative description of many of the uncertainty and variability factors associated with the parameters used to estimate risks to ecological receptors are provided in Table CII.7-1. The factors in Table CII.7-1 are generally applicable to both aquatic and terrestrial ecological risk assessment.

Due to the complexity of community and population dynamics, it is not currently possible to evaluate all possible exposures or effects. The information presented, while complete and accurate, may have missed long-term influences to the environmental chemistry of COPECs or other means of quantifying adverse effects of COPECs on receptors, or may have failed to address adaptation of robust natural communities to conditions such that some adaptations to chemical and physical effects has been imparted. In addition, while ecological functional redundancies contributed by unevaluated species may provide resiliency against adverse effects at the community and ecosystem levels, sensitivities may be present in other populations that have not been evaluated in the current study. In either case, the studies presented are only “snapshots” (albeit multiyear snapshots) of conditions as they exist at the site, and it is virtually certain that not all of the underlying variability and stressor effects have been quantified. Therefore, it is important to recognize that (1) potentially large uncertainties exist regarding community and population health, but (2) these uncertainties most probably do not directionally bias conclusions.

Further, it is important to recognize that substantial differences exist between observations and conclusions made at the individual, population, and community levels of biological organization. For example, effects not manifested at the population or community levels (e.g., mortality of only a few individuals) may not be observable in the field. The ramifications of this also include an understanding that because the assessment endpoints are protective of populations (not individuals), risks projected to cause loss of a few individuals may not cause impacts that are important at the levels of assessment where risk management decisions are made.

With the exception of special status species, most risk management decisions for fish and wildlife species are based on population level effects. Threatened and endangered species are protected, by law, as individual organisms, not at the population level. In contrast to the risk assessment for aquatic biota, wildlife exposure to contaminants is estimated for multiple media, in this case water and prey. Multimedia exposure estimates generally represent exposure of individuals to contaminants, expressed as an ingested dose (mg/kg/day). Wildlife toxicity data are almost exclusively based on individual level effects (Suter et al. 2000). Therefore, wildlife risk characterizations utilizing hazard quotients of multimedia exposure estimates and individual level toxicity data are individual level risk characterizations, the appropriate level of biological organization for assessing risks to a threatened or endangered species. No threatened or endangered species were used as target ecological receptors in this risk assessment.

The analysis performed for this assessment did not account for site-specific factors such as natural attenuation of COPECs over time, adaptive tolerance, reproductive potential, the small size of the affected area, the anthropogenically extensively modified nature of the available habitat, and recruitment from similar adjoining areas. Such factors would tend to mitigate the degree and ecological significance of loss or impairment of a portion of ecological population(s) due to both chemical and physical stressors in the area. As a result, the approach used in this assessment necessarily results in overestimation of risk.

CII.7.3 Specific Sources of Uncertainty

CII.7.3.1 Sediment RBSCs

The sediment RBSCs used in the EcoRA were either compiled from the Washington sediment management standards or derived using the USEPA ambient water quality criteria. In order to demonstrate the conservativeness of these RBSCs in this assessment, alternative screening criteria were evaluated in this uncertainty analysis.

As noted in Table CII 7-2, the sediment COPCs would be the same if the National Oceanographic and Atmospheric Administration (NOAA) Freshwater Threshold Effects Level (TEL) and Probable Effects Level (PEL) or Marine Effects Range Low (ERL) and Effects Range

Median (ERM) values were used as the basis for comparison. If both the freshwater TEL or PEL and marine ERL or ERM were available, the freshwater TEL or PEL was selected since although the creek is tidally-influenced, it may be freshwater during heavy rainfall. Therefore, even if the sediment RBSCs available on the NOAA SquiRT tables (NOAA 1999) were used as the RBSCs for this assessment, the conclusions of the risk assessment would not change.

CII.7.3.2 Temporal and Spatial Distribution of COPECs

The analytical database has inherent uncertainties and limitations. Also, the distribution of COPECs within surface soil was assumed to coincide with receptor contact with surface soil (i.e., the measured COPEC concentrations at the specific sampling locations are representative of COPEC concentrations throughout the site). The degree to which this assumption is met is not quantifiable and the direction of bias (if any) cannot be identified. In addition, due to the small available data base of detected chemicals, only a surrogate for the expected environmental concentration, the maximum detected concentration was used as exposure point concentrations. This technique introduces a considerable degree of conservatism as well as uncertainty.

Only the apparent worst case exposures were evaluated in this document during the screening level ecological risk assessment. TRVs for the organisms were compared to the maximum detected concentration within the available dataset. With the exception of sessile organisms, these exposure assumptions are overly conservative and unrealistic for several reasons. The available data is not a time-integrated series of observations, but are point estimates. These values will be influenced by precipitation, and groundwater infiltration and exfiltration rates. Thus, even for sessile organisms, exposure concentrations are not constant and will vary about some unknown mean concentration. Therefore, the mean or median is a better measure of the central tendency of the available data. Furthermore, organisms which are not sessile integrate their exposure over time and distance. For these organisms, the mean or median concentrations within their respective forage ranges is the best measure of central tendency. The use of an estimate of the mean site contaminant concentration (the 95%UCL of the arithmetic mean) as the exposure point concentration in the baseline risk assessment somewhat mitigates the conservative exposure assumptions used in the screening level ecological risk assessment.

CII.7.3.3 Toxicity Reference Values and Risk-Based Screening Concentrations

The RBSCs or TRVs selected for this document are not in all cases the lowest available adverse effects concentrations available in the scientific literature. Instead, they are based on the best professional judgment of those studies that best represent the ecological receptors present at the site, and the exposures they are expected to receive in the field. However, it should be noted that, for sediments, use of more conservative benchmarks had no effect on the selected sediment COPECs (Table CII.7-2). The TRVs in the ecological risk assessment are those that are most

relevant to population stability. The aquatic biota TRVs are based on studies which evaluated COPEC effects on survival, reproduction and growth.

In fact, NOAELs used as TRVs can be lower than true no effect exposures. This is because NOAELs are estimated from an incomplete dose-response relationship in which there is a large gap between the lowest exposure that caused no effect and the next higher concentration that did cause an effect. Therefore, the TRVs used in this document are very conservative, so that while, perhaps, still uncertain scientifically, they are more than adequate to provide a screening level estimate of ecological risks.

CII.7.3.4 Model Used to Derive RBSCs for Aquatic Biota

The model used to derive the RBSCs for petroleum alkanes, BTEX and PAHs did not account for the contribution of suspended particulates and contributes to the uncertainty of the EcoRA. Sorption of BTEX to suspended particulates is expected to be minimal and the exclusion of suspended particulates is expected to have minimal impact to these RBSCs. The Koc (organic carbon partition) for short chain alkanes (TPHCWG 1996) tend to be comparable to Koc values for PAHs. Generally, PAHs, particularly the high molecular weight PAHs, tend to bind tightly to suspended solids and the RBSCs may not be protective of some filter-feeding organisms. However, it should be noted that the degree of sorption to particulates can also influence the bioavailability and, therefore, the toxicity of a given contaminant.

The no effects tissue approach to deriving aquatic RBSCs is conservative for most PAHs. Although the U.S. EPA ambient water quality criteria (AWQC) (USEPA, 2002) for PAHs and BTEX have been withdrawn, NOAA AWQC benchmarks in their screening quick reference tables (SquiRTs) (NOAA 1999) typically used as risk-based screening benchmarks for acenaphthene for freshwater (520 µg/L) or saltwater (710 µg/L) as compared to concentrations used as RBSCs in this report of 56 µg/L. NOAA SQuiRT benchmarks for naphthalene for freshwater is 620 µg/L as compared to concentrations used as RBSCs in this report of 193 µg/L. For aliphatic petroleum constituents, toxicity data for a mix of freshwater (daphnia) and saltwater (sheepshead minnow) are presented in Table CII.5-4. As noted in Section CII.5, none of the adverse effect concentrations for this mix of freshwater or marine organisms for alkanes are lower than the alkane RBSCs derived using the no effects tissue concentrations. As such, the aquatic RBSCs used in this EcoRA are believed to be sufficiently protective of aquatic species in both freshwater and marine environments.

CII.7.3.5 Interspecies Extrapolations

Historically, toxicity data from surrogate (laboratory) animals was extrapolated to wildlife species using UFs and/or scaling for body mass. The use of UFs has been severely criticized

because very little interspecies data exists and most UFs are based on scientifically unsupported orders of ten. In an attempt to avoid the problems associated with UFs, TRVs derived from scaling of the body mass of the test species to the body mass of the target ecological receptor were chosen. This concept is firmly based in physiological research, mostly concerning basic metabolism.

Allometric scaling also has its limitations. An obvious example involves extrapolating from mice to elephants. As body mass increases, the animal is believed to become more sensitive to the effects of contaminants, because metabolism and its associated contaminant depuration and detoxification becomes relatively slower in larger species. Therefore, the dose required to kill a mouse should be adequate to kill several elephants. Obviously, there are problems associated with this concept.

One of the larger uncertainties in this ecological risk assessment is the utility of the conclusions of this ecological risk assessment for avian species such as the Lapland longspur. Aside from the uncertainty mentioned earlier that there are no avian TRVs available for any of the petroleum alkane mixtures which were COPECs in this risk assessment, there is uncertainty regarding the reliability of interclass extrapolations of risk from the Class Mammalia to the Class Aves. Unfortunately, there is no quantitative or qualitative method by which this extrapolation can be evaluated. As noted in Section CII.5.2.2, there is currently no recommended methodology available by which a mammalian TRV can be used to derive an avian TRV. In addition, diet and foraging habits can also influence exposure. For instance, avian invertivores would likely ingest a higher quantity of soil and, depending on uptake rates in insects, could possibly have a higher exposure via contaminated prey.

CII.7.3.6 Hazard Quotients

The hazard quotient method is the simplest and most commonly used method currently available by which to compare exposures to TRVs. A major advantage of the quotient method is that since exposure point concentrations are the maximum detected concentrations of abiotic media concentrations, exposure and risk is likely overestimated in all cases. The major disadvantage comes from the derivation of a point estimate of risk that results from use of a single TRV. Since all species have not been tested, and even different tests with the same organism frequently have different conclusions, it is possible that a given target ecological receptor will be more sensitive than the surrogate selected for the TRV derivation, and that this will lead to an underestimation of the risk to that particular receptor.

