Human Health and Ecological Risk Assessment
Northeast Cape Installation, St. Lawrence Island, Alaska

Final

Contract No. DACA85-98-D-0007
Task Order No. 026
MWH Americas, Inc. Job No. 1850574.260130

March 2004

Prepared for:
Department of the Army
U.S. Army Engineer District, Alaska
Corps of Engineers
P.O. Box 898
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NPDL WO# 01-106

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
P.O. BOX 6898
ELMENDORF AFB, ALASKA 99506-6898

REPLY TO
ATTENTION OF:

April 13, 2004

Programs and Project Management Division
Civil Projects Management Branch

«Title» «FirstName» «LastName»
«JobTitle»
«Company»
«Address1»
«City», «State» «PostalCode»

Dear «Title» «LastName»:

Enclosed for your files is a copy of the Final Human Health and Ecological Risk Assessment, Northeast Cape Installation, St. Lawrence Island, Alaska, submitted to the Corps by Montgomery Watson -Harza (MWH). This two-volume report is intended to evaluate potential impacts of site-related chemicals on public health and on the environment.

Since this is a final report, there is no mandated review period. Nonetheless, the U.S. Army Corps of Engineers is interested to know whether you feel your previous comments have been fully addressed. Therefore, upon reading the document, if you believe your concerns have not been satisfactorily responded to, please let me know. If you submitted written comments, a copy of your comments with a response is included. All comments will be supplied to the Information Repositories.

Please note, attached to the back inside cover of Volume I are comments from the US Army Center for Health Promotion and Preventive Medicine (CHPPM) regarding the Technical Memorandum, *Background Determination for Risk Assessment, Derivation of Ambient Concentrations for Abiotic Media Associated with the Northeast Cape Installation, St. Lawrence Island, Alaska*, May 2003. These comments were not sought until after the Technical Memorandum was finalized and could not be captured in the final document. Certain comments in this attachment are appropriate to the Risk Assessment as well.

This letter has also been furnished to the following individuals and organizations:

Honorable Fritz Waghiyi, President, Native Village of Savoonga
Honorable Jesse Gologergen, Mayor, Mayor of Savoonga
Mr. Job Koonooka, President, Sivuqaq, Inc.
Mr. Morris Toolie, Jr., President, Savoonga Native Corporation
Mr. Morris Toolie, Jr., RAB Community Co-chair, Savoonga
Information Repository

Gambell Information Repository
Mr. Jeff Brownlee, Alaska Department of Environmental Conservation
Ms. June Martin, SLI Coordinator, Alaska Community Action on Toxics
Mr. Jerald Reichlin, Fortier and Mikko
Dr. Ron Scrudato, State University of New York, TAPP Grant
National Parks Service, Nome Information Repository
ARLIS, Anchorage Information Repository
Ms. Ronie Shackelford, USACHPPM

If you have any questions, please contact me at (907) 753-2689, or by e-mail at carey.c.cossaboom@poa02.usace.army.mil.

Sincerely,

Carey Cossaboom
Project Manager

Enclosures

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
% UCL	percent upper confidence limit
AAC	Alaska Administrative Code
ACM	asbestos-containing materials
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AK	Alaska Method
Alaska District	U.S. Army Engineer District, Alaska
Army	U.S. Army
AST	above-ground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
BCF	bioconcentration factor
BD/DR	building demolition and debris removal
bgs	below ground surface
BMF	biomagnification factor
BTEX	benzene, toluene, ethylbenzene, and xylenes
BUTL	background upper tolerance limit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm^2	square centimeter
cm^3	cubic centimeter
CoC	chain-of-custody
CON/HTW	containerized hazardous or toxic waste
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSF	cancer slope factor
CSM	conceptual site model
DERP	Defense Environmental Restoration Program
DoD	U.S. Department of Defense
DQO	data quality objectives
DRO	diesel range organics
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
FCM	food chain multiplier
FS	Feasibility Study
FUDS	Formerly Used Defense Sites
GRO	gasoline range organics
HEAST	Health Effects Assessment Summary Tables

HHERA	human health and ecological risk assessment
HHRA	human health risk assessment
HQ	hazard quotient
IEUBK	Integrated Exposure Uptake Biokinetic
ILCR	incremental lifetime cancer risk
IRIS	Integrated Risk Information System
LOAEL	lowest observable adverse effect level
MF	modifying factor
m^3	cubic meter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg	milligram
ml	milliliter
NFA	no further action
NFRAP	no further remedial action planned
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observable adverse effect level
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyls
PHC	petroleum hydrocarbon
PL	Public Law
POL	petroleum, oil, and lubricants
QA/QC	quality assurance/quality control
RfD	reference dose
RI	Remedial Investigation
RRO	residual range organics
SARA	Superfund Amendments and Reauthorization Act
SHPO	State Historic and Preservation Office
SUF	site utilization factor
SVOC	semi-volatile organic compound
SW	Solid Waste Method (EPA)
TRPH	total recoverable petroleum hydrocarbons
TRV	toxicity reference value
UCL	upper confidence limit
UF	uncertainty factor
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USGS	U.S. Geologic Survey
UST	underground storage tank
VOC	volatile organic compounds

EXECUTIVE SUMMARY

Under contract to the U.S. Army Engineer District, Alaska (Alaska District), MWH Americas, Inc. (MWH) conducted a human health and ecological risk assessment (HHERA) as part of Phase III Remedial Investigation activities for the Northeast Cape Installation, located on the Northeast Cape of St. Lawrence Island, Alaska. The Northeast Cape Installation occupies approximately 4 square miles of land on St. Lawrence Island and has been divided into 33 individual sites. Of these sites, two sites were designated as "no further action" sites and 10 sites were recommended for no work other than containerized hazardous waste and/or building demolition/debris removal. The remaining 21 sites, including background areas and four White Alice Communications System sites, were addressed in this human health and ecological risk assessment.

Sites evaluated in the human health and ecological risk assessment are listed below. Some sites were grouped for evaluation and discussion.

Site Number	Site Description
Site 3	Fuel Line Corridor and Pumphouse
Site 4	Subsistence Fishing and Hunting Camp
Site 6	Cargo Beach Road Drum Field
Site 7	Cargo Beach Road Landfill
Site 9	Housing and Operations Landfill
Site 10	Buried Drum Field
Site 11	Fuel Storage Tank Area
Sites 13, 15, 19, and 27	Main Operations Complex
Site 16	Paint and Dope Storage Building
Site 21	Wastewater Treatment Facility
Site 22	Water Wells and Water Supply Building
Site 28	Drainage Basin
Site 29	Suqitughneq River
Site 30	Background Areas
Site 31	White Alice Site
Site 32	Lower Tram Terminal
Site 33	Upper Tram Terminal
Site 34	Upper Camp

Human health risk assessments were prepared or updated for Sites 3, 4, 6, 7, 9, 10, 11, 13, 15, 16, 19, 21, 22, 27, 28, 29, 31, 32, 33 and 34. Ecological risk assessments were prepared or updated for Sites: 3, 4, 6, 7, 9, 21, 22, 29, 31, 32, 33, and 34. Risks were evaluated in accordance with the Defense Environmental Restoration - Formerly Used Defense Sites Program; Comprehensive Environmental Restoration, Cleanup and Liability Act Remedial Response process; and Alaska State Oil and Other Hazardous Substances Pollution Control Regulations (18 Alaska Administrative Code 75). Results of these risk assessments will be considered during the feasibility study for evaluation of potential remedial options for the Northeast Cape Installation. At the request of the Alaska District, risk-based cleanup levels for media of concern are not currently proposed. Any future proposed cleanup levels will be included in the feasibility study, if one or more unacceptable health or environmental risk conditions are identified.

POTENTIAL HUMAN HEALTH RISKS

The human health risk assessment evaluated potential risks to human health based on current and hypothetical future land uses, consistent with the conceptual site model for the Northeast Cape Installation. Human health risk estimates for current receptors reflect current land uses and anticipated exposures for the near future. Current receptors include seasonal residents of the Site 4 (Subsistence Fishing and Hunting Camp), and visitors to the Northeast Cape Installation. Current seasonal residents use Site 4 for subsistence food collection during the summer months (i.e., mid-June through mid-September). Exposure pathways evaluated for current seasonal residents include direct contact with Site 4 soils and use of potable water derived from the primary fresh surface water feature at the Northeast Cape Installation, the Suqitughneq River. Current seasonal residents also consume fish and plants collected from non-impacted ambient locations (i.e., Site 30). Exposure pathways for current incidental site visitors include direct contact pathways for soil at the remaining sites (i.e., sites other than Site 4), and potable uses of fresh surface water obtained from the Suqitughneq River.

Health risk estimates for future receptors are hypothetical, and reflect potential human health risks in the event of increased utilization of the Northeast Cape Installation by future seasonal residents, or the establishment of permanent residences. Increased future utilization of the Northeast Cape Installation could include establishment of seasonal or permanent residences at sites other than Site 4. In this event, human health risks will depend upon the specific site inhabited, the source of potable water used, and locations in which subsistence foods are collected. Potential sources of potable water could include shallow subsurface water beneath sites where shallow subsurface water is present, deep subsurface water, or fresh surface water obtained from the Suqitughneq River (Site 29) or other fresh surface water sources (e.g., the tributary at Site 28). Subsistence food pathways for future seasonal or permanent residents could include consumption of plants and fish collected from impacted locations (e.g., Sites 28 and 29) or non-impacted ambient locations (i.e., Site 30). Risks associated with subsistence food consumption pathways were evaluated using data from plant tissue samples collected from Sites 28 and 30, and fish tissue samples collected from Sites 29 and 30.

Results of the human health risk assessment for current and future human receptors are described in the following subsections.

Current Receptors

Risks to current human receptors (i.e., seasonal residents of the Site 4 [Subsistence Fishing and Hunting Camp], and visitors to the Northeast Cape Installation) are below Alaska Department of Environmental Conservation point of departure criteria for carcinogenic risks and noncarcinogenic hazards of 1×10^{-5} and 1.0, respectively, based on exposure to site-specific media (Table ES-1). This conclusion is based on: (1) risk estimates for current inhabitants of the

Subsistence Fishing and Hunting Camp who are exposed to Site 4 soils, and (2) risk estimates for current site visitors exposed to soils and other media at remaining sites. Risk estimates based on exposure to water derived from the Suqitughneq River for potable uses by current seasonal residents of Site 4 and current visitors to the Northeast Cape Installation are also below Alaska Department of Environmental Conservation point of departure criteria. However, when subsistence food use is considered for current seasonal residents of Site 4, estimates of potential carcinogenic risk and noncarcinogenic hazard exceed Alaska Department of Environmental Conservation point of departure criteria. It should be noted, however, that these risks are likely overestimated due to the protective assumptions that were used in the human health risk assessment. Protective assumptions used in the human health risk assessment are described in the Risk Assessment Methodology and Uncertainty Analysis sections (Sections 3.1.2.1 and 5.0). In addition, results of the human health risk assessment suggest that regional, ambient contamination may contribute significantly to potential exposures and risks for current receptors engaged in subsistence food collection and use. Uncertainties related to the risk evaluation for subsistence food use are discussed in the Uncertainty Analysis and Summary and Conclusions sections (Sections 5.3 and 6.1.2.4).

Future Receptors

Potential risks to future receptors are highly dependent upon ultimate land uses for the Northeast Cape Installation. Based on continued use of the Northeast Cape Installation as a base for subsistence fishing and hunting, with seasonal residences at Site 4 (Subsistence Fishing and Hunting Camp) and incidental contact with other sites, future human health risks and hazards are as described above for current receptors. No sites within the Northeast Cape Installation were associated with carcinogenic risk or noncarcinogenic hazard estimates for future incidental visitors in excess of ADEC's point of departure criteria for risk management (Table ES-2). However, if future land uses for the Northeast Cape Installation include establishment of seasonal or permanent residences at sites other than Site 4, then human health risks will depend upon the specific site inhabited, the source of potable water used, and locations in which subsistence foods are collected. Health risk estimates associated with exposures to specific site media are discussed below.

Soils and Sediment

Sites associated with soil-related carcinogenic risk or noncarcinogenic hazard estimates for future seasonal or permanent residents in excess of Alaska Department of Environmental Conservation point of departure criteria include: Sites 4, 6, 7, 9, 10, 11, 13, 15, 16, 19, 21, 22, 27, 28, 31 and 32 (Table ES-2). The primary soil contaminants associated with risk or hazard estimates in excess of point of departure criteria include arsenic, diesel range organics, and polychlorinated biphenyls (Aroclor-1260). However, carcinogenic risk estimates for many of these sites (e.g., Sites 4, 13, 15, 19, 22, 31 and 32) were below the point of departure risk criterion, and noncarcinogenic HI estimates were only marginally above 1.0, due to the presence of diesel range organics in soil. Risk estimates for petroleum hydrocarbons including diesel range organics were most likely overestimated, as described in the Uncertainty Analysis section (Section 5.5). Other soil contaminants contributing to cumulative risk or hazard estimates in excess of point of departure criteria include dioxins/furans at Sites 7 and 9, and polycyclic aromatic hydrocarbons at Site 28.

The remaining sites (i.e., Sites 3, 29, 33, and 34) were associated with carcinogenic risk and noncarcinogenic hazard estimates for future human receptors below point of departure criteria, based on exposure to chemicals in soil or sediment.

Fresh Surface Water

Permanent fresh surface water at the Northeast Cape Installation that may serve as potential sources of potable water for future receptors include Site 28 (Drainage Basin) and the Suqitughneq River. Carcinogenic risk and noncarcinogenic hazard estimates for future seasonal residents using water obtained from Site 28 exceed point of departure criteria. Primary risk drivers for this potential potable water source included polychlorinated biphenyls and diesel range organics. No carcinogenic chemicals of potential concern were identified for water samples collected from the Suqitughneq River, and noncarcinogenic hazard estimates were below the point of departure criterion. The Suqitughneq River is the current source of potable water for seasonal residents or visitors to the Northeast Cape Installation.

Subsurface Water

Sites associated with excess carcinogenic risk or noncarcinogenic hazard estimates related to potential use of shallow subsurface water beneath the site as a potable water supply include:

- Sites 7, 11, 13, 15, 16, 19, 21, 27 and 28 – the primary contaminants in shallow subsurface water associated with risk or hazard estimates at these sites in excess of point of departure criteria include arsenic, benzene, diesel range organics, gasoline range organics or residual range organics.
- Site 9 (Housing and Operations Landfill) – the primary contaminants in shallow subsurface water associated with risk or hazard estimates at this site in excess of point of departure criteria include dioxins/furans, metals (aluminum and antimony) and diesel range organics.
- Sites 3, 4 and 22 – were associated with noncarcinogenic hazard estimates in excess of point of departure criteria due to the presence of diesel range organics and/or residual range organics in shallow subsurface water.

For the remaining sites (i.e., Sites 6, 10, 29, 31, 32, 33 and 34), either shallow subsurface water is absent from this location, or carcinogenic risk or noncarcinogenic hazard estimates related to use of this medium as a potable water supply are below point of departure criteria.

It should be noted that potential future use of shallow subsurface water at the Northeast Cape Installation as a permanent potable water supply is highly unlikely. This is due to the difficulty in developing this source (i.e., drilling a well or digging a pit), the availability of other clean, potable water sources (e.g., the Suqitughneq River) nearby, and the fact that shallow subsurface water lies within the permafrost zone and is frozen a significant portion of the year.

A more reasonable subsurface source of permanent potable water at the Northeast Cape Installation is deep subsurface water. The Air Force used three wells installed in deep subsurface water at Site 22 to produce potable water during historic military operations at the Northeast Cape Installation. The carcinogenic risk estimate for future permanent residents using deep subsurface water at Site 22 as a potable supply is below the point of departure criterion. However, the noncarcinogenic hazard estimate of 1.9 (attributable to residual range organics) exceeds the point of departure criterion of 1.0.

Subsistence Food Use

This human health risk assessment included an evaluation of potential risks associated with subsistence food use, assuming that subsistence fish and plants may be harvested from impacted areas of the Northeast Cape Installation or from locations within the vicinity of the Northeast Cape Installation that are believed unimpacted by site activities. Biological sampling activities included the collection of fish from the Tapisaghak River, which is presumed to be unimpacted by historic military operations. Carcinogenic risk and noncarcinogenic hazard estimates associated with future consumption of fish harvested from the Suqitughneq River were calculated as 9E-4 and 17, respectively (Table ES-3). These risk estimates were attributable to the presence of arsenic, polycyclic aromatic hydrocarbons, and polychlorinated biphenyls (Aroclor-1254 and Aroclor-1260) in fish fillet samples collected from the Suqitughneq River. The maximum target organ-specific hazard index for future seasonal residents consuming fish harvested from the Suqitughneq River was estimated as 12, and was attributable to arsenic. Carcinogenic risk and noncarcinogenic hazard estimates associated with future consumption of fish harvested from the Tapisaghak River (Site 30) were calculated as 1E-3 and 19, respectively. These risk estimates were attributable to the presence of arsenic and polychlorinated biphenyls (Aroclor-1254 and Aroclor-1260) in fish fillet samples collected from the Tapisaghak River. The maximum target organ-specific HI for future seasonal residents consuming fish harvested from the Tapisaghak River was estimated as 15, and was attributable to arsenic. The above results suggest that there is very little difference in risks associated with subsistence consumption of fish harvested from impacted areas versus ambient locations. However, concentrations of polychlorinated biphenyls were higher in fish tissue samples collected from the Suqitughneq River versus the Tapisaghak River, and polycyclic aromatic hydrocarbons were detected in fish tissue samples collected from the Suqitughneq River but not in samples collected from the Tapisaghak River. Attribution of polychlorinated biphenyl residues detected in fish tissue samples collected from the Suqitughneq River to historic releases from the Northeast Cape Installation is complicated by recent findings that (1) polychlorinated biphenyls are global contaminants and are widely distributed by aerial deposition and food chain transport, (2) salmon containing polychlorinated biphenyl residues accumulated from the open oceans are a source of contamination of sediments in Alaska inland streams and lakes as a result of migration and spawning, and (3) levels of polychlorinated biphenyls in fish tissue samples collected from both the Suqitughneq River and Tapisaghak River are within the range of concentrations measured in salmon sold in markets world wide. Nevertheless, arsenic was the primary risk driver for consumption of fish harvested from either impacted or ambient locations. The source of arsenic in fish tissue samples collected from impacted and ambient locations is not certain, although high ambient levels of arsenic are observed throughout Alaska.

The evaluation of ambient conditions for the Northeast Cape Installation also included biological sampling of plants collected from areas believed to be unimpacted by historic military activities (Site 30). Carcinogenic risk and noncarcinogenic hazard estimates associated with subsistence consumption of plants harvested from Site 28 (Drainage Basin) were 9E-04 and 38, respectively. Excess carcinogenic risk estimates were attributable to the presence of maximum concentrations of arsenic, polychlorinated biphenyls and polycyclic aromatic hydrocarbons in plant tissues. The maximum target organ-specific hazard estimates associated with consumption of plants from impacted areas is 26, and was attributable to polychlorinated biphenyls (Aroclor-1254 and Aroclor-1260). Corresponding carcinogenic risk and noncarcinogenic hazard estimates for subsistence consumption of plants harvested from ambient locations (Site 30) were 4E-04 and 12, respectively. Plant tissue samples collected from Site 28 contained higher levels of polycyclic aromatic hydrocarbons and polychlorinated biphenyls than did plant samples collected from Site 30. Overall, carcinogenic risk and noncarcinogenic hazard estimates associated with consumption of subsistence plants harvested from impacted areas were approximately double those estimates for ambient locations. These results suggest that plants growing within Site 28 have been impacted by historic releases from the Northeast Cape Installation. However, there is uncertainty regarding the magnitude of these impacts and associated risks relative to ambient conditions. This is due to the fact that 'ambient' plant samples were collected from within the Northeast Cape Installation (Site 30) and could possibly have been impacted during historic operations or recent construction activities through means such as aerial deposition of dust.

It should be noted that carcinogenic risk estimates for subsistence food collection from either impacted or ambient locations are about two orders of magnitude higher than the Alaska Department of Environmental Conservation point of departure criterion for risk management of 1E-5. These results suggest that a significant portion of the human health risk attributable to subsistence food use is associated with regional ambient contamination, risks for both impacted and ambient areas are overestimated, and/or contaminants associated with the Northeast Cape Installation have impacted 'ambient' areas. The latter suggestion is unlikely to adequately explain risk assessment results for subsistence food use, as described in the Uncertainty Analysis section (Section 5.3).

POTENTIAL ECOLOGICAL HAZARDS

The human health and ecological risk assessment presented in this report also included an evaluation of potential ecological hazards associated with contaminant releases at the Northeast Cape Installation. Ecological hazard estimates were calculated for three ecological indicator receptors (i.e., the tundra vole, cross fox, and glaucous-winged gull) based on modeled exposures to chemicals in site soil, sediment, surface water, or shallow subsurface water, as appropriate for a given site.

The results of the potential ecological hazards evaluation included:

- Ecological hazard estimates for the glaucous-winged gull were below the Alaska Department of Environmental Conservation District point of departure criterion of 1.0 for all sites evaluated in the ERA.

- Ecological hazard estimates for the cross fox were below the point of departure criterion of 1.0 for all sites, with the exception of combined Sites 6 and 7 (hazard quotient equal to 1.5). However, exceedence of the ecological criterion at this location was attributable to aluminum, which was present within the range of ambient concentrations.
- Ecological hazard estimates for the tundra vole exceeded the point of departure criterion for Sites: 6, 7, 21, 28, 31 and 32. The primary contaminants associated with ecological hazard estimates in excess of the point of departure criterion include diesel range organics, polychlorinated biphenyls (Aroclor 1254) and metals (e.g., aluminum, barium and zinc).
- Ecological hazards were not evaluated for the following sites because of inadequate habitat: Sites 10, 11, 13, 15, 16, 19, and 27.
- For the remaining sites (i.e., Sites 3, 9, 29, 33, and 34), ecological hazard estimates were below the point of departure criterion.

The above results suggest that chemicals present in soil at some sites within the Northeast Cape Installation are at concentrations that may potentially have an adverse impact on terrestrial ecological receptors.

The evaluation of potential impacts of chemical releases from the Northeast Cape Installation on off-site marine receptors included the collection of fish tissues samples, surface water samples, and sediment samples from the Suqitughneq River; and modeled exposures and hazards to the glaucous-winged gull. Although samples of fish collected from the Suqitughneq River contained chemical residues including arsenic and polychlorinated biphenyls, the concentrations of these chemicals were comparable to concentrations measured in the tissues of fish collected from the Tapisaghak River. A notable exception is polycyclic aromatic hydrocarbons, which were detected in higher concentrations in fish samples collected from the Suqitughneq River than in fish samples collected from the Tapisaghak River. However, tissue concentrations are a measure of exposure to a chemical, only, and do not necessarily indicate that an adverse effect has occurred. Ecological hazard estimates for the glaucous-winged gull, modeled using chemical concentrations measured in fish collected from the Suqitughneq River, were below the point of departure criterion. Finally, chemical concentrations measured in surface water and sediment samples collected from the Suqitughneq River are generally lower than available marine surface water and sediment quality criteria for these chemicals.

Table ES-1

CANCER RISK AND NONCANCER HAZARD ESTIMATES FOR SOIL
FOR CURRENT HUMAN RECEPTORS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Current Seasonal Resident ILCR	Current Seasonal Resident Total HI	Current Incidental Visitor ILCR	Current Incidental Visitor Total HI
3 - Fuel Line Corridor and Pumphouse					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	6.8E-13	0.00020
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.0013
4 - Subsistence Fishing and Hunting Camp					
	Non-PHCs (Cumulative Site Risk/HI)	na[b]	0	na[b]	0
	PHCs (Cumulative Site Risk/HI)	na[b]	0.48	na[b]	0.0037
6 - Cargo Beach Road Drum Field					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	2E-10	0.00051
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.055
7 - Cargo Beach Road Landfill					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	5E-07	0.010
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.017
9 - Housing and Operations Landfill					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	4E-07	0.0046
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.00070
10 - Buried Drum Field					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.00014
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.014
11 - Fuel Storage Tank Area					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	3E-11	0.00000024
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.036
13 - Heat and Electrical Power Bldg.					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	6E-06	0.47
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.0065
15 - Buried Fuel Line Spill Area					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	4E-11	0.00011
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.0082
16 - Paint and Dope Storage Bldg.					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	2E-07	0.0053
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	na[c]
19 - Auto Maintenance and Storage Facilities					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	6.E-10	0.00013
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.0073
21 - Wastewater Treatment Facility					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	7E-07	0.016
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.0027

Table ES-1

CANCER RISK AND NONCANCER HAZARD ESTIMATES FOR SOIL
FOR CURRENT HUMAN RECEPTORS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Current Seasonal Resident ILCR	Current Seasonal Resident Total HI	Current Incidental Visitor ILCR	Current Incidental Visitor Total HI
22 - Water wells and Water Supply Bldg.					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	2E-08	0.000000053
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.027
27 - Diesel Fuel Pump Island					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	5E-10	0.00075
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.027
28 - Drainage Basin					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	6E-07	0.0020
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.048
29 - Suqitughneq River					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[d]	na[d]
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[d]	na[d]
31 - White Alice Site					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	1E-06	0.089
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.0049
32 - Lower Tram Terminal					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[e]	na[e]
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.00091
33 - Upper Tram Terminal					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[e]	na[e]
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.00097
34 - Upper Camp					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[e]	na[e]
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.00091

Notes:

[a] No current seasonal residents reside at this site.
[b] PHCs were not evaluated for carcinogenic effects.
[c] No PHC COPCs were identified for this site.
[d] Soil was not sampled at this site.
[e] No non-PHC COPCs were identified for this site.

HI - noncancer hazard index
ILCR - Incremental Lifetime Cancer Risk
na - Not applicable
PHC- Petroleum hydrocarbons

Table ES-2

CANCER RISK AND NONCANCER HAZARD ESTIMATES FOR SOIL
FOR FUTURE HUMAN RECEPTORS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Future Permanent Resident		Future Seasonal Resident		Future Incidental Visitor	
		ILCR	HI	ILCR	HI	ILCR	HI
3 - Fuel Line Corridor and Pumphouse							
	Non-PHCs (Cumulative Site Risk/HI)	8.4E-11	0.039	2.8E-11	0.013	6.8E-13	0.00020
	PHCs (Cumulative Site Risk/HI)	na [a]	0.51	na [a]	0.17	na [a]	0.0013
4 - Subsistence Fishing and Hunting Camp							
	Non-PHCs (Cumulative Site Risk/HI)	na [a]	0	na [a]	0	na [a]	0
	PHCs (Cumulative Site Risk/HI)	na [a]	**1.4**	na [a]	0.48	na [a]	0.0037
6 - Cargo Beach Road Drum Field							
	Non-PHCs (Cumulative Site Risk/HI)	5E-09	0.14	2E-09	0.047	2E-10	0.00051
	PHCs (Cumulative Site Risk/HI)	na [a]	**21**	na [a]	**7.0**	na [a]	0.055
	Diesel Range Organics, Aliphatic	na [a]	**8.9**	na [a]	**3.0**	na [a]	0.023
	Diesel Range Organics, Aromatic	na [a]	**11**	na [a]	**3.7**	na [a]	0.029
7 - Cargo Beach Road Landfill							
	Non-PHCs (Cumulative Site Risk/HI)	**5E-05**	**2.4**	**2E-05**	0.79	5E-07	0.010
	Arsenic	**3E-05**	0.60	**1E-05**	0.19	3E-07	0.0020
	PCB-1260 (Aroclor 1260)	6E-06	**1.3**	2E-06	0.42	9E-08	0.0065
	Dioxins/furans	9E-06	na [b]	3E-06	na [b]	9E-08	na [b]
	PHCs (Cumulative Site Risk/HI)	na [a]	**6.7**	na [a]	**2.2**	na [a]	0.017
	Diesel Range Organics, Aliphatic	na [a]	**2.8**	na [a]	0.93	na [a]	0.0073
	Diesel Range Organics, Aromatic	na [a]	**3.5**	na [a]	**1.2**	na [a]	0.0091
9 - Housing and Operations Landfill							
	Non-PHCs (Cumulative Site Risk/HI)	**4E-05**	**1.4**	**1E-05**	0.46	4E-07	0.0046
	Arsenic	**3E-05**	0.66	**1E-05**	0.22	3E-07	0.0022
	Dioxins/furans	2E-06	na [b]	6E-07	na [b]	2E-08	na [b]
	PHCs (Cumulative Site Risk/HI)	na [a]	0.27	na [a]	0.089	na [a]	0.00070
10 - Buried Drum Field							
	Non-PHCs (Cumulative Site Risk/HI)	na [c]	0.053	na [c]	0.019	na [c]	0.00014
	PHCs (Cumulative Site Risk/HI)	na [a]	**5.2**	na [a]	**1.7**	na [a]	0.014
	Diesel Range Organics, Aliphatic	na [a]	**2.3**	na [a]	0.77	na [a]	0.0061
	Diesel Range Organics, Aromatic	na [a]	**2.9**	na [a]	0.96	na [a]	0.0076
11 - Fuel Storage Tank Area							
	Non-PHCs (Cumulative Site Risk/HI)	4E-09	0.000093	1E-09	0.000031	3E-11	0.00000024

Table ES-2

CANCER RISK AND NONCANCER HAZARD ESTIMATES FOR SOIL
FOR FUTURE HUMAN RECEPTORS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Future Permanent Resident		Future Seasonal Resident		Future Incidental Visitor	
		ILCR	HI	ILCR	HI	ILCR	HI
	PHCs (Cumulative Site Risk/HI)	na [a]	**14**	na [a]	**4.5**	na [a]	0.036
	Diesel Range Organics, Aliphatic	na [a]	**6.0**	na [a]	**2.0**	na [a]	0.016
	Diesel Range Organics, Aromatic	na [a]	**7.5**	na [a]	**2.5**	na [a]	0.020
13 - Heat and Electrical Power Bldg.							
	Non-PHCs (Cumulative Site Risk/HI)	**4E-04**	**91**	**1E-04**	**30**	6E-06	0.47
	PCB-1260 (Aroclor 1260)	**4E-04**	**91**	**1E-04**	**30**	6E-06	0.47
	PHCs (Cumulative Site Risk/HI)	na [a]	**2.5**	na [a]	0.83	na [a]	0.0065
	Diesel Range Organics, Aliphatic	na [a]	1.0	na [a]	0.35	na [a]	0.0027
	Diesel Range Organics, Aromatic	na [a]	**1.3**	na [a]	0.44	na [a]	0.0034
15 - Buried Fuel Line Spill Area							
	Non-PHCs (Cumulative Site Risk/HI)	5E-09	0.022	2E-09	0.0073	4E-11	0.00011
	PHCs (Cumulative Site Risk/HI)	na [a]	**3.1**	na [a]	1.0	na [a]	0.0082
	Diesel Range Organics, Aliphatic	na [a]	**1.4**	na [a]	0.47	na [a]	0.0037
	Diesel Range Organics, Aromatic	na [a]	**1.7**	na [a]	0.58	na [a]	0.0046
16 - Paint and Dope Storage Bldg.							
	Non-PHCs (Cumulative Site Risk/HI)	**2E-05**	1.4	5E-06	0.45	2E-07	0.0053
	Arsenic	**1E-05**	0.25	4E-06	0.085	1E-07	0.00085
	PCB-1260 (Aroclor 1260)	3E-06	0.61	1E-06	0.20	4E-08	0.0032
	PHCs (Cumulative Site Risk/HI)	na [a]	na [d]	na [a]	na [d]	na [a]	na [d]
	Diesel Range Organics, Aliphatic	na [a]	na [d]	na [a]	na [d]	na [a]	na [d]
	Diesel Range Organics, Aromatic	na [a]	na [d]	na [a]	na [d]	na [a]	na [d]
19 - Auto Maintenance and Storage Facilities							
	Non-PHCs (Cumulative Site Risk/HI)	6E-08	0.050	2E-08	0.017	6E-10	0.00013
	PHCs (Cumulative Site Risk/HI)	na [a]	**2.8**	na [a]	0.94	na [a]	0.0073
	Diesel Range Organics, Aliphatic	na [a]	**1.2**	na [a]	0.39	na [a]	0.0030
	Diesel Range Organics, Aromatic	na [a]	**1.5**	na [a]	0.48	na [a]	0.0038
21 - Wastewater Treatment Facility							
	Non-PHCs (Cumulative Site Risk/HI)	**7E-05**	**4.0**	**2E-05**	**1.3**	7E-07	0.016
	Arsenic	**6E-05**	1.1	**2E-05**	0.37	6E-07	0.0037
	PCB-1260 (Aroclor 1260)	9E-06	**1.9**	3E-06	0.63	1E-07	0.0098

Table ES-2

CANCER RISK AND NONCANCER HAZARD ESTIMATES FOR SOIL
FOR FUTURE HUMAN RECEPTORS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Future Permanent Resident ILCR	Future Permanent Resident HI	Future Seasonal Resident ILCR	Future Seasonal Resident HI	Future Incidental Visitor ILCR	Future Incidental Visitor HI
	PHCs (Cumulative Site Risk/HI)	na [a]	1.0	na [a]	0.34	na [a]	0.0027
	Diesel Range Organics, Aliphatic	na [a]	0.33	na [a]	0.11	na [a]	0.00087
	Diesel Range Organics, Aromatic	na [a]	0.41	na [a]	0.14	na [a]	0.0011
22 - Water wells and Water Supply Bldg.							
	Non-PHCs (Cumulative Site Risk/HI)	1E-06	0.000020	3E-07	0.0000068	2E-08	0.000000053
	PHCs (Cumulative Site Risk/HI)	na [a]	**1.2**	na [a]	0.41	na [a]	0.0032
	Diesel Range Organics, Aliphatic	na [a]	0.36	na [a]	0.12	na [a]	0.00093
	Diesel Range Organics, Aromatic	na [a]	0.44	na [a]	0.15	na [a]	0.0012
27 - Diesel Fuel Pump Island							
	Non-PHCs (Cumulative Site Risk/HI)	6E-08	0.15	2E-08	0.036	5E-10	0.00075
	PHCs (Cumulative Site Risk/HI)	na [a]	**10**	na [a]	**3.5**	na [a]	0.027
	Diesel Range Organics, Aliphatic	na [a]	**4.5**	na [a]	**1.5**	na [a]	0.012
	Diesel Range Organics, Aromatic	na [a]	**5.6**	na [a]	**1.9**	na [a]	0.015
28 - Drainage Basin							
	Non-PHCs (Cumulative Site Risk/HI)	na [e]	na [e]	**1E-05**	0.14	6E-07	0.0020
	Benzo(a)anthracene	na [e]	na [e]	2E-06	na [c]	9E-08	na [c]
	Benzo(a)pyrene	na [e]	na [e]	**1E-05**	na [c]	5E-07	na [c]
	Benzo(b)fluoranthene	na [e]	na [e]	1E-06	na [c]	5E-08	na [c]
	PHCs (Cumulative Site Risk/HI)	na [e]	na [e]	na [a]	**6.2**	na [a]	0.048
	Diesel Range Organics, Aliphatic	na [e]	na [e]	na [a]	**2.7**	na [a]	0.021
	Diesel Range Organics, Aromatic	na [e]	na [e]	na [a]	**3.4**	na [a]	0.026
29 - Suqitughneq River		na [f]	na [f]	na [f]	na [f]	na [f]	na [f]
31 - White Alice Site							
	Non-PHCs (Cumulative Site Risk/HI)	**8E-05**	**17**	**3E-05**	**5.8**	1E-06	0.089
	PCB-1260 (Aroclor 1260)	**8E-05**	**17**	**3E-05**	**5.8**	1E-06	0.089
	PHCs (Cumulative Site Risk/HI)	na [b]	**1.9**	na [a]	0.63	na [a]	0.0049
	Diesel Range Organics, Aliphatic	na [b]	0.73	na [a]	0.24	na [a]	0.0019
	Diesel Range Organics, Aromatic	na [b]	0.91	na [a]	0.30	na [a]	0.0024

Table ES-2

CANCER RISK AND NONCANCER HAZARD ESTIMATES FOR SOIL
FOR FUTURE HUMAN RECEPTORS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Future Permanent Resident		Future Seasonal Resident		Future Incidental Visitor	
		ILCR	HI	ILCR	HI	ILCR	HI
32 - Lower Tram Terminal							
	Non-PHCs (Cumulative Site Risk/HI)	na [g]	na [g]	na [g]	na [g]	na [g]	na [g]
	PHCs (Cumulative Site Risk/HI)	na [a]	**3.0**	na [a]	0.99	na [a]	0.0078
	Diesel Range Organics, Aliphatic	na [a]	**1.1**	na [a]	0.38	na [a]	0.0030
	Diesel Range Organics, Aromatic	na [a]	**1.4**	na [a]	0.47	na [a]	0.0037
33 - Upper Tram Terminal							
	Non-PHCs (Cumulative Site Risk/HI)	na [g]	na [g]	na [g]	na [g]	na [g]	na [g]
	PHCs (Cumulative Site Risk/HI)	na [a]	0.37	na [a]	0.12	na [a]	0.00097
34 - Upper Camp							
	Non-PHCs (Cumulative Site Risk/HI)	na [g]	na [g]	na [g]	na [g]	na [g]	na [g]
	PHCs (Cumulative Site Risk/HI)	na [a]	0.35	na [a]	0.12	na [a]	0.00091

Notes:

[a] Not a carcinogenic COPC.

[b] This chemical was evaluated for carcinogenic effects only.

[c] No carcinogenic COPCs were identified for this site.

[d] No PHC COPCs were identified for this site.

[e] Not applicable; it is highly unlikely that a residence would be constructed at this location in the future.

[f] Soil was not sampled at this site.

[g] Only PHC COPCs were identified for this site.

COPC - Chemical of potential concern
HI - Noncancer hazard index
ILCR - Incremental lifetime cancer risk
Inc - Incomplete
na - Not applicable
PCB - Polychlorinated biphenyls
PHC - Petroleum hydrocarbons

Table ES-3

COMPARISON OF SITE AND AMBIENT CANCER RISK AND NONCANCER HAZARD ESTIMATES FOR SUBSISTENCE FISH & PLANT CONSUMPTION NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site/Risk Drivers	Media	ILCR	HI
Sites 28 and 29 Total Subsistence Risk/HI:		**2E-03**	**55**
	(Site 29 - Fish Consumption Risk/HI):	**9E-04**	**17**
	Arsenic	**3E-04**	**3.5**
	Cadmium	0E+00	**4.3**
	Benzo(a)anthracene	**2E-05**	na [a]
	Benzo(a)pyrene	**3E-04**	na [a]
	Benzo(b)fluoranthene	**3E-05**	na [a]
	Dibenzo(a,h)anthracene	**6E-05**	na [a]
	Indeno(1,2,3-cd)pyrene	**4E-05**	na [a]
	PCB-1254 (Aroclor 1254)	**1E-04**	**17**
	PCB-1260 (Aroclor 1260)	**6E-05**	**9.4**
	(Site 28 - Plant Consumption Risk/HI):	**9E-04**	**38**
	Arsenic	**3E-04**	**3.5**
	Cadmium	0E+00	**4.3**
	Benzo(a)anthracene	**2E-05**	na [a]
	Benzo(a)pyrene	**3E-04**	na [a]
	Benzo(b)fluoranthene	**3E-05**	na [a]
	Dibenzo(a,h)anthracene	**6E-05**	na [a]
	Indeno(1,2,3-cd)pyrene	**4E-05**	na [a]
	PCB-1254 (Aroclor 1254)	**1E-04**	**17**
	PCB-1260 (Aroclor 1260)	**6E-05**	**9.4**
Ambient (Site 30) Total Subsistence Risk/HI:		**1E-03**	**30**
	(Fish Consumption Risk/HI):	**1E-03**	**19**
	Arsenic	**1E-03**	**15**
	PCB-1254 (Aroclor 1254)	**2E-05**	**2.8**
	(Plant Consumption Risk/HI):	**4E-04**	**12**
	Arsenic	**3E-04**	**3.6**
	Cadmium	0E+00	**3.4**
	Vanadium	na [b]	1.0
	Benzo(a)anthracene	**2E-05**	na [a]
	Benzo(a)pyrene	**5E-05**	na [a]
	Benzo(b)fluoranthene	1E-05	na [a]
	Dibenzo(a,h)anthracene	**3E-05**	na [a]
	PCB-1254 (Aroclor 1254)	7E-06	**1.1**
	PCB-1260 (Aroclor 1260)	6E-06	0.91

Notes:

[a] Chemical was evaluated for carcinogenic effects only.
[b] Not a carcinogenic COPC.

HI - noncancer hazard index
ILCR - Incremental Lifetime Cancer Risk
Inc - Incomplete
na - Not applicable
PCB- Polychlorinated biphenyls
PHC- Petroleum hydrocarbons

TABLE ES-4

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site/Chemicals of Concern	Maximum Ecological Hazard Estimate (HQ)		
	Tundra Vole [a] *Microtus oeconomus*	Cross Fox [a] *Vulpes vulpes*	Glaucous-winged Gull *Larus glaucescens*
3 - Fuel Line Corridor and Pumphouse	0.38	0.0014	0.0000090
4 - Subsistence Fishing and Hunting Camp	0.79	0.0079	0.000052
Sites 3 & 4 Combined	0.79	0.011	0.000071
6 - Cargo Beach Road Drum Field			
Aluminum	**15**	0.20	0.0000000039
Diesel Range Organics, Aliphatic	**15**	0.071	0.00047
Diesel Range Organics, Aromatic	**7.6**	0.035	0.00023
7 - Cargo Beach Road Landfill			
Diesel Range Organics, Aliphatic	**4.8**	0.15	0.0010
Diesel Range Organics, Aromatic	**2.4**	0.076	0.00050
Sites 6 & 7 Combined			
Aluminum	**15**	**1.5**	0.000000030
Diesel Range Organics, Aliphatic	**15**	0.56	0.0037
Diesel Range Organics, Aromatic	**7.6**	0.28	0.0018
9 - Housing and Operations Landfill	0.24	0.037	0.0000062
10 - Buried Drum Field	na[b]	na[b]	na[b]
11 - Fuel Storage Tank Area	na[b]	na[b]	na[b]
13 - Heat and Electrical Power Bldg.	na[b]	na[b]	na[b]
15 - Buried Fuel Line Spill Area	na[b]	na[b]	na[b]
16 - Paint and Dope Storage Bldg.	na[b]	na[b]	na[b]
19 - Auto Maintenance and Storage Facilities	na[b]	na[b]	na[b]
21 - Wastewater Treatment Facility			
Aluminum	**34**	0.65	0.000000013
Barium	**1.4**	0.016	0.000000016
Diesel Range Organics, Aliphatic	0.56	0.0040	0.000026
22 - Water wells and Water Supply Bldg.			
Diesel Range Organics, Aliphatic	0.60	0.00044	0.0000029
Zinc	0.083	0.00068	0.0000000000000000000012
27 - Diesel Fuel Pump Island	na[b]	na[b]	na[b]
28 - Drainage Basin			
Barium	**9.6**	0.11	0.0000028
Zinc	**1.3**	0.028	0.0000040
PCB-1254 (Aroclor 1254)	**2.0**	0.025	0.000011
Diesel Range Organics, Aliphatic	**14**	0.71	0.19
Diesel Range Organics, Aromatic	**5.5**	0.28	0.075

TABLE ES-4

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (HQ)		
Site/Chemicals of Concern	**Tundra Vole**[a] *Microtus oeconomus*	**Cross Fox**[a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
29 - Suqitughneq River			
Diesel Range Organics, Aliphatic	0.00000000055	0.00000000015	0.0034
Silver, dissolved	0.0000000082	0.0000000023	0.0000000013
Sites 28 & 29 Combined			
Barium	**9.6**	0.23	0.000024
Zinc	**1.3**	0.056	0.0000079
PCB-1254 (Aroclor 1254)	**2.0**	0.050	0.000023
Diesel Range Organics, Aliphatic	**14**	**1.4**	0.37
Diesel Range Organics, Aromatic	**6.9**	0.71	0.19
30 - Background Areas	na	na	na
31 - White Alice Site			
Diesel Range Organics, Aliphatic	**1.2**	0.0085	0.000056
Diesel Range Organics, Aromatic	0.62	0.0043	0.000028
32 - Lower Tram Terminal			
Diesel Range Organics, Aliphatic	**1.9**	0.0051	0.000034
Diesel Range Organics, Aromatic	0.97	0.0026	0.000017
33 - Upper Tram Terminal			
Diesel Range Organics, Aliphatic	0.098	0.0029	0.0000019
Residual Range Organics, Aliphatic	0.11	0.00081	0.00000014
34 - Upper Camp	0.16	0.0016	0.000011
Sites 33 & 34 Combined	0.16	0.0036	0.000014

Notes:

[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[b] This site was not evaluated under the ERA due to insufficient habitat quality to support ecological receptors.

HQ - Hazard quotient.
mg/kg - Milligrams per kilogram.
na - Not applicable.
PCB - Polychlorinated Biphenyls.

1.0 INTRODUCTION

Pursuant to Contract No. DACA85-98-D-0007, the U.S. Army Engineer District, Alaska (Alaska District), contracted with MWH Americas, Inc. (MWH), formerly Montgomery Watson (MW), to perform Phase III Remedial Investigation (RI) activities at Northeast Cape, St. Lawrence Island, Alaska, and to conduct a human health and ecological risk assessment (HHERA) for the site. The Phase III RI was conducted according to the guidelines of the Defense Environmental Restoration Program (DERP) Formerly Used Defense Sites (FUDS) program of the U.S. Department of Defense (DoD). Findings of the Phase III RI were presented in the Final Phase III RI report (MWH, 2002a). This HHERA is intended to evaluate potential impacts of site-related chemicals on public health and the environment based on results obtained from the Phase III RI, as well as previous environmental investigations conducted at Northeast Cape. Results of this HHERA will be considered during the feasibility study (FS) stage, for evaluation of potential remedial options for the Northeast Cape Installation.

This HHERA includes seven sections and nine appendices, as described below.

Section 1 Introduction – presents the purpose and objectives of this HHERA, including a summary of regulatory criteria and a brief history of operations and environmental investigations conducted at the Northeast Cape Installation.

Section 2 Data Evaluation – presents descriptions of data quality and quality assurance (QA) objectives for all environmental data evaluated in this HHERA.

Section 3 Risk Assessment Methodology – presents the methods and assumptions that were used in this HHERA, including the identification of potential human and ecological receptors and exposure pathways and methods for the estimation of risks.

Section 4 Risk Assessment Results – presents quantitative and qualitative estimates of risk to human and ecological receptors associated with the Northeast Cape Installation.

Section 5 Uncertainty Analysis – identifies and evaluates potential sources of uncertainty in this HHERA.

Section 6 Summary and Conclusions – provides a brief summary of potential risks to human and ecological receptors associated with the Northeast Cape Installation, and presents conclusions of this HHERA.

Section 7 References – lists the documents cited in this report.

Appendix A Description of the Subarctic Coastal Plains Ecoregion

Appendix B U.S. Army Corps of Engineers (USACE) Trip Report – Biological Sampling

Appendix C Community Surveys

Appendix D Example Dose and Risk Calculations for Human and Ecological Receptors

Appendix E Human Health Tier 1 Screening Tables

Appendix F Human Health Tier 2 Baseline Risk Assessment Calculations

Appendix G Ecological Tier I Screening Tables

Appendix H Ecological Tier 2 Risk Calculation Tables

Appendix I Summary Statistics and Exposure Point Concentration Calculations for Environmental Media

Tables and Figures referenced in a section are presented at the end of the section.

1.1 PURPOSE AND SCOPE

The purpose and scope of this HHERA are described in the following subsections.

1.1.1 Purpose

The purpose of this HHERA is to evaluate potential public health risks and potential threats to ecological habitats and receptors from chemicals released to the environment in and around the Northeast Cape Installation. Specifically, this HHERA describes:

- Sources and affected media from which contaminants may originate.
- Types of contaminants that may potentially impact human health or the environment and that were evaluated in this HHERA.
- Human and ecological receptors that may come into contact with site contaminants.
- Exposure pathways and assumptions for human and ecological receptors that are appropriate for evaluation.
- Methods used in the human toxicity and ecological effects assessments.
- Risk characterization methods used in the HHERA.
- Results of the HHERA for the Northeast Cape Installation.
- Uncertainties in the HHERA.

1.1.2 Scope

The HHERA study area described in this report is defined as the boundaries of the Northeast Cape Installation (Figure 1-1), which occupies approximately 4 square miles of land on St. Lawrence Island (USACHPPM, 2001) (Figure 1-2). The Northeast Cape Installation has been divided into 33 individual sites, as shown on Figure 1-3. Of these sites, three sites (1, 8, and 26) were designated as "no further action" (NFA) and 10 sites (2, 5, 12, 14, 17, 19, 20, 23, 24, and

25) were recommended for no work other than containerized hazardous waste and/or building demolition/debris removal (BD/DR) (MW, 1999). The remaining 20 sites, including background areas and the four White Alice Communications System sites, are addressed in this HHERA.

A summary of environmental issues identified in various media associated with DERP-FUDS sites identified for the Phase III RI at the Northeast Cape Installation is presented in Table 1-1.

Sites evaluated in this HHERA are listed below and shown on Figure 1-3. Some sites are grouped for presentation and discussion in this HHERA.

Site Number	Site Description
Site 3	Fuel Line Corridor and Pumphouse
Site 4	Subsistence Fishing and Hunting Camp
Site 6	Cargo Beach Road Drum Field
Site 7	Cargo Beach Road Landfill
Site 9	Housing and Operations Landfill
Site 10	Buried Drum Field
Site 11	Fuel Storage Tank Area
Sites 13, 15, 19, and 27	Main Operations Complex
Site 16	Paint and Dope Storage Building
Site 21	Wastewater Treatment Facility
Site 22	Water Wells and Water Supply Building
Site 28	Drainage Basin
Site 29	Suqitughneq River
Site 30	Background Areas
Site 31	White Alice Site
Site 32	Lower Tram Terminal
Site 33	Upper Tram Terminal
Site 34	Upper Camp

The specific objectives of the HHERA for the Northeast Cape Installation are as follows:

- Complete and update previous human health risk assessments (HHRAs) conducted for Sites 4, 10, 11, 13, 16, 19, 21, 27, and 28.
- Prepare HHRAs for Sites 3, 6, 7, 9, 15, 22, 29, 31, 32, 33, and 34.
- Complete and update the previous ecological risk assessment (ERA) conducted for Site 28.
- Prepare ERAs for Sites 3, 4, 6, 7, 9, 21, 22, 29, 31, 32, 33, and 34.

At the request of the Alaska District, alternate cleanup levels (ACLs) or risk-based cleanup levels for media of concern are not proposed in this HHERA. Any future proposed cleanup levels will be included in the FS for the Northeast Cape Installation, if one or more unacceptable health risk conditions are identified.

1.2 REGULATORY SETTING

Work for this HHERA was performed under the DERP-FUDS program. Authority for DERP-FUDS is derived from the following legislation:

- The Comprehensive Environmental Restoration, Compensation, and Liability Act of 1980 (CERCLA), Public Law (PL) 96-510, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, PL-99-499 (codified as 42 U.S. Code 9601-9675).
- Environmental Restoration Program, 10 U.S. Code 2701-2707.

The Phase III RI for the Northeast Cape Installation is being performed following the CERCLA process and procedures. In accordance with CERCLA, the Alaska State Oil and Other Hazardous Substance Pollution Control Regulations (18 Alaska Administrative Code [AAC] 75) govern the cleanup of contaminated sites in Alaska. The following regulations and standards are relevant to the characterization and cleanup of contaminated sites under 18 AAC 75:

- **Soil Cleanup Criteria** – 18 AAC 75 provides four options for determining appropriate soil cleanup criteria. Method One criteria may be used to support recommendations for NFAs where contaminant levels in soil fall below the Alaska Department of Environmental Conservation (ADEC) Method One matrix levels for petroleum, and ADEC Table B2 levels for petroleum constituents. For sites where petroleum levels exceed ADEC Method One levels, the cumulative risk may be assessed in accordance with Method Two procedures. If the cumulative risk exceeds Method Two criteria, site-specific information may be used to develop cleanup criteria in accordance with Method Three or Method Four procedures. Method Three procedures provide for the modification of Method Two criteria based on site-specific information relative to contaminant fate and transport. Method Four provides for the development of alternate cleanup levels based on a site-specific risk assessment. Once negotiated and accepted by ADEC, Method Three or Method Four cleanup levels are used in the FS to identify and evaluate remedial options.
- **Groundwater Cleanup Criteria** – Numerical cleanup critreria for groundwater that is a current or potential future drinking water source are identified in 18 AAC 75.345, Table C. Additionally, 18 AAC 75.345 requires that groundwater that is closely hydraulically connected to surface water may not cause a violation of the water quality standards in 18 AAC 70 for surface water or sediment. Additional modifying conditions are set forth in 18 AAC 75.345.

  At this time, ADEC considers the deep groundwater at the Northeast Cape Installation to be a reasonably expected potential future drinking water source. Information presented in Section 1.6 suggests that shallow groundwater at the Northeast Cape Installation is not a current or reasonably expected potential future drinking water source. However, 18 AAC 75.345 classifies all groundwater within the State of Alaska as a potential drinking water source, unless specific requirements in 18 AAC 75.350 are met. Therefore, shallow groundwater at the Northeast Cape Installation was considered a potential future drinking water source for purposes of this HHERA.

- **Surface Water and Sediment Cleanup Criteria** – Water quality standards specified in 18 AAC 70 are applicable when evaluating cleanup of contaminated surface waters. ADEC Water Quality Standards (as amended through June 26, 2003) reference numeric surface water quality criteria listed in the ADEC *Water Quality Criteria Manual* (as amended through May 15, 2003). Although 18 AAC 70 also includes sediment standards for use in evaluating cleanup of contaminated sediment, ADEC has not established numeric sediment cleanup criteria. Instead, numeric sediment quality benchmarks are obtained from sources including, but not limited to, U.S. Environmental Protection Agency (EPA) Sediment Quality Criteria (USEPA, 1993; as cited in ORNL, 1997a) and National Oceanic and Atmospheric Administration (NOAA) sediment screening values (NOAA, 1999). Additional sources of sediment quality benchmarks are described in Section 3.2.1.

Cleanup of soil, groundwater, surface water, and sediments is performed in order to protect public health and the environment. Cleanup of these media to established standards is designed to result in the reduction of site contaminants in vegetation, fish, and wildlife. ADEC is involved in the review and approval of all work plans, site work, and reports for the Northeast Cape Iinstallation.

1.3 SITE DESCRIPTION

The Northeast Cape Installation is located approximately 9 miles west of the northeastern cape of St. Lawrence Island, between Kitnagak Bay to the northeast and Kangighsak Point to the northwest. The Kinipaghulghat Mountains bound the southern portion of the site. St. Lawrence Island is located in the Bering Sea near the territorial waters of Russia, approximately 135 air miles southwest of Nome. The Northeast Cape Installation is accessible by boat, aircraft, or all terrain vehicle (Figures 1-1 and 1-2).

The Northeast Cape Installation was used by the military from the early 1950s until 1975, and is classified as a FUDS under the DoD DERP. Individual sites at the Northeast Cape Installation are shown on Figure 1-3. A summary of environmental issues identified in various media at the sites included in the Phase III RI is presented in Table 1-1.

1.4 SITE HISTORY AND PREVIOUS INVESTIGATIONS

Site history and previous investigation information contained in this HHERA have been summarized from previous documents about the Northeast Cape Installation. The following documents present results of field investigations, chemical sampling and analyses, and quality assurance/quality control (QA/QC) activities performed during previous investigations:

- Removal Action Report for the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program Northwest Area, White Alice Site, Northeast Cape, St. Lawrence Island, Alaska. URS Corporation. May 1991.
- Final Report, Site Inspection for the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program Northwest Area, White Alice Site, Northeast Cape, St. Lawrence Island, Alaska. Shannon & Wilson. May 1991.

- Preliminary Assessment Report, Naval Ocean Systems Center Special Areas, Alaska. Naval Energy and Environmental Support Activity. July 1991.
- Revised Site Inspection Final Report, White Alice Site, Northeast Cape, St. Lawrence Island, Alaska. URS Corporation. April 1992.
- Site Inventory, Northeast Cape, St. Lawrence Island, Alaska. Ecology and Environment. December 1992.
- Chemical Data Acquisition Plan, Site Inventory Update, Northeast Cape, St. Lawrence Island, Alaska. Ecology & Environment. February 1993.
- Remedial Investigation, Northeast Cape, St. Lawrence Island, Alaska. Montgomery Watson. January 1995.
- Building Demolition and Debris Removal Technical Memorandum, Northeast Cape, St. Lawrence Island, Alaska. Montgomery Watson. January 10, 1995.
- Remedial Action Alternatives Technical Memorandum, Northeast Cape, St. Lawrence Island, Alaska. Montgomery Watson. November 1995.
- Engineering Evaluation/Cost Analysis, Northeast Cape, Alaska. Montgomery Watson. April 1996.
- St. Lawrence Island Investigation HTW Activities Summary. Montgomery Watson. September 18, 1997.
- Phase II Remedial Investigation, Northeast Cape, St. Lawrence Island, Alaska. Montgomery Watson. August 1999.
- Phase II Remedial Investigation Report Addendum, 1999 Fieldwork, Northeast Cape, Alaska. Montgomery Watson. June 2000.
- Building Composite Sampling and Asbestos Survey Technical Memorandum, Northeast Cape, Alaska. Montgomery Watson. December 2000.
- Work Plan, Phase III Remedial Investigation, Northeast Cape, St. Lawrence Island, Alaska. Final. Montgomery Watson. August 2001.
- Biological Sampling Plan. 2001 Phase III Remedial Investigation. Northeast Cape, St. Lawrence Island. Montgomery Watson. August 2001.
- Summary Report Phase III Remedial Investigation, Northeast Cape, St. Lawrence Island, Alaska, Final. MWH. March 2003.

RIs have been conducted at the Northeast Cape Installation since 1994. During the Phase I RI, sampling results from the investigated sites were compared to conservative benchmark criteria to identify sites at which further evaluation would be necessary. Several sites were removed from further consideration because contamination was not present, was present at concentrations below benchmark criteria, or site-specific criteria showed no elevated risk to human health or the environment.

Phase II RI work was conducted to fill data gaps identified during review of Phase I RI work, to support assessment of remedial alternatives, and to support future work at the site. Phase II RI work included: posting danger signs, cutting wire, conducting radiological and asbestos surveys and environmental sampling, evaluating gravel borrow areas, removing containerized hazardous or toxic wastes (CON/HTW), identifying polychlorinated biphenyls (PCBs) and lead in paint and building materials, and performing ecological sampling and assessment.

Work performed during the 2000 field season at the Northeast Cape Installation included BD/DR, removal of CON/HTW, and sampling of building materials as described in this Work Plan and reported in a Technical Memorandum dated December 2000 (Montgomery Watson, 2000b).

Phase III field work performed in 2001 and detailed in the Phase III RI report (MWH, 2003a) included sampling surface water, groundwater, sediment, surface and subsurface soils, vegetation, and fish. Work planned for 2001 at the Main Operations Complex was postponed until 2002, and included drilling 22 soil borings and installing 10 monitoring wells. Documentation of the 2002 work and results are included in the Summary Report Phase III RI (MWH, 2003b).

1.5 ENVIRONMENTAL SETTING

The physical setting at Northeast Cape is described in this section. The information presented was summarized from the detailed site setting information provided in the Phase I RI Report (Montgomery Watson, 1995b), Phase II RI Report Addendum (Montgomery Watson, 2000a), and the Preliminary Conceptual Site Model, St. Lawrence Island, Alaska Northeast Cape FUDS (Preliminary CSM) (USACHPPM, 2001). Additional information can be found in Appendix A.

1.5.1 Climate

St. Lawrence Island has a cool, moist, subarctic maritime climate with some continental influences during winter, when much of the Bering Sea is capped with pack ice. Winds and fog are common; precipitation occurs approximately 300 days per year as light rain, mist, or snow. Annual snowfall is about 80 inches per year. Annual precipitation is about 16 inches per year, and more than half falls as light rain between June and September. Summer temperatures average between 34 and 48 degrees Fahrenheit (°F), with a record high of 65°F. Winter temperatures range from -2°F to 10°F, with an extreme low of -30°F (URS, 1985). Freeze-up normally occurs in October or November, and break-up normally occurs in June.

The wind is generally in a northerly to northeasterly direction from September to June, and southwesterly in July and August. Winds exceeding 10 knots occur 70 percent (%) of the time, and average 20 knots in winter months. The average wind speed is 18 miles per hour (USKH, 1993). Gusts at the Northeast Cape Installation have been measured as high as 110 miles per hour.

1.5.2 Topography

The site consists mainly of flat coastal plains, which gradually turn into rolling tundra towards the base of the Kinipaghulghat Mountains. The Kinipaghulghat Mountains rise abruptly to a maximum elevation of approximately 1,800 feet above sea level about 2 miles south of the Northeast Cape Installation. Most of the Northeast Cape Installation is at an elevation of 20 to 80 feet above mean sea level. The White Alice area is located upland in the Kinipaghulghat Mountains.

1.5.3 Geology

St. Lawrence Island consists of isolated bedrock highlands of igneous, metamorphic, and older sedimentary rocks surrounded by unconsolidated surficial deposits overlying a relatively shallow erosional bedrock surface. In the immediate Northeast Cape Installation vicinity, shallow unconsolidated surficial materials overlie quartz monzonitic rocks of the Kinipaghulghat Pluton (Patton and Csejtey, 1980). The Pluton forms the mountainous area south of the Northeast Cape Installation, which includes Kangukhsam Mountain. Immediately south of the Northeast Cape Installation, an unnamed drainage in the Kinipaghulghat Pluton has created an erosional valley and alluvial fan of unconsolidated sediments. The primary areas of this investigation are located on this alluvial fan, which progrades north from the mountain front toward the Bering Sea. Granitic bedrock materials are exposed at the coast north of the site at Kitnagak Bay, suggesting that quartz monzonitic bedrock underlies the unconsolidated materials at a relatively shallow depth on a wave-cut erosional platform.

The unconsolidated alluvial materials exhibit a soil profile in areas that have not been disturbed by man. In general, native soil stratigraphy at the Northeast Cape Installation is characterized by silts near the surface, overlying more sand-dominated soils at depth. The silt contains varying quantities of clay/sand/gravel, and varyies from zero to 10 feet in thickness. The silt is dark brown to dark green, and sometimes exhibits a mottled texture. In some areas, the silt exhibits an aqua green or blue color. Dark brown silts are observed in outcrops. The sand at depth contains varying degrees of silt/gravel/cobbles, and ranges from 2 feet to greater than 20 feet in thickness. These deeper, coarse-grained materials are generally unsorted and are likely to be of glaciofluvial origin. The depth to bedrock at the Northeast Cape Installation is unknown.

1.5.4 Hydrogeology

Because of the relatively remote and undeveloped nature of St. Lawrence Island, there is little data on the regional groundwater regime. The bedrock materials south of the Northeast Cape Installation (and underlying the unconsolidated deposits) are not expected to store and transmit significant quantities of groundwater. Typically, these types of granitic rocks are generally impermeable, and transmit groundwater only through localized fractures and weathered soil zones at the surface.

The primary aquifer at the Northeast Cape Installation is the unconsolidated alluvial material, which underlies all of the Northeast Cape Installation, except the White Alice site, the Lower Tram Terminal, Upper Tram Terminal, and Upper Camp. The mountainous area south of the site provides an ideal recharge area for the unconsolidated materials, providing runoff from rain and snowmelt during the summer months. Based on the topography and geology of the area, the regional, deep groundwater flow direction is expected to be from the mountainous recharge area south of the Northeast Cape Installation, flowing north and eventually discharging to the Bering Sea.

Facilities at the Northeast Cape Installation apparently used deep groundwater as a water supply. There are four abandoned production wells at Sites 22 and 26, designated Wells 1 through 4 (E&E, 1993a). Little is known about the capacity, construction characteristics, or methods of abandonment of these wells. A driller's log is available for one of the wells, indicating "coarse sand (water)" at a depth of 9 to 28 feet, underlying silty surficial deposits, and clean gravel and sand from 28 to 32 feet.

In 2001, the four production well pumps located at Sites 22 and 26 were pulled from each well, the wells were sampled, and then abandoned in place. Water levels and total well depths were meaured before sampling. Water levels in the four wells ranged from 11.45 to 28.25 feet below ground surface (bgs). The total depth ranged from 41.38 to 58.20 feet bgs. Sampling results and field logs can be found in MWH (2003b). Well locations were not surveyed during this field event.

There is insufficient data to determine whether this deep aquifer is continuous or not throughout the Northeast Cape Installation. It is suspected that the deep groundwater consists of pockets of groundwater interspersed within an intermittent permafrost layer.

At the Northeast Cape Installation, shallow subsurface water has been observed intermittently to a depth of 15 feet bgs over the course of the investigations conducted during the past 10 years. This shallow, intermittent, subsurface water is suspected to consist of seasonally-thawed water within the active layer of the shallow soils and percolated rainfall.

Over the last 8 years, it has been observed that monitoring wells installed in subsurface water at the time of construction failed to produce any water during a dry season.

There is currently insufficient information to determine whether the shallow intermittent subsurface water is hydraulically connected to the deep groundwater. A key factor influencing the flow of groundwater at the Northeast Cape Installation is the existence of permafrost and frozen soils, which can render the unconsolidated materials effectively impermeable. The U.S. Geological Survey (USGS) has classified St. Lawrence Island as an area of "moderately thick to thin permafrost." Although the depth of permafrost at St. Lawrence Island is unknown, the base of permafrost on the mainland at Nome (135 air miles to the northeast) is estimated to be at a depth of 120 feet (Ferrians, 1965). The deeper, unconsolidated deposits at the Northeast Cape Installation are probably permanently frozen, and the shallow soils investigated during this investigation represent the active layer where soils are thawed only during portions of the year. Frozen soils are expected to have a profound effect in retarding groundwater flow both vertically and horizontally during most of the year.

1.5.5 Hydrology

Other than the Bering Sea north of the Northeast Cape Installation, surface water in the vicinity consists of marshy areas, small streams, and small- to moderate-sized lakes, which are often ephemeral. Surface water generally flows from the highland area south of the Northeast Cape Installation in a northward direction. Small ephemeral surface-water bodies are common throughout the area. The primary stream drainage in the area is fed by runoff from the prominent drainage of the Kinipaghulghat Mountain valley south of the Northeast Cape Installation. In late 1999, this was designated as the Suqitughneq River. This stream drainage is fed by several smaller tributaries as it flows north to Kitnagak Point. The smaller tributaries originate from two small unnamed lakes (Figure 1-3).

During the period of field work for the Phase I RI (July and August 1994), it was noted that surface water flow was highly dynamic, changing significantly over the course of a few days (Montgomery Watson, 1995a). For example, it was noted that streamflow in the major drainage south of the site varied significantly, from several hundred gallons per minute during warm days, to no flow during relatively cold periods lasting more than a day (the runoff was primarily snowmelt from higher elevations). In other locations, small lakes and marshy areas created by recent snowmelt were observed to dry up and/or change shape over the course of a few days or weeks.

Over the course of the Phase I, II, and III RIs, it was observed that the primary permanent surface water features at the Northeast Cape Installation are the Suqutughneq River and it's tributaries. Although there are several permanent ponds or lakes, many of the "lakes" and marshy areas are ephemeral. During the RIs, surface water samples were often collected from puddles or marshy areas that dry up during the summer months. For clarity, in this document such areas are identified as ephemeral standing water.

1.5.6 Groundwater

Groundwater at the Northeast Cape Installation is suspected to consist of two regimes:

- Deep groundwater
- Shallow intermittent subsurface water

A deep groundwater source is suspected at the Northeast Cape Installation due to the presence of four former drinking water wells installed at Sites 22 and 26. There is insufficient data to determine whether or not this deep aquifer is continuous throughout the Northeast Cape Area. It is suspected that the deep groundwater consists of pockets of groundwater interspersed within an intermittent permafrost layer. Recent data collected from the four drinking water wells, suggests that deep groundwater at Sites 22 and 26 is at approximately 25 feet bgs.

The shallow intermittent subsurface water is suspected to consist of seasonally-thawed water within the active layer of the shallow soils. Over the past 10 years, shallow subsurface water has been intermittent across the Northeast Cape Installation to a depth of 15 feet bgs. Efforts to characterize the nature and extent of contamination in shallow subsurface water have been hindered by the intermittent nature of the shallow subsurface water. Several of the well points and groundwater monitoring wells installed across the Northeast Cape Installation have been dry or produce insufficient subsurface water for environmental sampling. Water is intermittent both spacially and temporally.

The deep groundwater at Sites 22 and 26 (Figure 1-3) has been used in the past as a drinking water source for the Northeast Cape Installation. The former production pumps have been removed and the wells abandoned. There are no functional wells at Sites 22 and 26. However, it appears that there is a reason to expect that the deeper groundwater at Sites 22 and 26 could be a future drinking water source based on historic use of this source. It should be noted, however, that petroleum contamination was found in one of the production wells and additional testing would be needed to verify the suitability of the deep groundwater at this location for use as a future drinking water supply.

In 2001, the four production well pumps located at Sites 22 and 26 were pulled, the wells were sampled, and then abandoned. Water levels and total well depths were measured before sampling. The water levels of the four wells ranged from 11.45 to 28.25 feet bgs. The total well depth ranged from 41.38 to 58.20 feet bgs. Sampling results and field logs can be found in the Summary Report, Phase III Remedial Investigation (MWH, 2003b). Well elevations were not surveyed during this field event.

The existence of deeper groundwater at other sites across the Northeast Cape Installation has not been confirmed or refuted. Therefore, no speculation regarding the presence of deep groundwater throughout the Northeast Cape Installation is advanced in this HHERA.

1.5.6.1 Current Use as a Drinking Water Source

Currently, there are no permanent residents at the Northeast Cape Installation, nor have there been any since the U.S. Army (Army) relinquished operation of the Northeast Cape Installation in 1975. A portion of the Northeast Cape Installation is used by some residents of Savoonga and Gambell as a subsistence hunting and fishing camp from June through September. In 2001 and 2003, a temporary construction camp was set up at the runway installation to house construction workers employed in the demolition cleanup activities.

The hunting and fishing camp residents obtain drinking water from the surface water of the Suqitughneq River, approximately at the location of the Station Access Road, which is topographically downgradient of Sites 9, 31, 32, 33, and 34. The temporary construction camp obtained drinking water from surface water of the Suqitughneg River, which was processed through a water filtration system prior to use. The withdrawal point was at the Suqitughneg River crossing, just south of the runway.

Suspected groundwater flow from the Northeast Cape Installation is to the north and, ultimately, into the Bering Sea. The Northeast Cape Installation is located on the coast with no other land between it and the sea. Therefore, with the potential exceptions of Sites 9, 31, 32, 33 and 34, shallow groundwater at the Northeast Cape Installation is not used for drinking water, not within the zone of influence of an active private or public drinking water system, or not within the recharge area for a private or public drinking water well, a wellhead protection area, or a sole-source aquifer.

The closest community to the Northeast Cape Installation is the Native village of Savoonga, which is located approximately 60 miles west-northwest of the Northeast Cape Installation. As discussed in Section 1.5.4, shallow and deep groundwater is suspected to flow north, into the Bering Sea. Based on the distance to Savoonga, the suspected northward flow directing the shallow groundwater at the Northeast Cape Installation, and the topography between the Northeast Cape Installation and Savoonga (i.e., the presence of numerous rivers, lakes, and lowland swamps), contaminants originating at the Northeast Cape Installation could not affect drinking water systems in Savoonga.

The evaluation of the potential future use of shallow subsurface water at the Northeast Cape Installation as a drinking water source includes the following assumptions:

- There is a reasonably expected potential that residents of St. Lawrence Island might reside at the Northeast Cape Installation permanently or seasonally in the future.
- A year-round source of drinking water would be required for permanent residents.
- A seasonal source of drinking water might be used by seasonal residents.

In accordance with 18 AAC 75.350(2), the criteria used to evaluate the expected future potential use include:

- Groundwater availability
- Groundwater quality
- Enforceable institutional controls
- Land use of the site and neighboring property
- Need for a drinking water source and the availability of an alternative source
- Exempt status under 40 Code of Federal Regulations (CFR) 146.4

Groundwater Availability. The shallow intermittent subsurface water is suspected to consist of seasonally-thawed water within the active layer of the shallow soils. At the Northeast Cape Installation, shallow subsurface water has been intermittent across the Northeast Cape Installation to a depth of 15 feet. Efforts to characterize the nature and extent of contamination in shallow subsurface water have been hindered by the intermittent nature of the shallow subsurface water. Several of the well points and groundwater monitoring wells installed across the Northeast Cape Installation in the summer have been dry or produce insufficient subsurface water for environmental sampling. Water is intermittent both spacially and temporally.

Additionally, the anticipated depth of freeze in soils in the winter is expected to be more than 6 to 10 feet bgs. Therefore, it is anticipated that shallow groundwater would only be available for use during the short summer season and would, therefore, not be a feasible source of drinking water for year-round residents.

Groundwater Quality. Based on the existing data there are no characteristics of the shallow groundwater that would restrict its use as a drinking water source. However, areas of shallow groundwater near the Bering Sea could be impacted by saltwater intrusion, and affect usability.

Enforceable Institutional Controls. There are no institutional controls currently in place or planned that would restrict the use of shallow groundwater at the site.

Land Use of the Site and Neighboring Property. There are no current or planned land uses that would restrict the use of shallow groundwater under the Northeast Cape Installation as a drinking water source.

Need for a Drinking Water Source and the Availability of an Alternative Source. St. Lawrence Island is sparsely populated, with virtually all of the permanent residents residing in one of the two established communities on the island: Gambell and Savoonga. Based on current information, there is no reason to believe that the Northeast Cape Installation would attract permanent residents in the foreseeable future. Seasonal use of the area in summer is anticipated to continue.

With the development of advanced electronic technology, it is unlikely that the Northeast Cape Installation would ever be redeveloped for military use. Current military efforts do not require the extensive on-site manpower that was required in the past. Currently, similar missions are unmanned or minimally manned.

Alternate sources of drinking water are available. The deep groundwater at Sites 22 and 26 is a viable source of drinking water. The deep groundwater at Sites 22 and 26 would also be potentially available for use by seasonal residents; however, it likely that seasonal residents would also use a more accessible source. As is currently practiced, seasonal residents would probably obtain drinking water from the Suqitughneq River upstream of the "Y" intersection of Cargo Beach and the runway access road.

Exempt Status Under 40 CFR 146.4. The groundwater at the Northeast Cape Installation does not qualify for exempt status under 40 CFR 146.4.

1.5.6.2 Contaminants Transported to a Drinking Water Source

The current and anticipated future drinking water sources at the Northeast Cape Installation are the Suqitughneq River and the deep groundwater at Sites 22 and 26.

Northeast Cape Installation topography dictates that surface water and shallow groundwater from Sites 9 through 22, 26 through 29, and 31 through 34 flows toward the Suqitughneq River. Water samples collected from the river have not exhibited levels of contaminants above the groundwater criteria identified in 18 AAC 75.345, Table C. This demonstrates that contaminated shallow groundwater is not currently causing water quality exceedences in the Suqitughneq River. For known areas of contamination, sentry wells near the river would be required to assess the impact of shallow groundwater on the surface water in the river.

There is currently insufficient information to determine whether shallow subsurface water is transported to the deep groundwater at Sites 22, 26 or other areas.

1.5.6.3 Shallow Intermittent Subsurface Water Use Summary

In conclusion, the shallow subsurface water at the Northeast Cape Installation is not currently used and is unlikely to be used in the future as a drinking water source, because:

- It is only available seasonally.
- When available in the summer, the quantity of water is unreliable and insufficient.
- Other reliable sources of drinking water are readily available in quantity.

Based on the site topography and drainage patterns, the shallow subsurface water drains toward the identified alternative sources of drinking water. However, the existing analytical results for surface water collected from the Suqitughneq River suggest that potential contaminants in shallow groundwater are not transported to the river at concentrations that exceed the groundwater cleanup levels. Nevertheless, shallow subsurface water beneath the Northeast Cape Installation was evaluated as a potential future drinking water source in this HHERA because the State of Alaska considers all groundwater to be a potential drinking water source, unless specific requirements in 18 AAC 75.350 are met.

There is currently insufficient information to determine whether shallow subsurface water is transported to the deep groundwater at Sites 22, 26, and other potential areas.

1.6 DEMOGRAPHY AND LAND USE

The village of Savoonga is located approximately 60 miles northwest of the Northeast Cape Installation and has a population of 643 people, as reported in the 2000 U.S. Census. There are currently no permanent residents at the Northeast Cape study site, but there is a small subsistence hunting and fishing area located at the site – primarily inhabited in the summer by residents of Savoonga and Gambell.

1.7 ECOLOGY, WILDLIFE, AND ENDANGERED SPECIES

The area surrounding the Northeast Cape Installation supports habitat for a variety of seabirds, waterfowl, and mammals that either breed in or migrate through the area. The ocean adjacent to the Northeast Cape Installation is used for subsistence fishing and hunting of halibut, walrus, seal, sea birds, and polar bear. Additionally, Arctic fox, cross fox, and reindeer inhabit the area surrounding, and within, the Northeast Cape Installation.

Biological resources present in the general area of the Northeast Cape Installation are described in more detail in Section 4.2 of this HHERA.

1.7.1 Vegetation

Vegetation in the vicinity of the Northeast Cape Installation is classified as alpine tundra. This type of vegetation consists predominantly of mat forming herbs, grasses, and sedges. Shrubs include bearberry, willows, heaths, and cassiopes. The Northeast Cape Installation has many low-lying areas featuring lakes, bogs, and poorly-drained soils. In these areas, vegetation is typically classified as wet tundra dominated by heaths, sedges, mosses, lichens, and cottongrass (URS, 1985).

1.7.2 Birds

The only breeding seabird colony known to exist in the vicinity of the Northeast Cape Installation consists of 60 glaucous gulls on Seevookhan Mountain. This colony, cataloged as 93-19 by the U.S. Fish and Wildlife Service *Catalog of Alaskan Seabird Colonies*, is the most current known estimate of breeding seabirds in the area. Several other species of birds have been sighted in the vicinity of the Northeast Cape Installation, including common ravens, snow bunting, whistling swans, Lapland longspurs, sandhill cranes, and sea gulls. In addition, Alaska District biologists observed a flock of several dabbler ducks, possibly pintails, feeding in the shallow lake at the head of the Suqitughneq River during the August 2001 fish tissue sampling event (MWH, 2002a).

1.7.3 Mammals

Large mammals are generally not abundant on St. Lawrence Island. However, polar bears can be seen on the island year round, especially when the ice pack is near shore. Grizzly bears have been reported on the island, but are rarely seen. A population of several hundred reindeer can also be found on the island. Arctic fox, red fox, cross fox, and several small mammals (tundra shrew, Arctic ground squirrel, Greenland collared lemming, red-backed vole, and tundra vole) also reside on the island (URS, 1985).

Marine mammals are present in the general vicinity of the Northeast Cape Installation as seasonal migrants in the offshore and near-shore marine waters, at haul-out sites, and in association with the advancing and retreating pack ice. However, there are no haul-out areas within the immediate vicinity of the Northeast Cape Installation. During the summer, walrus, sea lions, and spotted seals can be present in the offshore water. During the ice season, ringed seals, bearded seals, walrus, and spotted seals can be found in near-shore and offshore leads and open water. Whales that can be seen near the Northeast Cape Installation include bowhead, grays, minkes, killers, and belugas (USKH, 1993).

1.7.4 Fish

There are 10 primary species of fish that reside in the streams and tundra ponds of St. Lawrence Island. These include blackfish, nine-spined stickleback, grayling, Dolly Varden, and whitefish. Five of the six species of Pacific Salmon occur around the island. According to Savoonga natives, the Suqitughneq River tributary north of the Housing and Operations Complex (Figure 1-3) once supported large fish populations (including sockeye and silver salmon). This stream no longer supports these fish, perhaps due to a large diesel oil spill emanating from Site 11 (Fuel Storage Tank Area) which entered one of the stream's tributaries in 1969. Juvenile and adult Dolly Varden and Alaska blackfish have been observed throughout the Suqitughneq River and its tributaries.

1.7.5 Endangered Species

Endangered or threatened species of animals on St. Lawrence Island include the Spectacled Eider (threatened), the Steller's Eider (threatened), and the Steller's sea lion (threatened). Endangered species of whales that frequent the Bering Sea include blue, bowhead, fin and northern right whales (USKH, 1993). The prevalence of these animals at or in the vicinity of the Northeast Cape Installation is unknown. Polar bears are not an endangered or threatened species; however, they are protected under the Marine Mammal Protection Act. Alaska Natives are exempt from this act, and are allowed to hunt polar bears for subsistence purposes or handcrafts, as long as the population is not depleted and the animals are not wasted. Vegetative species present on St. Lawrence Island that have been proposed as threatened include *Rumex krausei* and *Primula tschuktschorum.*

1.8 ARCHAEOLOGICAL, HISTORICAL, AND CULTURAL RESOURCES

The Northeast Cape Installation has the potential for significant archaeological, historical, and cultural resources. As such, excavation activities associated with the Northeast Cape Installation will be undertaken only after the Section 106 process promulgated under the State Historic and Preservation Office (SHPO) has been completed. This process, a federal regulation under 36 CFR 800 of the National Historic Preservation Act of 1966, is administered by SHPO. The process entails identifying and evaluating potential historical properties and a federal review through the Advisory Council on Historic Preservation. Section 106 of the National Historic Preservation Act of 1966 requires that every federal agency take into account how each of its undertakings could affect historic properties. A historic property is defined as any property listed in or eligible for the National Register of Historic Places.

The Northeast Cape Installation was determined eligible for the National Register of Historic Places by the USACE with all the other White Alice Communication System sites in Alaska. SHPO was informed of the federal undertaking at the Northeast Cape Installation in January 1999 and a memorandum of agreement covering mitigation for the adverse effect at the Northeast Cape Installation and Hoonah was signed in July 1999. The only remaining stipulations to be satisfied for the Northeast Cape Installation are to supplement documentation for the Upper Tram Camp. All other mitigation for the White Alice site and the Housing and Operation Area have been completed.

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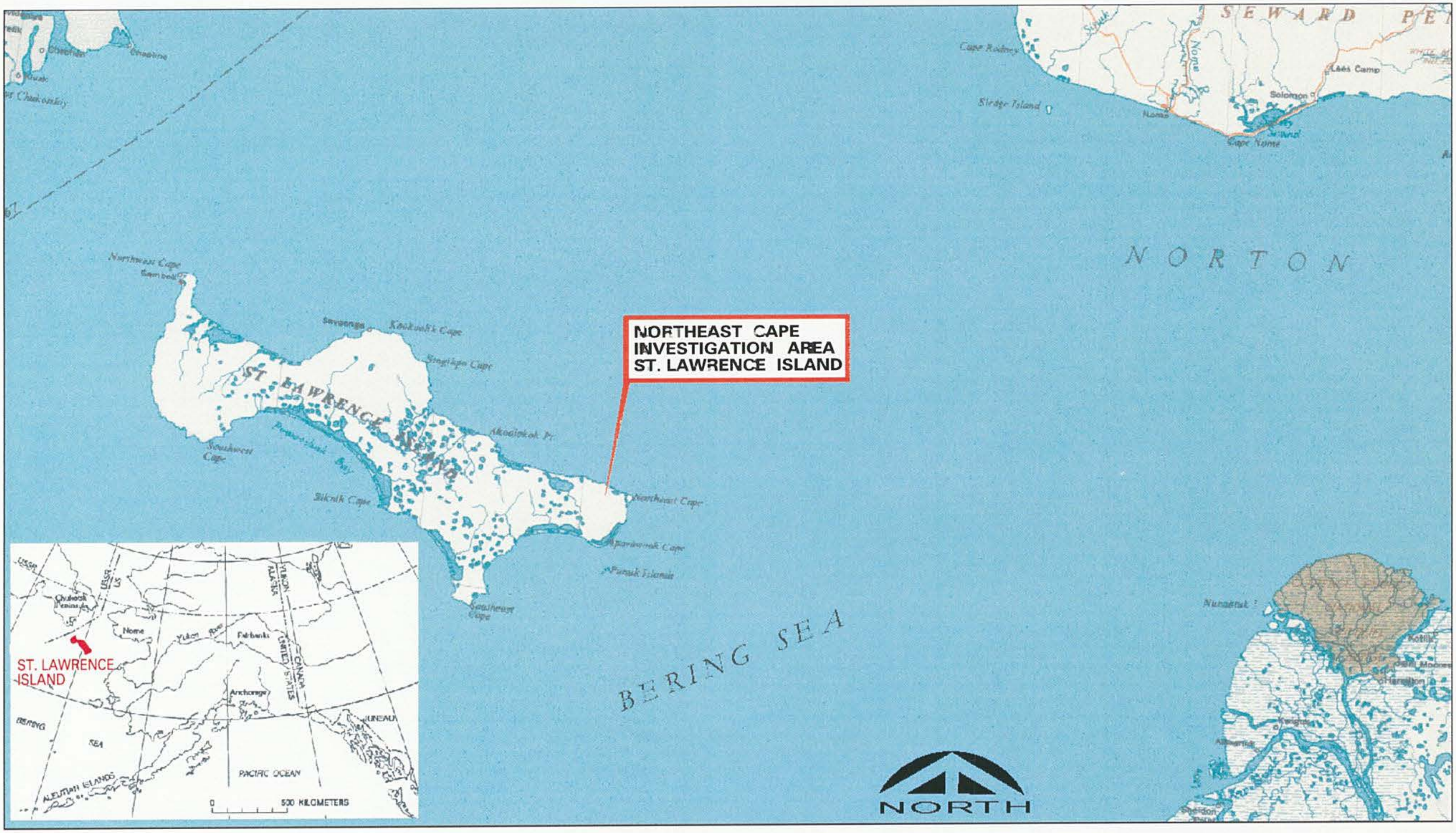

SOURCE: U.S. Geological Survey
Reston, Virginia 22092, 1976
St. Lawrence, Alaska
N6265 – W16830 /60x210
Surveyed 1948, Compiled 1957
Minor Revisions 1974
Scale 1:250,000 Contour Interval 100'

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Anchorage, Alaska

FIGURE 1-1

U. S. ARMY ENGINEER DISTRICT, ALASKA – NORTHEAST CAPE, ALASKA
2004 RISK ASSESSMENT (RA)

VICINITY MAP

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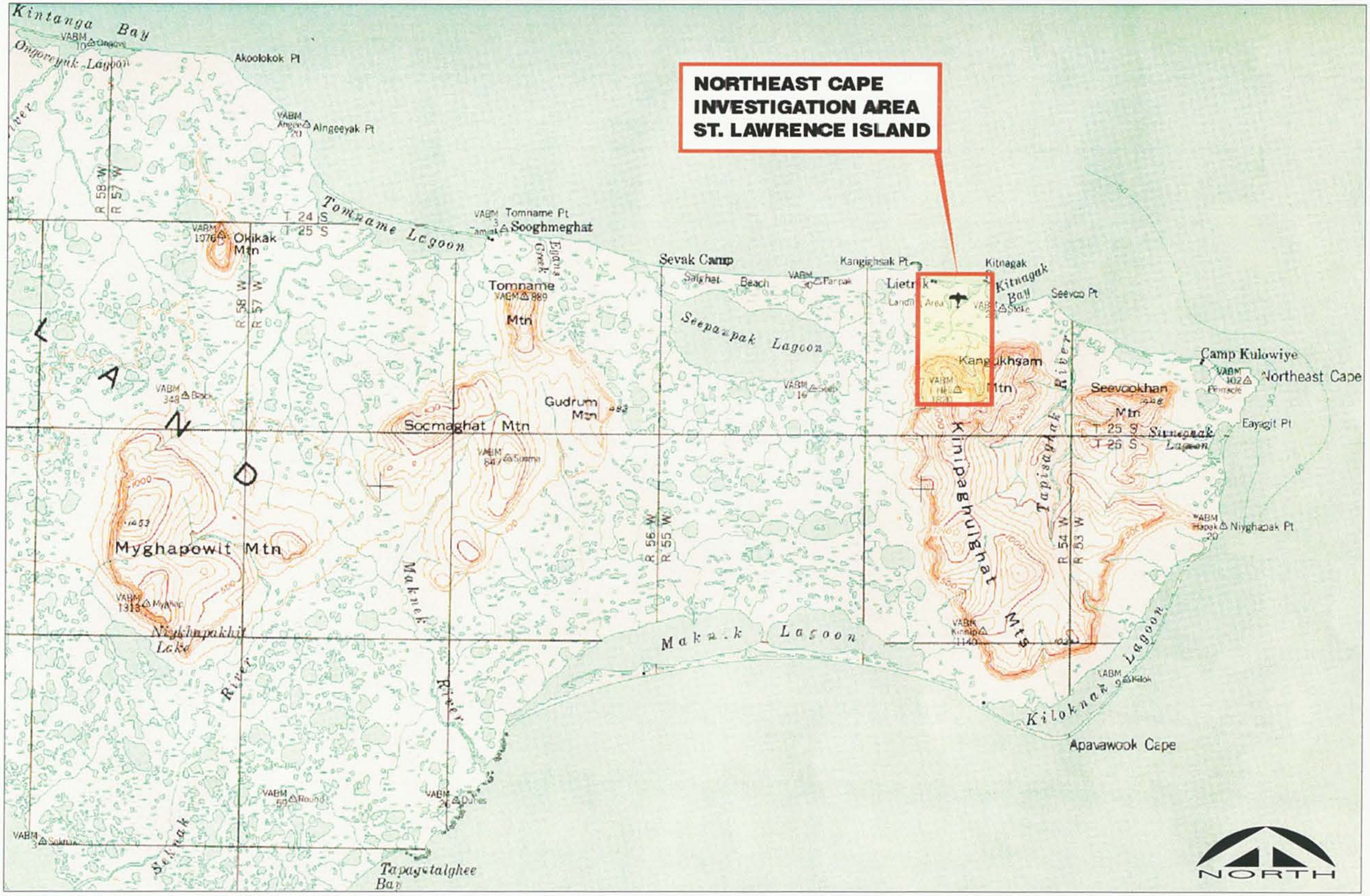

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SOURCE: U.S. Geological Survey
Reston, Virginia 22092, 1976
St. Lawrence, Alaska
N6265 – W16830 /60x210
Surveyed 1948 Compiled 1957
Minor Revisions 1974
Scale 1:250,000. Contour Interval =100 Ft., Varies

FIGURE 1–2

U. S. ARMY ENGINEER DISTRICT, ALASKA – NORTHEAST CAPE, ALASKA
2004 RISK ASSESSMENT (RA)

LOCATION MAP

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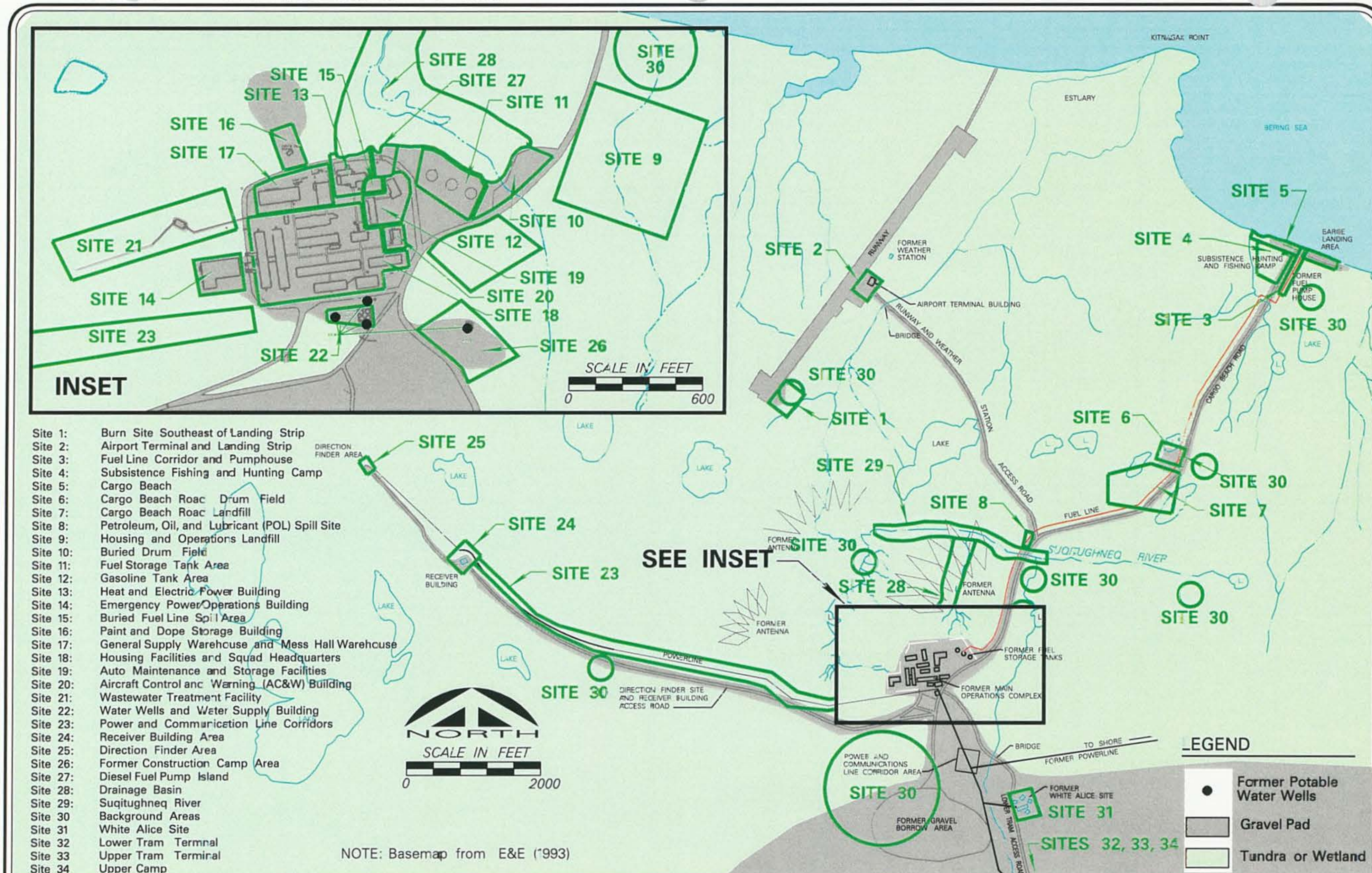

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FIGURE 1-3

U. S. ARMY ENGINEER DISTRICT, ALASKA – NORTHEAST CAPE, ALASKA
2004 RISK ASSESSMENT (RA)

SITE MAP

Table 1-1 Northeast Cape Installation FUDS Summary of Environmental Issues at Phase III RI Sites

Site	Source(s) of Contamination	Contamination Confirmed?[1]	Contaminant(s) of Concern[2]	Contaminated Media[3]	Status[4]
3 – Fuel Line Corridor and Pumphouse	ASTs, pumphouse, fuel line, lead-acid battery, paint	Yes	DRO, RRO	Soil, groundwater	HHRA, ERA
	ACM, LBP	Yes	Asbestos, lead	Building and/or surface materials	BD/DR
4 – Subsistence Fishing and Hunting Camp	Abandoned vehicles, empty drums	Yes	DRO, RRO	Soil, groundwater	HHRA, ERA, BD/DR
6 – Cargo Beach Road Drum Field	1,500 POL drums, battery	Yes	DRO, RRO, VOC, metals	Soil, sediment	HHRA, ERA, BD/DR
7 – Cargo Beach Road Landfill	Drums, batteries, other landfilled materials	Yes	DRO, RRO, PAH, VOC, metals	Soil	HHRA, ERA, BD/DR
		Yes	RRO, metals	Groundwater	HHRA, ERA
9 – Housing and Operations Landfill	Landfilled materials	Yes	DRO, RRO, PAH, metals	Tundra soil, sediment, groundwater	HHRA, ERA, BD/DR
10 –Buried Drum Field	Drum Spills	Yes	DRO	Soil	
	Buried Drum Field	No	Toluene		HHRA
11 – Fuel Storage Tank Area	Diesel Fuel	Yes	DRO, BTEX, PAH, PCB	Soil, groundwaer	HHRA
13 – Heat and Electrical Power Building	Diesel USTs and ASTs, transformers, generators, piping	Yes	DRO, GRO, PCB	Soil, groundwater	HHRA[5]; HSR
	ACM, LBP	Yes	Asbestos, lead	Building and/or surface materials	BD/DR
14 – Emergency Power/Operations Building	AST, transformers, drum of antifreeze	Yes	PCB	Soil	HSR
	ACM, LBP	Yes	Asbestos, lead	Building and/or surface materials	BD/DR
15 – Buried Fuel Line Spill Area	Diesel release from fuel line	Yes	DRO, RRO	Soil, groundwater	HHRA[5]
16 – Paint and Dope Storage Building	Abandoned containers, AST	Yes	PCB, pesticides	Soil	HHRA[5]
		Yes	bis-(2-ethylhexyl)-phthalate	Groundwater	HHRA[5]
	ACM, LBP	Yes	Asbestos, lead	Building and/or surface materials	BD/DR

Table 1-1 (cont.) Northeast Cape Installation FUDS Summary of Environmental Issues at Phase III RI Sites

Site	Source(s) of Contamination	Contamination Confirmed?[1]	Contaminant(s) of Concern[2]	Contaminated Media[3]	Status[4]
19 – Auto Maintenance and Storage Facilities	ASTs, work and storage areas, smudge pots, aircraft washing powder	Yes	DRO, GRO, arsenic, chromium	Soil, groundwater	HHRA[5]; HSR
	ACM, LBP	Yes	Asbestos, lead	Building and/or surface materials	BD/DR
21 – Wastewater Treatment Facility	Wastewater treatment effluent	Yes	DRO, RRO, PCB, metals	Tundra soil	HHRA, ERA
	ACM, LBP	Yes	Asbestos, lead	Building and/or surface materials	BD/DR
22 – Water Wells and Water Supply Building	Diesel engine, UST, cans of asbestos cement	Yes	DRO, antimony, lead	Soil	HHRA, ERA
	ACM, LBP	Yes	Asbestos, lead	Building and/or surface materials	BD/DR
24 – Receiver Building Area	Buried and scattered drums	Yes	DRO, RRO, metals, cis-1,3-dichloroethene	Soil, groundwater	BD/DR
	ACM, LBP	Yes	Asbestos, lead	Building and/or surface materials	BD/DR
26 – Former Construction Camp Area	Unknown	No	None	None	No Further Action
27 – Diesel Fuel Pump Island	Diesel release from a fuel pump and fuel line, buried drums	Yes	DRO, GRO, benzene, arsenic	Soil, groundwater	HHRA[5]; BD/DR
28 – Drainage Basin	Sites 10 through 20, 27	Yes	DRO, RRO, PCB, PAH, metals	Soil, sediment, surface water, groundwater	HHRA, ERA
		Yes	PCB, PAH, metals	Fish, plants	HHRA, ERA
29 – Suqitughneq River	Upgradient sites, especially Site 28	Yes	DRO, RRO, metals	Sediment	HHRA, ERA
		Yes	PCB, PAH, metals	Fish	HHRA, ERA
30 – Background Areas	None	No	None	None	Included for comparison
31 – White Alice Site	Transformers, ASTs	Yes	DRO, RRO, PCB	Soil	HHRA, ERA
	ACM, LBP, transformers	Yes	Asbestos, lead, PCB	Building and/or surface materials	BD/DR anticipated

Table 1-1 (cont.) Northeast Cape Installation FUDS Summary of Environmental Issues at Phase III RI Sites

Site	Source(s) of Contamination	Contamination Confirmed?[1]	Contaminant(s) of Concern[2]	Contaminated Media[3]	Status[4]
32 – Lower Tram Terminal	Transformers, AST, tram cables	Yes	DRO, RRO, PCB	Soil	HHRA, ERA
	ACM, LBP, PCB	Yes	Asbestos, lead, PCB	Building and/or surface materials	BD/DR anticipated
33 – Upper Tram Terminal	Tram cables	Yes	DRO, RRO	Soil	HHRA, ERA
	ACM, LBP	Yes	Asbestos, lead	Building and/or surface materials	BD/DR anticipated
34 – Upper Camp	Drum dump, transformer, AST	Yes	PCB, DRO	Soil	HHRA, ERA
	ACM, LBP	Yes	Asbestos, lead	Building and/or surface materials	BD/DR anticipated

Key:
1 – Contamination attributable to a military source in soil, sediment, surface water, or groundwater found at levels exceeding Tier I screening criteria. Building materials and surface coatings on building materials are listed if they contain regulated levels of ACM, LBP, or PCB.
2 – Consists of environmental issues remaining after pre-Phase III RI removal actions (i.e., remaining as of December 31, 2000).
3 – Building materials and surface coatings on building materials are listed if they contain regulated levels of ACM, LBP or PCB.
4 – The activities listed in the status column include work performed during 2000 and 2001, work planned for 2002, and risk assessment activities.
5 – Ecological risk assessment is not planned because the habitat value is considered too low to warrant quantitative ecological risk assessment.
ACM – asbestos-containing materials
AST – aboveground storage tank
BD/DR – building demolition and debris removal; includes removing debris not associated with building demolition (tanks, drums, etc.) and removing hot-spots; no risk assessment activities are planned for contaminants slated for BD/DR
DRO – diesel range organics
ERA – included in environmental risk assessment
FUDS – Formerly Used Defense Site
GRO – gasoline range organics
HHRA – included in human health risk assessment
HSR – hot-spot removal; consists of excavating and removing limited areas of stained soil; no risk assessment activities are planned for contaminants slated for HSR
LBP – lead-based paint
PAH – polynuclear aromatic hydrocarbons
PCB – polychlorinated biphenyls
POL – petroleum, oil, and lubricants
RI – Remedial Investigation
RRO – residual range organics
UST – underground storage tank
VOC – volatile organic compound

2.0 DATA EVALUATION

This section summarizes the data upon which the HHERA is based, discusses data quality, and the outlines QA objectives for all collected project data.

Environmental media sampled during the three phases of the RI consisted of soil, sediment, shallow ephemeral surface water, flowing surface water, shallow subsurface water, deep subsurface water, fish tissue, and plant tissue. All fieldwork complied with provisions of Nationwide Permit No. 6, General Concurrence No. 24, of the Coastal Zone Management Plan, survey activities were completed to the requirement of the Army's Nationwide Permit No. 6, and Land Use Agreement No. DACA 85-9-98-41 between the Alaska District and the landowners, Sivuquq and Swoonga Native Corporation. Except as noted, all fieldwork was performed in accordance with the Phase III Work Plan (Montgomery Watson, 2001b), and the Biological Sampling Plan (Montgomery Watson, 2001c).

