FINAL
SUPPLEMENTAL REMEDIAL INVESTIGATION REPORT
FORMER YAKUTAT AIR BASE
FORMERLY USED DEFENSE SITE
(F10AK060602)
YAKUTAT, ALASKA

Prepared for:

U.S. Army Corps of Engineers, Alaska District
CEPOA-PM-ESP-FUDS
P.O. Box 6898
JBER, Alaska 99506-6898

Contract: W911KB-11-D-0001
Task Order: 0012
AECOM Project No.: 60308481

April 2016

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April 2016

APPENDICES

FIGURES

TABLES

EXECUTIVE SUMMARY

The United States Army Corps of Engineers contracted AECOM Technical Services, Inc. to conduct a Supplemental Remedial Investigation (RI) of select areas of concern (AOCs) at the Former Yakutat Air Base Formerly Used Defense Sites (FUDS), located in Yakutat, Alaska. The purposes of the Supplemental RI were to collect data to address previously identified data gaps, characterize risk to human health and the environment, and where appropriate, to develop alternative cleanup levels (ACLs) under the Alaska Department of Environmental Conservation (ADEC) Method Three, using the online Method Three Calculator (18 Alaska Administrative Code [AAC] 75.340) and Hydrocarbon Risk Calculator (HRC).

The study areas investigated during the Supplemental RI are listed below.

- Point Carrew Garrison – Landfill/Drum Dump (AOC C2) and Surface Debris Area (AOC C4);
- Point Carrew Garrison 50,000-Gallon Diesel Oil Tank – No. 1094 (AOC C6);
- Army Dock Area Aboveground Storage Tanks 1 through 8 (sites referred to as AOC D1 through D8, or collectively as AOC D);
- Air Corps Increase Group No. 1 - 50 Kilowatt (kW) Powerhouse – No. 520 (AOC M3) and 400 kW Post Powerhouse – No. 564;
- Air Corps Warehouse Group No. 2 Suspected Drum Dump (AOC O1); and
- Army Airways Communications System (AACS) Receiver Station Powerhouse – No. 1202.

Contaminant sources investigated during the Former Yakutat Air Base FUDS Supplemental RI were derived primarily from powerhouse operations and fueling activities (i.e., releases from spills, tank or pipeline leaks, and/or direct discharge during fueling). Key overall objectives of the Supplemental RI were to collect sufficient data to characterize contaminant risk to both human health and the environment at each study area under Method Three (18 AAC Section 75.340), and to develop site-specific ACLs if unacceptable risk was identified. These overall objectives have been met as detailed in Sections 5.0 through 19.0 of this report and summarized below.

Several sources and release mechanisms have resulted in impacts above the Method Two cleanup levels to primary media at the AOC study areas. Contamination in a primary source medium can migrate to secondary source media through various mechanisms including erosion and deposition, volatilization, and leaching. These pathways and potential receptors were evaluated for each study area. Based on the conceptual site models developed for each site, human health risk evaluations were conducted (if applicable) using the HRC and following 18 AAC 75 Method Three guidance to assess compliance with the ADEC risk standard. Risk evaluation was based on site-specific exposure pathways, soil and groundwater exposure point concentrations, soil geotechnical properties and hydrogeologic conditions. Analytical data obtained from AOCs D2 and O1 indicate that media investigated at these areas do not contain contaminant concentrations above regulatory standards; therefore, risk evaluation was not required.

Constituents in soil exceeding regulatory standards (Method Two cleanup levels) at each AOC were established as constituents of potential concern (COPC). COPCs in soil and affected study areas include:

- Diesel range organics (DRO): AOCs C2, C4, D1, D3 – D8, M3, AACS
- Residual range organics (RRO): AOC C2
- Benzene: AOCs C2, D1, D3
- 1-Methylnaphthalene: AOCs C2, D1, D4, D5, D7, D8
- 2-Methylnaphthalene: AOCs C2, D1, D3 – D8
- Benzo(a)pyrene: AOC C4

With the exception of AOC C2, HRC results indicate that site conditions at the remaining AOCs meet the ADEC human health risk standard established in 18 AAC 75.325. A comparison of the soil exposure point concentrations determined at each site to the calculated ACLs shows that acceptable risk was met for all sites except AOC C2. Currently, conditions at these sites are protective of human health under an unrestricted (residential) land use scenario.

HRC results for the AOC C2 source area indicate that site conditions exceed the ADEC human health risk standard established in 18 AAC 75.325 and are not protective of human health under an unrestricted (residential) land use scenario. This determination is based on risk posed by the RRO aromatic fraction in excess of the risk standard for the direct contact pathway and the risk standard for the groundwater ingestion pathway, assuming a residential land use scenario.

RRO in soil at AOC C2 exceeds the corresponding ACL based on the direct contact pathway. RRO concentrations in soil exceed the calculated ACL of 10,033 milligrams per kilogram (mg/kg) at three AOC C2 locations: C2-TP07, C2-TP08 and C2-TP10 at concentrations ranging from 12,000 to 86,000 mg/kg. The footprint area and volume of RRO contaminated soil exceeding the ACL is estimated at 3,500 square feet and 480 cubic yards, respectively.

Ecological risk was also evaluated for each AOC and, with the exception of AOC D2 where constituents in soil and groundwater were below cleanup levels, a preliminary ecological CSM was developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). "Off-ramps" were established through the ecoscoping process for all AOCs, indicating that a more in-depth risk evaluation of these sites is not needed and site conditions are protective of the environment.

The following site-specific investigation objectives proposed to address data gaps and achieve the above key overall objectives were also met:

- The sources of subsurface anomalies (debris) at AOCs C2/C4 were identified, and associated contamination was characterized for soil and groundwater. Twelve test pits were excavated with observed debris consisting predominately of miscellaneous garbage (e.g., glass bottles, cans, plastic bags, shoes, oil filters, tires, etc.) and construction-type debris (e.g., wood/boards, scrap metal, pipes, steel cable, etc.). Soil sample results show DRO up to 19,000 mg/kg and RRO up to 86,000 mg/kg. One temporary groundwater well was installed within each of the AOC C2 and C4 source areas; groundwater collected from these wells exceeded the Table C groundwater cleanup levels for RRO (C2), DRO (C4), and 1-methylnaphthalene (C2/C4).
- Background conditions for lead in surface water and sediment were established for AOCs C2/C4 and current concentrations of lead and polychlorinated biphenyls (PCBs) in these media were evaluated at the site. Distributions of sediment concentrations between the site and background ponds are consistent with a naturally occurring source of lead. All detections of lead in sediment were below the National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRT) screening criteria. A single dissolved lead detection in pond surface water was at a concentration below the Alaska Water Quality Standards most stringent (chronic) criterion calculated using site-specific hardness data. PCBs were not detected in surface water and a single PCB detection in a pond sediment sample was at a concentration below NOAA SQuiRT screening criteria.
- Current groundwater quality and conditions were assessed at AOCs C2/C4, C6 and D. Groundwater results from source area wells show fuel concentrations (DRO or RRO) above the Table C cleanup level at AOC C2/C4, C6, and D (AOC D7 only).
- The tidal influence of the Ankau Slough on groundwater quality and net flow at AOC C6 was evaluated and a groundwater use determination performed under 18 AAC 75.350. A data filtering method was used to calculate a groundwater net flow direction to the south to southeast with a mean groundwater gradient of 0.00192 foot per foot. Groundwater at AOC C6 was determined to be neither a current nor expected potential future source of drinking water.