CII.7.3.7 Minor or Insignificant Exposure Pathways for Terrestrial Receptors

Exposure of terrestrial receptors to the creek through ingestion was considered a minor or insignificant pathway, as depicted on the CSM Figure CII.1-1. However, this pathway was evaluated in this uncertainty discussion. Surface water ingestion generally represents a small portion of the total dose for ecological receptors, particularly when the water concentrations are low as evidenced in Table CII.7-3. Using the rat as our receptor of concern, the exposure from surface water ingestion was quantitatively evaluated assuming the animal drank exclusively from the stream.

The mammalian water ingestion rate was estimated based on Calder and Braun (1983) equation of $0.99 (BW)^{0.9}$ kg, yielding a water ingestion rate of 0.438 L/day. The mammalian TRVs were taken from Table CII.5-9 and were the same values used to generate soil RBSCs for soil and food ingestion. As noted in Table CII.7-3, the hazard quotients for this exposure route are very low, indicating this route of exposure is insignificant relative to soil driven pathways. Therefore, exclusion of this pathway from quantitative evaluation is not likely to affect the conclusions reached in the ecological risk assessment.

CII.7.4 Summary of Ecological Evaluation of the South of Runway 18-36 Area

In accordance with Alaska DEC (2000) risk assessment guidance, the first stage of the ecological risk assessment for the South Runway Area was to determine whether a detailed, quantitative ecological risk assessment (required whenever the potential for an ecological threat from site contaminants exists) of the site was required. Alaska DEC terms this determination Ecological Scientific/Management Decision Point #1. In order to make that decision, Alaska DEC requires the assessment of two factors:

1. The potential presence of state or federal sensitive environments, critical habitats, or sensitive species at the South Runway Area; and
2. The potential presence of complete exposure pathways that result in the ecologically significant exposure of ecological receptors to site contaminants.

If, at Ecological Scientific/Management Decision Point #1, the determination can be made that: 1) no state or federal sensitive environments, critical habitats, or sensitive species are present; and 2) no exposure pathways exist that result in the ecologically significant exposure of ecological receptors to site contaminants; Alaska DEC (2000) guidance permits the ecological risk assessment process for a given site to be terminated.

An ecological checklist (found in Appendix B of the Alaska DEC Risk Assessment Procedures Manual [2000] and included in this report as Attachment CII-1) was completed, describing the location and characteristics (i.e., environmental setting, land use, environmental fate-and-transport, ecological receptors) of specific environments within the boundaries of the South Runway Area. Through this exercise, it was determined that critical habitat for anadromous salmonids is present at the South Runway Area.

An ecological CSM was also prepared for the South Runway Area, describing the completeness and significance of exposure pathways by which ecological receptors may potentially be exposed to site contaminants. The CSM (included as Figure CII.1-1) revealed that complete exposure pathways exist at the South Runway Area that result in the ecologically significant exposure of ecological receptors to site contaminants:

1. Aquatic receptors may be exposed to site contaminants in marine and fresh surface water and sediments; and
2. Terrestrial receptors may be exposed to site contaminants in surface soil 0 to 6 feet below ground surface.

Based on this assessment, a potential ecological threat exists to ecological receptors from petroleum release products in South Sweeper Creek, nearshore marine areas of Sweeper Cove, and at the South Runway Area. Therefore, an ecological effects evaluation that quantitatively described the potential ecological risk associated with exposure to site contaminants was conducted.

Site-specific soil, sediment and water data revealed that contaminants were not detected in soil at concentrations which exceed conservative ecological RBSCs. Therefore, ecological risk at the South Runway Area was estimated only for contaminants in surface water and sediment of South Sweeper Creek and nearshore marine areas of Sweeper Cove. Hazard quotients were derived for the detected contaminants using the methods outlined in Section CII.5 to determine whether any of the COPECs might present an unacceptable risk to ecological receptors. Three surface water contaminants and four sediment contaminants were identified as COPECs in the screening level ecological risk assessment presented in Section CII.4, and were forwarded to the baseline ecological risk assessment.

The risk characterization phase of the baseline ecological risk assessment identified all three surface water COPECs (i.e., indeno(1,2,3-cd)pyrene, DRO, GRO), and all four sediment COPECs (2-methylnaphthalene, phenanthrene, DRO, GRO) as having the potential to pose a significant, unacceptable risk to aquatic life and benthic biota.

FINAL FOCUSED FEASIBILITY STUDY REPORT
South of Runway 18-36 Area
U.S. Navy, Engineering Field Activity, Northwest
Contract No. N44255-02-D-2008
Delivery Order 0037

Appendix CII.0
Revision No.: 0
Date: 05/25/05
Page CII.7-9

Based on these data, a potential ecological threat exists to aquatic life and benthic biota at locations in South Sweeper Creek and nearshore marine areas of Sweeper Cove. Surface soils at the South Runway Area do not pose quantifiable risks to any ecological receptor.

**Table CII.7-1
 General Factors Associated With Uncertainty and Variability
 in the Ecological Risk Assessment**

Uncertainty/Variability Factor	Direction of Uncertainty	Comment
Use of conservative exposure scenarios	Will overestimate risk	Intent of using maximum exposure and dose concentrations is to be protective of biota and minimize effects of uncertainties that underestimate risks
Unavailability of toxicity reference values for some chemicals and exposure pathways	Will underestimate risk	Some site risks may be unquantifiable due inability to compare site concentrations to a concentration known to pose unacceptable risks to wildlife. Other uncertainties come from inability to quantify chemical risks to receptors DRO and RRO concentrations which exceed their maximum water solubility.
Use of smaller receptors to assess ecological risks	May overestimate or underestimate risks	<p>Smaller aquatic animals (or younger individuals of the same species) are generally more sensitive to toxic effects of chemicals than larger species or individuals. Larger aquatic animals may bioaccumulate higher concentrations of COPEC's, and may have more completely developed biochemical and physiological mechanisms which can affect toxicity.</p> <p>For terrestrial wildlife, smaller species are considered less sensitive to contaminants than are larger species, because the smaller species have higher metabolic rates, which allows them to detoxify and/or deplete contaminants more efficiently than can larger species.</p>
Point estimates of exposure concentrations of COPEC's in environmental media	Tends to overestimate risks	Point estimates do not take into account bioavailability of chemicals or the likelihood of variable exposure concentrations.
Focus of risk assessment on chemicals analyzed and detected	Will underestimate risk	Chemicals not detected or not analyzed for may contribute to risks.
Exposure of chemicals not related to the Site not considered	Will underestimate total risks, may overestimate Site-related risks if non-site chemicals are contributing to toxicity	Non-site related contaminants are potentially present in appreciable concentrations at South Runway
Hazard quotient calculation	May overestimate or underestimate risks	Direction of effect depends on accuracy with which TRVs describe the response of biota to chemicals

Table CII.7-1 (Continued)
General Factors Associated With Uncertainty and Variability
in the Ecological Risk Assessment

Uncertainty/Variability Factor	Direction of Uncertainty	Comment
Use of NOAEL's as TRV's instead of LOAEL's	May underestimate risks for sensitive species. No effect on or will overestimate risks for most species.	NOAEL values dependent on range of concentrations tested in laboratory studies, highest true NOAEL may be higher than NOAEL used as a TRV.
Analytical chemistry variability	May overestimate or underestimate risks	Organic analyses within 35% relative percent difference of each other may be equivalent.

Notes:
 COPEC - contamination of potential ecological concern
 DRO - diesel-range organics
 LOAEL - lowest-observed-adverse-effect
 NOAEL - no-observed-adverse-effect
 RRO - residual-range organics
 TRV - toxicity reference value

**Table CII.7-2
 Comparison of RBSCs Used to Identify COPECs in
 Sediment at the South of Runway 18-36 Area**

Chemical	Maximum Detected Concentration (mg/kg)	NOAA TEL/PEL or ERL/ERM ^a (mg/kg)	Exceeds TEL or ERL?	RBSC Used in the EcoRA (mg/kg)	Hazard Quotient	Exceeds RBSC?
2-Methylnaphthalene	0.13	0.07/0.67	YES	0.0202	6.4	YES
Ethylbenzene	0.03	---	---	14	0.002	NO
Fluoranthene	0.05	0.111/2.355	NO	0.6	0.08	NO
Naphthalene	0.13	0.16/2.1	NO	0.99	0.1	NO
Phenanthrene	1.4	0.042/0.515	YES	0.225	6.2	YES
Pyrene	0.03	0.053/0.875	NO	0.35	0.09	NO
Toluene	0.07	---	---	4.6	0.01	NO
TPH - Diesel range organics	1200	---	---	90.6	13.2	YES
TPH - Gasoline range organics	28	---	---	12.2	2.3	YES
Xylenes	0.2	---	---	0.79	0.3	NO

Notes:

- COPEC - Contaminant of potential ecological concern
- ERL - Effects Range Low
- ERM - Effects Range Median
- mg/kg - milligrams contaminant per kilogram of sediment
- NA - not available
- NC - not calculated
- NOAA - National Oceanographic and Atmospheric Administration
- PEL - Probable Effects Level
- RBSC - Risk-based screening concentration
- TEL - Threshold Effects Level
- TPH - Total petroleum hydrocarbons
- - no value

^a If both the freshwater TEL or PEL and marine ERL or ERM were available, the freshwater TEL or PEL was selected since although the creek is tidally-influenced, it may be freshwater during heavy rainfall.