2.1 DATA SUMMARY

This HHERA was performed using data from RI Phases I through III. Phase I RI fieldwork was performed in 1994, Phase II field work in 1996, 1998, and 1999, and Phase III fieldwork in 2000, 2001, and 2002. Fieldwork included sampling environmental and biological media, including soil, sediment, surface water, groundwater, and plant and fish tissue. Other media were also sampled, including wastes in drums and tanks, standing water in flooded sections of buildings hazardous waste, asbestos, paint, building materials, and wipe samples from building surfaces. The HHERA considered environmental and biological media data only; analytes detected at least once in each media at each site are identified in Table 2-1. Numbers of samples collected, sampling methods, sampling locations, analytical methods, and results are provided in the following documents:

- Building Demolition and Debris Removal Technical Memorandum. Northeast Cape, Alaska. Montgomery Watson.
- Remedial Investigation, Northeast Cape St. Lawrence Island, Alaska, Final Report. Montgomery Watson.
- Draft Phase II Remedial Investigation/Feasibility Study, Northeast Cape, Alaska. Montgomery Watson.
- Phase II Remedial Investigation, Northeast Cape, St. Lawrence Island, Alaska. Montgomery Watson.
- Phase II Remedial Investigation Report Addendum 1999 Fieldwork, Northeast Cape, Alaska. Montgomery Watson.
- Phase II Remedial Investigation/Feasibility Plan, Fall 2000 Building Composite Sampling and Asbestos Survey Technical Memorandum, Northeast Cape, Alaska. Montgomery Watson.
- Phase III Remedial Investigation Work Plan, Northeast Cape, St. Lawrence Island, Alaska. Montgomery Watson.

- Biological Sampling Plan, Northeast Cape, St. Lawrence Island, Alaska. Montgomery Watson.
- Site Characterization Technical Memorandum, Phase III Remedial Investigation, Northeast Cape, St. Lawrence Island, Alaska.
- MWH. 2002a. Phase III Remedial Investigation and Risk Assessment Update, Northeast Cape, St. Lawrence Island, Alaska. Draft. August.
- MWH, 2002b. Technical Memorandum. Background Determination for Risk Assessment, Northeast Cape, St. Lawrence Island, Alaska. March.
- MWH. 2002c. Site Characterization Technical Memorandum. Phase III Remedial Investigation, Sites 13, 15, 19, 27, and 22, Northeast Cape, St. Lawrence Island, Alaska.
- MWH. 2003a. Phase III Remedial Investigation, Northeast Cape, St. Lawrence Island, Alaska. Draft.
- MWH. 2003b. Summary Report, Phase III Remedial Investigation, Northeast Cape, St. Lawrence Island, Alaska. Final. March.

Sampling locations of environmental data collected during the 2001 RI are shown on Figures 2-1 through 2-5.

2.2 DATA QUALITY

MWH used established QA/QC procedures to ensure that analytical data are of suitable quantity and quality to meet project data quality objectives (DQO). Screening level and definitive data were collected during the three phases of the RI for the Northeast Cape Installation. Definitive data includes only data produced from laboratory analysis using approved EPA or ADEC collection, preparation and analytical methods. Other data, such as readings from field instruments, do not qualify as definitive data and were not quantitatively evaluated in this HHERA.

2.3 QA OBJECTIVES

QA objectives are quantitative and qualitative statements specifying data quality required to support intended uses. Simply stated, these objectives prescribe the total acceptable error from sample collection, preparation, and analysis. Acceptability of project data is based on these objectives.

To meet project QA objectives, specific procedures were followed in both the field and laboratory. In the field, environmental sampling, preservation, and shipping activities were performed in accordance with standard operating procedures and analytical method requirements. Field duplicate, QA triplicate, trip blank, and field blank samples were collected as required by project laboratories. Laboratories used internal QC checks to verify and control the validity of individual analyses. Standard formulas were used for calculating precision, accuracy, completeness, and reporting limits.

2.4 DATA REVIEW

The responsible laboratory analyst performed initial analytical and QC data reviews. Data were checked for errors in transcription, calculation, and dilution factors, and for compliance with QC requirements. Failure to meet method performance criteria resulted in reanalysis of the sample or batch of samples, depending on the nature of the failure. After the initial review was completed, data were collected from summary sheets, workbooks, or computer files and assembled into a data package.

Laboratory managers or designated laboratory supervisors were responsible for the next level of data review. Items checked in this portion of the review included:

- Proper chain-of-custody (CoC) and sample handling
- Sample preparation and analysis within holding times
- Sample preparation and analysis according to specified methods
- Instruments calibrated according to specified methods
- Spike (surrogate and standard) recoveries within specified ranges
- Blanks prepared and analyzed as required
- Calculations performed and verified correctly
- Correct transcriptions of raw and final data
- Detection limits determined correctly and within required limits

The checklist was completed and signed by the designated data reviewers, usually chemists, and the laboratory supervisor. Any problems discovered during review, and corrective actions necessary to resolve problems, were communicated to the laboratory manager. All problems and associated corrective actions were discussed with the Quality Services Manager (QSM) prior to final approval of the data.

Data then entered the MWH review process. Data packages for primary and field duplicate samples were evaluated for completeness, correctness, consistency, and compliance with contract requirements. The completeness evaluation included verification that data were present for all requested analytes and that all hard copy and electronic deliverables were present. Verifying correct analytical methods and reporting limits (RL) were also performed as part of this step.

After verification, data packages for primary and field duplicate samples were reviewed for compliance with analytical DQOs. These objectives were defined in Chemical Data Quality Plan (CDQP) and Quality Assurance Project Plan (QAPP) documents produced during the RI planning stages and by respective laboratory control limits stated in the data packages. Results outside project DQOs or laboratory limits were qualified using Alaska District Electronic Data Format (EDF) valid values.

Specific review items included:

- Sample-handling procedures documented on CoC and cooler receipt forms and in case narratives

- Temperature of cooler temperature blanks
- Sample holding times
- Laboratory QC samples, including:
  - Method blanks
  - Laboratory control sample (LCS)/laboratory control sample duplicates (LCSD)
  - Matrix spike (MS)/matrix spike duplicate (MSD) samples
  - Sample duplicates
  - Surrogates
  - Continuing calibration verification standards (CCVS)
- Comparison of primary and field duplicate samples to assess field precision
- Review of project correspondence to determine if changes made to the analytical program during the project were implemented in the laboratories

An independent data review, including the steps described above, was performed by the Alaska District. The Alaska District reviewed information provided by MWH, data from the primary project laboratories, and data from the QA triplicate samples submitted to laboratories contracted separately by the Alaska District. The Alaska District compared, reviewed, and assessed data quality, then presented results in a Chemical Data Quality Review (CDQR) document.

2.5 DATA USABILITY

Based on intended use and required quality of the data, MWH and Alaska District reviewers prepare narratives assessing data usability within the context of project DQOs. All qualified data were deemed usable, with the exception of data qualified as rejected. Sample results can be rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria, resulting in the inability to verify the presence or absence of the analyte. No rejected data were used in this HHERA.

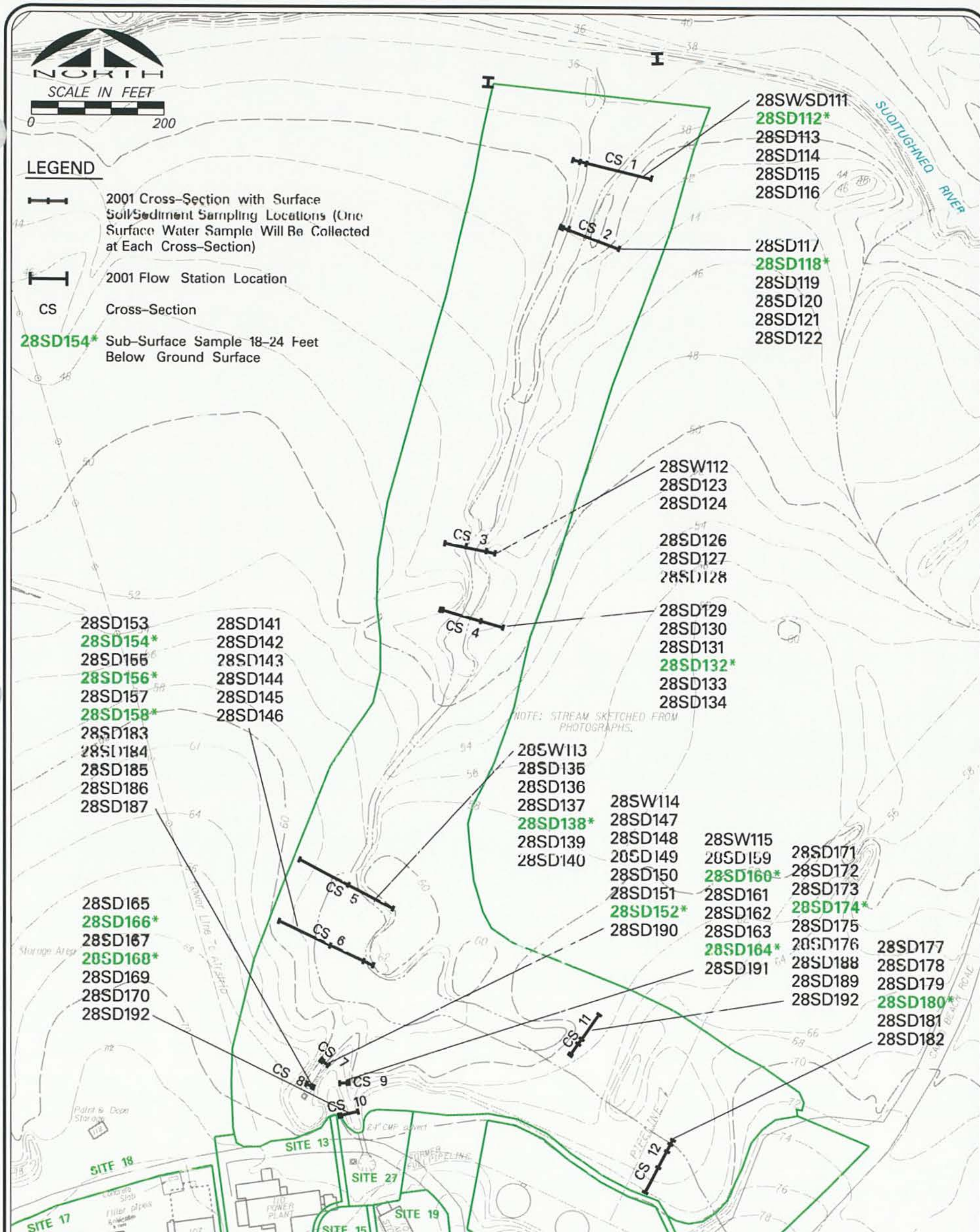

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FIGURE 2-1

U. S. ARMY ENGINEER DISTRICT, ALASKA – NORTHEAST CAPE, ALASKA
2004 RISK ASSESSMENT (RA)

DRAINAGE BASIN (SITE 28) 2001 SAMPLING LOCATIONS

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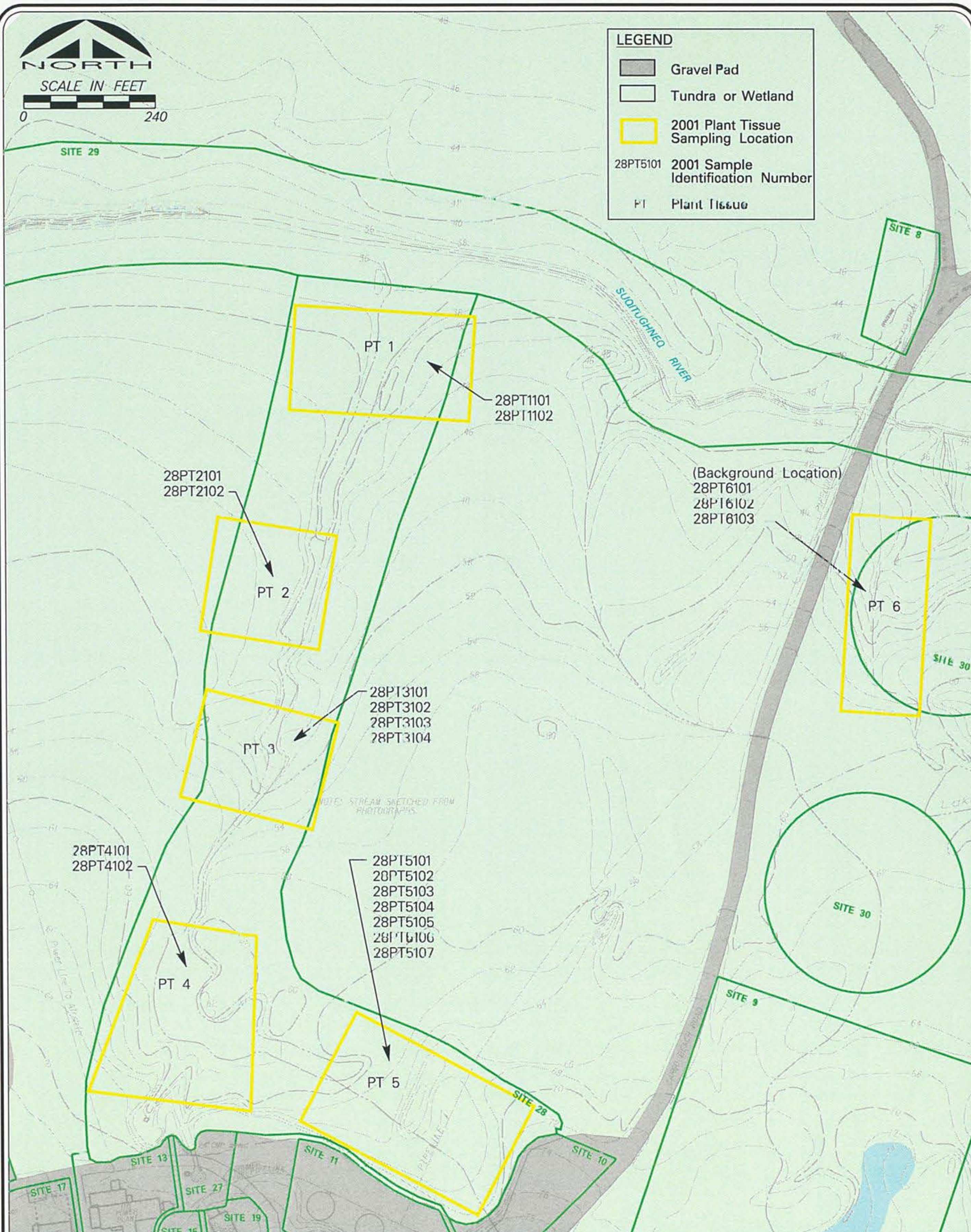

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MWH
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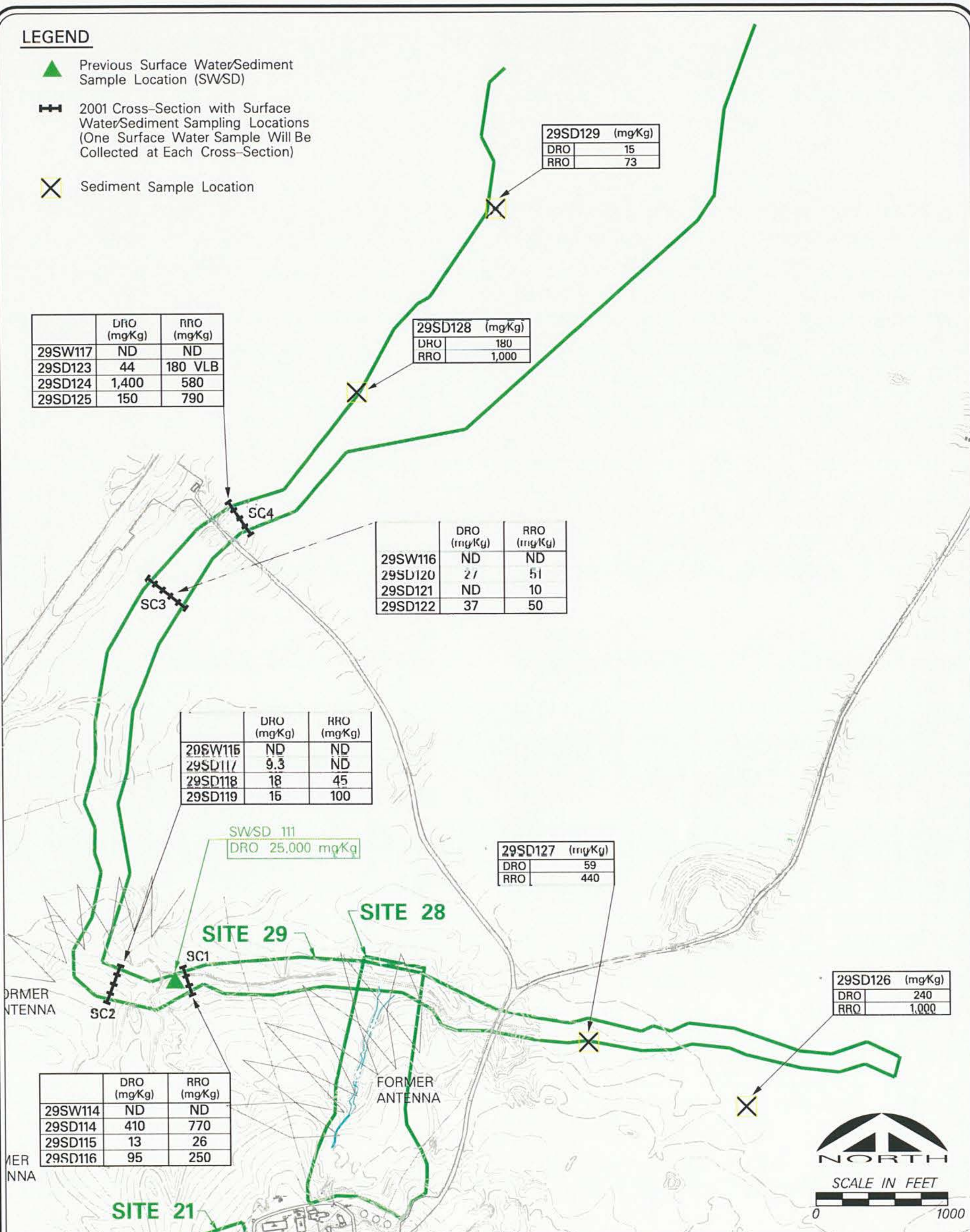
FIGURE 2–2

U. S. ARMY ENGINEER DISTRICT, ALASKA – NORTHEAST CAPE, ALASKA
2004 RISK ASSESSMENT (RA)

DRAINAGE BASIN (SITE 28) 2001 PLANT TISSUE SAMPLING LOCATIONS



29SD129	(mg/Kg)
DRO	15
RRO	73

29SD128	(mg/Kg)
DRO	180
RRO	1,000

	DRO (mg/Kg)	RRO (mg/Kg)
29SW117	ND	ND
29SD123	44	180 VLB
29SD124	1,400	580
29SD125	150	790

	DRO (mg/Kg)	RRO (mg/Kg)
29SW116	ND	ND
29SD120	27	51
29SD121	ND	10
29SD122	37	50

	DRO (mg/Kg)	RRO (mg/Kg)
29SW115	ND	ND
29SD117	9.3	ND
29SD118	18	45
29SD119	16	100

29SD127	(mg/Kg)
DRO	59
RRO	440

29SD126	(mg/Kg)
DRO	240
RRO	1,000

	DRO (mg/Kg)	RRO (mg/Kg)
29SW114	ND	ND
29SD114	410	770
29SD115	13	26
29SD116	95	250

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FIGURE 2–3

U. S. ARMY ENGINEER DISTRICT, ALASKA – NORTHEAST CAPE, ALASKA
2004 RISK ASSESSMENT (RA)

SUQITUGHNEQ RIVER (SITE 29) 2001 SAMPLING LOCATIONS AND SELECTED RESULTS

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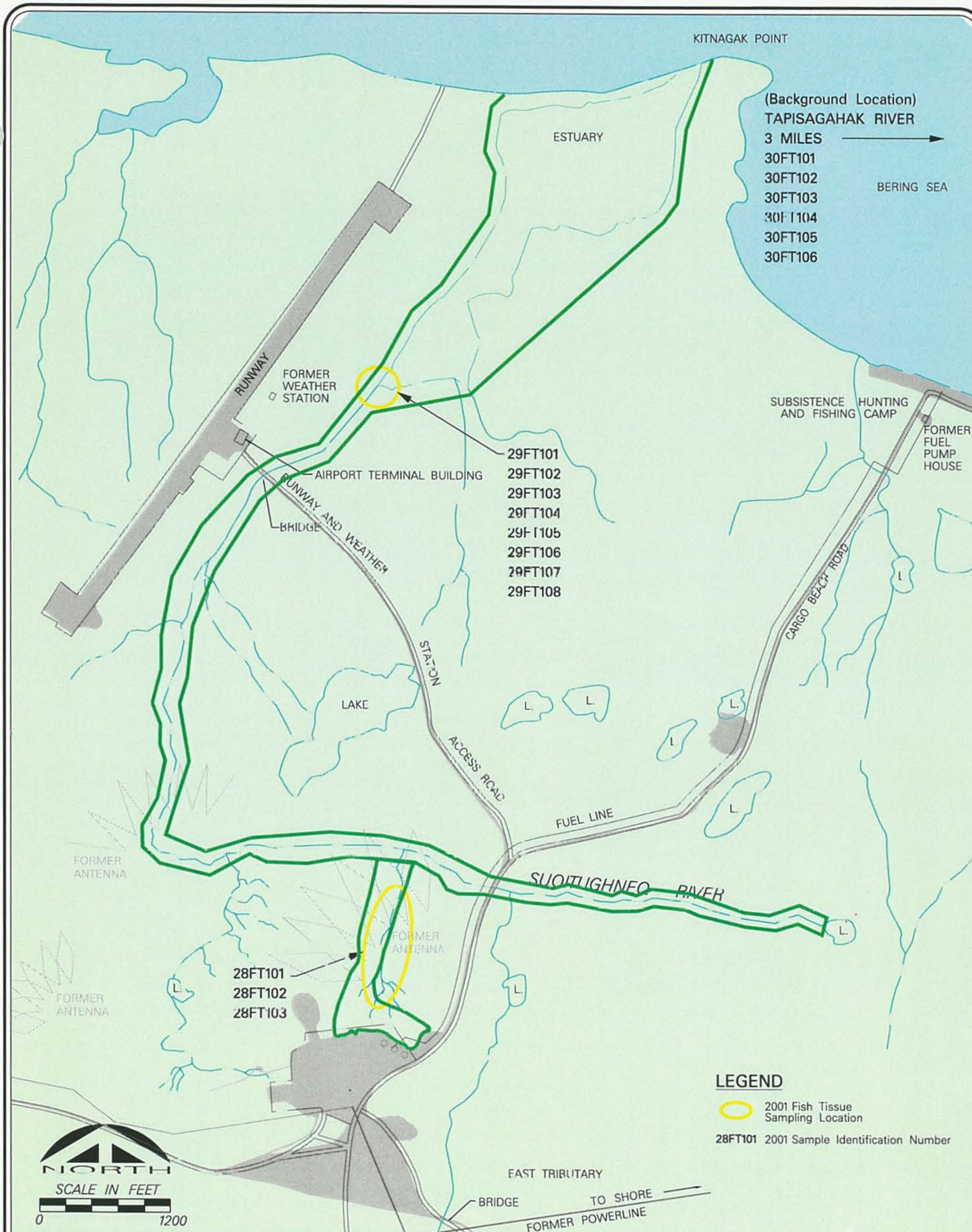

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FIGURE 2–4

U. S. ARMY ENGINEER DISTRICT, ALASKA – NORTHEAST CAPE, ALASKA
2004 RISK ASSESSMENT (RA)

SUQITUGHNEQ RIVER (SITE 29) FISH TISSUE SAMPLING LOCATIONS

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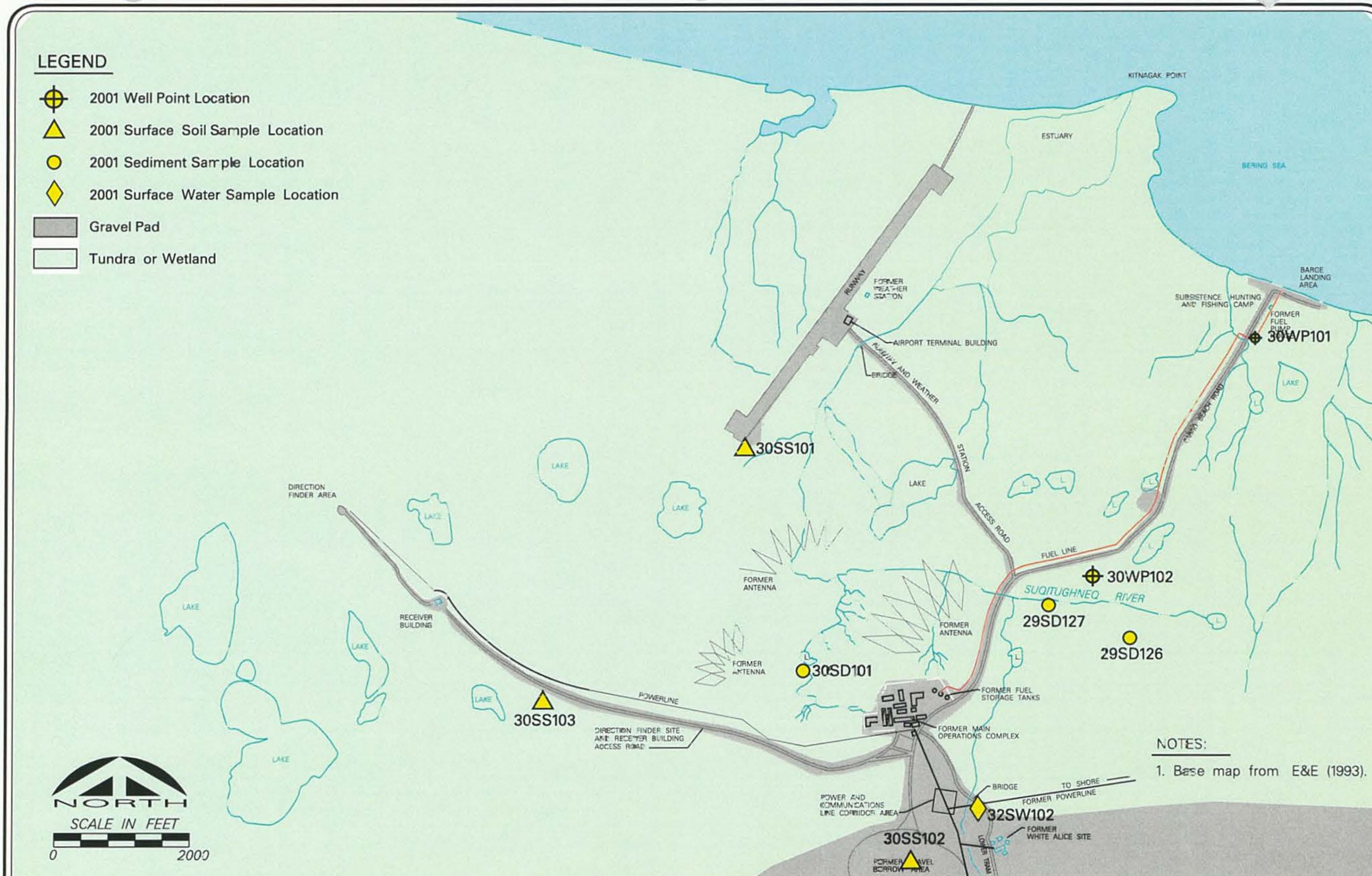

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FIGURE 2-5

U.S. ARMY ENGINEER DISTRICT, ALASKA – NORTHEAST CAPE, ALASKA
2004 RISK ASSESSMENT (RA)

AMBIENT SAMPLING LOCATIONS 2001

Table 2-1 Summary of Detected Analytes at Northeast Cape Installation ERA and HHERA Sites

	Site 3		Site 4		Site 6				Site 7				Site 9				Site 10			Site 11		Site 13		Site 15		Site 16		Site 19				Site 21				Site 22		Site 27		Site 28						Site 29					Site 30					Site 31		Site 32	Site 33	Site 34
Analyte	Soil	GW	Soil	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	Soil	GW	Soil	GW	Soil	GW	Soil	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	GW	Soil	GW	Soil	GW	Soil	Sediment	SW	GW	Biological[f]	Biological[g]	Fresh Sed	Marine Sed	Fresh SW	Marine SW	Biological	Soil	Sediment	SW	GW	Biological	Soil	SW	Soil	Soil	Soil
INORGANICS																																																											
Aluminum					X		X	X	X	X	X		X	X	X																X	X	X													X	X	X			X	X		X			X			
Antimony													X	X		X										X							X				X									X	X					X	X	X								
Arsenic					X		X	X	X	X	X	X	X		X						X		X	X		X	X		X	X	X	X	X			X	X				X	X	X	X	X			X	X	X		X	X			
Arsenic, Dissolved																						X		X											X			X																X					
Barium					X		X	X	X	X	X		X	X	X													X			X	X	X									X	X	X	X	X		X	X	X		X	X		X				
Beryllium					X	X		X	X	X	X	X	X	X		X	X									X	X	X					X	X					X		X	X					X	X				X	X								
Cadmium					X			X	X	X	X		X	X		X	X				X						X	X	X	X			X	X							X	X			X	X					X	X	X			X				
Calcium					X		X	X	X	X	X		X	X	X																	X	X	X													X	X	X			X	X		X			X			
Chromium	X				X	X		X	X	X	X	X	X	X		X	X	X		X			X		X	X	X	X	X		X	X	X		X	X		X	X	X	X	X	X		X	X	X				X	X		X	X				
Chromium, Dissolved											X																																																			
Cobalt					X		X	X	X		X		X		X																X	X													X	X				X	X		X					
Copper	X				X	X		X	X	X	X	X	X	X	X	X	X	X		X			X		X	X	X	X				X	X	X	X	X	X		X	X	X	X		X	X	X	X	X			X	X	X		X	X				
Iron					X		X	X	X	X	X		X	X	X																	X	X	X				X									X	X	X			X	X		X			X			
Iron, dissolved																																					X																							
Lead	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X			X		X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X			X	X		X	X				
Lead, Dissolved								X													X					X												X			X																				
Magnesium					X		X	X	X	X	X		X	X	X															X	X	X	X													X	X	X			X	X		X			X			
Manganese					X		X	X	X	X	X		X	X	X																	X	X	X				X		X							X	X	X			X	X		X			X			
Manganese, dissolved																																					X																							
Mercury								X	X	X	X	X		X		X																X			X										X	X		X			X	X			X	X				
Mercury, Dissolved											X																																																			
Nickel	X				X	X		X	X	X	X	X	X	X		X	X			X			X		X	X	X	X				X	X		X	X		X	X	X	X		X	X	X	X			X	X		X	X				
Potassium					X		X	X	X	X	X		X	X	X																	X	X	X													X	X	X			X	X		X					
Selenium										X			X												X						X							X							X	X					X				X	X				
Silver									X																						X															X					X					X				
Silver, Dissolved																		X																																		X										
Sodium					X		X	X	X	X	X		X	X	X																	X	X	X													X	X	X			X	X		X			X			
Sulfate																																					X		X																X					
Thallium					X			X	X	X	X		X				X									X						X						X		X	X																				
Thallium, Dissolved											X																																																			
Vanadium					X		X	X	X		X		X		X																X	X													X	X	X	X			X	X	X	X		X	X				
Zinc	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X			X		X	X	X	X			X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X				
Zinc, Dissolved							X					X				X																	X				X			X																			
VOLATILE ORGANIC COMPOUNDS																																																											
1,1,1-Trichloroethane									X	X				X																X																												
1,2,4-Trimethylbenzene					X																			X	X					X																												
1,3,5-Trimethylbenzene																					X					X					X						X																			
2-Butanone								X				X				X										X					X			X																X	X								
4-Isopropyltoluene																											X																																
Acetone								X	X	X		X		X		X									X						X			X				X												X	X	X	X					
Benzene								X				X	X			X					X		X						X			X					X	X		X																			
Bromoethane									X	X				X																																												
Ethylbenzene		X			X	X													X	X		X			X	X	X				X					X	X	X	X	X																	
Isopropylbenzene																					X						X					X																												
m,p-Xylene (Sum of Isomers)					X	X			X				X			X				X						X	X				X	X															X									X					
Methylene chloride	X				X				X				X								X					X					X								X											X	X							
n-Butylbenzene																															X																												
n-Propylbenzene																					X					X					X			X																							
o-Xylene					X	X																									X																							X					
sec-Butylbenzene																											X					X																												
Styrene													X													X																																			

Table 2-1 Summary of Detected Analytes at Northeast Cape Installation ERA and HHERA Sites

	Site 3		Site 4		Site 6				Site 7				Site 9				Site 10			Site 11		Site 13		Site 15		Site 16		Site 19				Site 21				Site 22		Site 27		Site 28						Site 29					Site 30					Site 31		Site 32	Site 33	Site 34
Analyte	Soil	GW	Soil	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	Soil	GW	Soil	GW	Soil	GW	Soil	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	GW	Soil	GW	Soil	GW	Soil	Sediment	SW	GW	Biological[f]	Biological[g]	Fresh Sed	Marine Sed	Fresh SW	Marine SW	Biological	Soil	Sediment	SW	GW	Biological	Soil	SW	Soil	Soil	Soil
VOLATILE ORGANIC COMPOUNDS (Cont.)																																																												
Toluene					X	X		X	X	X	X		X	X		X	X				X	X	X	X		X	X	X			X	X	X					X	X	X	X					X	X				X	X		X		X				
Trichloroethene																											X																																	
Xylenes		X			X															X	X	X	X		X		X	X			X							X	X		X	X																		
SEMI-VOLATILE ORGANIC COMPOUNDS																																																												
4-Chloroaniline																																X																												
4-Methylphenol (p-Cresol)									X	X																																																		
Benzoic acid												X				X										X	X								X																									
Benzyl butyl phthalate																																									X																			
bis-(2-ethylhexyl)phthalate										X			X														X					X									X																			
Cresols (Methyl Phenols)																																	X																											
Dibenzofuran																																									X					X														
Di-n-butyl phthalate					X					X			X				X									X						X				X																		X						
Phenol																																				X																								
POLYNUCLEAR AROMATIC HYDROCARBONS																																																												
2-Methylnaphthalene									X																															X	X			X	X	X				X										
Acenaphthene																											X														X			X	X	X				X										
Acenaphthylene																																									X					X														
Anthracene																																								X	X				X	X				X										
Benzo(a)anthracene														X																											X				X					X										
Benzo(a)pyrene									X					X																						X					X				X					X										
Benzo(b)fluoranthene										X				X																						X					X				X	X				X										
Benzo(g,h,i)perylene														X																										X	X			X	X					X										
Benzo(k)fluoranthene										X				X																											X				X	X				X										
Chrysene									X	X				X																						X					X				X	X				X										
Dibenzo(a,h)anthracene																																									X				X					X										
Fluoranthene														X																										X	X			X	X	X				X					X					
Fluorene		X																									X														X			X	X	X				X										
Indeno(1,2,3-cd)pyrene														X																											X				X					X										
Naphthalene		X							X												X						X														X			X	X	X				X										
Phenanthrene									X					X																										X	X			X	X	X				X										
Pyrene									X	X				X																										X	X			X	X	X				X										
POLYCHLORINATED BIPHENYLS																																																												
PCB-1242 (Aroclor 1242)																																									X																			
PCB-1254 (Aroclor 1254)																				X						X						X	X							X	X				X					X					X					X
PCB-1260 (Aroclor 1260)	X								X	X			X									X				X						X	X							X	X	X		X	X					X					X	X		X		X
Total Polychlorinatedbiphenyls																																	X																											
DIOXINS AND FURANS																																																												
1,2,3,4,6,7,8,9-Octachlorodibenzofuran									X	X	X		X	X		X																																						X						
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin									X	X	X	X	X	X	X	X																																			X	X		X						
1,2,3,4,6,7,8-Heptachlorodibenzofuran									X	X			X	X		X																																						X						
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin									X	X	X		X	X		X																																			X			X						
1,2,3,4,7,8,9-Heptachlorodibenzofuran									X				X																																									X						
1,2,3,4,7,8-Hexachlorodibenzofuran									X	X			X																																									X						
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin									X				X																																									X						
1,2,3,6,7,8-Hexachlorodibenzofuran													X																																															
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin										X			X																																									X						
1,2,3,7,8,9-Hexachlorodibenzofuran									X				X																																									X						
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin									X	X			X																																									X						
1,2,3,7,8-Pentachlorodibenzofuran									X				X																																									X						
1,2,3,7,8-Pentachlorodibenzo-p-dioxin									X				X																																															

Table 2-1 Summary of Detected Analytes at Northeast Cape Installation ERA and HHERA Sites

Analyte	Site 3		Site 4		Site 6				Site 7				Site 9				Site 10		
	Soil	GW	Soil	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW
DIOXINS AND FURANS (Cont.)																			
2,3,4,6,7,8-Hexachlorodibenzofuran									X			X	X						
2,3,4,7,8-Pentachlorodibenzofuran									X				X						
2,3,7,8-Tetrachlorodibenzofuran									X	X			X			X			
Total Heptachlorodibenzofurans (HpCDF)										X			X	X					
Total Heptachlorodibenzo-p-dioxins (HpCDD)									X	X	X		X	X					
Total Hexachlorodibenzofurans (HxCDF)									X	X			X						
Total Hexachlorodibenzo-p-dioxins (HxCDD)										X			X						
Total Pentachlorodibenzofurans (PeCDF)										X			X						
Total Pentachlorodibenzo-p-dioxin (PeCDD)													X						
Total Tetrachlorodibenzofurans (TCDF)									X	X			X	X					
Total Tetrachlorodibenzo-p-dioxins (TCDD)									X	X			X						
PESTICIDES																			
4,4'-DDD																			
4,4'-DDE																			
4,4'-DDT																			
beta-BHC																			
Endosulfan I																			
Endosulfan sulfate																			
gamma-BHC (Lindane)																			
Heptachlor																			
PETROLEUM HYDROCARBONS																			
Diesel Range Organics	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		
Diesel Range Organics, Aliphatic																	X		
Diesel Range Organics, Aromatic																	X		
Gasoline Range Organics								X											
Residual Range Organics		X		X	X	X			X	X		X	X	X		X	X		
Residual Range Organics, Aliphatic																			
Residual Range Organics, Aromatic																	X		
Total Recoverable Petroleum Hydrocarbons	X		X		X	X	X		X	X	X		X	X		X	X	X	
Total Analytes Detected	9	6	3	3	19	24	5	27	56	51	29	26	46	44	13	34	16	5	1

Analyte	Site 11		Site 13		Site 15		Site 16		Site 19				Site 21				Site 22		Site 27	
	Soil	GW	Soil	GW	Soil	GW	Soil	GW	Soil	Sediment	SW	GW	Soil	Sediment	SW	GW	Soil	GW	Soil	GW
DIOXINS AND FURANS (Cont.)																				
2,3,4,6,7,8-Hexachlorodibenzofuran																				
2,3,4,7,8-Pentachlorodibenzofuran																				
2,3,7,8-Tetrachlorodibenzofuran																				
Total Heptachlorodibenzofurans (HpCDF)																				
Total Heptachlorodibenzo-p-dioxins (HpCDD)																				
Total Hexachlorodibenzofurans (HxCDF)																				
Total Hexachlorodibenzo-p-dioxins (HxCDD)																				
Total Pentachlorodibenzofurans (PeCDF)																				
Total Pentachlorodibenzo-p-dioxin (PeCDD)																				
Total Tetrachlorodibenzofurans (TCDF)																				
Total Tetrachlorodibenzo-p-dioxins (TCDD)																				
PESTICIDES																				
4,4'-DDD							X													
4,4'-DDE							X													
4,4'-DDT							X													
beta-BHC																				
Endosulfan I							X													
Endosulfan sulfate																				
gamma-BHC (Lindane)																				
Heptachlor																				
PETROLEUM HYDROCARBONS																				
Diesel Range Organics	X	X	X	X	X	X			X			X	X	X	X	X	X	X	X	X
Diesel Range Organics, Aliphatic																				
Diesel Range Organics, Aromatic																				
Gasoline Range Organics	X	X	X	X					X			X							X	X
Residual Range Organics						X							X	X				X		
Residual Range Organics, Aliphatic																				
Residual Range Organics, Aromatic																				
Total Recoverable Petroleum Hydrocarbons	X	X	X	X	X	X			X		X	X	X	X			X		X	X
Total Analytes Detected	12	13	6	15	3	12	26	25	14	5	1	12	45	27	14	13	13	7	16	18

Analyte	Site 28						Site 29					Site 30					Site 31		Site 32	Site 33	Site 34
	Soil	Sediment	SW	GW	Biological[f]	Biological[g]	Fresh Sed	Marine Sed	Fresh SW	Marine SW	Biological	Soil	Sediment	SW	GW	Biological	Soil	SW	Soil	Soil	Soil
DIOXINS AND FURANS (Cont.)																					
2,3,4,6,7,8-Hexachlorodibenzofuran													X		X						
2,3,4,7,8-Pentachlorodibenzofuran																					
2,3,7,8-Tetrachlorodibenzofuran															X						
Total Heptachlorodibenzofurans (HpCDF)															X						
Total Heptachlorodibenzo-p-dioxins (HpCDD)															X						
Total Hexachlorodibenzofurans (HxCDF)															X						
Total Hexachlorodibenzo-p-dioxins (HxCDD)																					
Total Pentachlorodibenzofurans (PeCDF)																					
Total Pentachlorodibenzo-p-dioxin (PeCDD)																					
Total Tetrachlorodibenzofurans (TCDF)															X						
Total Tetrachlorodibenzo-p-dioxins (TCDD)																					
PESTICIDES																					
4,4'-DDD		X																			
4,4'-DDE																					
4,4'-DDT																					
beta-BHC		X																			
Endosulfan I																					
Endosulfan sulfate		X																			
gamma-BHC (Lindane)		X																			
Heptachlor		X																			
PETROLEUM HYDROCARBONS																					
Diesel Range Organics	X	X	X	X			X	X	X			X	X		X		X		X	X	X
Diesel Range Organics, Aliphatic	X	X					X		X			X	X								
Diesel Range Organics, Aromatic	X																				
Gasoline Range Organics	X	X							X												
Residual Range Organics	X	X					X	X				X	X		X		X		X	X	X
Residual Range Organics, Aliphatic	X	X											X								
Residual Range Organics, Aromatic	X	X					X					X	X								
Total Recoverable Petroleum Hydrocarbons	X	X	X									X	X		X						
Total Analytes Detected	29	47	10	7	20	18	35	22	12	1	30	31	31	1	43	15	6	7	3	2	4

Key:
ERA - ecological risk assessment
GW - groundwater.
HHERA - Human Health and Ecological Risk Assessment
Sed - sediment
SW - surface Water

3.0 RISK ASSESSMENT METHODOLOGY

This section presents the methods and assumptions that were used in this HHERA for the Northeast Cape Installation. Risks to public health and the environment were evaluated in accordance with the DERP-FUDS program, CERCLA Remedial Response process, as amended by the SARA, and Alaska State Oil and Other Hazardous Substances Pollution Control Regulations (18 AAC 75). This HHERA is comprised of an HHRA and an ERA. The HHRA evaluated potential public health risks associated with releases of chemicals to the Northeast Cape environment. Potential threats to ecological habitats and receptors were evaluated in the ERA.

This HHERA was performed in accordance with, or in consideration of, the following ADEC, EPA, and USACE guidance documents or reference materials:

- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final (USEPA, 1988).
- Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual, Part A. Baseline Risk Assessment (USEPA, 1989a).
- Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors (USEPA, 1991a).
- Final Exposure Assessment Guidelines (USEPA, 1992).
- Wildlife Exposure Factors Handbook (USEPA, 1993).
- Health Effects Assessment Summary Tables (HEAST) (USEPA, 1995a).
- Risk Assessment Handbook, Volume I: Human Health Evaluation (USACE, 1996).
- Exposure Factors Handbook, Volume I: General Factors (USEPA, 1997a).
- Exposure Factors Handbook, Volume III: Activity Factors (USEPA, 1997b).
- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final (USEPA, 1997c).
- Risk Assessment Handbook, Volume II: Environmental Evaluation (USACE, 1999).
- User's Guide for Selection and Application of Default Assessment Endpoints and Indicator Species in Alaskan Ecoregions (ADEC, 1999).
- Polychlorinated Biphenyls (PCBs) Update: Impact on Fish Advisories (USEPA, 1999b).
- Guidance for Cleanup of Petroleum Contaminated Sites (ADEC, 2000a).
- Risk Assessment Procedures Manual (ADEC, 2000b).
- Risk Assessment Guidance for Superfund (RAGS), Supplemental Guidance for Dermal Risk Assessment, Interim (USEPA, 2001a).
- Mercury Update: Impact on Fish Advisories (USEPA, 2001b).

- Screening Procedures for COPCs Under Method Four, Technical Memorandum 01-003 (ADEC, 2001a).
- Calculated Cleanup Levels for Compunds without Tabulated Values in Site Cleanup Rules, Technical Memorandum 01-007 (ADEC, 2001b).
- 18 AAC 75 – Oil and Other Hazardous Substance Control regulations, as amended through January 30, 2003 (ADEC, 2003a).
- 18 AAC 70 – Water Quality Standards, as amended through June 22, 2003 (ADEC, 2003b).
- Cumulative Risk Guidance (ADEC, 2002a).
- Cleanup Levels Guidance (ADEC, 2002b).
- Use of the Bootstrap Method in Calculating the Concentration Term for Estimating Risk at Contaminated Sites, Technical Memorandum 01-004 (ADEC, 2003c).
- Integrated Risk Information System (IRIS) Database (USEPA, 2003a).

There are three distinct areas referenced in this HHERA, including:

- Northeast Cape Installation – refers to the boundaries of the former Northeast Cape Installation.
- Northeast Cape area – refers to the general vicinity of the Northeast Cape Installation.
- Northeast Cape Study Area – refers to areas that were included in site investigation activities, including the Northeast Cape Installation and any areas that were sampled.

Methods and assumptions used in the HHRA for the Northeast Cape Installation are described in Section 3.1. The ERA methods and assumptions are presented in Section 3.2.

3.1 HUMAN HEALTH RISK ASSESSMENT METHODS

This HHRA was conducted in accordance with the State of Alaska's Oil and Other Hazardous Substance Pollution Control Regulations (18 AAC 75). Site cleanup rules provided in 18 AAC 75 establish administrative processes and standards to determine the necessity for and degree of cleanup required to protect human health, safety, and welfare, and the environment at a site where one or more hazardous substances are located. The administrative processes and standards in 18 AAC 75 include generic soil and groundwater cleanup levels (i.e., Methods 1 and 2), and procedures for establishing site-specific cleanup levels (i.e., Methods 3 and 4). USACE and ADEC agreed to the use of Method 4 to conduct site-specific human health and ecological risk assessments for the Northeast Cape Installation. Risk assessments conducted under Method 4 will ultimately serve as the basis for the development of media-specific cleanup levels for the site.

The HHRA conducted for the Northeast Cape Installation used a two-tiered approach. Conservative screening (Tier I) was performed for all sites and abiotic media for which analytical data are currently available. The purpose of Tier I screening was to identify chemicals of potential concern (COPCs) for evaluation in the Tier II baseline HHRA. The Tier II baseline HHRA was performed consistent with ADEC Method Four procedures, as described above.

Those sites and media for which Tier II HHRA criteria are exceeded will be proposed for evaluation of remedial alternatives in the FS. Methods and assumptions used in the Tier I and Tier II HHRA processes for the Northeast Cape Installation are described in the following subsections.

3.1.1 Tier I Screening Assessment

Tier I screening is a conservative approach designed to ensure that risks associated with site contaminants are not underestimated. Tier I screening may overestimate site risks to ensure protectiveness. Tier I human health screening assessment methods for the Northeast Cape Installation are described below. Results of Tier I human health screening are presented in Section 4.0 – Risk Assessment Results.

3.1.1.1 Screening Methods – General

Tier I HHRA screening was conducted in accordance with State of Alaska regulations (18 AAC 75), ADEC's *Screening Procedures for COPCs Under Method Four* (ADEC, 2001a), and ADEC's *Risk Assessment Procedures Manual* (ADEC, 2000b). The conservative Tier I approach is based on comparing contaminant concentrations to:

- Ambient concentrations, AND
- One-tenth of the ADEC Method Two Soil Cleanup Levels (under 40-inch zone) compiled from Tables B1 and B2 (18 AAC 75.345) (equivalent to a one-in-one million risk for carcinogenic chemicals), OR
- One-tenth of the ADEC Table C Groundwater Cleanup Levels (18 AAC 75.345) (equivalent to a one-in-one million risk for carcinogenic chemicals)

Types of media sampled at sites evaluated in this HHRA include soil, sediment, surface water, groundwater, and biological tissues (Table 3-1). In order to evaluate whether concentrations of chemicals detected in these media are site-related or representative of ambient conditions, corresponding media from ambient locations were also collected and analyzed. Ambient locations were collectively referred to as Site 30 in the Phase III RI report (MWH, 2003a) and in this HHRA. A total of 10 soil samples, five sediment samples, three surface water samples, four shallow groundwater samples, and 10 fish tissue samples were collected during the Phase I, II, and III fieldwork for characterization of ambient conditions. Ambient sampling locations were selected based on distance away, or upgradient, from known contaminated sites, absence of evidence of contamination such as stains and stressed vegetation, and absence of historical, photographic, or anecdotal evidence of military activities.

Biological samples (i.e., fish tissue and vegetation) were collected from Site 28 (Drainage Basin) and Site 29 (Suqitughneq River) to evaluate potential contamination in fish and plants resulting from a historic petroleum release and potential discharges from the Housing and Operations Complex. Ambient fish tissue samples were also collected from areas believed to be non-impacted by the Northeast Cape Installation for comparison. A total of three Dolly Varden (*Salvelinus malma*) and three pink salmon (*Onchorhynchus gorbuscha*) were collected from the

Tapisaghak River. Although attempts were made to collect fish from the Seepanpak Lagoon during the August 2001 biological sampling event, these attempts were unsuccessful. Samples of heads, eggs, fillets, and remains of fish collected from the Tapisaghak River were analyzed for inorganic chemicals, PCBs, and polynuclear aromatic hydrocarbons (PAHs).

Ambient levels of inorganic chemicals, defined as the 95 percent background upper tolerance limit (95% BUTL), or maximum concentration of inorganic chemicals detected in ambient samples, were derived and presented in the RI and Risk Assessment Update (MWH, 2002a). However, many of the BUTLs so derived defaulted to the maximum concentration detected in ambient media due to low numbers of ambient samples. Consequently, an alternate method was used to derive ambient levels for inorganic chemicals in abiotic media (i.e., soil, sediment, surface water, and groundwater) based on statistical analyses of data distributions across the entire Northeast Cape Installation. Methods used in the evaluation of ambient conditions for the Northeast Cape Installation, and the resulting ambient levels, are documented in the *Derivation of Ambient Concentrations for Abiotic Media Associated with the Northeast Cape, St. Lawrence Island, Alaska – Final* (MWH, 2003b).

Ambient levels were developed for inorganic chemicals only, consistent with ADEC guidance (ADEC, 1998). Organic chemicals detected in abiotic media were primarily common laboratory contaminants, including acetone, 2-butanone, di-n-butyl phthalate, methylene chloride, and toluene. Exceptions included the detection of dioxins/furans and petroleum hydrocarbons (PHCs) in samples of soil, sediment, surface water, and groundwater. It should also be noted that different classifications of a medium (e.g., tundra soil versus gravel soil) may have different ambient levels of a chemical due to the unique geological and physical characteristics of the medium. To account for these potential differences, ambient levels were derived for the following media: tundra soil, gravel soil, freshwater sediment, fresh surface water, ephemeral surface water, shallow subsurface water, and deep aquifer groundwater. Ambient levels for abiotic media, expressed as BUTLs, are presented in Tables 3-2 through 3-5, along with Tier I human health screening benchmarks.

Ambient levels were not developed for biotic media (e.g., plant or fish tissues). Instead, human health risks associated with subsistence plant and fish consumption were evaluated. This was done by comparing risk estimates attributable to chemical concentrations detected in plant and fish tissue samples collected from impacted areas with risk estimates for plant and tissue samples collected from ambient areas (refer to Section 4.1).

For purposes of Tier I screening for abiotic media, the maximum concentration of each site-related chemical was compared to its respective BUTL. If the maximum concentration of a site-related chemical exceeded its BUTL, or if a BUTL was unavailable, the chemical was further evaluated in the Tier I screening assessment, as described in Sections 3.1.1.2 through 3.1.1.5, below. If the maximum concentration was less than its corresponding BUTL, the chemical was eliminated from further consideration (ADEC, 2001a). Tier I screening for biotic media is described in Section 3.1.1.6.

3.1.1.2 Screening Methods – Soil

Ambient levels were derived for 15 inorganic chemicals in tundra soil and eight inorganic chemicals in gravel soil (Table 3-2). Analytes detected in onsite tundra or gravel soil that exceeded their respective ambient concentrations were screened against one-tenth the ADEC Method Two Soil Cleanup Levels (under 40-inch zone), compiled from Tables B1 and B2 (18 AAC 75.345). These criteria are chemical-specific and are listed for the following three exposure or migration pathways: ingestion, inhalation, and migration-to-groundwater. For Tier I screening, maximum concentrations of chemicals detected in soil were compared to the lesser of one-tenth the Method Two Soil Cleanup Levels for the ingestion, inhalation, or migration-to-groundwater pathways derived from Tables B1 and B2. Chemicals exceeding one-tenth of the Method Two Soil Cleanup Levels were considered COPCs and were then evaluated further.

Chemicals without risk-based benchmarks were screened based on toxicity information for surrogate chemicals, to the extent appropriate. The use of surrogate chemicals was applied when screening benchmarks were available for:

- A chemical group but not for individual chemicals within the group (e.g., total PCBs versus individual Aroclors).
- A technical mixture of chemicals but not for individual isomers of the technical formulation (e.g., benzene hexachloride [BHC] versus alpha, beta and gamma isomers of hexachlorocyclohexane).
- A chemical but not for metabolites or degradation products of the parent chemical that retain its biological activitiy (e.g., endrin versus endrin aldehyde and endrin ketone).
- A chemical but not for a structurally and toxicologically similar chemical (e.g., anthracene versus phenanthrene).

The identification of surrogate chemicals and representative toxicity benchmarks for COPC screening was performed by a trained MWH toxicologist. Examples of the surrogate toxicity approach are provided in USEPA (2003a) in regard to cancer potency values for PCBs, and in Staats et al. (1997) in regard to noncarcinogenic toxicity values for petroleum mixtures. Additional details of this procedure for individual chemicals are provided in footnotes to Tables 3-2 through 3-5. Chemicals without reasonable surrogates were retained as COPCs and were further evaluated in the Tier II baseline HHRA.

Sites with chemicals detected in soils at concentrations that exceeded Tier I screening criteria, or for which screening criteria were unavailable, were carried into the Tier II baseline HHRA.

3.1.1.3 Screening Methods – Sediment

Materials designated as sediments consist of materials collected from two very different environments:

- Sediments (soils below standing surface water in ephemeral ponds)
- Sediments in lakes, flowing streams, and waterways (e.g., Suqitughneq River)

For clarity, sediments collected from permanenent water bodies, including flowing streams, and waterways are designated as freshwater sediments for the remainder of this HHERA. Ambient levels were derived for six inorganic chemicals in freshwater sediments (Table 3-3).

No human health screening criteria are currently available for contaminated sediments. For sediments below standing water in ephemeral ponds, analyte concentrations in sediments were compared to ambient concentrations and one-tenth the ADEC Method Two Soil Cleanup Levels (under 40-inch zone), compiled from Tables B1 and B2 (18 AAC 75.345), as described above for soils. Sites with chemicals detected in sediment at concentrations that exceeded Tier I screening criteria were carried into the Tier II baseline HHRA. For sediments in flowing streams, sediment concentrations were also screened against ecological criteria, including NOAA sediment benchmarks or other standards listed in 18 AAC 70. Other information sources that may be used for ecological screening are discussed in Section 3.2.

3.1.1.4 Screening Methods – Surface Water

Surface water at the Northeast Cape Installation was classified as fresh surface water and ephemeral surface water for purposes of this HHERA (refer to Section 1.5.5). Fresh surface water bodies include permanent lakes, flowing streams, and waterways such as the Suqitughneq River. Ephemeral surface water consists of puddles, marshy areas, and intermittent ponds and streams that dry up during the summer months. Insufficient data were available to derive ambient levels for any inroganic chemicals in permanent fresh surface water (Table 3-4). Ambient levels were derived for six inorganic chemicals in ephemeral surface water.

Fresh surface water from the upper Suqitughneq River is currently used as a domestic water supply by seasonal residents of the Subsistence Fishing and Hunting Camp (Site 4). In accordance with Alaska regulations for surface water that is a potential drinking water source , analytes detected in fresh surface water from flowing streams and waterways are compared to ambient concentrations and ADEC surface water criteria included in 18 AAC 70. Ambient levels were not developed for inorganic chemicals in surface water because only four to eight fresh surface water samples were available for any given chemical, and detections ranged from none to a maximum of four (MWH, 2003b). Therefore, surface water data were insufficient to derive statistically meaningful background levels for this medium. Analytes detected in ephemeral surface water were not evaluated as a potential drinking water source in this HHRA, consistent with the site-specific CSMs provided in Section 4.0.

Chemicals without risk-based benchmarks were screened based on toxicity information from surrogate chemicals, to the extent appropriate (refer to Section 3.1.1.2). Chemicals without reasonable surrogates were retained as COPCs and were evaluated further in the Tier II baseline HHRA.

3.1.1.5 Screening Methods – Groundwater

Groundwater at the Northeast Cape Installation consists of shallow subsurface water and deep subsurface water (refer to Section 1.5.6). Ambient levels were derived for 12 inorganic chemicals in shallow subsurface water (Table 3-5). Chemicals detected in shallow subsurface water exceeding ambient concentrations were compared to one-tenth of their respective ADEC Groundwater Cleanup Levels, Table C. The only inorganic chemical detected in deep subsurface water was manganese, and insufficient data were available to derive an ambient level for this chemical (Table 3-5). In the absence of ambient levels for deep subsurface water, all inorganic analytes detected in deep subsurface groundwater were compared to one-tenth of their respective Table C Groundwater Cleanup Levels. The criteria in Table C are chemical-specific and apply to groundwater that is a current or reasonably anticipated drinking water source. The only groundwater sampled at Northeast Cape that is an historic or reasonably anticipated drinking water source is derived from the potable water wells located at Sites 22 and 26. However, shallow subsurface water was evaluated as a potential drinking water source in accordance with ADEC regulations. Chemicals detected in shallow subsurface water or deep subsurface water at concentrations in excess of one-tenth of the Table C Groundwater Cleanup Levels were retained as COPCs, and were carried into the Tier II baseline HHRA.

Chemicals without risk-based benchmarks were screened based on toxicity information from surrogate chemicals, to the extent appropriate (refer to Section 3.1.1.2). Chemicals without reasonable surrogates were retained as COPCs and were evaluated further in the Tier II baseline HHRA.

3.1.1.6 Screening Methods – Biological Media

Although EPA Region III has developed risk-based concentrations (RBCs) for fish based on human consumption, similar levels have not been adopted by ADEC. Per the EPA, the states, territories, and Native American tribes have primary responsibility for protecting residents from the health risks of eating contaminated fish (USEPA, 2002a). To date, the State of Alaska has not developed numerical fish or plant advisories for potential use as COPC screening criteria. Therefore, all chemicals detected in fish or plant tissues were considered COPCs and were evaluated further in the Tier II baseline HHRA.

3.1.1.7 PHC Screening

ADEC regulations for the cleanup of PHC-contaminated media have changed since the 1994 Phase I RI data were collected. Initial Phase I investigations at the Northeast Cape Installation used EPA Method E418.1 for measuring total residual petroleum hydrocarbons (TRPH), in addition to EPA Methods Solid Waste (SW) 8015M for measuring gasoline range organics (GRO) and SW8100M for measuring diesel range organics (DRO). Method E418.1 is a non-specific method that includes identification of a broad range of natural and anthropogenic (i.e., man-made) hydrocarbons. Consistent with ADEC policy, this method was eliminated in later phases of the RI for the Northeast Cape Installation due to its non-specificity. Methods SW8015M and SW8100M were also replaced with ADEC-approved Alaska Methods (AK)101 and AK102, respectively, between 1996 and 1998. By 1998, all PHC data at the Northeast Cape Installation were collected and analyzed using AK101, AK102, and AK103 for GRO, DRO, and residual range organics (RRO), respectively. It should be noted that soil and groundwater cleanup criteria listed in 18 AAC 75.341 and 18 AAC 75.345 are based on analysis using AK101, AK102, and AK103. Consequently, Tier I screening for abiotic media at the Northeast Cape Installation included all PHC sampling results analyzed using methods AK101, AK102, and AK103. In addition, because PHC data for some sites and media (e.g., Site 3 soils) were only analyzed using methods SW8015M and 8100M, these data were also included in the quantitative Tier I screening process. However, data collected using Method E418.1 for TRPH were not included in Tier I screening, consistent with ADEC policy.

Samples of biological media (i.e., vegetation and fish) were not analyzed for GRO, DRO, or RRO because biological lipids typically interfere with PHC analyses. Consistent with ADEC and EPA policies, vegetation and fish tissue samples were analyzed for individual PAHs, which are constituents of PHCs and are recognized as risk drivers.

3.1.2 Tier II Baseline HHRA

The Tier II baseline HHRA consisted of the following five steps:

1. Exposure assessment
2. Exposure quantification
3. Toxicity assessment
4. Risk characterization
5. Uncertainty analysis

These five steps are discussed in detail in the following sections.

3.1.2.1 Exposure Assessment

The HHRA begins with development of a site-specific conceptual site model (CSM). The CSM is a descriptive and graphical presentation of relationships between chemical contaminants and potentially exposed populations. The CSM identifies chemical sources, complete exposure pathways, and potential receptors for each site for present and future exposure scenarios.

A preliminary CSM for the Northeast Cape Installation was prepared by the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM, 2001). The preliminary CSM evaluated: sources of contaminants and contaminated media; contaminant fate and transport, including food chain transfer; potentially exposed human and ecological populations; and potentially complete exposure pathways between contaminated media and receptor populations.

The HHRA for the Northeast Cape Installation was based upon a refined CSM incorporating preliminary CSM information and additional information, including: (1) results of interviews/surveys completed by St. Lawrence Island residents in June 2001; (2) field observations and data collected during July and August 2001 investigations; (3) results of a September 20, 2001, teleconference among representatives of the Alaska District, ADEC, USACHPPM, and MWH; and (4) results of an expanded survey completed by St. Lawrence Island residents in January 2003.

The refined Northeast Cape Installation human health CSM incorporates the following information:

- Contaminated media and COPCs.
- Contaminant fate and transport.
- Current and future land uses and potentially exposed populations.
- Potentially complete exposure pathways between contaminated media and receptors.

These CSM components for the Northeast Cape Installation are described in the following subsections.

3.1.2.1.1 Contaminant Sources and COPCs

Contaminated media and analytes detected at the Northeast Cape Installation were previously described in the Phase II RI Report (Montgomery Watson, 1999), Phase II RI Report Addendum (Montgomery Watson, 2000a), and Phase III RI Report (MWH, 2003a). Exposure to asbestos-containing material (ACM) and lead-based paint from existing structures and buildings was not evaluated as a complete exposure pathway because the buildings were removed. In addition, the FUDS Program cannot address beneficially used materials/buildings. However, the HHRA has evaluated lead contamination in affected environmental media, including soil and shallow subsurface groundwater.

3.1.2.1.2 Contaminant Fate and Transport

Information presented in this section summarizes material presented in the Preliminary Conceptual Site Model (USACHPPM, 2001).

Contaminants at the Northeast Cape Installation, primarily chemicals associated with PHC releases, are marked by low aqueous solubilities and high sorbing efficiencies onto carbon present in environmental media. Thus, these compounds have a high degree of retention in soils and sediments. This retention is demonstrated in areas where soils are stained black and in surface water where disturbing the sediments produces a sheen. At many of these locations, vegetation is noticeably stressed and sparse, while at other locations vegetation appears unaffected and no petroleum sheen is apparent (Montgomery Watson, 200a). In spite of the low aqueas solubilities and high retention of lipophilic chemicals such as PHCs in soils and sediments, leaching and migration of chemicals including DRO and PCBs to surface or subsurface water has occurred at the Northeast Cape Installation (MWH, 2003b). Thus, surface and subsurface water provide addtitional transport and exposure media for human and ecological receptors.

Fish and wildlife at the Northeast Cape Installation may bioaccumulate contaminants from exposure at spill locations or from ingesting affected plants and animals. PCBs may pose one of the greatest potential problems to environmental receptors at the Northeast Cape Installation. PCBs are highly lipophilic compounds (meaning they have an affinity to partition into adipose tissue) and are highly persistent in environmental media.

The greatest opportunities for bioaccumulation of contaminants originating from the Northeast Cape Installation would likely be sedentary forms including aquatic plants and sessile animals such as benthic invertebrates. Conversely, free- and wider-ranging receptors (such as cross fox and reindeer) have a reduced potential to bioaccumulate contaminants originiating from the Northeast Cape Installation because: (1) site contamination exists in isolated locations, (2) receptors spend only minimal time foraging at any given site, and (3) higher trophic level animals are able to metabolize many contaminants, such as VOCs and PAHs of petroleum origin (ATSDR, 1990c; Eisler, 1987).

Although plants and animals may bioaccumulate contaminants, the presence of contaminant concentrations in their tissues does not mean these organisms are themselves at risk; tissue concentrations (body burdens) of substances are indicators only of exposure, not of risk. The reported presence of healthy vegetation at a number of aquatic sites where major spills of diesel and other chemicals have occurred suggests that if the contaminants have been taken up by the plants, the bio-uptake has not adversely impacted them (Montgomery Watson, 2000a).

3.1.2.1.3 Current and Future Land Uses

Island residents harvest food from areas in and around the Northeast Cape Installation during the summer months (i.e., mid-June through mid-September), and others occasionally visit the area both in summer and winter. No people currently reside permanently at, or in the vicinity of, the Northeast Cape Installation. Two groups of individuals visit the Northeast Cape Installationduring the year to engage in subsistence fishing, hunting, and gathering. Food harvests consist of fish, animals, and plants.

Future land uses are likely to include subsistence fishing, hunting, and gathering. Interviews with island residents suggest that additional fishing/hunting camps may be built, and a permanent residential scenario is possible at some sites. The residential scenario is not considered for Sites 28, 29, and 34 due to physical conditions at these sites that would limit future residential construction (i.e., Sites 28 and 29 are lowland areas that undergo seasonal flooding, and Site 34 is situated in mountainous terrain with high winds).

3.1.2.1.4 Identifying Potentially Complete Exposure Pathways

Potentially exposed populations for the Northeast Cape Installation are consistent with the current and potential future land uses described in the previous subsection. Based on current and potential land uses, human receptors for the Northeast Cape Installation include the following:

- Current seasonal resident
- Future seasonal resident
- Future permanent resident
- Current incidental site visitor
- Future incidental site visitor

For chemical contaminants to pose a potential human health risk, a complete exposure pathway between the source of the contaminant and a human receptor must exist. A complete exposure pathway as defined by Risk Assessment Guidelines for Superfund (USEPA, 1989a) consists of the following four essential elements:

- Contaminant source and mechanism of release.
- Receiving or transport medium (soil, sediment, groundwater, surface water, air, or food).
- Point of potential human contact with the contaminant (exposure point).
- Exposure route, such as eating and drinking (ingestion), skin (dermal) contact, and breathing (inhalation).

An exposure pathway is incomplete if one or more of the above elements is absent.

The Tier II baseline risk assessment is intended to assess exposure based upon actual or anticipated exposure pathways and assumptions (USEPA, 1989a), in contrast to the Tier I assessment, described in Section 3.1.1, that evaluates default exposure pathways based on a residential scenario. The Tier II assessment considers specific exposure pathways, such as subsistence lifestyles as practiced at the Northeast Cape Installation, not included under typically evaluated Tier I scenarios. Consequently, detailed knowledge of the exposure setting, potentially exposed populations, and local activity patterns and dietary habits is necessary to complete an evaluation of probable exposure pathways. To identify complete exposure pathways for the Northeast Cape Installation, the following information sources were evaluated:

- Information collected during the Phase I, II, and III investigations.
- Comments received during Restoration Advisory Board meetings held at Savoonga and Nome, Alaska, between January 27, 2000, and May 30, 2001.
- Interview and survey information obtained from island residents during summer 2001 and January 2003 (Appendix C).
- Human health exposure assessment included in the Preliminary Conceptual Site Model (USACHPPM, 2001).

Potential exposure media and routes evaluated in the HHRA for the Northeast Cape Installation are described in the following subsections. Relevant exposure pathways for current and future receptors are described in a generalized CSM presented on Figure 3-1. Site-specific contaminant sources, human receptors and exposure pathways are described in more detail in Section 4.1.

3.1.2.1.5 Soil/Dust Exposure Pathways

Contaminants can enter surface and subsurface soil through dumping, spilling, leaking, and burying chemicals and wastes. Individuals who work, play, or conduct other outdoor activities such as fishing, hunting, or gathering may be exposed to COPCs that have been deposited onto or diffused into soil. Any outdoor activities that involve digging into soils may also expose individuals to COPCs via incidental ingestion and dermal pathways. Inhalation of COPCs in indoor dust derived from outdoor soil or sediment tracked indoors is also a potentially complete exposure pathway. This HHRA considered ingestion, dermal, and indoor inhalation soil exposure pathways as components of the human exposure scenarios. The indoor dust inhalation pathway was evaluated by calculating potential indoor dust intakes and dust-associated contaminant exposures and risks. Equations for calculating exposure doses are presented in Section 3.1.2.2.

Inhalation of particulates (dust) in outdoor air was not evaluated as a significant exposure route because: (1) the Northeast Cape Installation is covered by snow much of the year, (2) frequent precipitation events minimize generation of dust, and (3) soils at most of the sites have revegetated resulting in very little opportunity for particulate emissions. The outdoor inhalation of wind-borne contaminants pathway was qualitatively addressed in the HHRA.

The primary petroleum contamination associated with the Northeast Cape Installation consists of DRO and RRO. DRO consists primarily of aliphatic and aromatic hydrocarbons in the carbon range $C_{10} - C_{25}$, and RRO is primarily comprised of aliphatic and aromatic hydrocarbons in the carbon range $C_{25} - C_{36}$ (ADEC, 2000c). Neither of these petroleum fractions is appreciably volatile and volatilization is not expected to be a significant fate process in the vicinity of the Northeast Cape Installation, where winter temperatures range between -2°F and 10°F and summer temperatures range from 34°F to 48°F (Section 1.5.1). Furthermore, the island receives some form of precipitation approximately 300 days out of the year (Section 1.5.1). Consequently, inhalation of volatile organic compounds (VOCs) in outdoor air was not quantitatively evaluated in the HHRA.

It is not anticipated that future residences, or other structures, would include basements due to the existence of shallow, perched groundwater and permafrost conditions at the Northeast Cape Installation. Although volatile chemicals may migrate into structures without basements, migration to indoor air is not anticipated to be a significant exposure pathways for the primary volatile COPCs identified for the Northeast Cape Installation, namely PHCs including DRO. As stated above, primary petroleum fractions such as DRO are not appreciably volatile, and cold temperatures at the Northeast Cape Installation tend to minimize volatilization of such chemicals. Therefore, inhalation of VOCs in indoor air was considered to be an insignificant exposure pathway and was not quantitatively evaluated in the HHRA. However, these potential exposure pathways were qualitatively addressed in the uncertainty analysis.

3.1.2.1.6 Sediment Exposure Pathways

Contaminants can be transported into sediment via erosion and runoff from watershed soils that contain COPCs, or from direct deposition of chemicals and wastes to the surface water bodies of which they are a part. Exposure to COPCs in sediment through incidental ingestion or dermal contact during outdoor activities such as fishing (at Site 29) or marine mammal hunting is a potential human exposure pathway that was quantified in the HHRA.

For sediments below standing water in ephemeral ponds, incidental ingestion or dermal exposure was assessed as being comparable to soils, because when the ephemeral pond evaporates or dissipates the sediments behave as soils.

3.1.2.1.7 Surface Water Exposure Pathways

Contaminants can be transported to surface water via erosion and runoff from watershed soils that contain COPCs, or from direct deposition of chemicals or wastes to surface water. Exposure to COPCs in fresh surface water through ingestion (drinking water) and bathing are potential human exposure pathways. Therefore, exposures to COPCs in fresh surface water through ingestion and bathing were quantitatively evaluated for current and future receptors.

Results from ephemeral surface water samples (i.e., ephemeral puddles, marshy areas, and intermittent streams) were not included in this evaluation because such water bodies are not viable sources of water for drinking and bathing.

3.1.2.1.8 Groundwater Exposure Pathways

Contaminants can enter groundwater through migration from soils or through direct deposition of chemicals or wastes into water-bearing soils (the aquifer). No subsurface water is currently used at the Northeast Cape Installation; seasonal residents obtain potable water from the upper Suqitughneq River. However, future use of either shallow subsurface water or deep subsurface water as a domestic water supply cannot be ruled out. Consequently, exposures to COPCs in shallow and deep subsurface water through ingestion and bathing were quantitatively evaluated for future receptors. Groundwater was sampled in the Phase I, II, and III fieldwork from various sites up to depths of 60 feet bgs. The four potable water wells (GW101, GW102, GW103, and GW104) were determined to be installed into the deep aquifer, which represents the most viable future source of potable water at the Northeast Cape Installation.

For future receptors, both fresh surface water and shallow/deep subsurface water ingestion pathways were evaluated as potentially complete routes of exposure. The risks for each medium were calculated separately in the Tier II HHRA, and then incorporated into a cumulative site risk estimate across all potentially complete media and pathways for individual exposure scenarios. Cumulative risk estimation methods are described in more detail in Sections 3.1.2.4 and 4.1.

3.1.2.1.9 Food Chain Exposure Pathways

Contaminants may enter plant tissues by root uptake of COPCs in soil and water, by air-to-plant transfer of COPCs in vapor form, and through diffusion of COPCs directly deposited on leaves as dust. Aquatic species may take up substances dissolved in surface water or adsorbed to sediments. Animals may be exposed to COPCs by direct contact with contaminated media or by ingesting exposed plants or animals. Because contaminants present in soil, sediment, surface water, and groundwater may be taken up by plants and animals, human receptors may be exposed to COPCs indirectly via consumption in the food chain pathway. Subsistence resource users are particularly susceptible to this pathway; therefore, exposure through consumption of plant and animal tissues was quantified in the HHRA.

Human exposure to COPCs in the food chain was estimated based on concentrations of COPCs measured in food, types and amounts of foods consumed, and percentages of food species exposed to COPCs. The HHRA cannot evaluate every possible food chain pathway, but has instead focused on food items most likely to be impacted by the Northeast Cape Installation contaminants and those commonly consumed by potentially exposed individuals. Surveys and interviews of subsistence fishers, hunters, and gatherers in summer 2001 and January 2003 indicated that seasonal residents harvest fish, reindeer, marine mammals, and plants in and around the Northeast Cape Installation. The 2001 field investigation included collecting specific species of plants and fish based on information from these surveys and interviews. Plant species harvested by island residents and collected during the 2001 field investigation included roseroot (*nunivak* in Siberian Yupik), white Arctic mountain heather (*kittmik* in Siberian Yupik), and black crowberry. Only plant samples of these species were considered in the Tier II human health evaluation. Fish species harvested by island residents and collected during the 2001 field investigation included Dolly Varden and pink salmon. Tissue samples from these species were used in the Tier II human health evaluation. Analytical results from these samples were used to quantify exposures and risks associated with human consumption of locally harvested plants and fish. Specific survey information used in assessing exposures of subsistence users to locally harvested plants and fish is described below.

Average daily consumption rates for plants harvested from the Northeast Cape Study Area by island residents were derived from the survey and interview information obtained by Montgomery Watson during summer 2001 and by the USACE during January 2003 (Appendix C). Results of these surveys and interviews indicate that locally harvested plants consist primarily of berries, greens, and roots. The primary varieties of berries harvested in the vicinity of the Northeast Cape Installation include blackberries, crowberries, salmonberries, cloudberries, and lowbush cranberries. Greens and/or roots are harvested from rosewood, roseroot, Siberian spring beauty, dock, willow, saxifrage, lousewort, shakeeil, and white Arctic mountain heather. The above plants are harvested primarily in July and August, and may be frozen for consumption throughout the year.

More specific information regarding plant harvesting and consumption patterns was provided by June Martin in comments on the 2001 Phase III RI and Risk Assessment (MWH, 2002a). Entire-leaf roseroot (*nunivak* in Siberian Yupik) is picked at early stages, in late June, and is preserved in water for fermentation and later consumed throughout the year. Roots of entire-leaf roseroot (*saqlak* in Siberian Yupik) are harvested in late spring and are eaten raw, with seal blubber. Black crowberry is picked in late July and August, mixed with other berries in fish eggs/fish meat and other greens. Chamisso's and diamond willows are harvested in late spring, consumed with a variety of fish and seal blubber, and stored in freezers for future consumption. Salmonberries are harvested in late July and August, and are abundant around the Suqitughneq River. However, the locations where plants are harvested by island residents (as shown in Appendix C) are typically outside of the actual Northeast Cape Study Area. The derivation of plant consumption rates for evaluation in the HHRA is described in more detail in Section 3.1.2.2.3.

Survey and interview information obtained by Montgomery Watson during summer 2001 and by the USACE in January 2003 was used in deriving consumption rates for fish harvested from the Northeast Cape Study Area. Results of these surveys and interviews (Appendix C) indicate that subsistence users harvest and consume freshwater fish, including trout and whitefish, and saltwater fish, including salmon, Dolly Varden, herring, and tomcod. Based on the 2001 survey, the highest consumption rates of locally harvested fish were reported by Eugene and Marie Toolie (Appendix C). Consequently, a follow-up interview with Mr. Eugene Toolie was conducted by Dr. Bruce Narloch of MWH on January 14, 2002, to clarify and refine information obtained from the initial interview conducted on June 22, 2001. Information regarding local fish harvesting and consumptions patterns obtained from this follow-up interview is provided below.

The Toolies are seasonal residents of the Northeast Cape Installation and have a cabin at the Subsistence Fishing and Hunting Camp. The family consumes fish approximately two to three times per week during the summer months, during which the fish (primarily Dolly Varden and pink salmon) are harvested. Mr. Toolie confirmed that less than 25 percent of their diet is comprised of fish. Of the fish that they consume, less than 25 percent of their catch is obtained from the Suqitughneq River. Mr. Toolie indicated that fish of larger size and higher numbers are available in the Tapisaghak and Seepanpak Rivers, and are preferentially harvested there. More than 75 percent of their local catch comes from these sources. During the summer months, fish are primarily prepared fried or boiled, with the skins on. However, the skin is generally peeled off prior to consumption. Fish heads are consumed in the late summer; this part of the fish is generally boiled prior to consumption. Mr. Toolie indicated that fish heads are consumed during the late summer only, and comprise approximately two meals per month. Fish eggs are also harvested from wild-caught fish and are mixed with fish for consumption in the early winter. Fish eggs are consumed once every month or two. Fish heads, eggs, or whole fish are not frozen for consumption during winter months. A portion of the fish that are harvested during the summer are dried for consumption during the remainder of the year. Dried fish are consumed at a rate of one meal per week, or every other week, during the non-summer months. Mr. Toolie indicated that shellfish, including mussels, are also consumed. However, shellfish are not harvested from the Northeast Cape Study Area. Primary methods of shellfish harvesting include collecting shellfish that have washed up on beaches, or those found in the stomachs of harvested walruses. The derivation of fish consumption rates for evaluation in the HHRA is described in more detail in Section 3.1.2.2.3.

Due to the relatively low number of respondents to the 2001 survey, the USACE conducted a second, more detailed survey in January 2003. A total of six subsistence food users responded to the January 2003 survey. Although the number of respondents was less than desired, results of the 2003 survey provided additional information including size of the local fish harvest, types of fish caught, fish parts and proportions that are consumed, and seasonal consumption patterns. This information is documented in Appendix C, and further evaluated in Section 3.1.2.2.3. Uncertainties related to the surveys and exposure estimates related to subsistence food use are discussed in Section 5.3.

Potential exposures and risks associated with human consumption of reindeer harvested from the vicinity of the Northeast Cape Installation were evaluated by the Agency for Toxic Substances and Disease Registry (ATSDR) (USDHHS, 2001). The ATSDR health assessment indicated that risks associated with this pathway were not significant. Therefore, this pathway was not quantified in the Tier II HHRA.

Marine mammals, including seals, walruses, and polar bears, are present in the Northeast Cape Installation and are harvested by subsistence hunters for human consumption. However, potential exposures associated with this pathway are anticipated to be low because marine mammals: (1) have very wide foraging ranges, (2) are migratory species and are present at the Northeast Cape Installation for only a portion of the year, and (3) do not use inland areas or the lagoon for foraging or breeding. In addition, attributing chemical concentrations in these wide-ranging species to potential exposures from the Northeast Cape Installation would be extremely difficult. Consequently, potential exposures associated with human consumption of marine mammals were not quantified in the Tier II HHRA.

3.1.2.1.10 Maternal Milk Exposure Pathway

Exposing nursing infants to lipophilic COPCs through consumption of maternal milk is a potentially complete exposure pathway when the mother may be exposed to COPCs in the food chain. However, considerable uncertainty is associated with evaluating this pathway because only limited pharmacokinetic and toxicological data are available regarding nursing infant exposures. Consequently, no standard EPA or ADEC equations and exposure assumptions for quantifying this pathway are currently available. Toxicity values for the primary COPCs associated with this pathway (PCBs) are based on reproductive effects and protection of the developing fetus (USEPA, 2003a). Therefore, potential effects of PCBs on reproduction and development were taken into consideration through evaluating more traditional pathways such as food consumption, incidental ingestion, and dermal contact with abiotic media (e.g., soil, sediment, and water). For other chemicals, the maternal milk pathway was qualitatively evaluated in Tier II HHRA.

3.1.2.2 Exposure Quantification

This section describes how potential exposures to COPCs were quantified, including methods for deriving media exposure concentrations and calculations for quantifying exposure doses for current and future human receptors. Exposure point concentrations (EPCs), doses, and risks were estimated for each site.

3.1.2.2.1 Deriving Exposure Point Concentrations

An EPC describes the level of a chemical in soil, sediment, water, or food to which a receptor is exposed (USEPA, 1989a, 2002b; ADEC, 2003). As such, the EPC serves as the basis for quantifying pathway-specific exposure doses. Calculating EPCs in site media was based on both measured concentrations and nondetect results. If a data set contained nondetect results, one-half the sample quantitation limit was assumed for each nondetect result. EPCs were estimated as either the maximum detected contaminant concentration or the 95 percent upper confidence limit (95% UCL) on the arithmetic mean concentration detected. If the calculated 95% UCL was greater than the maximum value, then the maximum value was assumed as the EPC; otherwise, the 95% UCL was used.

The 95% UCL was calculated consistent with methods described by ADEC (ADEC, 2003) and the EPA (USEPA, 2002b). First, sampling results for individual COPCs detected within a given medium were evaluated to identify whether the data population is representative of an underlying normal or lognormal distribution. The Shapiro-Wilks W test for normality and the CV statistic (Gilbert, 1987) were used as necessary to test the underlying data distribution. For data sets that are best represented by a normal distribution, the 95% UCL was calculated based on the Student t-statistic (ADEC, 2003). The equation for calculating the UCL for a normal distribution (USEPA, 2002b) is:

$$UCL = x(bar) + t\,(s/\sqrt{n})$$

Where:

UCL	= Upper confidence limit
x(bar)	= Mean of the untransformed data
s	= Standard deviation of the untransformed data
t	= Student t-statistic (from table published in Gilbert, 1987)
n	= Number of samples

For data sets that are best represented by a lognormal distribution, 95% UCL concentrations were calculated based on the H-statistic (ADEC, 2003). Four-point Lagrangian interpolation and an H table from Gilbert (1987) were used to determine H values for UCL calculation. The equation for calculating the UCL for a lognormal distribution (Gilbert, 1987) is:

$$UCL = e^{x(bar)+0.5\,s2+sH/\sqrt{(n-1)}}$$

Where:

UCL	= Upper confidence limit
e	= Constant (base of the natural log, equal to 2.718)
x(bar)	= Mean of the transformed data
s	= Standard deviation of the transformed data
H	= H-statistic (Gilbert, 1987)
N	= Number of samples

For data sets that were inconculsive in terms of their underlying distribution, bootstrapping procedures were used to derive the 95% UCL consistent with methods described in ADEC (2003). EPCs and summary statistics for each site, media, and COPC are summarized in Appendix I.

3.1.2.2.2 Calculating Exposure Doses

This section describes HHRA methods for quantifying exposure doses for human receptors. The specific dose equations presented below were obtained from EPA guidance for exposure assessments (USEPA, 1989; 1992; and 1997a). Specific assumptions used in quantifying exposures for human receptors are summarized in Table 3-6. Where available and applicable, default ADEC or EPA exposure parameters were used. Peer-reviewed literature and/or professional judgement were used for parameters when no EPA default values exist or if more recent information supplants EPA values. Chemical-specific parameters including skin absorption factors, dermal permeability coefficients and volatility factors are provided in Appendix D. Sample dose and risk calculations are also included in Appendix D. As described in Appendix D, doses for adult and child residents were combined in the dose equation for seasonal and permanent residents for each exposure pathway.

Soil, Sediment, and Dust

Equations for quantifying exposures to COPCs in soil, sediment, and dust are as follows:

$$\text{Ingestion Intake for Soil/Sediment/Dust (mg/kg-day)} = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

- CS = Concentration in soil (milligrams per kilogram [mg/kg])
- IR = Ingestion rate (milligrams [mg] soil/day)
- CF = Conversion factor (10^{-6}kg/mg)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kilogram [kg])
- AT = Averaging time (period over which exposure is averaged – days)

$$\text{Dermal Intake for Soil/Sediment/Dust (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Where:

- CS = Concentration in soil (mg/kg)
- CF = Conversion factor (10^{-6} kg/mg)
- SA = Skin surface area exposed (square centimeter [cm^2])
- AF = Adherence factor of soil (mg/cm^2-day)
- ABS = Skin absorption factor (unitless)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time (period over which exposure is averaged–days)

$$\text{Inhalation Intake for Indoor Dust (mg/kg-day)} = \frac{CS \times (1/PEF) \times InhR \times EF \times ED}{BW \times AT}$$

Where:

- CS = Concentration in soil (mg/kg)
- PEF = Particulate emission factor (cubic meters [m^3]/kg)
- InhR = Inhalation rate (m^3/day)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time (period over which exposure is averaged – days)

Fresh Surface Water and Subsurface Water

Equations for quantifying exposures to COPCs in surface water and subsurface water are as follows:

$$\text{Ingestion Intake for Domestic Water (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Where:

- CW = Concentration in deep groundwater (milligrams per liter [mg/L])
- IR = Ingestion rate (liters groundwater/day)

EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged – days).

$$\text{Dermal Intake for Domestic Water (mg/kg-day)} = \frac{CW \times CF \times SA \times PC \times ET \times EF \times ED}{BW \times AT}$$

Where:

CW = Concentration in deep groundwater (mg/L)
CF = Conversion factor (10^{-3} L/cubic centimeter [cm^3])
SA = Skin surface area exposed (cm^2)
PC = Dermal permeability constant (cm/hour)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged – days).

$$\text{Inhalation Intake for VOCs in Domestic Water (mg/kg-day)} = \frac{CW \times VF \times InhR \times ET \times EF \times ED}{BW \times AT}$$

Where:

CW = Concentration in water (mg/L)
VF = Volatility factor (L/m^3)
InhR = Inhalation rate (m^3/hr)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged – days).

Plants and Animals

$$\text{Ingestion Intake for Subsistence Plant Consumption (mg/kg-day)} = \frac{C_{PLANTS} \times IR \times EF \times ED}{BW \times AT} \times CF$$

Where:

C_{PLANTS} = Concentration in human consumed plants (mg/kg)
IR = Ingestion rate (grams [g] plant/day)
CF = Conversion factor (10^{-3}kg/g)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged – days)

$$\text{Ingestion Intake for Subsistence Fish Consumption (mg/kg-day)} = \frac{C_{FISH} \times IR \times EF \times ED}{BW \times AT} \times CF$$

Where:

C_{FISH}	=	Concentration in fish fillet (mg/kg)
IR	=	Ingestion rate (g fish/day)
CF	=	Conversion factor (10^{-3}kg/g)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged – days)

3.1.2.2.3 Exposure Assumptions

Specific assumptions that were used in quantifying exposures for human receptors are summarized in Table 3-6. Where available and applicable, default EPA exposure parameters were generally used. Peer-reviewed literature and/or professional judgement were used for parameters when no EPA default value existed. Also, default parameters were, in some cases, supplanted by more recent EPA guidance/peer-reviewed literature.

Site-specific information obtained from surveys and interviews with local residents was used to develop subsistence level consumption rates for plants and fish. Results of the surveys and interviews are summarized in Section 3.1.2.1.9, and presented in full in Appendix C. The information and methods that were used to calculate consumption rates for plants and fish harvested from the vicinity of the Northeast Cape Installation are presented below.

Average daily rates of native plant consumption by island residents were derived from survey information obtained by Montgomery Watson and the USACE (Appendix C). The 2001 survey results and follow-up interview with the Toolies provided information on local plant harvest rates and general consumption patterns. However, information on portion sizes consumed by adults and children were not available from this earlier survey/interview effort, and previous portions consumed were derived from the EPA (USEPA, 1997b). Results of the January 2003 survey provided more specific information regarding portions of native plants consumed, as summarized in Table 3-7. Therefore, average daily plant consumption rates for use in estimating risks associated with subsistence plant gathering were calculated based on the information obtained from the 2003 survey. It should be recognized that a total of six individuals responded to the 2003 survey. Therefore, it was not possible to perform a detailed statistical evaluation of the survey results, or to statistically derive upper or lower bound estimates of plant consumption rates. However, the survey information was adequate to estimate average subsistence consumption rates for plants. Potential uncertainties related to the exposure estimates for subsistence food use are discussed further in Section 5.3.

January 2003 survey respondents described three categories of locally harvested plants: berries, greens, and roots. Native plants are eaten at a rate of four meals per week during the summer months (i.e., mid-June through mid-September), and one to two meals per month (average of 0.4 meals per week) during the non-summer months. Survey respondents estimated that adults consume about one-half pound (i.e., 8 ounces) of plants per meal, and children consume about one-quarter pound (i.e., 4 ounces) of plants per meal. The survey and interview information indicates that the majority of locally harvested plants are collected from outside the Northeast

Cape Installation. However, several respondents indicated that they harvest plants from within the Northeast Cape Installation.

Based on the 2003 survey information summarized in Table 3-7, the *average daily* consumption rates for plants harvested from the Northeast Cape Study Area during the summer months may be estimated for adults and children as follows:

Adult:

$$IR_{\text{Plants, summer – adult}} = \frac{\text{4 meals}}{\text{week}} \times \frac{\text{week}}{\text{7 days}} \times \frac{\text{8 ounces}}{\text{meal}} \times \frac{\text{28.3 grams}}{\text{1 ounce}}$$

$$= \text{130 grams per day}$$

Child:

$$IR_{\text{Plants, summer – child}} = \frac{\text{4 meals}}{\text{week}} \times \frac{\text{week}}{\text{7 days}} \times \frac{\text{4 ounces}}{\text{meal}} \times \frac{\text{28.3 grams}}{\text{1 ounce}}$$

$$= \text{65 grams per day}$$

Similarly, daily plant consumption rates during the *non-summer* months may be estimated for adults and children as follows.

Adult:

$$IR_{\text{Plants, winter – adult}} = \frac{\text{0.4 meals}}{\text{week}} \times \frac{\text{week}}{\text{7 days}} \times \frac{\text{8 ounces}}{\text{meal}} \times \frac{\text{28.3 grams}}{\text{1 ounce}}$$

$$= \text{13 grams per day}$$

Child:

$$IR_{\text{Plants, winter - child}} = \frac{\text{0.4 meals}}{\text{week}} \times \frac{\text{week}}{\text{7 days}} \times \frac{\text{4 ounces}}{\text{meal}} \times \frac{\text{28.3 grams}}{\text{1 ounce}}$$

$$= \text{6.5 grams per day}$$

The *average daily* consumption of native plants over the *entire* year can be calculated for adults and children as follows:

Adult:

$$IR_{\text{Plants, annual avg - adult}} = \frac{\text{(130 grams/day x 90 days) + (13 grams/day x 275 days)}}{\text{365 days}}$$

$$= \text{42 grams per day}$$

Child:

$$IR_{\text{Plants, annual avg - child}} = \frac{\text{(65 grams/day x 90 days) + (6.5 grams/day x 275 days)}}{\text{365 days}}$$

$$= \text{21 grams per day}$$

Average daily consumption rates for fish harvested from the vicinity of the Northeast Cape Installation by island residents were also derived from survey information obtained by Montgomery Watson and the USACE (Appendix C), and follow-up interviews. The 2001 survey results and follow-up interview with the Toolies provided information on local fish harvest rates and general consumption patterns. However, information on fish portion sizes consumed by adults and children were not available from this earlier survey/interview effort, and previous portions consumed were derived from the EPA (USEPA, 2002a). Results of the January 2003 survey provided more specific information regarding portions of fish consumed, as summarized in Table 3-8. Therefore, average daily fish consumption rates for use in estimating risks associated with subsistence fishing were calculated based on information obtained from the 2003 survey. As was the case for plant consumption rate estimates, there were certain limitations in the information obtained from the 2003 survey regarding subsistence fish consumption. Potential uncertainties related to the exposure estimates for subsistence food use are discussed further in Section 5.3.

As indicated in Table 3-8, fish fillets are the primary parts of fish consumed throughout the year. However, other fish parts (e.g., heads and eggs) are also consumed, primarily in the summer months. Non-fillet parts are consumed less frequently than fillets, and the portions consumed are less than for fillets. The August 2001 fish tissue sampling investigation included the collection of fish fillets, heads, eggs, and remains (Appendix B). Fish heads, eggs and remains were collected and analyzed to evaluate whether bioaccumulating chemicals may be higher in non-fillet parts of fish than in the fillets. However, an evaluation of fish tissue concentrations of bioaccumulating metals represented by mercury, PAHs represented by benzo(a)pyrene, and PCBs represented by Aroclor-1254, suggest that this is generally not the case. Mean concentrations of these bioaccumulating chemicals measured in fish heads, fillets, eggs, and remains were as follows:

	Mean Tissue Concentration (mg/kg – ww) [a,b]		
Fish Tissue [c]	Mercury	Benzo(a)pyrene	Aroclor-1254
Head	0.014 (+/-0.0029)	0.0024 (+/-0.0002)	0.023 (+/-0.009)
Fillet	0.019 (+/-0.0069)	0.0030 (+/-0.0010)	0.011 (+/-0.003)
Eggs	0.0052 (+/-0.0011)	0.0038 (+/-0.0029)	0.011 (+/-0.0038)
Remains	0.018 (+/-0.0045)	0.0003 (+/-0.0000)	0.011 (+/-0.0054)

[a] Mean concentration and standard deviation for fish tissues collected from Site 29 and ambient locations.
[b] One-half the reporting limit was assumed for non-detect results.
[c] Number of samples evaluated was as follows: head (n = 4), fillet (n = 13), eggs (n = 5), remains (n = 5).
Source: Montgomery Watson (2001d).

With the exception of a PCB (Aroclor-1254), in heads, concentrations of representative bioaccumulating chemicals detected in fish fillets appear to be approximately equal to concentrations in other tissues. Although fish heads may contain higher concentrations of Aroclor-1254 than fillets, heads comprise a much smaller portion of the subsistence fish diet (Table 3-8). Based on the above, fish fillet data were used exclusively in the HHRA to estimate potential human health risks associated with subsistence fish consumption. Potential uncertainties regarding the estimation of risks due to fish consumption are described in Section 5.0.

Using the information presented in Table 3-8, daily fish fillet consumption rates during the *summer* for fish harvested from the Northeast Cape Study Area were estimated for adults and children as follows:

Adult:

$$IR_{\text{Fish, summer - adult}} = \frac{2.5 \text{ meals}}{\text{week}} \times \frac{\text{week}}{7 \text{ days}} \times \frac{12 \text{ ounces}}{\text{meal}} \times \frac{28.3 \text{ grams}}{1 \text{ ounce}}$$

$$= 121 \text{ grams per day}$$

Child:

$$IR_{\text{Fish, summer – child}} = \frac{2.5 \text{ meals}}{\text{week}} \times \frac{\text{week}}{7 \text{ days}} \times \frac{6.7 \text{ ounces}}{\text{meal}} \times \frac{28.3 \text{ grams}}{1 \text{ ounce}}$$

$$= 68 \text{ grams per day}$$

Similarly, daily fish consumption rates during the *winter* for fish harvested from the Northeast Cape Study Area can be estimated for adults and children as follows.

Adult:

$$IR_{\text{Fish, winter – adult}} = \frac{2 \text{ meals}}{\text{week}} \times \frac{\text{week}}{7 \text{ days}} \times \frac{12 \text{ ounces}}{\text{meal}} \times \frac{28.3 \text{ grams}}{1 \text{ ounce}}$$

$$= 97 \text{ grams per day}$$

Child:

$$IR_{\text{Fish, winter - child}} = \frac{2 \text{ meals}}{\text{week}} \times \frac{\text{week}}{7 \text{ days}} \times \frac{6.7 \text{ounces}}{\text{meal}} \times \frac{28.3 \text{ grams}}{1 \text{ ounce}}$$

$$= 54 \text{ grams per day}$$

The *average daily* consumption of Northeast-Cape-derived fish over the *entire* year can be calculated for adults and children as follows:

Adult:

$$IR_{\text{Fish, annual avg - adult}} = \frac{(121 \text{ grams/day} \times 90 \text{ days}) + (97 \text{ grams/day} \times 275 \text{ days})}{365 \text{ days}}$$

$$= 103 \text{ grams per day}$$

Child:

$$IR_{\text{Fish, annual avg - child}} = \frac{(68 \text{ grams/day} \times 90 \text{ days}) + (54 \text{ grams/day} \times 275 \text{ days})}{365 \text{ days}}$$

$$= 57 \text{ grams per day}$$

Because the level of certainty in the survey results only allows two significant figures, average daily consumption rates for Northeast-Cape-derived fish were assumed as 103 grams per day and 57 grams per day for adults and children, respectively. These fish consumption rate estimates were used in the exposure dose and risk calculations for subsistence food users.

3.1.2.3 Toxicity Assessment

This section describes the toxicity assessment methodology for evaluating public health risks for the Northeast Cape Installation. The human health toxicity assessment methods were developed in accordance with ADEC (2000b) and USEPA (1989a) guidance.

Toxicity assessment involves a critical review and interpretation of toxicology data from epidemiological, clinical, animal, and *in vitro* studies. A review of toxicology data ideally determines both the nature of health effects associated with a particular chemical and the probability that a given dose of a chemical could result in an adverse health effect. Following are the primary sources of toxicity values that were used in the Tier II HHRA:

- IRIS Database (USEPA, 2003a).
- HEAST (USEPA, 1995a).
- National Center for Environmental Assessment (USEPA, 2003b).
- ATSDR Toxicology Profiles (ATSDR, 1990a, b, c)

Toxicology information important for quantitative risk assessment of long-term health effects is generally divided into the following two categories:

- Potential for carcinogenic health effects
- Potential for chronic noncarcinogenic, adverse health effects

3.1.2.3.1 Carcinogenic Effects of COPCs

The cancer slope factor (CSF) is the toxicity value used to quantitatively express the carcinogenic potential of cancer-causing constituents. The slope factor is expressed in units of milligrams per kilogram per day $(\text{mg/kg-day})^{-1}$ and represents the cancer risk per unit daily intake of a carcinogenic chemical. The CSF represents the upper 95 percent confidence interval of the slope of the dose response curve. The 95 percent upper confidence interval value assures a safety factor to protect the most sensitive receptors.

In cases where available carcinogenic toxicity values are presented as inhalation unit risks (expressed as the inverse of micrograms per cubic meter $(\mu g/m^3)^{-1}$) or drinking water unit risks (expressed as the inverse of micrograms per liter $(\mu g/L)^{-1}$), the following conversion method was used:

$$\text{Inhalation Slope Factor } (\text{mg/kg-day})^{-1} = \frac{\text{Air Unit Risk } (\mu g/m^3)^{-1} \times 70 \text{ kg} \times 10^3 \ \mu g/mg}{20 \ m^3/\text{day}}$$

$$\text{Oral Slope Factor } (\text{mg/kg-day})^{-1} = \frac{\text{Water Unit Risk } (\mu g/L)^{-1} \times 70 \text{ kg} \times 10^3 \ \mu g/mg}{2 \ L/\text{day}}$$

The following default assumptions (USEPA, 1991a) were incorporated as parameters for these equations:

- Body weight of 70 kilograms (kg).
- Inhalation rate of 20 cubic meters per day (m^3/day).
- Water ingestion rate of 2 liters per day (L/day).

When an absorption fraction of less than 1.0 is applied in deriving the unit risk, an additional conversion factor was necessary so that the slope factor was based on an administered dose. The standardized duration assumption for slope factors was continuous lifetime exposure.

3.1.2.3.2 Noncarcinogenic Effects of COPCs

The reference dose (RfD) is the toxicity value used to quantitatively express the potential for a chemical to produce chronic noncarcinogenic effects. The RfD is expressed in units of mg/kg-day and represents a daily intake of contaminant per kilogram of body weight that is not sufficient to cause the threshold effect of concern for the contaminant. Exposure doses that are above the RfD, the threshold dose for noncarcinogens, could potentially cause adverse health effects. Confidence in the RfD is subjective, based on EPA review groups and quality of the supporting database. Chemical-specific RfDs do not account for the potential effects of chemical mixtures.

RfDs are generally based on no observable adverse effect levels (NOAELs) derived from animal studies. When NOAEL values are unavailable, a lowest observable adverse effect level (LOAEL) is generally used. An uncertainty factor (UF) is typically incorporated into the RfD to reduce the numerical value, resulting in a more conservative toxicity value. UFs account for uncertainties associated with: (1) extrapolating dose-response data from animal studies to humans, (2) sensitive subpopulations within the human population, and (3) quality of laboratory studies and databases from which dose response information is derived. UFs are typically applied to NOAELs and LOAELs (USEPA, 1989a) as follows:

- A UF of up to 10 may be used to account for variations in the general population to protect sensitive subgroups (such as children and the elderly).
- A UF of 10 may be used when extrapolating from animals to humans to account for interspecies variability.
- A UF of 10 may be used when a NOAEL is derived from a subchronic, rather than a chronic, study.
- A UF of 10 may be used when the critical value is a LOAEL, to account for the uncertainty associated with extrapolation to a NOAEL value.

In addition to UFs, modifying factors (MFs) are often used in calculating RfDs. An MF ranging from 0 to 10 can be included to reflect a qualitative professional assessment of additional uncertainties in critical studies and available databases.

The equation for calculating an RfD is:

$$RfD = \frac{NOAEL \text{ or } LOAEL}{UF_1 \times UF_2 \ldots \times MF}$$

Where:

RfD	= Reference dose (mg/kg-day)
NOAEL	= No observed adverse effect level (mg/kg-day)
LOAEL	= Lowest observed adverse effect level (mg/kg-day)
UF_n	= Uncertainty factor
MF	= Modifying factor

3.1.2.3.3 Chemical-Specific Assumptions

Modeled exposure doses were compared to toxicity values obtained from the general toxicity information sources described above. Toxicity values used in the Tier II baseline HHRA for the Northeast Cape Installation are presented in Table 3-9. In some cases where toxicity values were unavailable for a specific chemical, surrogate toxicity values were obtained from chemicals with similar chemical structures and/or mechanisms of toxicity. A general description of the surrogate toxicity value approach was presented in Section 3.1.1.2. More detailed rationale for the selection of surrogate toxicity values for individual chemicals is provided in footnotes to Table 3-9.