- The vertical extent of petroleum soil contamination at AOC D7 was defined. DRO impacts above the Method Two cleanup level are present in the smear zone at approximately 60 to 64 feet below ground surface (bgs); however, screening results indicate hydrocarbon concentrations decrease significantly within the saturated zone below 65 feet. DRO concentrations in a sample collected to confirm delineation of impacts vertically at AOC D7 (70-72 feet bgs) were below cleanup levels.
- The nature and extent of soil contamination at AOC M3 were characterized and delineated. Through resampling, a previous benzo(a)pyrene exceedance of the Method Two cleanup level was shown to be below this criterion. The extent of PAHs around the previous exceedance was defined laterally and vertically. DRO and RRO were identified above the Method Two cleanup levels at concrete tank saddles with concentrations up to 3,300 mg/kg and 9,300 mg/kg respectively.
- An initial inspection of the former 400 kW Post Powerhouse located to the north of AOC M3 was performed and documented. Observations at the former powerhouse included an approximate 75 feet x 51 feet block foundation, collapsed wooden building debris, partially collapsed chimneys, piping, possible heat exchanger, spark arrester, various metal debris, and four empty partial or intact drums.
- Concentrations of lead in surface water from a stream/drainage ditch adjacent to AOC O1 were determined. Analytical results indicate lead is currently not present above Alaska Water Quality Standards in the stream/drainage ditch adjacent to AOC O1.
- The nature and extent of petroleum, oil, and lubricant contaminated soil was determined at the AACS. DRO was detected in soil above the Method Two cleanup level with concentrations up to 850 mg/kg.
- Background conditions for barium in surface water, as well as downgradient and current onsite concentrations, were established at the AACS. Sample results indicate that barium detected in site surface water is attributed to naturally occurring concentrations of this metal.

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ACRONYMS AND ABBREVIATIONS

>	greater than
<	less than
±	plus or minus
°C	degrees Celsius
°F	degrees Fahrenheit
µS/cm	microsiemens per centimeter
%R	percent recovery
%RE	percent reference emitter
AAC	Alaska Administrative Code
AACS	Army Airways Communications System
ACL	alternative cleanup level
ADEC	Alaska Department of Environmental Conservation
AECOM	AECOM Technical Services, Inc.
AML	Alaska Marine Lines
amsl	above mean seal level
AOC	area of concern
AST	aboveground storage tank
BCC-J	BC Contractors –Jacobs Joint Venture
bgs	below ground surface
BLM	Bureau of Land Management
BTEX	benzene, toluene, ethylbenzene, xylene
CAA	Civil Aeronautics Administration
CFR	Code of Federal Regulations
CME	Central Mining Equipment
COELT	Corps of Engineers Loading Tool
COPC	constituents of potential concern
CSM	conceptual site model
DAF	dilution-attenuation factor
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DOT	Department of Transportation
DRO	diesel range organics
EB	equipment blank
EDCC	Electronic Deliverable Consistency Checker
EDD	electronic data deliverable
EDF	Electronic Deliverable Format
ENSR	ENSR Consulting and Engineering
EPA	Environmental Protection Agency
EPH	extractable petroleum hydrocarbons
FOC	fractional organic carbon
FRMD#	FUDS Record Management Database Number
ft/ft	foot per foot
ft/day	foot per day
ft^2/day	feet squared per day
FUDS	Formerly Used Defense Sites
GAC	granular activated carbon
gal	gallon

GRO	gasoline range organics
HDL	Hattenburg, Dilley, and Linnell, LLC.
HI	hazard index
HRC	Hydrocarbon Risk Calculator
HSA	hollow stem auger
IC	institutional control
ID	inner diameter
IDW	investigative-derived waste
kW	kilowatt
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LDC	Laboratory Data Consultants
LIF	laser-induced fluorescence
LOD	limit of detection
LOQ	limit of quantitation
MCL	maximum contaminant level
MB	method blank
m^2/day	meters squared per day
MED	Manual for Electronic Deliverables, Requirements for Submittals of Documents, Laboratory Data, and Other Items
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg-CaCO3/L	milligrams calcium carbonate per liter
ml	milliliter
MLA	McClintock Land Associates, Inc.
mph	miles per hour
MS	matrix spike
MSD	matrix spike duplicate
NALEMP	Native American Lands Environmental Mitigation Program
NAPL	non-aqueous phase liquid
NOAA	National Oceanic and Atmospheric Administration
OCRRS	Ocean Cape Radio Relay Site
ORP	oxidation-reduction potential
PAL	project action limit
PAH	polycyclic aromatic hydrocarbon
PARCCS	Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity
PCBs	polychlorinated biphenyls
PID	photoionization detector
POL	petroleum, oil, and lubricants
ppt	parts per thousand
PVC	polyvinyl chloride
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
Q-Q	quantile-quantile
RI	Remedial Investigation
ROE	right-of-entry
ROST	Rapid Optical Screening Tools
RPD	relative percent difference
RRO	residual range organics

RTI	RTI Laboratories, Inc.
SDG	sample delivery group
SEDD	Staged Electronic Data Deliverable
SGC	silica gel cleanup
SOP	standard operating procedure
SQuiRT	Screening Quick Reference Tables
S&W	Shannon & Wilson
TAH	total aromatic hydrocarbon
TAqH	total aqueous hydrocarbon
TATW	Test America Tacoma Washington
TB	trip blank
TDS	total dissolved solids
TOC	total organic carbon
TO	task order
UCL	upper confidence limit
U.S.	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USFS	United States Forest Service
USGS	United States Geological Survey
VOCs	volatile organic compounds
VPH	volatile petroleum hydrocarbons
WP/QAPP	Work Plan/Quality Assurance Project Plan
WQS	Water Quality Standards

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1.0 INTRODUCTION

1.1 PROJECT PURPOSE AND OBJECTIVES

The United States Army Corps of Engineers (USACE) contracted AECOM Technical Services, Inc. (AECOM) to conduct a Supplemental Remedial Investigation (RI) of select areas of concern (AOCs) at the Former Yakutat Air Base Formerly Used Defense Sites (FUDS), located in Yakutat, Alaska. The work was contracted to AECOM under Indefinite Delivery/Indefinite Quantity Contract Number W911KB-11-D-0001, task order (TO) 0012. The purposes of the Supplemental RI were to collect data to address previously identified data gaps, characterize risk to human health and the environment, and where appropriate, to develop alternative cleanup levels (ACLs) under the Alaska Department of Environmental Conservation (ADEC) Method Three, using the online Method Three Calculator (18 Alaska Administrative Code [AAC] 75.340) and Hydrocarbon Risk Calculator (HRC) (ADEC 2011a).

The study areas investigated during the Supplemental RI are listed below.

- Point Carrew Garrison – Landfill/Drum Dump (AOC C2) and Surface Debris Area (AOC C4);
- Point Carrew Garrison 50,000-Gallon Diesel Oil Tank – No. 1094 (AOC C6);
- Army Dock Area Aboveground Storage Tanks (ASTs) 1 through 8 (sites referred to as AOC D1 through D8, or collectively as AOC D);
- Air Corps Increase Group No. 1 - 50 Kilowatt (kW) Powerhouse – No. 520 (AOC M3) and 400 kW Post Powerhouse – No. 564;
- Air Corps Warehouse Group No. 2 Suspected Drum Dump (AOC O1); and
- Army Airways Communications System (AACS) Receiver Station Powerhouse – No. 1202.

Although investigated as a single area previously, AOCs C2 and C4 will be discussed separately in this Supplemental RI Report due to site conditions and findings.