**Table CII.7-3
 Calculation of Hazards Associated with Ingestion of
 Surface Water at the South of Runway 18-36 Area**

Chemical	Maximum Detected Concentration (µg/L)	Ingestion Rate (L/day)	Body Weight (kg)	Conversion (µg to mg)	Dose (mg/kg/d)	TRV (mg/kg/d)	Hazard Quotient
2-Methylnaphthalene	1.50	0.438	0.4	0.001	0.0016	10	0.0002
Benzo(a)anthracene	0.84	0.438	0.4	0.001	0.0009	10	0.0001
Benzo(a)pyrene	0.34	0.438	0.4	0.001	0.0004	10	0.0000
Benzo(b)fluoranthene	0.50	0.438	0.4	0.001	0.0005	10	0.0001
Benzo(g,h,i)perylene	0.33	0.438	0.4	0.001	0.0004	10	0.00004
Benzo(k)fluoranthene	0.27	0.438	0.4	0.001	0.0003	10	0.00003
Chrysene	1.50	0.438	0.4	0.001	0.0016	10	0.0002
Ethylbenzene	1.50	0.438	0.4	0.001	0.0016	97	0.00002
Fluorene	3.50	0.438	0.4	0.001	0.0038	10	0.0004
Indeno(1,2,3-cd)pyrene	0.32	0.438	0.4	0.001	0.0004	10	0.00004
Toluene	1.10	0.438	0.4	0.001	0.0012	590	0.000002
TPH - Diesel range organics	79000	0.438	0.4	0.001	86.5050	952	0.0909
TPH - Gasoline range organics	650	0.438	0.4	0.001	0.7118	570	0.0012
Xylenes	5.70	0.438	0.4	0.001	0.0062	179	0.00003

Notes:

kg - kilogram

L - liter

µg/L - microgram per kilogram

mg - milligram

TPH - total petroleum hydrocarbon

CII.8 LITERATURE CITED

- Abernathy, S., A.M. Bobra, W.Y. Shiu, P.G. Wells, and D. Mackay. 1986. Acute Lethal Toxicity of Hydrocarbons and Chlorinated Hydrocarbons to Two Planktonic Crustaceans: The Key Role of Organism-Water Partitioning. *Aquatic Toxicology* 8(3):163-174.
- Alaska Department of Environmental Conservation (ADEC). 2000. Risk Assessment Procedures Manual. Contaminated Sites Remediation Program, Juneau, AK. June 8, 2000.
- Alaska Department of Environmental Conservation (ADEC). 1999. *User's Guide for Selection and Application of Default Assessment Endpoints and Indicator Species in Alaskan Ecoregions*. Contaminated Sites Remediation Program, Juneau, AK.
- Alaska Department of Environmental Conservation. 1996. Petroleum Cleanup Guidance: Background on Development of Regulations for Soil and Groundwater Cleanup Levels at Sites Contaminated with Petroleum Products. Public Review Draft, Division of Spill Prevention and Response, Juneau, AK. 23 pp.
- Amundsen, C.C. 1985. *Central Aleutian Tundra: Ecological Manifestations of Maritime Tundra Landscapes in the Central Aleutian Islands (Amchitka, Adak) Alaska*. Report ORO-4180-10, U.S. Department of Energy. Prepared by Department of Botany, University of Tennessee, Knoxville, TN.
- Bobra, A.M., W.Y. Shiu, and D. Mackay. 1983. A Predictive Correlation for the Acute Toxicity of Hydrocarbons and Chlorinated Hydrocarbons to the Water Flea (*Daphnia magna*). *Chemosphere* 12(9-10):1121-1129.
- Boehm, P.D. and J.G. Quinn. 1976. The effect of dissolved organic matter in sea water on the uptake of mixed individual hydrocarbons and number 2 fuel oil by a marine filter-feeding bivalve (*Mercenaria mercenaria*). *Estuar. Coast. Mar. Sci.* 4:93-105.
- Boudreau, B.P. 1994. Is burial velocity a master parameter for bioturbation? *Geochim. Cosmochim. Acta* 58:1243-1249.
- Bridges, T.S. and C.H. Lutz. 1999. *Interpreting Bioaccumulation Data with the Environmental Residue-Effects Database*. Dredging Research Technical Note EEDP-04-30, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, USA.

Bringmann, G. and R. Kuhn. 1982. Results of Toxic Action of Water Pollutants on *Daphnia magna Straus* Tested by an Improved Standardized Procedure. *Z. Wasser-Abwasser-Forsch.* 15(1):1-6.

Bringmann, G. and R. Kuhn. 1977. Results of the Damaging Effect of Water Pollutants on *Daphnia magna*. *Z. Wasser-Abwasser-Forsch.* 10(5):161-166.

Brooks, J.M., G.A. Fryxell, D.F. Reid, and W.M. Sackett. 1977. Gulf Underwater Flare Experiment (GUFEX): Effects of Hydrocarbons on Phytoplankton. In Proc. Pollution Effects Marine Organisms, C.S. Giam (Ed.). pp.45-75.

Brunstrom, B., D. Broman, and C. Naf. 1991. "Toxicity and EROD-Inducing Potency of 24 Polycyclic Aromatic Hydrocarbons (PAHs) in Chick Embryos." *Archives of Toxicology.* Volume 65. Pages 485-489.

Chapman, H.F. and D.W. Connell. 1986. Uptake and clearance of diesel alkanes from sediments by the Great Barrier Reef gastropod *Strombus luhuanus*. *Mar. Biol.* 92:15-19.

Cravedi, J.P. and J. Tulliez. 1982. Accumulation, distribution and depuration in trout of naphthenic and isoprenoid hydrocarbons (dodecylcyclohexane and pristane). *Bull. Environ. Contam. Toxicol.* 28:154-161.

Das, P.K.M.K. and S.K. Konar. 1988. Acute Toxicity of Petroleum Products, Crude Oil and Oil Refinery Effluent on Plankton, Benthic Invertebrates and Fish. *Environ. Ecol.* 6(4):885-891.

Deneer, J.W., T.L. Sinnige, W. Seinen and J.L.M. Hermens. 1988. The joint acute toxicity to *Daphnia magna* of industrial organic chemicals at low concentrations. *Aquat. Toxicol.* 12:33-38.

Donkin, P., J. Widdows, S.V. Evans and M.D. Brinsley. 1991. QSARs for the sublethal responses of marine mussels (*Mytilus edulis*). *Sci. Total Environ.* 109/110:461-476.

Donkin, P., J. Widdows, S.V. Evans, C.M. Worrall and M. Carr. 1989. Quantitative structure-activity relationships for the effect of hydrophobic organic chemicals on rate of feeding by mussels (*Mytilus edulis*). *Aquat. Toxicol.* 14:277-294.

Dyer, S.D., C.E. White-Hull and B.K. Shephard. 2000. Assessments of chemical mixtures via toxicity reference values overpredict hazard to Ohio fish communities. *Environ. Sci. Technol.* 34:2518-2524.

Eisler, R.M. 2000. Handbook of Chemical Risk Assessment, Health Hazards to Humans, Plants, and Animals. Volume 2, Organics. Lewis Publishers, Boca Raton, FL.

Ferrando, M.D., and E. Andreu-Molinar. 1992. Acute Toxicity of Toluene, Hexane, Xylene, and Benzene to the Rotifers *Brachionus calyciflorus* and *Brachionus plicatilis*. Bull. Environ. Contam. Toxicol. 49(2):266-271.

Foster, G.D. and R.E. Tullis. 1985. Quantitative Structure-Toxicity Relationships with Osmotically Stressed *Artemia salina* Nauplii. Environ. Pollut. Ser. A Ecol. Biol. 38:273-281.

Franks, N. and W. Lieb. 1978. Where do general anaesthetics act? Nature 274:339-342.

Freitag, D., L. Ballhorn, H. Geyer and F. Korte. 1985. Environmental hazard profile of organic chemicals: An experimental method for the assessment of the behaviour of organic chemicals in the ecosphere by means of laboratory tests with ¹⁴C labelled chemicals. Chemosphere 14:1589-1616.

Geiger, D.L., L.T. Brooke, and D.J. Call. 1990. Acute Toxicities of Organic Chemicals to Fathead Minnows (*Pimephales promelas*), Vol. 5. Center for Lake Superior Environmental Studies, University of Wisconsin, Superior, WI. 332 pp.

Ghatak, D.B., M.M. Hossain, and S.K. Konar. 1988. Acute Toxicity of n-Heptane and n-Hexane on Worm and Fish. Environ. Ecol. 6(4):943-947.

Golder Associates Ltd. 1995. Recommendations to B.C. Environment for Development of Remediation Criteria for Petroleum Hydrocarbons in Soil and Groundwater. Volume 1, Text. Submitted to Industrial Wastes and Hazardous Contaminants Branch, British Columbia Ministry of Environment, Lands and Parks, Victoria, B.C. June 16, 1995.

Guarino, A.M. and S.T. Arnold. 1979. Xenobiotic Transport Mechanisms and Pharmacokinetics in the Dogfish Shark. p. 233-258 in Khan, M.A.Q., J.J. Lech and J.J. Menn, eds. Pesticide and Xenobiotic Metabolism in Aquatic Organisms. American Chemical Society, ACS Symposium Series 99, Washington, D.C.

Guarino, A.M., G. Rieck, S. Arnold, P. Fenstermacher, J. Bend, M.J. Knutson, and J.B. Anderson. 1976. Distribution and Toxicity of Selected Water Pollutants in the Spiny Dogfish, *Squalus acanthias*. Bull. Mt. Desert Isl. Biol. Lab. 16:50-53.

Heitmuller, P.T., T.A. Hollister, and P.R. Parrish. 1981. Acute Toxicity of 54 Industrial Chemicals to Sheepshead Minnows (*Cyprinodon variegatus*). *Bull. Environ. Contam. Toxicol.* 27(5):596-604.

Herman, D.C., C.I. Mayfield and W.E. Inniss. 1991. The relationship between toxicity and bioconcentration of volatile organic hydrocarbons by the alga *Selenastrum capricornutum*. *Chemosphere* 22:665-676.

Hermens, J.L.M., H. Canton, P. Janssen and R. de Jong. 1984. Quantitative structure-activity relationships and toxicity studies of mixtures of chemicals with anesthetic potency: Acute lethal and sublethal toxicity to *Daphnia magna*. *Aquat. Toxicol.* 5:143-154.

Hill, E.F. and M.B. Camardese. 1986. Lethal Dietary Toxicities of Environmental Contaminants and Pesticides to *Coturnix*. U.S. Fish and Wildlife Service Technical Report 2, U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 147 pp.

Hodson, P.V., D.G. Dixon and K.L.E. Kaiser. 1984. Measurement of median lethal dose as a rapid indication of contaminant toxicity to fish. *Environ. Toxicol. Chem.* 3:243-254.

Hodson, P.V., D.G. Dixon and K.L.E. Kaiser. 1988. Estimating the acute toxicity of waterborne chemicals in trout from measurements of median lethal dose and the octanol-water partition coefficient. *Environ. Toxicol. Chem.* 7:443-454.

Huff, J.E., J.K. Kaseman, D.M. DeMarini, S. Eustis, R.R. Maronpot, A.C. Peters, R.L. Persing, C.E. Chrisp and A.C. Jacobs. 1989. Multiple site carcinogenicity of benzene in Fischer 344 rats and B6C3F₁ mice. *Environ. Health Perspect.* 82:125-163.

Hutchinson, T.C., J.A. Hellebust, D. Tam, D. Mackay, R.A. Mascarenhas, and W.Y. Shiu. 1980. The Correlation of the Toxicity to Algae of Hydrocarbons and Halogenated Hydrocarbons with their Physical-Chemical Properties. *Environ. Sci. Res.* 16:577-586.