Route-to-route extrapolations were used when toxicity values were not available for a given route of exposure. The most frequent route-to-route extrapolations were performed to derive dermal CSFs or RfDs from oral values, because dermal CSFs and RfDs are not typically available. However, route-to-route extrapolations were also perfomed when inhalation CSFs or RfDs were not available, and the toxicological information supports such extrapolation. Route-to-route extrapolations were performed as described in USEPA (2002c).

The toxicity assessment for the Northeast Cape Installation also included chemical-specific assumptions for COPCs requiring additional interpretation of the toxicological literature. These COPCs consist of PHCs, PCBs, and lead.

PHCs

Methods available for assessing risks from petroleum constituents include the following:

- Evaluating specific toxic indicator compounds of petroleum mixtures such as PAHs and benzene, toluene, ethylbenzene, and xylenes (BTEX).
- Interpreting toxicity information developed for neat petroleum products such as gasoline, jet fuel, or diesel.
- Interpreting toxicity values developed for petroleum components that are chemically and toxicologically representative of other components.

- Interpreting toxicity values developed for surrogate mixtures toxicologically similar to PHC mixtures to which human or ecological receptors are potentially exposed.

Although no universally accepted method is currently available for evaluating Tier II risks associated with exposures to petroleum mixtures, toxicity values have been developed for neat petroleum products and for surrogate petroleum fractions. ADEC has developed RfDs and reference for PHC ranges. The values published in *Guidance for Cleanup of Petroleum Contaminated Sites* (ADEC, 2000a) were used in evaluating potential health hazards associated with human exposures to GRO, DRO, and RRO.

Potential dermal exposures to DRO and RRO were not quantitatively evaluated in the Tier II HHRA due to uncertainties in extrapolating oral RfDs to the dermal route of administration. The potential uncertainties in not quantifying this pathway are further addressed in the uncertainty analysis (Section 5.0).

Petroleum indicator compounds, including BTEX and PAHs, were analyzed for during RIs at the Northeast Cape Installation. Assessing risks of these indicator compounds and risks of petroleum mixtures as described above could result in quantifying exposures for certain petroleum constituents twice. To avoid this potential overestimation, risks associated with indicator compounds were included in cumulative risk and hazard estimates for each site, while the health hazards associated with petroleum mixtures were evaluated and reported separately.

PCBs

In accordance with ADEC's *Risk Assessment Procedures Manual* (ADEC, 2000b) and the EPA's IRIS Database (USEPA, 2003a) toxicity classification, PCBs were evaluated based on non-congener-specific methods. Currently, there are no standard methods for analyzing PCB congeners in fish (USEPA, 1999b). In the absense of generally accepted methods for congener-specific analysis of fish tissue, the EPA recommends the continued use of total Aroclor chemical analysis of fish tissue when conducting HHRA for PCBs (USEPA, 1999b). It should be recognized that specific congeners of PCBs have varying degrees of environmental persistence and toxicity. Analysis of individual PCB congeners can be a useful method for identifying a source of PCB contamination through 'fingerprinting', and the relative percentage of highly toxic congeners. However, current USEPA methods for the evaluation of human health risks associated with PCBs are based on Aroclors, not specific PCB congeners. Consequently, exposures and risks associated with PCBs were evaluated in this HHRA based on sampling results for Aroclors. Additional uncertainties related to the evaluation of Aroclors versus individual PCB congeners are discussed in the uncertainty analysis (Section 5.0).

Lead

No CSF or RfD toxicity values are currently available for quantitatively evaluating potential human health impacts from exposures to lead in soils. The USEPA's RfD Work Group has concluded that there is no apparent threshold for lead-induced toxicity in humans; therefore, it is inappropriate to develop a RfD for this chemical (USEPA, 2003a; ATSDR, 2002). It should be noted, however, that lead is a natural element in soils and other environmental media. The EPA has developed several risk models based on modeled blood-lead concentrations to arrive at a generally accepted blood-lead criterion of 10 micrograms per deciliter (μg/dL). These models include the Integrated Exposure Uptake Biokinetic (IEUBK) Model for evaluating residential exposures to lead, and the Technical Review Workgroup for Lead Approach for Non-Residential Exposures to Lead (USEPA, 1996). Based on these models, the EPA has established a soil screening level of 400 mg/kg for lead in residential soil. Similarly, ADEC has established an ADEC Method Two Soil Cleanup Level of 400 mg/kg for residential soil, and a Table C Groundwater Cleanup Level of 0.015 mg/L (18 AAC 75.345). These models were used in quantitatively evaluating lead, as appropriate. Adjustments to input parameters for abiotic and biotic inputs to the IEUBK model were made in this HHERA to reflect the exposure parameters presented in Table 3-6.

Consistent with ADEC's *Cumulative Risk Guidance* (ADEC, 2002a), lead was not included in the cumulative risk calculations. Potential health effects associated with lead were evaluated separately from cumulative risk estimates.

3.1.2.4 Risk Characterization Methods

The Tier II human health risk characterization for the Northeast Cape Installation integrates results of exposure and toxicity assessments described in Sections 3.1.2.1, 3.1.2.2, and 3.1.2.3 to derive a quantitative and qualitative evaluation of potential risks to current and potential future human receptors. The methods used in the Tier II human health risk characterization are described below. Results of the Tier II baseline HHRA are presented in Section 4.1.

Estimated human exposure doses for each chemical were used to estimate chemical-specific and cumulative cancer risks, and non-cancer hazard quotients (HQ) and hazard indices (HI).

Risk of developing cancer from exposure to a carcinogenic chemical is estimated by multiplying the CSF by the exposure dose (USEPA, 1989a):

$$\text{ILCR (unitless)} = \text{CSF} \times \text{Dose}$$

Where:

ILCR = Incremental lifetime cancer risk (unitless)
CSF = Cancer slope factor $(\text{mg/kg-day})^{-1}$
Dose = Exposure dose (mg/kg-day)

Cancer risks from multiple COPCs are assumed to be additive and were summed to estimate a cumulative LCR for all carcinogenic site contaminants for each medium (e.g., soil, sediment, surface water, and groundwater).

The HQ describes the potential for site COPCs to produce noncarcinogenic effects. HQ is defined as the ratio of the exposure dose to the RfD (USEPA, 1989a):

$$\text{HQ (unitless)} = \frac{\text{Dose}}{\text{RfD}}$$

Where:

Dose = Exposure dose (mg/kg-day)
RfD = Reference dose (mg/kg-day)

An HQ greater than 1.0 indicates that the estimated exposure dose for that COPC may not be protective of noncarcinogenic health effects. An HQ of less than 1.0 suggests that noncarcinogenic health effects should not occur. Individual HQs for site COPCs were summed to produce a cumulative hazard estimate, termed the HI, for each medium. The HIs for various media were summed to calculate a total cumulative site HI. In cases where the cumulative HI exceeded 1.0, the HI was re-evaluated based on target organ effects and a maximum target organ-specific HI was reported. This procedure is consistent with USEPA (1989a) and ADEC (2002a) risk assessment guidance.

ADEC currently considers a cumulative cancer risk of 1.0 x 10^{-5} and noncancer HI of 1.0 as the point of departure for making risk management decisions concerning a site. Sites that were evaluated in the HHRA for the Northeast Cape Installation with associated cumulative cancer risk and noncancer HI estimates that exceed these criteria were proposed for further evaluation in the FS. For informational purposes, it should be noted that according to ADEC (AAC 75.325(h)) and USEPA (1991b), sites with a cumulative cancer risk estimate between 1.0 x 10^{-6} and 1.0 x 10^{-4}, and a noncancer HI of less than 1.0, may be appropriate for no further remedial action planned (NFRAP) following an evaluation of site-specific issues related to future land uses, technical feasibility of remediation, and related considerations. However, such a determination will only be made in the FS, as appropriate. It should be noted that all sites will be identified and discussed in the FS. Although all of the Northeast Cape Installation sites will be addressed in the FS, this does not mean that all sites will require remediation. Remedial measures may be required because unacceptable risk was demonstrated or because ARARs were exceeded. It should also be noted that the USACE's interpretation regarding the point of departure for cancer risk and noncancer HI is consistent with current EPA policy.

It was recognized that there is the potential to double-count exposure and risk, because in some instances exposure and risk were calculated two different ways based on the agreement by ADEC and the USACE to include the most conservative of the two results. Instances of this include:

- Calculation of ILCR or HI for PHCs using individual toxic indicator compounds of petroleum (e.g., BTEX and PAHs) and again using toxicity values for neat petroleum products and surrogate petroleum fractions.
- Calculation of ILCR or HI for soil and again for sediments at sites where sediments behave as soils (e.g., below standing water in ephemeral ponds).
- Calculation of ILCR or HI assuming drinking water consists 100 percent of site surface water, shallow subsurface water, or deep subsurface water.

To avoid double-counting risks attributable to PHCs and petroleum indicator compounds, as well as risks attributable to soil and sediment, the following were estimated individually:

- ILCR or HI from soil COPC except PHCs.

- ILCR or HI from soil PHCs.
- ILCR or HI from sediment COPC except PHCs.
- ILCR or HI from sediment PHCs.

The maximum ILCR or HI estimate from above was then added to the ILCR for other exposure pathways (e.g., potable water pathways and subsistence consumption of plants or fish) to derive a total cumulative ILCR or HI for a given site.

Although current seasonal residents of the Subsistence Fishing and Hunting Camp (Site 4) obtain potable water from the upper Suqitughneq River, there is the potential for future human receptors to use water derived from other permanent surface water bodies, shallow subsurface water, or deep subsurface water. In addition, subsistence plants and fish may be harvested from impacted areas of the Northeast Cape Installation (e.g., Site 28 and downsteam locations) or ambient areas of the island. Cumulative exposure and risk scenarios are described and evaluated on a site-specific basis in Section 4.1.

3.2 ECOLOGICAL RISK ASSESSMENT METHODS

Methods for assessing ecological risk for the Northeast Cape Installation are presented in this section. Ecological risk assessment methods were developed in accordance with the EPA's *Guidelines for Ecological Risk Assessment – Final* (USEPA, 1998b), and *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments – Interim Final* (USEPA, 1997c). In accordance with Alaska regulations (18 AAC 75) and ADEC's *Risk Assessment Procedures Manual* (ADEC, 2000b), the ERA included Tier I (screening) and Tier II (baseline) ecological assessments.

The Tier I ERA included comparisons of maximum analyte concentrations against protective, media-specific screening benchmarks. The Tier II baseline ERA involved a more detailed evaluation of ecological risk, including: (1) a "problem formulation phase," wherein biological resources are evaluated and assessment and measurement endpoints are selected, and (2) an "analysis phase," wherein exposures are quantified for representative ecological receptors. Results of this ERA will be considered in the FS during the evaluation of potential remedial response measures necessary to protect ecological habitats and receptors at the Northeast Cape Installation.

3.2.1 Tier I Screening

Tier I screening is a conservative approach designed to ensure that potential risks associated with site contaminants are not underestimated. Tier I ERA screening was conducted in accordance with state of Alaska regulations and ADEC's *Risk Assessment Procedures Manual* (ADEC, 2000b). The conservative Tier I approach is based on comparing contaminant concentrations to:

- Background concentrations, AND
- One-tenth the value of published ecological risk-based criteria.

Tier I screening included a comparison of maximum contaminant concentrations to background concentrations for inorganic chemicals, only. Methods for deriving site-specific background concentrations were previously described in Section 3.1.1.1. Contaminants in concentrations exceeding background concentrations were compared to media-specific ecological screening benchmarks in accordance with methods described in Section 3.3.2 of ADEC's *Risk Procedures Manual* (ADEC, 2000b). An exception to the standard ADEC ecological screening approach was comparison of maximum detected chemical concentrations to *one-tenth* the most protective screening criteria listed in 18 AAC 70 or 18 AAC 75.345. Ecological screening using one-tenth the benchmark concentration is not required by State of Alaska regulations and is highly protective (i.e, this practice results in the identification of more COPECs than screening based on the benchmark concentration itself). This approach tends to result in the identification of more COPECs than are likely to contribute to ecological impacts. However, the majority of COPECs so identified were excluded as risk drivers during the Tier II baseline ERA (refer to Section 4.0).

Screening benchmarks for ecological media include surface water and sediment standards listed in 18 AAC 70 and other information sources, including:

- ECOTOX thresholds listed in the EPA's Eco Updates
- AQUIRE database
- TERRETOX database
- PHYTOTOX database
- Screening Benchmarks for Ecological Risk Assessment (Oak Ridge National Laboratory)
- NOAA sediment guidelines
- National Ambient Water Quality Criteria for freshwater and marine sources
- EPA sediment quality criteria and sediment quality benchmarks
- EPA Hazardous Substances Database
- EPA IRIS

Although the above are listed as potential sources of ecological toxicity information in ADEC's *Risk Assessment Procedures Manual* (ADEC 2000b), some of these sources including IRIS (USEPA, 2003) were not used in the ERA for the Northeast Cape Installation. Tier I chemical of potential ecological concern (COPEC) screening criteria for soils, freshwater sediment, fresh and ephemeral surface water, and shallow subsurface water in potential communication with surface water are presented in Tables 3-10 through 3-13, respectively. Plant and fish tissue-based screening criteria are not generally available for ecological receptors. Therefore, Tier I ecological screening was not conducted for plant and fish tissue sampling results. All chemicals detected in plant and fish tissues were evaluated in the Tier II ERA.

Because screening benchmarks do not necessarily consider increased retention and risks associated with bioaccumulating chemicals, potential bioaccumulation was addressed on a case-by-case basis. The EPA has identified the following as persistent, bioaccumulating and toxic chemicals: aldrin/dieldrin, benzo(a)pyrene, chlordane, DDT/DDD/DDE, hexachlorobenzene, alky-lead, mercury and its compunds, mirex, octachlorostyrene, PCBs, dioxins/furans and taxaphene. These chemicals were analyzed for and, in some cases, detected in plant and fish tissues samples collected from the Northeast Cape Study Area. Because all plant and fish tissue sampling results were carried into the Tier II ERA exposure assessment, the above chemicals, when detected, were evaluated for their bioaccumulation potential through the use of chemical- and medium-specific bioconcentration factors (BCFs).

Chemicals exceeding Tier I ecological screening criteria were considered COPECs and were evaluated further in the Tier II ERA. Chemicals without risk-based benchmarks were screened based on toxicity information from surrogate chemicals to the extent appropriate. Others were retained as COPECs and were qualitatively addressed. Ecological Tier I Screening Tables are presented in Appendix G. Results of Tier I ecological screening are discussed in Section 4.1.

3.2.2 Tier II Baseline ERA - General

The Tier II baseline ERA consists of five steps:

1. Problem formulation
2. Exposure dose analysis
3. Ecological effects assessment
4. Risk characterization
5. Uncertainty analysis

The first four steps are discussed in detail in the following sections. The uncertainty analysis for the Northeast Cape Installation HHERA is presented in Section 5.0.

3.2.3 Tier II Baseline ERA - Problem Formulation

Problem formulation involves gaining a preliminary understanding how stressors, such as chemical contaminants, may impact ecological habitats and receptors. Problem formulation provides the foundation for the rest of the ERA. The following topics are considered:

- Potentially affected biological resources.
- Complete and incomplete exposure pathways between contaminant sources and receptors.
- Assessment and measurement endpoints that were used to evaluate potential effects of contaminants on ecological receptors.
- Indicator species selected as representative receptors.
- Indicator species not selected as representative receptors.

3.2.3.1 Potentially Affected Biological Resources

A summary of the biological resources that are present or potentially occurring at the Northeast Cape Installation is presented in this section. The information presented was summarized from the detailed site setting information provided in the Environmental Assessment (URS, 1985), Phase I RI Report (Montgomery Watson, 1995b), Phase II RI Report Addendum (Montgomery Watson, 2000a), and Preliminary CSM (USACHPPM, 2001). The island has been classified as consisting of "subarctic coastal plains" and "Seward Peninsula" ecoregions by the USGS Earth Resources Observation Systems (EROS) Data Center and the Alaska Department of Fish and Game (ADF&G) (Figure 3-2) (ADF&G, 2001a; USGS, 1997). For descriptions of these ecoregions as defined by USGS, please refer to Appendix A.

3.2.3.1.1 Vegetation

Northeast Cape area vegetation is classified as alpine tundra with many low-lying areas containing lakes, bogs, and poorly-drained soils. Alpine tundra vegetation is predominantly white mountain areas, and mat-forming herbs, grasses, and sedges. Shrubs include black crowberry, willows, and cassiopes. Low-lying areas typically contain vegetation classified as wet tundra, dominated by heaths, sedges, mosses, and lichens (URS, 1985). Several species of plants were collected from the Northeast Cape Installation during 2001 fieldwork and identified by a research botanist from the Alaska Natural Heritage Program (ANHP – ENRI, 2000). These plant species are listed in Table 3-14, with other plants potentially occurring on St. Lawrence Island; plant sampling locations are identified on Figure 2-2.

3.2.3.1.2 Birds

Several species of birds have been seen in the vicinity of the Northeast Cape Installation, including common ravens, snow bunting, tundra swans, Lapland longspurs, and sea gulls. Only one breeding population is documented: glaucous-winged gulls, which are located on Seevookhan Mountain. In addition, USACE biologists reported a flock of several dabbler ducks, possibly pintails, feeding in the shallow lake at the head of the Suqitughneq River during the August 2001 fish tissue sampling event (MWH, 2002a). Bird species present or potentially occurring at the Northeast Cape Installation are summarized in Table 3-15.

3.2.3.1.3 Fish

Ten primary fish species inhabit the streams and stream-fed lakes and ponds of the island, including Alaska blackfish, ninespined stickleback, Arctic grayling, Dolly Varden, and lake whitefish. Five of the six species of Pacific salmon also occur around the island (USACHPPM, 2001).

Results of fieldwork in 1999 and 2001 indicated that the Suqitughneq River, located within the Northeast Cape area, supports a viable fish population, including Dolly Varden, Alaska blackfish, ninespined stickleback, and sculpin (DOA, 2001). Fish tissue sampling locations from 2001 fieldwork are identified on Figure 2-4. Fish species present or potentially occurring in the vicinity of the Northeast Cape Installation are summarized in Table 3-16.

3.2.3.1.4 Shellfish

Shellfish and other aquatic invertebrate species occur in and around the Northeast Cape Installation; however, no shellfish were observed during biological sampling performed in 1999. Shellfish have a high potential for bio-uptake and bioaccumulation of COPECs, including PAHs and PCBs. Species of shellfish that occur or potentially occur in the vicinity of the Northeast Cape Installation are summarized in Table 3-17.

3.2.3.1.5 Terrestrial Mammals

Small terrestrial mammals are common at the Northeast Cape Installation, including cross fox, tundra shrew, Arctic ground squirrel, Greenland collared lemming, red-backed vole, and tundra vole (URS, 1985). While large mammals are not generally abundant on St. Lawrence Island, polar bears can be seen on the island year round, especially when the ice pack is near shore. Grizzly bears have been reported on the island but are rarely seen. Several hundred reindeer are herded on St. Lawrence Island; at times, these reindeer may feed in the Northeast Cape Installation. Large mammals contribute greatly to the subsistence diet of the island's human community (USDHHS, 2001). Terrestrial mammals present or potentially occurring at the Northeast Cape Installation are summarized in Table 3-18.

3.2.3.1.6 Marine Mammals

Marine mammals are present in the vicinity of the Northeast Cape Installation as seasonal migrants in the offshore and near-shore marine waters, at haul-out sites, and in association with the advancing and retreating pack ice. No haul-out areas are known within the Northeast Cape Installation. During the summer, walrus, Stellar's sea lions, and spotted seals may be present offshore. During the ice season, ringed seals, bearded seals, walrus, and spotted seals can be found in nearshore and offshore leads and open water. Whales seen near the Northeast Cape Installation include bowhead, gray, minke, killer, and beluga (USACHPPM, 2001; Montgomery Watson, 1999). Marine mammals present or potentially occurring in the Northeast Cape Installation are presented in Table 3-19.

3.2.3.1.7 Special Status Species

Several special status species are present and others could potentially occur in the vicinity of the Northeast Cape Installation; however, the extent of these species occurring in the immediate area of the Northeast Cape Installation is unknown (USACHPPM, 2001). Special status species present or potentially occurring in the vicinity of the Northeast Cape Installation are indicated in Tables 3-15 and 3-19.

Endangered species of whales that frequent the Bering Sea include blue, bowhead, fin and northern right whales (USKH, 1993). The prevalence of these animals in the vicinity of the Northeast Cape Installation is unknown. Some marine mammal species, such as polar bears, seasonally inhabit St. Lawrence Island and are protected under the Marine Mammal Protection Act. Alaska Natives are exempt from this act and are allowed to hunt marine mammals for subsistence purposes or handcrafts, as long as the population is not depleted and the animals are not wasted (Montgomery Watson, 1999).

3.2.3.2 Exposure Pathways

Simplified food webs were developed to help identify specific receptors that might be directly or indirectly exposed to COPECs and to perform the exposure assessment. A food web was constructed for each of the three primary ecosystem types present at the site: terrestrial (Figure 3-3), aquatic/wetland (Figure 3-4), and marine (Figure 3-5). These food webs show the major trophic levels present at Northeast Cape and the relationships between interconnecting patterns of consumption. Food webs depict how energy or contaminants may be transferred within an ecosystem.

3.2.3.3 Assessment and Measurement Endpoints

Assessment endpoints focus the ecological risk assessment on the guild or community that might be adversely affected by exposure to a COPEC. As defined in EPA's Guidelines for Ecological Risk Assessment (USEPA, 1998b), an assessment endpoint is an explicit expression of the environmental value that is to be protected (for example, growth, survival, and reproduction of a specific species population). A measurement endpoint is defined as a quantitative expression of an observed or measured effect of the hazard; that is, a measurable response to a stressor related to the ecological characteristic chosen as the assessment endpoint (USEPA, 1998b). Assessment and measurement endpoints selected for ecological receptors at the Northeast Cape Installation are described in the following subsections and summarized in Table 3-20.

3.2.3.3.1 Terrestrial Habitats

Contaminants at the Northeast Cape Installation may impact terrestrial vegetation. COPECs may enter plant tissues by root uptake of COPECs in soil and water, by air-to-plant transfer of COPECs in vapor form, and through diffusion of COPECs directly deposited on the leaves as dust. Revegetation has occurred significantly throughout most of the site (Montgomery Watson, 1999; Montgomery Watson, 2001c); however, the only screening benchmarks currently available for plants are based on unrelated species. Therefore, vegetation will not be quantitatively assessed in the ecological assessment, but will be qualitatively evaluated for potential adverse effects.

Terrestrial receptors inhabiting or foraging at the Northeast Cape Installation may be exposed to COPECs. Herbivorous mammals, such as voles and shrews, are likely to inhabit vegetated areas, including petroleum, oil, and lubricant (POL) spill areas and other potential sites. These species may serve as prey for higher trophic level carnivorous receptors, such as the cross fox, that use sites for foraging. Consequently, potential exposure of receptors from multiple trophic levels to site-related chemicals through food chain transfer is possible. These possible exposures and potential for impacts are reflected in the following assessment endpoints selected for terrestrial receptors:

- Protecting herbivorous terrestrial mammal populations from adverse effects of site-related COPECs on growth, survival, and reproduction.
- Protecting carnivorous terrestrial mammal populations from adverse effects of site-related COPECs on growth, survival, and reproduction.

Measurement endpoints used to evaluate the above assessment endpoint are concentrations of COPECs in abiotic and biotic media that are protective of growth, survival and reproduction necessary to sustain populations of herbivorous terrestrial mammals and carnivorous terrestrial mammals, as represented by calculated exposure doses for specific indicator receptors. Indicator receptors selected for evaluation in risk characterization are described in Section 3.2.3.4.2. The HQ approach is applied in evaluating the protectiveness of media concentrations and modeled exposure doses for each indicator receptor. Methods for calculating ecological HQs, and potential limitations and uncertainties in this approach, are described in Sections 3.2.5 and 5.5, respectively.

Measured plant tissue concentrations were used to calculate ecological HI values for herbivorous mammals at Site 28. Figure 2-2 shows plant tissue sampling locations at Site 28. For all other sites, and for carnivorous mammals, ecological HQs were based on modeled concentrations (refer to Section 3.2.2.2).

3.2.3.3.2 Aquatic/Wetland Habitats

Aquatic/wetland receptors may be exposed to site-derived COPECs. Constituents from various sites may leach into subsurface soil and groundwater, or migrate via surface runoff as dissolved or soil-borne forms to streams, ponds, and lakes. Once in these surface water bodies, COPECs can enter the aquatic food chain through uptake by aquatic and emergent plants and benthic invertebrates, organisms that may be used as food sources for fish, birds, and mammals. Because the primary COPECs for the Northeast Cape Installation (PHCs, PAHs, PCBs, and metals) tend to partition into sediments, benthic invertebrates and fish are particularly susceptible to uptake and impacts from these contaminants. Because PAHs and PCBs may bioaccumulate, higher trophic level piscivorous birds that forage in both marine and inland aquatic/wetland habitats are potentially sensitive to these chemicals. The following assessment endpoints were selected to account for the complex interrelationships among benthic communities, resident and anadromous fish, and piscivorous birds in aquatic/wetland habitats:

- Protecting aquatic/wetland benthic communities from adverse effects of site-related COPECs on diversity and abundance.
- Protecting populations of resident and anadromous fish from adverse effects of site-related COPECs on growth, survival, and reproduction.
- Protecting populations of piscivorous birds from adverse effects of site-related COPECs on growth, survival, and reproduction.

Measurement endpoints used in evaluating the above assessment endpoint for aquatic/wetland benthic communities are concentrations of COPECs in surface water and sediment that are protective of the diversity and abundance of aquatic/wetland benthic communities. The protectiveness of COPEC concentrations in aquatic media for aquatic/wetland assessment endpoints was evaluated through: (1) comparison of sediment COPEC concentrations to sediment benchmarks, and (2) results of sediment bioassays and benthic community surveys conducted by ENRI for the Northeast Cape Study Area (ENRI, 2000).

Measurement endpoints used in evaluating potential effects on resident and anadromous fish are concentrations of COPECs in abiotic and biotic media that are protective of the above assessment endpoint. The protectiveness of surface water concentrations for the indicated assessment endpoint was evaluated by comparing surface water COPEC concentrations to fresh surface water benchmarks. Although field investigations (ENRI, 2000; DOA, 2001) included collecting and analyzing resident and anadromous fish tissues for contaminant levels, the results provided a measure of exposure, not a measure of effect. Therefore, these data are of limited usefulness as measurement endpoints for fish. These data are potentially useful, however, in quantifying exposures and risks to higher trophic level organisms that may prey upon resident and anadromous fish at the Northeast Cape Installation. Consequently, fish tissue data was used in characterizing exposures and risks to piscivorous birds, as described below.

The measurement endpoints used in evaluating the assessment endpoint for piscivorous birds are concentrations of COPECs in abiotic and biotic media that are protective of growth, survival and reproduction necessary to sustain populations of piscivorous birds, as represented by calculated exposure doses. The HQ approach is applied in evaluating the protectiveness of media concentrations and modeled exposure doses, using COPEC concentrations measured in fish tissue samples collected from Site 28, or modeled aquatic biota concentrations for other sites. Figure 2-4 shows fish tissue sampling locations at the Northeast Cape Installation.

3.2.3.3.3 Marine Habitat

The Suqitughneq River drains into an estuary that interacts with the Bering Sea for most of the year. Site-related COPECs entering the Suqitughneq River as dissolved or sediment-sorbed forms can be taken up by marine plants and invertebrates in the estuary and near-shore areas of the Bering Sea. These organisms potentially provide food sources for marine fish, birds, and mammals. Because the primary COPECs for the Northeast Cape Installation (POLs, PAHs, PCBs, and metals) tend to partition into sediments, marine invertebrates are particularly susceptible to uptake and impacts from these contaminants. Consequently, the following assessment endpoint was selected for the marine habitat:

- Protection of marine invertebrate populations from adverse effects of site-related COPECs on growth and survival.

Measurement endpoints used in evaluating the above assessment endpoint are concentrations of COPECs in surface water and sediment that are protective of the growth and survival of marine invertebrate populations. The Suqitughneq River has been sampled to determine if any significant amounts of chemicals are present in the sediments or waters that could be transferred to the marine environment. The most recent sampling conducted included sediment samples collected from the Suqitughneq River Lagoon/Estuary (MWH, 2003a). Results of this sampling indicate sediments do not contain detectable levels of PCBs. Fish, including anadromous species, have been sampled rather than marine mammals because fish are directly exposed to potentially contaminated media at the Northeast Cape Installation. Furthermore, fish are exposed to site media during a very sensitive life stage (reproduction and early development). Therefore, anadromous fish are believed to be sentinel species for potential impacts to other marine organisms including marine mammals. If site-derived chemicals are detected in fish tissues at levels potentially harmful to other marine organisms that may consume them, the need to perform additional biomonitoring will be evaluated. Marine mammals were not monitored because (1) they are not anticipated to receive significant exposures to contaminants originating from the Northeast Cape Installation as described in Section 5.3, (2) it is not practical or feasible to monitor these species due to the time, expense and numbers of animals that would be required to obtain a statistically valid sampling population, (3) it would be difficult to attribute body burdens resulting from the Northeast Cape Installation to such wide-ranging species that accumulate contaminants from multiple possible sources including ubiquitous pollution in the oceans, and (4) methods are not currently available to correlate body burdens in marine mammals with a toxic response. Potential future biomonitoring would focus on possible impacts that can be directly related to the Northeast Cape Installation.

In addition to the above, it should be noted that the potential impacts of fish (which consume benthic invertebrates) on human receptors and ecological receptors (such as the glaucous-winged gull) were quantitatively evaluated in this HHERA as another "line of evidence" to evaluate potential food-chain transfers of contaminants through the marine ecosystem.

3.2.3.4 Indicator Receptors

Because evaluating all receptors inhabiting the Northeast Cape Installation ecosystem, or even all receptors representing an assessment endpoint, is not possible, three representative indicator species were selected for quantitative ERA evaluation.

3.2.3.4.1 Selection Criteria

Indicator receptors listed below were selected using the habitat-specific food webs and assessment and measurement endpoints previously described (ADEC, 1999), and the following factors (USEPA, 1998b):

- **Ecological Relevance** – Highly relevant receptors provide an important functional or structural aspect in the ecosystem. Attributes of highly relevant receptors typically fall under the categories of food, habitat, production, seed dispersal, pollination, and decomposition. Critical attributes include those that affect or determine the function or survival of a population.
- **Exposure Potential** – Receptors with high exposure potentials are those that, due to their metabolism, feeding habits and range, location, or reproductive strategy, tend to have higher potentials for exposure than other receptors.
- **Sensitivity** – Highly susceptible receptors include those with low tolerances to a COPC, and receptors with enhanced COPC susceptibility due to other contaminant stressors that may not be related to a COPC, such as reduced habitat availability. For example, a species that forages entirely within a contaminated site will be more exposed to a COPC and more sensitive.
- **Availability of Natural History Information** – Natural history information is essential to quantitatively evaluate risk to measurement receptors. If information such as body weight,

food, water, soil, and sediment ingestion rates was unavailable for the receptor, then another species was chosen, or estimates were made from taxonomically-related species.

- **Status** – Species designated as "threatened and endangered" or "priority for conservation and management" were given preference in selection as indicator receptors to ensure that potential risk to the most sensitive species was evaluated.

3.2.3.4.2 Selected Indicator Receptors

The three indicator receptors selected for the Northeast Cape Installation ERA consist of the tundra vole, cross fox, and glaucous-winged gull. Because these species are common, abundant natural history information is available. None of these species is threatened, endangered, or listed as a priority for conservation and management. Rationale used in selecting these species for analysis includes:

Tundra Vole – The tundra vole (*Microtus oeconomus*) is an herbivorous mammal found throughout Alaska. The tundra vole is present at, and ecologically relevant to, the Northeast Cape Installation because it is the staple food of several mammalian and avian species near the Northeast Cape Installation. Tundra voles do not hibernate and are active throughout the winter, resulting in increased exposure potential. ADEC suggested the use of the tundra vole as an indicator species for the Northwest ecoregion to assess the potential for significant adverse effects on terrestrial mammalian herbivore abundance and diversity (ADEC, 1999).

Cross Fox – The cross fox (*Vulpes vulpes*) is primarily carnivorous, preying on small mammals; voles are reportedly the preferred food of the cross fox (ADF&G, 2001b). Cross fox, abundant at the Northeast Cape Installation, may occasionally eat insects, fruits, berries, seeds, and nuts. The cross fox is non-migratory, stays active yearlong, and occupies an upper trophic level, resulting in high exposure potential.

Glaucous-Winged Gull – The glaucous-winged gull (*Larus glaucescens*) is an omnivorous avian species that forages in both inland streams and open ocean, preying on seaweed, salmon, and marine invertebrates such as barnacles, mollusks, and sea urchins (Zeiner et al., 1990). The glaucous-winged gull may also scavenge waste portions of slaughtered seals. Glaucous-winged gulls breed near the Northeast Cape Installation and may be used as a food source by subsistence hunters and gatherers (ADF&G, 1997). Because of its varied feeding habits, the glaucous-winged gull has high exposure potential and occupies both wetland/aquatic and marine food webs.

3.2.3.5 Species Not Selected as Assessment Endpoints or Indicator Receptors

Several ecologically important species were considered but ultimately rejected as assessment endpoints or indicator receptors because they failed to meet the selection criteria specified in Section 3.2.2.1.4, or because other species were considered more relevant or appropriate for the ERA. Species not selected as assessment endpoints or indicator receptors are discussed below.

Reindeer. Reindeer, which feed occasionally at the Northeast Cape Installation, comprise an important dietary source for St. Lawrence Island human inhabitants. Although reindeer use the

Northeast Cape Installation on occasion, they did not meet the potential selection criterion because:

- Reindeer reportedly prefer the upland areas of the Northeast Cape Installation rather than tundra wetland.
- Reindeer have wide foraging ranges throughout St. Lawrence Island, limiting exposure to site COPECs.

Furthermore, results of the ATSDR study indicated that reindeer exposures to site-related contaminants are low. The cross fox represents a more highly exposed terrestrial mammal because it has a smaller home range than reindeer and, as a carnivore, is at a higher trophic level. Therefore, the reindeer was not selected as an indicator receptor.

Waterfowl. Waterfowl reportedly use lakes and streams at the Northeast Cape Installation. Unconfirmed sightings of unidentified juvenile waterfowl were made at the Suqitughneq River and nearby wetlands during the 2001 field investigation. Island residents report that waterfowl breed in some of the large lakes on the island during the spring, but not in the Suqitughneq River drainage. Although they may be exposed to COPECs derived from sites, waterfowl did not meet the potential selection criterion because:

- Waterfowl are migratory and are present at the Northeast Cape Installation for only brief portions of the year.
- Waterfowl have wide foraging ranges and are anticipated to use the Norheast Cape Installation on a highly infrequent basis.
- Females typically feed very little while nesting, which limits exposures to site COPECs, such as PCBs, that may affect reproduction.

In addition, it is unlikely that there are significant populations of breeding freshwater waterfowl (such as Canada geese or mallards) exposed to freshwater surface water bodies at the Northeast Cape Installation. This is evidenced by the fact that residents of Savoonga are not reported to harvest eggs from such species, but do harvest significant numbers of eggs from marine species, including the common murre (*Uria aalge*). Because the common murre forages in the open marine environment, this species is unlikely to be exposed at levels comparable to potential exposure levels of the glaucous-winged gull.

Waterfowl are anticipated to have lower exposures to bioaccumulating COPECs, including PAHs and PCBs, than piscivorous birds such as the glaucous-winged gull; therefore, potential for site COPECs to impact waterfowl was not selected as a measurement endpoint for aquatic/wetland habitats and no waterfowl species were selected as indicator receptors.

Marine Fish. Marine fish may be exposed to COPECs migrating to the estuary and near-shore areas. However, marine fish did not meet the exposure potential criterion because they were anticipated to have much lower exposures than resident and anadromous fish using the Suqitughneq River for foraging and/or breeding. Therefore, potential for site COPECs to impact marine fish was not selected as a measurement endpoint for the marine habitat, and no marine fish species were selected as indicator receptors.

Marine Birds. Marine birds such as the common murre and least auklet (*Aethia pusilla*) spend the bulk of their lives foraging in open ocean water. Marine birds did not meet the exposure potential criterion because they are exposed less frequently to site-related COPECs than species such as the glaucous-winged gull that forage in both nearshore and inland areas. Therefore, potential for site COPECs to impact marine birds was not selected as a measurement endpoint for the marine habitat, and no marine bird species were selected as indicator receptors.

Marine Mammals. Marine mammals, including seals, walruses, and polar bears, may be exposed to bioaccumulating contaminants in the marine food chain. However, marine mammals did not meet the potential selection criterion because:

- Marine mammals are migratory and are present near the Northeast Cape Installation for only brief portions of the year.
- Marine mammals have wide foraging ranges and do not use the marine environment adjacent to the Northeast Cape Installation exclusively.

Furthermore, given the migratory patterns and wide foraging ranges of marine mammals, it would be extremely difficult to attribute potential effects in such species to the Northeast Cape Installation COPECs. Therefore, the potential for COPECs derived from the Northeast Cape Installation to impact marine mammals was not selected as a measurement endpoint for the marine habitat, and no marine mammal species were selected as indicator receptors.

3.2.4 Tier II Basline ERA – Exposure Dose Analysis

Exposure dose analysis uses statistical methods to determine or predict ecological responses to stressors under exposure conditions of interest (USEPA, 1998b). The following information is used to estimate the relationship between stressor(s) and response(s):

- Exposure pathways and routes.
- Exposure point concentrations.
- Exposure dose calculations.

3.2.4.1 Exposure Pathways and Routes

All potential exposure pathways for indicator receptors present or potentially occurring at the Northeast Cape Installation were evaluated, and potentially complete exposure pathways were identified. Food web diagrams aided in this evaluation. Complete exposure pathways for indicator receptors to be evaluated in the risk characterization for Northeast Cape Installation are shown on Figure 3-6. Complete and potentially complete exposure pathways and routes for terrestrial and aquatic/marine species are listed below.

For terrestrial species:

- Uptake through food chain transfer of chemicals in soil, surface water, or sediment.

- Direct exposure to contaminants in soil, surface water, or sediment through incidental ingestion and dermal contact.

For aquatic/marine species:

- Uptake through food chain transfer of chemicals in surface water and sediment.
- Direct exposure to contaminants in surface water and sediment through incidental ingestion and dermal contact.

Inhalation exposures were not quantified in the Tier II ERA due to lack of toxicity data and exposure information for this pathway. In addition, dermal exposure estimates were not quantified for indicator receptors. Dermal exposures are qualitatively, rather than quantitatively, evaluated for ecological receptors due to the uncertainties in quantifying this pathway. Although algorithms exist for evaluating this route of exposure, the lack of toxicity information for quantifying the exposures and for estimating the probability of toxicological effects limits the reliability of such calculations. The uncertainties associated with not quantitatively evaluating this pathway are described in Section 5.3.

3.2.4.2 Exposure Point Concentrations

EPC is the concentration of a COPEC at the point of contact with a receptor. EPCs for biotic and abiotic media were calculated to evaluate exposures to COPECs through food uptake and contact, respectively. Methods used in the derivation of EPCs for use in evaluating potential impacts of COPECs on ecological receptors are the same as those previously described for human health (refer to Section 3.1.2.2.1). EPCs for all media and sites are presented in Appendix I.

3.2.4.3 Exposure Dose Calculation

Exposure dose calculation consolidates exposure pathways and routes, EPCs, and exposure parameters into an equation that provides an exposure dose estimate in units of mg/kg-day.

Ingestion dose estimates were calculated using the following general equations derived from the EPA's *Wildlife Exposure Factors Handbook* (USEPA, 1993):

$$\text{Dose}_{\text{Ingestion}} = \frac{[(IR_{\text{Biotic}} \times C_{\text{Biotic}}) + (IR_{\text{Abiotic}} \times EPC_{\text{Abiotic}})] \times ED \times SUF \times UC}{BW}$$

Where:

$\text{Dose}_{\text{Ingestion}}$	= Estimated exposure dose from ingestion of food and ingestion of abiotic media (mg/kg-day)
IR_{Biotic}	= Food ingestion rate (mg/day)
C_{Biotic}	= Average concentration of COPEC in food items (mg/kg)
IR_{Abiotic}	= Abiotic media ingestion rate (mg/day)
EPC_{Abiotic}	= Concentration of COPEC in abiotic media (mg/kg) (referred to as C_{SOIL} below)
ED	= Exposure duration (unitless)

SUF = Site utilization factor (unitless)
UC = Unit conversion 10^{-6} kg/mg
BW = Body weight (kg)

Exposure parameters required for calculating estimated exposure doses include the following:

- Biotic and abiotic media ingestion rates
- Average concentrations of COPECs in food items and in abiotic media
- Exposure duration (time in a year that a receptor is exposed to site COPECs)
- Site utilization factor (the area of contamination in relation to the receptor's home range)
- Body weight

Exposure parameters were obtained from the following sources:

- Wildlife Notebook Series (ADF&G, 2001b)
- Museum of Zoology (UM, 2000)
- Field Guide to North American Mammals (NAS, 1996)
- Wildlife Exposure Factors Handbook (USEPA, 1993)
- CRC Handbook of Avian Body Masses (Dunning, 1993)
- California's Wildlife Volume II: Birds (Zeiner, 1990)

Assumptions used for these exposure parameters are presented in Table 3-21. Exposure dose equation parameters are defined in the following subsections.

3.2.4.3.1 Biotic Media Ingestion Rates

Food ingestion rates (IR) for each indicator receptor were calculated using allometric equations provided by the EPA handbook (USEPA, 1993). The equations are based on established relationships between body size and metabolic requirements. Food ingestion rates expressed in grams of food per day (g/day) were calculated based on the following equations provided in the EPA handbook (USEPA, 1993): Equation 3-9 for the tundra vole, Equation 3-6 for the glaucous-winged gull, and Equation 3-7 for the cross fox. These equations are summarized in Appendix D.

3.2.4.3.2 Abiotic Media Ingestion Rates

Abiotic media ingestion rates were derived from the EPA handbook (USEPA, 1993). Abiotic ingestion rates are available for the cross fox, but abiotic ingestion rates for other indicator receptors were estimated using values for similar species: values for the meadow vole were used for the tundra vole and values for the semipalmated sandpiper were used for the glaucous-winged gull. The percent soil/sediment ingestion rate was multiplied by the food ingestion rate for each species to determine exposure to soil or sediment through the ingestion pathway.

3.2.4.3.3 *Average Concentrations of COPECs in Food Items*

Food items include terrestrial plant tissues and herbivorous prey tissues. For sites other than Site 28 (where plant tissue concentrations were measured), estimating contaminant concentrations in plants is necessary for evaluating exposures to terrestrial indicator receptors. Estimating EPCs in plant and animal tissues were based on guidance in *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA, 1999c). The media transfer and exposure dose equations presented are generic in nature, and are not specific to products of combustion (e.g., oxidized chemicals). A variety of chemical classes are listed that these methods are applicable to; these chemical classes are representative of the contaminant types present at the Northeast Cape Installation.

At Site 28, plant tissue samples were collected and analyzed for tissue concentrations of metals, PCBs and PAHs. These data were used in the quantitative estimation of exposure and risk for the tundra vole, and to model concentrations in herbivorous prey for the cross fox, at Site 28. Although plant and animal tissue sampling at additional sites would have significantly reduced the uncertainty in the ecological exposure and risk assessments for these sites, such sampling was not feasible to conduct on a broad scale. For sites other than Site 28, tissue concentrations in plants and herbivorous mammals were modeled based on soil concentrations, as described in the following subsections.

Fish tissue sampling data collected at Site 28 were also used to quantify dietary exposure doses and risks for the glaucous-winged gull. At all other sites where fresh surface water was present, concentrations of COPECs in aquatic life consumed by the gull were modeled from sampling results for abiotic media.

Contaminant Concentration in Terrestrial Plant Tissues

For the ecological assessment, COPEC concentrations in terrestrial plants (C_{PLANTS}) were assumed to equal plant concentrations due to root uptake (Pr). The equation used to compute COPEC concentrations in terrestrial plants due to root uptake is:

$$C_{PLANTS} = 0.12 \times Pr$$

Where:

C_{PLANTS} = Total COPEC concentration in the plant (mg COPEC/kg wet tissue).
Pr = Concentration of COPEC in the plant due to root uptake (mg/kg dry tissue)
0.12 = Converts from dry tissue concentration to wet tissue concentration (USEPA, 1999c)

The concentration taken up by the roots is calculated by:

$$Pr = C_{SOIL} \times BCF_{S\text{-}P}$$

Where:

Pr = COPEC concentration in plant due to root uptake (mg/kg tissue)
C_{SOIL} = COPEC concentration in soil (mg/kg dry soil)
$BCF_{S\text{-}P}$ = Soil-to-terrestrial plant bioconcentration factor (kg dry soil/kg wet or dry tissue)

BCFs for metals were obtained from EPA (USEPA, 1999c). BCFs for organic compounds were estimated using the following equation from Travis and Arms (1988):

$$\log BCF_{S\text{-}P} = 1.588 - 0.578 \times \log Kow$$

Where:

$BCF_{S\text{-}P}$ = Soil-to-terrestrial plant BCF (mg COPEC/kg wet tissue)/(mg COPEC/kg dry soil or sediment)

Kow = Octanol-water partition coefficient (unitless)

Contaminant Concentrations in Herbivorous Prey Tissues

The food chain model for indicator receptors considers one herbivorous prey species, the tundra vole. COPEC concentrations in herbivores depend on ingestion of abiotic media and plant matter. The equation for calculating COPEC concentrations in herbivores is:

$$C_{HERB} = C_{PLANT} \times BCF_{TL2/TL1} + C_{SOIL} \times BCF_{S\text{-}H}$$

Where:

C_{HERB} = COPEC concentration in herbivore (mg/kg wet tissue)

C_{PLANT} = Total COPEC concentration in the plant (mg COPEC/kg wet tissue)

$BCF_{TL2/TL1}$ = Plant-to-herbivore BCF (kg wet plant tissue/kg wet herbivore tissue)

C_{SOIL} = COPEC concentration in soil (mg/kg dry soil or dry sediment)

$BCF_{S\text{-}H}$ = BCF for soil-to-herbivore (kg dry media/kg wet tissue)

Bioconcentration Factors

BCFs for estimating mammal and bird COPEC exposure by abiotic media ingestion and COPEC exposure by plant ingestion ($BCF_{TL2/TL1}$, $BCF_{TL3/TL1}$) were computed from biotransfer factors for beef cattle. Biotransfer factors for organic COPECs were calculated according to Travis and Arms (1998) and biotransfer factors for inorganic COPECs were estimated values taken from Baes et al. (1984). Media-to-wildlife and plant-to-herbivore/omnivore BCFs were computed for each mammal or bird consumer by:

$$BCF_{M\text{-}W} = Ba \times IR$$

Where:

$BCF_{M\text{-}W}$ = Media and plant-to-wildlife BCF (L water/kg wet tissue or kg media/kg wet tissue or kg wet plant tissue/kg wet tissue)

Ba = Biotransfer factor (day/kg wet tissue)

IR = Mammal or bird ingestion rate (kg food or media/day)

Biotransfer factors for metals were estimated from literature values by Baes et al. (1984) based on wet feed-to-cattle; these values can be used directly in the above equation. Biotransfer factors for organics were calculated using EPA guidance (USEPA, 1999c):

For mammals:

$$\log Ba_{mammal} = -7.6 + \log Kow$$

Where:

Ba_{mammal} = Biotransfer factor for mammals (day/kg wet tissue)
Kow = Octanol/water partition coefficient (unitless)

For birds:

$$Ba_{bird} = 0.8 \times Ba_{mammal}$$

Where:

Ba_{bird} = Biotransfer factor for birds (day/kg wet tissue)
Ba_{mammal} = Biotransfer factor for mammals (day/kg wet tissue)
0.8 = Bird and mammal fat content ratio

BCFs used in this ERA are presented in Table 3-22.

Biomagnification Factors

Biomagnification involves the transfer of a chemical in food through successive trophic levels. Exposure assessment uses food chain multiplier (FCM) ratios to estimate biomagnification factors (BMF) when TL3 species ingest TL2 food sources and when TL4 species (such as the cross fox) ingest TL2 and TL3 food sources. BMF equals the FCM of the measurement receptor divided by the FCM of the prey. For example:

$$BMF_{TL3/TL2} = FCM_{TL3} / FCM_{TL2}$$

FCMs were derived from values provided in EPA (USEPA, 1999c); these values were estimated for organics from the octanol-water partition coefficient (Kow). In accordance with this guidance, COPECs with a log Kow less than 2 were conservatively estimated to have an FCM of 1. FCMs for metals were assumed as 1 based on literature review and EPA (USEPA, 1997c).

FCMs for VOCs and PAHs were also assumed as 1 based on the observation that these chemicals do not tend to biomagnify in the environment (Eisler, 1987; Suedel et. al., 1994). Although VOCs are soluble in water and may be taken up by plant roots, this characteristic also promotes metabolism and evapotranspiration of VOCs by plants (Dietz and Schnoor, 2001; Shang et. al., 2001). This characteristic has been used to facilitate phytoremediation of VOC-contaminated soil and shallow groundwater (Chappel, 1998; Dietz and Schnoor, 2001; Shang et. al., 2001). In the event that residual VOCs in plant matter *are* consumed by terrestrial organisms, they are not anticipated to bioamagnify in the food chain. VOCs of petroleum origin are readily metabolized and eliminated by animals (ATSDR, 1989, 1990a, 1990b; USAF, 1989); hence, bioamagnification factors between subsequent trophic levels are anticipated to be less than 1.

In contrast to VOCs, PAHs have a tendency to be sequestered in soils (Manilal and Alexander, 1991) and are only poorly taken up by plants and animals (Kaplan et. al., 1996; Reeves et. al., 2001). Uptake of PAHs from petroleum-contaminated soils is further decreased with aging of the hydrocarbons. Studies have shown that aged PHCs have lower uptake in plants and earthworms, and are less toxic, than fresh PHCs (Reeves et. al., 2001). Biodegradation and sorption to soil are believed to be key factors in the reduced bioavailability of aged PHCs (Tang et. al., 1998; Reeves et. al., 2001). Once absorbed by animals, PAHs are subject to metabolism, primarily through the mixed function oxygenase (MFO) system (ATSDR, 1990c; Eisler, 1987). Conversion to metabolites of higher water solubility, followed by excretion, is the primary means of PAH elimination (ATSDR, 1990c; Eisler, 1987); even in lower life forms such as isopods (van Brummelen and van Straalen, 1996). An investigation of PAH residues in the livers of kangaroo rats inhabiting an oil well field where an oil well blowout occurred, showed no significant incorporation of PAHs into liver tissues when compared to controls (Kaplan et. al., 1996). Additional chemicals for which low bioavailability has been demonstarted due to sequestration in soil organic matter or microsites include PCBs, dioxins/furans and chlorinated pesticides (Umbreit et. al., 1986; Tang et. al., 1999; and Tannenbaum, 2003).

Based on the above observations, FCM and BMF values equal to 1.0 for VOCs and PAHs are assumed to be protective. Equations for estimating COPEC concentrations in ecological indicator receptors are summarized in Appendix D.

Chemical bioavailability was not considered in the above methods of estimating intermediate and upper trophic level exposures. FCMs for chemicals not described above were obtained from values provided in EPA (USEPA, 1999c). A number of inorganic chemicals have bioavailability factors less than 1, indicating that the absorbed dose is substantially lower than the administered dose. For example, bioactive arsenic occurs only in the organic form once it is present in animal tissues. Bioavailability factors were considered, as appropriate, in quantifying ecological exposures (see Table 3-22).

3.2.4.3.4 Exposure Duration

Exposure duration is the fraction of the year that a receptor is likely to spend utilizing a site. Exposure duration is a function of migration and/or hibernation potential. The exposure duration for the tundra vole and the cross fox equals 1.0 because these species do not migrate and are active yearlong. The exposure duration for the glaucous-winged gull equals 0.5 because most members of the glaucous-winged gull population at the Northeast Cape Installation reportedly migrate and are absent from St. Lawrence Island between October and March.

3.2.4.3.5 Site Utilization Factor

Site utilization factor (SUF) describes the area of contamination that a receptor potentially contacts relative to its home range. Home range is the area of habitat required by an ecological receptor to meet its dietary needs. Home range values were obtained from a variety of sources; in instances when multiple home range areas were reported, the average of all reported values was used.

Comparing a receptor's home range to the areal extent of site contamination determines the relative amount of potentially contaminated diet to which the receptor is exposed. SUF is calculated as the ratio of the area of contamination to a receptor's home range. When the receptor's home range is greater than the area of contamination, the SUF is less than 1. When a receptor's home range is less than or equal to the area of contamination, the SUF is equal to 1. SUF values were calculated for each site as the quotient of the site area to the receptor's home range. Where more than one site occurs within a receptor's home range and it is logical to group them due to proximity, habitat quality, source type and foraging range, the SUF was calculated based on site groupings. Sites evaluated as site groupings included Sites 3 and 4, Sites 6 and 7, Sites 28 and 29, and Sites 33 and 34. In such cases, COPEC concentrations across the sites were combined, and each receptor's SUF was increased to reflect the combined exposure area. This practice is highly protective in cases where a chemical occurs in only one of the sites included in the grouping; particularly, if the EPC is based on the maximum detected concentration. Effects of site grouping on ecological hazard estimates, and potential uncertainties related to this approach are discussed in Section 5.3.

EPCs and exposure doses for ecological receptors did not include contributions from chemicals in biotic and abiotic media from non-contaminated areas. Contributions of chemicals from non-contaminated areas were not included in the exposure estimate because (1) non-contaminated areas other than specific ambient sampling locations were not sampled, and (2) ecological HQ estimates were intended to represent incremental hazards above ambient exposures.

3.2.4.3.6 Body Weight

The average body weights for both males and females were used for each indicator receptor.

3.2.5 Tier II Baseline ERA – Ecological Effects Assessment

Tier II ecological effects assessment describes how toxicity information was used in characterizing ecological risks. Ecological effects assessment requires using ecological toxicity reference values (TRV) obtained from literature. Two types of ecological TRVs were used: 1) media-based TRVs for organisms inhabiting soil, sediment, and surface water; and 2) dietary-based TRVs for upper trophic level receptors (carnivorous indicator receptors such as the cross fox).

Sources of media-based TRVs include NOAA sediment quality guidelines (NOAA, 2000), and National Ambient Water Quality Criteria for freshwater and marine sources (USEPA, various dates).

Sources of dietary exposure-based TRVs include:

- Ecological Soil Screening Levels Guidance (USEPA, 2000b)
- Screening Level Ecological Risk Assessment Guidance for Hazardous Waste Facilities (USEPA, 1999c)
- Toxicological Benchmarks for Wildlife (USDOE, 1996)
- Great Lakes Water Quality Initiative Documents for the Protection of Wildlife (USEPA, 1995b).

Ecological hazards for PHCs were evaluated based on the use of sampling results for specific indicator chemicals (e.g., BTEX, PAHs). Although ADEC has developed RfDs for individual PHC fractions, these toxicity values were developed based on the protection of human health. Therefore, they will not be used to evaluate ecological receptors. In addition to the evaluation of indicator chemicals, as described above, potential impact of PHC mixtures (such as DRO) were evaluated through the use of TRVs for surrogate compounds (e.g., naphthalene).

Ecological TRVs for mammalian indicator receptors (tundra vole and cross fox) are presented in Table 3-23. Ecological TRVs for avian indicator receptors (glaucous-winged gull) are presented in Table 3-24.

3.2.6 Tier II Baseline ERA – Risk Characterization

Ecological risk characterization integrates results of the exposure dose analysis and effect assessment described in Section 3.2.4 and 3.2.5, respectively. Estimated exposure doses for each chemical and indicator receptor were compared to ecological TRVs to calculate a chemical-specific HQ for each site. The equation for calculating HQ is:

$$HQ = \frac{Dose}{TRV}$$

Where:

HQ	=	Hazard quotient (unitless)
Dose	=	Modeled exposure dose for indicator species (mg/kg-day)
TRV	=	Toxicity reference value for the indicator species (mg/kg-day)

The HQ value scheme is derived from toxicity testing in an aquatic framework and a high HQ may not necessarily mean that representative ecological receptors are experiencing adverse health effects. For example, the TRVs that were used in this ERA are NOAEL-based. Therefore, environmental exposures higher than the TRV may be without adverse effect. Additional limitations and uncertaintes in the HQ approach are described in Section 5.5.

HQ values exceeding 1.0 are generally considered to be indicative of potential biological or ecological effects on representative receptors. HQ values above 1 do not necessarily indicate that a biological or ecological effect will occur, only that a lower threshold has been exceeded (Menzie et al., 1992). Evaluating the significance of HQ values was conducted in a manner generally consistent with Menzie et al. (1992):

- HQ less than 1.0: no adverse effects on representative receptors
- HQ between 1.0 and 10: limited potential for adverse effects on representative receptors
- HQ between 10 and 100: potentially adverse effects on representative receptors
- HQ exceeds 100: significant potential for adverse effects on representative receptors

Note that these HQ ranges and anticipated outcomes are only guidelines. Site-specific factors such as spatial distribution and detection frequency of COPECs, uncertainty of assumptions used in exposure determination, and study endpoint used to determine toxicity benchmarks were considered when reviewing specific HQs.

The ADEC risk management level is set at an ecological HQ of 1.0. Consistent with ADEC guidance (ADEC, 2002a), chemicals and sites associated with ecological HQ estimates greater than 1.0 are retained for further evaluation. Further evaluation of sites with ecological HQ estimates in excess of 1.0 will be conducted during the FS stage of the RI/FS process for the Northeast Cape Installation. Potential options considered for such sites may include but not be limited to ecological field validation studies, additional investigations of ambient conditions, or remedial options. Sites where HQ values are less than 1.0 for all receptors were proposed for NFA in regard to ecological concerns. Similarly, if no chemicals of ecological concern are retained from Tier II refinement assessments, NFA was proposed in regard to ecological concerns.

LEGEND

- Red arrow: Complete Exposure Pathway
- Black arrow: Potentially Complete but Insignificant Pathway
- Dashed arrow: Incomplete Pathway
- ○ (white box): Insignificant or Incomplete Exposure Pathway
- ● (pink box): Complete Exposure Pathway

Pink boxes:
Indicate a complete exposure pathway

White boxes:
Indicate an insignificant or incomplete exposure pathway

NOTE:

[a] This pathway is considered insignificant due to the following:
(1) NEC is covered by snow much of the year
(2) Precipitation and cold temperatures minimize volatilization
(3) Soils at most of the sites have revegetated and there is very little opportunity for particulate emissions

Primary Sources	Release Mechanisms	Secondary Sources	Exposure Routes	Potential Receptors – Human: Seasonal Resident – Current	Seasonal Resident – Future	Future Permanent Resident	Incidental Visitor – Current	Incidental Visitor – Future
COPCs	Volatilization/Wind Blown Dust	Ambient Air	Uptake by Plants[a]	○	○	○	○	○
			Dermal Contact[a]	○	○	○	○	○
			Direct Inhalation[a]	○	○	○	○	○
	Spills/Leaks	Soils	Uptake by Plants	●	●	●	○	○
			Uptake by Animals	●	●	●	○	○
			Ingestion/Incidental Ingestion	●	●	●	●	●
			Dermal Contact	●	●	●	●	●
			Indoor Dust Inhalation	●	●	●	●	●
		Sediment	Dermal Contact	●	●	●	●	●
			Uptake by Fish	●	●	●	○	○
			Ingestion/Incidental Ingestion	●	●	●	●	●
			Indoor Dust Inhalation	●	●	●	●	●
	Surface Water Runoff	Surface Water (Lakes/Streams/Wetland)	Volatilization/Inhalation	●	●	●	●	●
			Dermal Contact/Exposure	●	●	●	●	●
			Uptake by Fish	●	●	●	○	○
			Uptake by Plants	●	●	●	○	○
			Ingestion/Incidental Ingestion	●	●	●	●	●
	Infiltration/Percolation	Groundwater	Volatilization/Inhalation	○	●	●	○	●
			Ingestion/Incidental Ingestion	○	●	●	○	●
			Dermal Contact	○	●	●	○	●
		Surface Water (Marine)	Uptake by Plants	○	○	○	○	○
			Uptake by Fish	●	●	●	○	○
			Ingestion/Incidental Ingestion	○	○	○	○	○
			Dermal Contact	○	○	○	○	○
			Volatilization/Inhalation	○	○	○	○	○

U.S. ARMY CORPS OF ENGINEERS

PROJECT: Northeast Cape Risk Assessment

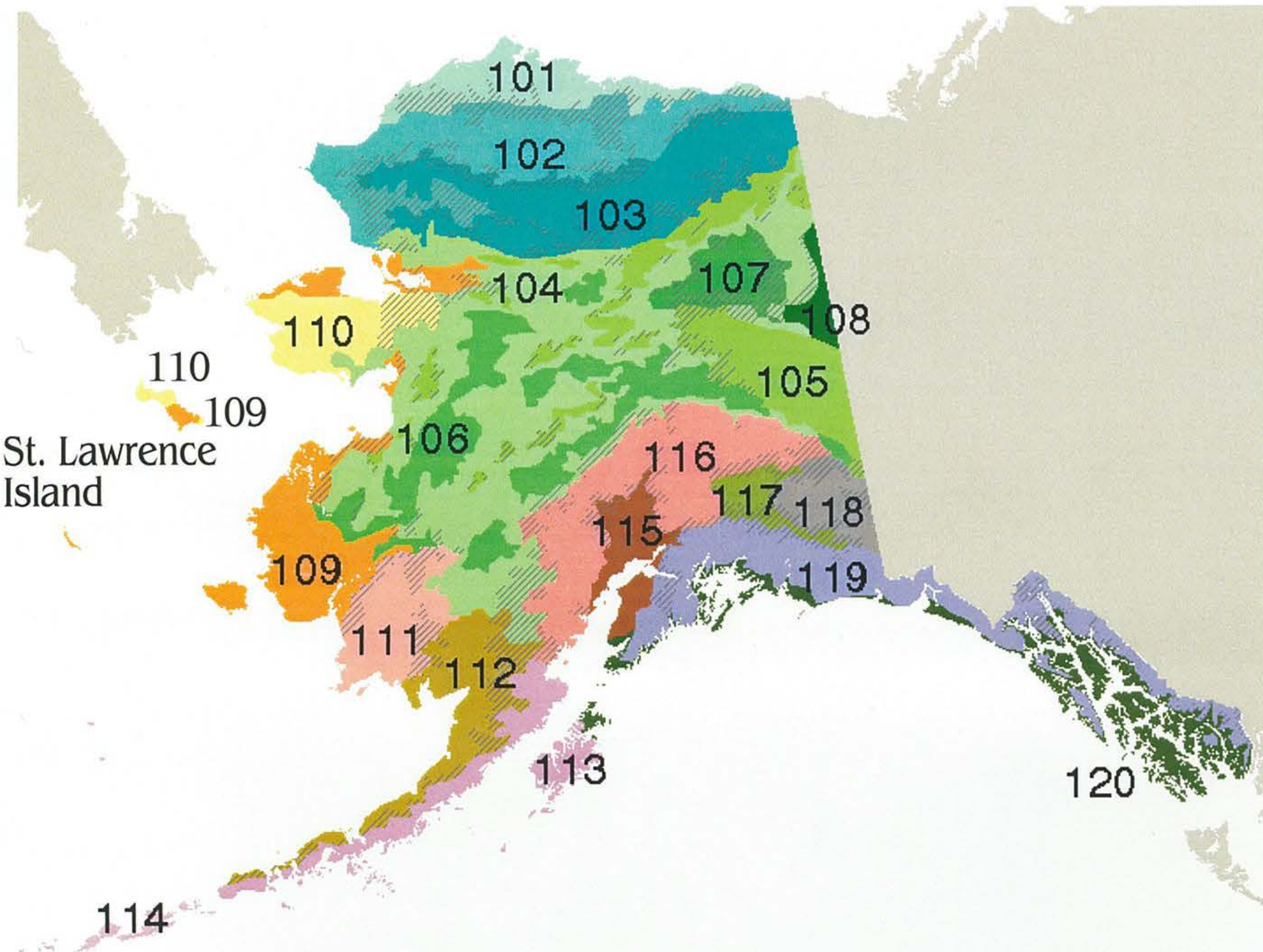
DRAWING TITLE: HUMAN HEALTH CONCEPTUAL SITE MODEL

MWH MONTGOMERY WATSON HARZA

Sheet 1 Of 1 Sheets | SCALE: Not To Scale | FIGURE 3-1

AutoCAD FILE: 4-1 Heal... PROJECT NUMBER: 1227010

JOB No. c oj\usace\necape\2002RA\DraftFinal\fig3_02.cdr



101. Arctic Coastal Plain
102. Arctic Foothills
103. Brooks Range
104. Interior Forested Lowlands and Uplands
105. Interior Highlands
106. Interior Bottomlands
107. Yukon Flats
108. Ogilvie Mountains
109. Subarctic Coastal Plains
110. Seward Peninsula
111. Ahklun and Kilbuck Mountains
112. Bristol Bay - Nushagek Lowlands
113. Alaska Peninsula Mountains
114. Aleution Islands
115. Cook Inlet
116. Alaska Range
117. Copper Plateau
118. Wrangell Mountains
119. Pacific Coastal Mountains
120. Coastal Western Hemlock-Sitka Spruce Forest

Cross-hatched portions along the ecoregion boundaries represent transitional areas sharing characteristics of two or more adjacent ecoregions. Due to the map scale and resolution, as well as to the resolution of the information sued to derive the map, not all transition zones can be represented.

This map shows that St. Lawrence Island consists of both "Subarctic Coastal Plains" and "Seward Peninsula" type ecoregions.

Source: USGS 1997
National Mapping Information - Earth Resources Observation Systems Data Center.

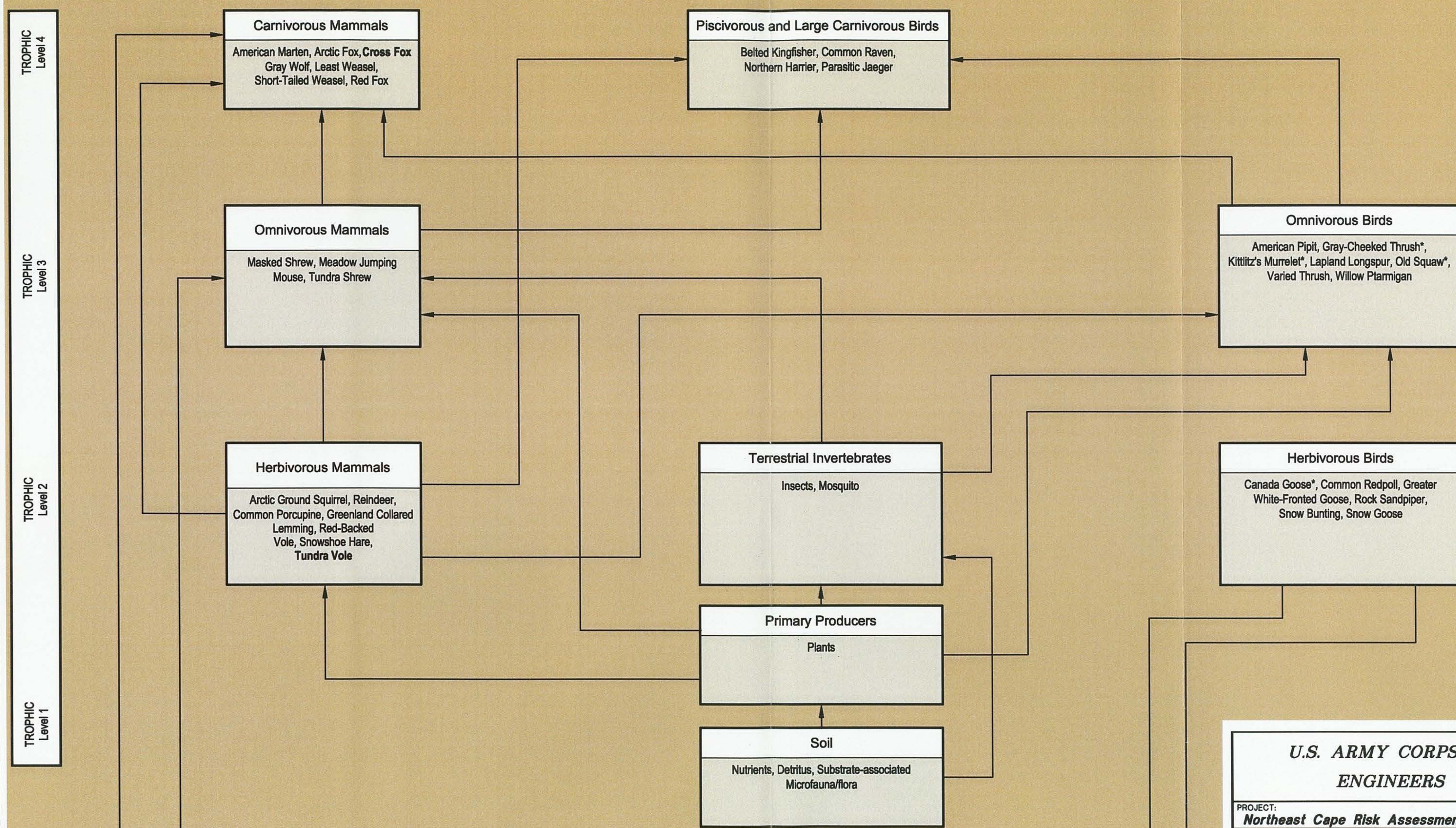
MWH
Anchorage, Alaska

FIGURE 3-2

U.S. ARMY ENGINEER DISTRICT, ALASKA - NORTHEAST CAPE, ALASKA
2004 RISK ASSESSMENT (RA)

ECOREGIONS OF ALASKA MAP

FOOD WEB FOR TERRESTRIAL HABITAT



NOTE:
[*] - Indicates federal or state listed priority for conservation and management
[**Bold**] - Indicates indicator receptor species selected for quantitative evaluation.

U.S. ARMY CORPS OF ENGINEERS

PROJECT: *Northeast Cape Risk Assessment*

DRAWING TITLE: *FOOD WEB FOR TERRESTRIAL HABITAT*

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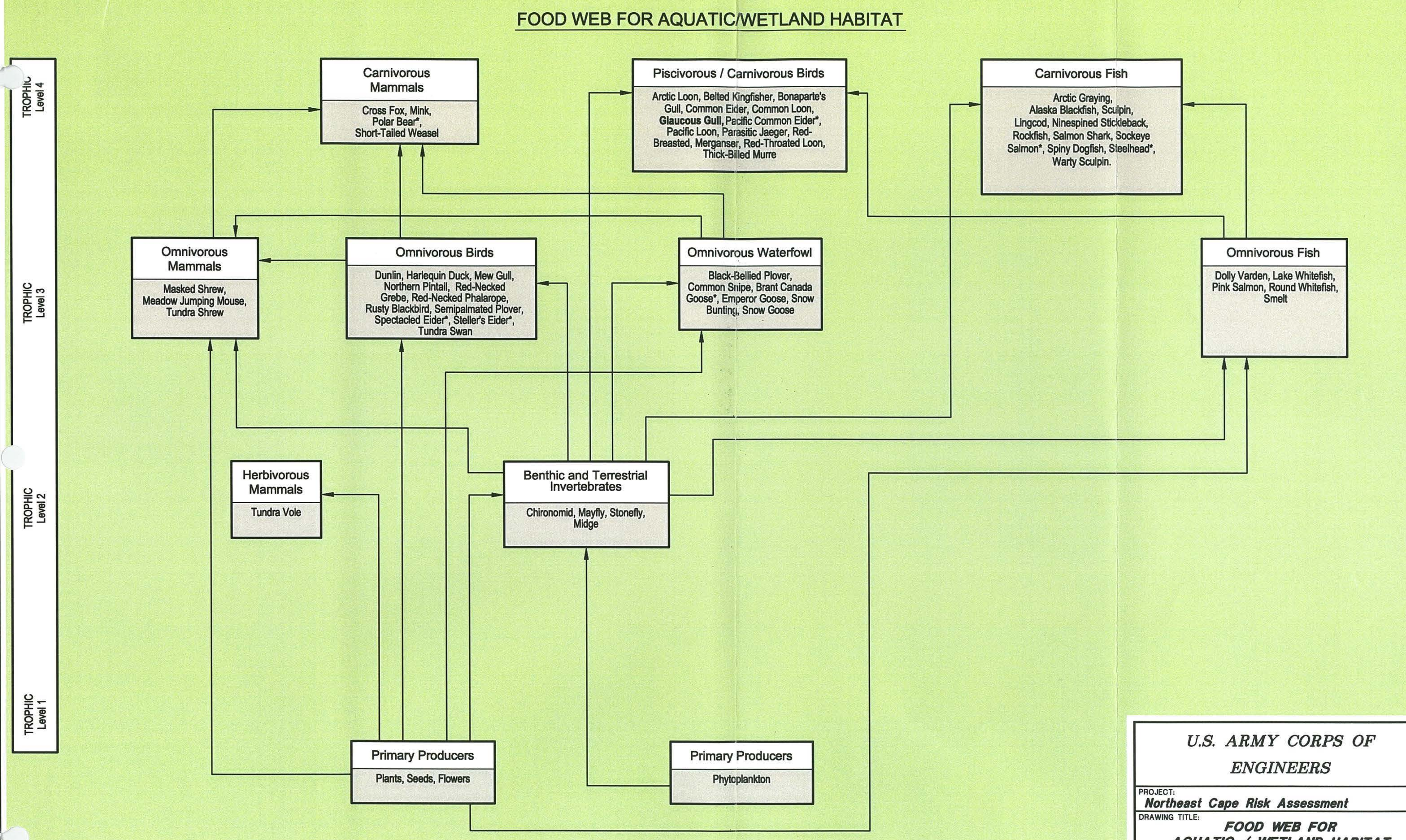
Sheet 1 Of 1 Sheets | SCALE: Not To Scale | FIGURE 3-3

AutoCAD FILE: 5-4 Terre... PROJECT NUMBER: 127010



NOTE:
[*] - Indicates federal or state listed priority for conservation and management
[Bold] - Indicates indicator receptor species selected for quantitative evaluation.

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PROJECT: ***Northeast Cape Risk Assessment***

DRAWING TITLE: ***FOOD WEB FOR AQUATIC / WETLAND HABITAT***

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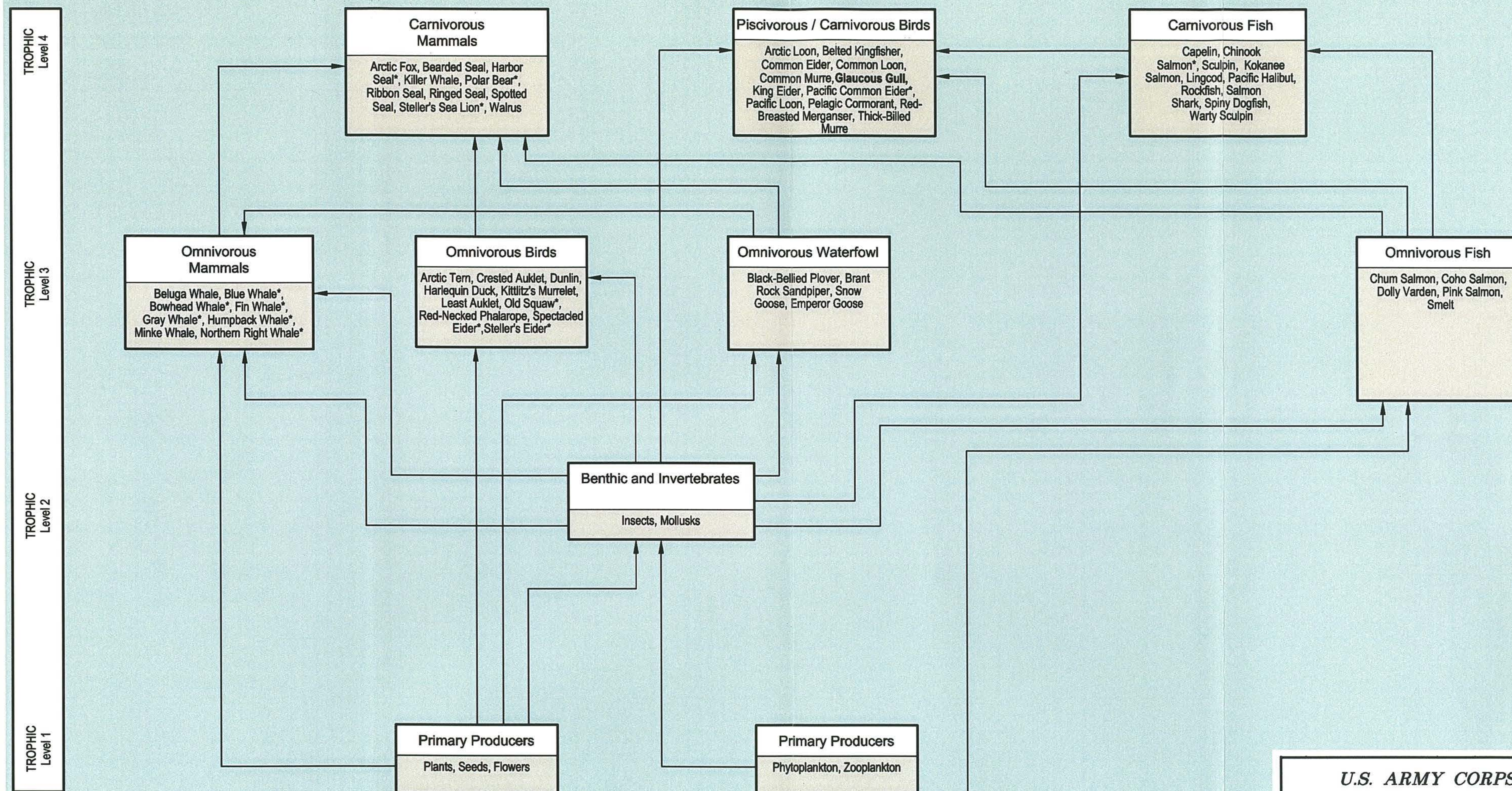
Sheet 1 Of 1 Sheets

SCALE: Not To Scale

FIGURE 3-4

FOOD WEB FOR MARINE HABITAT



NOTE:
[*] - Indicates federal or state listed priority for conservation and management
[Bold] - Indicates indicator receptor species selected for quantitative evaluation.

AutoCAD FILE: 5-6 Ma... PROJECT NUMBER 1227010

U.S. ARMY CORPS OF ENGINEERS

PROJECT: Northeast Cape Risk Assessment Work Plan

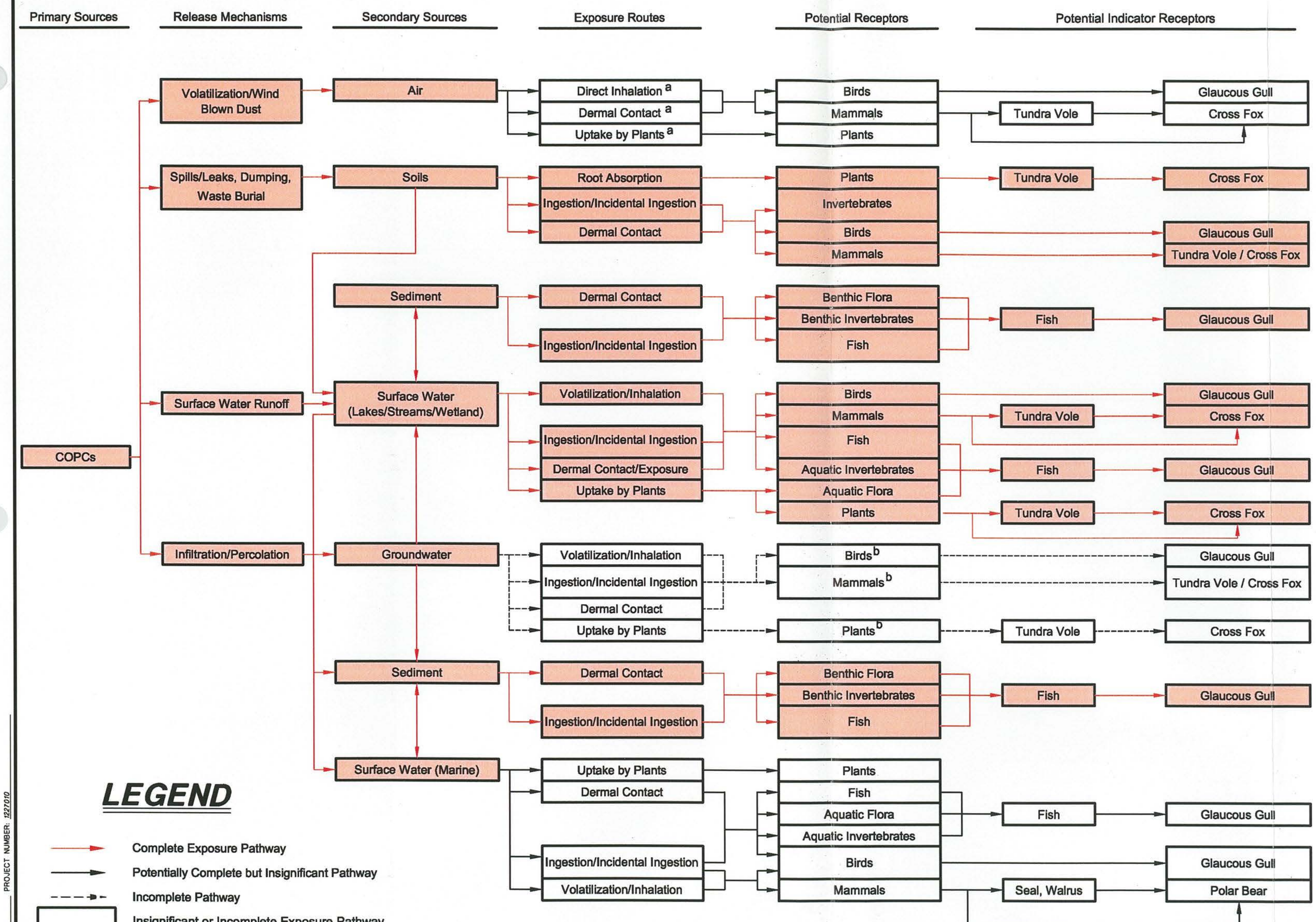
DRAWING TITLE: FOOD WEB FOR MARINE HABITAT

MWH MONTGOMERY WATSON HARZA

Sheet 1 Of 1 Sheets

SCALE: Not To Scale

FIGURE 3-5



LEGEND

- Complete Exposure Pathway
- Potentially Complete but Insignificant Pathway
- Incomplete Pathway
- Insignificant or Incomplete Exposure Pathway
- Complete Exposure Pathway

Pink boxes:
Indicate a complete exposure pathway
White boxes:
Indicate an insignificant or incomplete exposure pathway

NOTE:

a This pathway is considered insignificant due to the following:
(1) NEC is covered by snow much of the year.
(2) Precipitation and cold temperatures minimize volatilization.
(3) Soils at most of the sites have revegetated and there is very little opportunity for particulate emissions.

b This pathway is considered incomplete because these receptors do not contact groundwater.

AutoCAD FILE: 5-7 Eco .dwg PROJECT NUMBER: 1227010

U.S. ARMY CORPS OF ENGINEERS

PROJECT: Northeast Cape Risk Assessment

DRAWING TITLE: ECOLOGICAL CONCEPTUAL SITE MODEL

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Sheet 1 Of 1 Sheets

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FIGURE 3-5

Table 3-1 Environmental Media Sampled During Remedial Investigations, 1994 – 2002

Site No.	Description	1994 Phase I RI					1996 Phase II RI					1998 Phase II RI					1999 Phase II RI					2000 Phase III RI					2001 Phase III RI					2002 Phase III RI				
		Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological
1	Burn Site Southeast of Landing Strip																																			
2	Airport Terminal and Landing Strip	X										X																								
3	Fuel Line Corridor and Pumphouse	X													X															X		△			X	
4	Subsistence Fishing and Hunting Camp	X													X															X		△			X	
5	Cargo Beach	X																																		
6	Cargo Beach Road Drum Field	X	X	X	X							X															X	X	X	X		X	X	X	X	
7	Cargo Beach Road Landfill	X	X	X	X							X			X			X									X	X	X	X		X	X	X	X	
8	POL Spill Site																																			
9	Housing and Operations Landfill	X	X	X	X							X			X													X	X	X			X	X	X	
10	Former Drum Storage Area	X	X	X	X		X					X			X																					
11	Fuel Storage Tank Area	X			X										X																					
12	Gasoline Tank Area																X																			
13	Heat and Electrical Power Building	X			X							X			X																	④			④	
14	Emergency Power/Operations Building											X															X					X	△			
15	Buried Fuel Line Spill Area	X			X										X																	④	△			
16	Paint and Dope Storage Building	X			X										X												X			X		X			X	
17	General Supply Warehouse and Mess Hall Warehouse	X																																		
18	Housing Facilities and Squad Headquarters																																			

Table 3-1 (cont.) Environmental Media Sampled During Remedial Investigations, 1994 – 2002

		1994 Phase I RI					1996 Phase II RI					1998 Phase II RI					1999 Phase II RI					2000 Phase III RI					2001 Phase III RI					2002 Phase III RI				
Site No.	Description	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological	Soil	Sediment	Surface Water	Groundwater	Biological
19	Auto Maintenance and Storage Facilities	X			X										X																	④			④	
20	Air Force Aircraft Control and Warning Building																															④			④	
21	Wastewater Treatment Facility	X	X	X	X													X										X	X	X			X	X	X	
22	Water Wells and Water Supply Building	X			X																									X		④			X	
23	Power and Communications Line Corridors	X																																		
24	Receiver Building Area	X	X	X	X																							X	X				X	X		
25	Direction Finder Area	X	X	X								X																								
26	Former Construction Camp Area																													X					X	
27	Diesel Fuel Pump Island	X	X	X	X		X								X																	△ ④			④	
28	Drainage Basin Area						X	X	X		X	X	X	X							X							X	X		X		X	X		X
29	Suqitughneq River						X	X	X		X	X	X	X							X							X	X		X		X	X		X
30	Background Areas	X	X	X	X								X	X			X	X			X						X	X		X	X	X	X		X	X
31	White Alice Site																										X		X			X		X		
32	Lower Tram Terminal																										X		X			X		X		
33	Upper Tram Terminal																										X					X				
34	Upper Camp																										X					X				

Key:

No. – Number
POL – petroleum, oil, and lubricant
RI – Remedial Investigation

△ – Confirmation excavation samples collected by Nuggett Construction (2001).
④ – MWH samples collected in 2002 (postponded from 2001 RI).

Note: Environmental media do not include wipe, drum, tank, building flood water, hazardous waste, asbestos

Table 3-2 Tier I Human Health COPC Screening Criteria - Tundra and Gravel Soil

Analyte	Soil BUTL (mg/kg) [a] Tundra	Soil BUTL (mg/kg) [a] Gravel	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
Inorganics				
Aluminum	30,357	nc	na	na
Antimony	nc	nc	3.6	0.36
Arsenic	7.8	11	2	0.2
Barium	174	nc	1,100	110
Beryllium	3.8	nc	42	4.2
Cadmium	1.4	3.1	5	0.5
Calcium	nc	nc	NA [d]	NA
Chromium	48	50	26	2.6
Cobalt	49	nc	na	na
Copper	107	44	4,060	406
Iron	nc	nc	NA [d]	NA
Lead	106	112	400 [e]	40
Magnesium	nc	nc	NA [d]	NA
Manganese	1,589	nc	na	na
Mercury	0.43	nc	1.4	0.14
Nickel	59	30	87	8.7
Potassium	nc	nc	NA [d]	NA
Selenium	nc	nc	3.5	0.35
Silver	nc	nc	21	2.1
Sodium	nc	nc	NA [d]	NA
Thallium	1.6	0.56	na	na
Vanadium	73	nc	710	71
Zinc	615	157	9,100	910
Volatile Organic Compounds				
1,1,1,2-Tetrachloroethane	nc	nc	na	na
1,1,1-Trichloroethane	nc	nc	1	0.1
1,1,2,2-Tetrachloroethane	nc	nc	0.017	0.0017
1,1,2-Trichloroethane	nc	nc	0.017	0.0017
1,1-Dichloroethane	nc	nc	12	1.2
1,1-Dichloroethene	nc	nc	0.03	0.003
1,1-Dichloropropene	nc	nc	na	na
1,2,3-Trichlorobenzene	nc	nc	na	na
1,2,3-Trichloropropane	nc	nc	na	na
1,2,4-Trichlorobenzene	nc	nc	2	0.2
1,2,4-Trimethylbenzene	nc	nc	95.2	9.52
1,2-Dibromo-3-chloropropane	nc	nc	na	na
1,2-Dibromoethane	nc	nc	na	na
1,2-Dichlorobenzene	nc	nc	7	0.7
1,2-Dichloroethane	nc	nc	0.015	0.0015
1,2-Dichloropropane	nc	nc	0.017	0.0017
1,3,5-Trimethylbenzene	nc	nc	25	2.5
1,3-Dichlorobenzene	nc	nc	0.26	0.026
1,3-Dichloropropane	nc	nc	na	na
1,4-Dichlorobenzene	nc	nc	0.8	0.08

Table 3-2 Tier I Human Health COPC Screening Criteria - Tundra and Gravel Soil

Analyte	Soil BUTL (mg/kg) [a]		Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
	Tundra	Gravel		
Volatile Organic Compounds (Cont.)				
2,2-Dichloropropane	nc	nc	na	na
2-Butanone	nc	nc	60	6
2-Chloroethyl vinyl ether	nc	nc	na	na
2-Chloronaphthalene	nc	nc	na	na
2-Chlorophenol	nc	nc	1.4	0.14
2-Chlorotoluene	nc	nc	na	na
2-Hexanone	nc	nc	na	na
4-Bromophenyl phenyl ether	nc	nc	na	na
4-Chlorophenyl phenyl ether	nc	nc	na	na
4-Isopropyltoluene	nc	nc	na	na
4-Methyl-2-pentanone	nc	nc	na	na
Acetone	nc	nc	10	1
Acrolein	nc	nc	na	na
Benzene	nc	nc	0.02	0.002
bis-(2-Chloroethyl)ether	nc	nc	0.002	0.0002
bis(2-Chloroisopropyl)ether	nc	nc	na	na
Bromobenzene	nc	nc	na	na
Bromochloromethane	nc	nc	na	na
Bromodichloromethane	nc	nc	0.35	0.035
Bromoethane	nc	nc	na	na
Bromoform	nc	nc	0.38	0.038
Bromomethane	nc	nc	na	na
Carbon disulfide	nc	nc	17	1.7
Carbon tetrachloride	nc	nc	0.03	0.003
Chlorobenzene	nc	nc	0.6	0.06
Chloroethane	nc	nc	na	na
Chloroform	nc	nc	0.34	0.034
Chloromethane	nc	nc	na	na
cis-1,2-Dichloroethene	nc	nc	0.2	0.02
cis-1,3-Dichloropropene	nc	nc	0.02	0.002
Dibromochloromethane	nc	nc	na	na
Dibromomethane	nc	nc	na	na
Dichlorodifluoromethane	nc	nc	na	na
Ethylbenzene	nc	nc	5.5	0.55
Isopropylbenzene	nc	nc	227	22.7
m,p-Xylene (Sum of Isomers)	nc	nc	na	na
Methyl iodide	nc	nc	na	na
Methylene chloride	nc	nc	0.015	0.0015
n-Butylbenzene	nc	nc	na	na
Nitrobenzene	nc	nc	0.06	0.006
n-Propylbenzene	nc	nc	na	na
o-Xylene	nc	nc	na	na
p-Isopropyltoluene	nc	nc	na	na
sec-Butylbenzene	nc	nc	na	na
Styrene	nc	nc	1.3	0.13

Table 3-2 Tier I Human Health COPC Screening Criteria - Tundra and Gravel Soil

Analyte	Soil BUTL (mg/kg) [a] Tundra	Soil BUTL (mg/kg) [a] Gravel	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
Volatile Organic Compounds (Cont.)				
tert-Butylbenzene	nc	nc	na	na
Tetrachloroethene	nc	nc	0.03	0.003
Toluene	nc	nc	5.4	0.54
trans-1,2-Dichloroethene	nc	nc	0.4	0.04
trans-1,3-Dichloropropene	nc	nc	0.02	0.002
trans-1,4-Dichloro-2-butene	nc	nc	na	na
Trichloroethene	nc	nc	0.027	0.0027
Trichlorofluoromethane	nc	nc	na	na
Vinyl acetate	nc	nc	100	10
Vinyl chloride	nc	nc	0.009	0.0009
Xylene, Isomers m & p	nc	nc	na	na
Xylenes	nc	nc	78	7.8
Semi-volatile Organic Compounds				
2,4,5-Trichlorophenol	nc	nc	90	9
2,4,6-Trichlorophenol	nc	nc	0.6	0.06
2,4-Dichlorophenol	nc	nc	0.45	0.045
2,4-Dimethylphenol	nc	nc	4	0.4
2,4-Dinitrophenol	nc	nc	0.2	0.02
2,4-Dinitrotoluene	nc	nc	0.005	0.0005
2,6-Dinitrotoluene	nc	nc	0.0044	0.00044
2-Methyl-4,6-dinitrophenol	nc	nc	na	na
2-Methylphenol (o-Cresol)	nc	nc	7	0.7
2-Nitroaniline	nc	nc	na	na
2-Nitrophenol	nc	nc	na	na
3,3-Dichlorobenzidine	nc	nc	0.02	0.002
3-Nitroaniline	nc	nc	na	na
4-Chloro-3-methylphenol	nc	nc	na	na
4-Chloroaniline	nc	nc	0.5	0.05
4-Chlorotoluene	nc	nc	na	na
4-Methylphenol (p-Cresol)	nc	nc	na	na
4-Nitroaniline	nc	nc	na	na
4-Nitrophenol	nc	nc	na	na
Acrylamide	nc	nc	na	na
Benzidine	nc	nc	na	na
Benzoic acid	nc	nc	390	39
Benzyl alcohol	nc	nc	na	na
Benzyl butyl phthalate	nc	nc	5,600	560
bis-(2-chloroethoxy)methane	nc	nc	na	na
bis-(2-ethylhexyl)phthalate	nc	nc	590	59
Cresols (Methyl Phenols)	nc	nc	na	na
Diethyl phthalate	nc	nc	190	19
Dimethyl phthalate	nc	nc	1,400	140
Di-n-butyl phthalate	nc	nc	1,700	170
Di-n-octyl phthalate	nc	nc	2,000	200

Table 3-2 Tier I Human Health COPC Screening Criteria - Tundra and Gravel Soil

Analyte	Soil BUTL (mg/kg) [a] Tundra	Soil BUTL (mg/kg) [a] Gravel	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
Semi-volatile Organic Compounds (Cont.)				
Hexachlorobenzene	nc	nc	0.73	0.073
Hexachlorobutadiene	nc	nc	8	0.8
Hexachlorocyclopentadiene	nc	nc	7	0.7
Hexachloroethane	nc	nc	1.6	0.16
Isophorone	nc	nc	3	0.3
n-Nitrosodi-n-propylamine	nc	nc	0.00036	0.000036
n-Nitrosodiphenylamine	nc	nc	3.4	0.34
Pentachlorophenol	nc	nc	0.01	0.001
Pyridine	nc	nc	na	na
Toxaphene	nc	nc	8	0.8
Polychlorinated Biphenyls				
PCB-1016 (Aroclor 1016)	nc	nc	10 [f]	1
PCB-1221 (Aroclor 1221)	nc	nc	10 [f]	1
PCB-1232 (Aroclor 1232)	nc	nc	10 [f]	1
PCB-1242 (Aroclor 1242)	nc	nc	10 [f]	1
PCB-1248 (Aroclor 1248)	nc	nc	10 [f]	1
PCB-1254 (Aroclor 1254)	nc	nc	10 [f]	1
PCB-1260 (Aroclor 1260)	nc	nc	10 [f]	1
Total Polychlorinatedbiphenyls	nc	nc	10	1
Pesticides				
4,4'-DDD	nc	nc	35	3.5
4,4'-DDE	nc	nc	24	2.4
4,4'-DDT	nc	nc	24	2.4
Aldrin	nc	nc	0.5	0.05
alpha-BHC	nc	nc	0.0026	0.00026
alpha-Chlordane	nc	nc	3 [g]	0.3
beta-BHC	nc	nc	0.009	0.0009
Chlordane	nc	nc	3	0.3
delta-BHC	nc	nc	0.0026 [h]	0.00026
Dieldrin	nc	nc	0.015	0.0015
Endosulfan I	nc	nc	7	0.7
Endosulfan II	nc	nc	7 [i]	0.7
Endosulfan sulfate	nc	nc	7 [i]	0.7
Endrin aldehyde	nc	nc	0.3 [j]	0.03
Endrin ketone	nc	nc	0.3 [j]	0.03
Endrin	nc	nc	0.3	0.03
gamma-BHC (Lindane)	nc	nc	0.003	0.0003
gamma-Chlordane	nc	nc	3 [g]	0.3
Heptachlor epoxide	nc	nc	0.2	0.02
Heptachlor	nc	nc	0.8	0.08
Methoxychlor	nc	nc	52	5.2
Dioxins and Furans				
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	nc	nc	na [k]	na
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	nc	nc	na [k]	na

Table 3-2 Tier I Human Health COPC Screening Criteria - Tundra and Gravel Soil

Analyte	Soil BUTL (mg/kg) [a] Tundra	Soil BUTL (mg/kg) [a] Gravel	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
Dioxins and Furans (Cont.)				
1,2,3,4,6,7,8-Heptachlorodibenzofuran	nc	nc	na [k]	na
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	nc	nc	na [k]	na
1,2,3,4,7,8,9-Heptachlorodibenzofuran	nc	nc	na [k]	na
1,2,3,4,7,8-Hexachlorodibenzofuran	nc	nc	na [k]	na
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	nc	nc	na [k]	na
1,2,3,6,7,8-Hexachlorodibenzofuran	nc	nc	na [k]	na
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	nc	nc	na [k]	na
1,2,3,7,8,9-Hexachlorodibenzofuran	nc	nc	na [k]	na
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	nc	nc	na [k]	na
1,2,3,7,8-Pentachlorodibenzofuran	nc	nc	na [k]	na
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	nc	nc	na [k]	na
2,3,4,6,7,8-Hexachlorodibenzofuran	nc	nc	na [k]	na
2,3,4,7,8-Pentachlorodibenzofuran	nc	nc	na [k]	na
2,3,7,8-Tetrachlorodibenzofuran	nc	nc	na [k]	na
2,3,7,8-Tetrachlorodibenzo-p-dioxin	nc	nc	na [k]	na
Dibenzofuran	nc	nc	na [k]	na
Octachlorodibenzofuran	nc	nc	na [k]	na
Octachlorodibenzo-p-dioxin	nc	nc	na [k]	na
Total Heptachlorodibenzofurans (HpCDF)	nc	nc	na [k]	na
Total Heptachlorodibenzo-p-dioxins (HpCDD)	nc	nc	na [k]	na
Total Hexachlorodibenzofurans (HxCDF)	nc	nc	na [k]	na
Total Hexachlorodibenzo-p-dioxins (HxCDD)	nc	nc	na [k]	na
Total Pentachlorodibenzofurans (PeCDF)	nc	nc	na [k]	na
Total Pentachlorodibenzo-p-dioxin (PeCDD)	nc	nc	na [k]	na
Total Tetrachlorodibenzofurans (TCDF)	nc	nc	na [k]	na
Total Tetrachlorodibenzo-p-dioxins (TCDD)	nc	nc	na [k]	na
Polynuclear Aromatic Hydrocarbons				
2-Methylnaphthalene	nc	nc	43	4.3
Acenaphthene	nc	nc	210	21
Acenaphthylene	nc	nc	210	21
Anthracene	nc	nc	4,300	430
Benzo(a)anthracene	nc	nc	6	0.6
Benzo(a)pyrene	nc	nc	1	0.1
Benzo(b)fluoranthene	nc	nc	11	1.1
Benzo(g,h,i)perylene	nc	nc	1,500	150
Benzo(k)fluoranthene	nc	nc	110	11
Chrysene	nc	nc	620	62
Dibenzo(a,h)anthracene	nc	nc	1	0.1
Fluoranthene	nc	nc	2,100	210
Fluorene	nc	nc	270	27
Indeno(1,2,3-cd)pyrene	nc	nc	11	1.1
Naphthalene	nc	nc	21	2.1
Phenanthrene	nc	nc	4,300	430
Phenol	nc	nc	67	6.7
Pyrene	nc	nc	1,500	150

Table 3-2 Tier I Human Health COPC Screening Criteria - Tundra and Gravel Soil

Analyte	Soil BUTL (mg/kg) [a]		Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
	Tundra	Gravel		
Petroleum Hydrocarbons				
DRO	nc	nc	250	25
DRO - Aromatic	nc	nc	100	10
DRO - Aliphatic	nc	nc	7,200	720
GRO	nc	nc	300	30
GRO - Aromatic	nc	nc	150	15
GRO - Aliphatic	nc	nc	270	27
RRO	nc	nc	10,000	1,000
RRO - Aliphatic	nc	nc	20,000	2,000
RRO - Aromatic	nc	nc	3,000	300
Total Recoverable Petroleum Hydrocarbons	nc	nc	NA [1]	NA

Notes:

ADEC - Alaska Department of Environmental Conservation
BHC - Benzene hexachloride
BUTL - Background upper tolerance limit
COPC - Chemical of potential concern
DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethylene
DDT - Dichlorodiphenyltrichloroethane
DRO - Diesel range organics
GRO - Gasoline range organics
mg/kg - Milligrams per kilogram
NA - Not applicable
na - Not available
nc - Not calculated
PCB - Polychlorinated bipheyls
RRO - Residual range organics

[a] Please refer to MWH, 2003b. Ambient levels in the form of background upper tolerance limits (BUTLs) were not calculated (nc) when insufficient sampling results were available to derive a statistically meaningful BUTL. Ambient levels were only derived for inorganic chemicals, not organic chemicals.

[b] Regulatory Criteria is derived from the following hierarchy:

1. Minimum of 3 pathways listed in Tables B1 and B2, Under 40 inch zone: ADEC, 2003a. 18 AAC 75 Oil and Hazardous Substances Pollution Control. January 30.
2. Minimum of 3 pathways listed in Tables B1 and B2, Under 40 inch zone: ADEC, 2002a. Cumulative Risk Guidance. November 7.
3. Minimum of 3 pathways listed in Tables B1 and B2, Under 40 inch zone: ADEC, 2001b. Calculated Cleanup Levels for Compounds without Tabular Values in Site Cleanup Rules - Technical Memorandum 01-007. December 18.

[c] Benchmark criterion is equal to 1/10 the indicated regulatory criterion.

[d] This analyte is excluded as a COPC due to status as an essential nutrient.