Key overall objectives of the Supplemental RI were to collect sufficient data to characterize risk to both human health and the environment at AOCs C2, C4, C6, D1, D2, D3, D4, D5, D6, D7, D8 and AACS, and to develop possible future remedial alternatives if unacceptable risk is identified. For purposes of this report, contaminant source areas evaluated for risk include samples with petroleum contamination exceeding ADEC Method Two criteria. In addition to evaluating risk, Supplemental RI objectives included evaluating the nature and extent of impacts to select media at AOCs C2/C4, M3, O1 and AACS.

Site-specific investigation activities, proposed to achieve the above key objectives, were approved by the ADEC through their acceptance of the *Final Supplemental Remedial Investigation Work Plan/QAPP, Former Yakutat Air Force Base, Formerly Used Defense Site (F10AK060602), Yakutat, Alaska* (Work Plan [WP]/Quality Assurance Project Plan [QAPP]) (AECOM 2014) and are listed below.

- Evaluate whether contaminated soil and groundwater remaining at AOCs C2, C4, C6, D, and the AACS investigation sites present unacceptable risk under Method Three (18 AAC Section 75.340) using the ADEC online Method Three Calculator (hereinafter referred to as the Online Calculator), and/or the HRC. If unacceptable risk is identified, develop site-specific ACLs.
- Characterize the vertical extent of petroleum soil contamination within the saturated zone at AOC D7.
- Investigate for potential remaining subsurface debris associated with elevated geophysical survey responses previously identified at AOCs C2 and C4.
- Sample surface water and sediment adjacent to the source area and both up and downgradient of the AOC C2 source area(s) to determine if lead and polychlorinated biphenyls (PCBs) are present, and establish upgradient levels for lead and PCBs.

- Evaluate the tidal influence of the Ankau Slough on groundwater quality at AOC C6 to determine net flow direction and a possible groundwater use determination under 18 AAC 75.350.
- Measure current groundwater conditions at AOCs C2, C4, C6, and D.
- Investigate the vertical and horizontal extent of the polycyclic aromatic hydrocarbons (PAHs) detected in soil above ADEC Method Two cleanup levels at AOC M3, and perform a visual inspection to determine and/or evaluate for a possible non-FUDS PAH source.
- Determine whether petroleum, oil, and lubricant (POL)-contaminated soil is associated with the concrete saddles identified at AOC M3 and if so, investigate the nature and extent of contamination.
- Locate and provide a site survey of the former 400 kW Post Powerhouse located to the north of AOC M3 to document any remaining debris, potential source or signs of contamination, or other evidence of the former powerhouse location.
- Establish both background concentrations and downstream surface water concentrations of total and dissolved lead and hardness at AOC O1, and identify a possible source of contamination.
- Investigate the extent of POL-contaminated soil found near the concrete saddles identified at the AACS.
- Establish both background concentrations and downgradient concentrations of barium in surface water at the AACS, and locate a possible source of contamination.

1.2 REPORT ORGANIZATION

This Supplemental RI Report is structured to present the field activities conducted during continued investigation at the AOCs identified above, methodologies and approach for the risk evaluations performed, and results of the risk evaluations applicable to each site. As outlined below, the project objectives, general site information, AOC-specific background information, and investigation approach and procedures implemented during the Supplemental RI, are provided in Sections 1.0 through 3.0. Section 4.0 presents an overview of the risk evaluation approach and a detailed discussion of the selected methods applied. The evaluation of risk at each AOC was calculated separately; therefore, investigation activities, results, and risk associated with each area are discussed as separate sections for clarity.

The Supplemental RI Report is outlined as follows:

- *Section 1.0, Introduction:* Presents project objectives and report organization.
- *Section 2.0. Background:* Presents a description and history of the site, physical site characteristics, and a summary of previous investigations.
- *Section 3.0. Investigation Approach:* Presents the project team, a discussion of mobilization/demobilization tasks, a contaminant source determination and sampling rationale, procedures used to implement the Supplemental RI, waste management tasks, data quality review, and modifications or deviations from the WP/QAPP.
- *Section 4.0. Risk Evaluation and Alternative Cleanup Levels Determination:* Describes the risk evaluation process, presents the input parameters for calculating risk, provides an evaluation of the Online Calculator and HRC, and details the HRC methodology and approach.
- *Sections 5.0 through 19.0*: These sections present AOC-specific discussions of the Supplemental RI activities performed, including individual discussions for each AST at AOC D1 through D8. These discussions include:
  - A brief description of the area and background summary
  - Data collection objectives
  - A summary of investigation tasks

  - Discussion of groundwater conditions
  - Presentation of analytical results
  - Human health risk evaluation
  - Calculation of soil ACLs (where applicable)
  - Ecological risk evaluation
- *Section 20.0. Conclusions:* Presents a recap of Supplemental RI objectives and a determination of whether the objectives have been met, provides a summary of ACLs for constituents of potential concern (COPCs) applicable to each AOC, summarizes risk at each AOC (human health and ecological), and identifies potential data gaps that may exist for the FUDS.
- *Section 21.0 References:* Provides reference documents used to prepare this Supplemental RI Report.

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2.0 BACKGROUND

2.1 SITE DESCRIPTION AND HISTORY

2.1.1 Site Description

Yakutat is located at the mouth of Yakutat Bay, approximately 225 miles northwest of Juneau and 220 miles southeast of Cordova, Alaska. Yakutat is surrounded by the Wrangell-Saint Elias Mountains and Yakutat Bay to the north, by the Saint Elias Mountains and Tongass National Forest to the south and east, and by the Gulf of Alaska to the west. The Yakutat Borough has a population of 590, approximately half of whom are Alaskan Native. Yakutat's economy is dependent on commercial and sport fishing, fish processing, and government employment.

AOCs C2, C4, C6, and D are located in Sections 25 and 28, Township 27 South, Range 34 East, Copper River Meridian. These parcels are owned by Yak-Tat Kwaan, Inc. and Sealaska Corporation (subsurface owner). AOCs C2, C4 and C6 are located on Phipps Peninsula, north of the Ankau Slough. AOC D is located at the southeast edge of Monti Bay. The locations of former ASTs that comprise AOC D are accessed via a gravel road just off Ocean Cape Road. The former tank locations extend from the City of Yakutat pump house to the northwest and down the access road west of the Delta Western tank farm to the Malaspina warehouse. AOCs M3, O1, and AACS are located on United States Forest Service (USFS) land. AOCs AACS and M3 are located north of Cannon Beach Road and AOC O1 is located just south of National Forest Road 9975, between Cannon Beach Road and the Yakutat airport. These AOC study areas are shown on Figure 2-1.

2.1.2 Site History

United States (U.S.) military interest in Yakutat began by Executive Order in 1929 with the creation of the Yakutat Bay Naval Reservation. However, occupation was not set in motion until 1939 with a proposal by the Civil Aeronautics Administration (CAA), now known as the Federal Aviation Administration, to develop a landing field. The War Department acquired 46,083 acres from the U.S. Department of the Interior, U.S. Department of the Navy, and the U.S. Department of Commerce for the establishment of an "Auxiliary Landing Field and Staging Area". Runway construction began in 1940 and with the arrival of the first troops in October of that year, the Yakutat Landing Field was activated. In September 1942, the Yakutat Naval Base was established as a "Naval Air Facility", and upon completion of the base in February 1943, was re-designated as a "Naval Auxiliary Air Facility". This small naval facility included a Seaplane Base.