Idoniboye-Obu, B. 1979. Toxicity of Isolated Water-Soluble C₆ Petroleum Hydrocarbons to Lobsters, *Homarus americanus*. In Symp. Animals Monitors Environ. Pollut., S.W. Nielsen, G. Migaki, and D.G. Scarpelli (Eds.). 12:383-384.

Jenkins, D., S.A. Klein and R.C. Cooper. 1977. Fish toxicity of jet fuels - I. The toxicity of the synthetic fuel JP-9 and its components. *Water Res.* 11:1059-1067.

Kaiser, K.L.E., D.G. Dixon and P.V. Hodson. 1984. QSAR Studies on Chlorophenols, Chlorobenzenes and Para-Substituted Phenols. p. 189-206 in Kaiser, K.L.E., ed. QSAR in Environmental Toxicology. D. Reidel Publishing Co., Dordrecht, Holland.

LeBlanc, G.A. 1980. Acute Toxicity of Priority Pollutants to Water Flea (*Daphnia magna*). Bull. Environ. Contam. Toxicol. 24(5):684-691.

Lee, R.F., R. Sauerheber and A.A. Benson. 1972. Petroleum hydrocarbons: Uptake and discharge by the marine mussel *Mytilus edulis*. Science 177:344-346.

Legore, R.S. 1974. The Effect of Alaskan Crude Oil and Selected Hydrocarbon Compounds on Embryonic Development of the Pacific Oyster, *Crassostrea gigas*. Ph.D. Thesis, University of Washington, Seattle, WA. 189 pp.

Mackenzie, K.M. and D.M. Angevine. 1981. Infertility in mice exposed in utero to benzo(a)pyrene. Biol. Repro. 24:183-191.

Marks, T.A., T.A. Ledoux and J.A. Moore. 1982. Teratogenicity of a commercial xylene mixture in the mouse. J. Toxicol. Environ. Health 9: 97-106.

Massachusetts Department of Environmental Protection (MDEP). 2002. Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology. Draft. Bureau of Waste Site Cleanup, Boston, MA. May 2002.

Massachusetts Department of Environmental Protection (MDEP). 2001. Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MDEP VPH/EPH Approach, Final Draft. Bureau of Waste Site Cleanup, Boston, MA. June 2001.

McCall, P.L. and M.J.S. Tevesz. 1982. The effects of benthos on physical properties of freshwater sediments. p. 105-176 in McCall, P.L. and M.J.S. Tevesz, eds. Animal-Sediment Relations. Plenum Press, New York, NY.

McCarty, L.S. and D. Mackay. 1993. Enhancing ecotoxicological modeling and assessment: Body residues and modes of toxic action. Environ. Sci. Technol. 27:1719-1728.

Michelsen, T. 1997. MTCA Technical Support Document. The Narcosis Model for Predicting the Toxicity of Dissolved Petroleum Constituents in Groundwater to Surface Water Receptors. External Agency Review Draft, Toxics Cleanup Program, Washington Department of Ecology, Bellevue, WA. December 1997.

Morrow, J.E., R.L. Gritz, and M.P. Kirton. 1975. Effects of Some Components of Crude Oil on Young Coho Salmon. *Copeia* 2:326-331.

Nunes, P. and P.E. Benville, Jr. 1979. Uptake and depuration of petroleum hydrocarbons in the Manila clam, *Tapes semidecussata* Reeve. *Bull. Environ. Contam. Toxicol.* 21:719-726.

Ogata, M., K. Fujisawa, Y. Ogino and E. Mano. 1984. Partition coefficient as a measure of bioconcentration potential of crude oil compounds in fish and shellfish. *Bull. Environ. Contam. Toxicol.* 33:561-567.

Passino, D.R.M. and S.B. Smith. 1987. Acute Bioassays and Hazard Evaluation of Representative Contaminants Detected in Great Lakes Fish. *Environ. Toxicol. Chem.* 6(11):901-907.

Patton, J.F. and M.P. Dieter. 1980. Effects of petroleum hydrocarbons on hepatic function in the duck. *Comp. Biochem. Physiol.* 65C:33-36.

Pawlisz, A.V. and R.H. Peters. 1995. Effects of sublethal exposure on lethal body burdens of narcotic organic chemicals in *Daphnia magna*. *Environ. Sci. Technol.* 29:613-621.

Rogerson, A., W.Y. Shiu, G.L. Huang, D. Mackay, and J. Berger. 1983. Determination and Interpretation of Hydrocarbon Toxicity to Ciliate Protozoa. *Aquatic Toxicology* 3(3):215-228.

Schultz, T.W. 1997. Comments on: Influence of the energy relationships of organic compounds on toxicity to the cladoceran *Daphnia magna* and the fish *Pimephales promelas*. *Ecotoxicol. Environ. Saf.* 38:336-337.

Shephard, B.K. and J.W. Webb. 1998. Ecological toxicity reference values for petroleum alkane mixture toxicity to aquatic biota. Poster PMP060, 19th Annual Meeting, Society of Environmental Toxicology and Chemistry, Charlotte, NC.

Shephard, B.K. and L.S. McCarty. 1997. Tissue residue approaches to deriving numerical sediment quality criteria. Interactive Poster Presentation 590, 18th Annual Meeting, Society of Environmental Toxicology and Chemistry, San Francisco, CA.

Shephard, B.K. 1998. Quantification of Ecological Risks to Aquatic Biota from Bioaccumulated Chemicals. p. 2-31 to 2-52 in National Sediment Bioaccumulation Conference Proceedings, EPA 823-R-98-002, Office of Water, U.S. Environmental Protection Agency, Washington, D.C.

Snell, T.W., B.D. Moffat, C. Janssen, and G. Persoone. 1991. Acute Toxicity Tests Using Rotifers IV. Effects of Cyst Age, Temperature, and Salinity on the Sensitivity of *Barachionus calyciflorus*. *Ecotoxicol. Environ. Saf.* 21(3):308-317.

Snyder, R. 1987. *Ethel Browning's Toxicity and Metabolism of Industrial Solvents, 2nd edition, Vol. 1: Hydrocarbons*. Elsevier Science Publishing Company, Amsterdam, The Netherlands.

Stratton, G.W. 1987. Toxic Effects of Organic Solvents on the Growth of Blue-Green Algae. *Bull. Environ. Contam. Toxicol.* 38(6):1012-1019.

Stratton, G.W. and T.M. Smith. 1988. Interaction of Organic Solvents with the Green Alga *Chlorella pyrenoidosa*. *Bull. Environ. Contam. Toxicol.* 40(5):736-742.

Struhsaker, J.W. 1977. Effects of benzene (a toxic component of petroleum) on spawning Pacific herring, *Clupea harengus pallasii*. *Fish. Bull.* 75:43-49.

Suter, G.W. II, R.A. Eftoymson, B.E. Sample and D.S. Jones. 2000. *Ecological Risk Assessment for Contaminated Sites*. Lewis Publishers, Boca Raton, FL. 438 pp.

Swihart, R.K., N.A. Slade and B.J. Bergstrom. 1988. Relating body size to the rate of home range usage in mammals. *Ecology* 69:393-399.

Thoms, S.R., G. Matisoff, P.L. McCall and X. Wang. 1995. *Models for Alteration of Sediments by Benthic Organisms*. Report D43014, Project 92-NPS-2, Water Environment Research Foundation, Alexandria, VA.

TPH Criteria Working Group (TPHCWG). 1996. *Selection of Representative TPH Fractions Based on Fate and Transport Considerations*. Vol. III. Amherst Scientific Publishing.

Travis, C.C. and A.D. Arms. 1988. Bioconcentration of organics in beef, milk, and vegetation. *Environ. Sci. Technol.* 22:271-274.

Tsuji, S., Y. Tonogai, Y. Ito, and S. Kanoh. 1986. The Influence of Rearing Temperatures on the Toxicity of Various Environmental Pollutants for Killifish (*Oryzias latipes*). *J. Hyg. Chem.* 32(1):46-53.

URS Consultants, Inc. 1997. Final Remedial Investigation/Feasibility Study Report, Operable Unit A, Adak Naval Complex, Adak Island, Alaska. CTO-214. Prepared for Engineering Field Activity, Northwest, Southwest Division, Naval Facilities Engineering Command, Poulsbo, WA by URS Consultants, Seattle, WA.

URS Consultants, Inc. 1996a. Final Preliminary Source Evaluation 2 (PSE-2) Guidance Document, Operable Unit A, Naval Air Facility (NAF) Adak, Adak Island, Alaska. CTO-165. Prepared for Engineering Field Activity, Northwest, Southwest Division, Naval Facilities Engineering Command, Poulsbo, WA by URS Consultants, Seattle, WA.

URS Consultants, Inc. 1996b. Final Remedial Investigation/Feasibility Study Management Plan, Adak Naval Complex, Adak Island, Alaska. CTO-203. Prepared for Engineering Field Activity, Northwest, Southwest Division, Naval Facilities Engineering Command, Poulsbo, WA by URS Consultants, Seattle, WA.

URS Consultants, Inc. 1996c. Draft Methodology Report: Tiered Approach to Risk Assessment for Petroleum Site Cleanup. Naval Air Facility Adak, Adak Island, Alaska. CTO-213. Prepared for Engineering Field Activity, Northwest, Southwest Division, Naval Facilities Engineering Command, Poulsbo, WA by URS Consultants, Seattle, WA.

URS Consultants, Inc. 1996d. Baseline Ecological Survey Report, Adak Island, Alaska. Prepared for Engineering Field Activity, Northwest, Southwest Division, Naval Facilities Engineering Command, Poulsbo, WA by URS Consultants, Seattle, Washington. CTO-197.

URS Consultants, Inc. 1996e. Draft Final Preliminary Source Evaluation 2 (PSE-2) Report for Batch 2 Sites, Volume 1 of 3. Operable Unit A, Adak Naval Complex, Adak Island, Alaska. CTO-196.

URS Consultants, Inc. 1995. Draft Ecological Risk Assessment Scoping Document, Naval Air Facility (NAF) Adak, Adak Island, Alaska. CTO-152. Prepared for Engineering Field Activity, Northwest, Southwest Division, Naval Facilities Engineering Command, Poulsbo, WA by URS Consultants, Seattle, WA.

URS Consultants, Inc. 1994. Draft Literature Review of Habitats and Wildlife, Adak Island, Alaska. CTO-152. Prepared for Engineering Field Activity, Northwest, Southwest Division, Naval Facilities Engineering Command, Poulsbo, WA by URS Consultants, Seattle, WA.