[e] Based on residential cleanup value calculated according to Risk Assessment Procedures Manual guidance (18 AAC 75.340).

[f] Total polychlorinated biphenyls (PCBs) used as a surrogate for all PCBs (i.e., Aroclors). Consistent with IRIS (USEPA, 2003a), carcinogenic effects of Aroclors are evaluated using the cancer slope factor for "polychlorinated biphenyls".

Table 3-2 Tier I Human Health COPC Screening Criteria - Tundra and Gravel Soil

Analyte	Soil BUTL (mg/kg) [a] Tundra	Gravel	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)

[g] Chlordane used as a surrogate for alpha- and gamma-chlordane. Alpha and gamma isomers of chlordane are structurally similar cyclodiene insecticides and neurotoxicants, and are components of technical chlordane.

[h] Alpha-BHC used as a surrogate for delta-BHC. Alpha, beta, gamma and delta isomers of hexachlorocyclohexane (BHC) are structurally similar neurotoxicants, and are all components of technical BHC.

[i] Endosulfan used as a surrogate for endosulfan II and endosulfan sulfate. Endosulfan I and endosulfan II are structural isomers of one another, toxicologically similar, and comprise technical endosulfan. Endosulfan sulfate is an impurity in technical endosulfan, is an oxidative metabolite of endosulfan I and endosulfan II, and retains the biological activity of endosulfan.

[j] Endrin used as a surrogate for endrin aldehyde and endrin ketone. Endrin aldehyde is an impurity in technical endrin, as well as a metabolite of endrin. Endrin ketone is formed when endrin is exposed to light. Endrin aldehyde and endrin ketone retain the biological activity of endrin.

[k] Screening criteria is currently not available for dioxins and furans; therefore, these analytes are carried through as COPCs.

[l] Total recoverable petroleum hydrocarbons (TRPHs) are excluded as a COPC due to outdated analytical methods.

Table 3-3 Tier I Human Health COPC Screening Criteria - Freshwater Sediment

Analyte	BUTL (mg/kg) [a]	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
Inorganics			
Aluminum	nc	na	na
Antimony	nc	3.6	0.36
Arsenic	nc	2	0.2
Barium	nc	1,100	110
Beryllium	9.8	42	4.2
Cadmium	nc	5	0.5
Calcium	nc	NA [d]	NA
Chromium	34	26	2.6
Cobalt	nc	na	na
Copper	40	4,060	406
Iron	nc	NA [d]	NA
Lead	78	400 [e]	40
Magnesium	nc	NA [d]	NA
Manganese	nc	na	na
Mercury	nc	1.4	0.14
Nickel	126	87	8.7
Potassium	nc	NA [d]	NA
Selenium	nc	3.5	0.35
Silver	nc	21	2.1
Sodium	nc	NA [d]	NA
Thallium	nc	na	na
Vanadium	nc	710	71
Zinc	148	9,100	910
Volatile Organic Compounds			
1,1,1,2-Tetrachloroethane	nc	na	na
1,1,1-Trichloroethane	nc	1	0.1
1,1,2,2-Tetrachloroethane	nc	0.017	0.0017
1,1,2-Trichloroethane	nc	0.017	0.0017
1,1-Dichloroethane	nc	12	1.2
1,1-Dichloroethene	nc	0.03	0.003
1,1-Dichloropropene	nc	na	na
1,2,3-Trichlorobenzene	nc	na	na
1,2,3-Trichloropropane	nc	na	na
1,2,4-Trichlorobenzene	nc	2	0.2
1,2,4-Trimethylbenzene	nc	95.2	9.52
1,2-Dibromo-3-chloropropane	nc	na	na
1,2-Dibromoethane	nc	na	na
1,2-Dichlorobenzene	nc	7	0.7
1,2-Dichloroethane	nc	0.015	0.0015
1,2-Dichloropropane	nc	0.017	0.0017
1,3,5-Trimethylbenzene	nc	25	2.5
1,3-Dichlorobenzene	nc	0.26	0.026
1,3-Dichloropropane	nc	na	na
1,4-Dichlorobenzene	nc	0.8	0.08
2,2-Dichloropropane	nc	na	na

Table 3-3 Tier I Human Health COPC Screening Criteria - Freshwater Sediment

Analyte	BUTL (mg/kg) [a]	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
Volatile Organic Compounds (Cont.)			
2-Butanone	nc	60	6
2-Chloroethyl vinyl ether	nc	na	na
2-Chloronaphthalene	nc	na	na
2-Chlorophenol	nc	1.4	0.14
2-Chlorotoluene	nc	na	na
2-Hexanone	nc	na	na
4-Bromophenyl phenyl ether	nc	na	na
4-Chlorophenyl phenyl ether	nc	na	na
4-Isopropyltoluene	nc	na	na
4-Methyl-2-pentanone	nc	na	na
Acetone	nc	10	1
Acrolein	nc	na	na
Benzene	nc	0.02	0.002
bis-(2-Chloroethyl)ether	nc	0.002	0.0002
bis(2-Chloroisopropyl)ether	nc	na	na
Bromobenzene	nc	na	na
Bromochloromethane	nc	na	na
Bromodichloromethane	nc	0.35	0.035
Bromoethane	nc	na	na
Bromoform	nc	0.38	0.038
Bromomethane	nc	na	na
Carbon disulfide	nc	17	1.7
Carbon tetrachloride	nc	0.03	0.003
Chlorobenzene	nc	0.6	0.06
Chloroethane	nc	na	na
Chloroform	nc	0.34	0.034
Chloromethane	nc	na	na
cis-1,2-Dichloroethene	nc	0.2	0.02
cis-1,3-Dichloropropene	nc	0.02	0.002
Dibromochloromethane	nc	na	na
Dibromomethane	nc	na	na
Dichlorodifluoromethane	nc	na	na
Ethylbenzene	nc	5.5	0.55
Isopropylbenzene	nc	227	22.7
m,p-Xylene (Sum of Isomers)	nc	na	na
Methyl iodide	nc	na	na
Methylene chloride	nc	0.015	0.0015
n-Butylbenzene	nc	na	na
Nitrobenzene	nc	0.06	0.006
n-Propylbenzene	nc	na	na
o-Xylene	nc	na	na
p-Isopropyltoluene	nc	na	na
sec-Butylbenzene	nc	na	na
Styrene	nc	1.3	0.13
tert-Butylbenzene	nc	na	na

Table 3-3 Tier I Human Health COPC Screening Criteria - Freshwater Sediment

Analyte	BUTL (mg/kg) [a]	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
Volatile Organic Compounds (Cont.)			
Tetrachloroethene	nc	0.03	0.003
Toluene	nc	5.4	0.54
trans-1,2-Dichloroethene	nc	0.4	0.04
trans-1,3-Dichloropropene	nc	0.02	0.002
trans-1,4-Dichloro-2-butene	nc	na	na
Trichloroethene	nc	0.027	0.0027
Trichlorofluoromethane	nc	na	na
Vinyl acetate	nc	100	10
Vinyl chloride	nc	0.009	0.0009
Xylene, Isomers m & p	nc	na	na
Xylenes	nc	78	7.8
Semi-volatile Organic Compounds			
2,4,5-Trichlorophenol	nc	90	9
2,4,6-Trichlorophenol	nc	0.6	0.06
2,4-Dichlorophenol	nc	0.45	0.045
2,4-Dimethylphenol	nc	4	0.4
2,4-Dinitrophenol	nc	0.2	0.02
2,4-Dinitrotoluene	nc	0.005	0.0005
2,6-Dinitrotoluene	nc	0.0044	0.00044
2-Methyl-4,6-dinitrophenol	nc	na	na
2-Methylphenol (o-Cresol)	nc	7	0.7
2-Nitroaniline	nc	na	na
2-Nitrophenol	nc	na	na
3,3-Dichlorobenzidine	nc	0.02	0.002
3-Nitroaniline	nc	na	na
4-Chloro-3-methylphenol	nc	na	na
4-Chloroaniline	nc	0.5	0.05
4-Chlorotoluene	nc	na	na
4-Methylphenol (p-Cresol)	nc	na	na
4-Nitroaniline	nc	na	na
4-Nitrophenol	nc	na	na
Acrylamide	nc	na	na
Benzidine	nc	na	na
Benzoic acid	nc	390	39
Benzyl alcohol	nc	na	na
Benzyl butyl phthalate	nc	5,600	560
bis-(2-chloroethoxy)methane	nc	na	na
bis-(2-ethylhexyl)phthalate	nc	590	59
Cresols (Methyl Phenols)	nc	na	na
Diethyl phthalate	nc	190	19
Dimethyl phthalate	nc	1,400	140
Di-n-butyl phthalate	nc	1,700	170
Di-n-octyl phthalate	nc	2,000	200
Hexachlorobenzene	nc	0.73	0.073
Hexachlorobutadiene	nc	8	0.8

Table 3-3 Tier I Human Health COPC Screening Criteria - Freshwater Sediment

Analyte	BUTL (mg/kg) [a]	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
Semi-volatile Organic Compounds (Cont.)			
Hexachlorocyclopentadiene	nc	7	0.7
Hexachloroethane	nc	1.6	0.16
Isophorone	nc	3	0.3
n-Nitrosodi-n-propylamine	nc	0.00036	0.000036
n-Nitrosodiphenylamine	nc	3.4	0.34
Pentachlorophenol	nc	0.01	0.001
Phenol	nc	67	6.7
Pyridine	nc	na	na
Toxaphene	nc	8	0.8
Polychlorinated Biphenyls			
PCB-1016 (Aroclor 1016)	nc	10 [f]	1
PCB-1221 (Aroclor 1221)	nc	10 [f]	1
PCB-1232 (Aroclor 1232)	nc	10 [f]	1
PCB-1242 (Aroclor 1242)	nc	10 [f]	1
PCB-1248 (Aroclor 1248)	nc	10 [f]	1
PCB-1254 (Aroclor 1254)	nc	10 [f]	1
PCB-1260 (Aroclor 1260)	nc	10 [f]	1
Total Polychlorinatedbiphenyls	nc	10	1
Pesticides			
4,4'-DDD	nc	35	3.5
4,4'-DDE	nc	24	2.4
4,4'-DDT	nc	24	2.4
Aldrin	nc	0.5	0.05
alpha-BHC	nc	0.0026	0.00026
alpha-Chlordane	nc	3 [g]	0.3
beta-BHC	nc	0.009	0.0009
Chlordane	nc	3	0.3
delta-BHC	nc	0.0026 [h]	0.00026
Dieldrin	nc	0.015	0.0015
Endosulfan I	nc	7	0.7
Endosulfan II	nc	7 [i]	0.7
Endosulfan sulfate	nc	7 [i]	0.7
Endrin aldehyde	nc	0.3 [j]	0.03
Endrin ketone	nc	0.3 [j]	0.03
Endrin	nc	0.3	0.03
gamma-BHC (Lindane)	nc	0.003	0.0003
gamma-Chlordane	nc	3 [g]	0.3
Heptachlor epoxide	nc	0.2	0.02
Heptachlor	nc	0.8	0.08
Methoxychlor	nc	52	5.2
Dioxins and Furans			
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	nc	na [k]	na
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	nc	na [k]	na
1,2,3,4,6,7,8-Heptachlorodibenzofuran	nc	na [k]	na

Table 3-3 Tier I Human Health COPC Screening Criteria - Freshwater Sediment

Analyte	BUTL (mg/kg) [a]	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
Dioxins and Furans (Cont.)			
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	nc	na [k]	na
1,2,3,4,7,8,9-Heptachlorodibenzofuran	nc	na [k]	na
1,2,3,4,7,8-Hexachlorodibenzofuran	nc	na [k]	na
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	nc	na [k]	na
1,2,3,6,7,8-Hexachlorodibenzofuran	nc	na [k]	na
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	nc	na [k]	na
1,2,3,7,8,9-Hexachlorodibenzofuran	nc	na [k]	na
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	nc	na [k]	na
1,2,3,7,8-Pentachlorodibenzofuran	nc	na [k]	na
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	nc	na [k]	na
2,3,4,6,7,8-Hexachlorodibenzofuran	nc	na [k]	na
2,3,4,7,8-Pentachlorodibenzofuran	nc	na [k]	na
2,3,7,8-Tetrachlorodibenzofuran	nc	na [k]	na
2,3,7,8-Tetrachlorodibenzo-p-dioxin	nc	na [k]	na
Dibenzofuran	nc	na [k]	na
Octachlorodibenzofuran	nc	na [k]	na
Octachlorodibenzo-p-dioxin	nc	na [k]	na
Total Heptachlorodibenzofurans (HpCDF)	nc	na [k]	na
Total Heptachlorodibenzo-p-dioxins (HpCDD)	nc	na [k]	na
Total Hexachlorodibenzofurans (HxCDF)	nc	na [k]	na
Total Hexachlorodibenzo-p-dioxins (HxCDD)	nc	na [k]	na
Total Pentachlorodibenzofurans (PeCDF)	nc	na [k]	na
Total Pentachlorodibenzo-p-dioxin (PeCDD)	nc	na [k]	na
Total Tetrachlorodibenzofurans (TCDF)	nc	na [k]	na
Total Tetrachlorodibenzo-p-dioxins (TCDD)	nc	na [k]	na
Polynuclear Aromatic Hydrocarbons			
2-Methylnaphthalene	nc	43	4.3
Acenaphthene	nc	210	21
Acenaphthylene	nc	210	21
Anthracene	nc	4,300	430
Benzo(a)anthracene	nc	6	0.6
Benzo(a)pyrene	nc	1	0.1
Benzo(b)fluoranthene	nc	11	1.1
Benzo(g,h,i)perylene	nc	1,500	150
Benzo(k)fluoranthene	nc	110	11
Chrysene	nc	620	62
Dibenzo(a,h)anthracene	nc	1	0.1
Fluoranthene	nc	2,100	210
Fluorene	nc	270	27
Indeno(1,2,3-cd)pyrene	nc	11	1.1
Naphthalene	nc	21	2.1

Table 3-3 Tier I Human Health COPC Screening Criteria - Freshwater Sediment

Analyte	BUTL (mg/kg) [a]	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)
Polynuclear Aromatic Hydrocarbons (Cont.)			
Phenanthrene	nc	4,300	430
Pyrene	nc	1,500	150
Petroleum Hydrocarbons			
DRO	nc	250	25
DRO - Aromatic	nc	100	10
DRO - Aliphatic	nc	7,200	720
GRO	nc	300	30
GRO - Aromatic	nc	150	15
GRO - Aliphatic	nc	270	27
RRO	nc	10,000	1,000
RRO - Aliphatic	nc	20,000	2,000
RRO - Aromatic	nc	3,000	300
Total Recoverable Petroleum Hydrocarbons	nc	NA [1]	NA

Notes:

ADEC - Alaska Department of Environmental Conservation
BHC - Benzene hexachloride
BUTL - Background upper tolerance limit
COPC - Chemical of potential concern
DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethylene
DDT - Dichlorodiphenyltrichloroethane
DRO - Diesel range organics
GRO - Gasoline range organics
mg/kg - Milligrams per kilogram
NA - Not applicable
na - Not available
nc - Not calculated
PCB - Polychlorinated bipheyls
RRO - Residual range organics

[a] Please refer to MWH, 2003b. Ambient levels in the form of background upper tolerance limits (BUTLs) were not calculated (nc) when insufficient sampling results were available to derive a statistically meaningful BUTL. Ambient levels were only derived for inorganic chemicals, not organic chemicals.

[b] Regulatory Criteria is derived from the following hierarchy:

1. Minimum of 3 pathways listed in Tables B1 and B2, Under 40 inch zone: ADEC, 2003a. 18 AAC 75 Oil and Hazardous Substances Pollution Control. January 30.
2. Minimum of 3 pathways listed in Tables B1 and B2, Under 40 inch zone: ADEC, 2002a. Cumulative Risk Guidance. November 7.
3. Minimum of 3 pathways listed in Tables B1 and B2, Under 40 inch zone: ADEC, 2001b. Calculated Cleanup Levels for Compounds without Tabular Values in Site Cleanup Rules - Technical Memorandum 01-007. December 18.

[c] Benchmark criterion is equal to 1/10 the indicated regulatory criterion.

[d] This analyte is excluded as a COPC due to status as an essential nutrient.

[e] Based on residential cleanup value cited in 18 AAC 75.340, calculated according to Risk Assessment Procedures Manual guidance.

Table 3-3 Tier I Human Health COPC Screening Criteria - Freshwater Sediment

Analyte	BUTL (mg/kg) [a]	Regulatory Criteria[b] (mg/kg)	COPC Screening Benchmark[c] (mg/kg)

[f] Total polychlorinated biphenyls (PCBs) used as a surrogate for all PCBs (i.e., Aroclors). Consistent with IRIS (USEPA, 2003a), carcinogenic effects of Aroclors are evaluated using the cancer slope factor for "polychlorinated biphenyls".

[g] Chlordane used as a surrogate for alpha- and gamma-chlordane. Alpha and gamma isomers of chlordane are structurally similar cyclodiene insecticides and neurotoxicants, and are components of technical chlordane.

[h] Alpha-BHC used as a surrogate for delta-BHC. Alpha, beta, gamma and delta isomers of hexachlorocyclohexane (BHC) are structurally similar neurotoxicants, and are all components of technical BHC.

[i] Endosulfan used as a surrogate for endosulfan II and endosulfan sulfate. Endosulfan I and endosulfan II are structural isomers of one another, toxicologically similar, and comprise technical endosulfan. Endosulfan sulfate is an impurity in technical endosulfan, is an oxidative metabolite of endosulfan I and endosulfan II, and retains the biological activity of endosulfan.

[j] Endrin used as a surrogate for endrin aldehyde and endrin ketone. Endrin aldehyde is an impurity in technical endrin, as well as a metabolite of endrin. Endrin ketone is formed when endrin is exposed to light. Endrin aldehyde and endrin ketone retain the biological activity of endrin.

[k] Screening criteria is currently not available for dioxins and furans; therefore, these analytes are carried through as COPCs.

[l] Total recoverable petroleum hydrocarbons (TRPHs) are excluded as a COPC due to outdated analytical methods.

Table 3-4 Tier I Human Health COPC Screening Criteria - Fresh Surface Water

Analyte	BUTL (mg/L) [a]	Regulatory Criteria[b] (mg/L)	COPC Screening Benchmark[c] (mg/L)
Inorganics, Total			
Aluminum	nc	0.087	0.0087
Antimony	nc	0.006	0.0006
Arsenic	nc	0.036	0.0036
Barium	nc	2	0.2
Beryllium	nc	0.004	0.0004
Cadmium	nc	0.005	0.0005
Calcium	nc	NA [d]	NA
Chromium	nc	0.011	0.0011
Cobalt	nc	0.05	0.005
Copper	nc	0.0031	0.00031
Iron	nc	NA [d]	NA
Lead	nc	0.0081	0.00081
Magnesium	nc	NA [d]	NA
Manganese	nc	0.05	0.005
Mercury	nc	0.000050	0.0000050
Nickel	nc	0.0082	0.00082
Potassium	nc	NA [d]	NA
Selenium	nc	0.005	0.0005
Silver	nc	0.0019	0.00019
Sodium	nc	NA [d]	NA
Thallium	nc	0.0017	0.00017
Vanadium	nc	0.10	0.010
Zinc	nc	0.081	0.0081
Inorganics, Dissolved			
Antimony, Dissolved	nc	0.006	0.0006
Arsenic, Dissolved	nc	0.05	0.005
Beryllium, Dissolved	nc	0.004	0.0004
Cadmium, Dissolved	nc	0.005	0.0005
Chromium, Dissolved	nc	0.1	0.01
Copper, Dissolved	nc	1.3	0.13
Iron, dissolved	nc	na	na
Lead, Dissolved	nc	0.015	0.0015
Manganese, dissolved	nc	na	na
Mercury, Dissolved	nc	0.002	0.0002
Nickel, Dissolved	nc	0.1	0.01
Selenium, Dissolved	nc	0.05	0.005
Silver, Dissolved	nc	0.18	0.018
Thallium, Dissolved	nc	0.002	0.0002
Zinc, Dissolved	nc	11	1.1

Table 3-4 Tier I Human Health COPC Screening Criteria - Fresh Surface Water

Analyte	BUTL (mg/L) [a]	Regulatory Criteria[b] (mg/L)	COPC Screening Benchmark[c] (mg/L)
Volatile Organic Compounds			
1,1,1,2-Tetrachloroethane	nc	na	na
1,1,1-Trichloroethane	nc	0.2	0.02
1,1,2,2-Tetrachloroethane	nc	0.004	0.0004
1,1,2-Trichloroethane	nc	0.005	0.0005
1,1-Dichloroethane	nc	3.65	0.365
1,1-Dichloroethene	nc	0.007	0.0007
1,1-Dichloropropene	nc	na	na
1,2,3-Trichlorobenzene	nc	na	na
1,2,3-Trichloropropane	nc	0.0004	0.00004
1,2,4-Trichlorobenzene	nc	0.07	0.007
1,2,4-Trimethylbenzene	nc	1.85	0.185
1,2-Dibromo-3-chloropropane	nc	0.0002	0.00002
1,2-Dibromoethane	nc	na	na
1,2-Dichlorobenzene	nc	0.6	0.06
1,2-Dichloroethane	nc	0.005	0.0005
1,2-Dichloropropane	nc	0.005	0.0005
1,3,5-Trimethylbenzene	nc	1.85	0.185
1,3-Dichlorobenzene	nc	0.03	0.003
1,3-Dichloropropane	nc	0.01	0.001
1,4-Dichlorobenzene	nc	0.075	0.0075
1-Chlorohexane	nc	na	na
2,2-Dichloropropane	nc	na	na
2-Butanone	nc	22	2.2
2-Chloroethyl vinyl ether	nc	na	na
2-Chloronaphthalene	nc	1.5	0.15
2-Chlorophenol	nc	0.12	0.012
2-Chlorotoluene	nc	na	na
2-Hexanone	nc	na	na
4-Bromophenyl phenyl ether	nc	na	na
4-Chlorophenyl phenyl ether	nc	na	na
4-Isopropyltoluene	nc	na	na
4-Methyl-2-pentanone	nc	na	na
Acetone	nc	3.65	0.365
Acrolein	nc	0.32	0.032
Benzene	nc	0.005	0.0005
bis-(2-Chloroethyl)ether	nc	0.00077	0.000077
bis(2-Chloroisopropyl)ether	nc	0.0014	0.00014
Bromobenzene	nc	na	na
Bromochloromethane	nc	na	na
Bromodichloromethane	nc	0.1	0.01

Table 3-4 Tier I Human Health COPC Screening Criteria - Fresh Surface Water

Analyte	BUTL (mg/L) [a]	Regulatory Criteria[b] (mg/L)	COPC Screening Benchmark[c] (mg/L)
Volatile Organic Compounds (Cont.)			
Bromoethane	nc	na	na
Bromoform	nc	0.1	0.01
Bromomethane	nc	na	na
Carbon disulfide	nc	3.65	0.365
Carbon tetrachloride	nc	0.005	0.0005
Chlorobenzene	nc	0.1	0.01
Chloroethane	nc	na	na
Chloroform	nc	0.1	0.01
Chloromethane	nc	na	na
cis-1,2-Dichloroethene	nc	0.07	0.007
cis-1,3-Dichloropropene	nc	0.005	0.0005
Dibromochloromethane	nc	na	na
Dibromomethane	nc	na	na
Dichlorodifluoromethane	nc	7.3	0.73
Ethane	nc	na	na
Ethene	nc	na	na
Ethylbenzene	nc	0.7	0.07
Isopropylbenzene	nc	3.65	0.365
m,p-Xylene (Sum of Isomers)	nc	10	1
Methane	nc	na	na
Methyl iodide	nc	na	na
Methylene chloride	nc	0.005	0.0005
n-Butylbenzene	nc	na	na
Nitrobenzene	nc	0.017	0.0017
n-Propylbenzene	nc	na	na
o-Xylene	nc	10	1
p-Isopropyltoluene	nc	na	na
sec-Butylbenzene	nc	na	na
Styrene	nc	0.1	0.01
tert-Butylbenzene	nc	na	na
Tetrachloroethene	nc	0.005	0.0005
Toluene	nc	1	0.1
trans-1,2-Dichloroethene	nc	0.1	0.01
trans-1,3-Dichloropropene	nc	0.005	0.0005
trans-1,4-Dichloro-2-butene	nc	na	na
Trichloroethene	nc	0.005	0.0005
Trichlorofluoromethane	nc	na	na
Vinyl acetate	nc	36.5	3.65
Vinyl chloride	nc	0.002	0.0002
Xylene, Isomers m & p	nc	10	1
Xylenes	nc	10	1

Table 3-4 Tier I Human Health COPC Screening Criteria - Fresh Surface Water

Analyte	BUTL (mg/L) [a]	Regulatory Criteria[b] (mg/L)	COPC Screening Benchmark[c] (mg/L)
Semi-volatile Organic Compounds			
1,1,2-Trichloro-1,2,2-trifluoroethane	nc	na	na
2,4,5-Trichlorophenol	nc	3.65	0.365
2,4,6-Trichlorophenol	nc	0.077	0.0077
2,4-Dichlorophenol	nc	0.093	0.0093
2,4-Dimethylphenol	nc	0.54	0.054
2,4-Dinitrophenol	nc	0.07	0.007
2,4-Dinitrotoluene	nc	0.00125	0.000125
2,6-Dinitrotoluene	nc	0.00125	0.000125
2-Methyl-4,6-dinitrophenol	nc	0.0134	0.00134
2-Methylphenol (o-Cresol)	nc	1.8	0.18
2-Nitroaniline	nc	na	na
2-Nitrophenol	nc	na	na
3,3-Dichlorobenzidine	nc	0.002	0.0002
3-Nitroaniline	nc	na	na
4-Chloro-3-methylphenol	nc	na	na
4-Chloroaniline	nc	0.15	0.015
4-Chlorotoluene	nc	na	na
4-Methylphenol (p-Cresol)	nc	na	na
4-Nitroaniline	nc	na	na
4-Nitrophenol	nc	na	na
Acrylamide	nc	na	na
Benzidine	nc	na	na
Benzoic acid	nc	146	14.6
Benzyl alcohol	nc	na	na
Benzyl butyl phthalate	nc	3.0	0.30
bis-(2-chloroethoxy)methane	nc	na	na
bis-(2-ethylhexyl)phthalate	nc	0.006	0.0006
Carbazole	nc	0.04	0.004
Diethyl phthalate	nc	23	2.3
Dimethyl phthalate	nc	313	31.3
Di-n-butyl phthalate	nc	2.7	0.27
Di-n-octyl phthalate	nc	0.7	0.07
Hexachlorobenzene	nc	0.001	0.0001
Hexachlorobutadiene	nc	0.01	0.001
Hexachlorocyclopentadiene	nc	0.05	0.005
Hexachloroethane	nc	0.06	0.006
Isophorone	nc	0.9	0.09
n-Nitrosodi-n-propylamine	nc	0.0001	0.00001

Table 3-4 Tier I Human Health COPC Screening Criteria - Fresh Surface Water

Analyte	BUTL (mg/L) [a]	Regulatory Criteria[b] (mg/L)	COPC Screening Benchmark[c] (mg/L)
Semi-volatile Organic Compounds (Cont.)			
n-Nitrosodiphenylamine	nc	0.17	0.017
Pentachlorophenol	nc	0.001	0.0001
Polychlorinated Biphenyls			
PCB-1016 (Aroclor 1016)	nc	0.000014 [e]	0.0000014
PCB-1221 (Aroclor 1221)	nc	0.000014 [e]	0.0000014
PCB-1232 (Aroclor 1232)	nc	0.000014 [e]	0.0000014
PCB-1242 (Aroclor 1242)	nc	0.000014 [e]	0.0000014
PCB-1248 (Aroclor 1248)	nc	0.000014 [e]	0.0000014
PCB-1254 (Aroclor 1254)	nc	0.000014 [e]	0.0000014
PCB-1260 (Aroclor 1260)	nc	0.000014 [e]	0.0000014
Pesticides			
4,4'-DDD	nc	0.0036	0.00036
4,4'-DDE	nc	0.0025	0.00025
4,4'-DDT	nc	0.000001	0.0000001
Aldrin	nc	0.00005	0.000005
delta-BHC	nc	0.0001 [f]	0.00001
Dieldrin	nc	0.0000019	0.00000019
Endrin aldehyde	nc	0.00076 [g]	0.000076
gamma-BHC (Lindane)	nc	0.00016	0.000016
Heptachlor epoxide	nc	0.0000036	0.00000036
Heptachlor	nc	0.0000036	0.00000036
Dioxins and Furans			
1,2,3,4,6,7,8,9-Octachlordibenzofuran	nc	na [h]	na
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	nc	na [h]	na
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	nc	na [h]	na
1,2,3,4,6,7,8-Heptachlorodibenzofuran	nc	na [h]	na
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	nc	na [h]	na
1,2,3,4,7,8,9-Heptachlorodibenzofuran	nc	na [h]	na
1,2,3,4,7,8-Hexachlorodibenzofuran	nc	na [h]	na
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	nc	na [h]	na
1,2,3,6,7,8-Hexachlorodibenzofuran	nc	na [h]	na
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	nc	na [h]	na
1,2,3,7,8,9-Hexachlorodibenzofuran	nc	na [h]	na
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	nc	na [h]	na
1,2,3,7,8-Pentachlorodibenzofuran	nc	na [h]	na
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	nc	na [h]	na
2,3,4,6,7,8-Hexachlorodibenzofuran	nc	na [h]	na
2,3,4,7,8-Pentachlorodibenzofuran	nc	na [h]	na

Table 3-4 Tier I Human Health COPC Screening Criteria - Fresh Surface Water

Analyte	BUTL (mg/L) [a]	Regulatory Criteria[b] (mg/L)	COPC Screening Benchmark[c] (mg/L)
Dioxins and Furans (Cont.)			
2,3,7,8-Tetrachlorodibenzofuran	nc	na [h]	na
2,3,7,8-Tetrachlorodibenzo-p-dioxin	nc	na [h]	na
Dibenzofuran	nc	0.15	0.015
Total Heptachlorodibenzofurans (HpCDF)	nc	na [h]	na
Total Heptachlorodibenzo-p-dioxins (HpCDD)	nc	na [h]	na
Total Hexachlorodibenzofurans (HxCDF)	nc	na [h]	na
Total Hexachlorodibenzo-p-dioxins (HxCDD)	nc	na [h]	na
Total Pentachlorodibenzofurans (PeCDF)	nc	na [h]	na
Total Pentachlorodibenzo-p-dioxin (PeCDD)	nc	na [h]	na
Total Tetrachlorodibenzofurans (TCDF)	nc	na [h]	na
Total Tetrachlorodibenzo-p-dioxins (TCDD)	nc	na [h]	na
Polynuclear Aromatic Hydrocarbons			
2-Methylnaphthalene	nc	1.5	0.15
Acenaphthene	nc	1.2	0.12
Acenaphthylene	nc	2.2	0.22
Anthracene	nc	9.6	0.96
Benzo(a)anthracene	nc	0.001	0.0001
Benzo(a)pyrene	nc	0.0002	0.00002
Benzo(b)fluoranthene	nc	0.001	0.0001
Benzo(g,h,i)perylene	nc	1.1	0.11
Benzo(k)fluoranthene	nc	0.01	0.001
Chrysene	nc	0.1	0.01
Dibenzo(a,h)anthracene	nc	0.0001	0.00001
Fluoranthene	nc	1.3	0.13
Fluorene	nc	1.46	0.146
Indeno(1,2,3-cd)pyrene	nc	0.001	0.0001
Naphthalene	nc	1.46	0.146
Phenanthrene	nc	11	1.1
Phenol	nc	21	2.1
Pyrene	nc	0.96	0.096
Petroleum Hydrocarbons			
DRO	nc	1.5	0.15
DRO - Aliphatic	nc	0.1	0.01
GRO	nc	1.3	0.13
RRO	nc	1.1	0.11
RRO - Aliphatic	nc	NA [i]	NA
RRO - Aromatic	nc	1.1	0.11
Total Recoverable Petroleum Hydrocarbons	nc	NA [j]	NA

Table 3-4 Tier I Human Health COPC Screening Criteria - Fresh Surface Water

Analyte	BUTL (mg/L) [a]	Regulatory Criteria[b] (mg/L)	COPC Screening Benchmark[c] (mg/L)

Notes:

ADEC - Alaska Department of Environmental Conservation
BHC - Benzene hexachloride
BUTL - Background upper tolerance limit
COPC - Chemical of potential concern
DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethylene
DDT - Dichlorodiphenyltrichloroethane
DRO - Diesel range organics
GRO - Gasoline range organics
mg/kg - Milligrams per kilogram
NA - Not applicable
na - Not available
nc - Not calculated
PCB - Polychlorinated bipheyls
RRO - Residual range organics

[a] Please refer to MWH, 2003b. Ambient levels in the form of background upper tolerance limits (BUTLs) were not calculated (nc) when insufficient sampling results were available to derive a statistically meaningful BUTL. Ambient levels were only derived for inorganic chemicals, not organic chemicals.

[b] Regulatory Criteria is equal to the minimum ADEC Groundwater Cleanup Level proposed by the following:
- ADEC Water Quality Standards 18 AAC 70, amended June 26, 2003b.
- ADEC Groundwater Cleanup Levels Table C. ADEC, 2003a.
- ADEC Calculated Cleanup Levels for Compounds without Tabulated Values in Site Cleanup Rules. ADEC, 2001b.

[c] Benchmark criterion is equal to 1/10 the indicated regulatory criterion.

[d] This analyte is excluded as a COPC due to status as an essential nutrient.

[e] Total polychlorinated biphenyls (PCBs) used as a surrogate for all PCBs (i.e., Aroclors). Consistent with IRIS (USEPA, 2003a), carcinogenic effects of Aroclors are evaluated using the cancer slope factor for "polychlorinated biphenyls".

[f] Alpha-BHC used as a surrogate for delta-BHC. Alpha, beta, gamma and delta isomers of hexachlorocyclohexane (BHC) are structurally similar neurotoxicants, and are all components of technical BHC.

[g] Endrin used as a surrogate for endrin aldehyde and endrin ketone. Endrin aldehyde is an impurity in technical endrin, as well as a metabolite of endrin. Endrin ketone is formed when endrin is exposed to light. Endrin aldehyde and endrin ketone retain the biological activity of endrin.

[h] Screening criteria is currently not available for dioxins and furans; therefore, these analytes are carried through as COPCs.

[i] RRO_aliphatic is non-soluble and is, therefore, excluded as a COPC.

[j] Total recoverable petroleum hydrocarbons (TRPHs) are excluded as a COPC due to outdated analytical methods.

Table 3-5 Tier I Human Health COPC Screening Criteria - Subsurface Water

Analyte	Subsurface Water BUTL (mg/L) [a] Shallow	Subsurface Water BUTL (mg/L) [a] Deep	Regulatory Criteria [b] (mg/L)	COPC Screening Benchmark [c] (mg/L)
Inorganics, Total				
Aluminum	nc	nc	na	na
Antimony	nc	nc	0.006	0.0006
Arsenic	0.025	nc	0.05	0.005
Barium	nc	nc	2	0.2
Beryllium	0.021	nc	0.004	0.0004
Cadmium	0.060	nc	0.005	0.0005
Calcium	nc	nc	NA [d]	NA
Chromium	1.7	nc	0.1	0.01
Cobalt	0.011	nc	na	na
Copper	0.087	nc	1.3	0.13
Iron	nc	nc	NA [d]	NA
Lead	0.013	nc	0.015	0.0015
Magnesium	nc	nc	NA [d]	NA
Manganese	0.20	nc	na	na
Mercury	0.00041	nc	0.002	0.0002
Nickel	0.056	nc	0.1	0.01
Potassium	nc	nc	NA [d]	NA
Selenium	nc	nc	0.05	0.005
Silver	nc	nc	0.18	0.018
Sodium	nc	nc	NA [d]	NA
Thallium	nc	nc	0.002	0.0002
Vanadium	0.097	nc	0.26	0.026
Zinc	0.29	nc	11	1.1
Inorganics, Dissolved				
Antimony, Dissolved	nc	nc	0.006	0.0006
Arsenic, Dissolved	nc	nc	0.05	0.005
Beryllium, Dissolved	nc	nc	0.004	0.0004
Cadmium, Dissolved	nc	nc	0.005	0.0005
Chromium, Dissolved	nc	nc	0.1	0.01
Copper, Dissolved	nc	nc	1.3	0.13
Iron, dissolved	nc	nc	na	na
Lead, Dissolved	nc	nc	0.015	0.0015
Manganese, dissolved	nc	nc	na	na
Mercury, Dissolved	nc	nc	0.002	0.0002
Nickel, Dissolved	nc	nc	0.1	0.01
Selenium, Dissolved	nc	nc	0.05	0.005
Silver, Dissolved	nc	nc	0.18	0.018
Thallium, Dissolved	nc	nc	0.002	0.0002
Zinc, Dissolved	nc	nc	11	1.1

Table 3-5 Tier I Human Health COPC Screening Criteria - Subsurface Water

Analyte	Subsurface Water BUTL (mg/L) [a]		Regulatory Criteria [b] (mg/L)	COPC Screening Benchmark [c] (mg/L)
	Shallow	Deep		
Volatile Organic Compounds				
1,1,1,2-Tetrachloroethane	nc	nc	na	na
1,1,1-Trichloroethane	nc	nc	0.2	0.02
1,1,2,2-Tetrachloroethane	nc	nc	0.004	0.0004
1,1,2-Trichloroethane	nc	nc	0.005	0.0005
1,1-Dichloroethane	nc	nc	3.65	0.365
1,1-Dichloroethene	nc	nc	0.007	0.0007
1,1-Dichloropropene	nc	nc	na	na
1,2,3-Trichlorobenzene	nc	nc	na	na
1,2,3-Trichloropropane	nc	nc	0.0004	0.00004
1,2,4-Trichlorobenzene	nc	nc	0.07	0.007
1,2,4-Trimethylbenzene	nc	nc	1.85	0.185
1,2-Dibromo-3-chloropropane	nc	nc	na	na
1,2-Dibromoethane	nc	nc	na	na
1,2-Dichlorobenzene	nc	nc	0.6	0.06
1,2-Dichloroethane	nc	nc	0.005	0.0005
1,2-Dichloropropane	nc	nc	0.005	0.0005
1,3,5-Trimethylbenzene	nc	nc	1.85	0.185
1,3-Dichlorobenzene	nc	nc	0.03	0.003
1,3-Dichloropropane	nc	nc	na	na
1,4-Dichlorobenzene	nc	nc	0.075	0.0075
1-Chlorohexane	nc	nc	na	na
2,2-Dichloropropane	nc	nc	na	na
2-Butanone	nc	nc	22	2.2
2-Chloroethyl vinyl ether	nc	nc	na	na
2-Chloronaphthalene	nc	nc	1.5	0.15
2-Chlorophenol	nc	nc	0.2	0.02
2-Chlorotoluene	nc	nc	na	na
2-Hexanone	nc	nc	na	na
4-Bromophenyl phenyl ether	nc	nc	na	na
4-Chlorophenyl phenyl ether	nc	nc	na	na
4-Isopropyltoluene	nc	nc	na	na
4-Methyl-2-pentanone	nc	nc	na	na
Acetone	nc	nc	3.65	0.365
Acrolein	nc	nc	na	na
Benzene	nc	nc	0.005	0.0005
bis-(2-Chloroethyl)ether	nc	nc	0.00077	0.000077
bis(2-Chloroisopropyl)ether	nc	nc	na	na
Bromobenzene	nc	nc	na	na
Bromochloromethane	nc	nc	na	na
Bromodichloromethane	nc	nc	0.1	0.01
Bromoethane	nc	nc	na	na

Table 3-5 Tier I Human Health COPC Screening Criteria - Subsurface Water

Analyte	Subsurface Water BUTL (mg/L) [a] Shallow	Subsurface Water BUTL (mg/L) [a] Deep	Regulatory Criteria [b] (mg/L)	COPC Screening Benchmark [c] (mg/L)
Volatile Organic Compounds (Cont.)				
Bromoform	nc	nc	0.1	0.01
Bromomethane	nc	nc	na	na
Carbon disulfide	nc	nc	3.65	0.365
Carbon tetrachloride	nc	nc	0.005	0.0005
Chlorobenzene	nc	nc	0.1	0.01
Chloroethane	nc	nc	na	na
Chloroform	nc	nc	0.1	0.01
Chloromethane	nc	nc	na	na
cis-1,2-Dichloroethene	nc	nc	0.07	0.007
cis-1,3-Dichloropropene	nc	nc	0.005	0.0005
Dibromochloromethane	nc	nc	na	na
Dibromomethane	nc	nc	na	na
Dichlorodifluoromethane	nc	nc	7.3	0.73
Ethane	nc	nc	na	na
Ethene	nc	nc	na	na
Ethylbenzene	nc	nc	0.7	0.07
Isopropylbenzene	nc	nc	3.65	0.365
m,p-Xylene (Sum of Isomers)	nc	nc	10	1
Methane	nc	nc	na	na
Methyl iodide	nc	nc	na	na
Methylene chloride	nc	nc	0.005	0.0005
n-Butylbenzene	nc	nc	na	na
Nitrobenzene	nc	nc	0.018	0.0018
n-Propylbenzene	nc	nc	na	na
o-Xylene	nc	nc	10	1
p-Isopropyltoluene	nc	nc	na	na
sec-Butylbenzene	nc	nc	na	na
Styrene	nc	nc	0.1	0.01
tert-Butylbenzene	nc	nc	na	na
Tetrachloroethene	nc	nc	0.005	0.0005
Toluene	nc	nc	10	1
trans-1,2-Dichloroethene	nc	nc	0.1	0.01
trans-1,3-Dichloropropene	nc	nc	0.005	0.0005
trans-1,4-Dichloro-2-butene	nc	nc	na	na
Trichloroethene	nc	nc	0.005	0.0005
Trichlorofluoromethane	nc	nc	na	na
Vinyl acetate	nc	nc	36.5	3.65
Vinyl chloride	nc	nc	0.002	0.0002
Xylene, Isomers m & p	nc	nc	10	1
Xylenes	nc	nc	10	1

Table 3-5 Tier I Human Health COPC Screening Criteria - Subsurface Water

Analyte	Subsurface Water BUTL (mg/L) [a]		Regulatory Criteria [b] (mg/L)	COPC Screening Benchmark [c] (mg/L)
	Shallow	Deep		
Semi-volatile Organic Compounds				
1,1,2-Trichloro-1,2,2-trifluoroethane	nc	nc	na	na
2,4,5-Trichlorophenol	nc	nc	3.65	0.365
2,4,6-Trichlorophenol	nc	nc	0.077	0.0077
2,4-Dichlorophenol	nc	nc	0.1	0.01
2,4-Dimethylphenol	nc	nc	0.7	0.07
2,4-Dinitrophenol	nc	nc	0.07	0.007
2,4-Dinitrotoluene	nc	nc	0.00125	0.000125
2,6-Dinitrotoluene	nc	nc	0.00125	0.000125
2-Methyl-4,6-dinitrophenol	nc	nc	na	na
2-Methylphenol (o-Cresol)	nc	nc	1.8	0.18
2-Nitroaniline	nc	nc	na	na
2-Nitrophenol	nc	nc	na	na
3,3-Dichlorobenzidine	nc	nc	0.002	0.0002
3-Nitroaniline	nc	nc	na	na
4-Chloro-3-methylphenol	nc	nc	na	na
4-Chloroaniline	nc	nc	0.15	0.015
4-Chlorotoluene	nc	nc	na	na
4-Methylphenol (p-Cresol)	nc	nc	na	na
4-Nitroaniline	nc	nc	na	na
4-Nitrophenol	nc	nc	na	na
Acrylamide	nc	nc	na	na
Benzidine	nc	nc	na	na
Benzoic acid	nc	nc	146	14.6
Benzyl alcohol	nc	nc	na	na
Benzyl butyl phthalate	nc	nc	7.3	0.73
bis-(2-chloroethoxy)methane	nc	nc	na	na
bis-(2-ethylhexyl)phthalate	nc	nc	0.006	0.0006
Carbazole	nc	nc	0.04	0.004
Diethyl phthalate	nc	nc	29	2.9
Dimethyl phthalate	nc	nc	na	na
Di-n-butyl phthalate	nc	nc	na	na
Di-n-octyl phthalate	nc	nc	0.7	0.07
Hexachlorobenzene	nc	nc	0.001	0.0001
Hexachlorobutadiene	nc	nc	0.01	0.001
Hexachlorocyclopentadiene	nc	nc	0.05	0.005
Hexachloroethane	nc	nc	0.06	0.006
Isophorone	nc	nc	0.9	0.09
n-Nitrosodi-n-propylamine	nc	nc	0.0001	0.00001
n-Nitrosodiphenylamine	nc	nc	0.17	0.017
Pentachlorophenol	nc	nc	0.001	0.0001

Table 3-5 Tier I Human Health COPC Screening Criteria - Subsurface Water

Analyte	Subsurface Water BUTL (mg/L) [a] Shallow	Subsurface Water BUTL (mg/L) [a] Deep	Regulatory Criteria [b] (mg/L)	COPC Screening Benchmark [c] (mg/L)
Polychlorinated Biphenyls				
PCB-1016 (Aroclor 1016)	nc	nc	0.0005 [e]	0.00005
PCB-1221 (Aroclor 1221)	nc	nc	0.0005 [e]	0.00005
PCB-1232 (Aroclor 1232)	nc	nc	0.0005 [e]	0.00005
PCB-1242 (Aroclor 1242)	nc	nc	0.0005 [e]	0.00005
PCB-1248 (Aroclor 1248)	nc	nc	0.0005 [e]	0.00005
PCB-1254 (Aroclor 1254)	nc	nc	0.0005 [e]	0.00005
PCB-1260 (Aroclor 1260)	nc	nc	0.0005 [e]	0.00005
Pesticides				
4,4'-DDD	nc	nc	0.0036	0.00036
4,4'-DDE	nc	nc	0.0025	0.00025
4,4'-DDT	nc	nc	0.0025	0.00025
Aldrin	nc	nc	0.00005	0.000005
delta-BHC	nc	nc	0.0001 [f]	0.00001
Dieldrin	nc	nc	0.00005	0.000005
Endrin aldehyde	nc	nc	0.002 [g]	0.0002
gamma-BHC (Lindane)	nc	nc	0.0002	0.00002
Heptachlor epoxide	nc	nc	0.0002	0.00002
Heptachlor	nc	nc	0.0004	0.00004
Dioxins and Furans				
1,2,3,4,6,7,8,9-Octachlordibenzofuran	nc	nc	na [h]	na
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	nc	nc	na [h]	na
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	nc	nc	na [h]	na
1,2,3,4,6,7,8-Heptachlorodibenzofuran	nc	nc	na [h]	na
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	nc	nc	na [h]	na
1,2,3,4,7,8,9-Heptachlorodibenzofuran	nc	nc	na [h]	na
1,2,3,4,7,8-Hexachlorodibenzofuran	nc	nc	na [h]	na
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	nc	nc	na [h]	na
1,2,3,6,7,8-Hexachlorodibenzofuran	nc	nc	na [h]	na
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	nc	nc	na [h]	na
1,2,3,7,8,9-Hexachlorodibenzofuran	nc	nc	na [h]	na
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	nc	nc	na [h]	na
1,2,3,7,8-Pentachlorodibenzofuran	nc	nc	na [h]	na
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	nc	nc	na [h]	na
2,3,4,6,7,8-Hexachlorodibenzofuran	nc	nc	na [h]	na
2,3,4,7,8-Pentachlorodibenzofuran	nc	nc	na [h]	na
2,3,7,8-Tetrachlorodibenzofuran	nc	nc	na [h]	na
2,3,7,8-Tetrachlorodibenzo-p-dioxin	nc	nc	na [h]	na
Dibenzofuran	nc	nc	0.15	0.015
Total Heptachlorodibenzofurans (HpCDF)	nc	nc	na [h]	na
Total Heptachlorodibenzo-p-dioxins (HpCDD)	nc	nc	na [h]	na

Table 3-5 Tier I Human Health COPC Screening Criteria - Subsurface Water

Analyte	Subsurface Water BUTL (mg/L) [a] Shallow	Subsurface Water BUTL (mg/L) [a] Deep	Regulatory Criteria [b] (mg/L)	COPC Screening Benchmark [c] (mg/L)
Dioxins and Furans (Cont.)				
Total Hexachlorodibenzofurans (HxCDF)	nc	nc	na [h]	na
Total Hexachlorodibenzo-p-dioxins (HxCDD)	nc	nc	na [h]	na
Total Pentachlorodibenzofurans (PeCDF)	nc	nc	na [h]	na
Total Pentachlorodibenzo-p-dioxin (PeCDD)	nc	nc	na [h]	na
Total Tetrachlorodibenzofurans (TCDF)	nc	nc	na [h]	na
Total Tetrachlorodibenzo-p-dioxins (TCDD)	nc	nc	na [h]	na
Polynuclear Aromatic Hydrocarbons				
2-Methylnaphthalene	nc	nc	1.5	0.15
Acenaphthene	nc	nc	2.2	0.22
Acenaphthylene	nc	nc	2.2	0.22
Anthracene	nc	nc	11	1.1
Benzo(a)anthracene	nc	nc	0.001	0.0001
Benzo(a)pyrene	nc	nc	0.0002	0.00002
Benzo(b)fluoranthene	nc	nc	0.001	0.0001
Benzo(g,h,i)perylene	nc	nc	1.1	0.11
Benzo(k)fluoranthene	nc	nc	0.01	0.001
Chrysene	nc	nc	0.1	0.01
Dibenzo(a,h)anthracene	nc	nc	0.0001	0.00001
Fluoranthene	nc	nc	1.46	0.146
Fluorene	nc	nc	1.46	0.146
Indeno(1,2,3-cd)pyrene	nc	nc	0.001	0.0001
Naphthalene	nc	nc	1.46	0.146
Phenanthrene	nc	nc	11	1.1
Phenol	nc	nc	22	2.2
Pyrene	nc	nc	1.1	0.11
Petroleum Hydrocarbons				
DRO	nc	nc	1.5	0.15
DRO - Aliphatic	nc	nc	0.1	0.01
GRO	nc	nc	1.3	0.13
RRO	nc	nc	1.1	0.11
RRO - Aliphatic	nc	nc	NA [i]	NA
RRO - Aromatic	nc	nc	1.1	0.11
Total Recoverable Petroleum Hydrocarbons	nc	nc	NA [j]	NA

Notes:

ADEC - Alaska Department of Environmental Conservation

BHC - Benzene hexachloride

BUTL - Background upper tolerance limit

COPC - Chemical of potential concern

Table 3-5 Tier I Human Health COPC Screening Criteria - Subsurface Water

Analyte	Subsurface Water BUTL (mg/L) [a] Shallow	Subsurface Water BUTL (mg/L) [a] Deep	Regulatory Criteria [b] (mg/L)	COPC Screening Benchmark [c] (mg/L)

DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethylene
DDT - Dichlorodiphenyltrichloroethane
DRO - Diesel range organics
GRO - Gasoline range organics
mg/kg - Milligrams per kilogram
NA - Not applicable
na - Not available
nc - Not calculated
PCB - Polychlorinated bipheyls
RRO - Residual range organics

[a] Please refer to MWH, 2003b. Ambient levels in the form of background upper tolerance limits (BUTLs) were not calculated (nc) when insufficient sampling results were available to derive a statistically meaningful BUTL. Ambient levels were only derived for inorganic chemicals, not organic chemicals.

[b] Regulatory Criteria is equal to the minimum ADEC Groundwater Cleanup Level proposed by the following:

- ADEC Groundwater Cleanup Levels Table C. ADEC, 2003a.
- ADEC Calculated Cleanup Levels for Compounds without Tabulated Values in Site Cleanup Rules. ADEC, 2001b.

[c] Benchmark criterion is equal to 1/10 the indicated regulatory criterion.

[d] This analyte is excluded as a COPC due to status as an essential nutrient.

[e] Total polychlorinated biphenyls (PCBs) used as a surrogate for all PCBs (i.e., Aroclors). Consistent with IRIS (USEPA, 2003a), carcinogenic effects of Aroclors are evaluated using the cancer slope factor for "polychlorinated biphenyls".

[f] Alpha-BHC used as a surrogate for delta-BHC. Alpha, beta, gamma and delta isomers of hexachlorocyclohexane (BHC) are structurally similar neurotoxicants, and are all components of technical BHC.

[g] Endrin used as a surrogate for endrin aldehyde and endrin ketone. Endrin aldehyde is an impurity in technical endrin, as well as a metabolite of endrin. Endrin ketone is formed when endrin is exposed to light. Endrin aldehyde and endrin ketone retain the biological activity of endrin.

[h] Screening criteria is currently not available for dioxins and furans; therefore, these analytes are carried through as COPCs.

[i] RRO_aliphatic is non-soluble and is, therefore, excluded as a COPC.

[j] Total recoverable petroleum hydrocarbons (TRPHs) are excluded as a COPC due to outdated analytical methods.

Table 3-6 Exposure Parameters for Human Receptors

Exposure Parameter	Units	Current/Future Seasonal Resident		Future Permanent Resident		Current/Future Incidental Visitor
		Adult	Child	Adult	Child	
General						
Soil/Sediment/Dust Concentration - C_S	mg/kg	SS	SS	SS	SS	SS
Body Weight - BW [a]	kg	70	15	70	15	70
Averaging Time - AT [a]						
Carcinogens	years	70	70	70	70	70
Noncarcinogens	years	24	6	24	6	25
Ingestion of Soil/Sediment/Dust						
Soil Ingestion Rate - IR [b]	mg/day	100	200	100	200	50
Exposure Frequency - EF [c]	days/year	90	90	270	270	14
Exposure Duration - ED [a]	year	24	6	24	6	25
Dermal Contact with Soil/Sediment/Dust						
Dermal Surface Area - SA [d]	cm^2/event	3,300	2,800	3,300	2,800	3,300
Skin Adherence Factor - AF [d]	mg/cm^2	0.2	0.2	0.2	0.2	0.2
Skin Absorption Factor - ABS	unitless	CS	CS	CS	CS	CS
Exposure Frequency -EF [c]	days/year	90	90	270	270	14
Exposure Duration - ED [a]	year	24	6	24	6	25
Inhalation of Particulates from Indoor Dust						
Inhalation Rate - InhR [a]	m^3/day	20	10	20	10	20
Particulate Emission Factor - PEF [e]	m^3/kg	1.30E+09	1.30E+09	1.30E+09	1.30E+09	1.30E+09
Exposure Frequency -EF [c]	days/year	90	90	270	270	14
Exposure Duration - ED [a]	year	24	6	24	6	25
Ingestion of Surface Water/Groundwater						
Groundwater Ingestion Rate - IR [a]	liters/day	2	1	2	1	2
Exposure Frequency - EF [f]	days/year	90	90	350	350	14
Exposure Duration - ED [a]	year	24	6	24	6	25
Inhalation of Constituents Volatilizing from Surface Water/Groundwater						
Inhalation Rate - InhR [a]	m^3/day	20	10	20	10	20
Exposure Time - ET [g]	hours/day	0.25	0.25	0.25	0.25	0.25
Volatility Factor - VF	m^3/kg	CS	CS	CS	CS	CS
Exposure Frequency - EF [f]	days/year	90	90	350	350	14
Exposure Duration - ED [a]	year	24	6	24	6	25
Dermal Contact with Surface Water/Groundwater						
Exposure Time - ET [g]	hr	0.25	0.25	0.25	0.25	0.25
Dermal Surface Area - SA [a]	cm^2/event	20,000	20,000	20,000	20,000	20,000
Dermal Permeability Constant - PC	cm/hr	CS	CS	CS	CS	CS
Exposure Frequency -EF [f]	days/year	90	90	350	350	14

Table 3-6 (cont.) Exposure Parameters for Human Receptors

Exposure Parameter	Units	Current/Future Seasonal Resident		Future Permanent Resident		Current/Future Incidental Visitor
		Adult	Child	Adult	Child	
Ingestion of Plants						
Plant Ingestion Rate - IR [h]	grams/day	42	21	42	21	na
Exposure Frequency - EF [i]	day/year	350	350	350	350	na
Exposure Duration - ED [a]	year	24	6	24	6	na
Ingestion of Fish						
Fish Ingestion Rate - IR [j]	grams/day	100	57	100	57	na
Exposure Frequency - EF [i]	days/year	350	350	350	350	na
Exposure Duration - ED [a]	year	24	6	24	6	na

Notes:
cm – Centimeter
cm^2 – Square centimeter
CS – Chemical-specific
gm – Gram(s)
kg – Kilograms
m^3 – Cubic meter
mg - Milligrams
na – Not applicable
SS – Site-specific

[a] Source: Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors (USEPA, 1991a).
[b] Soil ingestion rates (IR) are not currently available for a visitor. The visitor soil ingestion rate is based on assumptions for an industrial worker visiting the site (USEPA, 1991a).
[c] An exposure frequency (EF) of 90 days per year for current/future seasonal residents is based on interviews with locals who indicate that they use the installation for subsistence fishing/hunting/gathering for approximately 3 months of the year.
An EF of 270 days per year for future permanent residents was obtained from Cleanup Levels Guidance (ADEC, 2002b).
An EF of 14 days per year for current/future incidental visitors is based on the assumption that agency representatives, contractors, or other individuals would visit the installation for a total of 2 weeks per year for non-subsistence purposes.
[d] Source: Risk Assessment Guidance for Superfund (RAGS), Supplemental Guidance for Dermal Risk Assessment, Interim (USEPA, 2001a).
[e] Source: Region 10 Interim Final Guidance - Developing Risk-Based Clean-up Levels at Resource Conservation and Recovery Sites in Region 10 (USEPA, 1998c).
[f] An EF of 90 days per year for current/future seasonal residents is based on interviews with locals who indicate that they use the installation for subsistence fishing/hunting/gathering for approximately 3 months of the year. An EF of 350 days per year for contact with surface water/groundwater that is used for domestic purposes was obtained from ADEC (2002b). An EF of 14 days per year for current/future incidental visitors is based on the assumption that agency representatives, contractors, or other individuals would visit the installation for a total of 2 weeks per year for non-subsistence purposes.
[g] Derived from average shower times as cited in Table 4-6 of USEPA (1998c).
[h] Indicated plant ingestion rates (IRPLANTS)for adult and child receptors are based on results of site-specific interviews and surveys conducted at the Northeast Cape Installation, and represent the average daily consumption rate as described in Section 3.1.2.2.3.
i An EF of 350 days per year is assumed, based on plant and fish ingestion rates presented as average annual daily exposures.
[j] Indicated fish ingestion rates (IRFISH) for adult and child receptors is based on the results of site-specific surveys.

Table 3-7 Summary of 2003 Supplemental Survey Results for Subsistence Plant Consumption[a]

	Survey Response (Respondent)					
	Three Males			One Female	Married Couple	
Survey Question	(No. 1)	(No. 2)	(No. 3)	(No. 4)	(No. 5)	(No. 6)
The three main categories of native plants eaten are berries, greens and roots:	Agree	Agree	Agree	Agree	Agree	Agree
Percent of native plants harvested from the Northeast Cape Installation area:	30%	0%	Don't know	10%	0%	0%
Harvested plants are frozen for consumption during the winter:	Agree	Agree	Agree	Agree	Agree	Agree
Frequency of native plant consumption in summer months (meals/week):	4	4	<4	4	<4	<4
Frequency of native plant consumption in non-summer months (meals/month):	1	2	4	2	2	2
Portion size per meal for an adult:	1/2 lb (8 oz)	1/2 lb (8 oz)	1/2 lb (8 oz)	1/2 lb (8 oz)	1/2 lb (8 oz)	1/2 lb (8 oz)
Portion size per meal for a child:	1/4 lb (4 oz)	1/4 lb (4 oz)	1/4 lb (4 oz)	1/4 lb (4 oz)	1/4 lb (4 oz)	1/4 lb (4 oz)

Notes:

[a] The supplemental subsistence food use survey for Northeast Cape was conducted by the U.S. Army Corps of Engineers in January 2003. Refer to Appendix C for complete survey results.

< - Less than

% - Percent

lb - Pound(s)

oz - Ounce(s)

Table 3-8 Summary of 2003 Supplemental Survey Results for Subsistence Fish Consumption [a]

Survey Question	Survey Response (Respondent)						Mean Response
	Three Males			One Female	Married Couple		
	(No. 1)	(No. 2)	(No. 3)	(No. 4)	(No. 5)	(No. 6)	
Number of fish harvested from the Suqitughneq River:	0	0	0	0	0	0	0
Number of fish harvested from other rivers:	~200	~100	~100	~200	100+		140
Number of people in your family who eat harvested fish:	Entire family	Entire family	Entire family	Entire family - 1	Entire family	Entire family	na
Are fish shared with relatives:	Yes	Yes	Yes	Yes	Yes	Yes	na
Are fish cooked with skin on:	Yes	Yes	Yes	Yes	Yes	Yes	na
Area fillets the main food:	Yes	Yes	Yes	Yes	Yes	Yes	na
Are fish dried for later consumption:	Yes	Yes	Yes	Yes	Yes	Yes	na
What portion of fish are dried:	~100	1/2 Catch	1/2 Catch	1/2 Catch	1/2 Catch		
		(50)	(50)	(100)	(50)		70
Frequency of fish fillet consumption in summer months (per week):	6	3	1	3	1	1	2.5
Frequency of dried fish fillet consumption in winter (per week):	1	1	<1	1	1	1	1
Frequency of frozen fish fillet consumption in winter (per week):	1	1	1	1	1	1	1
Number of people a Dolly Varden feeds:	2 adults or	1 adult or	2 adults or	2 adults or	2 adults or	2 adults or	1.8
	3 children	2 children	4 children	3 children	3 children	3 children	3
Portion size per meal for an adult:	1 lb	1 lb	3/4 lb	1 lb	1/3 lb	1/3 lb	
	(16 oz)	(16 oz)	(12 oz)	(16 oz)	(5.3 oz)	(5.3 oz)	12
Portion size per meal for a child:	1/2 lb	1/2 lb	3/4 lb	1/2 lb	1/8 lb	1/8 lb	
	(8 oz)	(8 oz)	(12 oz)	(8 oz)	(2 oz)	(2 oz)	6.7
Number of fish heads consumed per month:	10	1	2	1.67	2	2	<1
	(summer)	(summer)		(summer)	(summer)	(summer)	
Frequency of consumption of fish eggs (per month):	<1	<1	<1	4 - 5 times per yr	<1	<1	<0.25
Frequency of consumption of other fish parts (per week):	24	1	2 - 3	3	1	1	nc
(e.g., fish cheeks, heads, cartilage, etc.)	(summer)			(summer)	(summer)	(summer)	

Notes:

[a] The supplemental subsistence food use survey for Northeast Cape was conducted by the U.S. Army Corps of Engineers in January 2003. Refer to Appendix C for complete survey results.

~ - Approximately

< - Less than

lb - Pound

na - Not applicable

nc - Not calculated (nc) because the consumption frequency for Respondent No. 1 appears to have been a misunderstanding on the part of the respondent, or incorrectly recorded.

oz - Ounce

TABLE 3-9 TOXICITY VALUES USED IN THE BASELINE HUMAN HEALTH RISK ASSESSMENT

Chemical of Potential Concern	Cancer Slope Factor - CSF (mg/kg-d)$^{-1}$			Reference dose - RfD (mg/kg-d)		
	Oral	Dermal	Inhalation	Oral	Dermal	Inhalation
INORGANICS						
Aluminum	na	na	na	1.0E+00 N	1.0E+00 R	1.4E-03 N
Antimony	na	na	na	4.0E-04 I	4.0E-04 R	4.0E-04 R
Arsenic	1.5E+00 I	1.5E+00 R	1.5E+01 I	3.0E-04 I	3.0E-04 R	3.0E-04 R
Barium	na	na	na	7.0E-02 I	7.0E-02 R	1.4E-04 H
Beryllium	na	na	8.4E+00 I	2.0E-03 I	2.0E-03 R	5.7E-06 I [q]
Cadmium	na	na	6.3E+00 I	5.0E-04 I	5.0E-04 R	5.0E-04 R
Chromium	na	na	na	1.5E+00 I [a]	1.5E+00 R [a]	1.5E+00 R [a]
Cobalt	na	na	9.8E+00 N	2.0E-02 N	2.0E-02 R	5.7E-06 R
Copper	na	na	na	3.7E-02 H	3.7E-02 R	3.7E-02 R
Lead	na [b]	na [b]	na [b]	na [b]	na [b]	na [b]
Manganese	na	na	na	1.4E-01 I	1.4E-01 R	1.4E-05 I [q]
Mercury	na	na	na	3.0E-04 I	3.0E-04 R	8.0E-06 I [q]
Nickel	na	na	na	2.0E-02 I	2.0E-02 R	2.0E-02 R
Selenium	na	na	na	5.0E-03 I	5.0E-03 R	5.0E-03 R
Silver	na	na	na	5.0E-03 I	5.0E-03 R	5.0E-03 R
Thallium	na	na	na	7E-05 I [r]	7E-05 R [r]	7E-05 R [r]
Vanadium	na	na	na	7.0E-03 H	7.0E-03 R	7.0E-03 R
Zinc	na	na	na	3.0E-01 I	3.0E-01 R	3.0E-01 R
VOLATILE ORGANIC COMPOUNDS						
1,1,1-Trichloroethane	na	na	na	2.8E-01 N	2.8E-01 R	6.3E-01 N
1,2,4-Trimethylbenzene	na	na	na	5.0E-02 N	5.0E-02 R	1.7E-03 N
1,2-Dibromoethane	8.5E-01 I	8.5E-01 R	7.7E-01 I	5.7E-05 H	5.7E-05 R	5.7E-05 H
1,3-Dichlorobenzene	na	na	na	9.0E-04 N	9.0E-04 R	9.0E-04 R
1,3-Dichloropropane	6.8E-02 H [c]	6.8E-02 R [c]	6.8E-02 R [c]	1.1E-03 R [c]	1.1E-03 R [c]	1.1E-03 I [c,q]
2,2-Dichloropropane	6.8E-02 H [c]	6.8E-02 R [c]	6.8E-02 R [c]	1.1E-03 R [c]	1.1E-03 R [c]	1.1E-03 I [c,q]
2-Chloroethyl vinyl ether	na	na	na	na	na	na
2-Chlorotoluene	na	na	na	2.0E-02 I	2.0E-02 R	2.0E-02 R
2-Hexanone	na	na	na	8.0E-02 H [d]	8.0E-02 R [d]	2.3E-02 H [d]
4-Bromophenyl phenyl ether	na	na	na	na	na	na
4-Chlorophenyl phenyl ether	na	na	na	na	na	na
4-Isopropyltoluene	na	na	na	1.0E-01 I [e]	1.0E-01 R [e]	1.1E-01 R [e]
Acetone	na	na	na	9.0E-01 I	9.0E-01 R	9.0E-01 R
Benzene	5.5E-02 I	5.5E-02 R	2.7E-02 I [p]	4.0E-03 I	4.0E-03 R	8.6E-03 I [q]
Bromoethane	2.9E-03 N [s]	2.9E-03 R [s]	2.9E-03 R [s]	4.0E-01 Nd	4.0E-01 Rd	2.9E+00 Nd

TABLE 3-9 TOXICITY VALUES USED IN THE BASELINE HUMAN HEALTH RISK ASSESSMENT

Chemical of Potential Concern	Cancer Slope Factor - CSF (mg/kg-d)-1			Reference dose - RfD (mg/kg-d)		
	Oral	Dermal	Inhalation	Oral	Dermal	Inhalation
Bromomethane	na	na	na	1.4E-03 I	1.4E-03 R	1.4E-03 I [q]
Ethane	na	na	na	na	na	na
Ethylbenzene	3.9E-03 R	3.9E-03 R	3.9E-03 N	1.0E-01 I	1.0E-01 R	2.9E-01 I [q]
m,p-Xylene (Sum of Isomers)	na	na	na	2.0E-01 I[f]	2.0E-01 R[f]	2.9E-02 I[f,q]
Methylene chloride	7.5E-03 I	7.5E-03 R	1.6E-03 I[p]	6.0E-02 I	6.0E-02 R	8.6E-01 H
n-Butylbenzene	na	na	na	4.0E-02 N	4.0E-02 R	4.0E-02 R
n-Propylbenzene	na	na	na	4.0E-02 N	4.0E-02 R	4.0E-02 R
o-Xylene	na	na	na	2.0E-01 I[f]	2.0E-01 R[f]	2.9E-02 I[f,q]
sec-Butylbenzene	na	na	na	4.0E-02 N	4.0E-02 R	4.0E-02 R
Toluene	na	na	na	2.0E-01 I	2.0E-01 R	1.1E-01 I [q]
Trichloroethene	4.0E-01 N	4.0E-01 R	4.0E-01 N	3.0E-04 N	3.0E-04 R	1.0E-02 N
Xylene, Isomers m & p	na	na	na	2.0E-01 I[f]	2.0E-01 R[f]	2.9E-02 I[f,q]
Xylenes	na	na	na	2.0E-01 I[f]	2.0E-01 R[f]	2.9E-02 I[f,q]
SEMIVOLATILE ORGANIC COMPOUNDS						
3-Nitroaniline	na	na	na	2.9E-05 R[g]	2.9E-05 R[g]	2.9E-05 H[g]
4-Chloroaniline	na	na	na	4.0E-03 I	4.0E-03 R	4.0E-03 R
4-Chlorotoluene	na	na	na	2.0E-02 I[h]	2.0E-02 R[h]	2.0E-02 R[h]
4-Methylphenol (p-Cresol)	na	na	na	5.0E-03 H	5.0E-03 R	5.0E-03 R
4-Methyl-4,6-dinitrophenol	na	na	na	5.0E-04 I[j]	5.0E-04 H[j]	5.7E-04 H[j]
4-Nitroaniline	na	na	na	2.9E-05 R[i]	2.9E-05 R[i]	2.9E-05 H[i]
4-Nitrophenol	na	na	na	5.0E-04 I[j]	5.0E-04 H[j]	5.7E-04 H[j]
Benzoic acid	na	na	na	4.0E+00 I	4.0E+00 R	4.0E+00 R
bis(2-ethylexyl)phthalate	1.4E-02 I	1.4E-02 R	1.4E-02 R	2.0E-02 I	2.0E-02 R	2.0E-02 R
Cresols (Methyl Phenols)	na	na	na	5.0E-03 H	5.0E-03 R	5.0E-03 R
POLYNUCLEAR AROMATIC HYDROCARBONS						
2-Methylnaphthalene	na	na	na	2.0E-02 I[k]	2.0E-02 R[k]	8.6E-04 I[k,q]
Acenaphthene	na	na	na	6.0E-02 I	6.0E-02 R	6.0E-02 R
Anthracene	na	na	na	3.0E-01 I	3.0E-01 R	3.0E-01 R
Benzo(a)anthracene	7.3E-01 N	7.3E-01 R	7.3E-01 N	na	na	na
Benzo(a)pyrene	7.3E+00 I	7.3E+00 R	7.3E+00 N	na	na	na
Benzo(b)fluoranthene	7.3E-01 N	7.3E-01 R	7.3E-01 N	na	na	na
Benzo(g,h,i)perylene	na	na	na	2.0E-02 I[k]	2.0E-02 R[k]	8.6E-04 I[k,q]
Benzo(k)fluoranthene	7.3E-02 N	7.3E-02 R	7.3E-02 N	na	na	na
Chrysene	7.3E-03 N	7.3E-03 R	7.3E-03 N	na	na	na

TABLE 3-9 TOXICITY VALUES USED IN THE BASELINE HUMAN HEALTH RISK ASSESSMENT

Chemical of Potential Concern	Cancer Slope Factor - CSF $(mg/kg\text{-}d)^{-1}$			Reference dose - RfD (mg/kg-d)		
	Oral	Dermal	Inhalation	Oral	Dermal	Inhalation
Dibenzo(a,h)anthracene	7.3E+00 N	7.3E+00 R	7.3E+00 N	na	na	na
Fluoranthene	na	na	na	4.0E-02 I	4.0E-02 R	4.0E-02 R
Fluorene	na	na	na	4.0E-02 I	4.0E-02 R	4.0E-02 R
Indeno(1,2,3-cd)pyrene	7.3E-01 N	7.3E-01 R	7.3E-01 N	na	na	na
Naphthalene	na	na	na	2.0E-02 I	2.0E-02 R	8.6E-04 I [q]
Phenanthrene	na	na	na	3.0E-01 I[l]	3.0E-01 R[l]	3.0E-01 R[l]
Pyrene	na	na	na	3.0E-02 I	3.0E-02 R	3.0E-02 R
POLYCHLORINATED BIPHENYLS						
PCB-1242 (Aroclor 1242)	2.0E+00 I[m]	2.0E+00 R[m]	2.0E+00 I[m]	na	na	na
PCB-1254 (Aroclor 1254)	2.0E+00 I[m]	2.0E+00 R[m]	2.0E+00 I[m]	2.0E-05 I	2.0E-05 R	2.0E-05 I
PCB-1260 (Aroclor 1260)	2.0E+00 I[m]	2.0E+00 R[m]	2.0E+00 I[m]	2.0E-05 I	2.0E-05 R	2.0E-05 I
Total Polychlorinated biphenyls	2.0E+00 I[m]	2.0E+00 R[m]	2.0E+00 I[m]	na	na	na
DIOXINS/FURANS						
2,3,7,8-Tetrachlorodibenzo-p-dioxins (TCDD) Toxicity Equivalents (TEQ)	1.5E+05 H[n]	1.5E+05 R[n]	1.5E+05 H[n]	na	na	na
Dibenzofuran	na	na	na	4.0E-03 N	4.0E-03 R	4.0E-03 R
PESTICIDES						
beta-BHC	1.8E+00 I	1.8E+00 R	1.9E+00 I[p]	na	na	na
gamma-BHC (Lindane)	1.3E+00 H	1.3E+00 R	1.3E+00 R	3.0E-04 I	3.0E-04 R	3.0E-04 R
PETROLEUM HYDROCARBONS						
Gasoline Range Organics, Aliphatic	na	na	na	5.0E+00 [o]	na	5.3E+00 [o]
Gasoline Range Organics, Aromatic	na	na	na	2.0E-01 [o]	na	1.1E-01 [o]
Diesel Range Organics, Aliphatic	na	na	na	1.0E-01 [o]	na	2.9E-01 [o]
Diesel Range Organics, Aromatic	na	na	na	4.0E-02 [o]	na	5.7E-01 [o]
Residual Range Organics, Aliphatic	na	na	na	2.0E+00 [o]	na	na
Residual Range Organics, Aromatic	na	na	na	3.0E-02 [o]	na	na

Notes:

BHC - Benzene hexachloride

COPC - Chemical of potential concern.

CSF - Cancer slope factor.

mg/kg-d - Milligram per kilogram per day.

na - Not applicable.

PCB - Polychlorinated bipheyls

TABLE 3-9 TOXICITY VALUES USED IN THE BASELINE HUMAN HEALTH RISK ASSESSMENT

Chemical of Potential Concern	Cancer Slope Factor - CSF $(mg/kg\text{-}d)^{-1}$			Reference dose - RfD (mg/kg-d)		
	Oral	Dermal	Inhalation	Oral	Dermal	Inhalation

RfD - Reference Dose.

SVOC - Semivolatile organic compound.

VOC - Volatile organic compound.

Source Data:

I Integrated Risk Information System (IRIS) Database (USEPA, 2003a)

H Health Effects Assessment Summary Tables (HEAST) (USEPA, 1995a)

N National Center for Environmental Assessment (NCEA) (USEPA, 2003b)

R Route Extrapolation.

[a] Assuming Chromium is present in the trivalent (+3) oxidation state.

[b] As per ADEC (2000b) guidance, lead is evaluated using biokinetic models.

[c] 1,2 Dicloropropane used as a surrogate for 1,3-dichloropropane and 2,2-dichloropropane. 1,2-Dichloropropane, 1,3-dichloropropane and 2,2-dichloropropane have identical molecular weights and are structural isomers of one another. 1,2-Dichloropropane is a solvent that was commonly used in paint strippers, paints, varnishes and varnish removers. 1,3-Dichloropropane and 2,2-dichloropropane are not known to be carcinogenic. IARC has determined that 1,2-dichloropropane is unclassifiable as to human carcinogenicity, although HEAST lists an oral cancer slope factor for this isomer. Evaluation of 1,3-dichloropropane and 2,2-dichloropropane as carcinogens is most likely overprotective.

[d] Methyl isobuytl ketone (MIBK; hexanone) used as a surrogate for 2-hexanone (methyl butyl ketone; MNBK). MIBK (hexanone) and MNBK (2-hexanone) are identical molecular weight ketone solvents and structural isomers of one another. MIBK and MNBK both have low toxicities (LD50 > 2,000 mg/kg), and similar environmental fate and anticipated biological effects at the low environmental concentrations at which these ubiquitous chemicals are typically found.

[e] Isopropylbenzene (1-methylethyl benzene; cumene) used as a surrogate for 4-isopropyltoluene (1-methylisopropyl benzene; cymene). Cumene and cymene are volatile, petroleum-related VOCs that are also naturally produced in the oils of plants including marsh grasses. These chemicals have low toxicities (LD50 > 2,000 mg/kg), and similar chemical structures, environmental fates and anticipated biological effects. With respect to metabolism, cumene is more anologous to toluene than it is to methyl benzene. Neither cumene or cymene have been classified as human carcinogens.

[f] Xylenes used as a surrogate for individual xylene isomers (i.e., m-, o- and p-isomers of xylene). Commercial xylene solvents are mixtures of all three isomers, and the RfD for "xylenes" is based on a commercial mixture.

[g] 2-Nitroaniline used as a surrogate for 3-Nitroaniline. 2-Nitroaniline (nitrobenzeneamine) and 3-Nitroaniline are both nitro-substituted benzenes. The acute and chronic toxicity of dinitrocresol is lower than that of 2-nitroaniline. Use of 2-Nitroaniline as a surrogate for 3-Nitroaniline is most likely protective.

[h] o-chlorotoluene used as a surrogate for 4-chlorotoluene (p-chlorotoluene). o-Chlorotoluene and p-chlorotoluene have identical molecular weights and are structural isomers of one another. These chemicals have similar physical/chemical characteristics, and anticipated fates in the environment. The acute toxicity of p-chlorotoluene is lower than that of o-chlorotoluene. Use of o-chlorotoluene as a surrogate for p-chlorotoluene is most likely protective.

[i] 2-Nitroaniline used as a surrogate 4-Nitroaniline. 2-Nitroaniline (nitrobenzeneamine) and dinitrocresol are both nitro-substituted benzenes. The acute and chronic toxicity of dinitrocresol is lower than that of 2-nitroaniline. Use of 2-Nitroaniline as a surrogate for dinitrocresol is most likely protective.

[j] Nitrobenzene used as a surrogate for nitrophenol and 2-Methyl-4,6-dinitrophenol. Nitrobenzene and nitrophenol are structurally similar, and nitrophenol is an environmental degradation product and human/animal metabolite of nitrobenzene. The acute toxicities of nitrobenzene and nitrophenol are similar. Nitrobenzene causes hematological effects, kidney and liver toxicity, and is carcinogenic. Nitrophenol has not been classified as to its potential carcinogenicity. Evaluation of nitrophenol as a carcinogen is most likely protective.

[k] Naphthalene used as a surrogate for 2-methylnaphthalene and benzo(g,h,i)perylene. Naphthalene, 2-methylnaphthalene, and benzo(g,h,i)perylene are structurally similar bicyclic aromatic compounds found in coal tar and petroleum products. Naphthalene has been classified as a Group C, possible human carcinogen, while 2-methylnaphthalane has not been demonstrated to be tumorigenic or carcinogenic. Naphthalene toxicity and carcinogenicity are hypothesized to be due to metabolism to reactive metabolites such as the 1,2-epoxide or 1,2-quinone derivatives. The metabolic formation of ring epoxides is a relatively minor pathway for 2-methylnaphthalene. Evaluation of naphthalene as a surrogate for 2-methylnaphthalene is most likely protective.

[l] Anthracene used as a surrogate for phenanthrene. Anthracene and phenanthrene are tricyclic PAHs, with identical molecular weight and similar toxicological properties. Both chemicals are noncarcinogenic PAHs.

[m] Highest CSF shown for conservatism.

[n] Evaluted based on Toxicity Equivalent Value from 2,3,7,8-Tetrachlorodibenzo-p-dioxins (TCDD).

TABLE 3-9 TOXICITY VALUES USED IN THE BASELINE HUMAN HEALTH RISK ASSESSMENT

Chemical of Potential Concern	Cancer Slope Factor - CSF $(mg/kg\text{-}d)^{-1}$			Reference dose - RfD (mg/kg-d)		
	Oral	Dermal	Inhalation	Oral	Dermal	Inhalation

[o] Source: ADEC Guidance for Cleanup of Petroleum contaminated Sites (ADEC, 2000a).

[p] Calculated using the 'air unit risk value' and equation CSF_{inh} $(mg/kg\text{-}d)^{-1}$ = (Unit Risk $(ug/m^3)^{-1}$ x 70 kg x 10^3 ug/m^3) / (20 m^3/day) taken from IRIS.

[q] Calculated using the Reference Concentration (RfC) and equation RfD_{inh} (mg/kg-d) = (RfC (mg/m^3) x 20 m^3/day) / (70 kg) taken from IRIS.

[r] The value in IRIS for thallium sulfate was converted from an RfD of 8E-05 mg/kg-day to elemental thallium according to molecular weight (conversion factor of 0.2), as described in IRIS.

[s] Chloroethane used as a surrogate for bromoethane (ethyl bromide). These volatile halogenated ethanes share similar chemical structures, physical/chemical characteristics, and anticipated fates in the environment. Chloroethane may appear in water supplies as a result of chlorination. Bromoethane may be produced in marine water by algae. IARC has determined that both chloroethane and bromoethane are not classifiable as to human carcinogenicity. However, NCEA lists a cancer slope factor for chloroethane. Evaluation of bromoethane as a carcinogen is most likely protective.

Table 3-10 Tier I Ecological COPEC Screening Criteria - Tundra and Gravel Soils

Chemical of Potential Concern	BUTL (mg/kg) [a] Tundra Soil	BUTL (mg/kg) [a] Gravel Soil	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Inorganics, Total				
Antimony	nc	nc	21 [d]	2.1
Arsenic	7.8	11	0.29 [e]	0.029
Barium	174	nc	500 [f]	50
Beryllium	3.8	nc	10 [f]	1
Cadmium	1.4	3.1	0.38 [e]	0.038
Calcium	nc	nc	NA [g]	NA
Chromium	48	50	5 [d]	0.5
Cobalt	49	nc	32 [d]	3.2
Copper	107	44	61 [d]	6.1
Iron	nc	nc	NA [g]	NA
Lead	106	112	50 [f]	5
Magnesium	nc	nc	NA [g]	NA
Manganese	1,589	nc	500 [f]	50
Mercury	0.43	nc	0.1 [h]	0.01
Nickel	59	30	30 [f]	3
Potassium	nc	nc	NA [g]	NA
Selenium	nc	nc	1 [f]	0.1
Silver	nc	nc	2 [f]	0.2
Sodium	nc	nc	NA [g]	na
Thallium	1.6	0.56	1 [f]	0.1
Vanadium	73	nc	2 [f]	0.2
Zinc	615	157	120 [d]	12
Volatile Organic Compounds				
1,1,1,2-Tetrachloroethane	nc	nc	na	na
1,1,1-Trichloroethane	nc	nc	2060 [e]	206
1,1,2,2-Tetrachloroethane	nc	nc	na	na
1,1,2-Trichloroethane	nc	nc	na	na
1,1-Dichloroethane	nc	nc	na	na
1,1-Dichloroethene	nc	nc	23.5 [e]	2.35
1,1-Dichloropropene	nc	nc	na	na
1,2,3-Trichlorobenzene	nc	nc	20 [h]	2
1,2,3-Trichloropropane	nc	nc	20 [h]	2
1,2,4-Trichlorobenzene	nc	nc	20 [h]	2
1,2,4-Trimethylbenzene	nc	nc	52.2 [i]	5.22
1,2-Dibromo-3-chloropropane	nc	nc	na	na
1,2-Dibromoethane	nc	nc	na	na
1,2-Dichlorobenzene	nc	nc	na	na
1,2-Dichloroethane	nc	nc	14.2 [e]	1.42
1,2-Dichloropropane	nc	nc	700 [h]	70
1,3,5-Trimethylbenzene	nc	nc	52.2 [i]	5.22
1,3-Dichlorobenzene	nc	nc	na	na
1,3-Dichloropropane	nc	nc	na	na
1,4-Dichlorobenzene	nc	nc	20 [h]	2

Table 3-10 Tier I Ecological COPEC Screening Criteria - Tundra and Gravel Soils

Chemical of Potential Concern	BUTL (mg/kg) [a] Tundra Soil	BUTL (mg/kg) [a] Gravel Soil	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Volatile Organic Compounds (Cont.)				
2,2-Dichloropropane	nc	nc	na	na
2-Butanone (MEK)	nc	nc	6487 [h]	648.7
2-Chloroethyl vinyl ether	nc	nc	na	na
2-Chloronaphthalene	nc	nc	na	na
2-Chlorophenol	nc	nc	na	na
2-Chlorotoluene	nc	nc	na	na
2-Hexanone	nc	nc	na	na
4-Bromophenyl phenyl ether	nc	nc	na	na
4-Chlorophenyl phenyl ether	nc	nc	na	na
4-Isopropyltoluene	nc	nc	na	na
4-Methyl-2-pentanone	nc	nc	91.6 [e]	9.16
Acetone	nc	nc	36.6 [e]	3.66
Acrolein	nc	nc	na	na
Benzene	nc	nc	52.2 [e]	5.22
bis-(2-Chloroethyl)ether	nc	nc	na	na
bis(2-Chloroisopropyl)ether	nc	nc	na	na
Bromobenzene	nc	nc	na	na
Bromochloromethane	nc	nc	na	na
Bromodichloromethane	nc	nc	na	na
Bromoethane	nc	nc	na	na
Bromoform	nc	nc	na	na
Bromomethane	nc	nc	na	na
Carbon disulfide	nc	nc	na	na
Carbon tetrachloride	nc	nc	58.6 [e]	5.86
Chlorobenzene	nc	nc	40 [h]	4
Chloroethane	nc	nc	na	na
Chloroform	nc	nc	55 [e]	5.5
Chloromethane	nc	nc	na	na
cis-1,2-Dichloroethene	nc	nc	89.6 [e]	8.96
cis-1,3-Dichloropropene	nc	nc	na	na
Dibromochloromethane	nc	nc	na	na
Dibromomethane	nc	nc	na	na
Dichlorodifluoromethane	nc	nc	na	na
Ethylbenzene	nc	nc	52.2 [i]	5.22
Isopropylbenzene	nc	nc	52.2 [i]	5.22
m,p-Xylene (Sum of Isomers)	nc	nc	4.162 [j]	0.4162
Methyl iodide	nc	nc	na	na
Methylene chloride	nc	nc	21.4 [e]	2.14
n-Butylbenzene	nc	nc	52.2 [i]	5.22
Nitrobenzene	nc	nc	40 [h]	4
n-Propylbenzene	nc	nc	52.2 [i]	5.22
o-Xylene	nc	nc	4.162 [j]	0.4162
p-Isopropyltoluene	nc	nc	na	na
sec-Butylbenzene	nc	nc	52.2 [i]	5.22

Table 3-10 Tier I Ecological COPEC Screening Criteria - Tundra and Gravel Soils

Chemical of Potential Concern	BUTL (mg/kg) [a] Tundra Soil	BUTL (mg/kg) [a] Gravel Soil	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Volatile Organic Compounds (Cont.)				
Styrene	nc	nc	300 [f]	30
tert-Butylbenzene	nc	nc	na	na
Tetrachloroethene	nc	nc	na	na
Toluene	nc	nc	200 [f]	20
trans-1,2-Dichloroethene	nc	nc	89.6 [e]	8.96
trans-1,3-Dichloropropene	nc	nc	na	na
trans-1,4-Dichloro-2-butene	nc	nc	na	na
Trichloroethene	nc	nc	1.387 [e]	0.1387
Trichlorofluoromethane	nc	nc	na	na
Vinyl acetate	nc	nc	na	na
Vinyl chloride	nc	nc	0.623 [e]	0.0623
Xylene, Isomers m & p	nc	nc	4.162 [j]	0.4162
Xylenes	nc	nc	4.162 [e]	0.4162
Semi-volatile Organic Compounds				
2,4,6-Trichlorophenol	nc	nc	10 [h]	1
2,4-Dimethylphenol	nc	nc	na	na
2,4-Dinitrophenol	nc	nc	20 [f]	2
2,4-Dinitrotoluene	nc	nc	na	na
2,6-Dinitrotoluene	nc	nc	na	na
2-Methyl-4,6-dinitrophenol	nc	nc	na	na
2-Methylphenol (o-Cresol)	nc	nc	na	na
2-Nitroaniline	nc	nc	na	na
2-Nitrophenol	nc	nc	na	na
3,3-Dichlorobenzidine	nc	nc	na	na
3-Nitroaniline	nc	nc	na	na
4-Chloro-3-methylphenol	nc	nc	na	na
4-Chloroaniline	nc	nc	na	na
4-Chlorotoluene	nc	nc	na	na
4-Methylphenol (p-Cresol)	nc	nc	30 [k]	3
4-Nitroaniline	nc	nc	na	na
4-Nitrophenol	nc	nc	7 [h]	0.7
Acrylamide	nc	nc	na	na
Benzidine	nc	nc	na	na
Benzoic acid	nc	nc	na	na
Benzyl alcohol	nc	nc	na	na
Benzyl butyl phthalate	nc	nc	na	na
bis-(2-chloroethoxy)methane	nc	nc	na	na
bis-(2-ethylhexyl)phthalate	nc	nc	200 [l]	20
Cresols (Methyl Phenols)	nc	nc	na	na
Diethyl phthalate	nc	nc	100 [f]	10
Dimethyl phthalate	nc	nc	na	na
Di-n-butyl phthalate	nc	nc	200 [f]	20
Di-n-octyl phthalate	nc	nc	na	na
Hexachlorobenzene	nc	nc	na	na

Table 3-10 Tier I Ecological COPEC Screening Criteria - Tundra and Gravel Soils

Chemical of Potential Concern	BUTL (mg/kg) [a] Tundra Soil	BUTL (mg/kg) [a] Gravel Soil	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Semi-volatile Organic Compounds (Cont.)				
Hexachlorobutadiene	nc	nc	na	na
Hexachlorocyclopentadiene	nc	nc	10 [f]	1
Hexachloroethane	nc	nc	na	na
Isophorone	nc	nc	na	na
n-Nitrosodi-n-propylamine	nc	nc	na	na
n-Nitrosodiphenylamine	nc	nc	na	na
Pentachlorophenol	nc	nc	3 [f]	0.3
Pyridine	nc	nc	na	na
Toxaphene	nc	nc	29.3 [e]	2.93
Polychlorinated Biphenyls				
PCB-1016 (Aroclor 1016)	nc	nc	6.52 [e,m]	0.652
PCB-1232 (Aroclor 1232)	nc	nc	40 [n]	4
PCB-1242 (Aroclor 1242)	nc	nc	0.329 [e,m]	0.0329
PCB-1248 (Aroclor 1248)	nc	nc	0.071 [e,m]	0.0071
PCB-1254 (Aroclor 1254)	nc	nc	0.111 [e,m]	0.0111
PCB-1260 (Aroclor 1260)	nc	nc	0.111 [o]	0.0111
Total Polychlorinatedbiphenyls	nc	nc	40 [f]	4
Pesticides				
4,4'-DDD	nc	nc	0.002 [p]	0.0002
4,4'-DDE	nc	nc	0.002 [p]	0.0002
Aldrin	nc	nc	0.733 [e]	0.0733
alpha-BHC	nc	nc	0.07 [q]	0.007
alpha-Chlordane	nc	nc	1.8 [r]	0.18
beta-BHC	nc	nc	1.47 [e]	0.147
Chlordane	nc	nc	1.8 [e]	0.18
delta-BHC	nc	nc	0.07 [q]	0.007
Dieldrin	nc	nc	0.0016 [e]	0.00016
Endosulfan I	nc	nc	0.55 [s]	0.055
Endosulfan II	nc	nc	0.55 [s]	0.055
Endosulfan sulfate	nc	nc	0.55 [s]	0.055
Endrin aldehyde	nc	nc	0.008 [t]	0.0008
Endrin ketone	nc	nc	0.008 [t]	0.0008
Endrin	nc	nc	0.008 [e]	0.0008
gamma-BHC (Lindane)	nc	nc	1.66 [e]	0.166
gamma-Chlordane	nc	nc	1.8 [r]	0.18
Heptachlor epoxide	nc	nc	0.476 [u]	0.0476
Heptachlor	nc	nc	0.476 [e]	0.0476
Methoxychlor	nc	nc	14.7 [e]	1.47
Dioxins and Furans				
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	nc	nc	0.00006 [v]	0.000006
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	nc	nc	0.00006 [v]	0.000006
1,2,3,4,6,7,8-Heptachlorodibenzofuran	nc	nc	0.00006 [v]	0.000006
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	nc	nc	0.00006 [v]	0.000006

Table 3-10 Tier I Ecological COPEC Screening Criteria - Tundra and Gravel Soils

Chemical of Potential Concern	BUTL (mg/kg) [a] Tundra Soil	BUTL (mg/kg) [a] Gravel Soil	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Dioxins and Furans (Cont.)				
1,2,3,4,7,8,9-Heptachlorodibenzofuran	nc	nc	0.00006 [v]	0.000006
1,2,3,4,7,8-Hexachlorodibenzofuran	nc	nc	0.00006 [v]	0.000006
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	nc	nc	0.00006 [v]	0.000006
1,2,3,6,7,8-Hexachlorodibenzofuran	nc	nc	0.00006 [v]	0.000006
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	nc	nc	0.00006 [v]	0.000006
1,2,3,7,8,9-Hexachlorodibenzofuran	nc	nc	0.00006 [v]	0.000006
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	nc	nc	0.00006 [v]	0.000006
1,2,3,7,8-Pentachlorodibenzofuran	nc	nc	0.00059 [e]	0.000059
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	nc	nc	0.00006 [v]	0.000006
2,3,4,6,7,8-Hexachlorodibenzofuran	nc	nc	0.00006 [v]	0.000006
2,3,4,7,8-Pentachlorodibenzofuran	nc	nc	0.00006 [e]	0.000006
2,3,7,8-Tetrachlorodibenzofuran	nc	nc	0.0000008 [e]	0.00000008
2,3,7,8-Tetrachlorodibenzo-p-dioxin	nc	nc	0.0000003 [e]	0.00000003
Dibenzofuran	nc	nc	na	na
Octachlorodibenzofuran	nc	nc	0.00006 [v]	0.000006
Octachlorodibenzo-p-dioxin	nc	nc	0.00006 [v]	0.000006
Total Heptachlorodibenzofurans (HpCDF)	nc	nc	0.00006 [v]	0.000006
Total Heptachlorodibenzo-p-dioxins (HpCDD)	nc	nc	0.00006 [v]	0.000006
Total Hexachlorodibenzofurans (HxCDF)	nc	nc	0.00006 [v]	0.000006
Total Hexachlorodibenzo-p-dioxins (HxCDD)	nc	nc	0.00006 [v]	0.000006
Total Pentachlorodibenzofurans (PeCDF)	nc	nc	0.00006 [v]	0.000006
Total Pentachlorodibenzo-p-dioxin (PeCDD)	nc	nc	0.00006 [v]	0.000006
Total Tetrachlorodibenzofurans (TCDF)	nc	nc	0.0000008 [w]	0.00000008
Total Tetrachlorodibenzo-p-dioxins (TCDD)	nc	nc	0.0000008 [w]	0.00000008
Polynuclear Aromatic Hydrocarbons				
2-Methylnaphthalene	nc	nc	1.98 [x]	0.198
Acenaphthene	nc	nc	20 [f]	2
Acenaphthylene	nc	nc	1.98 [x]	0.198
Anthracene	nc	nc	1.98 [x]	0.198
Benzo(a)anthracene	nc	nc	1.98 [x]	0.198
Benzo(a)pyrene	nc	nc	1.98 [e]	0.198
Benzo(b)fluoranthene	nc	nc	1.98 [x]	0.198
Benzo(g,h,i)perylene	nc	nc	1.98 [x]	0.198
Benzo(k)fluoranthene	nc	nc	1.98 [x]	0.198
Chrysene	nc	nc	1.98 [x]	0.198
Dibenzo(a,h)anthracene	nc	nc	1.98 [x]	0.198
Fluoranthene	nc	nc	1.98 [x]	0.198
Fluorene	nc	nc	30 [h]	3
Indeno(1,2,3-cd)pyrene	nc	nc	1.98 [x]	0.198
Naphthalene	nc	nc	1.98 [x]	0.198
Phenanthrene	nc	nc	1.98 [x]	0.198
Phenol	nc	nc	30 [h]	3
Pyrene	nc	nc	1.98 [x]	0.198

Table 3-10 Tier I Ecological COPEC Screening Criteria - Tundra and Gravel Soils

Chemical of Potential Concern	BUTL (mg/kg) [a] Tundra Soil	BUTL (mg/kg) [a] Gravel Soil	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Petroleum Hydrocarbons				
Diesel Range Organics	nc	nc	na	na
Diesel Range Organics - Aromatic	nc	nc	na	na
Diesel Range Organics - Aliphatic	nc	nc	na	na
Gasoline Range Organics	nc	nc	na	na
Residual Range Organics	nc	nc	na	na
Residual Range Organics - Aliphatic	nc	nc	na	na
Residual Range Organics - Aromatic	nc	nc	na	na
Total Recoverable Petroleum Hydrocarbons	nc	nc	NA [y]	NA

Notes:

BHC - Benzene hexachloride
BUTL - Background upper tolerance limit
COPEC - Chemical of potential ecological concern
DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethylene
DDT - Dichlorodiphenyltrichloroethane
DRO - Diesel range organics
ERBSC - Ecological Risk-Based Screening Criteria
GRO - Gasoline range organics
mg/kg - Milligrams per kilogram
NA - Not applicable
na - Not available
nc - Not calculated
ORNL - Oak Ridge National Laboratory
PCB - Polychlorinated bipheyls
RRO - Residual range organics
USEPA - U.S. Environmental Protection Agency

[a] Background upper tolerance limits (BUTLs) were not calculated (nc) for organic chemicals, or inorganic chemicals with insufficient data. Please refer to MWH (2003a) for further discussion of the methods used to derive BUTLs for Northeast Cape.

[b] Ecological Benchmark Criterion selected based on the following hierarchy:

1) Eco-SSLs - Ecological Soil Screening Level Guidance - Draft. Office of Emergency and Remedial Response. July 10. (USEPA, 2000b).
2) The lower of ORNL plant (ONRL, 1997c - Table 1) or soil invertebrate (ORNL, 1997b - Table 1) benchmarks.
3) The lower of ORNL mammalian or avian dietary wildlife benchmarks, assuming diet consists of 100 percent soil (ORNL, 1996b - Appendix D, Table 12).

[c] ERBSC is equal to one-tenth the ecological benchmark criterion.

[d] Benchmark Criteria Derived from Eco-SSLs (USEPA, 2000b).

[e] Benchmark Criteria Derived from ORNL Wildlife Benchmarks (ORNL, 1996b).

[f] Benchmark Criteria Derived from ORNL Plant Benchmarks (ORNL, 1997c).

[g] Soil Screening Criteria are not available for this essential nutrient. This analyte is excluded as a COPEC based on essential nutrient status.

[h] Benchmark Criteria Derived from ORNL Invertebrate Benchmarks (ORNL, 1997b).

[i] Benzene used as a surrogate for 1,2,3-Trimethylbenzene, ethylbenzene, isopropylbenzene, n-propylbenzene, etc. The alkyl substituted benzenes are generally less volatile and less toxic than benzene. Use of benzene as a surrogate chemical for the alkyl-substituted benzenes is assumed to be protective.

[j] Xylene used as a surrogate for individual xylene isomers (i.e., m-, o- and p-xylenes). Commercial xylene solvents are mixtures of all three isomers (i.e., m-, o- and p-xylenes), and toxicity studies for "xylenes" are based on the commercial mixture.

[k] Phenol used as surrogate for 4-methylphenol (p-Cresol). Phenol and 4-methylphenol are both hydroxy-substituted

Table 3-10 Tier I Ecological COPEC Screening Criteria - Tundra and Gravel Soils

Chemical of Potential Concern	BUTL (mg/kg) [a] Tundra Soil	BUTL (mg/kg) [a] Gravel Soil	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)

benzenes found in coal tar and wood preservatives. Both chemicals are neurotoxicants and have similar ranges of toxicity in aquatic and terrestrial organisms in which they have been studied.

[l] Di-n-butylphthalate used as a surrogate for bis(2-ethylhexyl)phthalate. These two phthalates are structurally related plasticizers that have similar environmental persistence and toxicological mechanisms. Both of these phthalates cause reproductive toxicity and have been reported to be endocrine disruptors in animals.

[m] Benchmark Criteria Derived from ORNL (1996b). Because polychlorinated biphenyls are bioaccumulating, the plant benchmarks are not adequately protective of potentially bioaccumulating effects on wildlife. Therefore, we defer to the mammalian or avian wildlife benchmarks.

[n] Total polychlorinated biphenyls (PCBs) used as a surrogate for all PCBs (i.e., Aroclors). Consistent with IRIS (USEPA, 2003a), carcinogenic effects of Aroclors are evaluated using the cancer slope factor for "polychlorinated biphenyls".

[o] Aroclor-1254 used as a surrogate for Aroclor 1260. Aroclor 1254 and Aroclor 1260 are commercial mixtures of polychlorinated biphenyls (PCBs) that vary in their percentage of individual PCB congeners. Many congeners of both Aroclors have similar chemical, environmental fate and toxicological characteristics.

[p] DDT and metabolites used as surrogates for 4,4'-DDD and 4-4'-DDE. 4,4'-DDD and 4-4'-DDE are metabolites of 4,4-DDT, and all three chemicals occurred in commercial formulations of DDT. These chemicals are structurally and toxicologically similar.

[q] BHC used as a surrogate for delta-BHC. Alpha, beta, gamma and delta isomers of hexachlorocyclohexane (BHC) are structurally similar neurotoxicants, and are all components of technical BHC.

[r] Chlordane used as a surrogate for alpha- and gamma-chlordane. Alpha and gamma isomers of chlordane are structurally similar cyclodiene insecticides and neurotoxicants, and are components of technical chlordane.

[s] Endosulfan used as a surrogate for endosulfan II and endosulfan sulfate. Endosulfan I and endosulfan II are structural isomers of one another, toxicologically similar, and comprise technical endosulfan. Endosulfan sulfate is an impurity in technical endosulfan, is an oxidative metabolite of endosulfan I and endosulfan II, and retains the biological activity of endosulfan.

[t] Endrin used as a surrogate for endrin aldehyde and endrin ketone. Endrin aldehyde is an impurity in technical endrin, as well as a metabolite of endrin. Endrin ketone is formed when endrin is exposed to light. Endrin aldehyde and endrin ketone retain the biological activity of endrin.

[u] Heptachlor used as a surrogate for heptachlor epoxide. Heptachlor epoxide is a toxicologically active metabolite and degradation product of heptachlor.

[v] 2,3,4,7,8-PCDF is used as a surrogate for many dioxins/furans. 2,3,4,7,8-PCDF is structurally and toxicologically similar to many coplanar dioxins and furans, and is among the most toxic.