Military facilities were established in Yakutat because of its strategic geographic location. The Yakutat Air Base was operated as an auxiliary airfield during World War II capable of supporting pursuit and bombardment aircraft. The air base also hosted large military vessels in Monti Bay. No aircraft were assigned permanently to Yakutat; instead, the base served as a ferrying post and temporary station for aircraft squadrons, and as a refueling stop between the 48 contiguous states and points in Alaska. A dock and wharf facility were built on Monti Bay in support of the Yakutat Air Base.

Completed in June 1943, the Yakutat Air Base was placed on caretaker status less than a year later in April 1944. In December 1945 it was declared surplus to military requirements and operation of the former Army airfield was transferred to the CAA. Tract B was relinquished to the U.S. Department of the Interior, Bureau of Land Management (BLM) in two parts in 1946 and 1947. Another section, Tract C, containing 147 acres, was retransferred to the Department of Commerce in 1948, and the remaining 3,499 acres comprising Tract A were relinquished and retransferred to the U.S. Department of the Navy in 1949. The Yakutat Bay Naval Reservation was revoked in 1953, and all but 266 acres were designated as part of the Tongass National Forest. The remaining land was placed in federal land holding for the CAA. The USACE carried out cleanup operations around Yakutat in 1984 and most of the remaining World War II facilities were removed at that time.

In 1960, the U.S. Air Force (USAF) acquired land from the USFS and State of Alaska Division of Lands to construct the Ocean Cape Radio Relay Site (OCRRS). The OCRRS was part of a Ballistic Missile Early

Warning System described as the White Alice Communications System. The OCRRS, located on Phipps Peninsula at the end of Point Carrew Road, approximately 5 miles west of the City of Yakutat, included industrial buildings, support facilities, water and fuel storage tanks, pipelines, billboard antennae, a bridge, roads, and utility lines. The facilities were leased to Recording Company America Alaska Communications, Inc. (RCA) between 1974 and 1976. The station closed and the OCRRS was declared excess by the USAF in June 1976. On 11 August 1976, USAF granted full occupancy rights to Yak-Tat Kwaan, Inc. (YTK), the Yakutat village corporation, under license DACA85-3-76-106, for a 1 year term ending 10 August 1977, with the right to renew on a year to year basis. The property was relinquished to BLM in May 1977, followed by interim conveyance to YTK in 1979. In 1983 it was formally conveyed to the corporation and remains under their ownership today. Four tropospheric dishes, industrial buildings, and associated equipment were removed during USACE cleanup activities in 1984. However, YTK requested that a 50,000-gal tank, POL pump house and pipeline, maintenance garage, and a water storage tank remain in place. The structures were later removed by the Yakutat Tlingit Tribe under the DoD Native American Lands Environmental Mitigation Program (NALEMP), beginning in 2009.

2.2 PHYSICAL SITE CHARACTERISTICS

2.2.1 Topography

AOCs C2, C4, and C6 are located on Phipps Peninsula, north of Ankau Slough. The AOCs are situated on glacial moraine and marine beach deposits at elevations ranging from approximately 17 to 25 feet above mean sea level (amsl). The topography at AOCs C2 and C4 is relatively flat, sloping gently to the south, and surrounded by wetlands/muskeg and a pond. The topography at AOC C6 slopes to the south-southeast, toward Ankau Slough.

AOC D is located inland from Monti Bay on glacial moraine deposits. Elevation at the site ranges from approximately 40 feet amsl north of AOC D1 to 95 feet amsl at AOC D8. The topography generally slopes to the north toward Monti Bay, with some steeply sloped areas located adjacent to several of the former AST locations.

AOCs M3, O1, and AACS are located near the Yakutat Airport on a relatively flat glaciofluvial outwash plain. The topography is relatively flat, with a surface elevation of approximately 16 feet amsl.

2.2.2 Vegetation

Three types of plant communities are found in the coastal area: true forest, grass-sedge meadows, and muskeg. The true forest generally consists of dense old-growth Sitka spruce, some western hemlock, and cottonwood; skunk cabbage and devil's club provide ground cover. Salmonberries, blueberries, and high bush cranberries are found in the forest. The forested areas in and around the Ankau Saltchucks on Point Carrew historically have been used to gather berries.

Grass-sedge meadows often border freshwater ponds and lakes, and are found at the mouth of river deltas. Fireweed, lousewort, paintbrush, lupine, and strawberries exist in this environment. Muskeg are interspersed throughout the forest, containing sedges, deer cabbage, heather, Alaska cotton grass, Arctic iris, yellow pond lily, willow, and nagoonberry. Muskeg is nutrient-poor peatland characterized by acidic saturated peat and scattered or clumped, stunted vegetation in a matrix of sphagnum mosses and shrubs.

2.2.3 Climate

Yakutat’s climate is dominated by its proximity to the coast. Meteorological data for Yakutat from 1981 to 2014 indicate monthly average temperatures of 54.4 degrees Fahrenheit (°F) in July and 28.1°F in January, with a maximum summer temperature of 88°F recorded in August 2004 and a minimum winter temperature of -24°F recorded in December 1964. Extreme temperature durations usually are only 4.9 days of below zero lows and 4 days of above 70°F highs annually.

Maritime conditions often are cloudy and wet. Average annual precipitation in the Yakutat area is 155 inches, with precipitation occurring an average of 240 days per year. June is the driest month, with an average of 6.39 inches of precipitation. September and October are the wettest months, with an average of 21.11 and 22.01 inches of precipitation, respectively. January has the greatest snowfall, with an average of 31.3 inches. Average snow depths during the winter and early spring months are typically less than 15 inches.

Wind in the Yakutat area generally blows toward the east from the Gulf of Alaska. In winter, these winds are more likely to blow east/northeast, while in summer winds are more likely to blow east/southeast. Surface wind velocities average 7.3 miles per hour (mph), with peak averages in January of 18.9 and 18.6 mph in 2001 and 2011, respectively (National Oceanic and Atmospheric Administration [NOAA] 2014).

2.2.4 Geology and Soils

The City of Yakutat is located on the Yakutat Forelands, a gently sloping glacial outwash plain between the Saint Elias Mountains and the Gulf of Alaska. Repeated cycles of glacial advance and retreat deposited the moraine complex and outer border of outwash that now make up the Yakutat Forelands. A great glacier occupying Yakutat Bay extended to Ocean Cape, creating the Phipps Peninsula and other moraine deposits in the area.

Eight dominant surficial deposits, primarily of Holocene age, have been mapped in the Yakutat area. These include organic, eolian, beach, delta-estuarine, alluvial, outwash, moraine deposits, and artificial fill. Artificial fill is present mostly under the airport runways and other areas that were extensively modified during construction, including the Yakutat Civic Center. In addition to artificial fill, sediments beneath the FUDS AOCs principally include outwash and moraine deposits. These deposits contain layers of both well-graded and poorly-graded sand, sand with gravel, and silty sand.

Two outwash deposits are mapped, based on grain size. The deposits begin close to the end moraine near Yakutat Bay. Cobble gravel is the major constituent of the outwash close to the moraines. Grain size decreases with increasing distance away from the end moraines, which are poorly sorted and contain silts and clays. The outwash deposits range in thickness from approximately 3 to 56 feet and overlie old delta-estuarine sediments and some buried moraine deposits.