United States Environmental Protection Agency (USEPA). 2002. National Recommended Water Quality Criteria: 2002. EPA-822-R-02-047, Office of Water, Washington, D.C. November 2002.

U.S. Environmental Protection Agency (USEPA). 1999. Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites. OSWER Directive 9285.7-28 P, Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1999. *Draft Equilibrium Partitioning Sediment Guidelines (ESGs) for the Protection of Benthic Organisms: PAH Mixtures*. Office of Science and Technology and Office of Research and Development. November 10, 1999.

U.S. Environmental Protection Agency (USEPA). 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F, Risk Assessment Forum, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1997a. Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments – Interim Final. EPA 540-R-97-006, Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1997b. EPA Region 10 Supplemental Ecological Risk Assessment Guidance for Superfund. EPA-910-R-97-005, Risk Evaluation Unit, USEPA Region 10, Seattle, WA.

U.S. Environmental Protection Agency (USEPA). 1994. Wildlife Exposure Factors Handbook. EPA/600/R-93/187a and b, Office of Research and Development, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1993. Technical Basis for Deriving Sediment Quality Criteria for Nonionic Organic Contaminants for the Protection of Benthic Organisms by Using Equilibrium Partitioning. EPA-822-R-93-011, Office of Water, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1992. Health Effects Assessment Summary Tables (HEAST). EPA/540/1-86-060, Environmental Criteria and Assessment Office, Cincinnati, Ohio.

United States Environmental Protection Agency (USEPA). 1991. Water Quality Criteria Summary. Office of Science and Technology, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1980. Ambient Water Quality Criteria for Polynuclear Aromatic Hydrocarbons. EPA 440/5-80-069, Criteria and Standards Division, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1978. In-Depth Studies on Health and Environmental Impacts of Selected Water Pollutants. U.S. Environmental Protection Agency, Duluth, MN.

Van Wezel, A.P. and A. Opperhuizen. 1995. Narcosis due to environmental pollutants in aquatic organisms: Residue-based toxicity, mechanisms, and membrane burdens. *Crit. Rev. Toxicol.* 25:255-279.

Varanasi, U., J.E. Stein and M. Nishimoto. 1989. Biotransformation and disposition of polycyclic aromatic hydrocarbons (PAH) in fish. p. 93-149 in Varanasi, U., ed. *Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment*. CRC Press, Boca Raton, FL. 341 pp.

Wallen, I.E., W.C. Greer, and R. Lasater. 1957. Toxicity to *Gambusia affinis* of Certain Pure Chemicals in Turbid Waters. *Sewage Ind. Wastes* 29(6):695-711.

Washington Department of Ecology (Ecology). 2001. Model Toxics Control Act Cleanup Regulation. Chapter 173-340 WAC. Publication 94-06, Toxics Cleanup Program, Washington Department of Ecology, Olympia, WA. February 12, 2001.

Washington Department of Ecology (Ecology). 1995. Sediment Management Standards. Chapter 173-204 WAC. Sediment Management Unit, Toxics Cleanup Program, Washington Department of Ecology, Olympia, WA. December 29, 1995.

Wentzel, R.S., T.W. LaPoint, M. Simini, R.T. Checkai, D. Ludwig and L.W. Brewer. 1996. Tri-Service Procedural Guidelines for Ecological Risk Assessments, Volume 1. U.S. Army Edgewood Research, Development and Engineering Center, Aberdeen Proving Ground, MD. 108 pp.

Wolf, M.A., V.K. Rowe, D.D. McCollister, R.L. Hollingsworth and F. Oyen. 1956. Toxicological studies of certain alkylated benzenes and benzene. *Arch. Ind. Health* 14: 387-398.

Zeiner, D.C., W.M. Laudenslayer, K.E. Mayer and M. White. 1990. California's Wildlife, Volume III: Mammals. California State Wildlife Habitats Relationships System, The Resources Agency, Dept. of Fish and Game, Sacramento, CA.

ATTACHMENT CII-1

Ecological Checklist

ECOLOGICAL CHECKLIST

Source: Alaska Department of Environmental Conservation (ADEC). Risk Assessment Procedures Manual, Appendix B. June 8, 2000.

Figure B.1 ECOLOGICAL CHECKLIST #1: GENERAL

1. SITE NAME: South of Runway 18-36 Area

ADEC LC: _____

2. LOCATION: Adak Island, Alaska

3. LATITUDE: _____

4. LONGITUDE: _____

5. APPROXIMATE SITE AREA: 15 acres

6. DATES OF SITE VISITS: Ongoing since 1994

- ATTACH USGS TOPOGRAPHIC MAP
 ATTACH AVAILABLE PHOTOS

7. LAND USE ON THE SITE

_____ % RESIDENTIAL
_____ % RURAL
_____ % URBAN
50 % INDUSTRIAL/COMMERCIAL
_____ % AGRICULTURAL
_____ % RECREATIONAL
_____ % FOREST/WOODED
_____ % WETLANDS
50 % UNDISTURBED
_____ % OTHER _____

8. LAND USE SURROUNDING THE SITE

_____ % RESIDENTIAL
_____ % RURAL
_____ % URBAN
100 % INDUSTRIAL/COMMERCIAL
_____ % AGRICULTURAL
_____ % RECREATIONAL
_____ % FOREST/WOODED
_____ % WETLANDS
_____ % UNDISTURBED
_____ % OTHER _____

9. DESCRIBE MOVEMENT OF SOIL ON THE SITE

- AGRICULTURAL USE
- NATURAL EVENTS
- EROSION
- HEAVY EQUIPMENT
- MINING
- OTHER

10. IDENTIFY SENSITIVE ENVIRONMENTS

(PLEASE SEE SECTION 4.2.4.2 State Sensitive Environments AND 4.2.4.3 Federal Sensitive Environments)

State-Sensitive Environments:

South Sweeper Creek and Coastal Area of Sweeper Cove = Migratory and feeding area critical for maintenance of andromous populations of Dolly Varden.

South Sweeper Creek and Coastal Area of Sweeper Cove = Spawning area critical for maintenance of andromous populations of Dolly Varden and shellfish species (i.e., Blue Mussels).

11. POTENTIAL ROUTES OF OFFSITE MIGRATION

- SWALES
- RUNOFF
- DEPRESSIONS
- WINDBLOWN PARTICULATES
- DRAINAGE DITCHES
- VEHICULAR TRAFFIC
- OTHER _____

12. DEPTH OF WATER TABLE 5 to 10 feet

13. IDENTIFY WATER BODIES IN THE VICINITY OF THE SITE

South Sweeper Creek: forms western boundary of site

Sweeper Cove: forms southern boundary of site

East, West, & Crossover Canals of Airport Ditch System: located in northern portion of site

14. EVIDENCE OF FLOODING

- YES
- NO

Figure B.2 ECOLOGICAL CHECKLIST #2: TERRESTRIAL

A. WOODED AREAS

1. ARE THERE WOODED AREAS AT THE SITE

- YES
- NO

2. PERCENTAGE OF SITE WOODED

0 %

_____ ACRES

3. DOMINANT TYPE OF VEGETATION

- DECIDUOUS
- MIXED
- OTHER _____

4. DOMINANT TREE SIZE BY DIAMETER

- 0-6 INCH
- 6-12 INCH
- > 12 INCH

B. SHRUB/SCRUB

1. IS THERE SHRUB/SCRUB VEGETATION PRESENT AT THE SITE

- YES
- NO

2. PERCENTAGE OF SITE COVERED WITH SHRUB/SCRUB

0 %

_____ ACRES

3. DOMINANT TYPE OF VEGETATION

-
-
-

4. DOMINANT HEIGHT OF SHRUB/SCRUB VEGETATION

- 0-2 FEET
- 2-5 FEET
- > 5 FEET

5. SHRUB/SCRUB DENSITY

- DENSE
- PATCHY
- SPARSE

C. OPEN AREAS

1. ARE THERE OPEN (BARE, BARREN) FIELD AREAS PRESENT AT THE SITE

- YES
- NO

2. PERCENTAGE OF SITE OPEN FIELD

50 %

7.5 ACRES

3. DOMINANT TYPE OF PLANT

- MARITIME TUNDRA
- NONE

4. DOMINANT HEIGHT OF DOMINANT PLANT

- 0-2 FEET
- 2-5 FEET
- > 5 FEET

5. DOMINANT PLANT DENSITY

- DENSE
- PATCHY
- SPARSE

Figure B.3 ECOLOGICAL CHECKLIST #3: AQUATIC-FLOWING SYSTEMS

1. TYPE OF FLOWING WATER SYSTEMS PRESENT AT THE SITE

- RIVER
 - PERENNIAL
 - INTERMITTENT
- STREAM South Sweeper Creek at western boundary of site
 - PERENNIAL
 - INTERMITTENT
- CREEK
- BROOK
- DRY-WASH
- MAN-MADE East, West, & Crossover Canals of Airport Ditch System in northern portion of site
- ARROYO
- INTERMITTENT STREAM
- CHANNELING SPARSE
- LAKE OR POND
- TIDAL STREAM
 - BAY Sweeper Cove at southern boundary of site
 - ESTUARY South Sweeper Creek at southwestern boundary of site as Creek empties into Sweeper Cove
- OTHER
- NONE

2. GENERAL COMPOSITION OF SUBSTRATE

- BEDROCK
- SAND
- SILT
- BOULDER
- COBBLE
- GRAVEL
- MARL
- CLAY
- MUCK
- DEBRIS
- CONCRETE
- OTHER

3. CONDITION OF THE BANK – HEIGHT, SLOPE, ETC.

Crossover Canal: Underground, therefore no bank.

East & West Canals: Typical riparian environment.

South Sweeper Creek: Typical riparian environment.

Sweeper Cove: Bank steep and rocky (engineered riprap).