[w] 2,3,7,8-TCDF is used as a surrogate for many dioxins/furans. 2,3,7,8-TCDF is structurally and toxicologically similar to many coplanar dioxins and furans, and is among the most toxic.

[x] Benzo(a)pyrene used as a surrogate for Benzo(a)anthracene, Benzo(b)fluoranthene, etc. The PAHs, benzo(a)pyrene benzo(a)anthracene, and benzo(b)fluoranthene, are multi-ring, high molecular weight components of mid- and high-distillation fraction petroleum hydrocarbons (PHCs). They share similar chemical, environmental fate and toxicological properties.

[y] Total recoverable petroleum hydrocarbons (TRPHs) are excluded as a COPC due to outdated analytical methods.

Table 3-11 Tier I Ecological COPEC Screening Criteria - Freshwater Sediment

Chemical of Potential Concern	BUTL (mg/kg) [a]	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Inorganics			
Aluminum	nc	25,500 [d]	2550
Antimony	nc	2 [e]	0.2
Arsenic	nc	9.79 [f]	0.979
Barium	nc	na	na
Beryllium	9.8	na	na
Cadmium	nc	0.99 [f]	0.099
Calcium	nc	NA [g]	NA
Chromium	34	43.4 [f]	4.34
Cobalt	nc	na	na
Copper	40	31.6 [f]	3.16
Iron	nc	NA [g]	na
Lead	78	35.8 [f]	3.58
Magnesium	nc	NA [g]	NA
Manganese	nc	1673 [h]	167.3
Mercury	nc	0.18 [f]	0.018
Nickel	126	22.7 [f]	2.27
Potassium	nc	na	na
Selenium	nc	na	na
Silver	nc	1 [e]	0.1
Sodium	nc	NA [g]	NA
Thallium	nc	na [h]	na
Vanadium	nc	na	na
Zinc	148	121 [f]	12.1
Volatile Organic Compounds			
1,1,1,2-Tetrachloroethane	nc	na	na
1,1,1-Trichloroethane	nc	0.17 [i]	0.017
1,1,2,2-Tetrachloroethane	nc	0.94 [i]	0.094
1,1,2-Trichloroethane	nc	na	na
1,1-Dichloroethane	nc	na	na
1,1-Dichloroethene	nc	na	na
1,1-Dichloropropene	nc	na	na
1,2,3-Trichlorobenzene	nc	na	na
1,2,3-Trichloropropane	nc	na	na
1,2,4-Trichlorobenzene	nc	9.2 [i]	0.92
1,2,4-Trimethylbenzene	nc	na	na
1,2-Dibromo-3-chloropropane	nc	na	na
1,2-Dibromoethane	nc	na	na
1,2-Dichlorobenzene	nc	0.34 [i]	0.034
1,2-Dichloroethane	nc	na	na
1,2-Dichloropropane	nc	na	na
1,3,5-Trimethylbenzene	nc	na	na
1,3-Dichlorobenzene	nc	1.7 [i]	0.17
1,3-Dichloropropane	nc	na	na
1,4-Dichlorobenzene	nc	0.35 [i]	0.035
2,2-Dichloropropane	nc	na	na
2-Butanone	nc	na	na

Table 3-11 Tier I Ecological COPEC Screening Criteria - Freshwater Sediment

Chemical of Potential Concern	BUTL (mg/kg) [a]	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Volatile Organic Compounds (Cont.)			
2-Chloroethyl vinyl ether	nc	na	na
2-Chloronaphthalene	nc	na	na
2-Chlorophenol	nc	na	na
2-Chlorotoluene	nc	na	na
2-Hexanone	nc	na	na
4-Bromophenyl phenyl ether	nc	1.3 [i]	0.13
4-Chlorophenyl phenyl ether	nc	na	na
4-Isopropyltoluene	nc	na	na
4-Methyl-2-pentanone	nc	na	na
Acetone	nc	na	na
Acrolein	nc	na	na
Benzene	nc	0.057 [i]	0.0057
bis-(2-Chloroethyl)ether	nc	na	na
bis(2-Chloroisopropyl)ether	nc	na	na
Bromobenzene	nc	na	na
Bromochloromethane	nc	na	na
Bromodichloromethane	nc	na	na
Bromoethane	nc	na	na
Bromoform	nc	na	na
Bromomethane	nc	na	na
Carbon disulfide	nc	na	na
Carbon tetrachloride	nc	na	na
Chlorobenzene	nc	0.82 [i]	0.082
Chloroethane	nc	na	na
Chloroform	nc	na	na
Chloromethane	nc	na	na
cis-1,2-Dichloroethene	nc	na	na
cis-1,3-Dichloropropene	nc	na	na
Dibromochloromethane	nc	na	na
Dibromomethane	nc	na	na
Dichlorodifluoromethane	nc	na	na
Ethylbenzene	nc	3.6 [i]	0.36
Isopropylbenzene	nc	na	na
m,p-Xylene (Sum of Isomers)	nc	0.025 [j]	0.0025
Methyl iodide	nc	na	na
Methylene chloride	nc	na	na
n-Butylbenzene	nc	na	na
Nitrobenzene	nc	na	na
n-Propylbenzene	nc	na	na
o-Xylene	nc	0.025 [j]	0.0025
p-Isopropyltoluene	nc	na	na
sec-Butylbenzene	nc	na	na
Styrene	nc	na	na
tert-Butylbenzene	nc	na	na
Tetrachloroethene	nc	0.53 [i]	0.053
Toluene	nc	0.67 [i]	0.067

Table 3-11 Tier I Ecological COPEC Screening Criteria - Freshwater Sediment

Chemical of Potential Concern	BUTL (mg/kg) [a]	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Volatile Organic Compounds (Cont.)			
trans-1,2-Dichloroethene	nc	na	na
trans-1,3-Dichloropropene	nc	na	na
trans-1,4-Dichloro-2-butene	nc	na	na
Trichloroethene	nc	1.6 [i]	0.16
Trichlorofluoromethane	nc	na	na
Vinyl acetate	nc	na	na
Vinyl chloride	nc	na	na
Xylene, Isomers m & p	nc	0.025 [j]	0.0025
Xylenes	nc	0.025 [i]	0.0025
Semi-volatile Organic Compounds			
2,4,5-Trichlorophenol	nc	na	na
2,4,6-Trichlorophenol	nc	na	na
2,4-Dichlorophenol	nc	na	na
2,4-Dimethylphenol	nc	na	na
2,4-Dinitrophenol	nc	na	na
2,4-Dinitrotoluene	nc	na	na
2,6-Dinitrotoluene	nc	na	na
2-Methyl-4,6-dinitrophenol	nc	na	na
2-Methylphenol (o-Cresol)	nc	na	na
2-Nitroaniline	nc	na	na
2-Nitrophenol	nc	na	na
3,3-Dichlorobenzidine	nc	na	na
3-Nitroaniline	nc	na	na
4-Chloro-3-methylphenol	nc	na	na
4-Chloroaniline	nc	na	na
4-Chlorotoluene	nc	na	na
4-Methylphenol (p-Cresol)	nc	na	na
4-Nitroaniline	nc	na	na
4-Nitrophenol	nc	na	na
Acrylamide	nc	na	na
Benzidine	nc	na	na
Benzoic acid	nc	na	na
Benzyl alcohol	nc	na	na
Benzyl butyl phthalate	nc	11 [i]	1.1
bis-(2-chloroethoxy)methane	nc	na	na
bis-(2-ethylhexyl)phthalate	nc	0.182 [k]	0.0182
Cresols (Methyl Phenols)	nc	na	na
Diethyl phthalate	nc	0.63 [i]	0.063
Dimethyl phthalate	nc	na	na
Di-n-butyl phthalate	nc	11 [i]	1.1
Di-n-octyl phthalate	nc	na	na
Hexachlorobenzene	nc	na	na
Hexachlorobutadiene	nc	na	na
Hexachlorocyclopentadiene	nc	na	na
Hexachloroethane	nc	1 [i]	0.1

Table 3-11 Tier I Ecological COPEC Screening Criteria - Freshwater Sediment

Chemical of Potential Concern	BUTL (mg/kg) [a]	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Semi-volatile Organic Compounds (Cont.)			
Isophorone	nc	na	na
n-Nitrosodi-n-propylamine	nc	na	na
n-Nitrosodiphenylamine	nc	na	na
Pentachlorophenol	nc	na	na
Pyridine	nc	na	na
Toxaphene	nc	0.028 [i]	0.0028
Polychlorinated Biphenyls			
PCB-1016 (Aroclor 1016)	nc	0.007 [l]	0.0007
PCB-1221 (Aroclor 1221)	nc	0.0598 [m]	0.00598
PCB-1232 (Aroclor 1232)	nc	0.0598 [m]	0.00598
PCB-1242 (Aroclor 1242)	nc	0.0598 [m]	0.00598
PCB-1248 (Aroclor 1248)	nc	0.03 [l]	0.003
PCB-1254 (Aroclor 1254)	nc	0.06 [l]	0.006
PCB-1260 (Aroclor 1260)	nc	0.005 [l]	0.0005
Total Polychlorinatedbiphenyls	nc	0.0598 [f]	0.00598
Pesticides			
4,4'-DDD	nc	0.00488 [f]	0.000488
4,4'-DDE	nc	0.00316 [f]	0.000316
4,4'-DDT	nc	0.00416 [f]	0.000416
Aldrin	nc	0.002 [l]	0.0002
alpha-BHC	nc	0.003 [l]	0.0003
alpha-Chlordane	nc	0.00324 [n]	0.000324
beta-BHC	nc	0.006 [l]	0.0006
Chlordane	nc	0.00324 [f]	0.000324
delta-BHC	nc	0.003 [o]	0.0003
Dieldrin	nc	0.0019 [f]	0.00019
Endosulfan I	nc	na	na
Endosulfan II	nc	na	na
Endosulfan sulfate	nc	na	na
Endrin aldehyde	nc	0.00222 [f]	0.000222
Endrin ketone	nc	0.00222 [p]	0.000222
Endrin	nc	0.00222 [p]	0.000222
gamma-BHC (Lindane)	nc	0.00237 [f]	0.000237
gamma-Chlordane	nc	0.00324 [n]	0.000324
Heptachlor epoxide	nc	na	na
Heptachlor	nc	0.00247 [f]	0.000247
Methoxychlor	nc	0.019 [i]	0.0019
Dioxins and Furans			
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	nc	0.0088 [q]	0.00088
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	nc	0.0088 [q]	0.00088
1,2,3,4,6,7,8-Heptachlorodibenzofuran	nc	0.0088 [q]	0.00088
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	nc	0.0088 [q]	0.00088
1,2,3,4,7,8,9-Heptachlorodibenzofuran	nc	0.0088 [q]	0.00088
1,2,3,4,7,8-Hexachlorodibenzofuran	nc	0.0088 [q]	0.00088
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	nc	0.0088 [q]	0.00088

Table 3-11 Tier I Ecological COPEC Screening Criteria - Freshwater Sediment

Chemical of Potential Concern	BUTL (mg/kg) [a]	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Dioxins and Furans (Cont.)			
1,2,3,6,7,8-Hexachlorodibenzofuran	nc	0.0088 [q]	0.00088
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	nc	0.0088 [q]	0.00088
1,2,3,7,8,9-Hexachlorodibenzofuran	nc	0.0088 [q]	0.00088
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	nc	0.0088 [q]	0.00088
1,2,3,7,8-Pentachlorodibenzofuran	nc	0.0088 [q]	0.00088
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	nc	0.0088 [q]	0.00088
2,3,4,6,7,8-Hexachlorodibenzofuran	nc	0.0088 [q]	0.00088
2,3,4,7,8-Pentachlorodibenzofuran	nc	0.0088 [q]	0.00088
2,3,7,8-Tetrachlorodibenzofuran	nc	0.0088 [q]	0.00088
2,3,7,8-Tetrachlorodibenzo-p-dioxin	nc	0.0088 [r]	0.00088
Dibenzofuran	nc	2 [i]	0.2
Octachlorodibenzofuran	nc	0.0088 [q]	0.00088
Octachlorodibenzo-p-dioxin	nc	0.0088 [q]	0.00088
Total Heptachlorodibenzofurans (HpCDF)	nc	0.0088 [q]	0.00088
Total Heptachlorodibenzo-p-dioxins (HpCDD)	nc	0.0088 [q]	0.00088
Total Hexachlorodibenzofurans (HxCDF)	nc	0.0088 [q]	0.00088
Total Hexachlorodibenzo-p-dioxins (HxCDD)	nc	0.0088 [q]	0.00088
Total Pentachlorodibenzofurans (PeCDF)	nc	0.0088 [q]	0.00088
Total Pentachlorodibenzo-p-dioxin (PeCDD)	nc	0.0088 [q]	0.00088
Total Tetrachlorodibenzofurans (TCDF)	nc	0.0088 [q]	0.00088
Total Tetrachlorodibenzo-p-dioxins (TCDD)	nc	0.0088 [q]	0.00088
Polynuclear Aromatic Hydrocarbons			
2-Methylnaphthalene	nc	0.07 [e]	0.007
Acenaphthene	nc	0.62 [g]	0.062
Acenaphthylene	nc	0.044 [e]	0.0044
Anthracene	nc	0.0572 [f]	0.00572
Benzo(a)anthracene	nc	0.108 [f]	0.0108
Benzo(a)pyrene	nc	0.15 [f]	0.015
Benzo(b)fluoranthene	nc	0.24 [s]	0.024
Benzo(g,h,i)perylene	nc	0.29 [h]	0.029
Benzo(k)fluoranthene	nc	0.24 [l]	0.024
Chrysene	nc	0.166 [f]	0.0166
Dibenzo(a,h)anthracene	nc	0.033 [f]	0.0033
Fluoranthene	nc	0.423 [f]	0.0423
Fluorene	nc	0.0774 [f]	0.00774
Indeno(1,2,3-cd)pyrene	nc	0.078 [h]	0.0078
Naphthalene	nc	0.176 [f]	0.0176
Phenanthrene	nc	0.204 [f]	0.0204
Phenol	nc	na	na
Pyrene	nc	0.195 [f]	0.0195
Petroleum Hydrocarbons			
Diesel Range Organics	nc	na	na
Diesel Range Organics - Aromatic	nc	na	na
Diesel Range Organics - Aliphatic	nc	na	na
Gasoline Range Organics	nc	na	na

Table 3-11 Tier I Ecological COPEC Screening Criteria - Freshwater Sediment

Chemical of Potential Concern	BUTL (mg/kg) [a]	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)
Petroleum Hydrocarbons (Cont.)			
Residual Range Organics	nc	na	na
Residual Range Organics - Aliphatic	nc	na	na
Residual Range Organics - Aromatic	nc	na	na
Total Recoverable Petroleum Hydrocarbons	nc	NA [l]	NA

Notes:

BHC - Benzene hexachloride
BUTL - Background upper tolerance limit.
COPEC - Chemical of potential ecological concern
DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethylene
DDT - Dichlorodiphenyltrichloroethane
DRO - Diesel range organics
ERBSC - Ecological Risk-Based Screening Criteria.
GRO - Gasoline range organics
mg/kg - Milligrams per kilogram
NA - Not applicable
na - Not available
nc - Not calculated
NOAA - National Oceanic and Atmospheric Administration
ORNL - Oak Ridge National Laboratory
SQuiRTs - NOAA Screening Quick Reference Tables
TEC - Threshold Effect Concentration
USEPA - U.S. Environmental Protection Agency

[a] Background upper tolerance limits (BUTLs) were not calculated (nc) for organic chemicals, or inorganic chemicals with insufficient data. Please refer to MWH (2003a) for further discussion of the methods used to derive BUTLs for Northeast Cape.
[b] Ecological Benchmark Criterion selected based on the following hierarchy:
1) Consensus-based Freshwater Threshold Effect Concentrations per MacDonald et al. (2000 - Table 2). Sediment quality guidelines for metals in freshwater ecosystems that reflect TECs (i.e., below which) harmful effects are unlikely to be observed).
2) Assessment and Remediation of Contaminated Sediment Program - TEC per ORNL, 1997a - Table 4.
3) Ontario Ministry of the Environment: Lowest effect level per ORNL, 1997a - Table 4.
4) EPA OSWER Value per ORNL, 1997a - Table 5.
5) NOAA ER-L per ORNL, 1997a - Table 1.
6) FDEP TEL Value per ORNL, 1997a - Table 1.

[c] ERBSC is equal to one-tenth the ecological benchmark criterion.
[d] Aluminum ecological benchmark criterion derived from lowest ARCS TEL (NOAA, 1999 - SQuiRTs).
[e] Benchmark Criteria Derived from NOAA ER-L (ORNL, 1997)
[f] Benchmark Criteria Derived from Consensus-based TEC (MacDonald et al., 2000).
[g] Soil Screening Criteria are not available for this essential nutrient. This analyte is excluded as a COPEC based on essential nutrient status.
[h] Benchmark Criteria Derived from ORNL ARCS-TEC (ORNL, 1997).
[i] Benchmark Criteria Derived from USEPA OSER Value (ORNL, 1997).
[j] Total xylene used as a surrogate for individual xylene isomers (i.e., m-, o- and p-xylenes). Commercial xylene solvents are mixtures of all three isomers (i.e., m-, o- and p-xylenes), and toxicity studies for "xylenes" are based on the commercial mixture.
[k] Benchmark Criteria Derived from FDEP TEL Value (ORNL, 1997).
[l] Benchmark Criteria Derived from ORNL Ontario MOE-Low (ORNL, 1997).
[m] Total polychlorinated biphenyls (PCBs) used as a surrogate for all PCBs (i.e., Aroclors). Consistent with IRIS (USEPA, 2003a), carcinogenic effects of Aroclors are evaluated using the cancer slope factor for "polychlorinated biphenyls".
[n] Chlordane used as a surrogate for alpha- and gamma-chlordane. Alpha and gamma isomers of chlordane are structurally similar cyclodiene insecticides and neurotoxicants, and are components of technical chlordane.

Table 3-11 Tier I Ecological COPEC Screening Criteria - Freshwater Sediment

Chemical of Potential Concern	BUTL (mg/kg) [a]	Ecological Benchmark Criterion [b] (mg/kg)	ERBSC Benchmark [c] (mg/kg)

[o] Alpha-BHC used as a surrogate for delta-BHC. Alpha, beta, gamma and delta isomers of hexachlorocyclohexane (BHC) are structurally similar neurotoxicants, and are all components of technical BHC.

[p] Endrin used as a surrogate for endrin aldehyde and endrin ketone. Endrin aldehyde is an impurity in technical endrin, as well as a metabolite of endrin. Endrin ketone is formed when endrin is exposed to light. Endrin aldehyde and endrin ketone retain the biological activity of endrin.

[q] 2,3,7,8 TCDD is used as a surrogate for many dioxins/furans. 2,3,4,7,8-PCDF is structurally and toxicologically similar to many coplanar dioxins and furans, and is among the most toxic.

[r] 2,3,7,8 TCDD ecological benchmark criterion derived from freshwater sediment Upper Effects Threshold (NOAA, 1999 - SQuiRTs).

[s] Benzo(k)fluoranthene used as a surrogate. The PAHs, benzo(a)pyrene, benzo(a)anthracene, and benzo(b)fluoranthene, are multi-ring, high molecular weight components of mid- and high-distillation fraction petroleum hydrocarbons (PHCs). They share similar chemical, environmental fate and toxicological properties.

[t] Total recoverable petroleum hydrocarbons (TRPHs) are excluded as a COPC due to outdated analytical methods.

Table 3-12 Tier I Ecological COPEC Screening Criteria - Surface Water

Constituent	BUTL (mg/L) [a] Fresh Surface Water	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Inorganics, Total			
Aluminum	nc	0.087 [d]	0.0087
Antimony	nc	0.03 [d]	0.003
Arsenic	nc	0.15 [d]	0.015
Barium	nc	na	na
Beryllium	nc	0.0053 [d]	0.00053
Cadmium	nc	0.0011 [d]	0.00011
Calcium	nc	NA [e]	NA
Chromium	nc	0.074 [d]	0.0074
Cobalt	nc	0.0051 [f]	0.00051
Copper	nc	0.009 [d]	0.0009
Iron	nc	NA [e]	NA
Lead	nc	0.0025 [d]	0.00025
Magnesium	nc	82 [f]	8.2
Manganese	nc	1.1 [f]	0.11
Mercury	nc	0.000012 [d]	0.0000012
Nickel	nc	0.052 [d]	0.0052
Potassium	nc	NA [e]	NA
Selenium	nc	0.005 [d]	0.0005
Silver	nc	0.00012 [d]	0.000012
Sodium	nc	NA [e]	NA
Thallium	nc	0.04 [d]	0.004
Vanadium	nc	1.9 [f]	0.19
Zinc	nc	0.11 [d]	0.011
Inorganics, Dissolved			
Antimony, Dissolved	nc	0.03 [d]	0.003
Arsenic, Dissolved	nc	0.15 [d]	0.015
Beryllium, Dissolved	nc	0.0053 [d]	0.00053
Cadmium, Dissolved	nc	0.0011 [d]	0.00011
Chromium, Dissolved	nc	0.074 [d]	0.0074
Copper, Dissolved	nc	0.009 [d]	0.0009
Iron, dissolved	nc	NA [e]	NA
Lead, Dissolved	nc	0.0025 [d]	0.00025
Manganese, dissolved	nc	1.1 [f]	0.11
Mercury, Dissolved	nc	0.000012 [d]	0.0000012
Nickel, Dissolved	nc	0.052 [d]	0.0052
Selenium, Dissolved	nc	0.005 [d]	0.0005
Silver, Dissolved	nc	0.00012 [d]	0.000012
Thallium, Dissolved	nc	0.04 [d]	0.004
Zinc, Dissolved	nc	0.11 [d]	0.011

Table 3-12 Tier I Ecological COPEC Screening Criteria - Surface Water

Constituent	BUTL (mg/L) [a] Fresh Surface Water	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Volatile Organic Compounds			
1,1,1,2-Tetrachloroethane	nc	na	na
1,1,1-Trichloroethane	nc	1.8 [g]	0.18
1,1,2,2-Tetrachloroethane	nc	2.4 [d]	0.24
1,1,2-Trichloroethane	nc	9.4 [d]	0.94
1,1-Dichloroethane	nc	na	na
1,1-Dichloroethene	nc	4.72 [f]	0.472
1,1-Dichloropropene	nc	na	na
1,2,3-Trichlorobenzene	nc	na	na
1,2,3-Trichloropropane	nc	na	na
1,2,4-Trichlorobenzene	nc	0.05 [d]	0.005
1,2,4-Trimethylbenzene	nc	na	na
1,2-Dibromo-3-chloropropane	nc	na	na
1,2-Dibromoethane	nc	na	na
1,2-Dichlorobenzene	nc	0.763 [d]	0.0763
1,2-Dichloroethane	nc	20 [d]	2
1,2-Dichloropropane	nc	na	na
1,3,5-Trimethylbenzene	nc	na	na
1,3-Dichlorobenzene	nc	na	na
1,3-Dichloropropane	nc	na	na
1,4-Dichlorobenzene	nc	0.763 [d]	0.0763
1-Chlorohexane	nc	na	na
2,2-Dichloropropane	nc	na	na
2-Butanone	nc	1,395 [f]	139.5
2-Chloroethyl vinyl ether	nc	na	na
2-Chloronaphthalene	nc	0.16 [g]	0.016
2-Chlorophenol	nc	0.438 [g]	0.0438
2-Chlorotoluene	nc	na	na
2-Hexanone	nc	na	na
4-Bromophenyl phenyl ether	nc	na	na
4-Chlorophenyl phenyl ether	nc	na	na
4-Isopropyltoluene	nc	na	na
4-Methyl-2-pentanone	nc	na	na
Acetone	nc	1.56 [f]	0.156
Acrolein	nc	0.021 [d]	0.0021
Benzene	nc	0.7 [h]	0.07
bis-(2-Chloroethyl)ether	nc	na	na
bis(2-Chloroisopropyl)ether	nc	na	na
Bromobenzene	nc	na	na
Bromochloromethane	nc	na	na
Bromodichloromethane	nc	na	na

Table 3-12 Tier I Ecological COPEC Screening Criteria - Surface Water

Constituent	BUTL (mg/L) [a] Fresh Surface Water	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Volatile Organic Compounds (Cont.)			
Bromoethane	nc	na	na
Bromoform	nc	na	na
Bromomethane	nc	na	na
Carbon disulfide	nc	0.244 [f]	0.0244
Carbon tetrachloride	nc	3.52 [g]	0.352
Chlorobenzene	nc	0.05 [d]	0.005
Chloroethane	nc	na	na
Chloroform	nc	1.24 [d]	0.124
Chloromethane	nc	na	na
cis-1,2-Dichloroethene	nc	1.16 [g]	0.116
cis-1,3-Dichloropropene	nc	na	na
Dibromochloromethane	nc	6.4 [h]	0.64
Dibromomethane	nc	6.4 [h]	0.64
Dichlorodifluoromethane	nc	6.4 [h]	0.64
Ethane	nc	na	na
Ethene	nc	na	na
Ethylbenzene	nc	3.2 [g]	0.32
Isopropylbenzene	nc	na	na
m,p-Xylene (Sum of Isomers)	nc	na	na
Methane	nc	na	na
Methyl iodide	nc	na	na
Methylene chloride	nc	6.4 [h]	0.64
n-Butylbenzene	nc	na	na
Nitrobenzene	nc	2.7 [g]	0.27
n-Propylbenzene	nc	na	na
o-Xylene	nc	na	na
p-Isopropyltoluene	nc	na	na
sec-Butylbenzene	nc	na	na
Styrene	nc	na	na
tert-Butylbenzene	nc	na	na
Tetrachloroethene	nc	0.84 [d]	0.084
Toluene	nc	5 [h]	0.5
trans-1,2-Dichloroethene	nc	1.16 [g]	0.116
trans-1,3-Dichloropropene	nc	na	na
trans-1,4-Dichloro-2-butene	nc	na	na
Trichloroethene	nc	21.9 [d]	2.19
Trichlorofluoromethane	nc	6.4 [h]	0.64
Vinyl acetate	nc	na	na
Vinyl chloride	nc	1.16 [g]	0.116
Xylene, Isomers m & p	nc	na	na

Table 3-12 Tier I Ecological COPEC Screening Criteria - Surface Water

Constituent	BUTL (mg/L) [a] Fresh Surface Water	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Volatile Organic Compounds (Cont.)			
Xylenes	nc	na	na
Semi-volatile Organic Compounds			
1,1,2-Trichloro-1,2,2-trifluoroethane	nc	na	na
2,4,5-Trichlorophenol	nc	0.063 [d]	0.0063
2,4,6-Trichlorophenol	nc	0.097 [g]	0.0097
2,4-Dichlorophenol	nc	0.365 [d]	0.0365
2,4-Dimethylphenol	nc	0.212 [g]	0.0212
2,4-Dinitrophenol	nc	na	na
2,4-Dinitrotoluene	nc	0.23 [d]	0.023
2,6-Dinitrotoluene	nc	na	na
2-Methyl-4,6-dinitrophenol	nc	na	na
2-Methylphenol (o-Cresol)	nc	1.316 [f]	0.1316
2-Nitroaniline	nc	na	na
2-Nitrophenol	nc	na	na
3,3-Dichlorobenzidine	nc	na	na
3-Nitroaniline	nc	na	na
4-Chloro-3-methylphenol	nc	na	na
4-Chloroaniline	nc	0.05 [d]	0.005
4-Chlorotoluene	nc	na	na
4-Methylphenol (p-Cresol)	nc	na	na
4-Nitroaniline	nc	na	na
4-Nitrophenol	nc	0.15 [d]	0.015
Acrylamide	nc	na	na
Benzidine	nc	na	na
Benzoic acid	nc	na	na
Benzyl alcohol	nc	na	na
Benzyl butyl phthalate	nc	0.003 [d]	0.0003
bis-(2-chloroethoxy)methane	nc	6.4 [h]	0.64
bis-(2-ethylhexyl)phthalate	nc	0.36 [d]	0.036
Carbazole	nc	na	na
Diethyl phthalate	nc	0.003 [d]	0.0003
Dimethyl phthalate	nc	0.003 [d]	0.0003
Di-n-butyl phthalate	nc	0.003 [d]	0.0003
Di-n-octyl phthalate	nc	0.003 [d]	0.0003
Hexachlorobenzene	nc	0.00368 [d]	0.000368
Hexachlorobutadiene	nc	0.0093 [d]	0.00093
Hexachlorocyclopentadiene	nc	0.0052 [d]	0.00052
Hexachloroethane	nc	0.54 [d]	0.054
Isophorone	nc	11.7 [g]	1.17
n-Nitrosodi-n-propylamine	nc	na	na

Table 3-12 Tier I Ecological COPEC Screening Criteria - Surface Water

Constituent	BUTL (mg/L) [a] Fresh Surface Water	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Semi-volatile Organic Compounds (Cont.)			
n-Nitrosodiphenylamine	nc	0.585 [g]	0.0585
Pentachlorophenol	nc	0.015 [d]	0.0015
Polychlorinated Biphenyls			
PCB-1016 (Aroclor 1016)	nc	0.000014 [d, i]	0.0000014
PCB-1221 (Aroclor 1221)	nc	0.000014 [d, i]	0.0000014
PCB-1232 (Aroclor 1232)	nc	0.000014 [d, i]	0.0000014
PCB-1242 (Aroclor 1242)	nc	0.000014 [d, i]	0.0000014
PCB-1248 (Aroclor 1248)	nc	0.000014 [d, i]	0.0000014
PCB-1254 (Aroclor 1254)	nc	0.0029 [f]	0.00029
PCB-1260 (Aroclor 1260)	nc	0.000014 [d, i]	0.0000014
Pesticides			
4,4'-DDD	nc	0.00006 [g]	0.000006
4,4'-DDE	nc	0.105 [g]	0.0105
4,4'-DDT	nc	0.0000005 [d]	0.00000005
Aldrin	nc	0.00015 [g]	0.000015
delta-BHC	nc	0.095 [f, j]	0.0095
Dieldrin	nc	0.000056 [d]	0.0000056
Endrin aldehyde	nc	0.000036 [d, k]	0.0000036
gamma-BHC (Lindane)	nc	0.00008 [d]	0.000008
Heptachlor epoxide	nc	0.0000019 [d]	0.00000019
Heptachlor	nc	0.0000019 [d]	0.00000019
Dioxins and Furans			
1,2,3,4,6,7,8,9-Octachlordibenzofuran	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,6,7,8-Heptachlorodibenzofuran	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,7,8,9-Heptachlorodibenzofuran	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,7,8-Hexachlorodibenzofuran	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	nc	0.00000001 [d, l]	0.000000001
1,2,3,6,7,8-Hexachlorodibenzofuran	nc	0.00000001 [d, l]	0.000000001
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	nc	0.00000001 [d, l]	0.000000001
1,2,3,7,8,9-Hexachlorodibenzofuran	nc	0.00000001 [d, l]	0.000000001
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	nc	0.00000001 [d, l]	0.000000001
1,2,3,7,8-Pentachlorodibenzofuran	nc	0.00000001 [d, l]	0.000000001
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	nc	0.00000001 [d, l]	0.000000001
2,3,4,6,7,8-Hexachlorodibenzofuran	nc	0.00000001 [d, l]	0.000000001

Table 3-12 Tier I Ecological COPEC Screening Criteria - Surface Water

Constituent	BUTL (mg/L) [a] Fresh Surface Water	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Dioxins and Furans (Cont.)			
2,3,4,7,8-Pentachlorodibenzofuran	nc	0.00000001 [d, l]	0.000000001
2,3,7,8-Tetrachlorodibenzofuran	nc	0.00000001 [d, l]	0.000000001
2,3,7,8-Tetrachlorodibenzo-p-dioxin	nc	0.00000001 [d, l]	0.000000001
Dibenzofuran	nc	1.003 [f]	0.1003
Total Heptachlorodibenzofurans (HpCDF)	nc	0.00000001 [d, l]	0.000000001
Total Heptachlorodibenzo-p-dioxins (HpCDD)	nc	0.00000001 [d, l]	0.000000001
Total Hexachlorodibenzofurans (HxCDF)	nc	0.00000001 [d, l]	0.000000001
Total Hexachlorodibenzo-p-dioxins (HxCDD)	nc	0.00000001 [d, l]	0.000000001
Total Pentachlorodibenzofurans (PeCDF)	nc	0.00000001 [d, l]	0.000000001
Total Pentachlorodibenzo-p-dioxin (PeCDD)	nc	0.00000001 [d, l]	0.000000001
Total Tetrachlorodibenzofurans (TCDF)	nc	0.00000001 [d, l]	0.000000001
Total Tetrachlorodibenzo-p-dioxins (TCDD)	nc	0.00000001 [d, l]	0.000000001
Polynuclear Aromatic Hydrocarbons			
2-Methylnaphthalene	nc	0.03 [m]	0.003
Acenaphthene	nc	0.52 [d]	0.052
Acenaphthylene	nc	0.03 [m]	0.003
Anthracene	nc	0.03 [m]	0.003
Benzo(a)anthracene	nc	0.03 [m]	0.003
Benzo(a)pyrene	nc	0.03 [m]	0.003
Benzo(b)fluoranthene	nc	0.03 [m]	0.003
Benzo(g,h,i)perylene	nc	0.03 [m]	0.003
Benzo(k)fluoranthene	nc	0.03 [m]	0.003
Chrysene	nc	0.03 [m]	0.003
Dibenzo(a,h)anthracene	nc	0.03 [m]	0.003
Fluoranthene	nc	0.398 [g]	0.0398
Fluorene	nc	0.03 [m]	0.003
Indeno(1,2,3-cd)pyrene	nc	0.03 [m]	0.003
Naphthalene	nc	0.62 [d]	0.062
Phenanthrene	nc	0.0063 [d]	0.00063
Phenol	nc	2.56 [d]	0.256
Pyrene	nc	0.03 [m]	0.003
Petroleum Hydrocarbons			
Diesel Range Organics	nc	na	na
Diesel Range Organics - Aliphatic	nc	na	na
Gasoline Range Organics	nc	na	na
Residual Range Organics	nc	na	na
Residual Range Organics - Aliphatic	nc	na	na
Residual Range Organics - Aromatic	nc	na	na
Total Recoverable Petroleum Hydrocarbons	nc	NA [n]	NA

Table 3-12 Tier I Ecological COPEC Screening Criteria - Surface Water

Constituent	BUTL (mg/L) [a] Fresh Surface Water	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)

Notes:

BHC - Benzene hexachloride
BUTL - Background upper tolerance limit.
COPEC - chemical of potential ecological concern
DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethylene
DDT - Dichlorodiphenyltrichloroethane
DRO - Diesel range organics
ERBSC - Ecological Risk-Based Screening Criteria.
GRO - Gasoline range organics
mg/L - milligrams per liter
NA - not applicable
na - not available
NAWQC - National Ambient Water Quality Criteria
nc - not calculated
NOAA - National Oceanic and Atmospheric Administration
PCB - Polychlorinated bipheyls
ORNL - Oak Ridge National Laboratory
SQuiRT - Screening Quick Reference Tables
USEPA - U.S. Environmental Protection Agency

[a] Background upper tolerance limits (BUTLs) were not calculated (nc) for organic chemicals, or inorganic chemicals with insufficient data. Please refer to MWH (2003a) for further discussion of the methods used to derive BUTLs for Northeast Cape.
[b] Ecological Benchmark Criterion selected based on the following hierarchy:
1) EPA NAWQC - Freshwater Chronic Value. NOAA, 1999. SQuiRT, September.
2) EPA NAWQC - Marine Chronic Value. NOAA, 1999. SQuiRT, September.
3) EPA NAWQC - Freshwater Acute Value divided by 10. NOAA, 1999. SQuiRT, September.
4) EPA NAWQC - Marine Acute Value divided by 10. NOAA, 1999. SQuiRT, September.
5) Lowest Chronic Value observed in freshwater daphnids. ORNL, 1996a - Table 1.

[c] ERBSC is equal to one-tenth the ecological benchmark criterion.
[d] Benchmark Criteria Derived from NAWQC - Freshwater Chronic Value (NOAA, 1999).
[e] Surface Water Screening Criteria are not available for this essential nutrient. This analyte is excluded as a COPEC based on essential nutrient status.
[f] Benchmark Criteria Derived from Lowest Chronic Value for Freshwater Daphnids (ORNL, 1996a).
[g] Benchmark Criteria Derived from NAWQC - Freshwater Acute Value divided by 10 (NOAA, 1999).
[h] Benchmark Criteria Derived from NAWQC - Marine Chronic Value (NOAA, 1999).
[i] Total polychlorinated biphenyls (PCBs) used as a surrogate for all PCBs (i.e., Aroclors). Consistent with IRIS (USEPA, 2003a), carcinogenic effects of Aroclors are evaluated using the cancer slope factor for "polychlorinated biphenyls".
[j] BHC used as a surrogate for delta-BHC. Alpha, beta, gamma and delta isomers of hexachlorocyclohexane (BHC) are structurally similar neurotoxicants, and are all components of technical BHC.
[k] Endrin used as a surrogate for endrin aldehyde and endrin ketone. Endrin aldehyde is an impurity in technical endrin, as well as a metabolite of endrin. Endrin ketone is formed when endrin is exposed to light. Endrin aldehyde and endrin ketone retain the biological activity of endrin.
[l] 2,3,7,8-TCDD is used as a surrogate for many dioxins/furans. 2,3,4,7,8-PCDF is structurally and toxicologically similar to many coplanar dioxins and furans, and is among the most toxic.
[m] Benchmark Criteria Derived from NAWQC - Marine Acute Value divided by 10 (NOAA, 1999).
[n] Total recoverable petroleum hydrocarbons (TRPHs) are excluded as a COPC due to outdated analytical methods.

Table 3-13 Tier I Ecological COPEC Screening Criteria - Subsurface Water

Constituent	Subsurface Water BUTL [a] (mg/L) Shallow	Deep	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Inorganics, Total				
Aluminum	nc	nc	0.087 [d]	0.0087
Antimony	nc	nc	0.03 [d]	0.003
Arsenic	0.025	nc	0.15 [d]	0.015
Barium	nc	nc	na	na
Beryllium	0.021	nc	0.0053 [d]	0.00053
Cadmium	0.060	nc	0.0011 [d]	0.00011
Calcium	nc	nc	NA [e]	NA
Chromium	1.7	nc	0.074 [d]	0.0074
Cobalt	0.011	nc	0.0051 [f]	0.00051
Copper	0.087	nc	0.009 [d]	0.0009
Iron	nc	nc	NA [e]	NA
Lead	0.013	nc	0.0025 [d]	0.00025
Magnesium	nc	nc	82 [f]	8.2
Manganese	0.20	nc	1.1 [f]	0.11
Mercury	0.00041	nc	0.000012 [d]	0.0000012
Nickel	0.056	nc	0.052 [d]	0.0052
Potassium	nc	nc	NA [e]	NA
Selenium	nc	nc	0.005 [d]	0.0005
Silver	nc	nc	0.00012 [d]	0.000012
Sodium	nc	nc	NA [e]	NA
Thallium	nc	nc	0.04 [d]	0.004
Vanadium	0.097	nc	1.9 [f]	0.19
Zinc	0.29	nc	0.11 [d]	0.011
Inorganics, Dissolved				
Antimony, Dissolved	nc	nc	0.03 [d]	0.003
Arsenic, Dissolved	0.015	nc	0.15 [d]	0.015
Beryllium, Dissolved	nc	nc	0.0053 [d]	0.00053
Cadmium, Dissolved	nc	nc	0.0011 [d]	0.00011
Chromium, Dissolved	nc	nc	0.074 [d]	0.0074
Copper, Dissolved	nc	nc	0.009 [d]	0.0009
Iron, dissolved	nc	nc	NA [e]	NA
Lead, Dissolved	nc	nc	0.0025 [d]	0.00025
Manganese, dissolved	nc	nc	1.1 [f]	0.11
Mercury, Dissolved	nc	nc	0.000012 [d]	0.0000012
Nickel, Dissolved	nc	nc	0.052 [d]	0.0052
Selenium, Dissolved	nc	nc	0.005 [d]	0.0005
Silver, Dissolved	nc	nc	0.00012 [d]	0.000012
Thallium, Dissolved	nc	nc	0.04 [d]	0.004
Zinc, Dissolved	nc	nc	0.11 [d]	0.011
Volatile Organic Compounds				
1,1,1,2-Tetrachloroethane	nc	nc	na	na
1,1,1-Trichloroethane	nc	nc	1.8 [g]	0.18
1,1,2,2-Tetrachloroethane	nc	nc	2.4 [d]	0.24
1,1,2-Trichloroethane	nc	nc	9.4 [d]	0.94
1,1-Dichloroethane	nc	nc	na	na

Table 3-13 Tier I Ecological COPEC Screening Criteria - Subsurface Water

Constituent	Subsurface Water BUTL [a] (mg/L) Shallow	Subsurface Water BUTL [a] (mg/L) Deep	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Volatile Organic Compounds (Cont.)				
1,1-Dichloroethene	nc	nc	4.72 [f]	0.472
1,1-Dichloropropene	nc	nc	na	na
1,2,3-Trichlorobenzene	nc	nc	na	na
1,2,3-Trichloropropane	nc	nc	na	na
1,2,4-Trichlorobenzene	nc	nc	0.05 [d]	0.005
1,2,4-Trimethylbenzene	nc	nc	na	na
1,2-Dibromo-3-chloropropane	nc	nc	na	na
1,2-Dibromoethane	nc	nc	na	na
1,2-Dichlorobenzene	nc	nc	0.763 [d]	0.0763
1,2-Dichloroethane	nc	nc	20 [d]	2
1,2-Dichloropropane	nc	nc	na	na
1,3,5-Trimethylbenzene	nc	nc	na	na
1,3-Dichlorobenzene	nc	nc	na	na
1,3-Dichloropropane	nc	nc	na	na
1,4-Dichlorobenzene	nc	nc	0.763 [d]	0.0763
1-Chlorohexane	nc	nc	na	na
2,2-Dichloropropane	nc	nc	na	na
2-Butanone	nc	nc	1395 [f]	139
2-Chloroethyl vinyl ether	nc	nc	na	na
2-Chloronaphthalene	nc	nc	0.16 [g]	0.016
2-Chlorophenol	nc	nc	0.438 [g]	0.0438
2-Chlorotoluene	nc	nc	na	na
2-Hexanone	nc	nc	na	na
4-Bromophenyl phenyl ether	nc	nc	na	na
4-Chlorophenyl phenyl ether	nc	nc	na	na
4-Isopropyltoluene	nc	nc	na	na
4-Methyl-2-pentanone	nc	nc	na	na
Acetone	nc	nc	1.56 [f]	0.156
Acrolein	nc	nc	0.021 [d]	0.0021
Benzene	nc	nc	0.7 [h]	0.07
bis-(2-Chloroethyl)ether	nc	nc	na	na
bis(2-Chloroisopropyl)ether	nc	nc	na	na
Bromobenzene	nc	nc	na	na
Bromochloromethane	nc	nc	na	na
Bromodichloromethane	nc	nc	na	na
Bromoethane	nc	nc	na	na
Bromoform	nc	nc	na	na
Bromomethane	nc	nc	na	na
Carbon disulfide	nc	nc	0.244 [f]	0.0244
Carbon tetrachloride	nc	nc	3.52 [g]	0.352
Chlorobenzene	nc	nc	0.05 [d]	0.005
Chloroethane	nc	nc	na	na
Chloroform	nc	nc	1.24 [d]	0.124
Chloromethane	nc	nc	na	na
cis-1,2-Dichloroethene	nc	nc	1.16 [g]	0.116

Table 3-13 Tier I Ecological COPEC Screening Criteria - Subsurface Water

Constituent	Subsurface Water BUTL [a] (mg/L) Shallow	Subsurface Water BUTL [a] (mg/L) Deep	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Volatile Organic Compounds				
cis-1,3-Dichloropropene	nc	nc	na	na
Dibromochloromethane	nc	nc	6.4 [h]	0.64
Dibromomethane	nc	nc	6.4 [h]	0.64
Dichlorodifluoromethane	nc	nc	6.4 [h]	0.64
Ethane	nc	nc	na	na
Ethene	nc	nc	na	na
Ethylbenzene	nc	nc	3.2 [g]	0.32
Isopropylbenzene	nc	nc	na	na
m,p-Xylene (Sum of Isomers)	nc	nc	na	na
Methane	nc	nc	na	na
Methyl iodide	nc	nc	na	na
Methylene chloride	nc	nc	6.4 [h]	0.64
n-Butylbenzene	nc	nc	na	na
Nitrobenzene	nc	nc	2.7 [g]	0.27
n-Propylbenzene	nc	nc	na	na
o-Xylene	nc	nc	na	na
p-Isopropyltoluene	nc	nc	na	na
sec-Butylbenzene	nc	nc	na	na
Styrene	nc	nc	na	na
tert-Butylbenzene	nc	nc	na	na
Tetrachloroethene	nc	nc	0.84 [d]	0.084
Toluene	nc	nc	5 [h]	0.5
trans-1,2-Dichloroethene	nc	nc	1.16 [g]	0.116
trans-1,3-Dichloropropene	nc	nc	na	na
trans-1,4-Dichloro-2-butene	nc	nc	na	na
Trichloroethene	nc	nc	21.9 [d]	2.19
Trichlorofluoromethane	nc	nc	6.4 [h]	0.64
Vinyl acetate	nc	nc	na	na
Vinyl chloride	nc	nc	1.16 [g]	0.116
Xylene, Isomers m & p	nc	nc	na	na
Xylenes	nc	nc	na	na
Semi-volatile Organic Compounds				
1,1,2-Trichloro-1,2,2-trifluoroethane	nc	nc	na	na
2,4,5-Trichlorophenol	nc	nc	0.063 [d]	0.0063
2,4,6-Trichlorophenol	nc	nc	0.097 [g]	0.0097
2,4-Dichlorophenol	nc	nc	0.365 [d]	0.0365
2,4-Dimethylphenol	nc	nc	0.212 [g]	0.0212
2,4-Dinitrophenol	nc	nc	na	na
2,4-Dinitrotoluene	nc	nc	0.23 [d]	0.023
2,6-Dinitrotoluene	nc	nc	na	na
2-Methyl-4,6-dinitrophenol	nc	nc	na	na
2-Methylphenol (o-Cresol)	nc	nc	1.316 [f]	0.1316
2-Nitroaniline	nc	nc	na	na
2-Nitrophenol	nc	nc	na	na
3,3-Dichlorobenzidine	nc	nc	na	na

Table 3-13 Tier I Ecological COPEC Screening Criteria - Subsurface Water

Constituent	Subsurface Water BUTL [a] (mg/L) Shallow	Subsurface Water BUTL [a] (mg/L) Deep	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Semi-volatile Organic Compounds (Cont.)				
3-Nitroaniline	nc	nc	na	na
4-Chloro-3-methylphenol	nc	nc	na	na
4-Chloroaniline	nc	nc	0.05 [d]	0.005
4-Chlorotoluene	nc	nc	na	na
4-Methylphenol (p-Cresol)	nc	nc	na	na
4-Nitroaniline	nc	nc	na	na
4-Nitrophenol	nc	nc	0.15 [d]	0.015
Acrylamide	nc	nc	na	na
Benzidine	nc	nc	na	na
Benzoic acid	nc	nc	na	na
Benzyl alcohol	nc	nc	na	na
Benzyl butyl phthalate	nc	nc	0.003 [d]	0.0003
bis-(2-chloroethoxy)methane	nc	nc	6.4 [h]	0.64
bis-(2-ethylhexyl)phthalate	nc	nc	0.36 [d]	0.036
Carbazole	nc	nc	na	na
Diethyl phthalate	nc	nc	1.003 [f]	0.1003
Dimethyl phthalate	nc	nc	0.003 [d]	0.0003
Di-n-butyl phthalate	nc	nc	0.003 [d]	0.0003
Di-n-octyl phthalate	nc	nc	0.003 [d]	0.0003
Hexachlorobenzene	nc	nc	0.003 [d]	0.0003
Hexachlorobutadiene	nc	nc	0.00368 [d]	0.000368
Hexachlorocyclopentadiene	nc	nc	0.0093 [d]	0.00093
Hexachloroethane	nc	nc	0.0052 [d]	0.00052
Isophorone	nc	nc	0.54 [d]	0.054
n-Nitrosodi-n-propylamine	nc	nc	11.7 [g]	1.17
n-Nitrosodiphenylamine	nc	nc	na	na
Pentachlorophenol	nc	nc	0.585 [g]	0.0585
Phenol	nc	nc	2.56 [d]	0.256
Polychlorinated Biphenyls				
PCB-1016 (Aroclor 1016)	nc	nc		
PCB-1221 (Aroclor 1221)	nc	nc	0.000014 [d, i]	0.0000014
PCB-1232 (Aroclor 1232)	nc	nc	0.000014 [d, i]	0.0000014
PCB-1242 (Aroclor 1242)	nc	nc	0.000014 [d, i]	0.0000014
PCB-1248 (Aroclor 1248)	nc	nc	0.000014 [d, i]	0.0000014
PCB-1254 (Aroclor 1254)	nc	nc	0.000014 [d, i]	0.0000014
PCB-1260 (Aroclor 1260)	nc	nc	0.0029 [f]	0.00029
Pesticides				
4,4'-DDD	nc	nc		
4,4'-DDE	nc	nc	0.00006 [g]	0.000006
4,4'-DDT	nc	nc	0.105 [g]	0.0105
Aldrin	nc	nc	0.0000005 [d]	0.00000005
delta-BHC	nc	nc	0.00015 [g]	0.000015
Dieldrin	nc	nc	0.095 [f]	0.0095
Endrin aldehyde	nc	nc	0.000056 [d,k]	0.0000056
gamma-BHC (Lindane)	nc	nc	0.000036 [d, j]	0.0000036

Table 3-13 Tier I Ecological COPEC Screening Criteria - Subsurface Water

Constituent	Subsurface Water BUTL [a] (mg/L) Shallow	Subsurface Water BUTL [a] (mg/L) Deep	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Pesticides (Cont.)				
Heptachlor epoxide	nc	nc	0.00008 [d]	0.000008
Heptachlor	nc	nc	0.0000019 [d]	0.00000019
Dioxins and Furans				
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,6,7,8-Heptachlorodibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,7,8,9-Heptachlorodibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,7,8-Hexachlorodibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,6,7,8-Hexachlorodibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,7,8,9-Hexachlorodibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,7,8-Pentachlorodibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	nc	nc	0.00000001 [d, l]	0.000000001
2,3,4,6,7,8-Hexachlorodibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
2,3,4,7,8-Pentachlorodibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
2,3,7,8-Tetrachlorodibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
2,3,7,8-Tetrachlorodibenzo-p-dioxin	nc	nc	0.00000001 [d, l]	0.000000001
Dibenzofuran	nc	nc	0.00000001 [d, l]	0.000000001
Total Heptachlorodibenzofurans (HpCDF)	nc	nc	0.00000001 [d, l]	0.000000001
Total Heptachlorodibenzo-p-dioxins (HpCDD)	nc	nc	0.00000001 [d, l]	0.000000001
Total Hexachlorodibenzofurans (HxCDF)	nc	nc	0.00000001 [d, l]	0.000000001
Total Hexachlorodibenzo-p-dioxins (HxCDD)	nc	nc	0.00000001 [d, l]	0.000000001
Total Pentachlorodibenzofurans (PeCDF)	nc	nc	0.00000001 [d, l]	0.000000001
Total Pentachlorodibenzo-p-dioxin (PeCDD)	nc	nc	0.00000001 [d, l]	0.000000001
Total Tetrachlorodibenzofurans (TCDF)	nc	nc	0.00000001 [d, l]	0.000000001
Total Tetrachlorodibenzo-p-dioxins (TCDD)	nc	nc	0.00000001 [d, l]	0.000000001
Polynuclear Aromatic Hydrocarbons				
2-Methylnaphthalene	nc	nc	0.03 [m]	0.003
Acenaphthene	nc	nc	0.52 [d]	0.052
Acenaphthylene	nc	nc	0.03 [m]	0.003
Anthracene	nc	nc	0.03 [m]	0.003
Benzo(a)anthracene	nc	nc	0.03 [m]	0.003
Benzo(a)pyrene	nc	nc	0.03 [m]	0.003
Benzo(b)fluoranthene	nc	nc	0.03 [m]	0.003
Benzo(g,h,i)perylene	nc	nc	0.03 [m]	0.003
Benzo(k)fluoranthene	nc	nc	0.03 [m]	0.003
Chrysene	nc	nc	0.03 [m]	0.003
Dibenzo(a,h)anthracene	nc	nc	0.03 [m]	0.003
Fluoranthene	nc	nc	0.398 [g]	0.0398
Fluorene	nc	nc	0.03 [m]	0.003
Indeno(1,2,3-cd)pyrene	nc	nc	0.03 [m]	0.003
Naphthalene	nc	nc	0.62 [d]	0.062

Table 3-13 Tier I Ecological COPEC Screening Criteria - Subsurface Water

Constituent	Subsurface Water BUTL [a] (mg/L) Shallow	Deep	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)
Polynuclear Aromatic Hydrocarbons (cont.)				
Phenanthrene	nc	nc	0.0063 [d]	0.00063
Pyrene	nc	nc	0.03 [m]	0.003
Petroleum Hydrocarbons				
Diesel Range Organics	nc	nc	na	na
Diesel Range Organics - Aliphatic	nc	nc	na	na
Gasoline Range Organics	nc	nc	na	na
Residual Range Organics	nc	nc	na	na
Residual Range Organics - Aliphatic	nc	nc	na	na
Residual Range Organics - Aromatic	nc	nc	na	na
Total Recoverable Petroleum Hydrocarbons	nc	nc	NA [n]	NA

Notes:

BHC - Benzene hexachloride
BUTL - Background upper tolerance limit.
COPEC - Chemical of potential ecological concern
DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethylene
DDT - Dichlorodiphenyltrichloroethane
DRO - Diesel range organics
ERBSC - Ecological Risk-Based Screening Criteria.
GRO - Gasoline range organics
mg/L - Milligrams per liter
NA - Not applicable
na - Not available
NAWQC - National Ambient Water Quality Criteria
nc - Not calculated
NOAA - National Oceanic and Atmospheric Administration
ORNL - Oak Ridge National Laboratory
PCB - Polychlorinated bipheyls
RRO - Residual range organics
SQuiRT - Screening Quick Reference Tables
USEPA - U.S. Environmental Protection Agency

[a] Background upper tolerance limits (BUTLs) were not calculated (nc) for organic chemicals, or inorganic chemicals with insufficient data. Please refer to MWH (2003a) for further discussion of the methods used to derive BUTLs for Northeast Cape.
[b] Ecological Benchmark Criterion selected based on the following hierarchy:
1) EPA NAWQC - Freshwater Chronic Value. NOAA, 1999. SQuiRT, September.
2) EPA NAWQC - Marine Chronic Value. NOAA, 1999. SQuiRT, September.
3) EPA NAWQC - Freshwater Acute Value divided by 10. NOAA, 1999. SQuiRT, September.
4) EPA NAWQC - Marine Acute Value divided by 10. NOAA, 1999. SQuiRT, September.
5) Lowest Chronic Value observed in freshwater daphnids. ORNL, 1996a - Table 1.

[c] ERBSC is equal to one-tenth the ecological benchmark criterion.
[d] Benchmark Criteria Derived from NAWQC - Freshwater Chronic Value (NOAA, 1999).
[e] Surface Water Screening Criteria are not available for this essential nutrient. This analyte is excluded as a COPEC based on essential nutrient status.
[f] Benchmark Criteria Derived from Lowest Chronic Value for Freshwater Daphnids (ORNL, 1996a).
[g] Benchmark Criteria Derived from NAWQC - Freshwater Acute Value divided by 10 (NOAA, 1999).
[h] Benchmark Criteria Derived from NAWQC - Marine Chronic Value (NOAA, 1999).
[i] Total polychlorinated biphenyls (PCBs) used as a surrogate for all PCBs (i.e., Aroclors). Consistent with IRIS (USEPA, 2003a), carcinogenic effects of Aroclors are evaluated using the cancer slope factor for "polychlorinated biphenyls".

Table 3-13 Tier I Ecological COPEC Screening Criteria - Subsurface Water

Constituent	Subsurface Water BUTL [a] (mg/L) Shallow	Deep	Ecological Benchmark Criterion [b] (mg/L)	ERBSC Benchmark [c] (mg/L)

[j] BHC used as a surrogate for delta-BHC. Alpha, beta, gamma and delta isomers of hexachlorocyclohexane (BHC) are structurally similar neurotoxicants, and are all components of technical BHC.

[k] Endrin used as a surrogate for endrin aldehyde and endrin ketone. Endrin aldehyde is an impurity in technical endrin, as well as a metabolite of endrin. Endrin ketone is formed when endrin is exposed to light. Endrin aldehyde and endrin ketone retain the biological activity of endrin.

[l] 2,3,7,8-TCDD is used as a surrogate for many dioxins/furans. 2,3,4,7,8-PCDF is structurally and toxicologically similar to many coplanar dioxins and furans, and is among the most toxic.

[m] Benchmark Criteria Derived from NAWQC - Marine Acute Value divided by 10 (NOAA, 1999).

[n] Total recoverable petroleum hydrocarbons (TRPHs) are excluded as a COPC due to outdated analytical methods.

Table 3-14 Vascular Plants Present or Potentially Occurring at or near the Northeast Cape Installation

Common Name	Scientific Name	State Status [a]	Federal Status	Consumer	Source
Black Crowberry	*Empetrum nigrum ssp. hermaphroditum/Empetrum hermaphroditum*	N	N	Human	b, c
Chamisso's Willow	*Salix chamissonis*	N	N	Reindeer/ Human	b, c
Chukchi Primrose	*Primula tschuktschorum*	N	N	None	d
Diamond-Leaf Willow	*Salix pulchra/Salix planifolia spp. Pulchra*	N	N	Human	b, c
Entire-Leaf Roseroot	*Rhodiola integrifolia/Sedum roseum ssp. Integrifolium*	N	N	Human	b, c
Krause's Sorrel	*Rumex krausei*	N	N	None	d
Langsdorf's Lousewort	*Pedicularis langsdorfii*	N	N	Reindeer	b, c
Lessing's Leopardbane	*Arnica lessingii*	N	N	Reindeer	b, c
Pendant Grass	*Arctophila fulva*	N	N	None	d
Tall Jacob's Ladder	*Polemonium acutiflorum*	N	N	Reindeer	b, c
White Arctic Mountain-Heather	*Cassiope tetragona*	N	N	Human	b, c
Moss	*Sphagnum sp.*(moss)	N	N	Reindeer	b, c
Grass	*Carex sp.*	N	N	None	b, c
Lichens	*Cladina sp.*(lichen)	N	N	Reindeer	b, c
	Thamnolia sp.(lichen)	N	N	Reindeer	b, c
	Stereocaulon sp.(lichen)	N	N	Reindeer	b, c
	Umbilicaria sp. (lichen)	N	N	Reindeer	b, c

Notes:

[a] Alaska Fish & Game Laws and Regulations Annotated: Including Updates to the Alaska Administrative Code through Register 158 (ADF&G, 2001d).
[b] Field Report (Montgomery Watson, 2001a).
[c] Plant Identification (ANHP, 2001).
[d] Phase II RI Report (Montgomery Watson, 1999).

Status Definitions:
N – Not a threatened, endangered, proposed, candidate, or delisted species under federal or state guidelines; not a species of special concern under State of Alaska guidelines.

Table 3-15 Bird Species Present or Potentially Occurring at or near the Northeast Cape Installation

Common Name	Scientific Name	State Status [a]	Federal Status	Sources
Black-Legged Kittiwake	*Rissa tridactyla*	N	N	b
Brant	*Branta bernicla*	N	N	c
Canada Goose	*Branta canadensis*	N	N	b, c, d
Common Eider	*Somateria mollissima*	N	N	b, c
Common Loon	*Gavia immer*	N	N	b, c
Common Murre	*Uria aalge*	N	N	b
Common Raven	*Corvus corax*	N	N	c, e, f
Crested Auklet	*Aethia cristatella*	N	N	b
Emperor Goose	*Chen canagica*	N	N	c
Glaucous-Winged Gull	*Larus glaucescens*	N	N	b, c
Gray-Cheeked Thrush	*Catharus minimus*	SoC	N	c, d
Harlequin Duck	*Histrionicus histrionicus*	N	N	c
King Eider	*Somateria spectabilis*	N	N	d
Lapland Longspur	*Calcarius lapponicus*	N	N	c, f
Least Auklet	*Aethia pusilla*	N	N	b
Old Squaw	*Clangula hyemalis*	N	N	b, d
Pacific Common Eider	*Somateria mollissima var. nigra*	N	N	d
Pacific Loon	*Gavia pacifica*	N	N	b, g
Parasitic Jaeger	*Stercorarius parasiticus*	N	N	c
Pelagic Cormorant	*Phalacrocorax pelagicus*	N	N	b
Sandhill Crane	*Grus canadensis*	N	N	c, d
Short-Tailed Albatross	*Phoebastria albatrus*	E	E	d
Snow Bunting	*Plectrophenax nivalis*	N	N	f
Snow Goose	*Chen caerulescens*	N	N	b, c
Spectacled Eider	*Somateria fishcheri*	SoC	T	e
Steller's Eider	*Polysticta stelleri*	SoC	T	c, e
Thick-Billed Murre	*Uria lomvia*	N	N	b
Tundra Swan	*Cygnus columbianus*	N	N	b, c

Notes:

[a] Alaska Fish & Game Laws and Regulations Annotated: Including Updates to the Alaska Administrative Code through Register 158 (ADF&G, 2001d).
[b] 1996 Subsistence Bird Hunting Summary (ADF&G, 1997). Based on harvests from Savoonga residents.
[c] Field Guides (eNature, 2001).
[d] Alaska National Heritage Program (ANHP, 1998).
[e] Preliminary Conceptual Site Model No. 39-EJ-6591-01 St. Lawrence Island, Alaska. (USACHPPM, 2001).
[f] Phase II RI Report (Montgomery Watson, 1999).
[g] Attour 1997 Birding and Trip Results (Attour, 1997).

Status Definitions:

[E] Endangered: A species which is in danger of extinction throughout all or a significant portion of its range.
[N] Not a threatened, endangered, proposed, candidate, or delisted species under federal or state guidelines; not a species of special concern under State of Alaska guidelines.
[SoC] Species of Concern
[T] Threatened: A species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Table 3-16 Fish Species Present or Potentially Occurring at or near the Northeast Cape Installation

Common Name	Scientific Name	State Status [a]	Federal Status	Sources
Alaska Blackfish	*Dallia pectoralis*	N	N	b, c, d
Arctic Char	*Salvelinus alpinus*	N	N	b, e
Arctic Grayling	*Thymallus arcticus*	N	N	b, d, e
Chinook Salmon	*Oncorhynchus tshawytscha*	N	N	b, c, e, f, g
Chum Salmon	*Oncorhynchus keta*	N	N	b, e
Coho Salmon	*Oncorhynchus kisutch*	N	N	b, e
Dolly Varden	*Salvelinus malma*	N	N	c, e
Fourhorn Sculpin	*Myoxocephalus quadricornis*	N	N	h
Lake Whitefish	*Corgonus clupeaformis.*	N	N	b, d, e
Ninespined Stickleback	*Pungitius pungitius*	N	N	b, d
Pink Salmon	*Oncorhynchus gorbuscha*	N	N	b, c, e
Round Whitefish	*Prosopium cylindraceum*	N	N	d
Sockeye Salmon	*Oncorhynchus nerka*	N	E	b, e
Warty Sculpin	*Myoxocephalus verrucosus*	N	N	c

Notes:

[a] Alaska Fish & Game Laws and Regulations Annotated: Including Updates to the Alaska Administrative Code through Register 158 (ADF&G, 2001d).
[b] Preliminary Conceptual Site Model No. 39-EJ-6591-01 St. Lawrence Island, Alaska (USACHPPM, 2001).
[c] Memorandum for record (DOA, 2001).
[d] Field Guide to North American Fishes, Whales & Dolphins (NAS, 1997).
[e] ADF&G Wildlife Notebook Series (ADF&G, 2001b).
[f] Several runs are listed under federal protection as well as under state concern.
[g] Alaska National Heritage Program (ANHP, 1998).
[h] Tier II Ecological Risk Assessment for Northeast Cape (ENRI, 2000).

Status Definitions:
E – Endangered: A species that is in danger of extinction throughout all or a significant portion of its range.
N – Not a threatened, endangered, proposed, candidate, or delisted species under federal or state guidelines; not a species of special concern under State of Alaska guidelines.

Table 3-17 Shellfish Species Present or Potentially Occurring at or near the Northeast Cape Installation

Common Name	Scientific Name	State Status [a]	Federal Status	Sources
Alaska Surf Clam	*Spisula polynyma*	N	N	b
Butter Clam	*Saxidomus giganteus*	N	N	b
Cockle	*Clinocardium nuttallii*	N	N	b
Dungeness Crab	*Cancer magister*	N	N	b
Eastern Softshell Clam	*Mya arenaria*	N	N	b
Gaper Clam	*Tresus capax*	N	N	b
King Crab	*Paralithodes camtschatica*	N	N	b
Littleneck Clam	*Protothaca staminea*	N	N	b
Razor Clam	*Siliqua patula*	N	N	b
Shrimp	*Pandalidae*	N	N	b
Tanner Crab	*Chionoecetes bairdi*	N	N	b
Truncated Mya	*Mya truncata*	N	N	b

Notes:

[a] Alaska Fish & Game Laws and Regulations Annotated: Including Updates to the Alaska Administrative Code through Register 158 (ADF&G, 2001d).

[b] ADF&G Wildlife Notebook Series (ADF&G, 2001b).

Status Definitions:

N – Not a threatened, endangered, proposed, candidate, or delisted species under federal guidelines; not a species of concern under State of Alaska guidelines.

Table 3-18 Terrestrial Mammal Species Present or Potentially Occurring at or near the Northeast Cape Installation

Common Name	Scientific Name	State Status [a]	Federal Status	Sources
Arctic Fox	*Alopex lagopus*	N	N	b, c, d
Arctic Ground Squirrel	*Spermophilus parryii*	N	N	b, c, d
Cross Fox	*Vulpes vulpes*	N	N	b, c, d, e, f
Greenland Collared Lemming	*Dicrostonyx groenlandicus*	N	N	d
Least Weasel	*Mustela nivalis*	N	N	b, c
Red-Backed Vole	*Clethrionomys gapperi*	N	N	b, d
Reindeer	*Rangifer tarandus*	N	N	b, c, g
Short-Tailed Weasel	*Mustela erminea*	N	N	b, c
Tundra Shrew	*Sorex tundrensis*	N	N	b, d
Tundra Vole	*Microtus oeconomus*	N	N	b, d

Notes:

[a] Alaska Fish & Game Laws and Regulations Annotated: Including Updates to the Alaska Administrative Code through Register 158 (ADF&G, 2001d).

[b] ADF&G, Kate Persons, personal communication (2001c).

[c] Field Guilds (eNature, 2001).

[d] Phase II RI Report (Montgomery Watson, 1999).

[e] Preliminary Conceptual Site Model NO. 39-EJ-6591-01 St. Lawrence Island, Alaska. (USACHPPM, 2001).

[f] Site Observations (Montgomery Watson, 2001a).

[g] Investigation of Persistent Organic Pollutants in Reindeer on St. Lawrence Island (USDHHS, 2001).

Status Definitions:

N – Not a threatened, endangered, proposed, candidate, or delisted species under federal guidelines; not a species of concern under State of Alaska guidelines.

Table 3-19 Marine Mammal Species Present or Potentially Occurring at or near the Northeast Cape Installation

Common Name	Scientific Name	State Status [a]	Federal Status	Sources
Bearded Seal	*Erignathus barbatus*	N	N	c, b
Beluga Whale	*Delphinapterus leucas*	SoC	N	b
Blue Whale	*Balaenoptera musculus*	E	E	c, d
Bowhead Whale	*Balaena mysticetus*	SoC	E	b, c, d, e
Fin Whale	*Balaenoptera physalus*	N	E	c, d
Gray Whale	*Eschrichtius robustus*	N	D	b, c, d
Killer Whale	*Orcinus orca*	N	N	b, c
Minke Whale	*Balaenoptera acutorostrata*	N	N	b, c
Northern Right Whale	*Balaena glacialis*	E	E	c, d
Polar Bear	*Ursus maritimus*	N	N	c, f
Ringed Seal	*Phoca hispida*	N	N	b
Spotted Seal	*Phoca largha*	N	N	b
Steller's Sea Lion	*Eumetopias jubatus*	SoC	T	b, c, d
Walrus	*Odebenus rosmarus*	N	N	b, c

Notes:

[a] Alaska Fish & Game Laws and Regulations Annotated: Including Updates to the Alaska Administrative Code through Register 158 (ADF&G, 2001d).
[b] Phase II RI Report (Montgomery Watson, 1999).
[c] eNature, 2001.
[d] Alaska National Heritage Program (ANHP, 1998).
[e] USGS, 1997.
[f] Preliminary Conceptual Site Model No. 39-EJ-6591-01, St. Lawrence Island, Alaska (USACHPPM, 2001).

Status Definitions:
D – Delisted: A species that has been removed from the list of threatened and endangered species.
E – Endangered: A species which is in danger of extinction throughout all or a significant portion of its range.
N – Not a threatened, endangered, proposed, candidate, or delisted species under federal guidelines; not a species of concern under State of Alaska guidelines.
SoC – Species of Concern
T – Threatened: A species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Table 3-20 Summary of Ecological Assessment and Measurement Endpoints

Assessment Endpoint	Indicator Receptor	Measurement Endpoint
Protection of populations of herbivorous terrestrial mammals from the adverse effects of site-related COPECs on growth, survival, and reproduction.	Tundra vole (*Microtus oeconomus*)	Concentrations of COPECs in abiotic and biotic media that are protective of growth, survival and reproduction necessary to sustain populations of herbivorous terrestrial mammals, as represented by calculated exposure doses for the tundra vole.
Protection of populations of carnivorous terrestrial mammals from the adverse effects of site-related COPECs on growth, survival, and reproduction.	Cross fox (*Vulpes vulpes*)	Concentrations of COPECs in abiotic and biotic media that are protective of growth, survival and reproduction necessary to sustain populations of carnivorous terrestrial mammals, as represented by calculated exposure doses for the cross fox.
Protection of aquatic/wetland benthic communities from the adverse effects of site-related COPECs on diversity and abundance.	Benthic invertebrates	Concentrations of COPECs in surface water and sediment that are protective of the diversity and abundance of aquatic/wetland benthic communities, as represented by: (1) comparison of sediment COPEC concentrations to sediment benchmarks, and (2) results of sediment bioassays and benthic community surveys.
Protection of populations of resident and anadromous fish from the adverse effects of site-related COPECs on growth, survival, and reproduction.	Freshwater and anadromous fish	Concentrations of COPECs in abiotic and biotic media that are protective of resident and anadromous fish, as represented by comparison of surface water COPEC concentrations to fresh surface water benchmarks.
Protection of populations of aquatic/wetland birds from the adverse effects of site-related COPECs on growth, survival, and reproduction.	Glaucous-winged gull (*Larus glaucescens*)	Concentrations of COPECs in abiotic and biotic media that are protective of growth, survival and reproduction necessary to sustain populations of piscivorous birds, as represented by calculated exposure doses for the glaucous-winged gull.
Protection of populations of marine animals from the adverse effects of site-related COPECs on growth, survival, and reproduction.	Benthic invertebrates	Concentrations of COPECs in surface water and sediment that are protective of the growth and survival of marine invertebrate populations, as represented by comparison of estuarine sediment concentrations to surface water benchmarks.

Notes:
HI – hazard index
COPECs – chemicals of potential ecological concern

Sampling of biological media was performed during the 1999 and 2001 field seasons. Refer to the 1999 Phase II Work Plan Addendum, 1999 Phase II Addendum Report (Montgomery and Watson, 2000a), and 2001 Phase III Biological Sampling Plan (Montgomery and Watson, 2001c) for details.

Table 3-21 Exposure Parameters for Ecological Receptors

Exposure Parameter	Exposure Value		
	Tundra Vole	Glaucous-Winged Gull	Cross Fox
	Microtus oeconomus	*Larus glaucescens*	*Vulpes vulpes*
Body Mass average (grams)[a]	52.5	1,412.5	4,750
Male Range [b]	25-80 [m]	1,280-1,820 [p]	2,700-6,800 [s]
Female Range	25-80 [m]	1,070-1,430 [p]	2,700-6,800 [s]
Diet Composition (percent)[c]			
Plant Matter	100 [m]	5 [q]	10 [o]
Animal Matter	0 [m]	95 [q]	90 [o]
Food Ingestion Rate (grams/day)[d]	10.3	81.7	248
Plant Matter	10.3	4.1	24.7
Animal Matter	0	77.6	223
Soil Ingestion Rate (grams/day)			
Percent[e, f]	2.4	30	2.8
Intake Rate (grams/day)	0.25	7.8	6.9
Home Range (acre^2)[i]	0.067 [n, o]	71,850 [r]	1,004 [o]
Exposure Area (acres)[j]	SS	SS	SS
Site Utilization Factor (unitless) [k]	SS	SS	SS
Exposure Duration (percent of year) [l]	1.0	0.5	1.0

Notes:

[a] Average body weight for males and females combined.

[b] Range of body weights for males and females.

[c] Cross fox diet varies seasonally; value reported is average of all seasons.

[d] Calculated using Equations 3-9 (tundra vole), 3-6 (glaucous-winged gull) and, 3-7 (cross fox) from USEPA (1993).

[e] Soil ingestion rates were derived from USEPA (1993); tundra vole based on meadow vole soil ingestion rate. Glaucous-winged gull based on semipalmated sandpiper soil ingestion rate. Cross fox based on red fox soil ingestion rate (cross fox and red fox are two names for the same species).

[f] Calculated as percent soil ingestion rates derived from USEPA (1993) multiplied by the food ingestion rate (g/d).

[g] Total skin surface area was calculated using Equations 3-22 (mammals) and 3-21 (birds) in USEPA (1993).

[h] Exposed skin surface area was calculated assuming the area of the feet (4 percent of total skin surface area) for the tundra vole and cross fox and the beak and legs (8 percent of total surface area) for the glaucous-winged gull.

[i] Home range is equal to the area necessary to support the dietary and reproductive needs of each animal. Home range for glaucous-winged gull was estimated from relevant home range data from related species. Data for home range was found for California gull (*Larus californicus*), western gull (*Larus occidentalis*), and ring-billed gull (*Larus delawarensis*). California gull was deemed irrelevant due to habitat type and location of data collection. Data for the remaining two marine species, western and ring-billed gull, was appropriate for comparison and averaged to estimate glaucous-winged gull home range value of 71,850 acres.

[j] Exposure area based on the total area of each site.

[k] Site utilization factors are calculated as the exposure area divided by the home range. Instances where the home range > exposure area are reported as 1.

[l] Exposure duration (precent of year exposed) for species based on the following facts: tundra vole = 1.0 – does not migrate and is active yearlong. Glaucous-winged gull = 0.5 – most individuals are anticipated to migrate between October and March. Cross fox = 1.0 – does not migrate and is active yearlong.

[m] Field Guide to North American Mammals (NAS, 1996).

[n] Home range for tundra vole based on similar species home range, meadow vole (*Microtus pennsylvanicus*).

[o] Wildlife Exposure Factors Handbook (USEPA, 1993).

[p] CRC Handbook of Avian Body Masses (Dunning, 1993).

[q] Museum of Zoology (UM, 2000).

[r] Based on average of similar species home ranges (western gull, ring-billed gull). California's Wildlife Volume II: Birds (Zeiner, et al., 1990).

[s] Wildlife Notebook Series (ADF&G, 2001b).

SS – site-specific

Table 3-22 Bioaccumulation Factors for Use in Modeling Food Chain Exposure for Ecological Receptors

Chemicals of Potental Ecological Concern	Chemical Information						BCF_{M-W}						FCM^{a}		
	log (K_{ow})/ Source		K_{ow}/Source		K_{oc}/Source		BCF_{S-H}/Source kg dry soil/ kg wet tissue		$BCF_{TL2/TL1}$ /Source kg plant tissue/ kg herb tissue		BCF_{S-P} /Source kg dry soil/ kg tissue		FCM_{TL2}	FCM_{TL3}	FCM_{TL4}
Inorganics															
Aluminum	na		na		na		1.50E-03	b	1.50E-03	b	0.004	c	1	1	1
Antimony	na		na		na		1.00E-03	b	1.00E-03	b	0.2	c	1	1	1
Arsenic	na		na		na		2.00E-03	b	2.00E-03	b	0.036	c	1	1	1
Barium	na		na		na		1.50E-04	b	1.50E-04	b	0.15	c	1	1	1
Beryllium	na		na		na		1.00E-03	b	1.00E-03	b	0.01	c	1	1	1
Cadmium	na		na		na		5.50E-04	b	5.50E-04	b	0.364	c	1	1	1
Chromium, Dissolved	na		na		na		5.50E-03	b	5.50E-03	b	0.0075	c	1	1	1
Cobalt	na		na		na		2.00E-02	b	2.00E-02	b	0.02	b	1	1	1
Copper	na		na		na		1.00E-02	b	1.00E-02	b	0.4	c	1	1	1
Lead	na		na		na		3.00E-04	b	3.00E-04	b	0.045	c	1	1	1
Manganese	na		na		na		4.00E-04	b	4.00E-04	b	0.25	b	1	1	1
Mercury, Dissolved	na		na		na		2.50E-01	b	2.50E-01	b	0.0375	c	1	1	1
Nickel	na		na		na		6.00E-03	b	6.00E-03	b	0.032	c	1	1	1
Selenium	na		na		na		1.50E-02	b	1.50E-02	b	0.016	c	1	1	1
Silver, Dissolved	na		na		na		3.00E-03	b	3.00E-03	b	0.4	c	1	1	1
Thallium	na		na		na		4.00E-02	b	4.00E-02	b	0.004	c	1	1	1
Vanadium	na		na		na		2.50E-03	b	2.50E-03	b	0.015	b	1	1	1
Zinc	na		na		na		1.00E-01	b	1.00E-01	b	1.2E-12	c	1	1	1
Volatile Organic Compounds															
Acetone	2.22	d	6.00E-03	c	9.50E-01	c	3.72E-14	f	1.55E-12	g	745.124	h	1	1	1
Benzene	2.14	d	1.37E+02	c	6.20E+01	c	8.49E-10	f	3.54E-08	g	2.25411	h	1	1	1
Bromoethane	2.14	d	1.37E+02	c	6.20E+01	c	8.49E-10	f	3.54E-08	g	2.25411	h	1	1	1
Bromomethane	1.11	d	1.30E+01	c	9.00E+00	c	8.05E-11	f	3.35E-09	g	8.79307	h	1	1	1
Ethylbenzene	3.12	d	1.33E+03	c	2.04E+02	c	8.24E-09	f	3.43E-07	g	0.60592	h	1	1	1
m,p-Xylene (Sum of Isomers)	3.13	d,e	1.35E+03	c	2.41E+02	c	8.36E-09	f	3.48E-07	g	0.60071	h	1	1	1
o-Xylene	3.13	d	1.35E+03	c	2.41E+02	c	8.36E-09	f	3.48E-07	g	0.60071	h	1	1	1
Toluene	2.67	d	4.65E+02	c	1.40E+02	c	2.88E-09	f	1.20E-07	g	1.11228	h	1	1	1
Xylenes	3.13	d,e	1.35E+03	c	2.41E+02	c	8.36E-09	f	3.48E-07	g	0.60071	h	1	1	1

Table 3-22 Bioaccumulation Factors for Use in Modeling Food Chain Exposure for Ecological Receptors

Chemicals of Potental Ecological Concern	Chemical Information						BCF$_{M-W}$						FCM [a]		
	log (K_{ow})/ Source		K_{ow}/Source		K_{oc}/Source		BCF$_{S-H}$/Source kg dry soil/ kg wet tissue		BCF$_{TL2/TL1}$ /Source kg plant tissue/ kg herb tissue		BCF$_{S-P}$ /Source kg dry soil/ kg tissue		FCM$_{TL2}$	FCM$_{TL3}$	FCM$_{TL4}$
Semi-volatile Organic Compounds															
4-Chloroaniline	1.83	i	6.76E+01	d	6.61E+01	i	4.19E-10	f	1.74E-08	g	3.39047	h	1	1	1
4-Methylphenol (p-Cresol)	1.94	d	8.70E+01	c	4.61E+01	c	5.39E-10	f	2.25E-08	g	2.93061	h	1	1	1
bis-(2-ethylhexyl)phthalate	5.20	d	1.60E+05	c	1.11E+05	c	9.91E-07	f	4.13E-05	g	0.03802	h	1	4.2	3.9
Cresols (Methyl Phenols)	0.79	i	6.17E+00	d	8.99E+00	i,j	3.82E-11	f	1.59E-09	g	13.5326	h	1	1	1
Di-n-butyl phthalate	4.72	d	5.25E+04	c	1.57E+03	c	3.25E-07	f	1.35E-05	g	0.0724	h	1	2.2	1.6
Polynuclear Aromatic Hydrocarbons															
2-Methylnaphthalene	4.13	i	1.35E+04	d	2.24E+03	i	8.36E-08	f	3.48E-06	g	0.1588	h	1	1	1
Acenaphthene	3.92	i	8.32E+03	d	7.08E+03	i	5.15E-08	f	2.15E-06	g	0.21001	h	1	1	1
Acenaphthylene	4.07	i	1.17E+04	d	2.00E+03	i	7.28E-08	f	3.03E-06	g	0.172	h	1	1	1
Anthracene	4.45	i	2.82E+04	d	2.95E+04	i	1.75E-07	f	7.27E-06	g	0.10373	h	1	1	1
Benzo(a)anthracene	5.68	d	4.77E+05	c	2.60E+05	c	2.95E-06	f	1.23E-04	g	0.02022	h	1	1	1
Benzo(a)pyrene	6.13	d	1.35E+06	c	9.69E+05	c	8.36E-06	f	3.48E-04	g	0.01108	h	1	1	1
Benzo(b)fluoranthene	6.20	d	1.59E+06	c	8.36E+05	c	9.85E-06	f	4.10E-04	g	0.01008	h	1	1	1
Benzo(g,h,i)perylene	6.70	i	5.01E+06	d	3.86E+06	i	3.10E-05	f	1.29E-03	g	0.00519	h	1	1	1
Benzo(k)fluoranthene	6.19	d	1.56E+06	c	8.32E+05	c	9.66E-06	f	4.03E-04	g	0.01019	h	1	1	1
Chrysene	5.74	d	5.48E+05	c	2.97E+05	c	3.39E-06	f	1.41E-04	g	0.01866	h	1	1	1
Dibenzo(a,h)anthracene	6.55	d	3.53E+06	c	1.79E+06	c	2.19E-05	f	9.11E-04	g	0.00636	h	1	1	1
Fluoranthene	5.08	d	1.21E+05	c	4.91E+04	c	7.50E-07	f	3.12E-05	g	0.04468	h	1	1	1
Fluorene	4.17	d	1.47E+04	c	7.71E+03	c	9.11E-08	f	3.79E-06	g	0.15111	h	1	1	1
Indeno(1,2,3-cd)pyrene	6.91	d	8.22E+06	c	4.11E+06	c	5.09E-05	f	2.12E-03	g	0.0039	h	1	1	1
Naphthalene	3.37	d	2.36E+03	c	1.19E+03	c	1.46E-08	f	6.09E-07	g	0.43497	h	1	1	1
Phenanthrene	4.55	i	3.55E+04	d	4.80E+03	i	2.20E-07	f	9.16E-06	g	0.0908	h	1	1	1
Pyrene	5.00	d	1.00E+05	c	6.80E+04	c	6.19E-07	f	2.58E-05	g	0.04989	h	1	1	1
Polychlorinated Biphenyls															
PCB-1242 (Aroclor 1242)	6.21	d	1.61E+06	c	9.83E+04	c,k	9.97E-06	f	4.15E-04	g	0.01001	h	1	12	20
PCB-1254 (Aroclor 1254)	6.21	d	1.61E+06	c	9.83E+04	c,k	9.98E-06	f	4.16E-04	g	0.01001	h	1	12	20
PCB-1260 (Aroclor 1260)	6.21	d	1.61E+06	c	9.83E+04	c,k	9.98E-06	f	4.16E-04	g	0.01001	h	1	12	20
Total Polychlorinated Biphenyls	6.21	d	1.61E+06	c	9.83E+04	c,k	9.98E-06	f	4.16E-04	g	0.01001	h	1	12	20

Table 3-22 Bioaccumulation Factors for Use in Modeling Food Chain Exposure for Ecological Receptors

Chemicals of Potental Ecological Concern	Chemical Information						BCF_{M-W}						FCM [a]		
	log (K_{ow})/ Source		K_{ow}/Source		K_{oc}/Source		BCF_{S-H}/Source (kg dry soil/ kg wet tissue)		$BCF_{TL2/TL1}$ /Source (kg plant tissue/ kg herb tissue)		BCF_{S-P} /Source (kg dry soil/ kg tissue)		FCM_{TL2}	FCM_{TL3}	FCM_{TL4}
Dioxins and Furans															
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	6.53	i,l	3.39E+06	d	2.63E+06	i,l	2.10E-05	f	8.74E-04	g	0.00651	h	1	14	25
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	6.64	i,m	4.37E+06	d	4.57E+03	i,m	2.70E-05	f	1.13E-03	g	0.00562	h	1	14	26
1,2,3,4,6,7,8-Heptachlorodibenzofuran	6.53	i,l	3.39E+06	d	2.63E+06	i,l	2.10E-05	f	8.74E-04	g	0.00651	h	1	14	25
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	6.64	i,m	4.37E+06	d	4.57E+03	i,m	2.70E-05	f	1.13E-03	g	0.00562	h	1	14	16
1,2,3,4,7,8-Hexachlorodibenzofuran	6.53	i,l	3.39E+06	d	2.63E+06	i,l	2.10E-05	f	8.74E-04	g	0.00651	h	1	14	25
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	6.64	i,m	4.37E+06	d	4.57E+03	i,m	2.70E-05	f	1.13E-03	g	0.00562	h	1	14	26
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	6.64	i,m	4.37E+06	d	4.57E+03	i,m	2.70E-05	f	1.13E-03	g	0.00562	h	1	14	26
2,3,4,6,7,8-Hexachlorodibenzofuran	6.53	i,l	3.39E+06	d	2.63E+06	i,l	2.10E-05	f	8.74E-04	g	0.00651	h	1	14	25
2,3,4,7,8-Pentachlorodibenzofuran	6.53	i,l	3.39E+06	d	2.63E+06	i,l	2.10E-05	f	8.74E-04	g	0.00651	h	1	14	25
2,3,7,8-Tetrachlorodibenzofuran	6.53	i,l	3.39E+06	d	2.63E+06	i,l	2.10E-05	f	8.74E-04	g	0.00651	h	1	14	25
Dibenzofuran	4.12	i	1.32E+04	d	8.13E+03	i	8.17E-08	f	3.40E-06	g	0.16093	h	1	1.3	1.1
Total Heptachlorodibenzofurans (HpCDF)	na		na		na		6.19E-12	f	2.58E-10	g	na		na	na	na
Total Heptachlorodibenzo-p-dioxins (HpCDD)	na		na		na		6.19E-12	f	2.58E-10	g	na		na	na	na
Total Hexachlorodibenzofurans (HxCDF)	na		na		na		6.19E-12	f	2.58E-10	g	na		na	na	na
Total Hexachlorodibenzo-p-dioxins (HxCDD)	na		na		na		6.19E-12	f	2.58E-10	g	na		na	na	na
Total Pentachlorodibenzofurans (PeCDF)	na		na		na		6.19E-12	f	2.58E-10	g	na		na	na	na
Total Tetrachlorodibenzofurans (TCDF)	na		na		na		6.19E-12	f	2.58E-10	g	na		na	na	na
Total Tetrachlorodibenzo-p-dioxins (TCDD)	na		na		na		6.19E-12	f	2.58E-10	g	na		na	na	na
Pesticides															
4,4'-DDD	6.10	i	1.26E+06	d	1.00E+06	i	7.80E-06	f	3.25E-04	g	0.01154	h	1	11	18
beta-BHC	3.83	d	6.81E+03	c	2.14E+03	c	4.22E-08	f	1.76E-06	g	0.23574	h	1	1.2	1
Endosulfan sulfate	3.48	d	3.02E+03	c	2.04E+03	c	1.87E-08	f	7.79E-07	g	0.37719	h	1	1.1	1
gamma-BHC (Lindane)	3.83	d	6.81E+03	c,n	2.14E+03	c,n	4.22E-08	f	1.76E-06	g	0.23574	h	1	1.2	1
Heptachlor	5.02	c	1.04E+05	d	1.41E+06	i	6.41E-07	f	2.67E-05	g	0.0489	h	1	3.2	2.6
Petroleum Hydrocarbons															
Diesel Range Organics	3.37	o	2.36E+03	o	1.19E+03	o	1.46E-08	f	6.09E-07	g	0.43497	h	1	1	1
Diesel Range Organics, Aliphatic	3.37	o	2.36E+03	o	1.19E+03	o	1.46E-08	f	6.09E-07	g	0.43497	h	1	1	1
Diesel Range Organics, Aromatic	3.37	o	2.36E+03	o	1.19E+03	o	1.46E-08	f	6.09E-07	g	0.43497	h	1	1	1
Gasoline Range Organics	2.14	p	1.37E+02	p	6.20E+01	p	8.49E-10	f	3.54E-08	g	2.25411	h	1	1	1

Table 3-22 Bioaccumulation Factors for Use in Modeling Food Chain Exposure for Ecological Receptors

Chemicals of Potental Ecological Concern	Chemical Information							BCF$_{M-W}$						FCM[a]		
	log (K_{ow})/ Source		K_{ow}/Source		K_{oc}/Source			BCF$_{S-H}$/Source (kg dry soil/ kg wet tissue)		BCF$_{TL2/TL1}$ /Source (kg plant tissue/ kg herb tissue)		BCF$_{S-P}$ /Source (kg dry soil/ kg tissue)		FCM$_{TL2}$	FCM$_{TL3}$	FCM$_{TL4}$
Petroleum Hydrocarbons (Cont.)																
Gasoline Range Organics, Aliphatic	2.14	p	1.37E+02	p	6.20E+01	p		8.49E-10	f	3.54E-08	g	2.25411	h	1	1	1
Gasoline Range Organics, Aromatic	2.14	p	1.37E+02	p	6.20E+01	p		8.49E-10	f	3.54E-08	g	2.25411	h	1	1	1
Residual Range Organics	6.13	q	1.35E+06	q	9.69E+05	q		8.36E-06	f	3.48E-04	g	0.01108	h	1	1	1
Residual Range Organics, Aliphatic	6.13	q	1.35E+06	q	9.69E+05	q		8.36E-06	f	3.48E-04	g	0.01108	h	1	1	1
Residual Range Organics, Aromatic	6.13	q	1.35E+06	q	9.69E+05	q		8.36E-06	f	3.48E-04	g	0.01108	h	1	1	1

Key:

BCF$_{M-W}$ - Bioconcentration Factor - Media to Wildlife.
BCF$_{S-H}$ -Bioconcentration Factor - Soil to Herbivore
BCF$_{S-P}$ - Bioconcentration Factor - Soil to Plant.
BCF$_{TL2/TL1}$ - Bioconcentration Factor - Trophic level 1 to Trophic level 2
FCM$_{TL2}$ - Food Chain Multiplier - Trophic Level 2
FCM$_{TL3}$ - Food Chain Multiplier - Trophic Level 3
FCM$_{TL4}$ - Food Chain Multiplier - Trophic Level 4
Koc - Organic Carbon Partition Coef. (L/kg)
K$_{OW}$ - Octanol/Water Partition Coefficient
na - not available

[a] FCM derived from Kow Values listed in Table 5-2 of Screening Level Ecological Risk Assessment Protocol (USEPA, 1999) except VOCs and PAHs a described in Section 3.2.4.3.3.

[b] Baes et. Al, 1984

[c] Screening Level Ecological Risk Assessment Protocol (USEPA, 1999

[d] Calculated from Log (Kow) or Kow

[e] o-xylene used as a surrogate for m-xylene and xylenes. Commercial xylene solvents are mixtures of all three isomers (i.e., m-, o- and p-xylenes), and toxicity studies for o-xylenes are based on the commercial mixture.

[f] Calculated using BCF$_{S-H}$ = Ba_mammal*IRsoil_tv*10^-6

[g] Calculated using BCF$_{TL2/TL1}$ = Ba_mammal*IRplant_tv*10^-6

[h] (Travis & Arms, 1988) log BCF$_{S-P}$ = 1.588-0.578*log Kow

[i] RAIS (http://risk.lsd.ornl.gov/tox/tox_values.shtml)

[j] P-Cresol used as a surrogate for cresols (Methyl phenols). P-Cresol and cresols (Methyl phenols) have identical molecular weights and are structural isomers of one another. These chemicals have similar physical/chemical properties, and anticipated fates in the environment. P-Cresol and Cresol (Methyl phenols) are both hydroxy-substituted benzenes found in coal tar and wood preservatives. Both chemicals are neurotoxicants and have similar ranges of toxicity in aquatic and terrestrial organisms in which they have been studied.

[k] Aroclor 1254 used as a surrogate for other Aroclors. Aroclors 1242, 1254 and 1260 are commercial mixtures of polychlorinated biphenyls (PCBs) that vary in their percentage of individual PCB congeners. Many congeners of both Aroclors have similar chemical, environmental fate and toxicological characteristics.

[l] 2,3,7,8-TCDF is used as a surrogate for many dioxins/furans. 2,3,7,8-TCDF is structurally and toxicologically similar to many coplanar dioxins and furans, and is among the most toxic.

Table 3-22 Bioaccumulation Factors for Use in Modeling Food Chain Exposure for Ecological Receptors

Chemicals of Potental Ecological Concern	Chemical Information			BCF$_{M-W}$			FCM [a]		
	log (K_{ow})/ Source	K_{ow}/Source	K_{oc}/Source	BCF$_{S-H}$/Source kg dry soil/ kg wet tissue	BCF$_{TL2/TL1}$ /Source kg plant tissue/ kg herb tissue	BCF$_{S-P}$ /Source kg dry soil/ kg tissue	FCM$_{TL2}$	FCM$_{TL3}$	FCM$_{TL4}$

[m] 2,3,7,8-TCDD is used as a surrogate for many dioxins/furans. 2,3,7,8-TCDD is structurally and toxicologically similar to many coplanar dioxins and furans, and is among the most toxic.

[n] beta BHC used as a surrogate. Alpha, beta, gamma and delta isomers of hexachlorocyclohexane (BHC) are structurally similar neurotoxicants, and are all components of technical BHC.

[o] Naphthalene used as a surrogate for DRO. Naphthalene is representative of the C10 – C25 aromatic fraction of petroleum hydrocarbons, and is a significant component of DRO.

[p] Benzene used as a surrogate for GRO. Benzene is representative of the C6 – C10 aromatic fraction of petroleum hydrocarbons, and is a significant component of GRO.

[q] Benzo(a)pyrene used as a surrogate for RRO. Benzo(a)pyrene is representative of the C25 – C36 aromatic fraction of petroleum hydrocarbons, and may be a significant component of RRO.

Table 3-23 Ecological Toxicity Reference Values for Mammalian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Tundra Vole (*Microtus oeconomus*)	Allometric TRV (mg/kg-day) Cross Fox (*Vulpes vulpes*)
Inorganics					
Aluminum	1.93E+00	Rat [a,b]	0.35 [c]	3.10E+00	1.79E-01
Antimony	4.40E+00	Vole [d]	0.044 [c]	4.21E+00	2.43E-01
Arsenic	1.25E+00	Dog [a,b]	12.7 [c]	4.93E+00	2.84E-01
Barium	5.10E-01	Rat [a,b]	0.35 [c]	8.19E-01	4.73E-02
Beryllium	6.60E-01	Rat [a,b]	0.35 [c]	1.06E+00	6.11E-02
Cadmium	1.00E+00	Rat [c,b]	0.35 [c]	1.61E+00	9.26E-02
Chromium	3.50E+00	Rat [a,b]	0.35 [c]	5.62E+00	3.24E-01
Cobalt	1.04E+01	Vole [d]	0.044 [c]	9.95E+00	5.74E-01
Copper	1.20E+01	Mink [a,b]	1 [c]	2.51E+01	1.45E+00
Lead	8.00E+00	Rat [c,b]	0.35 [c]	1.29E+01	7.41E-01
Manganese	8.80E+01	Rat [c]	0.35 [c]	1.41E+02	8.15E+00
Mercury	1.00E+00	Mink [c]	1 [c]	2.09E+00	1.20E-01
Nickel	5.00E+01	Rat [a,b]	0.35 [c]	8.03E+01	4.63E+00
Selenium	7.60E-02	Mouse [a,b]	0.03 [c]	6.61E-02	3.81E-03
Silver	3.75E-01	Mouse [a,b]	0.03 [c]	3.26E-01	1.88E-02
Thallium	1.31E-02	Rat [a,b]	0.35 [c]	2.10E-02	1.21E-03
Vanadium	2.10E+00	Rat [e]	0.35 [c]	3.37E+00	1.95E-01
Zinc	1.04E+01	Mouse [a,b]	0.03 [c]	9.04E+00	5.21E-01
Volatile Organic Compounds					
1,1,1-Trichloroethane	1.00E+03	Mouse [e]	0.03 [c]	8.69E+02	5.01E+01
1,2,4-Trimethylbenzene[h]	5.00E+02	Rat [e]	0.35 [c]	8.03E+02	4.63E+01
1,2-Dibromoethane	na	na	na	na	na
1,2-Dichlorobenzene	na	na	na	na	na
1,3-Dichlorobenzene	na	na	na	na	na
1,3-Dichloropropane	na	na	na	na	na
2,2-Dichloropropane	na	na	na	na	na
2-Chloroethyl vinyl ether	na	na	na	na	na
2-Chlorotoluene	na	na	na	na	na
2-Hexanone (MIBK)	2.50E+01	Rat [c]	0.35 [c]	4.02E+01	2.32E+00
4-Bromophenyl phenyl ether	na	na	na	na	na

Table 3-23 Ecological Toxicity Reference Values for Mammalian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Tundra Vole (*Microtus oeconomus*)	Allometric TRV (mg/kg-day) Cross Fox (*Vulpes vulpes*)
Volatile Organic Compounds (Cont.)					
4-Chlorophenyl phenyl ether	na	na	na	na	na
4-Isopropyltoluene[f]	5.00E+02	Rat [e]	0.35 [c]	8.03E+02	4.63E+01
Acetone	1.00E+01	Rat [a,b]	0.35 [c]	1.61E+01	9.26E-01
Benzene	2.64E+01	Mouse [c]	0.03 [c]	2.30E+01	1.32E+00
Bromoethane[g]	5.00E+01	Mouse [c]	0.03 [c]	4.35E+01	2.51E+00
Ethylbenzene[h]	2.64E+02	Mouse [e]	0.03 [c]	2.30E+02	1.32E+01
Methylene chloride	5.85E+00	Rat [c]	0.35 [c]	9.40E+00	5.42E-01
n-Butylbenzene[h]	2.64E+02	Mouse [e]	0.03 [c]	2.30E+02	1.32E+01
n-Propylbenzene[h]	2.64E+02	Mouse [e]	0.03 [c]	2.30E+02	1.32E+01
sec-Butylbenzene[h]	2.64E+02	Mouse [e]	0.03 [c]	2.30E+02	1.32E+01
Toluene	2.60E+02	Rat [e]	0.35 [c]	4.18E+02	2.41E+01
Trichloroethene	7.00E-01	Mouse [c]	0.03 [c]	6.09E-01	3.51E-02
Xylenes	5.00E+02	Rat [e]	0.35 [c]	8.03E+02	4.63E+01
Semivolatile Organic Compounds					
2,4-Dichlorophenol	na	na	na	na	na
2,4-Dimethylphenol	na	na	na	na	na
2,4-Dinitrotoluene	7.00E-01	Dog [a]	12.7 [c]	2.76E+00	1.59E-01
2,6-Dinitrotoluene	4.00E+00	Dog [a]	12.7 [c]	1.58E+01	9.10E-01
2-Methyl-4,6-dinitrophenol	na	na	na	na	na
3,3-Dichlorobenzidine	na	na	na	na	na
3-Nitroaniline	na	na	na	na	na
4-Chloroaniline	1.05E+00	Rat [a]	0.35 [c]	1.69E+00	9.73E-02
4-Chlorotoluene	na	na	na	na	na
4-Methylphenol (p-Cresol)[i]	2.20E+02	Mink [c]	1 [c]	4.60E+02	2.65E+01
4-Nitroaniline	na	na	na	na	na
bis-(2-ethylhexyl)phthalate	6.00E+01	Rat [a,b]	0.35 [c]	9.64E+01	5.56E+00
Cresols (Methyl Phenols)[i]	2.20E+02	Mink [c]	1 [c]	4.60E+02	2.65E+01
Di-n-butyl phthalate	5.50E+02	Mouse [c]	0.03 [c]	4.78E+02	2.76E+01

Table 3-23 Ecological Toxicity Reference Values for Mammalian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Tundra Vole (*Microtus oeconomus*)	Allometric TRV (mg/kg-day) Cross Fox (*Vulpes vulpes*)
Polynuclear Aromatic Hydrocarbons					
Acenaphthene[l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Acenaphthylene [l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Anthracene[l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Benzo(a)anthracene	1.67E+02	Mouse [a]	0.03 [c]	1.45E+02	8.37E+00
Benzo(a)pyrene	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Benzo(b)fluoranthene [l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Benzo(ghi)perylene [l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Benzo(k)fluoranthene [l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Chrysene [l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Dibenzo(a,h)anthracene	2.00E+00	Rat [a]	0.35 [c]	3.21E+00	1.85E-01
Fluoranthene [l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Fluorene[l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Indeno(123-cd)pyrene [l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Naphthalene	5.00E+01	Rat [e]	0.35 [c]	8.03E+01	4.63E+00
Phenanthrene[l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Pyrene [l]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Polychlorinated Biphenyls					
Aroclor 1242[j]	1.40E-01	Mink [c]	1.0 [c]	2.92E-01	1.69E-02
Aroclor 1254	1.40E-01	Mink [c]	1.0 [c]	2.92E-01	1.69E-02
Aroclor 1260[j]	1.40E-01	Mink [c]	1.0 [c]	2.92E-01	1.69E-02
Total Polychlorinated Biphenyls	1.40E-01	Mink [c]	1.0 [c]	2.92E-01	1.69E-02
Dioxins and Furans					
1,2,3,4,6,7,8,9-Octachlorodibenzofuran[m]	1.00E-02	Rat [a,b]	0.35 [c]	1.61E-02	9.26E-04
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin[m]	1.00E-03	Rat [a,b]	0.35 [c]	1.61E-03	9.26E-05
1,2,3,4,6,7,8-Heptachlorodibenzofuran[m]	1.00E-04	Rat [a,b]	0.35 [c]	1.61E-04	9.26E-06
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin[m]	1.00E-04	Rat [a,b]	0.35 [c]	1.61E-04	9.26E-06
1,2,3,4,7,8,9-Heptachlorodibenzofuran[m]	1.00E-04	Rat [a,b]	0.35 [c]	1.61E-04	9.26E-06
1,2,3,4,7,8-Hexachlorodibenzofuran[m]	1.00E-05	Rat [a,b]	0.35 [c]	1.61E-05	9.26E-07
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin[m]	1.00E-05	Rat [a,b]	0.35 [c]	1.61E-05	9.26E-07
1,2,3,6,7,8-Hexachlorodibenzofuran[m]	1.00E-05	Rat [a,b]	0.35 [c]	1.61E-05	9.26E-07

Table 3-23 Ecological Toxicity Reference Values for Mammalian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Tundra Vole (*Microtus oeconomus*)	Cross Fox (*Vulpes vulpes*)
Dioxins and Furans (Cont.)					
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin[m]	1.00E-05	Rat [a,b]	0.35 [c]	1.61E-05	9.26E-07
1,2,3,7,8,9-Hexachlorodibenzofuran[m]	1.00E-05	Rat [a,b]	0.35 [c]	1.61E-05	9.26E-07
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin[m]	1.00E-05	Rat [a,b]	0.35 [c]	1.61E-05	9.26E-07
1,2,3,7,8-Pentachlorodibenzofuran[m]	2.00E-05	Rat [a,b]	0.35 [c]	3.21E-05	1.85E-06
1,2,3,7,8-Pentachlorodibenzo-p-dioxin[m]	1.00E-06	Rat [a,b]	0.35 [c]	1.61E-06	9.26E-08
2,3,4,6,7,8-Hexachlorodibenzofuran[m]	1.00E-05	Rat [a,b]	0.35 [c]	1.61E-05	9.26E-07
2,3,4,7,8-Pentachlorodibenzofuran[m]	2.00E-06	Rat [a,b]	0.35 [c]	3.21E-06	1.85E-07
2,3,7,8-Tetrachlorodibenzofuran[m]	1.00E-06	Rat [a,b]	0.35 [c]	1.61E-06	9.26E-08
Dibenzofuran[k]	1.00E-02	Rat [a,b]	0.35 [c]	1.61E-02	9.26E-04
Total Heptachlorodibenzofurans (HpCDF)	na	na	na	na	na
Total Heptachlorodibenzo-p-dioxins (HpCDD)	na	na	na	na	na
Total Hexachlorodibenzofurans (HxCDF)	na	na	na	na	na
Total Hexachlorodibenzo-p-dioxins (HxCDD)	na	na	na	na	na
Total Pentachlorodibenzofurans (PeCDF)	na	na	na	na	na
Total Pentachlorodibenzo-p-dioxin (PeCDD)	na	na	na	na	na
Total Tetrachlorodibenzofurans (TCDF)	na	na	na	na	na
Total Tetrachlorodibenzo-p-dioxins (TCDD)	na	na	na	na	na
Pesticides					
4-4'-DDD[r]	1.00E+03	Rat [a]	0.35 [c]	1.61E+03	9.26E+01
beta-BHC	2.40E+00	Rat [e]	0.35 [c]	3.86E+00	2.22E-01
Endosulfan sulfate	1.00E+00	Rat [e]	0.35 [c]	1.61E+00	9.26E-02
gamma-BHC (Lindane)	2.40E+00	Rat [e]	0.35 [c]	3.86E+00	2.22E-01
Heptachlor	2.50E+00	Rat [a]	0.35 [c]	4.02E+00	2.32E-01
Petroleum Hydrocarbons					
Diesel Range Organics[o]	5.00E+01	Rat [e]	0.35 [c]	8.03E+01	4.63E+00
Diesel Range Organics - Aliphatic[o]	5.00E+01	Rat [e]	0.35 [c]	8.03E+01	4.63E+00
Diesel Range Organics - Aromatic[o]	5.00E+01	Rat [e]	0.35 [c]	8.03E+01	4.63E+00
Gasoline Range Organics[p]	2.64E+01	Mouse [c]	0.03 [c]	2.30E+01	1.32E+00
Gasoline Range Organics - Aliphatic[p]	2.64E+01	Mouse [c]	0.03 [c]	2.30E+01	1.32E+00
Gasoline Range Organics - Aromatic[p]	2.64E+01	Mouse [c]	0.03 [c]	2.30E+01	1.32E+00

Table 3-23 Ecological Toxicity Reference Values for Mammalian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Tundra Vole (*Microtus oeconomus*)	Cross Fox (*Vulpes vulpes*)
Petroleum Hydrocarbons (Cont.)					
Residual Range Organics[q]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Residual Range Organics - Aliphatic[q]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00
Residual Range Organics - Aromatic[q]	1.00E+02	Mouse [a]	0.03 [c]	8.69E+01	5.01E+00

Notes:

BHC - Benzene hexachloride

DDD - Dichlorodiphenyldichloroethane

kg - Kilograms

mg/kg-dry - Milligrams per kilogram dry weight

MIBK - Methyl isobutyl ketone

na - Not applicable

TRV - Toxicity Reference Value

[1] Receptor-specific TRVs are derived from body weight based allometric conversion of the toxicity benchmark value (USDOE, 1996) .