End-moraine and ground-moraine deposits have not been separated into subunits. The mixture of till that composes the moraines is mainly gravel-laden silt and sand, in varying proportions, with lesser amounts of cobbles, clay, and boulders. Rarely, organic material is present in the till. Numerous bogs and ponds are found between moraine ridges. Subordinate glaciofluvial deposits, including kames, eskers, crevasse fillings, and minor outwash deposits, also exist between moraine ridges. Moraine deposits vary in thickness by up to approximately 250 feet (United States Geological Survey [USGS] 1979, 1998).

2.2.5 Hydrogeology and Hydrology

The Yakutat Forelands aquifer is a water-table aquifer, fed by precipitation infiltration and drained by small streams. Recharge also can occur by the streams when the stage of streams is higher than the local water table. Groundwater generally occurs within 10 feet of the ground surface in most locations. However, groundwater is located as deep as 65 feet below ground surface (bgs) at the moraine deposit that forms AOC D. Groundwater flows both vertically and laterally through the unconfined regional aquifer. The groundwater flow in the region generally follows topography, towards streams, lakes, the coastline, and manufactured drains. Glacial moraine and outwash deposits make up the majority of the regional aquifer. These materials typically exhibit a wide range of hydrogeological parameters that are based on the depositional history and grain size of the deposits. Outwash deposits are generally well-sorted, coarsely grained materials with higher permeability than moraines and tills (USGS 1998).

2.3 PREVIOUS INVESTIGATIONS

Several previous investigations have been conducted at the Former Yakutat Air Base FUDS as presented in the WP/QAPP. The previous investigation reports applicable to each AOC investigated as part of this Supplemental RI are listed in Table 2-1. A brief summary of previous investigation activities and results identifying media impacts for each AOC is presented in Sections 5.0 through 19.0. Details of these investigations can be found in the documents listed in Table 2-1.

Table 2-1: Previous Investigation Reports

In-Text Citation	FRMD #	Report Title	Report Date	Subject AOCs addressed in the report
USACE 1984	F10AK060601_01.04_0500_p	Environmental Restoration Defense Account Debris Cleanup and Site Restoration Design, Yakutat, Alaska	July 1984	C2, C4
Ecology & Environment (E&E) 1994	F10AK0606--_01.09_0500_a	Field Investigation Report, Former Yakutat Air Base, Formerly Used Defense Site, Yakutat, Alaska, Site No. F10AK060600	August 1994	C2, C4
AGRA Earth & Environmental, Inc. (AGRA) 1997	F10AK060601_01.05_0001_p	Summary Investigation of DoD Activities on Yakutat Tribal Lands	March 1997	C2, C4, C6
E&E 1997	F10AK0606--_01.09_0501_a	Draft Yakutat Air Base/Ocean Cape Radio Relay Site Investigation Report, Yakutat, Alaska	December 1997	C2, C4, M3
ENSR Consulting and Engineering (ENSR) 2003a	F10AK060602_03.10_0006_a	2000 Remedial Investigation Report – Final – Remedial Investigation/Feasibility Study, Yakutat Area, Alaska	February 2003	C2, C4, D
ENSR 2003b	F10AK060602_03.10_0005_a	2001 Remedial Investigation Report – Final – Remedial Investigation/Feasibility Study Yakutat Area, Alaska	March 2003	C2, C4, C6, D, M3, O1
ENSR 2005	F10AK060602_04.09_0500_a	Final Feasibility Study, Yakutat Area RI/FS. Yakutat, Alaska.	January 2005	C2, C4, C6, D, M3, O1
Shannon & Wilson (S&W) 2006a	F10AK060602_03.10_0001_a	Final Focused Remedial Investigation, Former Yakutat Air Force Base, Yakutat, Alaska	April 2006	C6, D, O1
S&W 2006b	F10AK060602_03.10_0002_a	2005 Final Focused Remedial Investigation, Former Yakutat Air Force Base, Yakutat, Alaska	August 2006	D
USACE 2006	F10AK060602_03.10_0007_a	Final Rapid Optical Screening Tool (ROST)/Laser-Induced Fluorescence (LIF) Focused Remedial Investigation Former Yakutat Air Force Base, Yakutat, Alaska	September 2006	C2, C4, C6, D
BC Contractors –Jacobs Joint Venture (BCC-J) 2007	F10AK060602_03.10_0004_a	Former Yakutat Air Force Base Remedial Investigation Report, Yakutat, Alaska, Final	March 2007	C6
USACE 2008	F10AK0606--_01.09_0505_a	Final Military Munitions Response Program CERCLA Preliminary Assessment for the Yakutat Air Base, Yakutat, Alaska	May 2008	C2, C4, C6, D
S&W 2010	F10AK060602_04.09_0503_a	Final Feasibility Study Report, Former Yakutat Air Force Base, Yakutat, Alaska	July 2010	C2, C4, C6, D
S&W 2012	F10AK060602_03.10_0008_a	2010 Supplemental Remedial Investigation Former Yakutat Air Force Base, Yakutat, Alaska	February 2012	C2, C4, M3, AACS

Source: Historic 1959 USGS Yakutat Quadrangle Sheets (B-5, C-5) 1:63,360 series.

1 in = 1 miles

FIGURE 2-1

Vicinity Map
Former Yakutat Air Base

US Army Corps
of Engineers
Alaska District

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

3.0 INVESTIGATION APPROACH

3.1 PROJECT TEAM

The Supplemental RI field effort was managed by the following key personnel and supported by the subcontracted companies listed. All sampling and oversight of subcontractors was performed by an ADEC Qualified Person per 18 AAC 75.990.

- USACE Project Manager: Christy Baez
- USACE Project Engineer: Thomas Reed
- USACE Project Chemist: Michael Utley
- ADEC Project Manager: Jessica Morris
- AECOM TO Manager: Quinn Meehan
- AECOM Field Manager/Site Safety & Health Officer: Teresa Watson
- AECOM Quality Assurance (QA) Manager/Project Chemist: Hugh Prentice
- AECOM Qualified Staff: Charles Begeal, Nicole Ward, Mark Love
- HRC Assessment: Lawrence Acomb, Geosphere, Inc.
- Drilling Services: Discovery Drilling, Inc. (Discovery)
- Land Survey: McClintock Land Associates, Inc. (MLA)
- Construction Services: Pate Construction
- Bear Guard: Red Bear Wilderness Guides
- Waste Transportation and Disposal: Emerald Services, Inc.
- Laboratory (Chemical): Test America Tacoma Washington (TATW)
- Laboratory (Geotechnical): Hattenburg, Dilley, and Linnell, LLC. (HDL)
- QA Laboratory: RTI Laboratories, Inc. (RTI)
- Data Review: Laboratory Data Consultants, Inc. (LDC), Carlsbad, California

3.2 MOBILIZATION/DEMOBILIZATION

3.2.1 Right-of-Entry

AOCs C2, C4, C6, and D are located on land owned by Yak-Tat Kwaan, Inc. and Sealaska, Corporation. The USACE coordinated with these landowners and the City of Yakutat to obtain the necessary right-of-entry (ROE) approval for environmental assessment and response prior to field mobilization. Copies of the Department of the Army ROEs for the City of Yakutat (DACA85-8-13-00021), Yak-Tat Kwaan, Inc. (DACA85-8-13-00028), and Sealaska, Corporation (DACA85-8-13-00029) were provided as an appendix to the WP/QAPP and kept onsite during implementation of the Supplemental RI.