4. FLOW INTERMITTENT

- YES
- NO

5. DISCHARGE FROM SITE TO WATER BODY

- YES
 NO

6. DISCHARGE FROM WATER BODY

- YES
 NO

7. TYPE OF AQUATIC VEGETATION PRESENT

- EMERGENT South Sweeper Creek, Sweeper Cove, East Canal, West Canal
 SUBMERGENT
 FLOATING
 NONE Crossover Canal (underground)

8. OTHER ORGANISMS PRESENT

- BENTHIC MACRO INVERTEBRATES
 FISH
 BIRDS
 MAMMALS
 OTHER
 NONE

Figure B.4 ECOLOGICAL CHECKLIST #4: AQUATIC NON-FLOWING SYSTEMS

1. TYPE OF OPEN WATER NON-FLOWING SYSTEMS PRESENT AT THE SITE

- NATURAL
- MAN-MADE
- NONE

2. KNOWN USES OF WATER BODY

- RECREATIONAL
- NAVIGATIONAL
- SUBSISTENCE
- OTHER _____

3. APPROXIMATE SIZE OF WATER BODIES

_____ ACRES

4. TYPE OF AQUATIC VEGETATION PRESENT

- EMERGENT
- SUBMERGENT
- FLOATING

5. DEPTH OF WATER

_____ FEET (INTERMITTENT)

6. GENERAL COMPOSITION OF SUBSTRATE

- BEDROCK
- SAND
- SILT
- BOULDER
- COBBLE
- GRAVEL
- MARL
- CLAY
- MUCK
- DEBRIS
- CONCRETE
- OTHER

7. SOURCE OF WATER IN THE WATER BODY

- RIVER/STREAM/CREEK
- GROUNDWATER
- SURFACE RUNOFF (INTERMITTENT)
- INDUSTRIAL DISCHARGE
- OTHER

8. DISCHARGE FROM SITE TO WATER BODY

- YES
- NO

9. DISCHARGE FROM WATER BODY

- | | | |
|---------------------------------------|---------------------------------|----------------------------------|
| <input type="checkbox"/> RIVER/STREAM | <input type="checkbox"/> ONSITE | <input type="checkbox"/> OFFSITE |
| <input type="checkbox"/> GROUNDWATER | <input type="checkbox"/> ONSITE | <input type="checkbox"/> OFFSITE |
| <input type="checkbox"/> WETLAND | <input type="checkbox"/> ONSITE | <input type="checkbox"/> OFFSITE |
| <input type="checkbox"/> IMPOUNDMENT | <input type="checkbox"/> ONSITE | <input type="checkbox"/> OFFSITE |
| <input type="checkbox"/> NONE | | |

Figure B.5 ECOLOGICAL CHECKLIST #5: WETLANDS

1. ANY DESIGNATED OR KNOWN WETLANDS AT THE SITE

- YES
- NO

2. ARE WETLANDS HABITATS EXPECTED

- YES
- NO

3. TYPES OF VEGETATION PRESENT

- EMERGENT
- SUBMERGENT
- SCRUB/SHRUB
- WOODED
- OTHER

4. DISCHARGE FROM SITE TO WETLANDS

- YES
- NO

5. DISCHARGE FROM WETLAND

- | | | |
|---------------------------------------|---------------------------------|----------------------------------|
| <input type="checkbox"/> RIVER/STREAM | <input type="checkbox"/> ONSITE | <input type="checkbox"/> OFFSITE |
| <input type="checkbox"/> GROUNDWATER | <input type="checkbox"/> ONSITE | <input type="checkbox"/> OFFSITE |
| <input type="checkbox"/> LAKE/POND | <input type="checkbox"/> ONSITE | <input type="checkbox"/> OFFSITE |
| <input type="checkbox"/> MARINE | <input type="checkbox"/> ONSITE | <input type="checkbox"/> OFFSITE |
| <input type="checkbox"/> NONE | | |

ATTACHMENT CII-2

Data Used in Ecological Risk Assessment

Attachment CII-2
 Data Used in Ecological Risk Assessment

Loc	Seq	id	Installation	Zone ID	Zone Name	Site ID	Loc ID	LocationXref	Location Type	Field Sample Number	Company Sample ID	Consultant	Sample Date	Matrix ID	Sample Type ID	Beginning Depth	Ending Depth	Lab Code	Method Class	Method	CAS	Analyte	Result	DQ	Units
138980	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	744	18/36SB8	BH	218736	18/36SB8-05	BRISTOL	9/24/2001 9:05	SB	ES	5	7	NCA	TPH	AK 102.0	-34	Total Petroleum Hydrocarbons-Diesel	297	J	mg/kg		
138972	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	736	18/36SB-11	BH	218742	18/36SB11-04	BRISTOL	9/25/2001 2:35	SB	ES	4	6	NCA	TPH	AK 102.0	-34	Total Petroleum Hydrocarbons-Diesel	237	J	mg/kg		
138980	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	744	18/36SB8	BH	218719	18/36SB8-02	BRISTOL	9/24/2001 8:55	SB	FD	1	3	NCA	TPH	AK 102.0	-34	Total Petroleum Hydrocarbons-Diesel	44.6	J	mg/kg		
138980	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	744	18/36SB8	BH	218720	18/36SB8-01	BRISTOL	9/24/2001 8:50	SB	ES	1	3	NCA	TPH	AK 102.0	-34	Total Petroleum Hydrocarbons-Diesel	42.1	J	mg/kg		
138980	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	744	18/36SB8	BH	218730	18/36SB8-03	BRISTOL	9/24/2001 9:00	SB	ES	3	5	NCA	TPH	AK 102.0	-34	Total Petroleum Hydrocarbons-Diesel	15	J	mg/kg		
138978	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	742	18/36SB6	BH	218725	18/36SB6-04	BRISTOL	9/22/2001 2:10	SB	ES	4	6	NCA	TPH	AK 102.0	-34	Total Petroleum Hydrocarbons-Diesel	10.6	J	mg/kg		
138973	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	737	18/36SB5	BH	218762	18/36SB5-12	BRISTOL	9/25/2001 4:10	SB	ES	4	6	NCA	TPH	AK 102.0	-34	Total Petroleum Hydrocarbons-Diesel	9.26	J	mg/kg		
11082	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	517	02-517	GB	42131	42131	URS	8/7/1997 3:11	SB	ES	6	8	AAI	TPH	8100 MOD	-34	Total Petroleum Hydrocarbons-Diesel	8.4	A	mg/kg		
138979	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	743	18/36SB7	BH	218722	18/36SB7-04	BRISTOL	9/22/2001 3:30	SB	ES	4	6	NCA	TPH	AK 102.0	-34	Total Petroleum Hydrocarbons-Diesel	6.53	J	mg/kg		
138981	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	745	18/36SB-9	BH	218740	18/36SB9-04	BRISTOL	9/25/2001 8:30	SB	ES	4	6	NCA	TPH	AK 102.0	-34	Total Petroleum Hydrocarbons-Diesel	5.43	J	mg/kg		
138977	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	741	18/36SB5	BH	218739	18/36SB5-04	BRISTOL	9/22/2001 11:02	SB	ES	4	6	NCA	TPH	AK 102.0	-34	Total Petroleum Hydrocarbons-Diesel	5.14	J	mg/kg		
138972	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	736	18/36SB-11	BH	218742	18/36SB11-04	BRISTOL	9/25/2001 2:35	SB	ES	4	6	NCA	TPH	AK 101.0	8006-61-9	Total Petroleum Hydrocarbons-Gasoline	2.86	J	mg/kg		
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	SVOA	8270	193-39-5	2-Methylnaphthalene	2.2	A	mg/kg		
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47168	47168	URS	8/5/1998 4:20	SD	ES	0	0.33	SOUND	SVOA	8270	91-57-6	2-Methylnaphthalene	0.13	J	mg/kg		
11199	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	767	W DITCH N CONFL	CH	42168	42168	URS	8/30/1997 12:47	SD	ES	0	0.33	COLUMBWA	SVOA	8270	56-55-3	Benzo(a)anthracene	0.8	A	mg/kg		
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	SVOA	8270	56-55-3	Benzo(a)anthracene	0.5	A	mg/kg		
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42171	42171	URS	8/30/1997 3:39	SD	FR	0	0.33	COLUMBWA	SVOA	8270	56-55-3	Benzo(a)anthracene	0.3	A	mg/kg		
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42184	42184	URS	8/31/1997 3:19	SD	ES	0	0.33	COLUMBWA	SVOA	8270	56-55-3	Benzo(a)anthracene	0.2	A	mg/kg		
11199	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	767	W DITCH N CONFL	CH	42168	42168	URS	8/30/1997 12:47	SD	ES	0	0.33	COLUMBWA	SVOA	8270	50-32-8	Benzo(a)pyrene	0.6	A	mg/kg		
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42170	42170	URS	8/30/1997 3:10	SD	FR	0	0.33	COLUMBWA	SVOA	8270	50-32-8	Benzo(a)pyrene	0.4	A	mg/kg		
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42170	42170	URS	8/30/1997 3:39	SD	FR	0	0.33	COLUMBWA	SVOA	8270	50-32-8	Benzo(a)pyrene	0.4	A	mg/kg		
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42184	42184	URS	8/31/1997 3:19	SD	ES	0	0.33	COLUMBWA	SVOA	8270	50-32-8	Benzo(a)pyrene	0.3	A	mg/kg		
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42170	42170	URS	8/30/1997 3:10	SD	FR	0	0.33	COLUMBWA	SVOA	8270	50-32-8	Benzo(a)pyrene	0.3	A	mg/kg		
11199	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	767	W DITCH N CONFL	CH	42168	42168	URS	8/30/1997 12:47	SD	ES	0	0.33	COLUMBWA	SVOA	8270	205-99-2	Benzo(b)fluoranthene	0.7	A	mg/kg		
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	SVOA	8270	205-99-2	Benzo(b)fluoranthene	0.6	A	mg/kg		
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42188	42188	URS	9/1/1997 9:46	SD	FR	0	0.33	COLUMBWA	SVOA	8270	205-99-2	Benzo(b)fluoranthene	0.5	A	mg/kg		
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42171	42171	URS	8/30/1997 3:39	SD	FR	0	0.33	COLUMBWA	SVOA	8270	205-99-2	Benzo(b)fluoranthene	0.4	A	mg/kg		
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42171	42171	URS	8/30/1997 3:39	SD	FR	0	0.33	COLUMBWA	SVOA	8270	205-99-2	Benzo(b)fluoranthene	0.4	A	mg/kg		
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42171	42171	URS	8/30/1997 3:10	SD	FR	0	0.33	COLUMBWA	SVOA	8270	205-99-2	Benzo(b)fluoranthene	0.3	A	mg/kg		
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42187	42187	URS	9/1/1997 9:11	SD	ES	0	0.33	COLUMBWA	SVOA	8270	205-99-2	Benzo(b)fluoranthene	0.2	A	mg/kg		
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42189	42189	URS	9/1/1997 10:16	SD	FR	0	0.33	COLUMBWA	SVOA	8270	205-99-2	Benzo(b)fluoranthene	0.2	A	mg/kg		
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42185	42185	URS	8/31/1997 3:49	SD	FR	0	0.33	COLUMBWA	SVOA	8270	205-99-2	Benzo(b)fluoranthene	0.2	A	mg/kg		
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	SVOA	8270	191-24-2	Benzo(g,h,i)perylene	0.4	A	mg/kg		
11199	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	767	W DITCH N CONFL	CH	42168	42168	URS	8/30/1997 12:47	SD	ES	0	0.33	COLUMBWA	SVOA	8270	191-24-2	Benzo(g,h,i)perylene	0.3	A	mg/kg		
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42188	42188	URS	9/1/1997 9:46	SD	FR	0	0.33	COLUMBWA	SVOA	8270	191-24-2	Benzo(g,h,i)perylene	0.3	A	mg/kg		
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42184	42184	URS	8/31/1997 3:19	SD	ES	0	0.33	COLUMBWA	SVOA	8270	191-24-2	Benzo(g,h,i)perylene	0.2	A	mg/kg		
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42171	42171	URS	8/30/1997 3:39	SD	FR	0	0.33	COLUMBWA	SVOA	8270	191-24-2	Benzo(g,h,i)perylene	0.2	A	mg/kg		
11199	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	767	W DITCH N CONFL	CH	42168	42168	URS	8/30/1997 12:47	SD	ES	0	0.33	COLUMBWA	SVOA	8270	207-08-9	Benzo(k)fluoranthene	0.6	A	mg/kg		
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	SVOA	8270	207-08-9	Benzo(k)fluoranthene	0.4	A	mg/kg		
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42171	42171	URS	8/30/1997 3:39	SD	FR	0	0.33	COLUMBWA	SVOA	8270	207-08-9	Benzo(k)fluoranthene	0.4	A	mg/kg		
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42170	42170	URS	8/30/1997 3:10	SD	FR	0	0.33	COLUMBWA	SVOA	8270	207-08-9	Benzo(k)fluoranthene	0.3	A	mg/kg		
21039	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	852	02-852	RV	48011	48011	URS	9/7/1998 10:01	SD	ES	0	0.5	AAI	VOA	8020	-71	BTEX (total)	0.298	A	mg/kg		
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	SVOA	8270	218-01-9	Chrysene	0.7	A	mg/kg		
11199	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	767	W DITCH N CONFL	CH	42168	42168	URS	8/30/1997 12:47	SD	ES	0	0.33	COLUMBWA	SVOA	8270	218-01-9	Chrysene	0.6	A	mg/kg		
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42187	42187	URS	9/1/1997 9:11	SD	ES	0	0.33	COLUMBWA	SVOA	8270	218-01-9	Chrysene	0.4	A	mg/kg		
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42188	42188	URS	9/1/1997 9:46	SD	FR	0	0.33	COLUMBWA	SVOA	8270	218-01-9	Chrysene	0.4	A	mg/kg		
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42184	42184	URS	8/31/1997 3:19	SD	ES	0	0.33	COLUMBWA	SVOA	8270	218-01-9	Chrysene	0.4	A	mg/kg		
11196	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	764	SPUR DITCH PIPE (NSH)	CH	42189	42189	URS	9/1/1997														