[a] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA, 1999).

[b] Mammal toxicity reference value.

[c] ORNL, 1996 Toxicological Benchmarks for Wildlife.

[d] Eco-SSL (USEPA, 2000a).

[e] Technical Plan for Human Health and Ecological Risk Assessment (USEPA, 2000b).

[f] Isopropylbenzene (1-methylethyl benzene; cumene) used as a surrogate for 4-isopropyltoluene (1-methylisopropyl benzene; cymene). Cumene and cymene are volatile, petroleum-related VOCs that are also naturally produced in the oils of plants including marsh grasses. These chemicals have low toxicities (LD50 > 2,000 mg/kg), and similar chemical structures, environmental fates and anticipated biological effects. With respect to metabolism, cumene is more anologous to toluene than it is to methyl benzene. Neither cumene or cymene have been classified as human carcinogens.

[g] 1,2-Dichlorothane is used as a surrogate for bromoethane. Dichloroethane and bromoethane are volatile halogenated ethanes that share similar chemical structures, physical/chemical characteristics, and anticipated fates in the environment. Bromoethane may be produced in marine water by algae. Dichloroethane is anticipated to be more persistent in the environment. Use of dichloroethane as a surrogate for bromoethane is most likely protective.

[h] Benzene is used as a surrogate. The alkyl substituted benzenes are generally less volatile and less toxic than benzene. Use of benzene as a surrogate chemical for the alkyl-substituted benzenes is assumed to be protective.

[i] O-cresol used as a surrogate for p-cresol (4-methylphenol). O-Cresol (2-methylphenol) and p-cresol (4-methylphenol) have identical molecular weights and are structural isomers of one another. These chemicals have similar physical/chemical properties, and anticipated fates in the environment. O-Cresol and p-cresol are both hydroxy-substituted benzenes found in coal tar and wood preservatives. Both chemicals are neurotoxicants and have similar ranges of toxicity in aquatic and terrestrial organisms in which they have been studied.

[j] Aroclor 1254 is used as a surrogate for Aroclor 1260 and Aroclor 1242. Aroclor 1242, Aroclor 1254, Aroclor 1260 are commercial mixtures of polychlorinated biphenyls (PCBs) that vary in their percentage of individual PCB congeners. Many congeners of both Aroclors have similar chemical,

Table 3-23 Ecological Toxicity Reference Values for Mammalian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Tundra Vole (*Microtus oeconomus*)	Cross Fox (*Vulpes vulpes*)

environmental fate and toxicological characteristics.

[k] PCDD is used as a surrogate for dibenzofuran. Dibenzofuran is a non-halogenated dibenzofuran and, as such, does not share the same characteristics of environmental persistence and toxicity as the halogenated dioxins/furans. Use of PCDD as a surrogate for dibenzofuran is highly overprotective.

[l] Benzo(a)pyrene is used as a surrogate for all polynuclear aromatic hydrocarbonss without specific benchmark concentrations available.

[m] 2,3,7,8-TCDD is used as a surrogate for many dioxins/furans. 2,3,7,8-TCDD is structurally and toxicologically similar to many coplanar dioxins and furans, and is among the most toxic.

[n] 4-4'-DDE and used as a surrogate for 4,4'-DDD. 4,4'-DDD and 4-4'-DDE are metabolites of 4,4-DDT, and all three chemicals occurred in commercial formulations of DDT. These chemicals are structurally and toxicologically similar.

[o] Naphthalene used as a surrogate for DRO. Naphthalene is representative of the C10 – C25 aromatic fraction of petroleum hydrocarbons, and is a significant component of DRO.

[p] Benzene used as a surrogate for GRO. Benzene is representative of the C6 – C10 aromatic fraction of petroleum hydrocarbons, and is a significant component of GRO.

[q] Benzo(a)pyrene used as a surrogate for RRO. Benzo(a)pyrene is representative of the C25 – C36 aromatic fraction of petroleum hydrocarbons, and may be a significant component of RRO.

Table 3-24 Ecological Toxicity Reference Values for Avian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Glaucous-Winged Gull *Larus glaucescens*
Inorganics				
Aluminum	1.0E+02	Ringed Turtle Dove [a,b]	0.155 [c]	5.8E+01
Antimony[d]	2.5E+00	Brown-headed cowbird [a,b]	0.049 [c]	1.1E+00
Arsenic	2.5E+00	Brown-headed cowbird [a,b]	0.049 [c]	1.1E+00
Barium	2.1E+01	1-day old chicks [a,b]	0.121 [c]	1.1E+01
Beryllium[e]	2.1E+01	1-day old chicks [a,b]	0.121 [c]	1.1E+01
Cadmium	1.5E+00	Mallard duck [a,b]	1 [c]	1.3E+00
Chromium	1.0E+00	Black duck [a,b]	1.25 [c]	9.7E-01
Cobalt	1.3E+00	Hawk [f]	0.78 [c,g]	1.1E+00
Copper	4.7E+01	1-day old chicks [a,b]	0.121 [c]	2.5E+01
Lead	3.9E+00	American Kestrel [c]	0.13 [c]	2.1E+00
Manganese	1.0E+03	Japanese Quail [c]	0.15 [c]	5.7E+02
Mercury	4.5E-01	Japanese Quail [a,b]	0.15 [b]	2.6E-01
Nickel	7.7E+01	Mallard [c]	1.0 [c]	7.1E+01
Selenium	5.0E-01	Mallard [a,b]	1.0 [c]	4.6E-01
Silver	1.8E+02	Mallard [a,b]	1.0 [c]	1.6E+02
Thallium	3.5E-01	Starling [a,b]	0.077 [g]	1.7E-01
Vanadium	1.1E+01	Mallard	1.0 [c]	1.0E+01
Zinc	1.3E+02	Leghorn hen and New Hampshire rooster [a,b]	1.85 [c]	1.4E+02
Volatile Organic Compounds				
1,1,1-Trichloroethane[h]	1.7E+01	Chicken [c]	1.6 [c]	1.8E+01
1,2,4-Trimethylbenzene	na	na	na	na
1,2-Dibromoethane	na	na	na	na
1,2-Dichlorobenzene	na	na	na	na
1,3-Dichlorobenzene	na	na	na	na
1,3-Dichloropropane	na	na	na	na
2,2-Dichloropropane	na	na	na	na
2-Chloroethyl vinyl ether	na	na	na	na
2-Chlorotoluene	na	na	na	na
2-Hexanone (MIBK)	na	na	na	na
4-Bromophenyl phenyl ether	na	na	na	na

Table 3-24 Ecological Toxicity Reference Values for Avian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Glaucous-Winged Gull *Larus glaucescens*
Volatile Organic Compounds (Cont.)				
4-Chlorophenyl phenyl ether	na	na	na	na
4-Isopropyltoluene	na	na	na	na
Acetone	5.2E+01	Quail [a,b]	0.15 [c]	3.0E+01
Benzene	7.9E-01	Chick embryo [a,b]	0.121 [c]	4.3E-01
Bromoethane	na	na	na	na
Ethylbenzene	na	na	na	na
Methylene chloride	na	na	na	na
n-Butylbenzene	na	na	na	na
n-Propylbenzene	na	na	na	na
sec-Butylbenzene	na	na	na	na
Toluene	na	na	na	na
Trichloroethene	na	na	na	na
Xylenes	na	na	na	na
Semivolatile Organic Compounds				
2,4-Dichlorophenol	na	na	na	na
2,4-Dimethylphenol	na	na	na	na
2,4-Dinitrotoluene	na	na	na	na
2,6-Dinitrotoluene	na	na	na	na
2-Methyl-4,6-dinitrophenol	na	na	na	na
3,3-Dichlorobenzidine	na	na	na	na
3-Nitroaniline	na	na	na	na
4-Chloroaniline	4.2E-01	Redwing Blackbird [a,b]	0.064 [c]	1.9E-01
4-Chlorotoluene	na	na	na	na
4-Methylphenol (p-Cresol)	na	na	na	na
4-Nitroaniline	na	na	na	na
Bis-(2-ethylhexyl)phthalate	1.1E-01	Ringed Dove [a,b]	0.155 [c]	6.4E-02
Cresols (Methyl Phenols)	na	na	na	na
Di-n-butyl phthalate	1.1E-01	Ringed Dove [c]	0.155 [c]	6.3E-02

Table 3-24 Ecological Toxicity Reference Values for Avian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Glaucous-Winged Gull *Larus glaucescens*
Polynuclear Aromatic Hydrocarbons				
2-Methylnaphthalene[k]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Acenaphthene[k]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Acenaphthylene[k]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Anthracene[k]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Benzo(a)anthracene	7.9E-01	Chicken embryo [a]	0.121 [c]	4.3E-01
Benzo(a)pyrene	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Benzo(b)fluoranthene[k]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Benzo(ghi)perylene[k]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Benzo(k)fluoranthene	1.4E-01	Chicken embryo [a]	0.121 [c]	7.6E-02
Chrysene	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Dibenzo(a,h)anthracene	3.9E-01	Chicken embryo [a]	0.121 [c]	2.1E-01
Fluoranthene[k]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Fluorene[k]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Indeno(123-cd)pyrene	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Naphthalene[k]	7.9E-01	Chick embryo [a]	0.121 [c]	4.3E-01
Phenanthrene[k]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Pyrene[k]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Polychlorinated Biphenyls				
Aroclor 1242	4.2E-01	Screech Owl [b,l]	0.2 [b]	2.6E-01
Aroclor 1254	7.2E-02	Ringed Dove [a,b]	0.155 [c]	4.1E-02
Aroclor 1260	4.2E-01	Screech Owl [b,l]	0.2 [b]	2.6E-01
Total Polychlorinated Biphenyls	4.2E-01	Screech Owl [b,l]	0.2 [b]	2.6E-01
Dioxins and Furans				
1,2,3,4,6,7,8,9-Octachlorodibenzofuran[m]	1.0E-01	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-01
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin[m]	1.0E-01	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-01
1,2,3,4,6,7,8-Heptachlorodibenzofuran[m]	1.0E-03	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-03
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin[m]	1.0E-02	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-02
1,2,3,4,7,8,9-Heptachlorodibenzofuran[m]	1.0E-03	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-03
1,2,3,4,7,8-Hexachlorodibenzofuran[m]	1.0E-04	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-04

Table 3-24 Ecological Toxicity Reference Values for Avian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Glaucous-Winged Gull *Larus glaucescens*
Dioxins and Furans (Cont.)				
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin[m]	2.0E-04	Ring-necked pheasant [a,b]	1.85 [c,g]	2.1E-04
1,2,3,6,7,8-Hexachlorodibenzofuran[m]	1.0E-04	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-04
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin[m]	1.0E-03	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-03
1,2,3,7,8,9-Hexachlorodibenzofuran[m]	1.0E-04	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-04
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin[m]	1.0E-04	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-04
1,2,3,7,8-Pentachlorodibenzofuran[m]	1.0E-04	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-04
1,2,3,7,8-Pentachlorodibenzo-p-dioxin[m]	1.0E-05	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-05
2,3,4,6,7,8-Hexachlorodibenzofuran[m]	1.0E-04	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-04
2,3,4,7,8-Pentachlorodibenzofuran[m]	1.0E-05	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-05
2,3,7,8-Tetrachlorodibenzofuran[m]	1.0E-05	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-05
Dibenzofuran[j]	1.0E-01	Ring-necked pheasant [a,b]	1.85 [c,g]	1.1E-01
Total Heptachlorodibenzofurans (HpCDF)	na	na	na	na
Total Heptachlorodibenzo-p-dioxins (HpCDD)	na	na	na	na
Total Hexachlorodibenzofurans (HxCDF)	na	na	na	na
Total Hexachlorodibenzo-p-dioxins (HxCDD)	na	na	na	na
Total Pentachlorodibenzofurans (PeCDF)	na	na	na	na
Total Pentachlorodibenzo-p-dioxin (PeCDD)	na	na	na	na
Total Tetrachlorodibenzofurans (TCDF)	na	na	na	na
Total Tetrachlorodibenzo-p-dioxins (TCDD)	na	na	na	na
Pesticides				
4,4'-DDD[n]	8.5E+02	Coturnix Quail [a]	0.15 [c]	4.8E+02
beta-BHC	5.7E+00	Mallard [l]	1.0 [c]	5.2E+00
Endosulfan sulfate	1.0E+01	Gray Partridge [l]	0.4 [l]	7.3E+00
gamma-BHC (Lindane)	5.7E+00	Mallard [l]	1.0 [c]	5.2E+00
Heptachlor	6.5E+01	Quail [a]	0.15 [c]	3.7E+01
Petroleum Hydrocarbons				
Diesel Range Organics[o]	7.9E-01	Chick embryo [a]	0.121 [c]	4.3E-01
Diesel Range Organics - Aliphatic[o]	7.9E-01	Chick embryo [a]	0.121 [c]	4.3E-01
Diesel Range Organics - Aromatic[o]	7.9E-01	Chick embryo [a]	0.121 [c]	4.3E-01

Table 3-24 Ecological Toxicity Reference Values for Avian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Glaucous-Winged Gull *Larus glaucescens*
Petroleum Hydrocarbons (Cont.)				
Gasoline Range Organics[p]	7.9E-01	Chick embryo [a,b]	0.121 [c]	4.3E-01
Gasoline Range Organics - Aliphatic[p]	7.9E-01	Chick embryo [a,b]	0.121 [c]	4.3E-01
Gasoline Range Organics - Aromatic[p]	7.9E-01	Chick embryo [a,b]	0.121 [c]	4.3E-01
Residual Range Organics[q]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Residual Range Organics - Aliphatic[q]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01
Residual Range Organics - Aromatic[q]	1.0E+00	Chicken embryo [a]	0.121 [c]	5.4E-01

Notes:

BHC - Benzene hexachloride
DDD - Dichlorodiphenyldichloroethane
kg - Kilograms
mg/kg-dry - Milligrams per kilogram dry weight
na - Not applicable
TRV - Toxicity Reference Value

[1] Receptor-specific TRVs are derived from body weight based allometric conversion of the toxicity benchmark value (USDOE, 1996).

[a] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA, 1999c).
[b] Bird toxicity reference value.
[c] ORNL, 1996 Toxicological Benchmarks for Wildlife.
[d] Arsenic (Another Group-VA metal) is used as a surrogate.
[e] Barium (another Group-IIA metal) is used as a surrogate.
[f] Eco-SSL (USEPA, 2000a).
[g] Body weight derived from a similar species body weight (ORNL, 1996b).
[h] Dichloroethane is used as a surrogate for 1,1,1-Trichloroethane. They share similar chemical structures, physical/chemical characteristics, and anticipated fates in the environment. Use of dichloroethane as a surrogate for 1,1,1-Trichloroethane is most likely protective.
[i] Benzo(a)anthracene used as a surrogate for naphthalene. They share similar chemical, environmental fate and toxicological properties.
[j] PCDD is used as a surrogate for dibenzofuran. Dibenzofuran is a non-halogenated dibenzofuran and, as such, does not share the same characteristics of environmental persistence and toxicity as the halogenated dioxins/furans. Use of PCDD as a surrogate for dibenzofuran is highly overprotective.
[k] Benzo(a)pyrene used as a surrogate for all polynuclear aromatic hydrocarbons without specific benchmark concentrations available. The PAHs, benzo(a)pyrene, benzo(a)anthracene, and benzo(b)fluoranthene, are multi-ring, high molecular weight components of mid- and high-distillation fraction petroleum hydrocarbons (PHCs). They share similar chemical, environmental fate and toxicological properties.

Table 3-24 Ecological Toxicity Reference Values for Avian Indicator Receptors[1]

Chemicals of Potential Ecological Concern	Benchmark Dose (mg/kg-day)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric TRV (mg/kg-day) Glaucous-Winged Gull *Larus glaucescens*

[1] Technical Plan for Human Health and Ecological Risk Assessment (USEPA, 2000b)

[m] 2,3,7,8-TCDD is used as a surrogate for many dioxins/furans. 2,3,7,8-TCDD is structurally and toxicologically similar to many coplanar dioxins and furans, and is among the most toxic.

[n] 4-4'-DDE and used as a surrogate for 4,4'-DDD. 4,4'-DDD and 4-4'-DDE are metabolites of 4,4-DDT, and all three chemicals occurred in commercial formulations of DDT. These chemicals are structurally and toxicologically similar.

[o] Naphthalene used as a surrogate for DRO. Naphthalene is representative of the C10 – C25 aromatic fraction of petroleum hydrocarbons, and is a significant component of DRO.

[p] Benzene used as a surrogate for GRO. Benzene is representative of the C6 – C10 aromatic fraction of petroleum hydrocarbons, and is a significant component of GRO.

[q] Benzo(a)pyrene used as a surrogate for RRO. Benzo(a)pyrene is representative of the C25 – C36 aromatic fraction of petroleum hydrocarbons, and may be a significant component of RRO.

4.0 RISK ASSESSMENT RESULTS

This section presents the results of the HHERA conducted for the Northeast Cape Installation. Results of the HHRA for potential public health impacts are presented as quantitative estimates of carcinogenic risk and noncancer HI estimates, and qualitative discussions of risk. ADEC currently considers a cumulative cancer risk of 1.0 x 10^{-5} and noncancer HI of 1.0 as the point of departure for making risk management decisions concerning a site. Sites evaluated in the HHRA with associated cumulative cancer risk and noncancer HI estimates that exceed these criteria will be further evaluated in the FS. For informational purposes, it should be noted that according to the State of Alaska (AAC 75.325(h)) and EPA (USEPA, 1991b), sites with a cumulative cancer risk estimate between 1.0 x 10^{-6} and 1.0 x 10^{-4}, and a noncancer HI of less than 1.0, may be appropriate for NFRAP following an evaluation of site-specific issues related to future land uses, technical feasibility of remediation, and related considerations. However, such a determination will only be made in the FS, as appropriate. The USACE's interpretation regarding the point of departure for cancer risk and noncancer HI is consistent with current EPA (USEPA, 1991b) policy.

Ecological HQ estimates are presented and discussed as part of the evaluation of potential environmental impacts at the Northeast Cape Installation. Consistent with ADEC guidance, HQ estimates exceeding 1.0 are considered to be indicative of the potential for biological or ecological effects on representative receptors. However, site-specific factors such as spatial distribution and detection frequency of COPECs, ambient conditions, uncertainty of assumptions used in exposure determination, and study endpoint used to determine toxicity benchmarks were considered when reviewing specific HQs. Sites containing COPECs at concentrations that are associated with ecological HQs greater than 1.0 will be further evaluated in the FS. Sites where HQ values are less than 1.0 for all receptors were proposed for NFA in regard to ecological concerns. Similarly, if no chemicals of ecological concern are retained from Tier II refinement assessments, NFA was proposed in regard to ecological concerns.

Sites evaluated in this HHERA vary considerably with respect to exposure media, potential contaminant migration pathways, and complete or incomplete human health and ecological exposure pathways. For example, some sites contain surface water while other sites do not. For those sites that are associated with surface water, it may be either ephemeral or permanent in nature. In addition, shallow surface water is present at some locations of the Northeast Cape Installation and absent from other areas. For these reasons, this section is organized by site, with discussions of potential contaminant sources, media present and/or sampled, potential migration and exposure pathways, and HHERA results presented for each site.

It should also be noted that this HHERA presents risk estimates based on current and anticipated future land uses and exposure pathways, as well as hypothetical future exposures. For example, current seasonal residents of the Subsistence Fishing and Hunting Camp (Site 4) obtain potable water from the upper Suqitughneq River, and harvest fish and plants from areas outside of the Drainage Basin (Site 28) and downstream locations. However, there is a potential for future human receptors to obtain potable water from shallow or deep groundwater beneath individual sites, and harvest subsistence food from the Suqitughneq River or from ambient locations. Therefore, potential cumulative human health risks are presented for various exposure scenarios.

4.1 SITE 3 – FUEL LINE CORRIDOR AND PUMPHOUSE

Site 3 is located in the northeast corner of the Northeast Cape Installation on Cargo Beach (Figure 1-3). It consisted of a fuel pumphouse housing engine-driven pumps, two 500-gallon aboveground storage tanks (ASTs) (AST 3-1 and AST 3-2) located outside the pumphouse, and a 4-inch welded steel fuel line. The fuel line was used to transfer diesel fuel approximately 8,000 feet from the pumphouse at Cargo Beach to the bulk storage facilities at the Housing and Operations Complex.

Miscellaneous debris, including an auto battery and a bucket of paint, were found scattered at the site during BD/DR activities (MW, 1995a). The two 500-gallon diesel ASTs were found to be empty. ACM and/or suspected ACM was observed in buildings and surrounding areas (MW, 1995a, b). Non-friable ACM was observed at the site. No warning signs were posted for non-friable ACM. Painted surfaces were assumed to be lead-based paint, based on sampling performed at other sites (MW, 1995a, b).

Environmental sampling activities for Site 3 included the collection of soil and shallow subsurface water samples (Table 3-1). Chemicals detected in soil include several metals, methylene chloride, Aroclor-1260, two PAHs (anthracene and naphthalene), DRO, and TRPH. Chemicals detected in shallow subsurface water include ethylbenzene, xylenes, DRO, and RRO (Table 2-1). A radiological survey was also performed at Site 3 in response to concerns raised during a community meeting. However, no radioactive materials were detected at the site (MW, 1999). All chemicals detected in site media, with the exception of TRPH, were evaluated in Tier I human health and ecological screening assessments. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.1.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 3 is presented in Table 4-1.

Site 3 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 3 are incomplete.

Potential future land use at Site 3 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 3 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.1.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 3 include lead, methylene chloride, naphthalene and DRO in soil; and DRO and RRO in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-2, and detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 3 soil and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.1.1.2 Tier II Baseline HHRA Results

Based on results of the Tier I screening HHRA, the only site-specific medium containing carcinogenic COPCs is soil. Carcinogenic risk estimates for potential exposures to Site 3 soils ranged from 7E-13 for current and future site visitors to 8E-11 for future permanent residents (Table 4-3). These carcinogenic risk estimates are below the ADEC point of departure criterion for risk management of 1E-5.

Noncarcinogenic HI estimates for all receptors exposed to Site 3 soils were below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-4).

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. No carcinogenic COPCs were identified for shallow subsurface water. Noncarcinogenic HI estimates for future seasonal residents and future permanent residents exposed to shallow subsurface water were 3.1 and 12, respectively (Table 4-4). These HI estimates were attributable to the presence of DRO in shallow subsurface water. However, if potable water is obtained from the Suqitughneq River, as is the current practice, the noncarcinogenic HI estimate is below 1.0 (refer to cumulative HI_1 and cumulative HI_2 for PHCs in Table 4-4).

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation. If future seasonal residents and future permanent residents at Site 3 obtain potable water from the Suqitughneq River and subsistence food from ambient locations (i.e., Site 30), the estimated carcinogenic risk ($ILCR_1$) is 1E-3. This carcinogenic risk estimate is attributable to the presence of arsenic, PCBs, and PAHs in ambient plants, and arsenic and PCBs in ambient fish. Alternatively, if future seasonal and permanent residents at Site 3 obtain potable water from the Suqitughneq River and subsistence food from Sites 28 and 29, the estimated carcinogenic risk ($ILCR_2$) is 2E-3. This carcinogenic risk estimate is attributable to the presence of arsenic, PCBs, and PAHs in Site 28 plants, and arsenic, PCBs and PAHs in Site 29 fish.

If these same subsistence food use scenarios are followed, but potable water is obtained from shallow subsurface water beneath the site ($ILCR_3$ and $ILCR_4$), the carcinogenic risk estimates are the same as $ILCR_1$ and $ILCR_2$. This is because estimated risks attributable to subsistence food consumption dominate the cumulative risk estimate, and the source of potable water is less important. This evaluation also suggests that the source of subsistence food collection (i.e., impacted areas versus ambient locations) approximately doubles the cumulative carcinogenic risk estimate for future seasonal and permanent residents. However, carcinogenic risk estimates for subsistence food collection from either impacted or ambient locations are about two orders of magnitude higher than the ADEC point of departure criterion for risk management of 1E-5. Potential implications of this phenomenon on risks to current and future subsistence users are described further in Section 5.3.

A similar analysis of noncarcinogenic hazard estimates shows that if future seasonal and permanent residents at Site 3 obtain potable water from the Suqitughneq River and subsistence food from ambient locations (i.e., Site 30), the estimated cumulative HI (HI_1) is 30. This cumulative HI estimate is attributable to the presence of arsenic, cadmium, vanadium and PCBs in ambient plants, and arsenic and PCBs in ambient fish. Alternatively, if future seasonal and permanent residents at Site 3 obtain potable water from the Suqitughneq River and subsistence food from Sites 28 and 29, the estimated cumuative HI (HI_2) is 55. Cumulative HI_2 is attributable to the presence of arsenic, barium, cadmium, and PCBs in Site 28 plants, and arsenic and PCBs in Site 29 fish. Similar to the case for carcinogenic risk estimates, the source of potable water makes little difference with respect to the cumulative HI for non-PHC COPCs (i.e., HI_1 and HI_2 are the same as HI_3 and HI_4, respectively, because the subsistence food pathway dominates the cumulative HI estimate). However, the source of potable water makes a substantial difference with respect to the cumulative HI for PHC-related COPCs. That is, HI_1 and HI_2 for PHCs, which are calculated based on the assumption that future seasonal and permanent residents obtain potable water from the Suqitughneq River, are substantially lower than HI_3 and HI_4, which are based on the assumption that shallow subsurface water beneath Site 3 is used as the primary source of potable water. This is because PHC concentrations in the Suqitughneq River are much lower than PHC concentrations in Site 3 groundwater. Potential implications of potable water source on risks to current and potential future residents of the Northeast Cape Installation are discussed further in Section 5.3.

Total cumulative HI estimates (HI_1 and HI_2) for current and future site visitors are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-4).

4.1.2 Ecological Conceptual Model and Risk Analysis

Site 3 lies within an area of the Northeast Cape Installation comprised predominantly of alpine tundra habitat. Dominant vegetation types include grasses, sedges, and mat-forming herbs. Shrubs include willow, heaths, cassiopes, and bearberry. Vegetation at Site 3 is disturbed and miscellaneous debris is scattered about the site. Wildlife expected to use this habitat include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals.

Ecological indicator species selected for evaluation in the ERA include the tundra vole, cross fox, and glaucous-winged gull (refer to Section 3.2.3.4). Primary exposure pathways for the tundra vole include consumption of plants, incidental ingestion of soil, and consumption of surface water (Section 3.2.4.1). Shallow subsurface water was assumed to be in contact with surface water, and was used to evaluate the surface water consumption pathway. The cross fox may be exposed to site contaminants through predation on small mammals (including the tundra vole), incidental ingestion of soil, and consumption of surface water. The glaucous-winged gull may be exposed to site contaminants through consumption of surface water (Table 4-5).

4.1.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.2.1. Tier I COPECs identified for Site 3 include: lead, Aroclor-1260, two PAHs (anthracene and naphthalene), and DRO in soil; and xylenes, DRO and RRO in shallow subsurface water. The results of Tier I ecological screening are summarized in Table 4-6, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 3 soil and shallow subsurface water were further evaluated in a Tier II baseline ERA.

4.1.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to Site 3 soil and shallow subsurface water is 0.38 (Table 4-7). This value is below the ADEC ecological criterion of 1.0, and indicates that no adverse effects on representative receptors are anticipated.

The maximum HQ estimates for the cross fox (0.0014) and glaucous-winged gull (0.0000090) (Table 4-7) are also below the ADEC ecological criterion of 1.0, and indicate that no adverse effects on representative receptors are anticipated.

In summary, the HI estimates for ecological indicator receptors at Site 3 are all below the ADEC ecological criterion of 1.0. Consequently, ecological impacts at Site 3 are unlikely to occur.

4.2 SITE 4 – SUBSISTENCE FISHING AND HUNTING CAMP

Site 4 is located southwest of the Cargo Beach barge off-loading area (Figure 1-3). The site includes wood frame structures originally constructed as housing for Alaskan Native civilian employees of the Northeast Cape Installation. Three of the structures are currently used by Alaskan Natives as a fishing and hunting camp for part of the year. The other structures are in disrepair due to inclement weather.

There were two abandoned vehicles and two abandoned ASTs located just south of the housing area. The larger (AST 4-1) was an approximately 15,000-gallon, steel construction AST with dimensions of 27 feet long and 10 feet in diameter. The second tank (AST 4-2) was approximately 400 gallons, double-walled and insulated, and 5.5 feet long and 3.6 feet in diameter. According to Eugene Toolie, both tanks (AST 4-1 and AST 4-2) were used to supply potable water to the Subsistence Fishing and Hunting Camp (Toolie, 1996).

The three structures that are currently used as seasonal housing were inspected for ACM by a certified asbestos inspector; no ACM were noted in any of the homes. Painted surfaces are assumed to be lead-based paint, based on sampling performed at other sites (MW, 1995a, b). The buildings at the site were constructed by local residents and are therefore not eligible for DERP-FUDS action. MWH personnel inventoried the ASTs at Site 4. AST 4-1 (15,000 gallons) was empty and all points of entry were secured. AST 4-2 (400 gallons) was about 30 percent full of rainwater. The potential sources of environmental contamination identified at Site 4 (i.e., the vehicles and abandoned, rusted drums) were removed from the site during 2001 through 2003 BD/DR activities.

Environmental sampling activities for Site 4 included the collection of soil and shallow subsurface water samples (Table 3-1). Chemicals detected in soil include lead, several PAHs (anthracene, chrysene and fluorene), DRO, RRO, and TRPH. Chemicals detected in shallow subsurface water include xylenes, DRO, and RRO (Table 2-1). A radiological survey was also performed in response to concerns raised during a community meeting. No radioactive materials were detected at the site (MW, 1999). All chemicals detected in site media, with the exception of TRPH, were evaluated in Tier I human health and ecological screening assessments. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.2.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 4 is presented in Table 4-8.

Site 4 is seasonally inhabited during the summer months for subsistence hunting, fishing, and gathering. Current human receptors of concern include seasonal residents and site visitors. Potential exposure pathways for seasonal residents and current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Shallow subsurface water at Site 4 is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Exposure pathways between current human receptors and shallow subsurface water at Site 4 are incomplete.

Potential future land uses at Site 4 could include continued use as a seasonal residence or the establishment of a permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current seasonal resident and site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 4 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.2.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 4 include lead, DRO and RRO in soil; and DRO and RRO in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-9, and detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 4 soil and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.2.1.2 Tier II Baseline HHRA Results

Based on results of the Tier I screening HHRA, no carcinogenic COPCs were identified in site-specific media (i.e., soil or shallow subsurface water). Therefore, carcinogenic risk estimates were not calculated for soil or shallow subsurface water at Site 4 (Table 4-10).

Noncarcinogenic HI estimates for Site 4 soils were below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 for all receptors, with the exception of the future permanent resident (Table 4-11). A noncarcinogenic HI of 1.4 was estimated for the future permanent resident exposed to soil. This HI estimate was primarily attributable to maximum detected concentration of DRO in soil.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. No carcinogenic COPCs were identified for shallow subsurface water. Noncarcinogenic HI estimates for future seasonal and future permanent residents consuming shallow subsurface water were 1.2 and 3.0, respectively (Table 4-11). These HI estimates were primarily attributable to the maximum detected concentration of DRO in shallow subsurface water. However, if potable water is obtained from the Suqitughneq River, as is the current practice, the noncarcinogenic HI estimate for PHCs for future seasonal residents is below 1.0 (refer to cumulative $ILCR_1$ and $ILCR_2$ for PHCs for the future seasonal resident in Table 4-11).

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for current and future seasonal residents, as well as future permanent residents, exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-10). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for current or future seasonal residents, and future permanent residents, exceeded the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative HI estimates (HI_1 and HI_2) for current and future site visitors are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-11).

4.2.2 Ecological Conceptual Model and Risk Analysis

Vegetation at Site 4 consists primarily of sedges and grasses, giving way to beach grasses near the Bering Sea Coast. The vegetation appears to be healthy with extensive coverage over the site, with the exception of the Cargo Beach Road and the beach itself. Drainage from the site is north/northeast towards the beach, with standing water scattered about the site in depressed areas.

Wildlife expected to use this habitat include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals. Potential exposure media include soil, surface water, and dietary items. Shallow subsurface water was assumed to be in contact with surface water, and was used to evaluate the surface water consumption pathway. Primary exposure pathways between ecological indicator receptors and site contaminants are presented in Table 4-12.

4.2.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.2.1. Tier I COPECs identified for Site 4 include: PAHs (anthracene, chrysene and fluorene), DRO and RRO in soil; and xylenes, DRO and RRO in shallow subsurface water. The results of Tier I ecological screening are summarized in Table 4-13, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 4 soil and shallow subsurface water were further evaluated in a Tier II baseline ERA.

4.2.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to Site 4 soil and shallow subsurface water is 0.79 (Table 4-14). This value is below the ADEC ecological criterion of 1.0, and indicates that adverse effects in representative receptors are not anticipated. The HQ estimate was primarily attributable to the presence of DRO in soil.

The maximum HQ estimates for the cross fox (0.0079) and glaucous-winged gull (0.000052) (Table 4-14) are also below the ADEC ecological criterion of 1.0, and indicate that no adverse effects on representative receptors are anticipated.

Due to the proximity of Sites 3 and 4, ecological hazards were also estimated for a combined Site 3 and 4. Ecological estimates for combined exposure to Sites 3 and 4 as shown in Table 4-14 are tundra vole (0.79), cross fox (0.011), and glaucous-winged gull (0.000071). The conclusions for these combined hazard estimates are virtually the same as those described above for Site 4.

4.3 SITE 6 – CARGO BEACH ROAD DRUM FIELD

Site 6 is located 0.6 miles south of Sites 3 and 4 along Cargo Beach Road (Figure 1-3). No structures were present at this site. The drum field was used primarily for the disposal of empty drums containing POL generated during operation of the former Northeast Cape Installation. Site 6 consisted of approximately 1,500 POL drums, one empty 500-gallon potable water storage tank, a battery, and miscellaneous metal debris. The POL drums and battery were removed from the site during 2001 through 2003 BD/DR activities.

Environmental sampling activities for Site 6 included the collection of soil, sediment (beneath standing, ephemeral surface water), ephemeral surface water, and shallow subsurface water samples (Table 3-1). Chemicals detected in soil include metals, VOCs, di-n-butyl phthalate, DRO, RRO, and TRPH. Chemicals detected in sediment include metals, VOCs, DRO, RRO, and TRPH. Lead and zinc were detected in ephemeral surface water samples collected from the site. Chemicals detected in shallow subsurface water include metals, VOCs, DRO, and GRO (Table 2-1). A radiological survey was also performed at Site 6; however, no radioactive materials were detected at the site (MW, 1999). All chemicals detected in site media, with the exception of TRPH, were evaluated in Tier I human health and ecological screening assessments. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.3.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 6 is presented in Table 4-15.

Site 6 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Consistent with the generalized exposure assessment presented in Section 3.1.2.1, sediment exposure pathways were assumed to be the same as those for soil, and exposure pathways for ephemeral surface water were judged to be incomplete. Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 6 are incomplete.

Potential future land use at Site 6 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 6 as a potable water supply. It should be noted, however, that 6.2 hours were required to collect 1 liter of water from the bedrock interface at Site

6 during the sampling investigation. In addition, test pits were dug to 5 feet bgs at Site 6 and no subsurface water was encountered. Therefore, shallow subsurface water was not considered an exposure medium for this site.

4.3.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil/sediment and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 6 include metals, VOCs (methylene chloride and xylenes), DRO and RRO in soil/sediment. The results of Tier I human health screening are summarized in Table 4-16; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 6 soil/sediment were further evaluated in a Tier II baseline HHRA.

4.3.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for potential exposures to Site 6 soils ranged from 2E-10 for current and future site visitors to 6E-9 for future permanent residents (Table 4-17). These carcinogenic risk estimates are below the ADEC point of departure criterion for risk management of 1E-5. Noncarcinogenic HI estimates for Site 6 soils exceeded the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 for future seasonal residents and future permanent residents (Table 4-18). The HI estimates were primarily attributable to maximum detected concentration of DRO in soil. Noncarcinogenic HI estimates for current and future site visitors exposed to Site 6 soils were below the ADEC point of departure criterion.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water derived from the Suqitughneq River (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal residents and future permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-17). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal residents and future permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of subsistence food items on risks to future receptors are discussed further in Section 5.3.

Use of water from the Suqitughneq River as a potable supply has no significant impact on cumulative risk and HI estimates, since no carcinogenic COPCs were identified in surface water samples collected from the Suquitughneq River, and the HI for all receptors using Suqitughneq River water as a potable supply were well below 1.0.

Total cumulative HI estimates (HI_1 and HI_2) for current and future site visitors are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-18).

4.3.2 Ecological Conceptual Model and Risk Analysis

Site 6 lies within a portion of the Northeast Cape Installation that is comprised predominantly of alpine tundra habitat. Dominant vegetation types are grasses and sedges, with shrubs including willows, heaths, cassiopes, and bearberry. Small, ephemeral surface water features are present at the site. Wildlife expected to use this habitat include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals.

Potential exposure media include soil, standing ephemeral surface water, sediment, and dietary items. Standing ephemeral surface water was used to evaluate the surface water consumption pathway. Primary exposure pathways between ecological indicator receptors and site contaminants are presented in Table 4-19.

4.3.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil/sediment and ephemeral surface water in accordance with methods described in Section 3.2.1. Tier I COPECs identified for Site 6 include: several metals (aluminum, manganese and zinc), DRO and RRO in soil; and DRO in surface water. The results of Tier I ecological screening are summarized in Table 4-20, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 6 soil and ephemeral surface water were further evaluated in a Tier II baseline ERA.

4.3.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to Site 6 soil and ephemeral surface water is 15 (Table 4-21). Estimated HQs of 15 were derived for both aluminum and DRO in soil.. It should be noted that the maximum detected soil concentration of aluminum (9,850 mg/kg) is well within the range of ambient concentrations derived for aluminum in tundra soils at the Northeast Cape Installation (BUTL = 30,357 mg/kg). The maximum concentration of DRO in soil was measured as 102,000 mg/kg. The HQ for the tundra vole exposed to DRO in Site 6 soils exceeds the ADEC ecological criterion of 1.0, and suggests there is a potential for adverse effects in representative ecological receptors.

The maximum HQ estimates for the cross fox (0.20) and glaucous-winged gull (0.00047) (Table 4-21) are below the ADEC ecological criterion of 1.0, and indicate that no adverse effects on representative receptors are anticipated.

4.4 SITE 7 – CARGO BEACH ROAD LANDFILL

Site 7 is located approximately 0.8 miles south of Sites 3 and 4 along Cargo Beach Road (Figure 1-3). The landfill was used as the Northeast Cape Installation's solid waste disposal area from 1965 to closure in 1974 (E&E, 1993a), and contains a wide variety of materials. According to E&E (1993a), the landfill contains approximately 2,300 exposed POL drums, miscellaneous metal debris, and several batteries. Based on available information this was not an ADEC-permitted landfill. According to seasonal residents, the trash was often burned prior to burial (E&E, 1993a). These reports of burned debris have lead to a concern that dioxins and furans may be present.

No structures (e.g., buildings) or tanks (i.e., ASTs or underground storage tanks [USTs]) were present at Site 7. Some ACM was identified in the landfill. No signs could be posted, since the asbestos materials were in the open. Exposed debris is present at the landfill, and some exposed debris was removed from the site during 2001 through 2003 activities. However, buried debris is not eligible for removal as BD/DR and was not included in the inventory of debris slated for demolition.

Environmental sampling activities for Site 7 included the collection of soil, sediment (beneath standing, ephemeral surface water), ephemeral surface water, and shallow subsurface water samples (Table 3-1). Chemicals detected in soil include metals, VOCs, para-cresol, PAHs, dioxins/furans, Arolclor-1260, DRO, RRO, and TRPH. Chemicals detected in sediment included metals, VOCs, several semi-volatile organic compounds (SVOCs) [para-cresol, bis-(2-ethylhexyl)phthalate, and di-n-butyl(phthalate)], PAHs, Aroclor-1260, DRO, RRO, and TRPH. Chemicals detected in ephemeral surface water included metals, toluene, dioxins/furans, DRO and TRPH. Chemicals detected in shallow subsurface water included metals, VOCs, benzoic acid, dioxins/furans, DRO, and RRO (Table 2-1). A radiological survey was also performed at Site 7; however, no radioactive materials were detected at the site (MW, 1999). All chemicals detected in site media, with the exception of TRPH, were evaluated in Tier I human health and ecological screening assessments. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.4.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 7 is presented in Table 4-22.

Site 7 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Consistent with the generalized exposure assessment presented in Section 3.1.2.1, sediment exposure pathways were assumed to be the same as those for soil, and exposure pathways for ephemeral surface water were judged to be incomplete. Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 7 are incomplete.

Potential future land use at Site 7 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 7 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.4.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 7 include metals, various VOCs, para-cresol, Aroclor-1260, dioxins/furans, DRO and RRO in soil/sediment; and various metals, benzene, octachlorodibenzo-p-dioxin, DRO and RRO in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-23; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 7 soil/sediment and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.4.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for future seasonal residents and future permanent residents exposed to Site 7 soils exceed ADEC's point of departure criterion for carcinogenic risk of 1E-5 (Table 4-24). This exceedance is primarily attributable to the presence of arsenic in soil, with lesser contributions from Aroclor-1260 and dioxins/furans. Noncarcinogenic HI estimates exceeding the ADEC point of departure criterion of 1.0 were estimated for future seasonal residents (for PHCs, only) and future permanent residents (for non-PHCs and PHCs) exposed to soil (Table 4-25). Excess HI estimates for these receptors were attributable to the presence of Aroclor-1260 and DRO in soil. Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors are below ADEC's point of departure criteria.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. Carcinogenic risk estimates for future seasonal residents, future permanent residents, and current and future site visitors using shallow subsurface water as a potable supply are below ADEC's point of departure criterion of 1E-5 (Table 4-24). Noncarcinogenic HI estimates for future seasonal and permanent residents using shallow subsurface water as a potable supply exceed ADEC's point of departure criterion of 1.0 (Table 4-25). Chemical-specific HQs in excess of the ADEC hazard criterion of 1.0 were estimated for barium and nickel in shallow subsurface water. Maximum concentrations of DRO and RRO in shallow subsurface water also contributed to an exceedence of the ADEC hazard criterion.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-24). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative HI estimates (HI_1 and HI_2) for current and future site visitors are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-25).

4.4.2 Ecological Conceptual Model and Risk Analysis

Site 7 lies within an area of the Northeast Cape Installation classified as alpine tundra habitat. Ephemeral standing water is present on a portion of the site. Wildlife expected to use this habitat include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals.

Potential exposure media include soil, standing ephemeral surface water, sediment, and dietary items. Standing ephemeral surface water was used to evaluate the surface water consumption pathway. Primary exposure pathways between ecological indicator receptors and site contaminants are presented in Table 4-26.

4.4.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil/sediment and ephemeral surface water in accordance with methods described in Section 3.2.1. Tier I COPECs identified for Site 7 include: metals, bromomethane, para-cresol, Aroclor-1260, dioxins/furans, DRO and RRO in soil/sediment; and metals, dioxins/furans and DRO in ephemeral surface water. The results of Tier I ecological screening are summarized in Table 4-27, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 7 soil/sediment and ephemeral surface water were further evaluated in a Tier II baseline ERA.

4.4.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to Site 7 soil/sediment and ephemeral surface water is 4.8 (Table 4-28). This value exceeds the ADEC ecological criterion of 1.0, and indicates that there is a limited potential for adverse effects in representative receptors. The only COPEC with an HQ estimate in excess of 1.0 was DRO in soil.

The maximum HQ estimates for the cross fox (0.15) and glaucous-winged gull (0.0010) (Table 4-28) were below the ADEC ecological criterion of 1.0, and indicate that no adverse effects on representative receptors are anticipated.

Due to the proximity of Sites 6 and 7, ecological hazards were also estimated for a combined Site 6 and 7. Maximum HQ estimates for combined exposure to Sites 6 and 7 are shown in Table 4-

28, and are tundra vole (15), cross fox (1.5) and glaucous-winged gull (0.0037). Chemicals with HQ estimates in excess of 1.0 were aluminum and DRO for the tundra vole, and aluminum for the cross fox. The maximum detected soil concentration of aluminum (9,850 mg/kg) is well within the range of ambient concentrations derived for aluminum in tundra soils at the Northeast Cape Installation (BUTL = 30,357 mg/kg). The maximum concentration of DRO in soil was measured as 102,000 mg/kg. The HQ for the tundra vole exposed to DRO in Site 6 and 7 soils exceeds the ADEC ecological criterion of 1.0, and suggests there is a potential for adverse effects in representative ecological receptors.

4.5 SITE 9 – HOUSING AND OPERATIONS LANDFILL

Site 9 is located approximately 500 feet northeast of the Housing and Operations Complex (Figure 1-3). This landfill was a waste disposal area from the time period of Northeast Cape Installation construction in 1952 to 1965, to when Site 7 became the primary landfill (E&E, 1993a). Visible landfill debris consisted of miscellaneous metal debris, POL drums, and one abandoned vehicle in the surface water body near the southwest corner of the landfill perimeter. Based on current information, this landfill was not permitted by ADEC. As with Site 7, local residents report that most waste was burned prior to burial (E&E, 1993a), thus presenting the potential for dioxin and furan contamination.

No structures (e.g., buildings) or tanks (i.e., ASTs or USTs) were present on the site. Most debris at the landfill is buried. Buried debris is not eligible for removal as BD/DR, and was not included in the inventory of the buildings and debris slated for demolition. Exposed debris was removed from the site during 2001 through 2003 field activities.

Environmental sampling activities for Site 9 included the collection of soil, sediment (beneath standing, ephemeral surface water), ephemeral surface water, and shallow subsurface water samples (Table 3-1). Chemicals detected in soil include metals, VOCs, bis-(2-ethylhexyl)phthalate, di-n-butyl(phthalate), Aroclor-1260, dioxins/furans, DRO, RRO, and TRPH. Chemicals detected in sediment include metals, VOCs, PAHs, dioxins/furans, DRO, RRO, and TRPH. Metals and octachlorodibenzo-p-dioxin were detected in ephemeral surface water. Chemicals detected in shallow subsurface water include metals, VOCs, benzoic acid, dioxins/furans, DRO, RRO, and TRPH (Table 2-1). A radiological survey was also performed at Site 9; however, no radioactive materials were detected at the site (MW, 1999). All chemicals detected in site media, with the exception of TRPH, were evaluated in Tier I human health and ecological screening assessments. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.5.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 9 is presented in Table 4-29.

Site 9 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Consistent with the generalized exposure assessment presented in Section 3.1.2.1, sediment exposure pathways were assumed to be the same as those for soil, and exposure pathways for ephemeral surface water were judged to be incomplete. Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 9 are incomplete.

Potential future land use at Site 9 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 9 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.5.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 9 include: metals, various VOCs, SVOCs, dioxins/furans, DRO and RRO in soil/sediment; and various metals, benzene, dioxins/furans, DRO and RRO in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-30; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 9 soil/sediment and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.5.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for future permanent residents exposed to Site 9 soils exceed ADEC's point of departure criterion for carcinogenic risk of 1E-5 (Table 4-31). This exceedance is attributable to the presence of arsenic in soil. The maximum concentration of arsenic detected in Site 9 soil was 20 mg/kg. Future permanent residents were the only receptor with a noncarcinogenic HI estimate for soil exceeding the ADEC point of departure criterion of 1.0 (Table 4-32). The HI estimate of 1.4 for this receptor is attributable to antimony and arsenic in soil. However, these chemicals affect different target organs, and the chemical-specific HQ for each is less than 1.0 (Appendix F). Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors are below ADEC's point of departure criterion.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. Carcinogenic risk estimates for future seasonal residents, future permanent residents and future site visitors using shallow subsurface water as a potable supply exceed ADEC's point of departure criterion of 1E-5 (Table 4-31). Excess risk estimates were attributable to the presence of dioxins and furans in shallow subsurface water beneath Site 9.

Noncarcinogenic HI estimates for future seasonal residents and future permanent residents using shallow subsurface water as a potable supply also exceed ADEC's point of departure criterion of 1.0 (Table 4-32). Chemical-specific HQs in excess of the ADEC hazard criterion of 1.0 were estimated for antimony, aluminum and DRO in shallow subsurface water.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-31). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative HI estimatesfor current and future site visitors who obtain potable water from the Suqitughneq River (HI_1 and HI_2) are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-32). Future site visitors who may use shallow subsurface water at Site 9 as a potable supply (HI_3 and HI_4) exceeded the ADEC point of departure criterion.

4.5.2 Ecological Conceptual Model and Risk Analysis

Habitat in the vicinity of Site 9 is classified as alpine tundra habitat. A standing, ephemeral surface water feature is present near the southwest corner of the landfill perimeter. Wildlife expected to use the site include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals.

Potential exposure media include soil, standing ephemeral surface water, sediment, and dietary items. Standing ephemeral surface water was used to evaluate the surface water consumption pathway. Primary exposure pathways between ecological indicator receptors and site contaminants are shown in Table 4-33.

4.5.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil/sediment, ephemeral surface water and shallow subsurface water in accordance with methods described in Section 3.2.1. Tier I COPECs identified for Site 9 include: metals, VOCs, SVOCs, Aroclor-1260, dioxins/furans, DRO and RRO in soil/sediment; and barium, zinc, and octachlorodibenzo-p-dioxin in ephemeral surface water. The results of Tier I ecological screening are summarized in Table 4-34, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 9 soil and ephemeral surface water were further evaluated in a Tier II baseline ERA.

4.5.2.2 Tier II Baseline ERA Results

The total HI estimated for the tundra vole exposed to Site 9 soil and ephemeral surface water is 0.24 (Table 4-35). This value is below the ADEC ecological criterion of 1.0, and indicates that no adverse effects on representative receptors are anticipated.

The total HI estimates for the cross fox (0.037) and glaucous-winged gull (0.0000062) (Table 4-35) are also below the ADEC ecological criterion of 1.0, and indicate that no adverse effects on representative receptors are anticipated.

In summary, the HI estimates for ecological indicator receptors at Site 9 are all below the ADEC ecological criterion of 1.0. Consequently, ecological impacts at Site 9 are unlikely to occur.

4.6 SITE 10 – BURIED DRUM FIELD

Site 10 is located across Cargo Beach Road from Site 9, and lies approximately 400 feet northeast of the Housing and Operations Complex. The site is level with the road and proceeds eastward where it drops off approximately 8 feet. According to local residents (E&E, 1993a), this area was believed to hold approximately 29,500 drums containing 90-weight waste oil. The area was used as a drum storage area for a variety of POL types (Toolie, 1996). There was a large stained area towards the northwest corner of the burial plateau along with numerous smaller stained areas on the surface of the site. There was also visible staining along the bermed west edge of the site.

Approximately 60 percent of the site is covered by a gravel pad extending from the Cargo Beach access road to Site 10. The gravel pad consists of compacted fine to medium gravels with sand. The sparse vegetation present includes sedges, grasses, and some mosses. Drainage of the site is north to northwesterly through Site 11 towards the Drainage Basin (Site 28).

No structures (e.g., buildings), tanks (i.e., ASTs or USTs) or CON/HTW were present at the site. The potential source of environmental contamination at Site 10 was buried drums. A geophysical magnetic survey found only a small anomaly in this area, suggesting that the burial of 29,500 drums may have been an overestimate. All exposed debris was removed from the site during 2001 through 2003 BD/DR activities.

Environmental sampling activities for Site 10 included the collection of soil, sediment (beneath standing, ephemeral surface water), ephemeral surface water, and shallow subsurface water samples (Table 3-1). Chemicals detected in soil include metals, toluene, di-n-butyl(phthalate), DRO, RRO, and TRPH. Chemicals detected in sediment include metals and TRPH. Silver was detected in ephemeral surface water, while no chemicals were detected in shallow subsurface water (Table 2-1). A radiological survey was performed at Site 10; however, no radioactive materials were detected at the site (MW, 1999). All chemicals detected in site media, with the exception of TRPH, were evaluated in the HHERA. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.6.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 10 is presented in Table 4-36.

Site 10 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Consistent with the generalized exposure assessment presented in Section 3.1.2.1, sediment exposure pathways were assumed to be the same as those for soil, and exposure pathways for ephemeral surface water were judged to be incomplete. Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 10 are incomplete.

Potential future land use at Site 10 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 10 as a potable water supply. However, no chemicals were detected in shallow subsurface water.

4.6.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 10 include thallium, DRO, and RRO in soil. The results of Tier I human health screening are summarized in Table 4-37; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 10 soil/sediment were further evaluated in a Tier II baseline HHRA.

4.6.1.2 Tier II Baseline HHRA Results

Based on results of the Tier I screening HHRA, no carcinogenic COPCs were identified in soil. Therefore, carcinogenic risk estimates were not calculated for soil or shallow subsurface water at Site 10 (Table 4-38). Noncarcinogenic HI estimates exceeding the ADEC point of departure criterion of 1.0 were estimated for future seasonal residents and future permanent residents (for PHCs, only) (Table 4-39). Excess HI estimates for these receptors were attributable to the presence of DRO in soil. Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors are below ADEC's point of departure criteria.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water derived from the Suqitughneq River (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal residents and future permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-38). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal residents and future permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Use of water from the Suqitughneq River as a potable supply has no significant impact on cumulative risk and HI estimates, since no carcinogenic COPCs were identified in surface water samples collected from the Suquitughneq River, and the HI for all receptors using Suqitughneq River water as a potable supply were well below 1.0.

Total cumulative HI estimates (HI_1 through HI_4) for current and future site visitors are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-39).

4.6.2 Ecological Conceptual Model and Risk Analysis

Vegetation at Site 10 is limited due to the gravel pad covering approximately 60 percent of the site. The sparse vegetation covering the remainder of the site includes sedges, grasses, and some mosses. Drainage of the site is north to northwesterly through Site 11 towards the Drainage Basin (Site 28).

Due to the presence of minimal habitat at Site 10, this site was not quantitatively evaluated in the ERA for the Northeast Cape Installation. The potential for migration of contaminants from Site 10 is evaluated in the ERA conducted for Site 28 (Drainage Basin).

4.7 SITE 11 – FUEL STORAGE TANK AREA

Site 11 is located adjacent to and west of Site 10 in the northeast corner of the Housing and Operations Complex (Figure 1-3). The site consisted of three diesel fuel ASTs measuring 50 feet in diameter and 28 feet in height (approximately 400,000 gallons) and all associated piping and valves. The gravel pad has little to no vegetation. Drainage from Site 11 is north/ northwesterly to a large pond which discharges towards the Drainage Basin (Site 28).

In March of 1967 or 1968, AST 11-2 was punctured during snow removal operations and approximately 180,000 gallons of diesel fuel were released (E&E, 1993a; Toolie, 1998). The spill occurred in the winter when there was heavy blowing snow, but little ice. Mr. Toolie (Toolie, 1998) remembers that diesel was 1-inch thick all the way to the mouth of the Suqitughneq River at the Bering Sea. No cleanup was attempted. A large volume of the fuel collected in the sediment of the wetlands area directly north of the ASTs. Significant staining and distressed vegetation were still visible in the late 1990s.

No structures (e.g., buildings) were present at the site. Three 400,000-gallon ASTs were identified. AST 11-2 and AST 11-3 were empty, AST 11-1 contained about 4 inches of accumulated rain water with a petroleum sheen. The AST contents were sampled and analyzed to determine appropriate disposal. All ASTs and debris were removed from the site during 2001 through 2003 BD/DR activities.

Environmental sampling activities for Site 11 included the collection of soil and shallow subsurface water samples at the site proper (Table 3-1). Sampling investigations and results for downgradient areas are included in the risk descriptions for Site 28 (Drainage Basin) and Site 29 (Suqitughneq River). Chemicals detected in Site 11 soil include metals, ethylbenzene, xylenes, Aroclor-1254, DRO, GRO, and TRPH (Table 2-1). All chemicals detected in site media, with the exception of TRPH, were evaluated in the HHERA. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.7.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 11 is presented in Table 4-40.

Site 11 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 11 are incomplete.

Potential future land use at Site 11 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 11 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.7.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 11 include ethylbenzene, DRO and GRO in soil; and several VOCs (benzene, methylene chloride and n-propyl benzene), naphthalene, DRO and GRO in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-41; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 11 soil and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.7.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for potential exposures to Site 11 soils ranged from 3E-11 for current and future site visitors to 4E-9 for future permanent residents (Table 4-42). These carcinogenic risk estimates are below the ADEC point of departure criterion for risk management of 1E-5. Noncarcinogenic HI estimates for soil exceeding the ADEC point of departure criterion of 1.0 were estimated for future seasonal residents (for PHCs, only) and future permanent residents (for PHCs, only). Excess HI estimates for these receptors were attributable to the presence of DRO in soil (Table 4-43). The maximum detected concentration of DRO in soil was 69,100 mg/kg. Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors potentially exposed to soil are below ADEC's point of departure criterion.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. A carcinogenic risk estimate in excess of ADEC's point of departure criterion of 1E-5 was only calculated for a future permanent resident using shallow subsurface water as a potable supply (Table 4-42). The excess risk estimate was attributable to the presence of benzene in shallow subsurface water beneath Site 11. Noncarcinogenic HI estimates for future seasonal residents and future permanent residents using shallow subsurface water as a potable supply also exceeded ADEC's point of departure criterion of 1.0 (Table 4-43). Excess HI estimates were primarily attributable to the presence of naphthalene, DRO and GRO in shallow subsurface water.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-42). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative HI estimates for current and future site visitors who obtain potable water from the Suqitughneq River (HI_1 and HI_2) are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-43). Total cumulative HI estimates for future site visitors who may use shallow subsurface water at Site 11 as a potable supply (HI_3 and HI_4) were equal to, but did not exceed, the ADEC point of departure criterion.

4.7.2 Ecological Conceptual Model and Risk Analysis

Site 11 is located adjacent to the Housing and Operations Complex and was constructed on a gravel pad. Little to no vegetation is present at the site. In the vicinity of the historic diesel spill, significant staining and distressed vegetation are still visible. Drainage from Site 11 is north/ northwesterly to a large pond which discharges towards the Drainage Basin (Site 28).

Due to the presence of minimal habitat at Site 11, this site was not quantitatively evaluated in the ERA for the Northeast Cape Installation. The potential for migration of contaminants from Site 11 is evaluated in the ERA conducted for Site 28 (Drainage Basin).

4.8 SITE 13 – HEAT AND ELECTRICAL POWER BUILDING

Site 13 lies within the confines of the Housing and Operations Complex (Figure 1-3). This site was the central heating and power generating facility for the base. It consisted of Building 110 of the Housing and Operations Complex and the land surrounding it, and also included two diesel USTs, two diesel ASTs, and two potable water ASTs. The site formerly included three transformer banks consisting of three transformers each, which were removed during the 1994 removal action (NES, 1995). One was located in a room on the south side, another was in a room on the north side, and the third was in an add-on room on the southwest side of the building. Building 110 also contained four Cummins Diesel generators with associated piping and ventilation ducts.

There is virtually no vegetation at this site, since it lies within the confines of the Housing Operations Complex and was constructed exclusively on a gravel pad. Drainage from the site is northward towards the Drainage Basin (Site 28). There is no standing water at Site 13.

Site structures (e.g., buildings) were inspected for ACM. At this site, ACM and/or suspected ACM was observed in buildings and surrounding areas (Montgomery Watson, 1995a). Signs warning of the presence of asbestos and its potential hazards were posted at all viable entrances to the buildings suspected to contain friable asbestos. Samples of paint were tested and found to be lead-based paint (Montgomery Watson, 1995a). All structures and debris were removed from the site during 2001 through 2003 BD/DR activities. In response to concerns raised during a community meeting, a radiological survey was performed. No radioactive materials were detected at this site.

Environmental sampling activities for Site 13 included the collection of soil and shallow subsurface water samples (Table 3-1). Sampling investigations and results for downgradient areas are included in the risk descriptions for Site 28 (Drainage Basin) and Site 29 (Suqitughneq River). Chemicals detected in Site 13 soil include metals, VOCs, Aroclor-1260, PAHs, DRO, GRO, RRO, and TRPH. Chemicals detected in shallow subsurface water include metals, VOCs, DRO, GRO, RRO, and TRPH (Table 2-1). All chemicals detected in site media, with the exception of TRPH, were evaluated in the HHERA. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.8.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 13 is presented in Table 4-44.

Site 13 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 13 are incomplete.

Potential future land use at Site 13 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 13 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.8.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 13 include VOCs, Aroclor-1260, naphthalene, DRO, GRO and RRO in soil; and metals, several VOCs (benzene, ethylbenzene and toluene), DRO, GRO and RRO in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-45; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 13 soil and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.8.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for future seasonal and permanent residents exposed to Site 13 soils were calculated as 1E-4 and 4E-4, respectively (Table 4-46). These carcinogenic risk estimates exceed the ADEC point of departure criterion for risk management of 1E-5. Noncarcinogenic HI estimates for future seasonal residents and future permanent residents exposed to soil also exceeded the ADEC point of departure criterion of 1.0 (Table 4-47). Exceedances of risk management criteria were attributable to the presence of Aroclor-1260 in soil at a maximum concentration of 180 mg/kg, and DRO in soil at a maximum concentration of 12,000 mg/kg.

Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors exposured to Site 13 soils are below ADEC's point of departure criteria.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. Carcinogenic risk estimates in excess of ADEC's point of departure criterion of 1E-5 were calculated for future seasonal residents, future permanent residents and future site visitors using shallow subsurface water as a potable supply (Table 4-46). Excess risk estimates for these receptors were attributable to the presence of arsenic, benzene and ethylbenzene in shallow subsurface water beneath Site 13. Noncarcinogenic HI estimates for future seasonal residents, future permanent residents and future site visitors using shallow subsurface water as a potable supply also exceed ADEC's point of departure criterion of 1 (Table 4-47). Excess HI estimates were primarily attributable to the presence of arsenic, BTEX, DRO and GRO in shallow subsurface water.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-46). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative HI estimates for current and future site visitors who obtain potable water from the Suqitughneq River (HI_1 and HI_2) are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-47). Future site visitors who may use shallow subsurface water at Site 13 as a potable supply (HI_3 and HI_4) exceeded the ADEC point of departure criterion. The excess HI is attributable to DRO in shallow subsurface water.

4.8.2 Ecological Conceptual Model and Risk Analysis

Site 13 lies within the confines of the Housing and Operations Complex and was constructed exclusively on a gravel pad. There is virtually no vegetation present at this site. Drainage from the site is northward towards the Drainage Basin (Site 28). There is no standing water at Site 13.

Because there is no available habitat at Site 13, this site was not quantitatively evaluated in the ERA for the Northeast Cape Installation. The potential for migration of contaminants from Site 13 is evaluated in the ERA conducted for Site 28 (Drainage Basin).

4.9 SITE 15 – BURIED FUEL LINE SPILL AREA

This site encompasses the area running east-northeast from the 20,000-gallon UST at Site 13 towards the diesel fuel pump island at Site 27 (Figure 1-3). A break in this fuel line reportedly resulted in an approximately 40,000-gallon diesel fuel spill in 1971 or 1973 (Toolie, 1996). This ruptured fuel line was abandoned in place, and a second line was installed at a shallower depth (E&E, 1993a). No structures (e.g., buildings) or tanks (i.e., ASTs or USTs) were present on the site.

Vegetation in the area is minimal, since the site lies entirely on a gravel pad and within the confines of the Housing and Operations Complex. There is significant surface soil staining about the site, which may be attributable to the historic underground fuel release or fueling operations at the site. Drainage from the site is north through Sites 13 and 27 and into the Drainage Basin.

Environmental sampling activities for Site 15 included the collection of soil and shallow subsurface water samples (Table 3-1). Sampling investigations and results for downgradient areas are included in the risk descriptions for Site 28 (Drainage Basin) and Site 29 (Suqitughneq River). Chemicals detected in Site 15 soil include metals, VOCs, PAHs, DRO, GRO, RRO, and TRPH. Chemicals detected in shallow subsurface water include metals, xylenes, DRO, RRO, and TRPH (Table 2-1). All chemicals detected in site media, with the exception of TRPH, were evaluated in the HHERA. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.9.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 15 is presented in Table 4-48.

Site 15 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 15 are incomplete.

Potential future land use at Site 15 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 15 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.9.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 15 include VOCs (ethylbenzene and xylenes), naphthalene, DRO and GRO in soil; and metals, DRO and RRO in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-49; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 15 soil and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.9.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for potential exposures to Site 15 soils ranged from 4E-11 for current and future site visitors to 5E-9 for future permanent residents (Table 4-50). These carcinogenic risk estimates are below the ADEC point of departure criterion for risk management of 1E-5. The noncarcinogenic HI estimate for future permanent residents exposed to soil exceeded the ADEC point of departure criterion of 1.0 for PHCs, only (Table 4-51). The excess HI estimate for this receptor was attributable to the presence of DRO in soil at a maximum concentration of 16,000 mg/kg. Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors exposed to soil are below ADEC's point of departure criteria.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. Carcinogenic risk estimates for future seasonal residents, future permanent residents, and future site visitors using shallow subsurface water as a potable supply exceed ADEC's point of departure criterion of 1E-5 (Table 4-50). Excess risk estimates were attributable to the presence of arsenic in shallow subsurface water beneath Site 15. Noncarcinogenic HI estimates for future seasonal residents and future permanent residents using shallow subsurface water as a potable supply also exceed ADEC's point of departure criterion of 1.0 (Table 4-51). Excess HI estimates were attributable to the presence of arsenic, DRO and RRO in shallow subsurface water.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal residents, future permanent residents and future site visitors exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-50). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative HI estimates for current and future site visitors who obtain potable water from the Suqitughneq River (HI_1 and HI_2) are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-51). Future site visitors who may use shallow subsurface water at Site 15 as a potable supply (HI_3 and HI_4) exceeded the ADEC point of departure criterion. The excess HI is attributable to DRO in shallow subsurface water.

4.9.2 Ecological Conceptual Model and Risk Analysis

Site 15 lies within the confines of the Housing and Operations Complex and was constructed on gravel pad. Vegetation in the area of Site 15 is minimal. Drainage from the site is north, through Sites 13 and 27, into the Drainage Basin.

Because there is no available habitat at Site 15, this site was not quantitatively evaluated in the ERA for the Northeast Cape Installation. The potential for migration of contaminants from Site 15 is evaluated in the ERA conducted for Site 28 (Drainage Basin).

4.10 SITE 16 – PAINT AND DOPE STORAGE BUILDING

Site 16 included a single-room, wood-framed building on a concrete slab foundation located on the north side of the perimeter access road surrounding the Housing and Operations Complex (Figure 1-3). This site was originally a flammable liquids storage facility. Numerous decaying containers, ranging in size from 1 pint to 5 gallons, were scattered both inside the building and throughout the surrounding area. One steel AST, reported to be used for oiling roads (Toolie, 1996), was located on the northern border of the site. The AST was found to be approximately 50 percent full of the fluids, black oil, and gray water. The fluids appeared to be weathered heavy motor oil, and rainwater and snowmelt accumulation. In addition to the AST, there was a large amount of miscellaneous debris located on the north side of the building.

At this site, ACM and/or suspected ACM were observed in the building and surrounding areas (Montgomery Watson, 1995a, b). Painted surfaces were assumed to be lead-based paint, based on sampling performed at other sites (Montgomery Watson, 1995a, b). All structures and debris were removed from the site during 2001 through 2003 BD/DR activities.

Vegetation in the area is minimal due to physically disturbed earth and the gravel fill pad. However, the lack of vegetation appears to be the result of earthmoving rather than fuel contamination distress. The sparse grasses present at the site appeared healthy. There is no clear drainage pathway since the site is fairly well graded.

Environmental sampling activities for Site 16 included the collection of soil and shallow subsurface water samples (Table 3-1). Chemicals detected in Site 16 soil include metals, several VOCs, two SVOCs (benzoic acid and di-n-butyl phthalate), two PCBs (Aroclor-1254 and Aroclor-1260), and several pesticides. Chemicals detected in shallow subsurface water include metals, various VOCs, two SVOCs (benzoic acid and bis-(2-ethylhexyl)phthalate), and several PAHs (acenaphthene, fluorene, and naphthalene) (Table 2-1). All chemicals detected in site media were evaluated in Tier I human health and ecological screening assessments.

4.10.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 16 is presented in Table 4-52.

Site 16 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 16 are incomplete.

Potential future land use at Site 16 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 16 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.10.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 16 include metals, methylene chloride and Aroclor-1260 in soil; and metals, VOCs and bis-(2-ethylhexyl) phthalate in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-53; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 16 soil and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.10.1.2 Tier II Baseline HHRA Results

The carcinogenic risk estimate for a future permanent resident exposed to Site 16 soils exceeds ADEC's point of departure criterion for carcinogenic risk of 1E-5 (Table 4-54). This exceedance is attributable to the presence of arsenic in soil. The maximum concentration of arsenic detected in Site 16 soil was 12 mg/kg. Future permanent residents were the only receptor with a noncarcinogenic HI estimate exceeding the ADEC point of departure criterion of 1.0 (Table 4-55). The HI estimate of 1.4 for this receptor is attributable to antimony, arsenic and Aroclor-1260 in soil. However, these chemicals affect different target organs, and the chemical-specific HQ for each is less than 1.0 (Appendix F). Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors are below ADEC's point of departure criteria.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. The carcinogenic risk estimate for future site visitors using shallow subsurface water as a potable supply are below ADEC's point of departure criterion of 1E-5 (Table 4-54). Carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion of 1E-5. Excess carcinogenic risk estimates for these receptors are attributable to the presence of trichloroethylene in subsurface water. Noncarcinogenic HI estimates for future seasonal and permanent residents using shallow subsurface water as a potable supply also exceed ADEC's point of departure criterion of 1.0 (Table 4-55). Excess HI estimates were primarily attributable to the presence of cadmium in shallow subsurface water at a maximum concentration of 0.06 mg/L.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-54). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal residents and future permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors who obtain potable water from the Suqitughneq River (HI_1 and HI_2) are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Tables 4-54 and 4-55). Total cumulative carcinogenic risk and noncarcinogenic HI estimates for future site visitors who may use shallow subsurface water at Site 16 as a potable supply (HI_3 and HI_4) were also below the ADEC point of departure criterion.

4.10.2 Ecological Conceptual Model and Risk Analysis

Site 16 lies within the confines of the Housing and Operations Complex and was constructed on a gravel pad. Vegetation in the area is minimal due to physically disturbed earth and the gravel fill pad. However, the lack of vegetation appears to be the result of earthmoving rather than fuel contamination distress. The sparse grasses present at the site appeared healthy. There is no clear drainage pathway since the site is fairly well graded.

Because there is no available habitat at Site 16, this site was not quantitatively evaluated in the ERA for the Northeast Cape Installation.

4.11 SITE 19 – AUTO MAINTENANCE AND STORAGE FACILITIES

Site 19 is located in the Housing and Operations Complex (Figure 1-3). The site consisted of the Auto Storage Facility (Building 108), Auto Maintenance Facility (Building 109), and adjacent land. The buildings were constructed using wood framing, with steel columns and trusses that support the roofs. The flooring in both buildings was concrete slab. Both floors were stained and had floor drains, which were assumed to drain to the north along the downward sloping grade. There was a mechanics' work pit in the north end of the Auto Maintenance Facility, which was flooded with water. The site also contained the following CON/HTW items: one 250-gallon oblong AST located outside of the northeast corner of Building 108 containing approximately 50 gallons of spent antifreeze; one empty 250-gallon AST located by Building 108; 24 two-gallon smudge pots; and 72 five-gallon buckets of Military Aircraft Washing Powder. All structures and debris were removed from the site during 2001 through 2003 BD/DR activities.

Vegetation in the area is limited, since this site is located within the the Housing and Operations Complex on a gravel fill pad. The sparse vegetation consists of grasses and appears to be healthy. The drainage of the site is to the north towards the Drainage Basin. There is no standing water at the site.

Environmental sampling activities for Site 19 included the collection of soil and shallow subsurface water samples (Table 3-1). Chemicals detected in Site 19 soil include metals, VOCs, PAHs, DRO, GRO, RRO, and TRPH. Chemicals detected in shallow subsurface water include metals, VOCs, DRO, GRO, RRO, and TRPH (Table 2-1). All chemicals detected in site media, with the exception of TRPH, were evaluated in the HHERA. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.11.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 19 is presented in Table 4-56.

Site 19 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 19 are incomplete.

Potential future land use at Site 19 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 19 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.11.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 19 include: metals, BTEX, DRO and GRO in soil; and several metals (copper and lead), benzene, ethane, DRO, GRO and RRO in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-57; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 19 soil and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.11.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for potential exposures to Site 19 soils ranged from 6E-10 for current and future site visitors to 6E-8 for future permanent residents (Table 4-58). These carcinogenic risk estimates are below the ADEC point of departure criterion for risk management of 1E-5. Noncarcinogenic HI estimates exceeding the ADEC point of departure criterion of 1.0 were estimated for future permanent residents (for PHCs, only); HI estimates for the remaining receptors are below the point of departure criterion (Table 4-59). The excess HI estimate for the future permanent resident is attributable to the presence of DRO in soil at a maximum concentration of 13,300 mg/kg. Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors exposed to soil are below ADEC's point of departure criteria.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. The carcinogenic risk estimate for a future permanent resident using shallow subsurface water as a potable supply exceeds ADEC's point of departure criterion of 1E-5 (Table 4-58). This excess risk estimate was attributable to the presence of benzene in shallow subsurface water beneath Site 19. Noncarcinogenic HI estimates for future seasonal and permanent residents using shallow subsurface water as a potable supply also exceed ADEC's point of departure criterion of 1.0 (Table 4-59). Excess HI estimates were primarily attributable to the presence of DRO and GRO in shallow subsurface water.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-58). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors who obtain potable water from the Suqitughneq River (HI_1 and HI_2) are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Tables 4-58 and 4-59). Total cumulative carcinogenic risk and noncarcinogenic HI estimates for future site visitors who may use shallow subsurface water at Site 19 as a potable supply (HI_3 and HI_4) were also below the ADEC point of departure criterion.

4.11.2 Ecological Conceptual Model and Risk Analysis

Site 19 lies within the confines of the Housing and Operations Complex and was constructed on a gravel pad. Vegetation at this site is limited. The sparse vegetation consists of grasses and appears to be healthy. Drainage of the site is to the north, towards the Drainage Basin. There is no standing water at the site.

Because available habitat at Site 19 is limited, this site was not quantitatively evaluated in the ERA for the Northeast Cape Installation. The potential for migration of contaminants from Site 19 is evaluated in the ERA conducted for Site 28 (Drainage Basin).

4.12 SITE 21 – WASTEWATER TREATMENT FACILITY

Site 21 consisted of the wastewater treatment system which served the Housing and Operations Complex. The facility is located west of the perimeter road and consisted of two side-by-side septic settling tanks approximately 15 feet wide by 50 feet long and 8 feet deep (Figure 1-3) and a pumphouse. Effluent from these tanks was discharged via an 8-inch insulated cast iron pipe to a wetland area approximately 450 feet to the west. Two 500-gallon diesel ASTs were identified at the site and found to be empty.

The presence of ACM and/or suspected ACM was observed in buildings and surrounding areas (Montgomery Watson, 1995a, b). Signs warning of the presence of asbestos and its potential hazards were posted at all viable entrances to buildings suspected to contain friable asbestos. Painted surfaces are assumed to be lead-based paint, based on sampling performed at other sites (Montgomery Watson, 1995a, b). All structures and debris were removed from the site during 2001 through 2003 BD/DR activities.

Aside from areas of physically disturbed earth from earthmoving activities, vegetation in this area is healthy. Soil characteristics range from gravelly fill near the site structures to very organic marshy areas and grasses. The drainage of the site follows a stream located at the ends of the outfall approximately 1,000 feet west of the structures.

Environmental sampling activities for Site 21 included the collection of soil, sediment (beneath standing, ephemeral surface water), ephemeral surface water, and shallow subsurface water samples (Table 3-1). Chemicals detected in soil include metals, VOCs, SVOCs, PCBs (Aroclor-1254 and Aroclor-1260), DRO, RRO, and TRPH. Chemicals detected in sediment include metals, VOCs, cresols, PCBs (Arolclor-1254 and Aroclor-1260), DRO, RRO, and TRPH. Chemicals detected in ephemeral surface water include metals and DRO. Metals, VOCs, benzoic acid, and DRO were detected in shallow subsurface water (Table 2-1). A radiological survey was performed at Site 21; however, no radioactive materials were detected at the site (MW, 1999). All chemicals detected in site media, with the exception of TRPH, were evaluated in Tier I human health and ecological screening assessments. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.12.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 21 is presented in Table 4-60.

Site 21 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Consistent with the generalized exposure assessment presented in Section 3.1.2.1, sediment exposure pathways were assumed to be the same as those for soil, and exposure pathways for ephemeral surface water were judged to be incomplete. Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 21 are incomplete.

Potential future land use at Site 21 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 21 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.12.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil/sediment and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 21 include: metals, various VOCs, 4-chloroaniline, PCBs (Aroclor-1260), DRO and RRO in soil/sediment; and several metals, n-propylbenzene and DRO in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-61; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 21 soil and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.12.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for future seasonal and permanent residents exposed to Site 21 soils were calculated as 2E-5 and 7E-5, respectively (Table 4-62). These carcinogenic risk estimates exceed the ADEC point of departure criterion for risk management of 1E-5. Noncarcinogenic HI estimates for future seasonal and permanent residents exposed to soil also exceeded the ADEC point of departure criterion of 1.0 (Table 4-63). Exceedances of risk management criteria were attributable to the presence of arsenic and Aroclor-1260 in soil. Arsenic was detected at a maximum concentration of 170 mg/kg in soil, and the maximum concentration of Aroclor-1260 detected in soil was 3.1 mg/kg. Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors exposured to Site 21 soils are below ADEC's point of departure criteria.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. Carcinogenic risk estimates in excess of ADEC's point of departure criterion of 1E-5 were calculated for future seasonal residents, future permanent residents, and future site visitors using shallow subsurface water as a potable supply (Table 4-62). Excess risk estimates for these receptors were attributable to the presence of arsenic in shallow subsurface water beneath Site 21. Noncarcinogenic HI estimates for future seasonal and permanent residents using shallow subsurface water as a potable supply also exceed ADEC's point of departure criterion of 1.0 (Table 4-63). Excess HI estimates for these receptors were primarily attributable to the presence of arsenic in shallow subsurface water.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-62). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors who obtain potable water from the Suqitughneq River (HI_1 and HI_2) are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Tables 4-62 and 4-63). Total cumulative carcinogenic risk and noncarcinogenic HI estimates for future site visitors who may use shallow subsurface water at Site 21 as a potable supply (HI_3 and HI_4) exceed the ADEC point of departure criterion. These exceedances are primarily attributable to the presence of arsenic in shallow subsurface water.

4.12.2 Ecological Conceptual Model and Risk Analysis

Site 21 contains physically disturbed areas from earthmoving activities; however, vegetation in this area appears healthy. Soil characteristics range from gravelly fill near the site structures to very organic marshy areas and grasses. Drainage of the site follows a stream located at the end of the outfall approximately 1,000 feet west of the structures. Vegetation in the outfall area is classified as wet tundra, and is dominated by cotton grass, heath, sedges, mosses, and lichens. Wildlife expected to use the site include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals.

Potential exposure media include soil, standing ephemeral surface water, sediment, and dietary items. Standing ephemeral surface water was used to evaluate the surface water consumption pathway. Primary exposure pathways between ecological indicator receptors and site contaminants are presented in Table 4-64.

4.12.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil/sediment and ephemeral surface water in accordance with methods described in Section 3.2.1. Tier I COPECs identified for Site 21 include: metals, 4-chloroaniline, PCBs (Aroclor-1254 and Aroclor-1260), DRO and RRO in soil/sediment; and arsenic, barium, manganese and DRO in ephemeral surface water. The results of Tier I ecological screening are summarized in Table 4-65, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 21 soil/sediment, ephemeral surface water, and shallow subsurface water were further evaluated in a Tier II baseline ERA.

4.12.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to Site 21 soil and ephemeral surface water is 34 (Table 4-66). The maximum HQ estimate was attributable to the maximum concentration of aluminum present in soil at the site. Barium also resulted in an HQ estimate greater than the ADEC ecological criterion of 1.0. It should be noted that the EPC for aluminum (21,708 mg/kg) is within the range of ambient concentrations derived for aluminum in tundra soils at the Northeast Cape Installation (BUTL = 30,357 mg/kg). Similarly, the EPC for barium (136 mg/kg) is within the range of ambient concentrations derived for barium in tundra soils at the Northeast Cape Installation (BUTL = 174 mg/kg). Consequently, HQ estimates in excess of 1.0 for the tundra vole are believed to represent ambient conditions.

The maximum HQ estimates for the cross fox (0.65) and glaucous-winged gull (0.000026) (Table 4-66) are below the ADEC ecological criterion, and indicate that no adverse effects on representative receptors are anticipated.

4.13 SITE 22 – WATER WELLS AND WATER SUPPLY BUILDING

Site 22 was located adjacent to and south of the Housing and Operations Complex (Figure 1-3). This site consisted of the Potable Water Storage Building (Building 113), the Pumphouse (Building 114), and three of the four water supply wells at the Northeast Cape Installation. The Potable Water Storage Building held four 20-foot diameter by 26-foot high water tanks and miscellaneous piping.

Inside the building's northern entrance, 150 1-gallon paint cans containing Asbestos Retort Cement and ten 50-pound bags of asbestos cement were piled. The pumphouse contained a motor driven pump and diesel pump drive (E&E, 1993a). There was also a UST (UST 22-1), which apparently supplied the pump, located on the south side of this building. The building is in fair condition but has suffered some weathering due to the lack of windows and doors. Little information is available pertaining to the four wells.

The presence of ACM and/or suspected ACM was observed in buildings and surrounding areas (MW, 1995a, b). Signs warning of the presence of asbestos and its potential hazards were posted at all viable entrances to buildings suspected to contain friable asbestos. Paint chips from painted surfaces were collected, analyzed, and found to contain lead-based paint (MW, 1995a, b).

All attributers and debris were removed from the site during 2001 through 2003 BD/DR activities.

Environmental sampling activities for Site 22 included the collection of soil and deep subsurface water samples (Table 3-1). Chemicals detected in Site 22 soil include metals, ethylbenzene, di-n-butyl phthalate, PAHs, DRO, GRO, RRO and TRPH. Chemicals detected in deep subsurface water include iron, manganese, sulfate, DRO, and RRO (Table 2-1). The presence of petroleum-related contaminants (i.e., DRO and RRO) in deep groundwater at Site 22 is believed attributable to UST-22-1, located next to the pumphouse for Well #2. A radiological survey was performed for Site 22; however, no radioactive materials were detected at the site (MW, 1999). All chemicals detected in site media, with the exception of TRPH, were evaluated in Tier I human health and ecological screening assessments. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.13.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 22 is presented in Table 4-67.

Site 22 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Deep subsurface water from Site 22 served as the primary source of potable water for the Northeast Cape Installation during its operation. The three potable supply wells at Site 22 have since been decommissioned. Current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and deep subsurface water at Site 22 are incomplete.

Potential future land use at Site 22 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use deep subsurface groundwater at Site 22 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of deep subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.13.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and deep subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 22 include lead, ortho-xylene, benzo(a)pyrene, DRO, GRO and RRO in soil; and manganese, DRO and RRO in deep subsurface water. The results of Tier I human health screening are summarized in Table 4-68; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 22 soil and deep subsurface water were further evaluated in a Tier II baseline HHRA.

4.13.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for potential exposures to Site 22 soils ranged from 2E-8 for current and future site visitors to 1E-6 for future permanent residents (Table 4-69). These carcinogenic risk estimates are below the ADEC point of departure criterion for risk management of 1E-5. Noncarcinogenic HI estimates for Site 22 soils were below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 for all receptors, with the exception of the future permanent resident (Table 4-70). The noncarcinogenic HI estimate for the future permanent resident was calculated as 1.2, and is attributable to DRO and RRO in Site 22 soils at maximum concentrations of 4,070 mg/kg and 3,815 mg/kg, respectively.

Deep subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. No carcinogenic COPCs were identified for deep subsurface water. Therefore, carcinogenic risk estimates were not calculated for this medium. A noncarcinogenic HI estimate of 1.9 was calculated for a future permanent resident using deep subsurface water as a potable supply. This excess HI estimate was attributable to the presence of DRO and RRO in deep subsurface water at maximum concentrations of 1.4 and 2.8 mg/l, respectively.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water derived from the Suqitughneq River (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-69).

Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-70) regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Use of water from the Suqitughneq River as a potable supply has no significant impact on cumulative risk and HI estimates, since no carcinogenic COPCs were identified in surface water samples collected from the Suquitughneq River, and the HI for all receptors using Suqitughneq River water as a potable supply were well below 1.0.

Total cumulative carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors are below ADEC point of departure criteria (Tables 4-69 and 70).

4.13.2 Ecological Conceptual Model and Risk Analysis

Site 22 is located on the southern edge of the Housing and Operations Complex. Adjacent areas are typified by wet tundra vegetation. Wildlife expected to use the site include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals.

Potential exposure media include soil/sediment, ephemeral surface water, and dietary items. Subsurface water was not used to evaluate the surface water consumption pathway because deep subsurface water represents an incomplete exposure pathway. Primary exposure pathways between ecological indicator receptors and site contaminants are presented in Table 4-71.

4.13.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil in accordance with methods described in Section 3.2.1. Tier I COPECs identified for Site 22 soil include: metals (lead and zinc), di-n-butyl phthalate, PAHs, DRO, GRO and RRO in soil. The results of Tier I ecological screening are summarized in Table 4-72, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs identified for Site 22 soil were further evaluated in a Tier II baseline ERA.

4.13.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to soil at Site 22 is 0.6 (Table 4-73). This HQ estimate is below the ADEC ecological criterion, and suggests that no adverse effects on representative receptors are anticipated.

The maximum HQ estimates for the cross fox (0.00068) and glaucous-winged gull (0.0000029) are also below the ADEC ecological criterion (Table 4-73), and indicate that no adverse effects on representative receptors are anticipated.

4.14 SITE 27 – DIESEL FUEL PUMP ISLAND

Site 27 was located on the northeast site of the Housing and Operations Complex (Figure 1-3). It consisted of a 4 - by 6-foot fuel pump shed, a 4- by 4-foot cement valve box, and buried pipeline from the fuel storage tanks to the east. It was located approximately 100 feet north of the Auto Storage Facility (Building 108). It was originally used to refuel heavy equipment and vehicles; no gasoline was dispensed (Toolie, 1996). Diesel releases from the diesel fuel pump island have impacted the Drainage Basin (Site 28).

During the Phase I RI, no structures (e.g., buildings) or tanks (ASTs or USTs) were observed at the site. All structures and debris were removed from the site during 2001 through 2003 BD/DR activities.

Biota at the site is limited due to the gravel pad on which the site was built. The sparse vegetation (less than 5 percent coverage) consists primarily of grasses. However, what vegetation does exist appears healthy and unaffected by site conditions. Drainage from the site is north under the perimeter access road, through a culvert, and onto the Drainage Basin. During wet periods, subsurface water surfaces in a small spring immediately southeast of the pump island.

Environmental sampling activities for Site 27 included the collection of soil and shallow subsurface water samples (Table 3-1). Chemicals detected in soil include metals, VOCs, PCBs (Aroclor-1260), DRO, GRO, RRO and TRPH. Chemicals detected in shallow subsurface water include metals, VOCs, DRO, GRO, RRO and TRPH (Table 2-1). A radiological survey was performed at Site 27; however, no radioactive materials were detected at the site (MW, 1999). All chemicals detected in site media, with the exception of TRPH, were evaluated in the HHERA. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.14.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 27 is presented in Table 4-74.

Site 27 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Shallow subsurface water at the Northeast Cape Installation is not currently used as a potable water supply; current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and shallow subsurface water at Site 27 are incomplete.

Potential future land use at Site 27 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor. In addition, future receptors could potentially use shallow subsurface groundwater at Site 27 as a potable water supply. Therefore, exposure pathways for future receptors also potentially include ingestion of shallow subsurface water, and dermal contact with subsurface water or inhalation of VOCs derived from subsurface water while bathing.

4.14.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil and shallow subsurface water in accordance with methods described in Section 3.1.1. Human health COPCs identified for Site 27 include: BTEX, naphthalene, DRO, GRO and RRO in soil; and metals (lead and manganese), two VOCs (benzene and ethylbenzene), DRO, GRO and RRO in shallow subsurface water. The results of Tier I human health screening are summarized in Table 4-75; detailed Tier I human health screening tables are presented in Appendix E.

Tier I human health COPCs for Site 27 soil and shallow subsurface water were further evaluated in a Tier II baseline HHRA.

4.14.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for potential exposures to Site 27 soils ranged from 5E-10 for current and future site visitors to 6E-8 for future permanent residents (Table 4-76). These carcinogenic risk estimates are below the ADEC point of departure criterion for risk management of 1E-5. Noncarcinogenic HI estimates exceeding the ADEC point of departure criterion of 1.0 were estimated for future seasonal and permanent residents (both for PHCs, only); HI estimates for the remaining receptors are below the point of departure criterion (Table 4-77). Excess HI estimates for future seasonal and permanent residents are attributable to the presence of DRO in soil at a maximum concentration of 51,000 mg/kg. Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors exposed to soil are below ADEC's point of departure criteria.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. Carcinogenic risk estimates for future seasonal and permanent residents using shallow subsurface water as a potable supply exceed ADEC's point of departure criterion of 1E-5 (Table 4-76). Excess risk estimates of 3E-5 and 1E-04 for future seasonal and permanent residents were attributable to the presence of benzene and ethylbenzene in shallow subsurface water beneath Site 27. Noncarcinogenic HI estimates for future seasonal residents, future permanent residents, and future site visitors using shallow subsurface water as a potable supply also exceed ADEC's point of departure criterion of 1.0 (Table 4-77). Excess HI estimates are attributable to the presence of DRO and GRO in shallow subsurface water at maximum concentrations of 64 and 1.7 mg/L, respectively.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-76). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative carcinogenic risk and noncarcinogenic HI estimates (HI_1 and HI_2) for current and future site visitors who obtain potable water from the Suqitughneq River are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Tables 4-76 and 4-77). Total cumulative noncarcinogenic HI estimates, but not carcinogenic risk estimates, for future site visitors who may use shallow subsurface water at Site 21 as a potable supply (HI_3 and HI_4) exceed the ADEC point of departure criterion. These exceedances are attributable to the presence of DRO in shallow subsurface water.

4.14.2 Ecological Conceptual Model and Risk Analysis

Vegetation at Site 27 is limited due to the gravel pad on which the site was built. The sparse vegetation (less than 5 percent coverage) consists primarily of grasses. However, what vegetation does exist appears healthy and unaffected by site conditions. Drainage from the site is north under the perimeter access road, through a culvert, and onto the Drainage Basin.

Because available habitat at Site 27 is limited, this site was not quantitatively evaluated in the ERA for the Northeast Cape Installation. The potential for migration of contaminants from Site 27 is evaluated in the ERA conducted for Site 28 (Drainage Basin).

4.15 SITE 28 – DRAINAGE BASIN

The Drainage Basin is a tundra/wetland north of the Housing and Operations Complex (Figure 1-3). Surface water run-off and subsurface water seeps from the Housing and Operations Complex gravel pad drains into tundra/wetland. This surface water flows north into the Suqitughneq River.

Three discrete drainages originate from the Housing and Operations Complex gravel pad. The first is adjacent to Site 10 (Buried Drum Field) and Site 11 (Fuel Storage Tank Area). The second is adjacent to Site 13 (Heat and Electric Power Building), and the third is adjacent to Site 27 (Diesel Fuel Pump Island).

The Site 10 and 11 headwaters are west of Site 10 and north of Site 11. Heavy, black staining was observed on the edge of the gravel pad at Site 10. Soil staining was not observed beneath the 400,000-gallon diesel tanks at Site 11, even in the vicinity of the puncture in AST 11-2. However, a 120- by 30-foot area of soil staining and distressed vegetation was observed in the tundra at the foot of the gravel pad.

The Site 13 headwaters area originates from an artificially-created swale which contains a manhole and small (3- by 3-foot) concrete supporting structure. According to Eugene Toolie (1996), this manhole served as the drain for the Heat and Electric Power Buildings (Site 13). North of the manhole is an approximately 10-foot wide by 40-foot long area of surface water, which drains to the north. The surface water has no petroleum sheen, but the sediments in the drainage are stained dark brown and black, and produce a heavy sheen when disturbed. Staining is observed about 2 feet up the embankment from the current surface water elevation, possibly from ice damning during the winter. Vegetation consisting of seasonal grasses grows freely in the drainage, and does not appear significantly affected by hydrocarbon contamination.

The Site 27 headwaters area originates as a small swale south of the boundary road, which collects surface water run-off from the diesel pump island. The run-off is routed under the road via a culvert to an artificially created swale north of the perimeter road. An approximately 40- by 20-foot area of ponded water exists immediately north of the culvert outlet. Staining (black) is apparent around the culvert and on the rocks in the standing water. The swale is filled with grasses which are apparently unaffected by hydrocarbon contamination. Near the terminus of this swale, on the east side of the fill bank, is an approximately 20- by 30-foot area where the soils are stained black, and no vegetation grows. This staining also occurs 40 feet east of the terminus of the swale, where black soil extends 2 to 5 feet up the embankment. An approximately 10- by 20-foot area of buried drums is also evident on the embankment. In general, the area is heavily vegetated with grass, with the exception of the black stained soils at the end of the swale and approximately 800 square feet of soils that appear to have been disturbed by heavy equipment.

No structures (e.g., buildings) or tanks (ASTs or USTs) were present at Site 28.

Environmental sampling activities for Site 28 included the collection of soil, sediment, surface water, shallow subsurface water, vegetation, and fish samples (Table 3-1). Chemicals detected in soil included metals, VOCs, Aroclor-1260, PAHs, DRO, GRO, RRO, and TRPH. Chemicals detected in sediment included metals, BTEX, PCBs (Aroclor-1254 and Aroclor-1260), pesticides, dibenzofuran, PAHs, DRO, GRO, RRO, and TRPH. Metals, ethylbenzene, Aroclor-1260, DRO, GRO, and TRPH were detected in surface water, while metals and DRO were detected in shallow subsurface water. Chemicals detected in plants included metals, PAHs, and PCBs (Aroclor-1254 and Aroclor-1260). Chemicals detected in fish included metals, PAHs, and Aroclor-1260 (Table 2-1). All chemicals detected in site media, with the exception of TRPH, were evaluated in Tier I human health and ecological screening assessments. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

4.15.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 28 is presented in Table 4-78.

Site 28 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Consistent with the generalized exposure assessment presented in Section 3.1.2.1, sediment exposure pathways were assumed to be the same as those for soil. Surface water in the Drainage Basin is not currrently used as a source of potable water. Similarly, shallow subsurface water is not currently used as a potable water supply. Current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and surface water and shallow subsurface water at Site 28 are incomplete.

Because Site 28 is a wetland, it is highly unlikely that anyone would ever establish a residence at this location. However, the site could be used for occasional subsistence plant gathering activities by future seasonal residents. During such activities, seasonal residents may have direct contact with soil or sediment, consume surface water or shallow subsurface water, or eat plants. Future site visitors could be exposed to soil, sediment, surface water, or shallow subsurface water through similar exposure pathways. However, future visitors are not assumed to engage in subsistence plant consumption, consistent with the generalized exposure assessment presented in Section 3.1.2.1.

Fish collected or observed in the Drainage Basin were of inadequate size for human consumption, as well as of inadequate size to be collected by traditional subsistence methods. Although one of the main subsistence fish species (i.e., Dolly Varden) occurs in the Suqitughneq River and has potential access to the Drainage Basin, this species is not expected to use the Drainage Basin because the physical characteristics are unsuitable (i.e., it has generally low flow, is clogged with vegetation and provides unsuitable habitat for Dolly Varden). Therefore, subsistence fishing is considered to be an incomplete pathway for Site 28. However, future seasonal residents could potentially catch fish of harvestable size from the Suqitughneq River (Site 29). Therefore, risks associated with potential consumption of fish harvested from the Suqitughneq River were included in total cumulative risk estimates for future seasonal residents of Site 28 refer to Section 4.15.1.2).

4.15.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil, sediment, surface water, shallow subsurface water, and plants in accordance with methods described in Section 3.1.1. Fish collected or observed in the Drainage Basin were of inadequate size for human consumption, and were not screened for evaluation in the HHRA.

Soil COPCs identified for Site 28 include metals (beryllium and thallium), VOCs (ethylbenzene and methylene chloride), Aroclor-1254, several PAHs, DRO, GRO and RRO (Table 4-79). Sediment COPCs include metals (chromium, lead and zinc), VOCs (benzene and ethylbenzene), PCBs (Aroclor-1254 and Aroclor-1260), two pesticides (beta-BHC and gamma-BHC), dibenzofuran, PAHs, DRO, GRO and RRO. Surface water COPCs include metals, Aroclor-1260, DRO and GRO. The COPCs identified for shallow subsurface water include metals and DRO. The COPCs identified for plants include metals, PAHs and PCBs (Aroclor-1254 and Aroclor-1260) (Table 4-79).

Tier I human health COPCs for Site 28 soil, sediment, surface water, shallow subsurface water, and plants were further evaluated in a Tier II baseline HHRA.

4.15.1.2 Tier II Baseline HHRA Results

The carcinogenic risk estimate for soil/sediment for future seasonal residents who may use Site 28 for subsistence plant gathering was calculated as 1E-5 (Table 4-80). This carcinogenic risk estimate does not exceed the ADEC point of departure criterion for risk management of 1E-5. The noncarcinogenic HI estimate for future seasonal residents engaged in subsistence plant gathering activities at Site 28 exceeded the ADEC point of departure criterion of 1.0 (Table 4-81). This exceedance was attributable to the presence of DRO in soil/sediment. Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors exposed to Site 28 soil/sediment are below ADEC's point of departure criteria.

Permanent surface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75.345. Carcinogenic risk and/or noncarcinogenic HI estimates in excess of ADEC's point of departure criteria were calculated for future seasonal residents and site visitors using surface water at Site 28 as a potable supply (Tables 4-80 and 4-81). Excess risk estimates for these receptors were attributable to the presence of Aroclor-1260 in surface water; an excess HI estimate for future seasonal residents was attributable to Aroclor-1260 and DRO in surface water.