3.2.2 Equipment and Personnel Mobilization/Demobilization

Field work was conducted in phases over a five-week period from 2 June 2014 to 8 July 2014; and as such, AECOM field personnel and subcontractors were mobilized and demobilized from the field as needed. The AECOM Field Manager, one Qualified Staff member, and a Bear Guard were initially mobilized to Yakutat on 2 June 2014. AECOM equipment and supplies were shipped to Yakutat via air cargo and arrived on the afternoon of 2 June 2014. The equipment was staged at a storage space located at the Yakutat Airport for the duration of the project. Two additional AECOM Qualified Staff mobilized to the site from 5 June to 6 June 2014, and the AECOM TO Manager was onsite to kick-off the field work and perform a Project Management Site Visit from 5 June to 8 June 2014. The MLA survey crew was onsite from 5 June to 10 June 2014 to set up control points and complete initial survey activities. The Discovery drill rig, supply truck, ATV and drilling supplies were shipped to Yakutat in mid-May via barge and staged at Pate Construction to ensure that all equipment was available when the drilling crew arrived on 6 June 2014.

AECOM and subcontractor personnel were demobilized from the site as investigation activities were completed. Personnel demobilization occurred between 29 June and 8 July 2014. On 3 July 2014, MLA re-mobilized two personnel to Yakutat to perform a second (post-investigation) land survey of final sampling locations, which was completed on 7 July 2014. The Discovery drilling crew also demobilized on 7 July 2014 once drilling activities were completed. AECOM equipment was shipped from Yakutat to Anchorage via air cargo on 9 July 2014, and Discovery's drill rig and equipment were loaded onto a barge by Pate Construction personnel and shipped back to Anchorage on 10 July 2014.

3.2.3 Site Access

Sampling locations at AOCs C2, C4, C6, and O1 were easily accessible and required minimal to no vegetation clearing, whereas those associated with AOCs D, M3, and AACS required improvements. On 4 June 2014, Pate Construction cleared vegetation from the proposed sampling locations at AOC D3 through D8 using heavy equipment (loader). On 5 June 2014, Pate Construction cleared downed trees from the AOC M3 access path using chain saws, and installed a temporary bridge at the AACS access trailhead. The bridge consisted of a steel roll-off platform installed using an excavator. The excavator was mobilized to the trailhead using a lowboy trailer and the temporary bridge was transported to the site on a flatbed trailer. After the bridge was placed over the stream, small tree branches were cleared from the AACS access trail using loppers and a chain saw. For all remaining AOCs, clearing was limited to overgrown brush and fallen trees blocking access trails. Large growth trees with diameters larger than 3 inches were not cleared.

3.3 NAPL SOURCE DETERMINATION AND SAMPLING RATIONALE

Several AOCs (C2, C4, C6, D and AACS) with petroleum hydrocarbon contamination were evaluated using the HRC. This approach required characterization of the non-aqueous phase liquid (NAPL) contaminant source areas. The NAPL source areas are defined as a three-dimensional volume of soil with gasoline range organics (GRO) and/or diesel range organics (DRO) concentrations above the ADEC Method Two, Table B2 migration to groundwater cleanup levels (260 milligrams per kilogram [mg/kg] GRO and 230 mg/kg DRO). In addition, soils containing greater than 230 mg/kg residual range organics (RRO) are considered part of the NAPL contaminated soil source area (even though the Method Two cleanup level is 8,300 mg/kg). This is because the presence of RRO above about 230 mg/kg indicates the presence of NAPL at a concentration that significantly affects the phase partitioning and risk posed by the hydrocarbon fractions and individual constituents. NAPL may be present in soil below these concentrations; however, ADEC does not regulate the hydrocarbon fractions below the cited levels (ADEC 2011a).

Data collected during previous investigations were compiled and used initially to define the nature and extent of the NAPL source areas at each AOC. Petroleum contaminants identified at the site include GRO, DRO, RRO, volatile organic compounds (VOCs), and PAHs. In addition, data from a Rapid Optical Screening Tools (ROST) investigation were used to help determine the extent of the source zones. The ROST investigation used laser-induced fluorescence (LIF) technology to screen for the presence of hydrocarbon NAPL at direct-push probe locations. For the purposes of the WP/QAPP and this RI report, LIF readings above 1 percent (%) reference emitter (%RE) are considered to indicate the presence of NAPL above the ADEC cleanup level of 230 mg/kg DRO. Boring and ROST probe locations were plotted on each AOC base map to estimate the lateral extent of the source zones. The ROST and boring logs were also reviewed to determine the approximate depths of these impacts, along with the depths of analytical samples exceeding cleanup levels, in order to estimate the vertical extent of the NAPL source zones at each site. Physical characteristics of the NAPL source(s), including the lateral and vertical extent of the source zones at each AOC, were used as input parameters for the HRC to evaluate the risk potentially posed by individual constituents and exposure routes, the cumulative risk, and to calculate soil ACLs. Input parameters for the HRC and Online Calculator are discussed in Section 4.2.

Most of the soil data collected as part of the Supplemental RI were obtained from borings advanced within the NAPL source zones and samples collected at target depths to obtain sample data representative of the highest POL concentrations. Analytical data for these samples were then used to supplement historical data previously collected from within the source zones. AOC-specific data sets were then entered into the HRC for risk evaluation as discussed in Sections 5.0 through 19.0.

3.4 RI FIELD ACTIVITIES AND PROCEDURES

Supplemental RI activities at the Former Yakutat Air Base FUDS were conducted in accordance with procedures described in the ADEC *Draft Field Sampling Guidance* (ADEC 2010a) and the WP/QAPP. Site conditions and field activities were photographed (Appendix A) and documented in logbooks kept by the field team (Appendix B). These activities and procedures are discussed below.

3.4.1 Visual Inspection

Prior to implementing investigation activities, a site reconnaissance and visual inspection of each AOC was performed to photo document and assess current site conditions. Evidence of visible impacts (i.e., surface staining, distressed vegetation, etc.) was noted to aid in selecting or confirming appropriate sampling locations.

Test pits excavated at AOCs C2 and C4 were visually inspected to identify the type of debris present at areas with previously identified elevated geophysical responses. Abundant garbage and construction debris were observed in the majority of test pits at AOC C2. Black oily droplets and hydrocarbon sheen were observed on the water entering several of the C2 test pits. Contents of subsurface debris excavated from the test pits are shown on photos included in Appendix A. Discussions of the inspection results for AOCs C2 and C4 are presented in Section 5.3.1 and Section 6.3.1, respectively.

A visual inspection was conducted at the AOC M3 50 kW Powerhouse to identify potential PAH sources and non-FUDS related contaminant sources (e.g., ash piles, charcoal, burned wood, trash, or other evidence of recreational activities or dumping occurring in the area). The remains of a second powerhouse (400 kW Post Powerhouse – No.564) were visually inspected to identify any visible evidence of contamination and/or potential POL sources. The former 400 kW Post Powerhouse and surrounding area were photo documented (Appendix A). A discussion of the inspection results for the AOC M3 50 kW Powerhouse and the 400 kW Post Powerhouse – No.564 are presented in Section 16.3.1 and Section 17.3, respectively.

3.4.2 Soil Sampling

SOIL FIELD SCREENING

Soil samples were screened using a photoionization detector (PID) and headspace screening procedures to guide soil characterization and delineation activities. Ambient temperature (greater than [>] 40°F) headspace vapor screening was conducted by placing a portion of the soil sample in a re-sealable plastic bag approximately one third full. The bag was sealed and the enclosed air headspace was allowed to equilibrate for a minimum of 10 minutes, but no longer than an hour. The sample was agitated prior to taking a PID reading. The PID reading consisted of inserting the probe of the PID into a small opening in the bag and observing the maximum vapor concentration. The sample collection time, time the headspace reading was taken, and maximum vapor concentration value were recorded in a field logbook with the associated sample number.