Attachment CII-2 (Continued)
 Data Used in Ecological Risk Assessment

Loc	Seq	id	Installation	Zone ID	Zone Name	Site ID	Loc ID	LocationXref	Location Type	Field Sample Number	Company Sample ID	Consultant	Sample Date	Matrix ID	Sample Type ID	Beginning Depth	Ending Depth	Lab Code	Class	Method	CAS	Analyte	Result	DQ	Units
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42171	URS	8/30/1997 3:39	SD	FR	0	0.33	COLUMBWA	SVOA	8270	193-39-5			Indeno(1,2,3-cd)pyrene	0.2	A	mg/kg	
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	SVOA	8270	91-20-3			Naphthalene	2.5	A	mg/kg	
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47168	URS	8/5/1998 4:20	SD	ES	0	0.33	SOUND	SVOA	8270	91-20-3			Naphthalene	0.13	J	mg/kg	
21039	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	852	02-852	RV	48011	URS	9/7/1998 10:01	SD	ES	0	0.5	SOUND	SVOA	8270	85-01-8			Phenanthrene	1.4	J	mg/kg	
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	SVOA	8270	129-00-0			Pyrene	1	A	mg/kg	
11199	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	767	W DITCH N CONFL	CH	42168	URS	8/30/1997 12:47	SD	ES	0	0.33	COLUMBWA	SVOA	8270	129-00-0			Pyrene	0.39	J	mg/kg	
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42187	URS	9/1/1997 9:11	SD	ES	0	0.33	COLUMBWA	SVOA	8270	129-00-0			Pyrene	0.5	A	mg/kg	
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42171	URS	8/30/1997 3:39	SD	FR	0	0.33	COLUMBWA	SVOA	8270	129-00-0			Pyrene	0.5	J	mg/kg	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42184	URS	8/31/1997 3:19	SD	ES	0	0.33	COLUMBWA	SVOA	8270	129-00-0			Pyrene	0.4	A	mg/kg	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42185	URS	8/31/1997 3:49	SD	FR	0	0.33	COLUMBWA	SVOA	8270	129-00-0			Pyrene	0.4	A	mg/kg	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42186	URS	8/31/1997 4:22	SD	FR	0	0.33	COLUMBWA	SVOA	8270	129-00-0			Pyrene	0.4	A	mg/kg	
11196	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	764	SPUR DITCH PIPE (NSH)	CH	42182	URS	8/31/1997 1:38	SD	ES	0	0.33	COLUMBWA	SVOA	8270	129-00-0			Pyrene	0.4	J	mg/kg	
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42169	URS	8/30/1997 2:37	SD	ES	0	0.33	COLUMBWA	SVOA	8270	129-00-0			Pyrene	0.3	J	mg/kg	
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47168	URS	8/5/1998 4:20	SD	ES	0	0.33	COLUMBWA	SVOA	8270	129-00-0			Pyrene	0.3	J	mg/kg	
21039	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	852	02-852	RV	48011	URS	9/7/1998 10:01	SD	ES	0	0.5	SOUND	SVOA	8270	129-00-0			Pyrene	0.031	A	mg/kg	
11199	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	767	W DITCH N CONFL	CH	42168	URS	8/30/1997 12:47	SD	ES	0	0.33	AAI	VOA	8020	108-88-3			Toluene	0.066	A	mg/kg	
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42188	URS	9/1/1997 9:46	SD	FR	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	6.51	A	%	
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42188	URS	9/1/1997 9:46	SD	FR	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	6.22	A	%	
11197	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	765	SPUR DITCH PIPE (CTR)	CH	42183	URS	8/31/1997 2:25	SD	ES	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	6.17	A	%	
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42187	URS	9/1/1997 9:11	SD	ES	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	6.06	A	%	
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42170	URS	8/30/1997 3:10	SD	FR	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	4.8	A	%	
11196	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	764	SPUR DITCH PIPE (NSH)	CH	42182	URS	8/31/1997 1:38	SD	ES	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	3.82	A	%	
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42169	URS	8/30/1997 2:37	SD	ES	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	3.33	A	%	
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	3.25	A	%	
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42171	URS	8/30/1997 3:39	SD	FR	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	1.97	A	%	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42184	URS	8/31/1997 3:19	SD	ES	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	1.91	A	%	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42185	URS	8/31/1997 3:49	SD	FR	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	0.76	A	%	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42185	URS	8/31/1997 3:49	SD	FR	0	0.33	COLUMBWA	PCHAR	9060	-28			Total Organic Carbon	0.57	A	%	
11196	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	764	SPUR DITCH PIPE (NSH)	CH	42182	URS	8/31/1997 1:38	SD	ES	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	21800	A	mg/kg	
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42187	URS	9/1/1997 9:11	SD	ES	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	18900	J	mg/kg	
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42189	URS	9/1/1997 10:16	SD	FR	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	17600	J	mg/kg	
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	16100	J	mg/kg	
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42188	URS	9/1/1997 9:46	SD	FR	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	14100	J	mg/kg	
11199	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	767	W DITCH N CONFL	CH	42168	URS	8/30/1997 12:47	SD	ES	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	3130	J	mg/kg	
11197	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	765	SPUR DITCH PIPE (CTR)	CH	42183	URS	8/31/1997 2:25	SD	ES	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	7280	A	mg/kg	
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42171	URS	8/30/1997 3:39	SD	FR	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	6310	J	mg/kg	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42185	URS	8/31/1997 3:49	SD	FR	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	4640	A	mg/kg	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42186	URS	8/31/1997 4:22	SD	FR	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	4380	J	mg/kg	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42184	URS	8/31/1997 3:19	SD	ES	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	4100	A	mg/kg	
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42170	URS	8/30/1997 3:10	SD	FR	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	4080	J	mg/kg	
11198	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	766	SPUR DITCH HEAD	CH	42169	URS	8/30/1997 2:37	SD	ES	0	0.33	COLUMBWA	TPH	8100 MOD	-34			Total Petroleum Hydrocarbons-Diesel	3130	J	mg/kg	
21039	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	48011	URS	9/7/1998 10:01	SD	ES	0	0.5	AAI	TPH	AK 102.0	-34			Total Petroleum Hydrocarbons-Diesel	1200	A	mg/kg	
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47168	URS	8/5/1998 4:20	SD	ES	0	0.33	AAI	TPH	AK 102.0	-34			Total Petroleum Hydrocarbons-Diesel	330	A	mg/kg	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42184	URS	8/31/1997 3:19	SD	ES	0	0.33	COLUMBWA	TPH	8015 MOD	8006-61-9			Total Petroleum Hydrocarbons-Gasoline	37	J	mg/kg	
21039	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	852	02-852	RV	48011	URS	9/7/1998 10:01	SD	ES	0	0.5	AAI	TPH	AK 101.0	8006-61-9			Total Petroleum Hydrocarbons-Gasoline	28	A	mg/kg	
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42188	URS	9/1/1997 9:46	SD	FR	0	0.33	COLUMBWA	TPH	8015 MOD	8006-61-9			Total Petroleum Hydrocarbons-Gasoline	27	A	mg/kg	
11193	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	762	W DITCH SOUTH	CH	42189	URS	9/1/1997 10:16	SD	FR	0	0.33	COLUMBWA	TPH	8015 MOD	8006-61-9			Total Petroleum Hydrocarbons-Gasoline	27	A	mg/kg	
11192	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	761	W DITCH 28-106	CH	42190	URS	9/1/1997 10:43	SD	ES	0	0.33	COLUMBWA	TPH	8015 MOD	8006-61-9			Total Petroleum Hydrocarbons-Gasoline	21	A	mg/kg	
11195	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	SSCB	763	W DITCH - SPUR CONFL	CH	42186	URS	8/31/1997 4:22	SD	FR	0	0.33	COLUMBWA	TPH	8015 MOD	8006-61-9			Total Petroleum				