Shallow subsurface water was evaluated as a potential future source of potable water, in accordance with 18 AAC 75. Carcinogenic risk estimates in excess of ADEC's point of departure criterion of 1E-5 were calculated for future seasonal residents and site visitors using shallow subsurface water as a potable supply (Table 4-80). The noncarcinogenic HI estimate for the future seasonal resident also exceeds the point of departure criterion. Excess carcinogenic risk and noncarcinogenic HI estimates for these receptors were attributable to the presence of arsenic in shallow subsurface water beneath Site 28.

Finally, carcinogenic risk and noncarcinogenic hazard estimates for future seasonal residents consuming plants collected from Site 28 were calculated as 9E-4 and 38, respectively. Excess carcinogenic risk estimates for this receptor were attributable to the presence of maximum concentrations of arsenic, PCBs and PAHs in plant tissues. Excess noncarcinogenic HI estimates were primarily attributable to arsenic, barium, cadmium, and PCBs (Aroclor-1254 and Aroclor-1260) measured in plant tissue samples collected from Site 28. It should be noted that arsenic, barium, cadmium and PCBs affect different target organs. The maximum target organ-specific HI estimate associated with consumption of plants is 26, and is attributable to PCBs (Aroclor-1254 and Aroclor-1260) measured in plant tissue samples.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal residents ranged from 1E-3 when potable water is obtained from the Suqitughneq River and plants and fish are obtained from ambient locations (Site 30), to 2E-3 when potable water (in the form of permanent surface water) and plants are obtained from Site 28, and fish are harvested from the Suqitughneq River (Site 29). Noncarcinogenic HI estimates for future seasonal residents ranged from 31 to 62 for non-PHC COPCs over these same scenarios. When potable water (derived from shallow subsurface water) and plants are obtained from Site 28, and fish are harvested from the Suqitughneq River (Site 29), the noncarcinogenic HI estimate for future seasonal residents (HI_4) is equal to 56 for non-PHC COPCs. These results suggest that carcinogenic risks and noncarcinogenic hazards associated with collection of subsistence foods from impacted areas are approximately double those estimates for ambient locations. However, carcinogenic risk estimates for subsistence food collection from either impacted or ambient locations are about two orders of magnitude higher than the ADEC point of departure criterion for risk management of 1E-5.

Cumulative carcinogenic risk and noncarcinogenic HI estimates for future site visitors varied considerably between scenarios in which potable water is obtained from the Suqitughneq River versus Site 28 (Tables 4-80 and 4-81). These results suggest that the source of potable water used by future inhabitants or visitors to the site may have a substantial impact on overall cumulative risk.

4.15.2 Ecological Conceptual Model and Risk Analysis

Site 28 is a wetland, characterized by wet tundra and a fresh surface water drainage that discharges to the Suqitughneq River. Wildlife expected to use the site include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals. Alaska blackfish were captured in the Site 28 Drainage Basin during the 2001 sampling investigation.

Potential exposure media include soil, freshwater sediment, fresh surface water, and dietary items. Fresh surface water was used to evaluate the surface water consumption pathway. Primary exposure pathways between ecological indicator receptors and site contaminants are presented in Table 4-82.

4.15.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil, freshwater sediment, fresh surface water, fish and plants in accordance with methods described in Section 3.2.1. Soil COPECs identified for Site 28 include beryllium, Aroclor-1254, PAHs, DRO, GRO and RRO. Tier I COPECs identifed for freshwater sediment include several metals, VOCs, PCBs (Aroclor-1242, Aroclor-1254, and Aroclor-1260), pesticides, dibenzofuran, PAHs, DRO, GRO and RRO. Tier I COPECs identified for surface water include metals, Aroclor-1260, DRO and GRO. Numerical screening criteria for plant and fish tissues have not been adopted by ADEC (18 AAC 75). Therefore, all analytes detected in plant and fish samples collected from Site 28 were identified as COPECs. The results of Tier I ecological screening are summarized in Table 4-83, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 28 soil, freshwater sediment, fresh surface water, fish and plants were further evaluated in a Tier II baseline ERA.

4.15.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to COPEC concentrations measured in soil, surface water and plants collected from Site 28 is 14 (Table 4-84). The maximum HQ estimate was associated with DRO detected in soil and plants. Other COPECs associated with HQ estimates in excess of 1.0 include barium, zinc and Aroclor-1254. The HQ estimates for the tundra vole exceed the ADEC ecological criterion of 1.0. It should be noted that maximum concentrations of barium, zinc and Aroclor-1254 measured in plant tissue samples collected from Site 28 were 40, 76 and 0.25 mg/kg, while corresponding concentrations measured in plant tissue samples collected from ambient locations were 21, 57 and 0.011 mg/kg, respectively. Barium and zinc concentrations in plant tissue samples collected from Site 28 were less than two times corresponding concentrations measured in ambient plant tissue samples, while the maximum concentration of Aroclor-1254 measured in Site 28 plant tissue samples was more than twenty times that measured in ambient plant tissue samples. DRO was not detected in plant tissue samples collected from ambient locations. These results suggest that HQ estimates for Aroclor-1254 and DRO are attributable to site contamination.

Maximum HQ estimates for the cross fox (0.71) and glaucous-winged gull (0.19) (Table 4-84) are below the ADEC ecological criterion, and indicate that no adverse effects on representative receptors are anticipated.

4.16 SITE 29 – SUQITUGHNEQ RIVER

Several small creeks and lakes throughout the Northeast Cape Installation feed the Suqitughneq River. From the confluence of the Drainage Basin, the river flows to the west for approximately 2,200 feet, then meanders to the north for approximately 2,500 feet, and then turns to the northeast. As it flows to the northeast, it crosses under the airport road 400 feet southeast of the terminal building, and flows into a large estuary about 1,300 feet northeast of the road crossing. The total distance from the confluence of the site drainage to the estuary is approximately 1.5 miles (Figure 1-3).

Migration of contaminants from Sites 10 through 20, and 27 via the Drainage Basin (Site 28) serve as potential sources of contamination for the Suqitugheng River. The POL Spill Site (Site 8), may also present a potential source of contaminantion to the Suqitugheng River during periods of heavy rainfall, but is not in direct connection with the river. Consistent with Mr. Toolie's recollection, there is no evidence that diesel-contamination from Site 8 has flowed to the Suqitughneq River.

No structures (e.g., buildings) or tanks (ASTs or USTs) were present at Site 29.

Environmental sampling activities at Site 29 included the collection of fresh surface water and sediment samples associated with the Suqitughneq River; and fish tissue samples collected from the Suqitughneq River and lagoon (Table 3-1). Soils and plants in the vicinity of the Suqitughneq River or lagoon were not sampled because of their distance from known sources of contamination. Chemicals detected in fresh sediment included metals, VOCs, dibenzofuran, PAHs, DRO, RRO, and TRPH (Table 2-1). Chemicals detected in fresh surface water included metals, DRO, and GRO. Chemicals detected in fish tissue samples included metals, PAHs, and PCBs (Aroclor-1254 and Aroclor-1260). All chemicals detected in site media, with the exception of TRPH, were evaluated in Tier I human health and ecological screening assessments. TRPH was not evaluated in the HHERA due to the nonspecific analytical method used (Method E418.1), as described in section 3.1.1.7.

Fish tissue samples collected from the lagoon were evaluated in the HHRA because subsistence fishing is practiced in the area of the Northeast Cape Installation and there are concerns that chemicals present in Site 28 Drainage Basin sediments may result in contamination of fish potentially harvested from the Suqitughneq River. It should be noted, however, that the anadromous Dolly Varden sampled in the lagoon spend the majority of their adult lives in open ocean and have the potential to bioaccumulate contaminants from a variety of other sources. Limitations and uncertainties in the evaluation of subsistence fish consumption for Site 29 are further discussed in Section 4.16.1.2 and in Sections 5.0 and 6.0.

4.16.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 29 is presented in Table 4-85.

Site 29 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for sediment (i.e., incidental ingestion of sediment, dermal contact with sediment, and inhalation of sediment in the form of indoor dust after it dries out). Consistent with the generalized exposure assessment presented in Section 3.1.2.1. Surface water in the upper Suqitughneq River is used as a source of potable water by seasonal residents of the Subsistence Fishing and Hunting Camp (Site 4), and by current site visitors. Similarly, shallow subsurface water is not currently used as a potable water supply. Current seasonal residents or visitors obtain drinking water from the Suqitughneq River. Therefore, exposure pathways between current human receptors and surface water at Site 29 are considered to be complete. Results of the subsistence surveys (Appendix C) indicate that few fish, if any, are harvested from the Suqitughneq River.

Because Site 29 is a wetland, it is highly unlikely that anyone would ever establish a residence at this location. However, the site could be used for subsistence hunting/fishing/gathering activities by future residents of the Northeast Cape Installation. During such activities, future residents may have direct contact with sediment, consume surface water, or eat fish harvested from Site 29. Future site visitors could be exposed to sediment and surface water through similar exposure pathways. However, future visitors are not assumed to engage in subsistence fish consumption, consistent with the generalized exposure assessment presented in Section 3.1.2.1.

4.16.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for sediment, surface water, and fish in accordance with methods described in Section 3.1.1. Sediment COPCs identified for Site 29 include metals, m,p-xylene, dibenzofuran and DRO (Table 4-86). The COPCs identified for fresh surface water include metals, DRO and GRO. The COPCs identified in fish tissue include metals, PAHs and PCBs (Aroclor-1254 and Aroclor-1260).

Tier I human health COPCs for Site 29 sediment, surface water, and fish were further evaluated in a Tier II baseline HHRA.

4.16.1.2 Tier II Baseline HHRA Results

Carcinogenic risk and noncarcinogenic hazard estimates for future seasonal residents and current and future site visitors who may be exposed to Site 29 sediments were below ADEC's point of departure criteria (Tables 4-87 and 4-88).

No carcinogenic COPCs were identified in fresh surface water samples collected from the Suqitughneq River (Table 4-87). Noncarcinogenic hazard estimates for future seasonal residents and current and future site visitors are below ADEC's point of departure criterion (Table 4-88).

Carcinogenic risk and noncarcinogenic hazard estimates for future seasonal residents consuming fish harvested from the Suqitughneq River were calculated as 9E-4 and 17, respectively. These carcinogenic risk and noncarcinogenic hazard estimates were attributable to the presence of arsenic, PAHs, and PCBs (Aroclor-1254 and Aroclor-1260) in fish fillet samples collected from the Suqitughneq River. The maximum target organ-specific HI for future seasonal residents consuming fish harvested from the Suqitughneq River was estimated as 12, and was attributable to arsenic. Carcinogenic risk and noncarcinogenic hazard estimates for future seasonal residents consuming fish harvested from the ambient location (Site 30) were calculated as 1E-3 and 19, respectively. These carcinogenic risk and noncarcinogenic hazard estimates were attributable to the presence of arsenic and PCBs (Aroclor-1254 and Aroclor-1260) in fish fillet samples collected from the Tapisaghak River. The maximum target organ-specific HI for future seasonal residents consuming fish harvested from the Tapisaghak River was estimated as 15, and was attributable to arsenic. The Tapisaghak River was selected for ambient sampling because it is assumed not to be impacted by contaminant releases from the Northeast Cape Installation. The above results suggest that there is very little difference in risks associated with subsistence consumption of fish harvested from impacted versus ambient locations. Potential uncrtainties and implications regarding the analysis of risks associated with subsistence fish consumption are discussed further in Sections 5.3 and 6.0.

4.16.2 Ecological Conceptual Model and Risk Analysis

Site 29 is a wetland and includes the Suqitughneq River, adjacent wet tundra habitat, and an estuary that discharges into the Bering Sea. Wildlife expected to use the site include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals. Dolly Varden were captured in the Site 29 estuary during the 2001 sampling investigation.

Potential exposure media include soil, freshwater sediment, fresh surface water, and dietary items. Fresh surface water was used to evaluate the surface water consumption pathway. Primary exposure pathways between ecological indicator receptors and site contaminants are shown in Table 4-89.

4.16.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for fresh surface water, freshwater sediment, and fish in accordance with methods described in Section 3.2.1. Tier I COPECs identifed for freshwater sediment include metals, m,p-xylene, PAHs, DRO and RRO. Tier I COPECs identified for surface water include aluminum, barium, silver, DRO and GRO. Ecological screening criteria for fish tissues have not been adopted by ADEC (18 AAC 75). Therefore, all analytes detected in fish tissue samples collected from Site 29 were identified as COPECs. The results of Tier I ecological screening are summarized in Table 4-90, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 29 freshwater sediment, fresh surface water, and fish were further evaluated in a Tier II baseline ERA.

4.16.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to Site 29 surface water is 0.0000000082 (Table 4-91). This value is below the ADEC ecological criterion of 1.0, and suggests that that no adverse effects on representative receptors are anticipated.

The maximum HQ estimates for the cross fox (0.0000000023) and glaucous-winged gull (0.0034) (Table 4-91) are also below the ADEC ecological criterion, and indicate that no adverse effects on representative receptors are anticipated.

Due to the proximity of Sites 28 and 29, ecological hazards were also estimated for a combined Site 28 and 29. Ecological HQ estimates for combined exposure to Sites 28 and 29 are presented in Table 4-91, and are tundra vole (14), cross fox (1.4), and glaucous-winged gull (0.37). Maximum HQ estimates for the tundra vole and cross fox were attributable to DRO in Site 28 soil and plants. Estimated HQ values in excess of 1.0 were also calculated for the tundra vole exposed to barium, zinc and Aroclor-1254. Maximum HQ estimates for barium, zinc and Aroclor-1254 in the tundra vole were attributable to concentrations of these chemicals measured in plant tissue samples collected from Site 28. The conclusions for these combined hazard estimates are virtually the same as those described in Section 4.15.2.2 for Site 28.

4.17 SITE 31 – WHITE ALICE COMMUNICATIONS SITE

Site 31 was located at the base of Mt. Kangukhsam (Figure 1-3). The site consisted of an array of four antennae, the Main Electronics Center (Building 1001), the Automobile Maintenance Shop (Building 1055), a storage shed, and seven ASTs (six outside and one inside Building 1001). An ephemeral stream called the East Tributary drains from Sites 31 and 32 to the Suqitughneq River.

The ASTs and transformers from the pad at the Main Electronics Center are possible sources of fuel and PCB contamination at Site 31. Contamination has also been detected at an outfall pipe just north of the antennae. Site structures (e.g., buildings) were inspected for ACM. At Site 31, ACM and/or suspected ACM was observed in buildings and surrounding areas (MW, 2000a).

Signs warning of the presence of asbestos and its potential hazards were posted at all viable entrances to buildings suspected to contain friable asbestos. Painted surfaces are assumed to be lead-based paint, based on sampling performed at other sites (MW, 2000a). The seven ASTs present at the site were found to be empty. All structures and debris were removed from the site during 2001 through 2003 BD/DR activities.

Environmental sampling activities for Site 31 included the collection of soil and ephemeral surface water samples (Table 3-1). Chemicals detected in soil include VOCs, Aroclor-1260, DRO, and RRO. Chemicals detected in ephemeral surface water include metals (Table 2-1). All chemicals detected in site media were evaluated in Tier I human health and ecological screening assessments.

4.17.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 31 is presented in Table 4-92.

Site 31 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust). Consistent with the generalized exposure assessment presented in Section 3.1.2.1, exposure pathways for ephemeral surface water were judged to be incomplete.

Potential future land use at Site 31 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor.

4.17.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil in accordance with methods described in Section 3.1.1. Soil COPCs identified for Site 31 include xylenes, Aroclor-1260, DRO and RRO (Table 4-93).

Tier I human health COPCs for Site 31 soil were further evaluated in a Tier II baseline HHRA.

4.17.1.2 Tier II Baseline HHRA Results

Carcinogenic risk estimates for future seasonal residents and future permanent residents exposed to Site 31 soils exceed ADEC's point of departure criterion for carcinogenic risk of 1E-5 (Table 4-94). This exceedance is attributable to the presence of Aroclor-1260 in soil. The maximum concentration of Aroclor-1260 detected in Site 31 soil was 22 mg/kg. Noncarcinogenic HI estimates for future seasonal residents and future permanent residents also exceeded the ADEC point of departure criterion of 1.0 (Table 4-95). Exceedence of the HI criterion was attributable to the presence of Aroclor-1260 and DRO in soil. The maximum detected concentration of DRO in soil was 11,000 mg/kg. Carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors are below ADEC's point of departure criteria.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-94). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal residents and future permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-95) regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative carcinogenic risk and noncarcinogenic HI estimates for current and future site visitors who obtain potable water from the Suqitughneq River (HI_1 and HI_2) are below the ADEC point of departure criteria (Tables 4-94 and 4-95). A future scenario based on use of shallow subsurface water as a potable supply (HI_3 and HI_4) was not evaluated because shallow subsurface water is not present at this site.

4.17.2 Ecological Conceptual Model and Risk Analysis

Site 31 is located in an upland area at the base of Mt. Kangukhsam. Vegetation is sparse, and the dominant plant species include low grasses, lichens, and mosses. The area is occasionally grazed by reindeer. Wildlife anticipated to forage at the site on a more limited basis include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals. An ephemeral stream called the East Tributary drains from Sites 31 and 32 to the Suqitughneq River. The East Tributary is a narrow, high velocity stream and the bed is comprised primarily of rock and cobbles.

Potential exposure media include soil, ephemeral surface water, and dietary items. Primary exposure pathways between ecological indicator receptors and site contaminants are shown in Table 4-96.

4.17.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil and ephemeral surface water in accordance with methods described in Section 3.2.1. Tier I COPECs identifed for soil included Aroclor-1260, DRO, and RRO. Tier I COPECs identified for surface water were barium and manganese. The results of Tier I ecological screening are summarized in Table 4-97, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 31 soil and ephemeral surface water were further evaluated in a Tier II baseline ERA.

4.17.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to soil and surface water at Site 31 is 1.2 (Table 4-98). The maximum HQ estimate was attributable to the presence of DRO in site soil. This HQ estimate exceeds the ADEC ecological criterion of 1.0, and suggests that there is a limited potential for adverse effects in representative receptors.

The maximum HQ estimates for the cross fox (0.0085) and glaucous-winged gull (0.000056) (Table 4-98) are below the the ADEC ecological criterion of 1.0, and indicate that no adverse effects on representative receptors are anticipated.

4.18 SITE 32 – LOWER TRAM TERMINAL

The Lower Tram Terminal was located south of Site 31 at the northern base of Mt. Kangukhsam (Figure 1-3). The site consisted of a Tram Terminal Building, Substation Transformer Bank No. 2, three ASTs (two inside and one outside the Tram Terminal Building), a water well, and an anchor pit. The East Tributary drains from Sites 31 and 32 to the Suqitughneq River.

The presence of ACM and/or suspected ACM was observed in buildings and surrounding areas at Site 32 (MW, 2000a, b). Signs warning of the presence of asbestos and its potential hazards were posted at all viable entrances to buildings suspected to contain friable asbestos. Painted surfaces are assumed to be lead-based paint, based on sampling performed at other sites (MW, 2000a, b). MWH personnel prepared an inventory of ASTs, USTs, and their contents. The three ASTs identified at Site 31 were found to be empty. All structures and debris were removed from the site during 2001 through 2003 BD/DR activities, except for the Tram towers on the side on the mountain.

Environmental sampling activities for Site 32 included the collection of soil samples (Table 3-1). Chemicals detected in soil include Aroclor-1260, DRO, and RRO (Table 2-1). All chemicals detected in site soil were evaluated in Tier I human health and ecological screening assessments.

4.18.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 32 is presented in Table 4-99.

Site 32 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust).

Potential future land use at Site 32 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents, and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor.

4.18.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil in accordance with methods described in Section 3.1.1. Soil COPCs identified for Site 32 include DRO and RRO (Table 4-100).

Tier I human health COPCs for Site 32 soil were further evaluated in a Tier II baseline HHRA.

4.18.1.2 Tier II Baseline HHRA Results

Based on results of the Tier I screening HHRA, no carcinogenic COPCs were identified in site-specific medium (i.e., soil). Therefore, carcinogenic risk estimates were not calculated for soil at Site 32 (Table 4-101). Noncarcinogenic HI estimates for Site 32 soils were below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 for all receptors, with the exception of the future permanent resident (Table 4-102). A noncarcinogenic HI of 3.0 was estimated for the future permanent resident exposed to soil. This HI estimate was attributable to DRO in soil. The maximum detected concentration of DRO in Site 32 soil is 13,000 mg/kg.

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-101). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-102), regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative noncarcinogenic HI estimates for current and future site visitors who obtain potable water from the Suqitughneq River (HI_1 and HI_2) are below the ADEC point of departure criterion (Table 4-102). A future scenario based on use of shallow subsurface water as a potable supply (HI_3 and HI_4) was not evaluated because shallow subsurface water is not present at Site 32.

4.18.2 Ecological Conceptual Model and Risk Analysis

Site 32 is located in an upland area at the northern base of Mt. Kangukhsam. Vegetation is sparse, and the dominant plant species include low grasses, lichens, and mosses. Reindeer occasionally graze in the vicinity of Site 32. Other wildlife anticipated to forage at the site on a more limited basis include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals. An ephemeral stream called the East Tributary drains from Sites 31 and 32 to the Suqitughneq River. The East Tributary is a narrow, high velocity stream and the bed is comprised primarily of rock and cobbles.

Potential exposure media include soil, ephemeral surface water, and dietary items. Primary exposure pathways between ecological indicator receptors and site contaminants are presented in Table 4-103.

4.18.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil in accordance with methods described in Section 3.2.1. Surface water associated with the East Tributary was evaluated as part of the ERA for Site 31. Tier I COPECs identifed for soil include Aroclor-1260, DRO and RRO. The results of Tier I ecological screening are summarized in Table 4-104, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 32 soil were further evaluated in a Tier II baseline ERA.

4.18.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to soil at Site 32 is 1.9 (Table 4-105). The maximum HQ estimate was attributable to the presence of DRO in site soil. This HQ estimate exceeds the ADEC ecological criterion of 1.0, and suggests that there is a limited potential for adverse effects in representative receptors.

The maximum HQ estimates for the cross fox (0.0051) and glaucous-winged gull (0.000034) (Table 4-105) are below the ADEC ecological criterion of 1.0, and indicate that no adverse effects on representative receptors are anticipated.

4.19 SITE 33 – UPPER TRAM TERMINAL

A tramway links the Lower Tram Terminal Building to the Upper Tram Building, which is located on top of Mt. Kangukhsam (Figure 1-3). Site 33 consists of a Tram Terminal Building connected to the Upper Camp by an Enclosed Track Man-lift. Potential sources of environmental contamination at this site include the Tram cables, which dripped lubricant onto the ground below the cables.

The presence of ACM and/or suspected ACM was observed in buildings and surrounding areas (MW, 2000a). Signs warning of the presence of asbestos and its potential hazards were posted at all viable entrances to buildings suspected to contain friable asbestos. Painted surfaces are assumed to be lead-based paint, based on sampling performed at other sites (MW, 2000a). No ASTs or USTs were present at this site. All structures and debris were removed from the site during 2001 through 2003 BD/DR activities, except for the Tram towers on the side on the mountain.

Environmental sampling activities for Site 33 included the collection of soil samples (Table 3-1). Chemicals detected in soil include DRO and RRO (Table 2-1). Chemicals detected in site soil were evaluated in Tier I human health and ecological screening assessments.

4.19.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 33 is presented in Table 4-106.

Site 33 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust).

Potential future land use at Site 33 could include the establishment of a seasonal or permanent residence. Therefore, potential future human receptors include seasonal residents, permanent residents and site visitors. Potential soil exposure pathways for future receptors are the same as those described above for the current site visitor.

4.19.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil in accordance with methods described in Section 3.1.1. Soil COPCs identified for Site 33 include DRO and RRO (Table 4-107).

Tier I human health COPCs for Site 33 soil were further evaluated in a Tier II baseline HHRA.

4.19.1.2 Tier II Baseline HHRA Results

Based on results of the Tier I screening HHRA, no carcinogenic COPCs were identified in soil. Therefore, carcinogenic risk estimates were not calculated for soil at Site 33 (Table 4-108). Noncarcinogenic HI estimates for Site 33 soils were below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 for all receptors (Table 4-109).

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as subsistence food sources and potable water sources from several different locations at, or in the vicinity of, the Northeast Cape Installation (refer to Section 4.1.1.2). Cumulative carcinogenic risk estimates for future seasonal and permanent residents exceed ADEC's point of departure criterion for risk management of 1E-5 (Table 4-108). Exceedance of the risk management criterion occurs whether or not subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Similarly, cumulative noncarcinogenic HI estimates for future seasonal and permanent residents exceed the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-109), regardless of whether subsistence plants and fish are collected from impacted areas (i.e., Sites 28 and 29) or ambient locations (Site 30). Potential implications of the source of potable water or subsistence food items on risks to future receptors are discussed further in Section 5.3.

Total cumulative noncarcinogenic HI estimates for current and future site visitors who obtain potable water from the Suqitughneq River (HI_1 and HI_2) are below the ADEC point of departure criterion (Table 4-109). A future scenario based on use of shallow subsurface water as a potable supply (HI_3 and HI_4) was not evaluated because shallow subsurface water is not present at Site 33.

4.19.2 Ecological Conceptual Model and Risk Analysis

Site 33 is located near the top of Mt. Kangukhsam. Vegetation is sparse, and the dominant plant species include low grasses, lichens, and mosses. The area is occasionally grazed by reindeer. Wildlife anticipated to forage at the site on a more limited basis include herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals.

Potential exposure media include soil and dietary items. Primary exposure pathways between ecological indicator receptors and site contaminants are shown in Table 4-110.

4.19.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil in accordance with methods described in Section 3.2.1. Tier I COPECs identifed for soil are DRO and RRO. The results of Tier I ecological screening are summarized in Table 4-111, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 33 soil were further evaluated in a Tier II baseline ERA.

4.19.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to soil at Site 33 is 0.11 (Table 4-112). The maximum HQ estimate was attributable to the presence of DRO in site soil. This HQ estimate is below the ADEC ecological criterion of 1.0, and suggests that adverse effects in representative receptors are not anticipated.

The maximum HQ estimates for the cross fox (0.00081) and glaucous-winged gull (0.0000019) (Table 4-112) are also below the ADEC ecological criterion of 1.0, and indicate that no adverse effects on representative receptors are anticipated.

4.20 SITE 34 – UPPER CAMP

Site 34 was located at the top of Mt. Kangukhsam (Figure 1-3). Upper Camp structures were connected to the Upper Tram Terminal Building by an Enclosed Track Man-lift and consisted of a Substation Transformer Pad, one fuel AST, one water AST (10,000 gallons), a Radome (Building 221), and the Upper Quarters Building (Building 124).

Site structures (e.g., buildings) were inspected for ACM. At this site, ACM and/or suspected ACM was observed in buildings and surrounding areas (MW, 2000a). Signs warning of the presence of asbestos and its potential hazards were posted at all viable entrances to buildings suspected to contain friable asbestos. Painted surfaces are assumed to be lead-based paint, based on sampling performed at other sites (MW, 2000a). MWH personnel prepared an inventory of ASTs, USTs and their tank contents. At this site, two ASTs were identified and found to be empty. The potential sources of environmental contamination at this site are the AST and transformers. All structures and debris were removed from the site during 2001 through 2003 BD/DR activities.

Environmental sampling activities for Site 34 included the collection of soil samples (Table 3-1). Chemicals detected in soil include PCBs (Aroclor-1254 and Aroclor-1260), DRO, and RRO (Table 2-1). All chemicals detected in site soil were evaluated in Tier I human health and ecological screening assessments.

4.20.1 Human Health Conceptual Model and Risk Analysis

A summary of contaminant sources, environmental media sampled, and exposure pathways evaluated for Site 34 is presented in Table 4-113.

Site 34 is currently uninhabited. Current human receptors of concern include site visitors. Potential exposure pathways for current site visitors are limited to direct contact pathways for soil (i.e., incidental ingestion of soil, dermal contact with soil, and inhalation of soil in the form of indoor dust).

Site 34 is situated in high mountainous terrain with severe winds. It is highly unlikely that either a seasonal or permanent residence would ever be constructed at this location. Therefore, this site was not evaluated for a future residential scenario and potential future human receptors at Site 34 are limited to site visitors. Potential soil exposure pathways for future site visitors are the same as those described above for the current site visitor.

4.20.1.1 Tier I Human Health Screening Results

Tier I human health screening was conducted for soil in accordance with methods described in Section 3.1.1. Soil COPCs identified for Site 34 were DRO and RRO (Table 4-114).

Tier I human health COPCs for Site 34 soil were further evaluated in a Tier II baseline HHRA.

4.20.1.2 Tier II Baseline HHRA Results

Based on results of the Tier I screening HHRA, no carcinogenic COPCs were identified in site-specific medium (i.e., soil). Therefore, carcinogenic risk estimates were not calculated for soil at Site 33 (Table 4-115). As described in Section 4.20.1, it is highly unlikely that either a seasonal or permanent residence would ever be constructed at this location. Therefore, this site was not evaluated for a future residential scenario. Noncarcinogenic HI estimates for current and future site visitors are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-116).

Cumulative carcinogenic risk and noncarcinogenic HI estimates were derived based on the assumption that current and future receptors may be exposed to site-specific media, as well as potable water from an off-site source (refer to Section 4.1.1.2). For Site 34, the off-site source was assumed to be the Suqitughneq River. Cumulative carcinogenic risk estimates for current and future site visitors were not calculated, because no carcinogenic COPCs were identified for Site 34 soils or surface water samples collected from the Suqitughneq River. Cumulative noncarcinogenic HI estimates based on exposure to site soils and potable water obtained from the Suqitughneq River are below the ADEC point of departure criterion for noncarcinogenic hazards of 1.0 (Table 4-116). Potential implications of the source of potable water on risks to future receptors are discussed further in Section 5.3.

4.20.2 Ecological Conceptual Model and Risk Analysis

Site 34 is located at the top of Mt. Kangukhsam. The area is rocky, windy, and the sparse vegetation present is dominated by lichens and mosses. Reindeer are not known to graze in the vicinity of Site 34. Other wildlife may possibly forage at the site on a limited basis, including herbivorous and omnivorous small mammals, herbivorous and omnivorous birds, and carnivorous mammals.

Potential exposure media include soil and dietary items. Primary exposure pathways between ecological indicator receptors and site contaminants are presented in Table 4-117.

4.20.2.1 Tier I Ecological Screening Results

Tier I ecological screening was conducted for soil in accordance with methods described in Section 3.2.1. Tier I COPECs identifed for soil include PCBs (Aroclor-1254 and Aroclor-1260), DRO and RRO. The results of Tier I ecological screening are summarized in Table 4-118, and detailed Tier I ecological screening tables are presented in Appendix G.

Tier I COPECs for Site 34 soil were further evaluated in a Tier II baseline ERA.

4.20.2.2 Tier II Baseline ERA Results

The maximum HQ estimated for the tundra vole exposed to soil at Site 34 is 0.16 (Table 4-119). The maximum HQ estimate was attributable to the presence of DRO in site soil. This HQ estimate is below the ADEC ecological criterion of 1.0, and suggests that no adverse effects on representative receptors are anticipated.

The maximum HQ estimate for the cross fox (0.0016) and glaucous-winged gull (0.000011) (Table 4-119) are also below the ADEC ecological criterion of 1.0, and indicate that no adverse effects on representative receptors are anticipated.

Due to the proximity of Sites 33 and 34, ecological hazards were also estimated for a combined Site 33 and 34. Ecological estimates for combined exposure to Sites 33 and 34 are shown in Table 4-119, and are tundra vole (0.16), cross fox (0.0036), and glaucous-winged gull

(0.000014). The conclusions for these combined hazard estimates are virtually the same as those described above for Site 34.

TABLE 4-1

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 3 - Fuel Line Corridor and Pumphouse
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	**Media sampled**	**Number of samples**[b]	**Chemicals analyzed for**	**Current Seasonal Resident**	**Future Seasonal Resident**	**Future Permanent Resident**	**Current Incidental Visitor**	**Future Incidental Visitor**
ASTs, pumphouse, fuel line, lead-acid battery, paint, ACM, LBP	Soil Gravel (COPCs except PHCs)	1 - 7	Inorganics, VOCs, PCBs, PAHs, SVOCs,	Inc [c]	Complete	Complete	Complete	Complete
	Soil Gravel (PHCs)	3 - 6	PHCs (DRO, GRO, RRO, TRPH)	Inc [c]	Complete	Complete	Complete	Complete
	Shallow Subsurface Water	1 to 4	PAHs, PHCs (DRO, RRO)	Inc [c,d]	Complete	Complete	Inc [d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

ACM - Asbestos-containing materials
AST - Above ground storage tank
COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
LBP - Lead-based paint
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-2
HUMAN HEALTH COPCs
Site 3 - Fuel Line Corridor and Pumphouse
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
Inorganics	**Petroleum Hydrocarbons**
Lead	Diesel Range Organics (DRO)
	Residual Range Organics (RRO)
VOCs	
Methylene chloride	
PAHs	
Naphthalene	
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	

Notes:
COPC - Chemical of Potential Concern
PAH - Polynuclear Aromatic Hydrocarbons
VOC - Volatile Organic Compounds

Table 4-3
Human Health Carcinogenic Risk Estimates
Site 3 - Fuel Line Corridor and Pumphouse
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate			
		Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		3E-11	8E-11	7E-13	7E-13
Shallow Groundwater, COPCs except PHCs		na[e]	na[e]	na[f]	na[e]
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[g,h]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	7E-13	7E-13
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[g,i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	7E-13	7E-13
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[h]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	na[f]	7E-13
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[f]	7E-13

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable, No detected carcinogenic COPCs found in this medium.
[f] Not applicable; Current Site Visitors are not exposed to this medium.
[g] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

Table 4-3
Human Health Carcinogenic Risk Estimates
Site 3 - Fuel Line Corridor and Pumphouse
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[i] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Site: 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-4
Human Health Noncarcinogenic Hazard Estimates
Site 3 - Fuel Line Corridor and Pumphouse
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		0.013	0.039	0.00020	0.00020
Soil, PHCs		0.17	0.51	0.0013	0.0013
Shallow Groundwater, COPCs except PHCs		na[e]	na[e]	na[f]	na[e]
Shallow Groundwater, PHCs		**3.1** (DRO)	**12** (DRO)	na[f]	0.40
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30[g]** (As, Cd, V, PCB)	**30[g]** (As, Cd, V, PCB)	0.039	0.039
	PHCs:	0.34	0.67	0.013	0.013
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[g]** (As, Ba, Cd, PCB)	**55[g]** (As, Ba, Cd, PCB)	0.012	0.012
	PHCs:	0.34	0.67	0.013	0.013
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30[g]** (As, Cd, V, PCB)	**30[g]** (As, Cd, V, PCB)	na[f]	0.00020
	PHCs:	**3.3** (DRO)	**13** (DRO)	na[f]	0.40
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[g]** (As, Ba, Cd, PCB)	**55[g]** (As, Ba, Cd, PCB)	na[f]	0.00020
	PHCs:	**3.3** (DRO)	**13** (DRO)	na[f]	0.44

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gatherinç
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.

Table 4-4
Human Health Noncarcinogenic Hazard Estimates
Site 3 - Fuel Line Corridor and Pumphouse
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[e] Only Petroelum Hydrocarbons detected in this media.

[f] Not applicable; Current Site Visitors are not exposed to this medium.

[g] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-5

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 3 - Fuel Line Corridor and Pumphouse
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
ASTs, pumphouse, fuel line, lead-acid battery, paint, ACM, LBP	Soil Gravel (COPCs except PHCs)	1 - 7	Inorganics, VOCs, PCBs, PAHs, SVOCs,	Complete	Complete	Complete
	Soil Gravel (PHCs)	3 - 6	PHCs (DRO, GRO, RRO, TRPH)	Complete	Complete	Complete
	Shallow Subsurface Water	1 to 4	PAHs, PHCs (DRO, RRO)	Complete	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

ACM - Asbestos-containing materials
AST - Above ground storage tank
COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
LBP - Lead-based paint
PAH - Polynuclear aromatic hydrocarbons
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-6
ECOLOGICAL COPECs
Site 3 - Fuel Line Corridor and Pumphouse
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern	
Soil	**Subsurface Water**
Inorganics	**VOCs**
Lead	Xylenes
PCBs	**Petroleum Hydrocarbons**
PCB-1260 (Aroclor 1260)	Diesel Range Organics (DRO)
	Residual Range Organics (RRO)
PAHs	
Anthracene	
Naphthalene	
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	

Notes:
COPEC - Chemical of Potential Ecological Concern
PCB - Polychlorinated Biphenyls
PAH - Polynuclear Aromatic Hydrocarbons
VOC - Volatile Organic Compounds

TABLE 4-7

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 3 - Fuel Line Corridor and Pumphouse
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Diesel Range Organics, Aliphatic	0.38	0.0014	0.0000090

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .

TABLE 4-8

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 4 - Subsistence Fish and Hunting Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor
Abandoned vehicles, abandoned drums	Soil Tundra (COPCs except PHCs)	2 - 3	Inorganics, VOCs,	Inc[c]	Complete	Complete	Complete	Complete
	Soil Tundra (PHCs)	3	PHCs (DRO, GRO, TRPH)	Inc[c]	Complete	Complete	Complete	Complete
	Soil Gravel (COPCs except PHCs)	1	VOCs, PAHs	Inc[c]	Complete	Complete	Complete	Complete
	Soil Gravel (PHCs)	1	PHCs (DRO, GRO, RRO)	Inc[c]	Complete	Complete	Complete	Complete
	Shallow Subsurface Water	1 - 4	VOCs, PAHs, PHCs (DRO, GRO)	Inc[c,d]	Complete	Complete	Inc[d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
TRPH - Total residual petroleum hydrocarbons

TABLE 4-8

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 4 - Subsistence Fish and Hunting Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor

VOC - Volatile organic compounds

TABLE 4-9
HUMAN HEALTH COPCs
Site 4 - Subsistence Fishing and Hunting Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
Inorganics	**Petroleum Hydrocarbons**
Lead	Diesel Range Organics (DRO)
	Residual Range Organics (RRO)
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Residual Range Organics (RRO)	

Notes:
COPC - Chemical of Potential Concern

Table 4-10
Human Health Carcinogenic Risk Estimates
Site 4 - Subsistence Fish and Hunting Camp
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate: Current Seasonal Resident[a]	Future Seasonal Resident[b]	Future Permanent Resident[c]	Current Site Visitor[d]	Future Site Visitor[e]
Soil, COPCs except PHCs		na[f]	na[f]	na[f]	na[f]	na[f]
Shallow Groundwater, COPCs except PHCs		na[f]	na[f]	na[f]	na[g]	na[f]
Cumulative ILCR$_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[h,i]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	na[f]	na[f]
Cumulative ILCR$_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[h,j]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[f]	na[f]
Cumulative ILCR$_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Ambient Locations.[i]	**COPCs except PHCs:**	na[g]	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	na[g]	na[f]
Cumulative ILCR$_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[j]	**COPCs except PHCs:**	na[g]	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[g]	na[f]

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A current seasonal resident resides at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[c] A Future Permanent Resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[d] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[e] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[f] No detected carcinogenic COPCs found in this medium.
[g] Not applicable, current seasonal residents or site visitors not exposed to this medium.
[h] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[i] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.
[j] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-11
Human Health Noncarcinogenic Hazard Estimates
Site 4 - Subsistence Fish and Hunting Camp
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Current Seasonal Resident[a]	Future Seasonal Resident[b]	Future Permanent Resident[c]	Current Site Visitor[d]	Future Site Visitor[e]
Soil, COPCs except PHCs		na[f]	na[f]	na[f]	na[f]	na[f]
Soil, PHCs		0.48	0.48	**1.4** (DRO)	0.0037	0.0037
Shallow Groundwater, except PHCs		na[g]	na[f]	na[f]	na[f,g]	na[f]
Shallow Groundwater, PHCs		na[g]	**1.2** (DRO)	**3.0** (DRO)	na[f,g]	0.17
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30**[h] (As, Cd, V, PCB)	**30**[h] (As, Cd, V, PCB)	**30**[h] (As, Cd, V, PCB)	0.0050	0.0050
	PHCs:	0.64	0.64	1.6 (DRO)	0.016	0.016
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55**[h] (As, Ba, Cd, PCB)	**55**[h] (As, Ba, Cd, PCB)	**55**[h] (As, Ba, Cd, PCB)	0.0050	0.0050
	PHCs:	0.64	0.64	1.6 (DRO)	0.016	0.016
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	na[g]	**30**[h] (As, Cd, V, PCB)	**30**[h] (As, Cd, V, PCB)	na[f,g]	na[f]
	PHCs:	na[g]	**1.7** (DRO)	**4.5** (DRO)	na[f,g]	0.17
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	na[g]	**55**[h] (As, Ba, Cd, PCB)	**55**[h] (As, Ba, Cd, PCB)	na[f,g]	na[f]
	PHCs:	na[g]	**1.7** (DRO)	**4.5** (DRO)	na[f,g]	0.17

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

Table 4-11
Human Health Noncarcinogenic Hazard Estimates
Site 4 - Subsistence Fish and Hunting Camp
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate				
Exposure Media/Constituents	**Current Seasonal Resident[a]**	**Future Seasonal Resident[b]**	**Future Permanent Resident[c]**	**Current Site Visitor[d]**	**Future Site Visitor[e]**
V- Vanadium					

[a] A current seasonal resident resides at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence
[c] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[f] Only Petroelum Hydrocarbons detected in this media.
[g] Not applicable; Subsurface water is not consumed by current receptors.
[h] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-12

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 4 - Subsistence Fish and Hunting Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
Abandoned vehicles, abandoned drums	Soil Tundra (COPCs except PHCs)	2 - 3	Inorganics, VOCs,	Complete	Complete	Complete
	Soil Tundra (PHCs)	3	PHCs (DRO, GRO, TRPH)	Complete	Complete	Complete
	Soil Gravel (COPCs except PHCs)	1	VOCs, PAHs	Complete	Complete	Complete
	Soil Gravel (PHCs)	1	PHCs (DRO, GRO, RRO)	Complete	Complete	Complete
	Shallow Subsurface Water	1 - 4	VOCs, PAHs, PHCs (DRO, GRO)	Complete	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-13
ECOLOGICAL COPECs
Site 4 - Subsistance Fishing and Hunting Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern	
Soil	**Subsurface Water**
PAHs	**VOCs**
Anthracene	Xylenes
Chrysene	
Fluorene	**Petroleum Hydrocarbons**
	Diesel Range Organics (DRO)
Petroleum Hydrocarbons	Residual Range Organics (RRO)
Diesel Range Organics (DRO)	
Residual Range Organics (RRO)	

Notes:
COPEC - Chemical of Potential Ecological Concern
PAH - Polynuclear Aromatic Hydrocarbons
VOC - Volatile Organic Compounds

TABLE 4-14

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 4 - Subsistence Fishing and Hunting Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole**[a] *Microtus oeconomus*	**Cross Fox**[a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Diesel Range Organics, Aliphatic	0.79	0.0079	0.000052
Sites 3 & 4 Combined Diesel Range Organics, Aliphatic	0.79	0.011	0.000071

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .

TABLE 4-15

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 6 - Cargo Beach Drum Field
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	**Media sampled**	**Number of samples[b]**	**Chemicals analyzed for**	**Current Seasonal Resident**	**Future Seasonal Resident**	**Future Permanent Resident**	**Current Incidental Visitor**	**Future Incidental Visitor**
1,500 POL drums, battery	Soil Tundra (COPCs except PHCs)	1 - 5	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc [c]	Complete	Complete	Complete	Complete
	Soil Tundra (PHCs)	1 - 4	PHCs (DRO, GRO, RRO, TRPH)	Inc [c]	Complete	Complete	Complete	Complete
	Soil Gravel (COPCs except PHCs)	1 - 9	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc [c]	Complete	Complete	Complete	Complete
	Soil Gravel (PHCs)	5 - 13	PHCs (DRO, GRO, RRO, TRPH)	Inc [c]	Complete	Complete	Complete	Complete
	Ephemeral Surface Water	1 - 3	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Inc [c,e]	Inc[e]	Inc[e]	Inc[e]	Inc[e]
	Shallow Subsurface Water	1 - 4	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Inc [c,d]	Inc [d]	Inc [d]	Inc [d]	Inc [d]

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

[e] Ephemeral surface water results were not included in the evaluation as potable water sources.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete

TABLE 4-15

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 6 - Cargo Beach Drum Field
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor

PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
POL - Petroleum, oil and lubricants
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-16
HUMAN HEALTH COPCs
SITE 6 - Cargo Beach Road Drumfield
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern
Soil
Inorganics
Aluminum
Beryllium
Cobalt
Manganese
VOCs
Methylene chloride
m,p-Xylene
o-Xylene
Petroleum Hydrocarbons
Diesel Range Organics (DRO)
Residual Range Organics (RRO)

Notes:
COPC - Chemical of Potential Concern
VOC - Volatile Organic Compounds

Table 4-17
Human Health Carcinogenic Risk Estimates
Site 6 - Cargo Beach Drum Field
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		2E-09	6E-09	2E-10	2E-10
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[e,f]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	2E-10	2E-10
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[e,g]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	2E-10	2E-10

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[f] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.
[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-18
Human Health Noncarcinogenic Hazard Estimates
Site 6 - Cargo Beach Drum Field
Northeast Cape, St. Lawrence Island, Alaska

		Noncancer Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**
Soil, COPCs except PHCs		0.047	0.14	0.00051	0.00051
Soil, PHCs		**7.0** (DRO)	**21** (DRO)	0.055	0.055
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30[e]** (As, Cd, V, PCB)	**31[e]** (As, Cd, V, PCB)	0.0055	0.0055
	PHCs:	**7.2** (DRO)	**21** (DRO)	0.067	0.067
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[e]** (As, Ba, Cd, PCB)	**55[e]** (As, Ba, Cd, PCB)	0.0055	0.0055
	PHCs:	**7.2** (DRO)	**21** (DRO)	0.067	0.067

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-19

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 6 - Cargo Beach Drum Field
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
1,500 POL drums, battery	Soil Tundra (COPCs except PHCs)	1 - 5	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Complete	Complete	Complete
	Soil Tundra (PHCs)	1 - 5	PHCs (DRO, GRO, RRO, TRPH)	Complete	Complete	Complete
	Soil Gravel (COPCs except PHCs)	1 - 9	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Complete	Complete	Complete
	Soil Gravel (PHCs)	5 - 13	PHCs (DRO, GRO, RRO, TRPH)	Complete	Complete	Complete
	Ephemeral Surface Water	1 - 3	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Complete	Complete	Complete
	Shallow Subsurface Water	1 - 4	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Inc[d]	Inc[d]	Inc[d]

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[d] Subsurface water exposure pathways are incomplete for all ecological receptors.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls

TABLE 4-19

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 6 - Cargo Beach Drum Field
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Receptor: Tundra Vole [c]	Receptor: Cross Fox [c]	Receptor: Glaucous-winged Gull

PHCs - Petroleum hydrocarbons
POL - Petroleum oil lubricants
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-20
ECOLOGICAL COPECs
Site 6 - Cargo Beach Road Drum Field
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern	
Soil	**Surface Water**
Inorganics	**Petroleum Hydrocarbons**
Aluminum	Diesel Range Organics (DRO)
Manganese	
Zinc	
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Residual Range Organics (RRO)	

Notes:
COPEC - Chemical of Potential Ecological Concern

TABLE 4-21

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 6 - Cargo Beach Road Drum Field
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Aluminum	**15**	0.20	0.0000000039
Diesel Range Organics, Aliphatic	**15**	0.071	0.00047
Diesel Range Organics, Aromatic	**7.6**	0.035	0.00023

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .

TABLE 4-22

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 7 - Cargo Beach Road Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	**Media sampled**	**Number of samples[b]**	**Chemicals analyzed for**	**Current Seasonal Resident**	**Future Seasonal Resident**	**Future Permanent Resident**	**Current Incidental Visitor**	**Future Incidental Visitor**
Drums, batteries and other materials in the landfill	Soil Tundra (COPCs except PHCs)	5 - 22	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Complete	Complete	Complete
	Soil Tundra (PHCs)	14 - 24	PHCs (DRO, GRO, RRO, TRPH)	Inc[c]	Complete	Complete	Complete	Complete
	Ephemeral Surface Water	2 - 5	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Inc[c,e]	Inc[e]	Inc[e]	Inc[e]	Inc[e]
	Shallow Subsurface Water	1 - 5	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Inc[c,d]	Complete	Complete	Inc[d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

[e] Ephemeral surface water results were not included in the evaluation as potable water sources.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds

TABLE 4-22

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 7 - Cargo Beach Road Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor

TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-23
HUMAN HEALTH COPCs
SITE 7 - Cargo Beach Road Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
Inorganics	**Inorganics**
Aluminum	Aluminum
Arsenic	Barium
Cadmium	Cobalt
Chromium	Lead
Cobalt	Manganese
Lead	Nickel
Manganese	Zinc
Mercury	
Nickel	**VOCs**
Thallium	Benzene
VOCs	**Dioxins & Furans**
1,1,1-Trichloroethane	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin
Acetone	
Bromoethane	**Petroleum Hydrocarbons**
m,p-Xylene	Diesel Range Organics (DRO)
Methylene chloride	Residual Range Organics (RRO)
SVOCs	
4-Methylphenol (p-Cresol)	
Polycholinated Biphenyls	
PCB-1260 (Aroclor 1260)	
Dioxins & Furans	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	
1,2,3,4,7,8,9-Heptachlorodibenzofuran	
1,2,3,4,7,8-Hexachlorodibenzofuran	
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	
1,2,3,6,7,8-Hexachlorodibenzofuran	
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	
1,2,3,7,8,9-Hexachlorodibenzofuran	
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	
1,2,3,7,8-Pentachlorodibenzofuran	
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	
2,3,4,6,7,8-Hexachlorodibenzofuran	
2,3,4,7,8-Pentachlorodibenzofuran	
2,3,7,8-Tetrachlorodibenzofuran	
Total Heptachlorodibenzofurans (HpCDF)	
Total Heptachlorodibenzo-p-dioxins (HpCDD)	
Total Hexachlorodibenzofurans (HxCDF)	
Total Hexachlorodibenzo-p-dioxins (HxCDD)	

TABLE 4-23
HUMAN HEALTH COPCs
SITE 7 - Cargo Beach Road Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
Total Pentachlorodibenzofurans (PeCDF)	
Total Tetrachlorodibenzofurans (TCDF)	
Total Tetrachlorodibenzo-p-dioxins (TCDD)	
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Residual Range Organics (RRO)	

Notes:
COPC - Chemical of Potential Concern
PCB - Polychlorinated Biphenyls
SVOC - Semivolatile Organic Compounds
VOC- Volatile Organic Compounds

Table 4-24
Human Health Carcinogenic Risk Estimates
Site 7 - Cargo Beach Road Landfill
Northeast Cape, St. Lawrence Island, Alaska

		Carcinogenic Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident**[a]	**Future Permanent Resident**[b]	**Current Site Visitor**[c]	**Future Site Visitor**[d]
Soil, COPCs except PHCs		**2E-05** (As)	**5E-05** (As)	5E-07	5E-07
Shallow Groundwater, COPCs except PHCs		1E-06	5E-06 (Benzene)	na[e]	**3E-06** (Benzene)
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	5E-07	5E-07
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	5E-07	5E-07
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (Benzene, As, PAHs, PCBs)	na[e]	**3E-06** (Benzene)
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (Benzene, As, PAHs, PCBs)	na[e]	**3E-06** (Benzene)

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.

[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.

[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.

[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.

[e] Not applicable; Current Site Visitors are not exposed to this medium.

[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.

[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-25
Human Health Noncarcinogenic Hazard Estimates
Site 7 - Cargo Beach Road Landfill
Northeast Cape, St. Lawrence Island, Alaska

		Noncancer Risk Estimate			
Exposure Media/Constituents		Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		0.79	**2.4** (PCBs)	0.010	0.010
Soil, PHCs		**2.2** (DRO)	**6.7** (DRO)	0.017	0.017
Shallow Groundwater, COPCs except PHCs		**3.5** (Ba, Ni)	**14** (Ba, Ni)	na[e]	0.46
Shallow Groundwater, PHCs		0.35	**1.4** (DRO, RRO)	na[e]	0.046
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**31**[f] (As, Cd, V, PCB)	**33**[f] (As, Cd, V, PCB)	0.015	0.015
	PHCs:	**2.4** (DRO)	**6.8** (DRO, RRO)	0.029	0.029
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**56**[f] (As, Ba, Cd, PCB)	**57**[f] (As, Ba, Cd, PCB)	0.015	0.015
	PHCs:	**2.4** (DRO)	**6.8** (DRO, RRO)	0.029	0.029
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**35**[f] (As, Ba, Cd, Ni, V, PCB)	**46**[f] (As, Ba, Cd, Ni, V, PCB)	na[e]	0.47
	PHCs:	**2.6** (DRO)	**8.1** (DRO, RRO)	na[e]	0.068
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**59**[f] (As, Ba, Cd, Ni, PCB)	**71**[f] (As, Ba, Cd, Ni, PCB)	na[e]	0.47
	PHCs:	**2.6** (DRO)	**8.1** (DRO, RRO)	na[e]	0.068

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

Table 4-25
Human Health Noncarcinogenic Hazard Estimates
Site 7 - Cargo Beach Road Landfill
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

Ni - Nickel
RRO - Residual Range Organics
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-26

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 7 - Cargo Beach Road Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
Drums, batteries and other materials in the landfill	Soil Tundra (COPCs except PHCs)	5 - 22	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Complete	Complete	Complete
	Soil Tundra (PHCs)	14 - 24	PHCs (DRO, GRO, RRO, TRPH)	Complete	Complete	Complete
	Ephemeral Surface Water	2 - 5	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Complete	Complete	Complete
	Shallow Subsurface Water	1 - 5	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Inc[d]	Inc[d]	Inc[d]

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[d] Subsurface water exposure pathways are incomplete for all ecological receptors.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons

TABLE 4-26

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 7 - Cargo Beach Road Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull

VOC - Volatile organic compounds

TABLE 4-27
ECOLOGICAL COPECs
Site 7 - Cargo Beach Road Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern	
Soil	**Surface Water**
Inorganics	**Inorganics**
Arsenic	Arsenic
Cadmium	Barium
Chromium	Chromium
Copper	Lead
Lead	Nickel
Mercury	Thallium
Nickel	Mercury, Dissolved
Silver	Thallium, Dissolved
VOCs	**Dioxins & Furans**
Bromomethane	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin
	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin
SVOCs	Total Heptachlorodibenzo-p-dioxins (HpCDD)
4-Methylphenol (p-Cresol)	
	Petroleum Hydrocarbons
PCBs	Diesel Range Organics (DRO)
PCB-1260 (Aroclor 1260)	
Dioxins & Furans	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	
1,2,3,4,7,8-Hexachlorodibenzofuran	
1,2,3,6,7,8-Hexachlorodibenzofuran	
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	
2,3,4,6,7,8-Hexachlorodibenzofuran	
2,3,4,7,8-Pentachlorodibenzofuran	
2,3,7,8-Tetrachlorodibenzofuran	
Total Heptachlorodibenzofurans (HpCDF)	
Total Heptachlorodibenzo-p-dioxins (HpCDD)	
Total Hexachlorodibenzofurans (HxCDF)	
Total Hexachlorodibenzo-p-dioxins (HxCDD)	
Total Pentachlorodibenzofurans (PeCDF)	
Total Tetrachlorodibenzofurans (TCDF)	
Total Tetrachlorodibenzo-p-dioxins (TCDD)	
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Residual Range Organics (RRO)	

Notes:
COPEC - Chemical of Potential Ecological Concern
PCB - Polychlorinated Biphenyls
SVOCs- Semivolatile organic compounds
VOCs- Volatile organic compounds

TABLE 4-28

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 7 - Cargo Beach Road Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Diesel Range Organics, Aliphatic	**4.8**	0.15	0.0010
Diesel Range Organics, Aromatic	**2.4**	0.076	0.00050
Sites 6 & 7 Combined			
Aluminum	**15**	**1.5**	0.000000030
Diesel Range Organics, Aliphatic	**15**	0.56	0.0037
Diesel Range Organics, Aromatic	**7.6**	0.28	0.0018

Notes:

[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .

TABLE 4-29

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 9 - Housing and Operations Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Human Health: Current Seasonal Resident	Human Health: Future Seasonal Resident	Human Health: Future Permanent Resident	Human Health: Current Incidental Visitor	Human Health: Future Incidental Visitor
Materials in the landfill	Soil Tundra (COPCs except PHCs)	5 - 16	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Inc [c]	Complete	Complete	Complete	Complete
	Soil Tundra (PHCs)	6 - 16	PHCs (DRO, GRO, RRO, TRPH)	Inc [c]	Complete	Complete	Complete	Complete
	Ephemeral Surface Water	3 - 10	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Inc [c,e]	Inc[e]	Inc[e]	Inc[e]	Inc[e]
	Shallow Subsurface Water	2 - 8	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Inc [c,d]	Complete	Complete	Inc [d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

[e] Ephemeral surface water results were not included in the evaluation as potable water sources.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds

TABLE 4-29

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 9 - Housing and Operations Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor

TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-30
HUMAN HEALTH COPCs
SITE 9 - Housing and Operations Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
Inorganics	**Inorganics**
Aluminum	Aluminum
Antimony	Antimony
Arsenic	Barium
Cadmium	Cobalt
Chromium	Lead
Cobalt	Manganese
Copper	Nickel
Lead	Vanadium
Manganese	
Mercury	**VOCs**
Nickel	Benzene
Selenium	
Thallium	**Dioxins & Furans**
Zinc	1,2,3,4,6,7,8,9-Octachlorodibenzofuran
	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin
VOCs	1,2,3,4,6,7,8-Heptachlorodibenzofuran
1,1,1-Trichloroethane	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin
1,2-Dibromoethane	2,3,7,8-Tetrachlorodibenzofuran
1,3-Dichlorobenzene	
1,3-Dichloropropane	**Petroleum Hydrocarbons**
2,2-Dichloropropane	Diesel Range Organics (DRO)
2-Chloroethyl vinyl ether	Residual Range Organics (RRO)
2-Chlorotoluene	
2-Hexanone	
4-Bromophenyl phenyl ether	
4-Chlorophenyl phenyl ether	
4-Isopropyltoluene	
Bromomethane	
Toluene	
SVOCs	
3-Nitroaniline	
4-Chlorotoluene	
4-Nitroaniline	
4-Nitrophenol	
Dioxins & Furans	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	
1,2,3,4,7,8,9-Heptachlorodibenzofuran	
1,2,3,4,7,8-Hexachlorodibenzofuran	
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	
1,2,3,6,7,8-Hexachlorodibenzofuran	

TABLE 4-30
HUMAN HEALTH COPCs
SITE 9 - Housing and Operations Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
1,2,3,7,8,9-Hexachlorodibenzofuran	
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	
1,2,3,7,8-Pentachlorodibenzofuran	
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	
2,3,4,6,7,8-Hexachlorodibenzofuran	
2,3,4,7,8-Pentachlorodibenzofuran	
2,3,7,8-Tetrachlorodibenzofuran	
2,3,7,8-Tetrachlorodibenzo-p-dioxin	
Total Heptachlorodibenzofurans (HpCDF)	
Total Heptachlorodibenzo-p-dioxins (HpCDD)	
Total Tetrachlorodibenzofurans (TCDF)	
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Residual Range Organics (RRO)	

Notes:
COPC - Chemical of Potential Concern
SVOC- Semivolatile Organic Compounds
VOC- Volatile Organic Compounds

Table 4-31
Human Health Carcinogenic Risk Estimates
Site 9 - Housing and Operations Landfill
Northeast Cape, St. Lawrence Island, Alaska

		Carcinogenic Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**
Soil, COPCs except PHCs		1E-05 (As)	**4E-05** (As)	4E-07	4E-07
Shallow Groundwater, COPCs except PHCs		**6E-05** (Dioxins/furans)	**2E-04** (Dioxins/furans)	na[e]	**4E-05** (Dioxins/furans)
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs, dioxins/furans)	4E-07	4E-07
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCB's) Dioxins/furans)	4E-07	4E-07
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs, dioxins/furans)	**2E-03** (As, PCBs, PAHs, dioxins/furans)	na[e]	**4E-05** (Dioxins/furans)
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs, dioxins/furans)	**2E-03** (As, PCBs, PAHs, dioxins/furans)	na[e]	**4E-05** (Dioxins/furans)

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.
[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-32
Human Health Noncarcinogenic Hazard Estimates
Site 9 - Housing and Operations Landfill
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		0.46	**1.4** (As)	0.0046	0.0046
Soil, PHCs		0.089	0.27	0.00070	0.00070
Shallow Groundwater, COPCs except PHCs		**4.6** (Sb, Al)	**18** (Sb, Al)	na[e]	0.60
Shallow Groundwater, PHCs		**1.4** (DRO)	**5.5** (DRO)	na[e]	0.24
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**31**[f] (As, Cd, V, PCB)	**32**[f] (As, Cd, V, PCB)	0.0096	0.0096
	PHCs:	0.089	0.27	0.012	0.012
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55**[f] (As, Ba, PCBs)	**56**[f] (As, Ba, PCBs)	0.0096	0.0096
	PHCs:	0.089	0.27	0.012	0.012
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**35**[f] (Sb, Al, As, Cd, V, PCBs)	**50**[f] (Sb, Al, As, Cd, V, PCBs)	na[e]	0.61
	PHCs:	**1.5** (DRO)	**12** (DRO)	na[e]	0.24
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**60**[f] (Sb, Al, As, Cd, V, PCBs)	**74**[f] (Sb, Al, As, Cd, V, PCBs)	na[e]	0.61
	PHCs:	**1.5** (DRO)	**12** (DRO)	na[e]	0.24

Notes:
Al - Aluminum
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
Sb - Antimony
V- Vanadium

Table 4-32
Human Health Noncarcinogenic Hazard Estimates
Site 9 - Housing and Operations Landfill
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.

[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering

[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.

[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.

[e] Not applicable; Current Site Visitors are not exposed to this medium.

[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-33

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 9 - Housing and Operations Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Receptor: Tundra Vole [c]	Receptor: Cross Fox [c]	Receptor: Glaucous-winged Gull
Materials in the landfill	Soil Tundra (COPCs except PHCs)	5 - 16	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Complete	Complete	Complete
	Soil Tundra (PHCs)	6 - 16	PHCs (DRO, GRO, RRO, TRPH)	Complete	Complete	Complete
	Ephemeral Surface Water	3 - 10	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Complete	Complete	Complete
	Shallow Subsurface Water	2 - 8	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs	Inc[d]	Inc[d]	Inc[d]

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[d] Subsurface water exposure pathways are incomplete for all ecological receptors.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons

TABLE 4-33

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 9 - Housing and Operations Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull

VOC - Volatile organic compounds

TABLE 4-34
ECOLOGICAL COPECs
Site 9 - Housing and Operations Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern	
Soil	**Surface Water**
Inorganics	**Inorganics**
Antimony	Barium
Arsenic	Zinc, Dissolved
Cadmium	
Chromium	**Dioxins & Furans**
Copper	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin
Lead	
Mercury	
Nickel	
Selenium	
Zinc	
VOCs	
1,2-Dibromoethane	
1,2-Dichlorobenzene	
1,3-Dichlorobenzene	
1,3-Dichloropropane	
2,2-Dichloropropane	
2-Chloroethyl vinyl ether	
2-Chlorotoluene	
2-Hexanone	
4-Bromophenyl phenyl ether	
4-Chlorophenyl phenyl ether	
4-Isopropyltoluene	
Bromomethane	
SVOCs	
2,4-Dichlorophenol	
2,4-Dimethylphenol	
2,4-Dinitrotoluene	
2,6-Dinitrotoluene	
2-Methyl-4,6-dinitrophenol	
2-Methylphenol (o-Cresol)	
3,3-Dichlorobenzidine	
3-Nitroaniline	
4-Chloroaniline	
4-Chlorotoluene	
4-Nitroaniline	
PCBs	
PCB-1260 (Aroclor 1260)	
Dioxins & Furans	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	
1,2,3,4,7,8-Hexachlorodibenzofuran	
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	
2,3,7,8-Tetrachlorodibenzofuran	
2,3,7,8-Tetrachlorodibenzo-p-dioxin	
Total Heptachlorodibenzofurans (HpCDF)	
Total Heptachlorodibenzo-p-dioxins (HpCDD)	
Total Tetrachlorodibenzofurans (TCDF)	
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Residual Range Organics (RRO)	

TABLE 4-34
ECOLOGICAL COPECs
Site 9 - Housing and Operations Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern	
Soil	**Surface Water**

Notes:
COPEC - Chemical of Potential Ecological Concern
PCB- Polychlorinated Biphenyls
SVOCs- Semivolatile organic compounds
VOCs- Volatile organic compounds

TABLE 4-35

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 9 - Housing and Operations Landfill
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Zinc	0.24	0.037	0.0000062

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .

TABLE 4-36

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 10 - Buried Drum Field
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	**Media sampled**	**Number of samples [b]**	**Chemicals analyzed for**	**Current Seasonal Resident**	**Future Seasonal Resident**	**Future Permanent Resident**	**Current Incidental Visitor**	**Future Incidental Visitor**
Buried drums with 90-weight waste oil	Soil Gravel (COPCs except PHCs)	1 - 5	Inorganics, VOCs, SVOCs, PAHs, PCBs, Pesticides	Inc [c]	Complete	Complete	Complete	Complete
	Soil Gravel (PHCs)	1 - 11	PHCs (DRO, GRO, RRO, TRPH)	Inc [c]	Complete	Complete	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-37
HUMAN HEALTH COPCs
SITE 10 - Buried Drum Field
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern
Soil
Inorganics
Thallium
Petroleum Hydrocarbons
Diesel Range Organics (DRO)
Diesel Range Organics, Aromatic

Notes:
COPC - Chemical of Potential Concern

Table 4-38
Human Health Carcinogenic Risk Estimates
Site 10 - Buried Drum Field
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		na[e]	na[e]	na[e,f]	na[e]
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[g,h]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	na[e]	na[e]
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[g,i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[e]	na[e]
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[h]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	na[f]	na[e]
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[f]	na[e]

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable, No detected carcinogenic COPCs found in this medium.
[f] Not applicable; Current Site Visitors are not exposed to this medium.
[g] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish fron ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.
[i] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-39
Human Health Noncarcinogenic Hazard Estimates
Site 10 - Buried Drum Field
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
		Noncancer Risk Estimate			
Soil, COPCs except PHCs		0.019	0.053	0.00014	0.00014
Soil, PHCs		**1.7** (DRO)	**5.2** (DRO)	0.014	0.014
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30**[f] (As, Cd, V, PCB)	**30**[f] (As, Cd, V, PCB)	0.0051	0.0051
	PHCs:	**1.9** (DRO)	**5.4** (DRO)	0.025	0.025
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55**[f] (As, Ba, Cd, PCB)	**55**[f] (As, Ba, Cd, PCB)	0.0051	0.0051
	PHCs:	**1.9** (DRO)	**5.4** (DRO)	0.025	0.025
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30**[f] (As, Cd, V, PCB)	**30**[f] (As, Cd, V, PCB)	na[e]	0.00014
	PHCs:	**1.7** (DRO)	**5.2** (DRO)	na[e]	0.014
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55**[f] (As, Ba, Cd, PCB)	**55**[f] (As, Ba, Cd, PCB)	na[e]	0.00014
	PHCs:	**1.7** (DRO)	**5.2** (DRO)	na[e]	0.014

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-40

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 11 - Fuel Storage Tank Area
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	**Media sampled**	**Number of samples[b]**	**Chemicals analyzed for**	**Current Seasonal Resident**	**Future Seasonal Resident**	**Future Permanent Resident**	**Current Incidental Visitor**	**Future Incidental Visitor**
Diesel release from AST 11-2 and potential releases from the other two tanks	Soil Gravel (COPCs except PHCs)	1 - 9	Inorganics, VOCs, SVOCs, PAHs, PCBs, Pesticides	Inc[c]	Complete	Complete	Complete	Complete
	Soil Gravel (PHCs)	9	PHCs (DRO, GRO, TRPH)	Inc[c]	Complete	Complete	Complete	Complete
	Shallow Subsurface Water	2 - 4	VOCs, SVOCs, PHCs (DRO, GRO, RRO, TRPH)	Inc[c,d]	Complete	Complete	Inc[d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

AST - Above ground storage tank
COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-41
HUMAN HEALTH COPCs
SITE 11 - Fuel Storage Tank Area
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
VOCs	**VOCs**
Ethylbenzene	Benzene
	Methylene chloride
Petroleum Hydrocarbons	n-Propylbenzene
Diesel Range Organics (DRO)	
Gasoline Range Organics (GRO)	**PAHs**
	Naphthalene
	Petroleum Hydrocarbons
	Diesel Range Organics (DRO)
	Gasoline Range Organics (GRO)

Notes:
COPC - Chemical of Potential Concern
PAH - Polynuclear Aromatic Hydrocarbons
VOC- Volatile Organic Compounds

Table 4-42
Human Health Carcinogenic Risk Estimates
Site 11 - Fuel Storage Tank Area
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		1E-09	4E-09	3E-11	3E-11
Shallow Groundwater, COPCs except PHCs		6E-06 (Benzene)	**2E-05** (Benzene)	na[e]	6E-07
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	3E-11	3E-11
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	3E-11	3E-11
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**1E-03** (Benzene, As, PCBs, & PAHs)	**1E-03** (Benzene, As, PCBs & PAHs)	na[e]	6E-07
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**2E-03** (Benzene, As, PCBs & PAHs)	**2E-03** (Benzene, MeCl As, PCBs & PAHs)	na[e]	6E-07

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.
[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-43
Human Health Noncarcinogenic Hazard Estimates
Site 11 - Fuel Storage Tank Area
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		0.000031	0.000093	0.00000024	0.00000024
Soil, PHCs		**4.5** (DRO)	**14** (DRO)	0.036	0.036
Shallow Groundwater, COPCs except PHCs		0.95	**3.7** (Naphthalene)	na[e]	0.051
Shallow Groundwater, PHCs		**8.3** (DRO)	**32** (DRO)	na[e]	1.0 (DRO)
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30**[f] (As, Cd, V, PCB)	**30**[f] (As, Cd, V, PCB)	0.0050	0.0050
	PHCs:	**4.7** (DRO)	**14** (DRO)	0.047	0.047
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55**[f] (As, Ba, Cd, PCB)	**55**[f] (As, Ba, Cd, PCB)	0.0050	0.0050
	PHCs:	**4.6** (DRO)	**14** (DRO)	0.047	0.047
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**31**[f] (As, Cd, V, PCB)	**34**[f] (As, Cd, V, Naphthalene, PCB)	na[e]	0.051
	PHCs:	**13** (DRO)	**46** (DRO)	na[e]	1.0 (DRO)
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**56**[f] (As, Ba, Cd, PCB)	**59**[f] (As, Ba, Cd, Naphthalene, PCB)	na[e]	0.043
	PHCs:	**13** (DRO)	**46** (DRO)	na[e]	1.0 (DRO)

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

Table 4-43
Human Health Noncarcinogenic Hazard Estimates
Site 11 - Fuel Storage Tank Area
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**
V- Vanadium				

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-44

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 13 - Heat and Electrical Power Bldg.
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Human Health: Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor
Two diesel USTs, two diesel ASTs, three banks of transformers, generators and piping	Soil Gravel (COPCs except PHCs)	14 - 33	Inorganics, VOCs, SVOCs, PAHs, PCBs	Inc[c]	Complete	Complete	Complete	Complete
	Soil Gravel (PHCs)	8 - 29	PHCs (DRO, GRO, RRO, TRPH)	Inc[c]	Complete	Complete	Complete	Complete
	Shallow Subsurface Water	2 - 8	Inorganics, VOCs, PHCs (DRO, GRO, RRO, TRPH)	Inc[c,d]	Complete	Complete	Inc[d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

AST - Above ground storage tank
COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
UST - Underground storage tank
VOC - Volatile organic compounds

TABLE 4-45
HUMAN HEALTH COPCs
SITE 13 - Heat and Electrical Power Building
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
VOCs	**Inorganics**
Benzene	Arsenic
Ethylbenzene	Copper
m,p-Xylene	Lead
o-Xylene	Lead, Dissolved
Toluene	Nickel
PCBs	**VOCs**
PCB-1260 (Aroclor 1260)	Benzene
	Ethylbenzene
PAHs	Toluene
Naphthalene	
	Petroleum Hydrocarbons
Petroleum Hydrocarbons	Diesel Range Organics (DRO)
Diesel Range Organics (DRO)	Gasoline Range Organics (GRO)
Gasoline Range Organics (GRO)	Residual Range Organics (RRO)
Residual Range Organics (RRO)	

Notes:
COPC - Chemical of Potential Concern
PCB - Polychlorinated Biphenyls
PAH - Polynuclear Aromatic Hydrocarbons
SVOC - Semivolatile Organic Compounds
VOC - Volatile Organic Compounds

Table 4-46
Human Health Carcinogenic Risk Estimates
Site 13 - Heat and Electrical Power Building
Northeast Cape, St. Lawrence Island, Alaska

		Carcinogenic Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident**[a]	**Future Permanent Resident**[b]	**Current Site Visitor**[c]	**Future Site Visitor**[d]
Soil, COPCs except PHCs		**1E-04** (PCBs)	**4E-04** (PCBs)	6E-06	6E-06
Shallow Groundwater, COPCs except PHCs		**5E-04** (As, Benzene)	**2E-03** (As, Benzene)	na[e]	**5E-05** (As, Benzene)
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	6E-06	6E-06
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	6E-06	6E-06
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**2E-03** (Benzene, As, PAHs, PCBs)	**4E-03** (Benzene, As, PAHs, PCBs)	na[e]	**6E-05** (As, Benzene)
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**2E-03** (Benzene, As, PAHs, PCBs)	**4E-03** (Benzene, As, PAHs, PCBs)	na[e]	**6E-05** (As, Benzene)

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
EB - Ethylbenzene.
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.
[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-47
Human Health Noncarcinogenic Hazard Estimates
Site 13 - Heat and Electrical Power Building
Northeast Cape, St. Lawrence Island, Alaska

		Noncancer Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**
Soil, COPCs except PHCs		**30** (PCBs)	**91** (PCBs)	0.47	0.47
Soil, PHCs		0.83	**2.5** (DRO)	0.0065	0.0065
Shallow Groundwater, COPCs except PHCs		**4.0** (As, VOCs)	**16** (As, Benzene)	na[e]	0.40
Shallow Groundwater, PHCs		**20** (DRO)	**76** (DRO)	na[e]	**2.3** (DRO)
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**61[f]** (As, Cd, V, PCB)	**121[f]** (As, Cd, V, PCB)	0.47	0.47
	PHCs:	1.00	**2.7** (DRO)	0.018	0.018
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**85[f]** (VOCs, PCBs, As, Ba, Cd)	**146[f]** (VOCs, PCBs, As, Ba, Cd)	0.47	0.47
	PHCs:	1.00 (DRO)	**2.7** (DRO)	0.018	0.018
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**65[f]** (As, Cd, V, PCB)	**137[f]** (As, Benzene, Cd, V, PCB)	na[e]	0.87
	PHCs:	**20** (DRO)	**79** (DRO)	na[e]	**2.3** (DRO)
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**89[f]** (VOCs, As, Ba, Cd, PCBs)	**161[f]** (VOCs, As, Ba, Benzene, Cd, PCBs)	na[e]	0.87
	PHCs:	**20** (DRO)	**79** (DRO)	na[e]	**2.3** (DRO)

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons

Table 4-47
Human Health Noncarcinogenic Hazard Estimates
Site 13 - Heat and Electrical Power Building
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]

na - not available
V- Vanadium
VOC - Volatile Organic Compounds

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-48

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 15 - Buried Fuel Line Spill Area
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	**Media sampled**	**Number of samples**[b]	**Chemicals analyzed for**	**Current Seasonal Resident**	**Future Seasonal Resident**	**Future Permanent Resident**	**Current Incidental Visitor**	**Future Incidental Visitor**
Diesel release from fuel line	Soil Gravel (COPCs except PHCs)	2 - 4	Inorganics, VOCs, PAHs, PCBs	Inc [c]	Complete	Complete	Complete	Complete
	Soil Gravel (PHCs):	2 - 4	PHCs (DRO, GRO, RRO, TRPH)	Inc [c]	Complete	Complete	Complete	Complete
	Shallow Subsurface Groundwater	1 - 2	Inorganics, VOCs, PHCs (DRO, GRO, RRO, TRPH)	Inc [c,d]	Complete	Complete	Inc [d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-49
HUMAN HEALTH COPCs
SITE 15 - Buried Fuel Line Spill Area
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
VOCs	**Inorganics**
Ethylbenzene	Arsenic
m,p-Xylene	Arsenic, Dissolved
o-Xylene	Lead
	Nickel
PAHs	
Naphthalene	**Petroleum Hydrocarbons**
	Diesel Range Organics (DRO)
Petroleum Hydrocarbons	Residual Range Organics (RRO)
Diesel Range Organics (DRO)	
Gasoline Range Organics (GRO)	

Notes:
COPC - Chemical of Potential Concern
PAH - Polynuclear Aromatic Hydrocarbons
VOC - Volatile Organic Compounds

Table 4-50
Human Health Carcinogenic Risk Estimates
Site 15 - Buried Fuel Line Spill Area
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
		Carcinogenic Risk Estimate			
Soil, COPCs except PHCs		2E-09	5E-09	4E-11	4E-11
Shallow Groundwater, COPCs except PHCs		**6E-04** (As)	**2E-03** (As)	na[e]	**7E-05** (As)
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	4E-11	4E-11
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	4E-11	4E-11
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**4E-03** (As, PCBs, PAHs)	na[e]	**7E-05** (As)
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**4E-03** (As, PCBs, PAHs)	na[e]	**7E-05** (As)

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

Table 4-50
Human Health Carcinogenic Risk Estimates
Site 15 - Buried Fuel Line Spill Area
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident**[a]	**Future Permanent Resident**[b]	**Current Site Visitor**[c]	**Future Site Visitor**[d]

[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-51
Human Health Noncarcinogenic Hazard Estimates
Site 15 - Buried Fuel Line Spill Area
Northeast Cape, St. Lawrence Island, Alaska

		Noncancer Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**
Soil, COPCs except PHCs		0.0073	0.022	0.00011	0.00011
Soil, PHCs		1.0 (DRO)	3.1 (DRO)	0.0082	0.0082
Shallow Groundwater, COPCs except PHCs		**3.5** (As)	**14** (As)	na[e]	0.46
Shallow Groundwater, PHCs		**165** (DRO)	**642** (DRO,RRO)	na[e]	**21** (DRO)
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30[f]** (As, Cd, V, PCB)	**30[f]** (As, Cd, V, PCB)	0.0051	0.0051
	PHCs:	**1.2** (DRO)	**3.3** (DRO)	0.020	0.020
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[f]** (As, Ba, Cd, PCB)	**55[f]** (As, Ba, Cd, PCB)	0.005	0.005
	PHCs:	**1.2** (DRO)	**3.3** (DRO)	0.020	0.020
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**34[f]** (As, Cd, V, PCB)	**44[f]** (As, Cd, V, PCB)	na[e]	0.46
	PHCs:	**166** (DRO)	**645** (DRO,RRO)	na[e]	**21** (DRO)
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**58[f]** (As, Ba, Cd, PCB)	**68[f]** (As, Ba, Cd, PCB)	na[e]	0.46
	PHCs:	**166** (DRO)	**645** (DRO,RRO)	na[e]	**21** (DRO)

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
RRO - Residual Range Organics
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.

Table 4-51
Human Health Noncarcinogenic Hazard Estimates
Site 15 - Buried Fuel Line Spill Area
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[e] Not applicable; Current Site Visitors are not exposed to this medium.

[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-52

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 16 - Paint and Dope Storage Bldg.
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Human Health: Current Seasonal Resident	Human Health: Future Seasonal Resident	Human Health: Future Permanent Resident	Human Health: Current Incidental Visitor	Human Health: Future Incidental Visitor
Abandoned containers, AST	Soil Gravel	1 - 15	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Complete	Complete	Complete
	Shallow Subsurface Groundwater	2 - 8	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c,d]	Complete	Complete	Inc[d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

AST - Above ground storage tank
COPC - Chemcial of potential concern
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
SVOC - Semivolatile organic compounds
VOC - Volatile organic compounds

TABLE 4-53
HUMAN HEALTH COPCs
SITE 16 - Paint and Dope Storage Building
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
Inorganics	**Inorganics**
Antimony	Beryllium
Arsenic	Cadmium
Beryllium	Copper
Cadmium	Lead
Chromium	Lead, Dissolved
Lead	Nickel
Thallium	Zinc
Zinc	
	VOCs
VOCs	4-Isopropyltoluene
Methylene chloride	n-Propylbenzene
	sec-Butylbenzene
Polycholinated Biphenyls	Trichloroethene
PCB-1260 (Aroclor 1260)	
	SVOCs
	bis (2-ethylexyl) phthalate

Notes:
COPC - Chemical of Potential Concern
PCB - Polychlorinated Biphenyls
SVOC- Semivolatile Organic Compounds
VOC- Volatile Organic Compounds

Table 4-54
Human Health Carcinogenic Risk Estimates
Site 16 - Paint and Dope Storage Building
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		5E-06 (As)	**2E-05** (As)	2E-07	2E-07
Shallow Groundwater, COPCs except PHCs		**4E-05** (TCE)	**1E-04** (TCE)	na[e]	4E-06
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	2E-07	2E-07
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	2E-07	2E-07
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs, TCE)	**2E-03** (As, PCBs, PAHs, TCE)	na[e]	4E-06
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs, TCE)	**2E-03** (As, PCBs, PAHs, TCE)	na[e]	4E-06

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
TCE - Trichloroethene

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.

Table 4-54
Human Health Carcinogenic Risk Estimates
Site 16 - Paint and Dope Storage Building
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[a] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

[b] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-55
Human Health Noncarcinogenic Hazard Estimates
Site 16 - Paint and Dope Storage Building
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		0.45	**1.4** (PCBs)	0.0053	0.0053
Soil, PHCs		na[e]	na[e]	na[e]	na[e]
Shallow Groundwater, COPCs except PHCs		**1.9** (Cd)	**7.3** (Cd)	0.21	0.21
Shallow Groundwater, PHCs		na[e]	na[e]	na[e,f]	na[e]
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**31[g]** (As, Cd, V, PCB)	**32[g]** (As, Cd, V, PCB)	0.043	0.043
	PHCs:	0.17	0.17	0.012	0.012
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[g]** (As, Ba, Cd, PCB)	**56[g]** (As, Ba, Cd, PCB)	0.043	0.043
	PHCs:	0.17	0.17	0.012	0.012
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**33[g]** (As, Cd, V, PCB)	**39[g]** (As, Cd, V, PCB)	na[f]	0.21
	PHCs:	na[e]	na[e]	na[f]	na[e]
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**57[g]** (As, Ba, Cd, PCBs)	**64[g]** (As, Ba, Cd, PCBs)	na[f]	0.21
	PHCs:	na[e]	na[e]	na[f]	na[e]

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Only non-PHC's detected in this media.
[f] Not applicable; Current Site Visitors are not exposed to this medium.

Table 4-55
Human Health Noncarcinogenic Hazard Estimates
Site 16 - Paint and Dope Storage Building
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident**[a]	**Future Permanent Resident**[b]	**Current Site Visitor**[c]	**Future Site Visitor**[d]

[g] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-56

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 19 - Auto Maintenance and Storage Facilities
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	**Media sampled**	**Number of samples[b]**	**Chemicals analyzed for**	**Current Seasonal Resident**	**Future Seasonal Resident**	**Future Permanent Resident**	**Current Incidental Visitor**	**Future Incidental Visitor**
Two ASTs, mechanics' work pit, floor drains from auto maintenance and storage areas, 24 smudge pots, 72 buckets of Military Aircraft Washing Powder	Soil Gravel (COPCs except PHCs)	3 - 16	Inorganics, VOCs, SVOCs, PAHs, PCBs	Inc[c]	Complete	Complete	Complete	Complete
	Soil Gravel (PHCs):	8 - 16	PHCs (DRO, GRO, RRO, TRPH)	Inc[c]	Complete	Complete	Complete	Complete
	Shallow Subsurface Groundwater	1 - 8	Inorganics, VOCs, SVOCs, PHCs (DRO, GRO, RRO, TRPH)	Inc[c,d]	Complete	Complete	Inc[d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

AST - Above ground storage tank
COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-57
HUMAN HEALTH COPCs
SITE 19- Auto Maintenance and Storage Facilities
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
Inorganics	**Inorganics**
Cadmium	Copper
Chromium	Lead
Lead	
	VOCs
VOCs	Benzene
Benzene	Ethane
Ethylbenzene	
m,p-Xylene	**Petroleum Hydrocarbons**
Toluene	Diesel Range Organics (DRO)
Xylenes	Gasoline Range Organics (GRO)
	Residual Range Organics (RRO)
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Gasoline Range Organics (GRO)	

Notes:
COPC - Chemical of Potential Concern
SVOC - Semivolatile Organic Compounds
VOC- Volatile Organic Compounds

Table 4-58
Human Health Carcinogenic Risk Estimates
Site 19 - Auto Maintenance and Storage Facilities
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
		Carcinogenic Risk Estimate			
Soil, COPCs except PHCs		2E-08	6E-08	6E-10	6E-10
Shallow Groundwater, COPCs except PHCs		1E-05 (Benzene)	**6E-05** (Benzene)	na[e]	1E-06 (Benzene)
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	6E-10	6E-10
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	6E-10	6E-10
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**1E-03** (Benzene, As, PCBs, PAHs	**1E-03** (Benzene, As, PCBs, PAHs	na[e]	1E-06 (Benzene)
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**9E-04** (Benzene, As, PCBs, PAHs	**6E-05** (Benzene, As, PCBs, PAHs	na[e]	1E-06 (Benzene)

Notes:

As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

Table 4-58
Human Health Carcinogenic Risk Estimates
Site 19 - Auto Maintenance and Storage Facilities
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-59
Human Health Noncarcinogenic Hazard Estimates
Site 19 - Auto Maintenance and Storage Facilities
Northeast Cape, St. Lawrence Island, Alaska

		Noncancer Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**
Soil, COPCs except PHCs		0.017	0.051	0.00014	0.00014
Soil, PHCs		0.94	**2.8** (DRO)	0.0074	0.0074
Shallow Groundwater, COPCs except PHCs		0.19	0.72	na[e]	0.012
Shallow Groundwater, PHCs		**9.3** (DRO)	**36** (DRO,GRO)	na[e]	0.93
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30[f]** (As, Cd, V, PCB)	**30[f]** (As, Cd, V, PCB)	0.0051	0.0051
	PHCs:	**1.1** (DRO)	**3.0** (DRO)	0.019	0.019
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[f]** (As, Ba, Cd, PCB)	**55[f]** (As, Ba, Cd, PCB)	0.0051	0.0051
	PHCs:	**1.1** (DRO)	**3.0** (DRO)	0.019	0.019
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**31[f]** (As, Cd, V, PCB)	**31[f]** (As, Cd, V, PCB)	na[e]	0.012
	PHCs:	**10** (DRO)	**39** (DRO,GRO)	na[e]	0.94
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[f]** (As, Ba, Cd, PCB)	**56[f]** (As, Ba, Cd, PCB)	na[e]	0.012
	PHCs:	**10** (DRO)	**39** (DRO,GRO)	na[e]	0.94

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
GRO - Gasoline Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

Table 4-59
Human Health Noncarcinogenic Hazard Estimates
Site 19 - Auto Maintenance and Storage Facilities
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gatherin\[g\]
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-60

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 21 - Wastewater Treatment Facility
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Human Health				
				Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor
Wastewater treatment effluent	Soil Tundra (COPCs except PHCs)	1 - 19	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Complete	Complete	Complete
	Soil Tundra (PHCs)	10 - 19	PHCs (DRO, GRO, RRO, TRPH)	Inc[c]	Complete	Complete	Complete	Complete
	Ephemeral Surface Water	2 - 4	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs (DRO, GRO, RRO, TRPH)	Inc[c,e]	Inc[e]	Inc[e]	Inc[e]	Inc[e]
	Shallow Subsurface Groundwater	2	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PHCs (DRO, GRO, TRPH)	Inc[c,d]	Complete	Complete	Inc[d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

[e] Ephemeral surface water results were not included in the evaluation as potable water sources.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons

TABLE 4-60

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 21 - Wastewater Treatment Facility
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor

PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-61
HUMAN HEALTH COPCs
SITE 21 - Wastewater Treatment Facility
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
Inorganics	**Inorganics**
Aluminum	Arsenic
Antimony	Copper
Arsenic	Lead
Barium	Mercury
Cadmium	Nickel
Chromium	Zinc
Cobalt	
Manganese	**VOCs**
Mercury	n-Propylbenzene
Selenium	
Silver	**Petroleum Hydrocarbons**
Thallium	Diesel Range Organics (DRO)
Vanadium	
Zinc	
VOCs	
1,2,4-Trimethylbenzene	
m,p-Xylene	
Methylene chloride	
n-Butylbenzene	
n-Propylbenzene	
o-Xylene	
sec-Butylbenzene	
SVOCs	
4-Chloroaniline	
PCBs	
PCB-1260 (Aroclor 1260)	
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Residual Range Organics (RRO)	

Notes:
COPC - Chemical of Potential Concern
PCB - Polychlorinated Biphenyls
SVOC- Semivolatile Organic Compounds
VOC- Volatile Organic Compounds

Table 4-62
Human Health Carcinogenic Risk Estimates
Site 21 - Wastewater Treatment Facility
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
		Carcinogenic Risk Estimate			
Soil, COPCs except PHCs		**2E-05** (PCB, As)	**7E-05** (PCB, As)	7E-07	7E-07
Shallow Groundwater, COPCs except PHCs		**4E-04** (As)	**2E-03** (As)	na[e]	**4E-05** (As)
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	7E-07	7E-07
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	7E-07	7E-07
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**3E-03** (As, PCBs, PAHs)	na[e]	**4E-05** (As)
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**3E-03** (As, PCBs, PAHs)	na[e]	**4E-05** (As)

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

Table 4-62
Human Health Carcinogenic Risk Estimates
Site 21 - Wastewater Treatment Facility
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]

[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-63
Human Health Noncarcinogenic Hazard Estimates
Site 21 - Wastewater Treatment Facility
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		**1.3** (PCBs)	**4.0** (PCBs, As)	0.016	0.016
Soil, PHCs		0.34	**1.0** (DRO)	0.0027	0.0027
Shallow Groundwater, COPCs except PHCs		**2.4** (As)	**9.5** (As)	na[e]	0.32
Shallow Groundwater, PHCs		0.17	0.67	na[e]	0.021
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**32**[f] (As, Cd, V, PCB)	**34**[f] (As, Cd, V, PCB)	0.021	0.021
	PHCs:	0.51	1.2 (DRO)	0.014	0.014
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**56**[f] (As, Ba, Cd, PCB)	**59**[f] (As, Ba, Cd, PCB)	0.021	0.021
	PHCs:	0.51	1.2 (DRO)	0.014	0.014
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**34**[f] (As, Cd, V, PCB)	**44**[f] (As, Cd, V, PCB)	na[e]	0.33
	PHCs:	0.51	0.64	na[e]	0.024
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**59**[f] (As, Ba, Cd, PCB)	**68**[f] (As, Ba, Cd, PCB)	na[e]	0.33
	PHCs:	0.51	0.64	na[e]	0.024

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.

Table 4-63
Human Health Noncarcinogenic Hazard Estimates
Site 21 - Wastewater Treatment Facility
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering

[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.

[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.

[e] Not applicable; Current Site Visitors are not exposed to this medium.

[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-64

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 21 - Wastewater Treatment Facility
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
Wastewater treatment effluent	Soil Tundra (COPCs except PHCs)	1 - 19	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Complete	Complete	Complete
	Soil Tundra (PHCs)	10 - 19	PHCs (DRO, GRO, RRO, TRPH)	Complete	Complete	Complete
	Ephemeral Surface Water	2 - 4	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs, PHCs (DRO, GRO, RRO, TRPH)	Complete	Complete	Complete
	Shallow Subsurface Groundwater	2	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PHCs (DRO, GRO, TRPH)	Inc[d]	Inc[d]	Inc[d]

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[d] Subsurface water exposure pathways are incomplete for all ecological receptors.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics

TABLE 4-64

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 21 - Wastewater Treatment Facility
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Receptor: Tundra Vole [c]	Receptor: Cross Fox [c]	Receptor: Glaucous-winged Gull

SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-65
ECOLOGICAL COPECs
Site 21 - Wastewater Treatment Facility
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern	
Soil	**Surface Water**
Inorganics	**Inorganics**
Aluminum	Arsenic
Antimony	Barium
Arsenic	Manganese
Barium	
Cadmium	**Petroleum Hydrocarbons**
Chromium	Diesel Range Organics (DRO)
Copper	
Mercury	
Selenium	
Silver	
Vanadium	
Zinc	
SVOCs	
4-Chloroaniline	
PCBs	
PCB-1254 (Aroclor 1254)	
PCB-1260 (Aroclor 1260)	
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Residual Range Organics (RRO)	

Notes:
COPEC - Chemical of Potential Ecological Concern
PCB - Polychlorinated Biphenyls
SVOCs- Semivolatile organic compounds

TABLE 4-66

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
21 - Wastewater Treatment Facility
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Aluminum	**34**	0.65	0.000000013
Barium	**1.4**	0.016	0.000000016
Diesel Range Organics, Aliphatic	0.56	0.0040	0.000026

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard.

TABLE 4-67

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 22 - Water wells and Water Supply Bldg.
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor
Diesel-powered engine and pump, UST 22-1, cans and bags of asbestos cement	Soil Gravel (COPCs except PHCs)	1 - 11	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Complete	Complete	Complete
	Soil Gravel (PHCs):	1 - 10	PHCs (DRO, GRO, RRO, TRPH)	Inc[c]	Complete	Complete	Complete	Complete
	Deep Subsurface Water	1 - 4	Inorganics, VOCs, SVOCs, PHCs (DRO, GRO, RRO, TRPH)	Inc[c,d]	Complete	Complete	Inc[d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
UST - Underground storage tank
VOC - Volatile organic compounds

TABLE 4-68
HUMAN HEALTH COPCs
SITE 22 - Water Wells and Water Supply Building
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
Inorganics	**Inorganics**
Lead	Manganese
	Manganese, dissolved
VOCs	
o-Xylene	**Petroleum Hydrocarbons**
	Diesel Range Organics (DRO)
PAHs	Residual Range Organics (RRO)
Benzo(a)pyrene	
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Gasoline Range Organics (GRO)	
Residual Range Organics (RRO)	

Notes:
COPC - Chemical of Potential Concern
PAH - Polynuclear Aromatic Hydrocarbons
VOC - Volatile Organic Compounds

Table 4-69
Human Health Carcinogenic Risk Estimates
Site 22 - Water Wells and Water Supply Building
Northeast Cape, St. Lawrence Island, Alaska

		Carcinogenic Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident**[a]	**Future Permanent Resident**[b]	**Current Site Visitor**[c]	**Future Site Visitor**[d]
Soil, COPCs except PHCs		3E-07	1E-06 (Benzo(a)pyrene)	2E-08	2E-08
Deep Groundwater, COPCs except PHCs		na[e]	na[e]	na[ef]	na[e]
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[g,h]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs, Benzo(a)pyrene)	2E-08	2E-08
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[g,i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs, Benzo(a)pyrene)	2E-08	2E-08
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[h]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs, Benzo(a)pyrene)	na[f]	2E-08
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs, Benzo(a)pyrene)	na[f]	2E-08

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable, No detected carcinogenic COPCs found in this medium.
[f] Not applicable; Current Site Visitors are not exposed to this medium.
[g] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

Table 4-69
Human Health Carcinogenic Risk Estimates
Site 22 - Water Wells and Water Supply Building
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident**[a]	**Future Permanent Resident**[b]	**Current Site Visitor**[c]	**Future Site Visitor**[d]

[i] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Site 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-70
Human Health Noncarcinogenic Hazard Estimates
Site 22 - Water Wells and Water Supply Building
Northeast Cape, St. Lawrence Island, Alaska

		Noncancer Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**
Soil, COPCs except PHCs		0.0000068	0.000020	0.000000053	0.000000053
Soil, PHCs		0.41	**1.2** (DRO,RRO)	0.0032	0.0032
Deep Groundwater, COPCs except PHCs		0.023	0.091	na[e]	0.0030
Deep Groundwater, PHCs		0.49	**1.9** (RRO)	na[e]	0.063
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30[f]** (As, Cd, V, PCB)	**30[f]** (As, Cd, V, PCB)	0.0050	0.0050
	PHCs:	0.58	**1.4** (DRO,RRO)	0.015	0.015
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[f]** (As, Ba, Cd, PCB)	**55[f]** (As, Ba, Cd, PCB)	0.0050	0.0050
	PHCs:	0.43	**1.3** (DRO,RRO)	0.015	0.015
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30[f]** (As, Cd, V, PCB)	**30[f]** (As, Cd, V, PCB)	na[e]	0.0030
	PHCs:	**0.90** (DRO)	**3.1** (RRO)	na[e]	0.067
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[f]** (As, Ba, Cd, PCB)	**55[f]** (As, Ba, Cd, PCB)	na[e]	0.0030
	PHCs:	**0.90**	**3.1** (RRO)	na[e]	0.067

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
RRO - Residual Range Organics
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering

Table 4-70
Human Health Noncarcinogenic Hazard Estimates
Site 22 - Water Wells and Water Supply Building
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.

[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.

[e] Not applicable; Current Site Visitors are not exposed to this medium.

[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-71

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 22 - Water wells and Water Supply Building
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
Diesel-powered engine and pump, UST 22-1, cans and bags of asbestos cement	Soil Gravel (COPCs except PHCs)	1 - 11	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Complete	Complete	Complete
	Soil Gravel (PHCs):	1 - 10	PHCs (DRO, GRO, RRO, TRPH)	Complete	Complete	Complete
	Deep Subsurface Water	1 - 4	Inorganics, VOCs, SVOCs, PHCs (DRO, GRO, RRO, TRPH)	Inc[d]	Inc[d]	Inc[d]

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[d] Subsurface water exposure pathways are incomplete for all ecological receptors.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds
UST - Underground storage tank

TABLE 4-72
ECOLOGICAL COPECs
Site 22 - Water Wells and Water Supply Building
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern
Soil
Inorganics
Antimony
Lead
Zinc
SVOCs
Di-n-butyl phthalate
PAH
Benzo(a)pyrene
Benzo(b)fluoranthene
Chrysene
Naphthalene
Phenanthrene
Petroleum Hydrocarbons
Diesel Range Organics (DRO)
Gasoline Range Organics (GRO)
Residual Range Organics (RRO)

Notes:
COPEC - Chemical of Potential Ecological Concern
PAH - Polynuclear Aromatic Hydrocarbons
SVOC - Semivolatile Organic Compounds

TABLE 4-73

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 22 - Water wells and Water Supply Building
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Diesel Range Organics, Aliphatic	0.60	0.00044	0.0000029
Zinc	0.083	0.00068	0.0000000000000000000012

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .

TABLE 4-74

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 27 - Diesel Fuel Pump Island
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	**Media sampled**	**Number of samples[b]**	**Chemicals analyzed for**	**Current Seasonal Resident**	**Future Seasonal Resident**	**Future Permanent Resident**	**Current Incidental Visitor**	**Future Incidental Visitor**
Past diesel releases from the fuel pump and fuel line. Buried drums on the embankment	Soil Tundra	1 - 1	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Complete	Complete	Complete
	Soil Gravel	1 - 29	PHCs (DRO, GRO, RRO, TRPH)	Inc[c]	Complete	Complete	Complete	Complete
	Shallow Subsurface Water	1 - 3	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PHCs (DRO, GRO, TRPH)	Inc[c,d]	Complete	Complete	Inc[d]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

COPC - Chemcial of potential concern
DRO - Diesel range organics
GRO - Gasoline range organics
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-75
HUMAN HEALTH COPCs
SITE 27 - Diesel Fuel Pump Island
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern	
Soil	**Subsurface Water**
VOCs	**Inorganics**
Benzene	Lead
Ethylbenzene	Lead, Dissolved
m,p-Xylene	Manganese
o-Xylene	
Toluene	**VOCs**
	Benzene
PAHs	Ethylbenzene
Naphthalene	
	Petroleum Hydrocarbons
Petroleum Hydrocarbons	Diesel Range Organics (DRO)
Diesel Range Organics (DRO)	Gasoline Range Organics (GRO)
Gasoline Range Organics (GRO)	Residual Range Organics (RRO)
Residual Range Organics (RRO)	

Notes:
COPC - Chemical of Potential Concern
PAH - Polynuclear Aromatic Hydrocarbons
VOC- Volatile Organic Compounds

Table 4-76
Human Health Carcinogenic Risk Estimates
Site 27 - Diesel Fuel Pump Island
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
		Carcinogenic Risk Estimate			
Soil, COPCs except PHCs		2E-08	6E-08	5E-10	5E-10
Shallow Groundwater, COPCs except PHCs		**3E-05** (Benzene, EB)	**1E-04** (Benzene, EB)	na[e]	3E-06
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	5E-10	5E-10
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	5E-10	5E-10
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**1E-03** (Benzene, EB, As, PCBs, PAHs)	**2E-03** (Benzene, EB, As, PCBs, PAHs)	na[e]	3E-06
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**2E-03** (Benzene, EB, As, PCBs, PAHs)	**2E-03** (Benzene, EB, As, PCBs, PAHs)	na[e]	3E-06

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
EB - Ethylbenzene
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

Table 4-76
Human Health Carcinogenic Risk Estimates
Site 27 - Diesel Fuel Pump Island
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident**[a]	**Future Permanent Resident**[b]	**Current Site Visitor**[c]	**Future Site Visitor**[d]

[b] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-77
Human Health Noncarcinogenic Hazard Estimates
Site 27 - Diesel Fuel Pump Island
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		0.036	0.15	0.00075	0.00075
Soil, PHCs		**3.5** (DRO)	**10** (DRO)	0.027	0.027
Shallow Groundwater, COPCs except PHCs		0.47	0.90	na[e]	0.0017
Shallow Groundwater, PHCs		**12** (DRO)	**47** (DRO, GRO)	na[e]	**1.4** (DRO)
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30**[f] (As, Cd, V, PCB)	**31**[f] (As, Cd, V, PCB)	0.0057	0.0057
	PHCs:	**3.7** (DRO)	**10** (DRO)	0.039	0.039
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55**[f] (As, Ba, Cd, PCB)	**55**[f] (As, Ba, Cd, PCB)	0.0057	0.0057
	PHCs:	**3.7** (DRO)	**10** (DRO)	0.039	0.039
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**31**[f] (As, Cd, V, PCB)	**31**[f] (As, Cd, V, PCB)	na[e]	0.0024
	PHCs:	**16** (DRO)	**57** (DRO, GRO)	na[e]	**1.5** (DRO)
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55**[f] (As, Ba, Cd, PCB)	**56**[f] (As, Ba, Cd, PCB)	na[e]	0.0024
	PHCs:	**16** (DRO)	**57** (DRO, GRO)	na[e]	**1.5** (DRO)

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
GRO - Gasoline Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

Table 4-77
Human Health Noncarcinogenic Hazard Estimates
Site 27 - Diesel Fuel Pump Island
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**
V- Vanadium				

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.
[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-78

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 28 - Drainage Basin
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	**Media sampled**	**Number of samples[b]**	**Chemicals analyzed for**	**Current Seasonal Resident**	**Future Seasonal Resident**	**Future Permanent Resident**	**Current Incidental Visitor**	**Future Incidental Visitor**
Runoff from Sites 10 through 20 and Site 27.	Soil Tundra	1 - 10	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Inc[d]	Inc[c]	Complete
	Soil Gravel	1 - 11	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Inc[d]	Inc[c]	Complete
	Freshwater Sediment	1 - 83	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Inc[d]	Inc[c]	Complete
	Fresh Surface Water	1 - 17	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Inc[d]	Inc[c]	Complete
	Shallow Subsurface Water	1 - 2	Inorganics & PHCs	Inc[c,e]	Complete	Inc[d]	Inc[c,e]	Complete
	Fish Tissue	1 - 16	NA	NA	NA	NA	NA	NA
	Plant Tissue	1 - 5	Inorganics, PAHs, VOCs, Pesticides	Inc[c]	Complete	Inc[d]	Inc[c]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Incomplete; it is highly unlikely that a residence would be constructed at this location in the future.