SOIL CHARACTERIZATION AND DELINEATION SAMPLING

Soil sampling for source characterization and delineation was performed at AOCs C2, C4, C6, D, M3 and AACS. Appropriate sampling procedures were determined based on site conditions at each AOC and are discussed below. Soils at each sample location were described using the Unified Soil Classification System and recorded on a field sampling form or in the corresponding logbook, along with sample designation, date and time, and sample depth.

Test Pit Logs and Soil Boring Logs are provided in Appendix C.

Test Pits

Test pits were excavated at AOCs C2 and C4 to identify subsurface debris that caused geophysical anomalies and to collect soil characterization samples. Sample locations were selected to target the historical locations and depths with the highest POL concentrations and ROST/LIF responses, and were marked with wooden lathe by the MLA survey crew during the first survey mobilization. Test pits were excavated in 1-foot to 2-feet lifts using a tracked excavator, and advanced to total depths ranging from 3.5 to 10 feet bgs. Samples collected for volatiles analysis (as described below) and field screening were collected from a fresh soil surface from each lift, directly from the excavator bucket, prior to homogenization. Field screening samples were evaluated for volatile vapors using a PID as described above. Samples retained for laboratory analysis were collected from the target depth intervals at each test pit, and adjusted in the field as required depending on field observations (e.g., highest PID readings, visual staining/debris, and olfactory). After sample collection, native materials were immediately placed back into the test pit excavations. To the extent practicable, materials from the deepest lift were placed first and each 1-foot to 2-feet lift was tamped with the backhoe bucket for compaction.

Soil Borings: Drill Rig

At AOCs C6 and D, sample locations were selected to target the historical locations and depths with the highest POL concentrations, and were located with wooden lathe by the MLA survey crew during the first survey mobilization. Soil borings were advanced using a Central Mining Equipment (CME)-75 drill rig mounted on a Nodwell tracked carrier. The drill rig was equipped with hollow-stem augers (HSAs) and samples were retrieved by driving a 3-inch diameter split-spoon inside the augers using an automatic hammer. The rig was also capable of advancing borings using air rotary based on anticipated drilling conditions at AOC D. However, the air rotary technology was not needed and all borings were advanced using HSA.

At vadose zone sampling locations, split-spoons were driven and samples collected 2 feet above the target depth, at the target depth, and 2 feet below the target depth. For boring locations with shallow target depths (i.e., 0-2 feet bgs), field screening samples were collected from 0 to 2 feet bgs and 2 to 4 feet bgs. For saturated zone and smear zone sampling locations, split-spoons were advanced continuously from 4 feet above the estimated water table to a minimum of 4 feet below the static water level. Samples collected for volatiles analysis (as described below) and field screening were collected first from undisturbed material retained in the split-spoon sampler prior to homogenization. Field screening samples were evaluated for volatile vapors using a PID as described above. For each target depth range, an analytical sample was collected from the interval that appeared to be most heavily contaminated (i.e., highest PID result, odor, and sheen).

After sample collection was completed, borings were backfilled with bentonite chips to grade. Soil cuttings generated during drilling activities were considered investigation-derived waste (IDW) and containerized in 55-gal drums. IDW drums were staged at AOC D prior to transport to an offsite disposal facility (Section 3.5).

Soil Borings: Manual Jackhammer

Sampling locations to evaluate the nature and extent of impacted soils at the AACS and AOC M3 were determined in the field based on site conditions. Soil borings at these locations were advanced manually from 0 to 4 feet bgs using a jackhammer to drive 2-feet, 1.75-inch diameter split-spoons. Sampling locations at these sites were selected based on historical data and field observations. Samples collected for volatiles analysis and field screening were collected first from undisturbed material retained in the split-spoon sampler prior to homogenization. Field screening samples were evaluated for volatile vapors using a PID as described above. One analytical sample was collected from the depth interval with the most observed contamination (i.e., highest PID reading, olfactory, visible sheen). At the boring location with the highest field screening result, a second deeper soil sample was collected for vertical delineation of impacts.

After sample collection was completed, borings were backfilled with bentonite chips to grade. Excess sample material generated at the site was brought back to the temporary staging area at AOC D and placed in drums for disposal (Section 3.5).

Analytical Sample Collection

Samples collected and retained for definitive analysis at these locations were submitted for laboratory analysis of GRO, benzene, toluene, ethylbenzene, xylenes (BTEX), DRO, RRO, and PAHs. In addition**,** a subset of those samples collected from the most heavily contaminated areas targeted from historical data and selected based on field screening (i.e., highest PID reading, olfactory, visible sheen) were analyzed for extractable petroleum hydrocarbons (EPH) and volatile petroleum hydrocarbons (VPH) to meet HRC requirements. GRO, BTEX, and VPH samples were collected as quickly as possible by transferring approximately 25 grams of soil directly from the sampling device into a 4-ounce, pre-tared, wide mouth jar. The soil mass was measured in the field using a small portable scale. Immediately after transferring the soil to the jar, a 25-milliliter (ml) aliquot of methanol preservative was poured in the jar to completely submerse the sample. The optimum soil to methanol ratio is 1:1, but an additional 25 ml of methanol was added if the soil sample was not completely submerged in the methanol. In these instances, the extra methanol was noted in the logbook and on the chain-of-custody form. The methanol lot number for each sample was also recorded in the field logbook.

After field screening was completed to determine the appropriate sample for submittal to the laboratory, soil from the selected interval was thoroughly homogenized and transferred into laboratory-supplied containers for non-volatile analyses.

BACKGROUND SOIL SAMPLING FOR TOTAL ORGANIC CARBON AND GEOTECHNICAL PROPERTIES

Background soil samples were collected for total organic carbon (TOC) analysis at AOCs C2/C4, C6, D, and AACS as part of the Method Three evaluation. The background sample locations were selected to be outside of the estimated contaminant source zones and in areas with no visible signs of contamination. These samples were collected from soil types similar to those encountered within the source zone. The TOC analysis included measuring three separate aliquots of the soil (i.e. triplicate analysis). In addition to TOC analysis, the samples were analyzed for GRO, DRO/RRO, and DRO/RRO with silica gel cleanup (SGC) (ADEC Technical Memorandum 06-001, *Biogenic Interference and Silica Gel Cleanup* [ADEC 2006]) in order to document that the TOC results were not affected by hydrocarbon contamination. Samples for TOC were collected following *Technical Memorandum-08-002, Guidelines For Total Organic Carbon (TOC) Sample Collection and Data Reduction For Method Three and Method Four* (ADEC 2008c).

In addition to collecting uncontaminated soil samples for TOC analyses, background soil samples were collected for analysis of physical parameters (geotechnical index properties) including grain size, specific gravity, moisture content, and bulk density. Bulk density samples were collected by using the CME drill rig to push 3-inch diameter split-spoons lined with brass sleeves into the subsurface at a predetermined depth to obtain undisturbed material. If additional material was required for the remaining physical parameters, a second split-spoon was driven (without brass liners). At the AACS, background samples were collected from 1.75-inch diameter split-spoons driven manually using a jackhammer. Both the analytical and physical parameter samples were collected from the split-spoon.