Attachment CII-2 (Continued)
 Data Used in Ecological Risk Assessment

Loc	Seq	id	Installation	Zone ID	Zone Name	Site ID	Loc ID	LocationXref	Location Type	Field Sample Number	Company Sample ID	Consultant	Sample Date	Matrix ID	Sample Type ID	Beginning Depth	Ending Depth	Lab Code	Class	Method	CAS	Analyte	Result	DQ	Units
11012	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	511	CH-701	CH	41880	41880	URS	7/20/1997 3:15	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	71-43-2			Benzene	1.3	A	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41873	41873	URS	7/20/1997 3:43	SW	ES	0.7	0.7	LAUCKS	VOA	V-CLP-LOW	71-43-2			Benzene	1.2	A	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41874	41874	URS	7/20/1997 3:57	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	71-43-2			Benzene	1.2	A	ug/l
11014	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	513	CH-703	CH	41875	41875	URS	7/20/1997 4:25	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	71-43-2			Benzene	0.86	J	ug/l
11014	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	513	CH-703	CH	41876	41876	URS	7/20/1997 4:37	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	71-43-2			Benzene	0.78	J	ug/l
11017	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	516	CH-706	CH	41871	41871	URS	7/20/1997 12:10	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	71-43-2			Benzene	0.75	J	ug/l
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47167	47167	URS	8/5/1998 4:00	SW	ES			SOUND	SVOA	8270	56-55-3			Benzo(a)anthracene	0.84	J	ug/l
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47167	47167	URS	8/5/1998 4:00	SW	ES			SOUND	SVOA	8270	50-32-8			Benzo(a)pyrene	0.34	J	ug/l
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47167	47167	URS	8/5/1998 4:00	SW	ES			SOUND	SVOA	8270	205-99-2			Benzo(b)fluoranthene	0.5	J	ug/l
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47167	47167	URS	8/5/1998 4:00	SW	ES			SOUND	SVOA	8270	191-24-2			Benzo(g,h,i)perylene	0.33	J	ug/l
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47167	47167	URS	8/5/1998 4:00	SW	ES			SOUND	SVOA	8270	207-08-9			Benzo(k)fluoranthene	0.27	J	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41873	41873	URS	7/20/1997 3:43	SW	ES	0.7	0.7	LAUCKS	SVOA	SV-CLP-LOW	117-81-7			bis(2-Ethylhexyl)phthalate	2	J	ug/l
11015	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	514	CH-704	CH	41877	41877	URS	7/20/1997 1:00	SW	ES	1	1	LAUCKS	SVOA	SV-CLP-LOW	117-81-7			bis(2-Ethylhexyl)phthalate	1.5	J	ug/l
11015	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	514	CH-704	CH	41877	41877	URS	7/20/1997 1:00	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	36.1	A	ug/l
11015	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	514	CH-704	CH	41872	41872	URS	7/20/1997 1:21	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	32.8	A	ug/l
11016	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	515	CH-705	CH	41869	41869	URS	7/20/1997 10:55	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	18	A	ug/l
11014	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	513	CH-703	CH	41875	41875	URS	7/20/1997 4:25	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	12.46	A	ug/l
21037	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	850	02-850	CH	48009	48009	URS	9/7/1998 10:46	SW	ES	0	0.5	AAI	VOA	8020	-71			BTEX (total)	11.4	A	ug/l
11014	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	513	CH-703	CH	41876	41876	URS	7/20/1997 4:37	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	11.38	A	ug/l
11017	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	516	CH-706	CH	41870	41870	URS	7/20/1997 11:40	SW	ES	3	3	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	8.98	A	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41873	41873	URS	7/20/1997 3:43	SW	ES	0.7	0.7	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	8.9	A	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41874	41874	URS	7/20/1997 3:57	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	8.6	A	ug/l
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47167	47167	URS	8/5/1998 4:00	SW	ES			AAI	VOA	8020	-71			BTEX (total)	8.3	A	ug/l
11012	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	511	CH-701	CH	41879	41879	URS	7/20/1997 3:00	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	7.1	A	ug/l
11012	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	511	CH-701	CH	41880	41880	URS	7/20/1997 3:15	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	6.8	A	ug/l
11017	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	516	CH-706	CH	41871	41871	URS	7/20/1997 12:10	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	5.8	A	ug/l
11016	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	515	CH-705	CH	41868	41868	URS	7/20/1997 10:30	SW	ES	3	3	LAUCKS	VOA	V-CLP-LOW	-71			BTEX (total)	1.2	A	ug/l
11016	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	515	CH-705	CH	41869	41869	URS	7/20/1997 10:55	SW	ES	0	0	SOUND	SVOA	8270	218-01-9			Chrysene	0.54	J	ug/l
11014	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	513	CH-703	CH	41875	41875	URS	7/20/1997 4:25	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	156-59-2			cis-1,2-Dichloroethene	1.1	A	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41873	41873	URS	7/20/1997 3:43	SW	ES	0.7	0.7	LAUCKS	VOA	V-CLP-LOW	156-59-2			cis-1,2-Dichloroethene	1	A	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41874	41874	URS	7/20/1997 3:57	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	156-59-2			cis-1,2-Dichloroethene	0.99	J	ug/l
11014	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	513	CH-703	CH	41876	41876	URS	7/20/1997 4:37	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	156-59-2			cis-1,2-Dichloroethene	0.94	J	ug/l
11012	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	511	CH-701	CH	41880	41880	URS	7/20/1997 3:15	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	156-59-2			cis-1,2-Dichloroethene	0.82	J	ug/l
11012	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	511	CH-701	CH	41879	41879	URS	7/20/1997 3:00	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	156-59-2			cis-1,2-Dichloroethene	0.79	J	ug/l
11015	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	514	CH-704	CH	41877	41877	URS	7/20/1997 1:00	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	156-59-2			cis-1,2-Dichloroethene	0.54	J	ug/l
11016	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	515	CH-705	CH	41868	41868	URS	7/20/1997 10:30	SW	ES	3	3	LAUCKS	VOA	V-CLP-LOW	156-59-2			cis-1,2-Dichloroethene	0.54	J	ug/l
11015	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	514	CH-704	CH	41877	41877	URS	7/20/1997 1:00	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	156-59-2			cis-1,2-Dichloroethene	0.51	J	ug/l
11015	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	514	CH-704	CH	41872	41872	URS	7/20/1997 1:21	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	100-41-4			Ethylbenzene	6.9	A	ug/l
11015	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	514	CH-704	CH	41872	41872	URS	7/20/1997 1:21	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	100-41-4			Ethylbenzene	6.1	A	ug/l
11016	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	515	CH-705	CH	41869	41869	URS	7/20/1997 10:55	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	100-41-4			Ethylbenzene	3.5	A	ug/l
11017	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	516	CH-706	CH	41870	41870	URS	7/20/1997 11:40	SW	ES	3	3	LAUCKS	VOA	V-CLP-LOW	100-41-4			Ethylbenzene	3.3	A	ug/l
11014	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	513	CH-703	CH	41875	41875	URS	7/20/1997 4:25	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	100-41-4			Ethylbenzene	3.1	A	ug/l
11014	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	513	CH-703	CH	41876	41876	URS	7/20/1997 4:37	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	100-41-4			Ethylbenzene	2.9	A	ug/l
21037	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	850	02-850	CH	48009	48009	URS	9/7/1998 10:46	SW	ES	0	0.5	AAI	VOA	8020	100-41-4			Ethylbenzene	2.1	A	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41873	41873	URS	7/20/1997 3:43	SW	ES	0.7	0.7	LAUCKS	VOA	V-CLP-LOW	100-41-4			Ethylbenzene	2	A	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41874	41874	URS	7/20/1997 3:57	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	100-41-4			Ethylbenzene	1.9	A	ug/l
11012	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	511	CH-701	CH	41879	41879	URS	7/20/1997 3:00	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	100-41-4			Ethyl			

Attachment CII-2 (Continued)
 Data Used in Ecological Risk Assessment

Loc Seq id	Installation	Zone ID	Zone Name	Site ID	Loc ID	LocationXref	Location Type	Field Sample Number	Company Sample ID	Consultant	Sample Date	Matrix ID	Sample Type ID	Beginning Depth	Ending Depth	Lab Code	Method Class	Method	CAS	Analyte	Result	DQ	Units
11015	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	514	CH-704	CH	41872	41872	URS	7/20/1997 1:21	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	21	A	ug/l
11016	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	515	CH-705	CH	41869	41869	URS	7/20/1997 10:55	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	11	A	ug/l
21037	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	850	02-850	CH	48009	48009	URS	9/7/1998 10:46	SW	ES	0	0.5	AAI	VOA	8020	1330-20-7	Xylenes	7.5	A	ug/l
11014	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	513	CH-703	CH	41875	41875	URS	7/20/1997 4:25	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	6	A	ug/l
21038	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	851	02-851	RV	47167	47167	URS	8/5/1998 4:00	SW	ES			AAI	VOA	8020	1330-20-7	Xylenes	5.7	A	ug/l
11014	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	513	CH-703	CH	41876	41876	URS	7/20/1997 4:37	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	5.4	A	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41873	41873	URS	7/20/1997 3:43	SW	ES	0.7	0.7	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	4.1	A	ug/l
11013	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	512	CH-702	CH	41874	41874	URS	7/20/1997 3:57	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	3.9	A	ug/l
11017	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	516	CH-706	CH	41870	41870	URS	7/20/1997 11:40	SW	ES	3	3	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	3.4	A	ug/l
11017	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	516	CH-706	CH	41871	41871	URS	7/20/1997 12:10	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	3.2	A	ug/l
11012	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	511	CH-701	CH	41879	41879	URS	7/20/1997 3:00	SW	ES	1	1	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	3	A	ug/l
11012	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	511	CH-701	CH	41880	41880	URS	7/20/1997 3:15	SW	ES	0	0	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	2.9	A	ug/l
11016	ADAK	TARA4B	South Runway 18-36 Area (IDIQ 18)	S-RWAY	515	CH-705	CH	41868	41868	URS	7/20/1997 10:30	SW	ES	3	3	LAUCKS	VOA	V-CLP-LOW	1330-20-7	Xylenes	1.2	A	ug/l