[e] Subsurface water exposure pathways are incomplete for current receptors. Subsurface water is not currently consumed.

COPC - Chemcial of potential concern
DRO - Diesel range organics

TABLE 4-78

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 28 - Drainage Basin
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor

GRO - Gasoline range organics
Inc - Incomplete
NA - Not applicable
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
SVOC - Semivolatile organic compounds
TRPH - Total residual petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-79
HUMAN HEALTH COPCs
SITE 28 - Drainage Basin
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern				
Soil	**Sediment**	**Surface Water**	**Subsurface Water**	**Plant Tissue**
Inorganics	**Inorganics**	**Inorganics, Total**	**Inorganics**	**Inorganics**
Beryllium	Chromium	Chromium	Arsenic	Antimony
Thallium	Lead	Copper	Copper	Arsenic
	Zinc	Lead	Lead	Barium
VOCs		Lead, Dissolved	Nickel	Cadmium
Ethylbenzene	**VOCs**	Zinc		Chromium
Methylene chloride	Benzene	Zinc, Dissolved	**Petroleum Hydrocarbons**	Copper
	Ethylbenzene		Diesel Range Organics (DRO)	Lead
PCBs		**PCBs**		Mercury
PCB-1254 (Aroclor 1254)	**PCBs**	PCB-1260 (Aroclor 1260)		Nickel
	PCB-1254 (Aroclor 1254)			Selenium
PAHs	PCB-1260 (Aroclor 1260)	**Petroleum Hydrocarbons**		Silver
Benzo(a)anthracene		Diesel Range Organics (DRO)		Vanadium
Benzo(a)pyrene	**Pesticides**	Gasoline Range Organics (GRO)		Zinc
Benzo(b)fluoranthene	beta-BHC			
	gamma-BHC (Lindane)			**PAHs**
Petroleum Hydrocarbons				2-Methylnaphthalene
Diesel Range Organics (DRO)	**PAHs**			Acenaphthene
Diesel Range Organics, Aromatic	2-Methylnaphthalene			Anthracene
Gasoline Range Organics (GRO)	Benzo(a)anthracene			Benzo(a)anthracene
Residual Range Organics (RRO)	Benzo(a)pyrene			Benzo(a)pyrene
	Benzo(b)fluoranthene			Benzo(b)fluoranthene
	Indeno(1,2,3-cd)pyrene			Benzo(g,h,i)perylene
	Naphthalene			Benzo(k)fluoranthene
				Chrysene
	Dioxins/Furans			Dibenz(a,h)anthracene
	Dibenzofuran			Fluoranthene
				Fluorene
	Petroleum Hydrocarbons			Indeno(1,2,3-cd)pyrene
	Diesel Range Organics (DRO)			Naphthalene
	Diesel Range Organics, Aromatic			Phenanthrene
	Diesel Range Organics, Aliphatic			Pyrene
	Gasoline Range Organics (GRO)			
	Residual Range Organics (RRO)			**PCBs**
	Residual Range Organics, Aromatic			PCB-1254 (Aroclor 1254)
	Residual Range Organics, Aliphatic			PCB-1260 (Aroclor 1260)

Notes:
COPC - Chemical of Potential Concern

TABLE 4-79
HUMAN HEALTH COPCs
SITE 28 - Drainage Basin
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern				
Soil	Sediment	Surface Water	Subsurface Water	Plant Tissue

PAH - Polynuclear Aromatic Hydrocarbons
PCB - Plychlorinated Biphenyls
VOC- Volatile Organic Compounds

Table 4-80
Human Health Carcinogenic Risk Estimates
Site 28 - Drainage Basin
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		**1E-05** (PAHs)	na[i]	6E-07	6E-07
Permanent Suface Water, COPCs except PHCs		**4E-05** (PCBs)	na[i]	na[e]	3E-06
Shallow Groundwater, COPCs except PHCs		**2E-04** (As)	na[i]	na[e]	**2E-05** (As)
Plant Tissue, COPCs except PHCs		**9E-04** (As, PCBs, PAHs)	na[i]	na[e]	na[e]
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	na[i]	6E-07	6E-07
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	na[i]	6E-07	6E-07
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	na[i]	na[j]	**2E-05** (As)
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	na[i]	na[j]	**2E-05** (As)

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.

Table 4-80
Human Health Carcinogenic Risk Estimates
Site 28 - Drainage Basin
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[e] Not applicable; not exposed to this medium.

[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.

[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

[i] It is highly unlikely that a residence would be constructed at this location in the future.

[j] Not applicable; Current Site Visitors are not exposed to this medium.

Table 4-81
Human Health Noncarcinogenic Hazard Estimates
Site 28 - Drainage Basin
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil or Sediment, COPCs except PHCs		0.36	na[f]	0.0054	0.0054
Soil or Sediment, PHCs		**6.6** (DRO)	na[f]	0.052	0.052
Permanent Suface Water, COPCs except PHCs		**7.3** (PCBs)	na[f]	na[e]	0.25
Permanent Suface Water, PHCs		**8.3** (DRO)	na[f]	na[e]	1.0 (DRO)
Shallow Groundwater, COPCs except PHCs		**1.3** (As)	na[f]	na[e]	0.16
Shallow Groundwater, PHCs		0.55	na[f]	na[e]	0.069
Plant Tissue, COPCs except PHCs		**38**[g] (As, Ba, Cd, PCBs)	na[f]	na[e]	na[g]
Plant Tissue, PHCs		na	na[f]	na[e]	na[g]
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**31**[g] (As, Cd, V, PCB)	na[f]	0.010	0.010
	PHCs:	**6.8** (DRO)	na[f]	0.064	0.064
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55**[g] (As, Ba, Cd, PCB)	na[f]	0.010	0.010
	PHCs:	**6.8** (DRO)	na[f]	0.064	0.064
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**32**[g] (As, Cd, V, PCB)	na[f]	na[e]	0.17
	PHCs:	**7.1** (DRO)	na[f]	na[e]	0.12
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**56**[g] (As, Ba, Cd, PCB)	na[f]	na[e]	0.17
	PHCs:	**7.1** (DRO)	na[f]	na[e]	0.12

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics

Table 4-81
Human Health Noncarcinogenic Hazard Estimates
Site 28 - Drainage Basin
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium
[f] Not applicable; it is highly unlikely that a residence would be constructed at this location in the future.
[g] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-82

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 28 - Drainage Basin
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
Runoff from sites 10 through 20 and site 27.	Soil Tundra	1 - 10	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Complete	Complete	Complete
	Soil Gravel	1 - 11	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Complete	Complete	Complete
	Freshwater Sediment	1 - 83	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[d]	Inc[d]	Complete
	Fresh Surface Water	1 - 17	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Complete	Complete	Complete
	Shallow Subsurface Water	1 - 2	Inorganics & PHCs	Inc[d]	Inc[d]	Inc[d]
	Fish Tissue	1 - 4	Inorganics & PHCs	Inc[e]	Inc[e]	Complete
	Plant Tissue	1 - 17	Inorganics, PAHs, VOCs, Pesticides	Complete	Inc[e]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[d] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[e] The indicated receptor is not anticipated to consume this dietary item.

Inc - Incomplete

TABLE 4-82

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 28 - Drainage Basin
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull

PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
SVOC - Semivolatile organic compounds
VOC - Volatile organic compounds

TABLE 4-83
ECOLOGICAL COPECs
Site 28 - Drainage Basin
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern				
Soil	**Sediment**	**Surface Water**	**Fish Tissue**	**Plant Tissue**
Inorganics	**Inorganics**	**Inorganics**	**Inorganics**	**Inorganics**
Beryllium	Chromium	Chromium	Antimony	Antimony
	Lead	Copper	Arsenic	Arsenic
PCBs	Zinc	Lead	Barium	Barium
PCB-1254 (Aroclor 1254)		Lead, Dissolved	Cadmium	Cadmium
	VOCs	Zinc	Copper	Chromium
PAHs	Ethylbenzene	Zinc, Dissolved	Lead	Copper
Anthracene	Toluene		Mercury	Lead
Benzo(a)anthracene	Xylenes	**PCBs**	Nickel	Mercury
Benzo(a)pyrene		PCB-1260 (Aroclor 1260)	Selenium	Nickel
Benzo(b)fluoranthene	**PCBs**		Vanadium	Selenium
Benzo(k)fluoranthene	PCB-1242 (Aroclor 1242)	**Petroleum Hydrocarbons**	Zinc	Silver
Chrysene	PCB-1254 (Aroclor 1254)	Diesel Range Organics (DRO)		Vanadium
Fluoranthene	PCB-1260 (Aroclor 1260)	Gasoline Range Organics (GRO)	**PAHs**	Zinc
Phenanthrene			2-Methylnaphthalene	
Pyrene	**Pesticides**		Acenaphthene	**PAHs**
	4,4'-DDD		Benzo(g,h,i)perylene	2-Methylnaphthalene
Petroleum Hydrocarbons	beta-BHC		Fluoranthene	Acenaphthene
Diesel Range Organics (DRO)	Endosulfan sulfate		Fluorene	Anthracene
Diesel Range Organics_Aromatic	gamma-BHC (Lindane)		Naphthalene	Benzo(a)anthracene
Diesel Range Organics_Aliphatic	Heptachlor		Phenanthrene	Benzo(a)pyrene
Gasoline Range Organics (GRO)			Pyrene	Benzo(b)fluoranthene
Residual Range Organics (RRO)	**Dioxins & Furans**			Benzo(g,h,i)perylene
Residual Range Organics_Aromatic	Dibenzofuran		**PCBs**	Benzo(k)fluoranthene
			PCB-1260 (Aroclor 1260)	Chrysene
	PAHs			Dibenz(a,h)anthracene
	2-Methylnaphthalene			Fluoranthene
	Acenaphthene			Fluorene
	Acenaphthylene			Indeno(1,2,3-cd)pyrene
	Anthracene			Naphthalene
	Benzo(a)anthracene			Phenanthrene
	Benzo(a)pyrene			Pyrene
	Benzo(b)fluoranthene			
	Benzo(g,h,i)perylene			**PCBs**
	Benzo(k)fluoranthene			PCB-1254 (Aroclor 1254)
	Chrysene			PCB-1260 (Aroclor 1260)
	Dibenzo(a,h)anthracene			

TABLE 4-83
ECOLOGICAL COPECs
Site 28 - Drainage Basin
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern				
Soil	**Sediment**	**Surface Water**	**Fish Tissue**	**Plant Tissue**
	Fluoranthene			
	Fluorene			
	Indeno(1,2,3-cd)pyrene			
	Naphthalene			
	Phenanthrene			
	Pyrene			
	Petroleum Hydrocarbons			
	Diesel Range Organics (DRO)			
	Diesel Range Organics_Aromatic			
	Diesel Range Organics_Aliphatic			
	Gasoline Range Organics (GRO)			
	Residual Range Organics (RRO)			
	Residual Range Organics_ Aliphatic			
	Residual Range Organics_Aromatic			

Notes:
COPEC - Chemical of Potential Ecological Concern
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Hydrocarbons
VOCs- Volatile organic compounds

TABLE 4-84

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 28 - Drainage Basin
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Barium	**9.6**	0.11	0.0000028
Zinc	**1.3**	0.028	0.0000040
PCB-1254 (Aroclor 1254)	**2.0**	0.025	0.000011
Diesel Range Organics, Aliphatic	**14**	0.71	0.19
Diesel Range Organics, Aromatic	**5.5**	0.28	0.075

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .
PCB - Polychlorinated biphenyls.

TABLE 4-85

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 29 - Suqitughneq River
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Human Health				
				Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor
Upgradient sites, especially Site 28	Freshwater Sediment	1 - 26	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Inc[d]	Complete	Complete
	Fresh Surface Water	1 - 11	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[c]	Complete	Inc[d]	Complete	Complete
	Fish Tissue	1 - 8	Inorganics, VOCs, SVOCs, Pesticides, PAHs	Inc[c]	Complete	Inc[d]	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

[d] Incomplete; it is highly unlikely that a residence would be constructed at this location in the future.

COPC - Chemcial of potential concern
Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
SVOC - Semivolatile organic compounds
VOC - Volatile organic compounds

TABLE 4-86
HUMAN HEALTH COPCs
SITE 29 - Suqitughneg River
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Sediment	Surface Water	Fish Tissue
Inorganics	**Inorganics**	**Inorganics**
Aluminum	Aluminum	Arsenic
Arsenic	Barium	Barium
Barium	Manganese	Cadmium
Cobalt	Silver, Dissolved	Copper
Manganese	Zinc	Lead
Mercury		Mercury
Vanadium	**Petroleum Hydrocarbons**	Nickel
	Diesel Range Organics (DRO)	Selenium
VOCs	Diesel Range Organics, Aliphatic	Vanadium
m,p-Xylene	Gasoline Range Organics, (GRO)	Zinc
Dioxins & Furans		**PAHs**
Dibenzofuran		2-Methylnaphthalene
		Acenaphthene
Petroleum Hydrocarbons		Anthracene
Diesel Range Organics (DRO)		Benzo(a)anthracene
		Benzo(a)pyrene
		Benzo(b)fluoranthene
		Benzo(g,h,i)perylene
		Benzo(k)fluoranthene
		Chrysene
		Dibenz(a,h)anthracene
		Fluoranthene
		Fluorene
		Indeno(1,2,3-cd)pyrene
		Naphthalene
		Phenanthrene
		Pyrene
		PCBs
		PCB-1254 (Aroclor 1254)
		PCB-1260 (Aroclor 1260)

Notes:
COPC - Chemical of Potential Concern
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Plychlorinated Biphenyls
VOC- Volatile Organic Compounds

Table 4-87
Human Health Carcinogenic Risk Estimates
Site 29 - Suqitugneq River
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Sediment, COPCs except PHCs		4E-06 (As)	na[f]	1E-07	1E-07
Permanent Suface Water, COPCs except PHCs		na[e]	na[e]	na[e,g]	na[e]
Fish Tissue, COPCs except PHCs		**9E-04** (As, PCBs, PAHs)	na[f]	na[g]	na[g]
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[g,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	na[f]	1E-07	1E-07
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[g,i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	na[f]	1E-07	1E-07
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	na[f]	na[j]	1E-07
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	na[f]	na[j]	1E-07

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable, No detected carcinogenic COPCs found in this medium.
[f] It is highly unlikely that a residence would be constructed at this location in the future.
[g] No carcinogenic COPCs were identified in samples collected from the Suqi River.

Table 4-87
Human Health Carcinogenic Risk Estimates
Site 29 - Suqitugneq River
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

[i] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

[j] Not applicable; Current Site Visitors are not exposed to this medium.

Table 4-88
Human Health Noncarcinogenic Hazard Estimates
Site 29 - Suqitughneq River
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Sediment, COPCs except PHCs		0.16	na[f]	0.0016	0.0016
Sediment, PHCs		0.12	na[f]	0.0010	0.0010
Permanent Suface Water, COPCs except PHCs		0.038	na[f]	0.0050	0.0050
Permanent Suface Water, PHCs		0.19	na[f]	0.012	0.012
Fish Tissue, COPCs except PHCs		17[g] (As, PCBs)	na[f]	na[e]	na[e]
Fish Tissue, PHCs		na	na[f]	na[e]	na[e]
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	31[g] (As, Cd, V, PCB)	na[f]	0.0066	0.0066
	PHCs:	0.29	na[f]	0.013	0.013
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	55[g] (As, Ba, Cd, PCB)	na[f]	0.0066	0.0066
	PHCs:	0.29	na[f]	0.013	0.013
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	31[g] (As, Cd, V, PCB)	na[f]	na[e]	0.0016
	PHCs:	0.12	na[f]	na[e]	0.0010
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	55[g] (As, Ba, Cd, PCB)	na[f]	na[e]	0.0016
	PHCs:	0.12	na[f]	na[e]	0.0010

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.

Table 4-88
Human Health Noncarcinogenic Hazard Estimates
Site 29 - Suqitughneq River
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[e] Not applicable; Current and Site Visitors are not exposed to this medium.

[f] Not applicable; it is highly unlikely that a residence would be constructed at this location in the future.

[g] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-89

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 29 - Suqitughneq River
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
Upgradient sites, especially Site 28	Freshwater Sediment	1 - 26	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Inc[d]	Inc[d]	Complete
	Fresh Surface Water	1 - 13	Inorganics, VOCs, SVOCs, Pesticides, PAHs, PCBs	Complete	Complete	Complete
	Fish Tissue	1 - 16	Inorganics, VOCs, SVOCs, Pesticides, PAHs	Inc[e]	Inc[e]	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[d] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[e] The indicated receptor is not anticipated to consume this dietary item.

Inc - Incomplete
PAH - Polynuclear aromatic hydrocarbons
PCBs - Polychlorinated biphenyls
SVOC - Semivolatile organic compounds
VOC - Volatile organic compounds

TABLE 4-90
ECOLOGICAL COPECs
Site 29 - Suqitughneq River
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern		
Sediment	**Surface Water**	**Fish Tissue**
Inorganics	**Inorganics**	**Inorganics**
Aluminum	Aluminum	Antimony
Arsenic	Barium	Arsenic
Barium	Silver, Dissolved	Barium
Beryllium		Cadmium
Cobalt	**Petroleum Hydrocarbons**	Copper
Manganese	Diesel Range Organics (DRO)	Lead
Mercury	Diesel Range Organics, Aliphatic	Mercury
Vanadium	Gasoline Range Organics (GRO)	Nickel
		Selenium
VOCs		Silver
m,p-Xylene		Vanadium
		Zinc
PAHs		
2-Methylnaphthalene		**PAHs**
Acenaphthylene		2-Methylnaphthalene
Anthracene		Acenaphthene
Fluorene		Anthracene
Naphthalene		Benzo(a)anthracene
Phenanthrene		Benzo(a)pyrene
Pyrene		Benzo(b)fluoranthene
		Benzo(g,h,i)perylene
Petroleum Hydrocarbons		Benzo(k)fluoranthene
Diesel Range Organics (DRO)		Chrysene
Residual Range Organics (RRO)		Dibenz(a,h)anthracene
Residual Range Organics, Aromatic		Fluoranthene
		Fluorene
		Indeno(1,2,3-cd)pyrene
		Naphthalene
		Phenanthrene
		Pyrene
		PCBs
		PCB-1254 (Aroclor 1254)
		PCB-1260 (Aroclor 1260)

Notes:
COPEC - Chemical of Potential Ecological Concern
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Hydrocarbons
VOCs- Volatile organic compounds

TABLE 4-91

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 29 - Suqitughneq River
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Diesel Range Organics, Aliphatic	0.00000000055	0.00000000015	0.0034
Silver, dissolved	0.0000000082	0.0000000023	0.0000000013
Sites 28 & 29 Combined			
Barium	**9.6**	0.23	0.000024
Zinc	**1.3**	0.056	0.0000079
PCB-1254 (Aroclor 1254)	**2.0**	0.050	0.000023
Diesel Range Organics, Aliphatic	**14**	1.4	0.37
Diesel Range Organics, Aromatic	**6.9**	0.71	0.19

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .
PCB - Polychlorinated biphenyls.

TABLE 4-92

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 31 - White Alice Site
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor
Fuel and PCB contamination	Soil Tundra	1 - 24	VOCs, PCBs, PHCs	Inc [c]	Complete	Complete	Complete	Complete
	Ephemeral Surface Water	1 - 2	VOCs, PCBs, PHCs	Inc [c]	Complete	Complete	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

COPC - Chemcial of potential concern
Inc - Incomplete
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
RRO - Residual range organics
VOC - Volatile organic compounds

TABLE 4-93
HUMAN HEALTH COPCs
SITE 31 - White Alice Communications Site
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern
Soil
VOCs
m,p-Xylene
o-Xylene
PCBs
PCB-1260 (Aroclor 1260)
Petroleum Hydrocarbons
Diesel Range Organics (DRO)
Residual Range Organics (RRO)

Notes:
COPC - Chemical of Potential Concern
VOC -Volatile Organic Compounds
PCB - Polychlorinated Biphenyls

Table 4-94
Human Health Carcinogenic Risk Estimates
Site 31 - White Alice Site
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		**3E-05** (PCBs)	**8E-05** (PCBs)	1E-06	1E-06
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[f,g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	1E-06	1E-06
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[f,h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	1E-06	1E-06
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[g]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[e]	na[e]
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[h]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[e]	na[e]

Notes:

As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current and Future Site Visitors are not exposed to this medium.
[f] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[g] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

Table 4-94
Human Health Carcinogenic Risk Estimates
Site 31 - White Alice Site
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident**[a]	**Future Permanent Resident**[b]	**Current Site Visitor**[c]	**Future Site Visitor**[d]

[b] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-95
Human Health Noncarcinogenic Hazard Estimates
Site 31 - White Alice Site
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		**5.8** (PCBs)	**17** (PCBs)	0.089	0.089
Soil, PHCs		0.63	**1.9** (DRO)	0.0049	0.0049
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**36**[f] (As, Cd, V, PCB)	**48**[f] (As, Cd, V, PCB)	0.094	0.094
	PHCs:	0.79	**2.0** (DRO)	0.017	0.017
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**61**[f] (As, Ba, Cd, PCB)	**72**[f] (As, Ba, Cd, PCB)	0.094	0.094
	PHCs:	0.79	**2.0** (DRO)	0.017	0.017
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**36**[f] (As, Cd, V, PCB)	**48**[f] (As, Cd, V, PCB)	na[e]	na
	PHCs:	0.63	**1.9** (DRO)	na[e]	na
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**61**[f] (As, Ba, Cd, PCB)	**72**[f] (As, Ba, Cd, PCB)	na[e]	na
	PHCs:	0.63	**1.9** (DRO)	na[e]	na

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable; Current Site Visitors are not exposed to this medium.

Table 4-95
Human Health Noncarcinogenic Hazard Estimates
Site 31 - White Alice Site
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident**[a]	**Future Permanent Resident**[b]	**Current Site Visitor**[c]	**Future Site Visitor**[d]

[f] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-96

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 31 - White Alice Site
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
Fuel and PCB contamination	Soil Tundra	1 - 24	VOCs, PCBs, PHCs	Complete	Complete	Complete
	Ephemeral Surface Water	1 - 2	VOCs, PCBs, PHCs	Complete	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

Inc - Incomplete
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-97
ECOLOGICAL COPECs
Site 31 - White Alice Site
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern	
Soil	**Surface Water**
PCBs	**Inorganics**
PCB-1260 (Aroclor 1260)	Barium
	Manganese
Petroleum Hydrocarbons	
Diesel Range Organics (DRO)	
Residual Range Organics (RRO)	

Notes:
COPEC - Chemical of Potential Ecological Concern
PCB - Polychlorinated Biphenyls

TABLE 4-98

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 31 - White Alice Site
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Diesel Range Organics, Aliphatic	**1.2**	0.0085	0.000056
Diesel Range Organics, Aromatic	0.62	0.0043	0.000028

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .

TABLE 4-99

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 32 - Lower Tram Terminal
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor
ASTs, Transformer Bank No. 2, and the tram cables	Soil Gravel	2 - 5	VOCs, PCBs, PHCs	Inc [c]	Complete	Complete	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

AST - Above ground storage tank
COPC - Chemcial of potential concern
Inc - Incomplete
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-100
HUMAN HEALTH COPCs
SITE 32 - Lower Tram Terminal
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern
Soil
Petroleum Hydrocarbons
Diesel Range Organics (DRO)
Residual Range Organics (RRO)

Notes:
COPC - Chemical of Potential Concern

Table 4-101
Human Health Carcinogenic Risk Estimates
Site 32 - Lower Tram Terminal
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		na[e]	na[e]	na[e]	na[e]
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[g,h]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	na[f]	na[f]
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[g,i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[f]	na[f]
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[h]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	na[f]	na[f]
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[f]	na[f]

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable, No detected carcinogenic COPCs found in this medium.
[f] Not applicable; Current and Future Site Visitors are not exposed to this medium.
[g] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

Table 4-101
Human Health Carcinogenic Risk Estimates
Site 32 - Lower Tram Terminal
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident**[a]	**Future Permanent Resident**[b]	**Current Site Visitor**[c]	**Future Site Visitor**[d]

[i] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-102
Human Health Noncarcinogenic Hazard Estimates
Site 32 - Lower Tram Terminal
Northeast Cape, St. Lawrence Island, Alaska

		Noncancer Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident[a]**	**Future Permanent Resident**	**Current Site Visitor**	**Future Site Visitor**
Soil, COPCs except PHCs		na[e]	na[e]	na[e]	na[e]
Soil, PHCs		0.99 (DRO)	**3.0** (DRO)	0.0078	0.0078
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30[g]** (As, Cd, V, PCB)	**30[g]** (As, Cd, V, PCB)	0.0050	0.0050
	PHCs:	**1.2** (DRO)	**3.1** (DRO)	0.020	0.020
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[g]** (As, Ba, Cd, PCB)	**55[g]** (As, Ba, Cd, PCB)	0.0050	0.0050
	PHCs:	**1.2** (DRO)	**3.1** (DRO)	0.020	0.020
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	**30[g]** (As, Cd, V, PCB)	**30[g]** (As, Cd, V, PCB)	na[f]	na[e]
	PHCs:	0.99 (DRO)	**3.0** (DRO)	na[f]	0.0078
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	**55[g]** (As, Ba, Cd, PCB)	**55[g]** (As, Ba, Cd, PCB)	na[f]	na[e]
	PHCs:	0.99 (DRO)	**3.0** (DRO)	na[f]	0.0078

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Only PHC's detected in this media.

Table 4-102
Human Health Noncarcinogenic Hazard Estimates
Site 32 - Lower Tram Terminal
Northeast Cape, St. Lawrence Island, Alaska

	Noncancer Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident**	**Current Site Visitor**	**Future Site Visitor**

[1] Not applicable; Current Site Visitors are not exposed to this medium

[g] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-103

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 32 - Lower Tram Terminal
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Receptor		
				Tundra Vole [c]	Cross Fox [c]	Glaucous-winged Gull
ASTs, Transformer Bank No. 2, and the tram cables	Soil Gravel	2 - 5	VOCs, PCBs, PHCs	Complete	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

AST - Above ground storage tank
Inc - Incomplete
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-104
ECOLOGICAL COPECs
Site 32 - Lower Tram Terminal
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern
Soil
PCBs
PCB-1260 (Aroclor 1260)
Petroleum Hydrocarbons
Diesel Range Organics (DRO)
Residual Range Organics (RRO)

Notes:
COPEC - Chemical of Potential Ecological Concern
PCB - Polychlorinated Biphenyls

TABLE 4-105

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 32 - Lower Tram Terminal
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Diesel Range Organics, Aliphatic	**1.9**	0.0051	0.000034
Diesel Range Organics, Aromatic	0.97	0.0026	0.000017

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .

TABLE 4-106

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 33 - Upper Tram Terminal
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	**Media sampled**	**Number of samples**[b]	**Chemicals analyzed for**	**Current Seasonal Resident**	**Future Seasonal Resident**	**Future Permanent Resident**	**Current Incidental Visitor**	**Future Incidental Visitor**
Tram cables, ACM, LBP	Soil Gravel (COPCs except PHCs)	3	VOCs, PCBs, PHCs	Inc [c]	Complete	Complete	Complete	Complete
	Soil Gravel (PHCs)	3	VOCs, PCBs, PHCs	Inc [c]	Complete	Complete	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.
[b] Value shown is the minimum - maximum number of samples per analyte.
[c] No current seasonal residents reside at this site.

ACM - Asbestos-containing materials
COPC - Chemcial of potential concern
Inc - Incomplete
LBP - Lead-based paint
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-107
HUMAN HEALTH COPCs
SITE 33 - Upper Tram Terminal
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern
Soil
Petroleum Hydrocarbons
Diesel Range Organics (DRO)
Residual Range Organics (RRO)

Notes:
COPC - Chemical of Potential Concern

Table 4-108
Human Health Carcinogenic Risk Estimates
Site 33 - Upper Tram Terminal
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Carcinogenic Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		na[e]	na[e]	na[e]	na[e]
Cumulative $ILCR_1$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[g,h]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	na[f]	na[f]
Cumulative $ILCR_2$ - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[g,i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[f]	na[f]
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[h]	**COPCs except PHCs:**	**1E-03** (As, PCBs, PAHs)	**1E-03** (As, PCBs, PAHs)	na[f]	na[f]
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[i]	**COPCs except PHCs:**	**2E-03** (As, PCBs, PAHs)	**2E-03** (As, PCBs, PAHs)	na[f]	na[f]

Notes:
As - Arsenic
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Not applicable, No detected carcinogenic COPCs found in this medium.
[f] Not applicable; Current and Future Site Visitors are not exposed to this medium.
[g] No carcinogenic COPCs were identified in samples collected from the Suqi River.

Table 4-108
Human Health Carcinogenic Risk Estimates
Site 33 - Upper Tram Terminal
Northeast Cape, St. Lawrence Island, Alaska

	Carcinogenic Risk Estimate			
Exposure Media/Constituents	**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**

[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.

[i] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-109
Human Health Noncarcinogenic Hazard Estimates
Site 33 - Upper Tram Terminal
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		Noncancer Risk Estimate: Future Seasonal Resident[a]	Future Permanent Resident[b]	Current Site Visitor[c]	Future Site Visitor[d]
Soil, COPCs except PHCs		na[e]	na[e]	na[e]	na[e]
Soil, PHCs		0.12	0.37	0.00097	0.00097
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	COPCs except PHCs:	**30**[g] (As, Cd, V, PCB)	**30**[g] (As, Cd, V, PCB)	0.0050	0.0050
	PHCs:	0.29	0.54	0.013	0.013
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	COPCs except PHCs:	**55**[g] (As, Ba, Cd, PCB)	**55**[g] (As, Ba, Cd, PCB)	0.0050	0.0050
	PHCs:	0.29	0.54	0.013	0.013
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	COPCs except PHCs:	**30**[g] (As, Cd, V, PCB)	**30**[g] (As, Cd, V, PCB)	na[f]	na[e]
	PHCs:	0.12	0.37	na[f]	na[e]
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	COPCs except PHCs:	**55**[g] (As, Ba, Cd, PCB)	**55**[g] (As, Ba, Cd, PCB)	na[f]	na[e]
	PHCs:	0.12	0.37	na[f]	na[e]

Notes:
As - Arsenic
Ba - Barium
Cd - Cadmium
COPC - Chemical of Potential Concern
DRO - Diesel Range Organics
HI - Hazard Index
PCB - Polychlorinated Biphenyls
PHC - Petroleum Hydrocarbons
na - not available
V- Vanadium

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Only PHC's detected in this media.
[f] Not applicable; Current Site Visitors are not exposed to this medium.
[g] Please note that the maximum target organ-specific HI is lower than that indicated, but still exceeds the ADEC HI criterion of 1.0.

TABLE 4-110

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 33 - Upper Tram Terminal
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
Tram cables, ACM, LBP	Soil Gravel (COPCs except PHCs)	3	VOCs, PCBs, PHCs	Complete	Complete	Complete
	Soil Gravel (PHCs)	3	VOCs, PCBs, PHCs	Complete	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

ACM - Asbestos-containing materials
COPC - Chemcial of potential concern
Inc - Incomplete
LBP - Lead-based paint
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-111
ECOLOGICAL COPECs
Site 33 - Upper Tram Terminal
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern
Soil
Petroleum Hydrocarbons
Diesel Range Organics (DRO)
Residual Range Organics (RRO)

Notes:
COPEC - Chemical of Potential Ecological Concern

TABLE 4-112

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 33 - Upper Tram Terminal
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	Tundra Vole [a] *Microtus oeconomus*	Cross Fox [a] *Vulpes vulpes*	Glaucous-winged Gull *Larus glaucescens*
Diesel Range Organics, Aliphatic	0.098	0.00029	0.0000019
Residual Range Organics, Aliphatic	0.11	0.00081	0.00000014

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .

TABLE 4-113

SUMMARY OF COMPLETE HUMAN HEALTH EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 34 - Upper Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

				Human Health				
Potential sources of contamination[a]	Media sampled	Number of samples [b]	Chemicals analyzed for	Current Seasonal Resident	Future Seasonal Resident	Future Permanent Resident	Current Incidental Visitor	Future Incidental Visitor
Drum dump, transformer, AST, ACM, LBP	Soil Gravel (COPCs except PHCs)	4 - 9	VOCs, PCBs, PHCs	Inc [c]	Inc [c]	Inc [c]	Complete	Complete
	Soil Gravel (PHCs)	4 - 9	VOCs, PCBs, PHCs	Inc [c]	Inc [c]	Inc [c]	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] No current seasonal residents reside at this site.

ACM - Asbestos-containing materials
AST - Above ground storage tank
COPC - Chemcial of potential concern
Inc - Incomplete
LBP - Lead-based paint
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-114
HUMAN HEALTH COPCs
SITE 34 - Upper Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Concern
Soil
Petroleum Hydrocarbons
Diesel Range Organics (DRO)
Residual Range Organics (RRO)

Notes:
COPC - Chemical of Potential Concern

Table 4-115
Human Health Carcinogenic Risk Estimates
Site 34 - Upper Camp
Northeast Cape, St. Lawrence Island, Alaska

Exposure Media/Constituents		**Carcinogenic Risk Estimate** **Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**
Soil, COPCs except PHCs		na[e]	na[e]	na[ef]	na[e]
Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.[g,h]	**COPCs except PHCs:**	na[e]	na[e]	na[ef]	na[e]
Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.[g,i]	**COPCs except PHCs:**	na[e]	na[e]	na[ef]	na[e]
Cumulative $ILCR_3$ - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.[h]	**COPCs except PHCs:**	na[e]	na[e]	na[ef]	na[e]
Cumulative $ILCR_4$ - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.[i]	**COPCs except PHCs:**	na[e]	na[e]	na[ef]	na[e]

Notes:
COPC - Chemical of Potential Concern
ILCR - Incremental Lifetime Cancer Risk
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident was not evaluated at this site.
[b] A future permanent resident was not evaluated at this site.
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the site soil, and they obtain potable water from the Suqi River.
[e] Not applicable, No detected carcinogenic COPCs found in this medium.
[f] Not applicable; Current Site Visitors are not exposed to this medium.
[g] No carcinogenic COPCs were identified in samples collected from the Suqi River.
[h] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from ambient locations (Site 30) is 1E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic and PCBs in fish.
[i] The estimated cancer risk for seasonal or permanent residents due to subsistence consumption of plants and fish from Sites 28 & 29 is 2E-03. The primary carcinogenic risk drivers were arsenic, PCBs and PAHs in plants, as well as arsenic, PCBs & PAHs in fish.

Table 4-116
Human Health Noncarcinogenic Hazard Estimates
Site 34 - Upper Camp
Northeast Cape, St. Lawrence Island, Alaska

		Noncancer Risk Estimate			
Exposure Media/Constituents		**Future Seasonal Resident[a]**	**Future Permanent Resident[b]**	**Current Site Visitor[c]**	**Future Site Visitor[d]**
Soil, COPCs except PHCs		na[e]	na[e]	na[e]	na[e]
Soil, PHCs		0.12	0.35	0.00091	0.00091
Cumulative HI_1 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	na	na	0.0050	0.0050
	PHCs:	na	na	0.013	0.013
Cumulative HI_2 - Potable Water is Obtained from the Suqi River and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	na	na	na[e]	na[e]
	PHCs:	na	na	0.013	0.013
Cumulative HI_3 - Potable Water is Obtained from Shallow GW and Subsistence Food is Obtained from Ambient Locations.	**COPCs except PHCs:**	na	na	na[f]	na[e]
	PHCs:	na	na	na[f]	0.00091
Cumulative HI_4 - Potable Water is Obtained from the Shallow GW and Subsistence Food is Obtained from Site 28/29.	**COPCs except PHCs:**	na	na	na[f]	na[e]
	PHCs:	na	na	na[f]	0.00091

Notes:
COPC - Chemical of Potential Concern
HI - Hazard Index
PHC - Petroleum Hydrocarbons
na - not available

[a] A future seasonal resident will reside at the Northeast Cape during the summer months for subsistence hunting/fishing/gathering.
[b] A future permanent resident resides at the Northeast Cape year long and engages in subsistence hunting/fishing/gathering
[c] A current site visitor may be exposed to COPCs in site soil, and they obtain potable water from the Suqi River.
[d] A future site visitor may be exposed to COPCs in the soil, and obtains potable water from site groundwater.
[e] Only PHC's detected in this media.
[f] Not applicable; Current Site Visitors are not exposed to this medium.

TABLE 4-117

SUMMARY OF COMPLETE ECOLOGICAL EXPOSURE PATHWAYS FOR THE FINAL RISK ASSESSMENT
Site 34 - Upper Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Potential sources of contamination[a]	Media sampled	Number of samples[b]	Chemicals analyzed for	Receptor: Tundra Vole[c]	Receptor: Cross Fox[c]	Receptor: Glaucous-winged Gull
Drum dump, transformer, AST, ACM, LBP	Soil Gravel (COPCs except PHCs)	4 - 9	VOCs, PCBs, PHCs	Complete	Complete	Complete
	Soil Gravel (PHCs)	4 - 9	VOCs, PCBs, PHCs	Complete	Complete	Complete

Notes:

[a] Derived from Table 1-1 of the Draft 2001 Phase III Remedial Investigation and Risk Assessment Update.

[b] Value shown is the minimum - maximum number of samples per analyte.

[c] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

ACM - Asbestos-containing materials
AST - Above ground storage tank
COPC - Chemcial of potential concern
Inc - Incomplete
LBP - Lead-based paint
PCBs - Polychlorinated biphenyls
PHCs - Petroleum hydrocarbons
VOC - Volatile organic compounds

TABLE 4-118
ECOLOGICAL COPECs
Site 34 - Upper Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Chemical of Potential Ecological Concern
Soil
PCBs
PCB-1254 (Aroclor 1254)
PCB-1260 (Aroclor 1260)
Petroleum Hydrocarbons
Diesel Range Organics (DRO)
Residual Range Organics (RRO)

Notes:
COPEC - Chemical of Potential Ecological Concern
PCB - Polychlorinated Biphenyls

TABLE 4-119

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
Site 34 - Upper Camp
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (Max HQ)		
Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
Diesel Range Organics, Aliphatic	0.16	0.0016	0.000011
Sites 33 & 34 Combined			
Diesel Range Organics, Aliphatic	0.16	0.0036	0.000014

Notes:
[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

HQ - Ecological hazard .

5.0 UNCERTAINTY ANALYSIS

Following is a brief summary of potential uncertainties associated with the HHERA conducted for the Northeast Cape Installation. The following uncertainties have been identified based on limitations in the available information, methods, or assumptions that are described in this HHERA.

5.1 CONTAMINANT SOURCE CHARACTERIZATION

Environmental investigations conducted at the Northeast Cape Installation were based on site histories, known or suspected releases, and physical characteristics (the presence of waste materials or topographic anomalies). These site investigations focused on known or suspected sources of contamination, and included a tiered approach consisting of three phases of RIs and supplemental investigations, including biological assessments (ENRI, 2000). Nevertheless, a degree of uncertainty remains in the characterization of contaminant sources at the Northeast Cape Installation because it is not practicable to sample all areas of the 4-square mile site. However, USACE and ADEC concur that this uncertainty is sufficiently low to proceed with the risk assessment phase. Results of the risk assessment have identified the primary receptors potentially at risk, and the associated sites, exposure pathways, and contaminants associated with these potential risks. This information may result in recommendations to perform additional monitoring studies and/or confirmation sampling at the Northeast Cape Installation to supplement existing site characterization data, based on conclusions of the FS.

Most of the site characterization data were collected to evaluate both human health and ecological impacts. This process could potentially compromise the quality of data collected for the evaluation of potential risks to human health versus ecological receptors. For example, sampling and analysis of plants was performed to evaluate both human health and ecological impacts. However, the portions of plants consumed by humans versus animals may be different in some cases, and result in over- or under-estimation of the EPC. This was not the case for fish tissue sampling data, however. Whole fish samples (e.g., Alaska blackfish) were only collected for the evaluation of potential ecological exposures, and portions of fish (e.g., fillets, eggs, heads and remains) were collected to characterize potential human exposures to chemicals through the food chain. An investigation to assess biological impacts was conducted by ENRI (2000). Although this investigation did not include assessing all areas of the Suqitughneq River watershed, the most impacted areas, including the Drainage Basin, were targeted. Additional biological investigations, including monitoring of small mammals, marine mammals or birds that may be exposed to Northeast Cape Installation contaminants, have been proposed by the community. Potential exposures and risks to small mammals and birds were modeled in the predictive ERA. Results of the predictive ERA will be used to evaluate the need for, and potential parameters to be assessed in, any future biological monitoring activities for such species that may be proposed for the Northeast Cape Installation. Marine mammals were not monitored because (1) they are not anticipated to receive significant exposures to contaminants originating from the Northeast Cape Installation as described in Section 5.3, (2) it is not practical or feasible to monitor these species due to the time, expense and numbers of animals that would be required to obtain a statistically valid sampling population, (3) it would be difficult to attribute body burdens resulting from the Northeast Cape Installation to such wide-ranging species, and (4) methods are not currently available to correlate body burdens in marine mammals with a toxic response.

5.2 SITE COPC AND COPEC IDENTIFICATION

The process used in selecting site COPCs may introduce a degree of uncertainty in the HHRA. However, protective methods and assumptions were used in selecting site COPCs, in accordance with State of Alaska regulations (18 AAC 75). Protective assumptions used in the COPC screening procedure included comparison of maximum detected chemical concentrations to one-tenth of the most protective screening criteria listed in 18 AAC 70 and 18 AAC 75. Chemicals without risk-based screening benchmarks were screened based on toxicity information for surrogate chemicals to the extent appropriate (refer to Section 5.4 for a discussion of uncertainties in the surrogate approach). Chemicals that exceeded criteria and benchmarks, and chemicals without screening benchmarks or appropriate surrogates, were carried into the Tier II risk assessment.

Uncertainties exist in the identification and quantification of PHCs. ADEC regulations for the cleanup of PHC-contaminated media have changed since the 1994 Phase I RI data were collected. Initial Phase I investigations at the Northeast Cape Installation used EPA Method E418.1 for measuring TRPH, in addition to SW8015M for measuring GRO and SW8100M for measuring DRO. Method E418.1 is a non-specific method that includes identification of a broad range of natural and anthropogenic (i.e., man-made) hydrocarbons. Consistent with ADEC policy, this method was eliminated in later phases of the RI for the Northeast Cape Installation due to its non-specificity. Methods SW8015M and SW8100M were also replaced with ADEC-approved AK101 and AK102, respectively, between 1996 and 1998. By 1998, all PHC data at the Northeast Cape Installation were collected and analyzed using AK101, AK102, and AK103 for GRO, DRO, and RRO, respectively. It should be noted that soil and groundwater cleanup criteria listed in 18 AAC 75.341 and 18 AAC 75.345 are based on analysis using AK101, AK102, and AK103. Consequently, Tier I screening for abiotic media at the Northeast Cape Installation included all PHC sampling results analyzed using AK101, AK102, and AK103. In addition, because PHC data for some sites and media (e.g., Site 3 soils) were only analyzed using methods SW8015M and SW8100M, these data were also included in the quantitative Tier I screening process. However, data collected using Method E418.1 for TRPH were not included in Tier I screening, consistent with ADEC policy.

Samples of biological media (i.e., plants and fish) were not analyzed for GRO, DRO, or RRO because biological lipids may interfere with PHC analyses. Consistent with ADEC and EPA policies, plant and fish tissue samples were analyzed for individual PAHs. Samples of biological media and abiotic media (i.e., soil, sediment and water) were not analyzed for Mirex or individual PCB congeners. Mirex is not typically included in EPA's standard laboratory analytical methods. Analysis of individual PCB congeners can be a useful method for identifying a source of PCB contamination through 'fingerprinting'. This may be particularly useful where there are multiple potential sources of contamination, including possible regional atmospheric deposition of PCBs. However, current EPA methods for the evaluation of human health risks associated with PCBs are based on Aroclors, not specific PCB congeners. Therefore, the majority of PCB sampling data collected during the RI for the Northeast Cape Installation, and evaluated in this HHERA, were based on Aroclor analyses.

The specific process used in the selection of site COPECs for evaluation of risks to ecological receptors may also introduce a degree of uncertainty in the ERA. The State of Alaska does not list specific numeric criteria for screening environmental media for potential impacts to ecological receptors. However, State of Alaska regulations (18 AAC 70 and 18 AAC 75) and guidance documents do identify risk assessment procedures, sources of ecological screening benchmarks, and other information for the identification of site COPECs. Protective methods and assumptions were used in selecting site COPECs. Protective assumptions used in the COPEC screening procedure include comparing maximum detected chemical concentrations to one-tenth of the most protective screening criteria listed in 18 AAC 70 or 18 AAC 75.345. Ecological screening using one-tenth the benchmark concentration is not required by State of Alaska regulations (18 AAC 75) and is overly protective (i.e, this practice results in the identification of more COPECs than screening based on the benchmark concentration itself). Although this approach resulted in the identification of more COPECs than necessary, the majority of COPECs were excluded as risk drivers during the Tier II baseline ERA. Chemicals without risk-based screening benchmarks were screened based on ecotoxicity information for surrogate chemicals to the extent appropriate. Chemicals that exceeded criteria and benchmarks, and chemicals without screening benchmarks or appropriate surrogates were carried into the Tier II baseline ERA (refer to Section 5.4 for a discussion of uncertainties in the surrogate approach).

5.3 EXPOSURE ASSESSMENT/PROBLEM FORMULATION

Exposure assessment and problem formulation describe the processes used to identify potentially important receptors, exposure media, exposure pathways, and methods to quantify exposure of human health and ecological receptors, respectively, to site contaminants. Potential uncertainties in the exposure assessment include, but are not limited to, the receptors, exposure pathways, exposure assumptions, and EPCs that were quantitatively and/or qualitatively evaluated in the HHRA and ERA. Receptors that were quantitatively evaluated in the HHRA for the Northeast Cape Installation include current seasonal residents, future seasonal residents, and future permanent residents who may engage in subsistence hunting/fishing/gathering activities, and current and future site visitors. Although other human receptors may potentially be exposed to contaminants at the Northeast Cape Installation, it is believed that future seasonal and permanent residents represent the most highly exposed individuals and, therefore, result in the most protective estimates of risk.

Inhalation of wind-borne dust and VOCs were identified as potentially complete but insignificant exposure pathways for the Northeast Cape Installation. Although eliminating these exposure pathways from the quantitative portion of the HHRA may result in some uncertainty, the resulting risk estimates were not anticipated to be significantly underestimated based on the following:

- Primary petroleum fractions are not appreciably volatile.

- Absence of basements in future structures limit the potential for VOC inhalation in indoor air. However, VOCs may still migrate into and accumulate within residences without basements.
- Precipitation and cold temperatures minimize volatilization and generation of dust particulates.
- The Northeast Cape Installation is covered by snow much of the year, resulting in very little opportunity for particulate emissions.
- Soils at most of the sites have re-vegetated resulting in very little opportunity for particulate emissions.

Possible exceptions to the above include historic and ongoing investigation and construction activities at the Northeast Cape Installation that may result in entrainment of dusts from heavy equipment operation and transport of dusts to areas outside of the immediate Northeast Cape Installation. It should be noted, however, that this exposure pathway and the associated risk is generally related to heavy vehicle traffic associated with construction or remediation activities. Such risks are considered to be short-term in nature, and will be evaluated during the FS stage of the RI/FS process. Wind transport has also been proposed as a possible mechanism for transport of site-related contaminants to off-site areas and receptors. For example, wind transport has been proposed as an explanation for the observed detections of PCBs in plant tissue samples collected from ambient areas (Site 30) and fish tissue samples collected from the Tapisaghak River. However, prevailing winds are in a southwesterly direction during the summer months when wind transport of dust would be highest; therefore, Site 30 plants sampling locations are upwind of the Northeast Cape Installation. The location of ambient fish tissue sample collection (i.e., the Tapisaghak River) is also upwind of the Northeast Cape Installation during the summer months, and lies within a completely separate drainage system from the Northeast Cape Installation.

Exposure of nursing infants to lipophilic COPCs through the maternal milk pathway was identified as a potentially complete pathway that was not quantitatively evaluated in the HHRA for the Northeast Cape Installation. As described in Section 3.2.2.1.4.6, considerable uncertainty is associated with evaluating this pathway because only limited pharmacokinetic and toxicological data are available regarding nursing infant exposures. Consequently, no standard EPA or ADEC equations and exposure assumptions for quantifying this pathway are currently available.

The exposure assessment for human receptors included assumptions regarding potential future potable uses of ephemeral standing surface water, permanent fresh surface water, shallow subsurface water, and deep subsurface water. Current seasonal residents of the Northeast Cape Installation (i.e., the Toolies) obtain potable water from the upper reach of the Suqitughneq River, prior to its confluence with Site 28 (Drainage Basin). Consistent with 18 AAC 75.350, deep surface water, shallow subsurface water, and fresh surface water in potential communication with groundwater were assumed to be potential sources of potable water in the HHRA. Because the surface water data set for the Northeast Cape Installation included sampling results collected from standing water (including potholes), and other locations that are unlikely sources of potable water, ephemeral sources of water were not evaluated as potential potable water. However, it is possible that future visitors to the area may occasionally drink, or cook with, water obtained from such sources.

Groundwater associated with deep potable wells at Site 22 was evaluated as a potential future drinking water source for the Northeast Cape Installation. Carcinogenic risk estimates associated with this pathway were below ADEC's point of departure criterion for risk management, while noncarcinogenic HI estimates for future permanent residents slightly exceeded the criterion of 1.0. The risk drivers for potable uses of groundwater were DRO and RRO. Although the indicated risk estimates for Site 22 are believed to be representative of potential future risks associated with potable uses of groundwater at the Northeast Cape Installation, in general, the available data are spatially limited. Deep groundwater sampling data are not currently available for other locations, such as areas located hydraulically downgradient of Site 22.

Exposure of human receptors to COPCs through the food chain is typically associated with substantial uncertainty due to the methods and assumptions used in modeling food chain exposures. Attempts were made to minimize the uncertainties in evaluating this pathway through the use of: (1) site-specific information concerning dietary practices, and (2) measured rather than modeled EPCs in major subsistence items of dietary importance to receptors using the Northeast Cape Installation. To obtain information on dietary practices and subsistence food items harvested from the Northeast Cape Installation, surveys and interviews were conducted with individuals who engage in subsistence hunting, fishing, and plant gathering in the vicinity of the Northeast Cape Installation. Initial surveys and interviews were conducted in summer 2001 prior to conducting the 2001 field investigation, which included sampling of plants and fish at the Northeast Cape Installation and ambient locations. A follow-up interview was conducted with the Toolie family on January 14, 2002, to refine the previous survey information. However, information on portion sizes consumed by adults and children were not available from this early survey/interview information. A supplemental survey was conducted in January 2003, and provided more specific information regarding the frequency of subsistence plant and fish consumption and portions consumed by local seasonal residents. A significant uncertainty regarding the supplemental survey information is that it represents subsistence food harvesting and consumption patterns of only six respondents. Quantities of subsistence foods harvested and consumed by other individuals could be more or less than those assumed in this HHRA. This information was incorporated into the current HHRA conducted for the Northeast Cape Installation.

Besides fish and native plants, locally harvested reindeer, marine mammals, and shellfish were also identified in the surveys as important dietary items for subsistence users. However, these items were not quantitatively evaluated in the HHRA, as described above. Potential exposures and risks associated with human consumption of reindeer harvested from the vicinity of the Northeast Cape Installation were evaluated by the ATSDR (USDHHS, 2001). The ATSDR health assessment indicated that risks associated with this pathway were minimal. Therefore, this pathway was not quantitatively evaluated in the Tier II HHRA for the Northeast Cape Installation. Potential exposures to site contaminants associated with consumption of marine mammals are anticipated to be low because marine mammals: (1) have very wide foraging ranges, (2) are migratory species and are present in the vicinity of the Northeast Cape Installation for only a portion of the year, and (3) do not use inland areas or the lagoon for foraging or breeding. In addition, attributing chemical concentrations in these wide-ranging species to potential contaminant releases from the Northeast Cape Installation would be extremely difficult. Shellfish consumption was not quantified because shellfish are not harvested in the vicinity of the Northeast Cape Installation. Primary methods of shellfish harvesting include collecting shellfish that have washed up on beaches, or those found in the stomachs of harvested walruses.

Finally, the media-specific EPCs used to quantify exposures for human receptors may result in uncertainty in the exposure dose estimates. To address this potential uncertainty, maximum or 95% UCL concentrations were used in estimating exposure doses for current and hypothetical future receptors exposed to site-related media, consistent with ADEC (2000b) and USEPA (1989a, 1992a) guidelines. Based on the above considerations, the exposure doses that were presented in the HHRA for the Northeast Cape Installation are believed to represent protective, upper bound estimates of exposure.

Potential uncertainties in the problem formulation phase of the ERA included, but were not limited to, ecological resources determined to be potentially impacted, applicable exposure pathways, exposure information and assumptions, and the EPCs that were quantitatively and/or qualitatively evaluated in the ERA. It is possible that ecological species not identified in the biological characterization may occur at the Northeast Cape Installation. However, the species listed in Tables 3-14 through 3-19 were identified based on known sightings by island residents or biologists, communication with ADF&G personnel, biological sampling reports, and habitat-specific field guides.

Waterfowl and marine mammals are present in the vicinity of the Northeast Cape Installation, but were not identified as indicator receptors for evaluation in the ERA. These receptors may be exposed to COPECs derived from the Northeast Cape Installation, but did not meet the exposure potential criterion. Waterfowl were not chosen because:

- Waterfowl are migratory and are present in the vicinity of the Northeast Cape Installation for only brief portions of the year.
- Waterfowl have wide foraging ranges and are anticipated to use the Northeast Cape Installation on a highly infrequent basis.
- Females typically feed very little while nesting, which limits exposures to site COPECs, such as PCBs, that may affect reproduction.

In addition, waterfowl were anticipated to have lower exposures to bioaccumulating COPECs, including PAHs and PCBs, than piscivorous birds such as the glaucous-winged gull.

Marine mammals did not meet the exposure potential criterion because:

- Marine mammals are migratory and are present near the Northeast Cape Installation for only brief portions of the year.
- Marine mammals have wide foraging ranges and do not use the Northeast Cape Installation exclusively.

Furthermore, given the migratory patterns and wide foraging ranges of marine mammals, it would be extremely difficult to attribute potential effects in such species to the Northeast Cape Installation COPECs.

Exposure pathways quantitatively evaluated in the ERA for terrestrial mammals and birds include uptake through the food chain and incidental ingestion of abiotic media (soil, sediment, or surface water). Although potential exposures through inhalation and dermal contact are possible, these exposure pathways were not quantitatively evaluated in the ERA. Inhalation and dermal exposures cannot be quantified for ecological receptors at this time due to lack of toxicity data and exposure information for these pathways. It should be noted, however, that the ingestion pathway typically dominates the exposure dose for ecological receptors (Suter, 1993). Therefore, exclusion of inhalation and dermal pathways from the exposure estimate is not believed to significantly underestimate the ecological hazard.

Potential exposures to the tundra vole and glaucous-winged gull were evaluated at Sites 28 and 29, respectively, based on tissue sampling results for plants and fish. For the remainder of the sites, ecological exposures and risks were evaluated using modeled concentrations in forage or prey items based on abiotic sampling results. Although plant and animal tissue sampling at all sites would significantly reduce the uncertainty in the exposure estimates for indicator receptors, such sampling was demed to be too expensive to conduct on a broad scale. Results of the predictive ERA will be used to evaluate the need for, and potential parameters to be assessed in, any potential future biological monitoring activities conducted for the Northeast Cape Installation.

Exposure to multiple sites was evaluated in cases where sites occur in close proximity to one another. In such cases, COPEC concentrations across the sites were combined, and each receptor's SUF was increased to reflect the combined exposure area. Ecological hazard estimates generally increased for combined sites because the SUF increased. This practice was overly protective in cases where a chemical occurred in only one of the sites included in the grouping; particularly, if the EPC was based on the maximum detected concentration. This is because the chemical was assumed to be present at the maximum concentration over the entire site grouping, even though it may not have been detected at one of the sites.

EPCs and exposure doses for ecological receptors did not include contributions from chemicals in biotic and abiotic media from non-contaminated areas. Contributions of chemicals from non-contaminated areas were not included in the exposure estimate because (1) non-contaminated areas other than specific ambient sampling locations were not sampled, and (2) ecological HQ estimates were intended to represent incremental hazards above ambient exposures.

Finally, the media-specific EPCs used to quantify exposures for ecological receptors may result in uncertainty in exposure dose estimates. To address this potential uncertainty, maximum or 95 % UCL concentrations were used in estimating exposure doses for ecological receptors exposed to site-related media, consistent with ADEC (2000b) and USEPA (1989a, 1992a) guidelines. Based on the above considerations, the exposure doses presented in the ERA for the Northeast Cape Installation are believed to represent protective, upper bound estimates of exposure.

5.4 TOXICITY ASSESSMENT/ECOLOGICAL EFFECTS EVALUATION

The toxicity values (CSFs and RfDs) that were used in estimating carcinogenic risks and noncarcinogenic hazards also represent a potential source of uncertainty. The toxicity values used in the HHRA for the Northeast Cape Installation were derived from EPA sources, as described in Section 3.1.2.3. Toxicity values that are developed by the EPA generally represent upper bound estimates of toxicity, and incorporate uncertainty factors for extrapolation from animal data to humans, differences in individual sensitivity within populations, and the overall confidence in the data set. Because the toxicity values established by EPA are based on NOAEL concentrations and incorporate uncertainty factors, they are generally considered to be protective. The use of conservative toxicity values in the risk estimate tends to overestimate actual risks.

For chemicals without toxicity information, carcinogenic risk or noncarcinogenic hazard estimates were calculated using toxicity information for surrogate chemicals where available. The derivation of toxicity information based on the use surrogate chemicals was performed as described in Section 3.1.1.5. The surrogate approach was used because toxicity values or benchmarks have not been developed for many chemicals, and failure to quantitatively evaluate chemicals without toxicity values may underestimate the total cumulative risk for a contaminated site. It should be noted, however, that there are limitations and uncertainties in use of the surrogate approach. For example, chemicals with apparently similar chemical structures may have vastly different toxicological mechanisms or potencies. This point is illustrated by the chemicals 1,1-dichloroethane (a noncarcinogen) and 1,2-dichloroethane (a carcinogen). The structures of these chemicals differ only in the position of chlorine substitution. In many cases, it may be better not to assign surrogate toxicity values and acknowledge the uncertainty in the risk estimate. For this reason, the surrogate approach was applied sparingly and included evaluation of toxicological mechanisms and fate/transport information, rather than chemical structures alone.. Chemicals without surrogate toxicity information were qualitatively evaluated in the HHRA, and the uncertainties in not including them in the quantitative risk estimate were discussed.

The ADEC Method Two Soil Cleanup Levels for xylenes were inadvertently not used as surrogates for m,p-xylenes during the Tier I human health screening process. Although, this resulted in m- and p-xylenes being carried through the HHRA as COPCs for soil, xylenes were eliminated as chemicals of concern at all sites where they were detected during the Tier baseline HHRA.

Route-to-route extrapolations were used when toxicity values were not available for a given route of exposure. The most frequent route-to-route extrapolations were performed to derive dermal CSFs or RfDs from oral values, because dermal CSFs and RfDs are not typically available. However, route-to-route extrapolations were also perfomed when inhalation CSFs or RfDs were not available, and the toxicological information supports such extrapolation. Route-to-route extrapolations were performed as described in USEPA (2002c). Route-to-route extrapolation results in potential uncertainty in the toxicological and risk evaluations for chemicals where this practice was employed, because some chemicals may be more or less toxic, or exhibit a different mechanism of toxicity, by the dermal versus oral route of exposure. In the case of DRO and RRO, dermal RfDs are not currently available for these COPCs. Route-to-route extrapolations from oral toxicity information was not performed for PHCs including DRO and RRO, due to uncertainties regarding mechanisms of toxicity between oral and dermal routes of exposure to PHCs. Consequently, dermal hazards associated with DRO and RRO were not quantified in the Tier II HHRA. This is not anticipated to significantly underestimate hazards for these COPCs, since exposures and risks by the oral exposure route are typically much higher than those by the dermal exposure route for PHCs.

As described in Section 3.2.5, ecological TRVs were used to calculate HI estimates for ecological indicator receptors. Ecological TRVs were of the following two types: 1) media-based TRVs for organisms inhabiting soil, sediment, and surface water; and 2) dietary-based TRVs for upper trophic level receptors (carnivorous indicator receptors such as the cross fox). It must be noted that these sources do not include toxicity information specific to the avian and mammalian indicator species evaluated in the ERA for the Northeast Cape Installation. Instead, toxicity information derived from studies in other avian or mammalian species were used to quantify ecological hazards for these indicator species. A source of uncertainty in this practice is that an indicator receptor may be more or less sensitive to a particular chemical than the species in which the chemical was tested.

Another potential source of uncertainty derives from the fact that toxicity values may not be available for all COPECs. For chemicals without toxicity information, ecological hazards were evaluated using toxicity information for surrogate chemicals where available. Chemicals without surrogate toxicity information were qualitatively evaluated in the ERA, and the uncertainties in not including them in the quantitative risk estimate are discussed.

5.5 RISK CHARACTERIZATION

The different sources of uncertainty previously described are incorporated in the risk estimate. Because the majority of these uncertainties err on the conservative side, the estimated risks presented in the HHRA for the Northeast Cape Installation most likely represent upper bound estimates; the actual risks are anticipated to be less. For example, PHC measurements for DRO contributed to excess noncancer HI estimates and ecological HQ estimates in excess of the ADEC risk management criterion of 1.0 at a number of sites. However, for many of these sites (e.g., Sites 4, 13, 15, 19, 22, 31 and 32) the HI or HQ estimates were only marginally above 1.0. Contributing factors that likely result in overestimates of risk for PHCs such as DRO include:

- Ambient levels were not established for PHCs in abiotic media (i.e., soil, sediment or water) and natural plant waxes and lipids may have contributed to higher measured values of PHCs than actually exist in these media.
- When aliphatic and aromatic fractions of DRO were not measured, they were estimated from total measured DRO concentrations assuming 80 percent aliphatic hydrocarbons and 40 percent aromatic hydrocarbons, consistent with ADEC guidance (ADEC, 2000c). Thus, assumed concentrations of DRO that were used in HI and HQ estimates for human and ecological receptors were 20 percent higher than measured total DRO concentrations.
- Media transfer factors and toxicity values for PHCs are based on fresh petroleum hydrocarbons or surrogate chemicals. Use of such values tends to overestimate the uptake

and toxicity of chemicals such as petroleum hydrocarbons in aged soils, due to chemical sequestration processes (Reeves et. al., 2001; Tannenbaum, 2003).

ADEC currently considers a cumulative cancer risk estimate of 1E-5 and a noncancer HI of 1.0 as the point of departure for making risk management decisions concerning a site. It should be noted, however, that according to the State of Alaska (AAC 75.325(h)) and USEPA (1991b), sites with a cumulative cancer risk estimate between 1E-6 and 1E-4, and a noncancer HI of less than 1.0, may be appropriate for NFRAP following an evaluation of site-specific issues related to future land uses, technical feasibility of remediation, and related considerations. It should also be noted that the Army's interpretation regarding the point of departure for cancer risk and noncancer HI is consistent with current EPA policy (USEPA, 1991b).

The different sources of uncertainty previously described are incorporated in the ecological hazard estimate. Because many of the uncertainties in the ERA err on the conservative side, the estimated ecological hazards also most likely represent upper bound estimates; the actual hazards are anticipated to be less. ADEC currently considers an ecological HQ of 1.0 as the point of departure for making risk management decisions concerning a site. Ecological HQ values exceeding 1.0 are generally considered as indicative of potentially adverse biological or ecological effects on representative receptors. However, HQ values above 1.0 do not necessarily indicate that a biological or ecological effect will occur, only that a lower threshold has been exceeded. The HQ value scheme is derived from toxicity testing in an aquatic framework, and a high HQ may not necessarily mean that representative ecological receptors are experiencing adverse health effects. For example, the TRVs that were used in this ERA are NOAEL-based. Therefore, environmental exposures higher than the TRV may be without adverse effect. Potential limitations in the HQ approach, as applied to ERAs, are described further in Tannenbaum et al. (2003). Limitations in the HQ approach, as cited by Tannenbaum et al. (2003), include but are not limited to the following:

- The HQ is a measure of concern, not risk, and does not provide information regarding the probability of an adverse effect.
- The HQ is not a population based metric, and does not refer to the number of individuals or the percentage of the exposed population that is expected to develop the toxicological effect of concern.
- The HQ does not increase linearly as unity (1.0) is approached, thereby denying opportunities for HQ comparisons between chemicals.
- The HQ has a propensity to easily exceed its threshold value (i.e., 1.0) due to the protective toxicity values and exposure assumptions used.
- The HQ has a propensity to assume values that are unreasonably high.

Based on the above limitations, the ecological HQ estimate in and of itself should not be used to determine whether a contaminated site requires remediation. The ADEC risk management level is set at an ecological HQ of 1.0. Consistent with ADEC guidance (ADEC, 2002a), chemicals and sites associated with ecological HQ estimates greater than 1.0 are retained for further evaluation. Further evaluation of sites with ecological HQ estimates in excess of 1.0 will be conducted during the FS stage of the RI/FS process for the Northeast Cape Installation. Potential options considered for such sites may include but not be limited to ecological field validation studies, additional investigations of ambient conditions, or remedial options.

6.0 SUMMARY AND CONCLUSIONS

This HHERA evaluated potential risks to human health and the environment due to historic operations at the Northeast Cape Installation. Conclusions of the human health risk evaluation are summarized in Section 6.1 and potential ecological impacts are discussed in Section 6.2.

6.1 POTENTIAL HUMAN HEALTH RISKS

The HHRA for the Northeast Cape Installation evaluated potential risks to human health based on current and hypothetical future land uses, consistent with the CSM described in Section 3.1.2. Health risk estimates for current receptors reflect current land uses and anticipated exposures for the near future. Health risk estimates for future receptors are hypothetical, and reflect potential human health risks in the event of increased utilization of the Northeast Cape Installation by future seasonal residents, or the establishment of permanent residences. Results of the HHRA for current and future human receptors are described in the following subsections.

6.1.1 Current Receptors

Risks to current human receptors (i.e., seasonal residents of the Site 4 [Subsistence Fishing and Hunting Camp], and visitors to the Northeast Cape Installation) are below ADEC point of departure criteria for carcinogenic risk and noncarcinogenic hazard based on exposure to site-specific media (Table 6-1). This conclusion is based on: (1) risk estimates for current inhabitants of the Subsistence Fishing and Hunting Camp who are exposed to Site 4 soils, and (2) risk estimates for current site visitors exposed to soils and other media at remaining sites. Risk estimates based on exposure to water derived from the Suqitughneq River for potable uses by current seasonal residents of Site 4 and current visitors to the Northeast Cape Installation are also below ADEC point of departure criteria. However, when subsistence food use is considered for current seasonal residents of Site 4, estimates of potential carcinogenic risk and noncarcinogenic hazard exceed ADEC's point of departure criteria. It should be noted, however, that these risks are likely overestimated due to the protective assumptions that were used in this HHRA (refer to Sections 3.1.2.1 and 5.0). In addition, results of this HHRA suggest that regional, ambient contamination may contribute significantly to potential exposures and risks for current receptors engaged in subsistence food collection and use. Uncertainties related to the risk evaluation for subsistence food use are discussed further in Sections 5.3 and 6.1.2.4.

6.1.2 Future Receptors

Potential risks to future receptors are highly dependent upon ultimate land uses for the Northeast Cape Installation. Based on continued use of the Northeast Cape Installation as a base for subsistence fishing and hunting, with seasonal residences at Site 4 (Subsistence Fishing and Hunting Camp) and incidental contact with other sites, future human health risks and hazards are as described above for current receptors. No sites within the Northeast Cape Installation were associated with carcinogenic risk or noncarcinogenic hazard estimates for future incidental visitors in excess of ADEC's point of departure criteria for risk management (Table 6-2). However, if future land uses for the Northeast Cape Installation include establishment of seasonal or permanent residences at sites other than Site 4, then human health risks will depend upon the specific site inhabited, the source of potable water used, and locations in which subsistence foods are collected. Health risk estimates associated with exposures to specific site media are discussed below.

6.1.2.1 Soils and Sediment

Sites associated with soil-related carcinogenic risk or noncarcinogenic hazard estimates for future seasonal or permanent residents in excess of ADEC's point of departure criteria include: Sites 4, 6, 7, 9, 10, 11, 13, 15, 16, 19, 21, 22, 27, 28, 31 and 32 (Table 6-2). The primary soil contaminants associated with risk or hazard estimates in excess of ADEC's point of departure criteria include arsenic, DRO, and PCBs (Aroclor-1260). However, carcinogenic risk estimates for many of these sites (e.g., Sites 4, 13, 15, 19, 22, 31 and 32) were below the ADEC risk criterion and noncarcinogenic HI estimates were only marginally above 1.0, due to the presence of DRO in soil. Risk estimates for PHCs including DRO were most likely overestimated, as described in Section 5.5. Other soil contaminants contributing to cumulative risk or hazard estimates in excess of ADEC's point of departure criteria include dioxins/furans at Sites 7 and 9, and PAHs at Site 28.

The remaining sites (i.e., Sites 3, 29, 33 and 34) were associated with carcinogenic risk and noncarcinogenic hazard estimates for future human receptors below ADEC's point of departure criteria, based on exposure to chemicals in soil or sediment.

6.1.2.2 Fresh Surface Water

Permanent fresh surface water at the Northeast Cape Installation that may serve as potential sources of potable water for future receptors include Site 28 (Drainage Basin) and the Suqitughneq River. Carcinogenic risk and noncarcinogenic hazard estimates for future seasonal residents using water obtained from Site 28 exceed ADEC's point of departure criteria (Section 4.15). Primary risk drivers for this potential potable water source included PCBs and DRO. No carcinogenic COPCs were identified for water samples collected from the Suqitughneq River, and noncarcinogenic hazard estimates were below ADEC's point of departure criterion (Section 4.16). The Suqitughneq River is the current source of potable water for seasonal residents or visitors to the Northeast Cape Installation.

6.1.2.3 Subsurface Water

Sites associated with excess carcinogenic risk or noncarcinogenic hazard estimates related to potential use of shallow subsurface water beneath the site as a potable water supply include:

- Sites 7, 11, 13, 15, 16, 19, 21, 27 and 28 – the primary contaminants in shallow subsurface water associated with risk or hazard estimates at these sites in excess of ADEC's point of departure criteria include arsenic, benzene, DRO, GRO or RRO.
- Site 9 (Housing and Operations Landfill) – the primary contaminants in shallow subsurface water associated with risk or hazard estimates at this site in excess of ADEC's point of departure criteria include dioxins/furans, metals (aluminum and antimony) and DRO.

- Sites 3, 4 and 22 – were associated with noncarcinogenic hazard estimates in excess of ADEC's point of departure criteria due to the presence of DRO and/or RRO in shallow subsurface water.

For the remaining sites (i.e., Sites 6, 10, 29, 31, 32, 33 and 34), either shallow subsurface water is absent from this location, or carcinogenic risk or noncarcinogenic hazard estimates related to use of this medium as a potable water supply are below ADEC's point of departure criteria.

It should be noted that potential future use of shallow subsurface water at the Northeast Cape Installation as a permanent potable water supply is highly unlikely. This is due to the difficulty in developing this source (i.e., drilling a well or digging a pit), the availability of other clean, potable water sources (e.g., the Suqitughneq River) nearby, and the fact that shallow subsurface water lies within the permafrost zone and is frozen a significant portion of the year.

A more reasonable subsurface source of permanent potable water at the Northeast Cape Installation is deep subsurface water. The Air Force used three wells installed in deep subsurface water at Site 22 to produce potable water during historic military operations at the Northeast Cape Installation. The carcinogenic risk estimate for future permanent residents using deep subsurface water at Site 22 as a potable supply is below ADEC's point of departure criterion. However, the noncarcinogenic hazard estimate of 1.9 (attributable to RRO) exceeds the ADEC point of departure criterion of 1.0.

6.1.2.4 Subsistence Food Use

This HHRA included an evaluation of potential risks associated with subsistence food use, assuming that subsistence fish and plants may be harvested from impacted areas of the Northeast Cape Installation or from locations within the vicinity of the Northeast Cape Installation that are believed unimpacted by site activities. Biological sampling activities included the collection of fish from the Tapisaghak River, which is presumed to be unimpacted by historic military operations (refer to Section 5.3). Carcinogenic risk and noncarcinogenic hazard estimates associated with future consumption of fish harvested from the Suqitughneq River were calculated as 9E-4 and 17, respectively (Table 6-3). These risk estimates were attributable to the presence of arsenic, PAHs, and PCBs (Aroclor-1254 and Aroclor-1260) in fish fillet samples collected from the Suqitughneq River. The maximum target organ-specific HI for future seasonal residents consuming fish harvested from the Suqitughneq River was estimated as 12, and was attributable to arsenic. Carcinogenic risk and noncarcinogenic hazard estimates associated with future consumption of fish harvested from the Tapisaghak River (Site 30) were calculated as 1E-3 and 19, respectively. These risk estimates were attributable to the presence of arsenic and PCBs (Aroclor-1254 and Aroclor-1260) in fish fillet samples collected from the Tapisaghak River. The maximum target organ-specific HI for future seasonal residents consuming fish harvested from the Tapisaghak River was estimated as 15, and was attributable to arsenic. The above results suggest that there is very little difference in risks associated with subsistence consumption of fish harvested from impacted areas versus ambient locations. However, concentrations of PCBs were higher in fish tissue samples collected from the Suqitughneq River versus the Tapisaghak River, and PAHs were detected in fish tissue samples collected from the Suqitughneq River but not in samples collected from the Tapisaghak River.

Attribution of polychlorinated biphenyl residues detected in fish tissue samples collected from the Suqitughneq River to historic releases from the Northeast Cape Installation is complicated by recent findings that (1) polychlorinated biphenyls are global contaminants and are widely distributed by aerial deposition and food chain transport (Dalton, 2003; EWG, 2004), (2) salmon containing polychlorinated biphenyl residues accumulated from the open oceans are a source of contamination of sediments in Alaska inland streams and lakes as a result of migration and spawning (Dalton, 2003; Ewald, 1998), and (3) levels of polychlorinated biphenyls in fish tissue samples collected from both the Suqitughneq River and Tapisaghak River are within the range of concentrations measured in salmon sold in markets world wide. The average concentration of PCBs detected in salmon fillet samples obtained from various markets around the world was 0.027 mg/kg (EWG, 2004). The Environmental Working Group (2004) has estimated that 10.4 million people face a cancer risk exceeding one in one hundred thousand (1E-5), and 800,000 people face a cancer risk exceeding one in ten thousand (1E-4) from levels of PCBs in salmon in the general marketplace. These risk estimates include consumption of farm-raised salmon which contain generaly higher PCB concentrations than wild caught salmon (EWG, 2004). Concentrations of PCBs in fish tissue samples collected from the Suqitughneq and Tapisaghak Rivers were 0.019 and 0.011 mg/kg, respectively. Corresponding carcinogenic risk estimates for consumption of fish harvested from the Suqitughneq and Tapisaghak Rivers were 3E-5 and 2E-5, respectively. These PCB concentrations and risks appear to be comparable to those levels and risks reported for consumption of salmon by the general public.

Nevertheless, arsenic was a primary risk driver for consumption of fish harvested from either impacted or ambient locations at the Northeast Cape Installation. The source of arsenic in fish tissue samples collected from impacted and ambient locations is not certain, although high ambient levels of arsenic are observed throughout Alaska (USGS, 1988).

The evaluation of ambient conditions for the Northeast Cape Installation also included biological sampling of plants collected from areas believed to be unimpacted by historic military activities (Site 30). Carcinogenic risk and noncarcinogenic hazard estimates associated with subsistence consumption of plants harvested from Site 28 (Drainage Basin) were 9E-04 and 38, respectively. Excess carcinogenic risk estimates were attributable to the presence of maximum concentrations of arsenic, PCBs and PAHs in plant tissues. The maximum target organ-specific HI estimate associated with consumption of plants from impacted areas is 26, and was attributable to PCBs (Aroclor-1254 and Aroclor-1260). Corresponding carcinogenic risk and noncarcinogenic hazard estimates for subsistence consumption of plants harvested from ambient locations (Site 30) were 4E-04 and 12, respectively. Plant tissue samples collected from Site 28 contained higher levels of PAHs and PCBs than did plant samples collected from Site 30. Overall, carcinogenic risk and noncarcinogenic hazard estimates associated with consumption of subsistence plants harvested from impacted areas were approximately double those estimates for ambient locations. These results suggest that plants growing within Site 28 have been impacted by historic releases from the Northeast Cape Installation. However, there is uncertainty regarding the magnitude of these impacts and associated risks relative to ambient conditions. This is due to the fact that 'ambient' plant samples were collected from within the Northeast Cape Installation (Site 30) and could possibly have been impacted during historic operations or recent construction activities through means such as aerial deposition of dust.

It should be noted that carcinogenic risk estimates for subsistence food collection from either impacted or ambient locations are about two orders of magnitude higher than the ADEC point of departure criterion for risk management of 1E-5. These results suggest that a significant portion of the human health risk attributable to subsistence food use is associated with regional ambient contamination, risks for both impacted and ambient areas are overestimated, and/or contaminants associated with the Northeast Cape Installation have impacted 'ambient' areas. The latter suggestion is unlikely to adequately explain these risk assessment results, for the reasons provided in Section 5.3.

6.2 POTENTIAL ECOLOGICAL HAZARDS

The HHERA presented in this report also included an evaluation of potential ecological hazards associated with contaminant releases at the Northeast Cape Installation. Ecological hazard estimates were calculated for three ecological indicator receptors (i.e., the tundra vole, cross fox, and glaucous-winged gull) based on modeled exposures to chemicals in site soil, sediment, surface water, or shallow subsurface water, as appropriate for a given site (refer to Table 6-4).

The results of the potential ecological hazards evaluation included:

- Ecological hazard estimates for the glaucous-winged gull were below ADEC's point of departure criterion of 1.0 for all sites evaluated in the ERA.
- Ecological hazard estimates for the cross fox were below ADEC's point of departure criterion of 1.0 for all sites, with the exception of combined Sites 6 and 7 (HQ equal to 1.5). However, exceedence of the ADEC ecological criterion at this location was attributable to aluminum, which was present within the range of ambient concentrations.
- Ecological hazard estimates for the tundra vole exceeded ADEC's point of departure criterion for: Sites 6, 7, 21, 28, 31 and 32. The primary contaminants associated with ecological hazard estimates in excess of ADEC's point of departure criterion include DRO, PCBs (Aroclor 1254) and metals (e.g., aluminum, barium and zinc).
- Ecological hazards were not evaluated for the following sites because of inadequate habitat: Sites 10, 11, 13, 15, 16, 19, and 27.
- For the remaining sites (i.e., Sites 3, 9, 29, 33, and 34), ecological hazard estimates were below ADEC's point of departure criterion.

The above results suggest that chemicals present in soil at some sites within the Northeast Cape Installation are at concentrations that may potentially have an adverse impact on terrestrial ecological receptors.

The evaluation of potential impacts of chemical releases from the Northeast Cape Installation on off-site marine receptors included the collection of fish tissues samples, surface water samples, and sediment samples from the Suqitughneq River; and modeled exposures and hazards to the glaucous-winged gull. Although samples of fish collected from the Suqitughneq River contained chemical residues including arsenic and PCBs, the concentrations of these chemicals were comparable to concentrations measured in the tissues of fish collected from the Tapisaghak

River. A notable exception is PAHs, which were detected in higher concentrations in fish samples collected from the Suqitughneq River than in fish samples collected from the Tapisaghak River. However, tissue concentrations are a measure of exposure to a chemical, only, and do not necessarily indicate that an adverse effect has occurred. Ecological hazard estimates for the glaucous-winged gull, modeled using chemical concentrations measured in fish collected from the Suqitughneq River, were below ADEC's point of departure criterion. Finally, chemical concentrations measured in surface water and sediment samples collected from the Suqitughneq River are generally lower than available marine surface water and sediment quality criteria for these chemicals.

TABLE 6-1

CANCER RISK AND NONCANCER HAZARD ESTIMATES IN SOIL
FOR CURRENT HUMAN RECEPTORS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Current Seasonal Resident ILCR	Current Seasonal Resident Total HI	Current Incidental Visitor ILCR	Current Incidental Visitor Total HI
3 - Fuel Line Corridor and Pumphouse					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	6.8E-13	0.00020
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.0013
4 - Subsistence Fishing and Hunting Camp					
	Non-PHCs (Cumulative Site Risk/HI)	na [b]	0	na [b]	0
	PHCs (Cumulative Site Risk/HI)	na [b]	0.48	na [b]	0.0037
6 - Cargo Beach Road Drum Field					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	2E-10	0.00051
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.055
7 - Cargo Beach Road Landfill					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	5E-07	0.010
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.017
9 - Housing and Operations Landfill					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	4E-07	0.0046
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.00070
10 - Buried Drum Field					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.00014
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.014
11 - Fuel Storage Tank Area					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	3E-11	0.00000024
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.036
13 - Heat and Electrical Power Bldg.					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	6E-06	0.47
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.0065
15 - Buried Fuel Line Spill Area					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	4E-11	0.00011
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.0082
16 - Paint and Dope Storage Bldg.					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	2E-07	0.0053
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	na [c]
19 - Auto Maintenance and Storage Facilities					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	6.E-10	0.00013
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.0073
21 - Wastewater Treatment Facility					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	7E-07	0.016
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na [b]	0.0027

TABLE 6-1

CANCER RISK AND NONCANCER HAZARD ESTIMATES IN SOIL FOR CURRENT HUMAN RECEPTORS NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Current Seasonal Resident		Current Incidental Visitor	
		ILCR	Total HI	ILCR	Total HI
22 - Water wells and Water Supply Bldg.					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	2E-08	0.000000053
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.027
27 - Diesel Fuel Pump Island					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	5E-10	0.00075
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.027
28 - Drainage Basin					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	6E-07	0.0020
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.048
29 - Suqitughneq River					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[d]	na[d]
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[d]	na[d]
31 - White Alice Site					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	1E-06	0.089
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.0049
32 - Lower Tram Terminal					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[e]	na[e]
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.00091
33 - Upper Tram Terminal					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[e]	na[e]
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.00097
34 - Upper Camp					
	Non-PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[e]	na[e]
	PHCs (Cumulative Site Risk/HI)	na[a]	na[a]	na[b]	0.00091

Notes:

[a] No current seasonal residents reside at this site.

[b] PHCs were not evaluated for carcinogenic effects.

[c] No PHC COPCs were identified for this site.

[d] Soil was not sampled at this site.

[e] No non-PHC COPCs were identified for this site.

HI - noncancer hazard index
ILCR - Incremental Lifetime Cancer Risk
na - Not applicable
PHC- Petroleum hydrocarbons

TABLE 6-2

CANCER RISK AND NONCANCER HAZARD ESTIMATES IN SOIL FOR FUTURE HUMAN RECEPTORS NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Future Permanent Resident		Future Seasonal Resident		Future Incidental Visitor	
		ILCR	HI	ILCR	HI	ILCR	HI
3 - Fuel Line Corridor and Pumphouse							
	Non-PHCs (Cumulative Site Risk/HI)	8.4E-11	0.039	2.8E-11	0.013	6.8E-13	0.00020
	PHCs (Cumulative Site Risk/HI)	na [a]	0.51	na [a]	0.17	na [a]	0.0013
4 - Subsistence Fishing and Hunting Camp							
	Non-PHCs (Cumulative Site Risk/HI)	na [a]	0	na [a]	0	na [a]	0
	PHCs (Cumulative Site Risk/HI)	na [a]	**1.4**	na [a]	0.48	na [a]	0.0037
6 - Cargo Beach Road Drum Field							
	Non-PHCs (Cumulative Site Risk/HI)	5E-09	0.14	2E-09	0.047	2E-10	0.00051
	PHCs (Cumulative Site Risk/HI)	na [a]	**21**	na [a]	**7.0**	na [a]	0.055
	Diesel Range Organics, Aliphatic	na [a]	**8.9**	na [a]	**3.0**	na [a]	0.023
	Diesel Range Organics, Aromatic	na [a]	**11**	na [a]	**3.7**	na [a]	0.029
7 - Cargo Beach Road Landfill							
	Non-PHCs (Cumulative Site Risk/HI)	**5E-05**	**2.4**	**2E-05**	0.79	5E-07	0.010
	Arsenic	**3E-05**	0.60	**1E-05**	0.19	3E-07	0.0020
	PCB-1260 (Aroclor 1260)	6E-06	**1.3**	2E-06	0.42	9E-08	0.0065
	Dioxins/furans	9E-06	na [b]	3E-06	na [b]	9E-08	na [b]
	PHCs (Cumulative Site Risk/HI)	na [a]	**6.7**	na [a]	**2.2**	na [a]	0.017
	Diesel Range Organics, Aliphatic	na [a]	**2.8**	na [a]	0.93	na [a]	0.0073
	Diesel Range Organics, Aromatic	na [a]	**3.5**	na [a]	**1.2**	na [a]	0.0091
9 - Housing and Operations Landfill							
	Non-PHCs (Cumulative Site Risk/HI)	**4E-05**	**1.4**	**1E-05**	0.46	4E-07	0.0046
	Arsenic	**3E-05**	0.66	**1E-05**	0.22	3E-07	0.0022
	Dioxins/furans	2E-06	na [b]	6E-07	na [b]	2E-08	na [b]
	PHCs (Cumulative Site Risk/HI)	na [a]	0.27	na [a]	0.089	na [a]	0.00070
10 - Buried Drum Field							
	Non-PHCs (Cumulative Site Risk/HI)	na [c]	0.053	na [c]	0.019	na [c]	0.00014
	PHCs (Cumulative Site Risk/HI)	na [a]	**5.2**	na [a]	**1.7**	na [a]	0.014
	Diesel Range Organics, Aliphatic	na [a]	**2.3**	na [a]	0.77	na [a]	0.0061
	Diesel Range Organics, Aromatic	na [a]	**2.9**	na [a]	0.96	na [a]	0.0076
11 - Fuel Storage Tank Area							
	Non-PHCs (Cumulative Site Risk/HI)	4E-09	0.000093	1E-09	0.000031	3E-11	0.00000024

TABLE 6-2

CANCER RISK AND NONCANCER HAZARD ESTIMATES IN SOIL
FOR FUTURE HUMAN RECEPTORS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Future Permanent Resident		Future Seasonal Resident		Future Incidental Visitor	
		ILCR	HI	ILCR	HI	ILCR	HI
	PHCs (Cumulative Site Risk/HI)	na [a]	**14**	na [a]	**4.5**	na [a]	0.036
	Diesel Range Organics, Aliphatic	na [a]	**6.0**	na [a]	**2.0**	na [a]	0.016
	Diesel Range Organics, Aromatic	na [a]	**7.5**	na [a]	**2.5**	na [a]	0.020
13 - Heat and Electrical Power Bldg.							
	Non-PHCs (Cumulative Site Risk/HI)	**4E-04**	**91**	**1E-04**	**30**	6E-06	0.47
	PCB-1260 (Aroclor 1260)	**4E-04**	**91**	**1E-04**	**30**	6E-06	0.47
	PHCs (Cumulative Site Risk/HI)	na [a]	**2.5**	na [a]	0.83	na [a]	0.0065
	Diesel Range Organics, Aliphatic	na [a]	1.0	na [a]	0.35	na [a]	0.0027
	Diesel Range Organics, Aromatic	na [a]	**1.3**	na [a]	0.44	na [a]	0.0034
15 - Buried Fuel Line Spill Area							
	Non-PHCs (Cumulative Site Risk/HI)	5E-09	0.022	2E-09	0.0073	4E-11	0.00011
	PHCs (Cumulative Site Risk/HI)	na [a]	**3.1**	na [a]	1.0	na [a]	0.0082
	Diesel Range Organics, Aliphatic	na [a]	**1.4**	na [a]	0.47	na [a]	0.0037
	Diesel Range Organics, Aromatic	na [a]	**1.7**	na [a]	0.58	na [a]	0.0046
16 - Paint and Dope Storage Bldg.							
	Non-PHCs (Cumulative Site Risk/HI)	**2E-05**	**1.4**	5E-06	0.45	2E-07	0.0053
	Arsenic	**1E-05**	0.25	4E-06	0.085	1E-07	0.00085
	PCB-1260 (Aroclor 1260)	3E-06	0.61	1E-06	0.20	4E-08	0.0032
	PHCs (Cumulative Site Risk/HI)	na [a]	na [d]	na [a]	na [d]	na [a]	na [d]
	Diesel Range Organics, Aliphatic	na [a]	na [d]	na [a]	na [d]	na [a]	na [d]
	Diesel Range Organics, Aromatic	na [a]	na [d]	na [a]	na [d]	na [a]	na [d]
19 - Auto Maintenance and Storage Facilities							
	Non-PHCs (Cumulative Site Risk/HI)	6E-08	0.050	2E-08	0.017	6E-10	0.00013
	PHCs (Cumulative Site Risk/HI)	na [a]	**2.8**	na [a]	0.94	na [a]	0.0073
	Diesel Range Organics, Aliphatic	na [a]	**1.2**	na [a]	0.39	na [a]	0.0030
	Diesel Range Organics, Aromatic	na [a]	**1.5**	na [a]	0.48	na [a]	0.0038
21 - Wastewater Treatment Facility							
	Non-PHCs (Cumulative Site Risk/HI)	**7E-05**	**4.0**	**2E-05**	**1.3**	7E-07	0.016
	Arsenic	**6E-05**	**1.1**	**2E-05**	0.37	6E-07	0.0037
	PCB-1260 (Aroclor 1260)	9E-06	**1.9**	3E-06	0.63	1E-07	0.0098

TABLE 6-2

CANCER RISK AND NONCANCER HAZARD ESTIMATES IN SOIL
FOR FUTURE HUMAN RECEPTORS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site	Media	Future Permanent Resident		Future Seasonal Resident		Future Incidental Visitor	
		ILCR	HI	ILCR	HI	ILCR	HI
	PHCs (Cumulative Site Risk/HI)	na [a]	1.0	na [a]	0.34	na [a]	0.0027
	Diesel Range Organics, Aliphatic	na [a]	0.33	na [a]	0.11	na [a]	0.00087
	Diesel Range Organics, Aromatic	na [a]	0.41	na [a]	0.14	na [a]	0.0011
22 - Water wells and Water Supply Bldg.							
	Non-PHCs (Cumulative Site Risk/HI)	1E-06	0.000020	3E-07	0.0000068	2E-08	0.000000053
	PHCs (Cumulative Site Risk/HI)	na [a]	**1.2**	na [a]	0.41	na [a]	0.0032
	Diesel Range Organics, Aliphatic	na [a]	0.36	na [a]	0.12	na [a]	0.00093
	Diesel Range Organics, Aromatic	na [a]	0.44	na [a]	0.15	na [a]	0.0012
27 - Diesel Fuel Pump Island							
	Non-PHCs (Cumulative Site Risk/HI)	6E-08	0.15	2E-08	0.036	5E-10	0.00075
	PHCs (Cumulative Site Risk/HI)	na [a]	**10**	na [a]	**3.5**	na [a]	0.027
	Diesel Range Organics, Aliphatic	na [a]	**4.5**	na [a]	**1.5**	na [a]	0.012
	Diesel Range Organics, Aromatic	na [a]	**5.6**	na [a]	**1.9**	na [a]	0.015
28 - Drainage Basin							
	Non-PHCs (Cumulative Site Risk/HI)	na [e]	na [e]	**1E-05**	0.14	6E-07	0.0020
	Benzo(a)anthracene	na [e]	na [e]	2E-06	na [c]	9E-08	na [c]
	Benzo(a)pyrene	na [e]	na [e]	**1E-05**	na [c]	5E-07	na [c]
	Benzo(b)fluoranthene	na [e]	na [e]	1E-06	na [c]	5E-08	na [c]
	PHCs (Cumulative Site Risk/HI)	na [e]	na [e]	na [a]	**6.2**	na [a]	0.048
	Diesel Range Organics, Aliphatic	na [e]	na [e]	na [a]	**2.7**	na [a]	0.021
	Diesel Range Organics, Aromatic	na [e]	na [e]	na [a]	**3.4**	na [a]	0.026
29 - Suqitughneq River		na [f]	na [f]	na [f]	na [f]	na [f]	na [f]
31 - White Alice Site							
	Non-PHCs (Cumulative Site Risk/HI)	**8E-05**	**17**	**3E-05**	**5.8**	1E-06	0.089
	PCB-1260 (Aroclor 1260)	**8E-05**	**17**	**3E-05**	**5.8**	1E-06	0.089
	PHCs (Cumulative Site Risk/HI)	na [b]	**1.9**	na [a]	0.63	na [a]	0.0049
	Diesel Range Organics, Aliphatic	na [b]	0.73	na [a]	0.24	na [a]	0.0019
	Diesel Range Organics, Aromatic	na [b]	0.91	na [a]	0.30	na [a]	0.0024
32 - Lower Tram Terminal							
	Non-PHCs (Cumulative Site Risk/HI)	na [g]	na [g]	na [g]	na [g]	na [g]	na [g]

TABLE 6-2

**CANCER RISK AND NONCANCER HAZARD ESTIMATES IN SOIL
FOR FUTURE HUMAN RECEPTORS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA**

		Future Permanent Resident		Future Seasonal Resident		Future Incidental Visitor	
Site	**Media**	**ILCR**	**HI**	**ILCR**	**HI**	**ILCR**	**HI**
	PHCs (Cumulative Site Risk/HI)	na [a]	**3.0**	na [a]	0.99	na [a]	0.0078
	Diesel Range Organics, Aliphatic	na [a]	**1.1**	na [a]	0.38	na [a]	0.0030
	Diesel Range Organics, Aromatic	na [a]	**1.4**	na [a]	0.47	na [a]	0.0037
33 - Upper Tram Terminal							
	Non-PHCs (Cumulative Site Risk/HI)	na [g]	na [g]	na [g]	na [g]	na [g]	na [g]
	PHCs (Cumulative Site Risk/HI)	na [a]	0.37	na [a]	0.12	na [a]	0.00097
34 - Upper Camp							
	Non-PHCs (Cumulative Site Risk/HI)	na [g]	na [g]	na [g]	na [g]	na [g]	na [g]
	PHCs (Cumulative Site Risk/HI)	na [a]	0.35	na [a]	0.12	na [a]	0.00091

Notes:

[a] Not a carcinogenic COPC.
[b] This chemical was evaluated for carcinogenic effects only.
[c] No carcinogenic COPCs were identified for this site.
[d] No PHC COPCs were identified for this site.
[e] Not applicable; it is highly unlikely that a residence would be constructed at this location in the future.
[f] Soil was not sampled at this site.
[g] Only PHC COPCs were identified for this site.

COPC - Chemical of potential concern
HI - Noncancer hazard index
ILCR - Incremental lifetime cancer risk
Inc - Incomplete
na - Not applicable
PCB - Polychlorinated biphenyls
PHC - Petroleum hydrocarbons

TABLE 6-3

COMPARISON OF SITE AND AMBIENT CANCER RISK AND NONCANCER HAZARD ESTIMATES FOR SUBSISTENCE FISH & PLANT CONSUMPTION NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

Site/Risk Drivers	Media	ILCR	HI
Sites 28 and 29 Total Subsistence Risk/HI:		**2E-03**	**55**
	(Site 29 - Fish Consumption Risk/HI):	**9E-04**	**17**
	Arsenic	**3E-04**	**3.5**
	Cadmium	0E+00	**4.3**
	Benzo(a)anthracene	**2E-05**	na [a]
	Benzo(a)pyrene	**3E-04**	na [a]
	Benzo(b)fluoranthene	**3E-05**	na [a]
	Dibenzo(a,h)anthracene	**6E-05**	na [a]
	Indeno(1,2,3-cd)pyrene	**4E-05**	na [a]
	PCB-1254 (Aroclor 1254)	**1E-04**	**17**
	PCB-1260 (Aroclor 1260)	**6E-05**	**9.4**
	(Site 28 - Plant Consumption Risk/HI):	**9E-04**	**38**
	Arsenic	**3E-04**	**3.5**
	Cadmium	0E+00	**4.3**
	Benzo(a)anthracene	**2E-05**	na [a]
	Benzo(a)pyrene	**3E-04**	na [a]
	Benzo(b)fluoranthene	**3E-05**	na [a]
	Dibenzo(a,h)anthracene	**6E-05**	na [a]
	Indeno(1,2,3-cd)pyrene	**4E-05**	na [a]
	PCB-1254 (Aroclor 1254)	**1E-04**	**17**
	PCB-1260 (Aroclor 1260)	**6E-05**	**9.4**
Ambient (Site 30) Total Subsistence Risk/HI:		**1E-03**	**30**
	(Fish Consumption Risk/HI):	**1E-03**	**19**
	Arsenic	**1E-03**	**15**
	PCB-1254 (Aroclor 1254)	**2E-05**	**2.8**
	(Plant Consumption Risk/HI):	**4E-04**	**12**
	Arsenic	**3E-04**	**3.6**
	Cadmium	0E+00	**3.4**
	Vanadium	na [b]	1.0
	Benzo(a)anthracene	**2E-05**	na [a]
	Benzo(a)pyrene	**5E-05**	na [a]
	Benzo(b)fluoranthene	1E-05	na [a]
	Dibenzo(a,h)anthracene	**3E-05**	na [a]
	PCB-1254 (Aroclor 1254)	7E-06	**1.1**
	PCB-1260 (Aroclor 1260)	6E-06	0.91

Notes:

[a] Chemical was evaluated for carcinogenic effects only.
[b] Not a carcinogenic COPC.

HI - noncancer hazard index
ILCR - Incremental Lifetime Cancer Risk
Inc - Incomplete
na - Not applicable
PCB- Polychlorinated biphenyls
PHC- Petroleum hydrocarbons

TABLE 6-4

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (HQ)		
Site/Chemicals of Concern	Tundra Vole [a] *Microtus oeconomus*	Cross Fox [a] *Vulpes vulpes*	Glaucous-winged Gull *Larus glaucescens*
3 - Fuel Line Corridor and Pumphouse	0.38	0.0014	0.0000090
4 - Subsistence Fishing and Hunting Camp	0.79	0.0079	0.000052
Sites 3 & 4 Combined	0.79	0.011	0.000071
6 - Cargo Beach Road Drum Field			
Aluminum	**15**	0.20	0.0000000039
Diesel Range Organics, Aliphatic	**15**	0.071	0.00047
Diesel Range Organics, Aromatic	**7.6**	0.035	0.00023
7 - Cargo Beach Road Landfill			
Diesel Range Organics, Aliphatic	**4.8**	0.15	0.0010
Diesel Range Organics, Aromatic	**2.4**	0.076	0.00050
Sites 6 & 7 Combined			
Aluminum	**15**	**1.5**	0.000000030
Diesel Range Organics, Aliphatic	**15**	0.56	0.0037
Diesel Range Organics, Aromatic	**7.6**	0.28	0.0018
9 - Housing and Operations Landfill	0.24	0.037	0.0000062
10 - Buried Drum Field	na[b]	na[b]	na[b]
11 - Fuel Storage Tank Area	na[b]	na[b]	na[b]
13 - Heat and Electrical Power Bldg.	na[b]	na[b]	na[b]
15 - Buried Fuel Line Spill Area	na[b]	na[b]	na[b]
16 - Paint and Dope Storage Bldg.	na[b]	na[b]	na[b]
19 - Auto Maintenance and Storage Facilities	na[b]	na[b]	na[b]
21 - Wastewater Treatment Facility			
Aluminum	**34**	0.65	0.000000013
Barium	**1.4**	0.016	0.000000016
Diesel Range Organics, Aliphatic	0.56	0.0040	0.000026
22 - Water wells and Water Supply Bldg.			
Diesel Range Organics, Aliphatic	0.60	0.00044	0.0000029
Zinc	0.083	0.00068	0.000000000000000000000012
27 - Diesel Fuel Pump Island	na[b]	na[b]	na[b]
28 - Drainage Basin			
Barium	**9.6**	0.11	0.0000028
Zinc	**1.3**	0.028	0.0000040
PCB-1254 (Aroclor 1254)	**2.0**	0.025	0.000011
Diesel Range Organics, Aliphatic	**14**	0.71	0.19
Diesel Range Organics, Aromatic	**5.5**	0.28	0.075

TABLE 6-4

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS
NORTHEAST CAPE, ST. LAWRENCE ISLAND, ALASKA

	Maximum Ecological Hazard Estimate (HQ)		
Site/Chemicals of Concern	**Tundra Vole** [a] *Microtus oeconomus*	**Cross Fox** [a] *Vulpes vulpes*	**Glaucous-winged Gull** *Larus glaucescens*
29 - Suqitughneq River			
Diesel Range Organics, Aliphatic	0.00000000055	0.00000000015	0.0034
Silver, dissolved	0.0000000082	0.0000000023	0.0000000013
Sites 28 & 29 Combined			
Barium	**9.6**	0.23	0.000024
Zinc	**1.3**	0.056	0.0000079
PCB-1254 (Aroclor 1254)	**2.0**	0.050	0.000023
Diesel Range Organics, Aliphatic	**14**	**1.4**	0.37
Diesel Range Organics, Aromatic	**6.9**	0.71	0.19
30 - Background Areas	na	na	na
31 - White Alice Site			
Diesel Range Organics, Aliphatic	**1.2**	0.0085	0.000056
Diesel Range Organics, Aromatic	0.62	0.0043	0.000028
32 - Lower Tram Terminal			
Diesel Range Organics, Aliphatic	**1.9**	0.0051	0.000034
Diesel Range Organics, Aromatic	0.97	0.0026	0.000017
33 - Upper Tram Terminal			
Diesel Range Organics, Aliphatic	0.098	0.0029	0.0000019
Residual Range Organics, Aliphatic	0.11	0.00081	0.00000014
34 - Upper Camp	0.16	0.0016	0.000011
Sites 33 & 34 Combined	0.16	0.0036	0.000014

Notes:

[a] The indicated receptor is not anticipated to be exposed to incidental ingestion of sediment, consistent with the ecological conceptual site model.

[b] This site was not evaluated under the ERA due to insufficient habitat quality to support ecological receptors.

HQ - Hazard quotient.
mg/kg - Milligrams per kilogram.
na - Not applicable.
PCB - Polychlorinated Biphenyls.

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