3.4.3 Groundwater Sampling

Groundwater samples were collected from existing monitoring wells at AOCs C6 and D following procedures in the WP/QAPP and applicable field modifications (Section 3.7). In-source wells were sampled to evaluate groundwater impacts and collect data for the HRC. Wells outside the source areas were sampled to evaluate current groundwater quality and confirm that contamination has not migrated outside the source zones. Monitoring wells with 1-inch inner diameter (ID) casings were sampled using a 0.675-inch diameter pneumatic bladder pump with a dedicated bladder and tubing. Wells with 2-inch ID casings were sampled using a 1.75-inch diameter pneumatic bladder pump with a dedicated bladder and tubing. The pump intake was set at the approximate mid-point of the wetted portion of the screened interval; generally within 1 to 3 feet of the air-water interface. One exception was at well AST5-4, with the pump intake placed at approximately 5.3 feet below the air-water interface. Prior to sample collection, each well was gauged using a water level meter, and purged using low-flow methods. A YSI 556 water quality meter with a flow-through cell and LaMotte turbidity meter were used to monitor field parameters. In general, where sufficient yield was available, groundwater samples were collected following stabilization of water quality parameters (i.e., three successive readings were within plus or minus [±] 3% for temperature, ± 0.1 for pH, ± 3% for conductivity, ± 10 millivolts for oxidation-reduction potential (ORP), ± 10% for dissolved oxygen (DO), and ± 10% or less than [<] 10 nephelometric turbidity units for turbidity). Volatile samples (GRO, BTEX, and VPH) were collected first, followed by non-volatile constituents. Groundwater samples were analyzed for GRO, BTEX, DRO, RRO, and PAHs. In addition, samples collected from wells located inside source zones were analyzed for EPH and VPH. Low Flow Groundwater Sample Collection Records are provided in Appendix D.

At AOCs C2 and C4, two temporary well points were installed inside the source zones. The temporary well points consisted of ¾-inch diameter steel risers and screens. The temporary well points were placed in an open trench excavated to just above the estimated water table and the screens were driven manually approximately 1 to 2 feet into the water table using a slide hammer. Purging of the well points for development and sampling was performed using a peristaltic pump with dedicated tubing, with the pump run at the lowest flow possible to lift the water up the tubing. However, due to the shallow nature of the well points, minimal water column was present in both well points and they were purged dry after approximately 330-350 ml of water were removed. As such, the temporary well points did not contain enough water to continually monitor field parameters or attain stabilization prior to the well points going dry. Groundwater samples were collected directly from the peristaltic pump tubing after the well points attained 80% recharge, which took approximately 1.2 hours for C4-WP01 and 0.5 hour for C2-WP01. In order to obtain adequate sample volume, the sample containers were filled over approximately 8.5 hours for C4-WP01 and 3 hours for C2-WP01. This occurred because the wells continually purged dry throughout the day. After confirmation of sample receipt by the laboratory, the temporary well points were removed from the subsurface, and the boreholes were filled with bentonite chips.

In addition to the samples collected from the monitoring wells and temporary well points, water samples were collected from two City of Yakutat drinking water wells located at AOC D8. Access to the well houses for ARCO #1 and ARCO #2 was obtained by the Public Works Department. Samples were collected upstream of on-site treatment from high pressure valves located on pipes inside each well house. The valves were opened and water was allowed to flow for a minimum of 15 minutes prior to sampling. During sample collection, the valves were turned down as low as possible and water was collected directly into laboratory containers. For preserved containers, specifically vials for volatile organic analysis, an unpreserved liter bottle was used to collect water from the valve and immediately transferred to preserved containers to minimize volatilization to the extent possible. A round of post-sampling field parameters was measured after sample collection using a YSI 556 and LaMotte turbidity meter.

3.4.4 Surface Water and Sediment Sampling

Surface water samples were collected from various ponds, streams, and ditches at AOCs C2, O1, and AACS to evaluate surface water quality in these areas. A telescoping rod with dedicated tubing attached to the end was used to obtain surface water samples via a peristaltic pump. The rod was extended over the water body with the tubing intake extended beneath the water surface. This sampling method was implemented to allow field personnel to remain on the stream bank or shore of the water feature, thus minimizing the potential for sediment disturbance. At the AOC C2 ponds, samples were collected approximately 6 to 7 feet from the shoreline at depths ranging from 0.5 to 2 feet below the water surface. Surface water samples were collected from shallow streams at AOCs O1 and AACS using similar techniques as those for AOC C2. These samples were collected from approximately mid-stream at depths ranging from approximately 1.5 to 7 inches below the water surface, depending on the depth of the stream at that location.

At each surface water sample location, the pump was turned on at a low flow rate and field parameters (pH, salinity, conductivity, temperature, DO, ORP, and turbidity) were measured using a YSI 556 water quality meter and a LaMotte turbidity meter. Field parameters were collected at two depths, just below the water surface and just above the sediment surface (where attainable) and recorded on a Surface Water/Sediment Sampling Form (Appendix D). Generally, surface water samples were collected from the middle of the surface water column by disconnecting the flow through cell and transferring the water directly from the dedicated tubing into laboratory containers.

Co-located sediment samples were collected from the AOC C2 ponds after surface water sampling was completed. Sediment was collected using a decontaminated hand auger and placed on clean plastic sheeting. A description of the material recovered was logged on the Surface Water/Sediment Sampling form. Samples for analyses were obtained from the top 0 to 6 inches of the sediment surface, removing any vegetative mat (i.e., roots, leaves, pine needles, sticks, etc.). Each sediment sample was thoroughly homogenized prior to transfer to the appropriate sample container.

3.4.5 Aquifer (Slug) Testing

Slug tests were performed on existing monitoring wells at AOCs C2, C4, C6 and D to obtain hydraulic conductivity values. For 2-inch ID wells that contained a sufficient water column (>5 feet), testing was performed using a solid slug by inserting a 2 feet x 1-3/4 inch solid polyvinyl chloride (PVC) slug and allowing the aquifer to rebound to the original static water level (slug-in). The slug was then removed as quickly as possible and water levels were again recorded as the aquifer was allowed to rebound (slug-out). For smaller diameter wells or those with a minimal water column (<5 ft), testing was performed by pouring a known volume of water (1 gal of deionized or distilled) into each well as instantaneously as possible (slug-in only). With the exception of one well at the AOC C2/C4 area (Section 4.2.2), two slug tests were performed at each of the monitoring wells.

Measurement of the induced water level fluctuations were recorded with a vented pressure transducer and data logger until levels re-achieved equilibrium (or rebound) of the static water level prior to stopping the test. The slug test data were then downloaded from the data logger and reviewed in the field to ensure proper data collection for each slug test. The slug test data were later reduced using the AQTESOLV software program (AQTESOLV 2014). The data were evaluated using both the Hvorslev Method (1951) and Bouwer & Rice Method (1976) for partially penetrated, unconfined aquifers. The Bouwer & Rice Method is generally the preferred method for the site because it also accounts for well screen and filter pack geometry, as well as the effective radial distance over which the displaced water is dissipated. Appendix E includes the AQTESOLV raw data files, graphs of displacement vs. time for each test, and a spreadsheet summarizing site-specific input parameters and hydraulic conductivity results.

Slug test data downloaded from the pressure transducers at each well were evaluated for acceptability. This evaluation took into account that adding or removing the slug takes some time (especially a water slug) and cannot be done instantaneously. For each test, the last steady-state reading before the slug was added was assumed as the pre-test, steady-state water level. The water level reading with the maximum displacement was used to calculate initial displacement. If there were water level readings in between these two, they were removed as they do not represent any aquifer characteristics, but rather are due to limits of the methods used. This resulted in the removal of a few seconds' worth of water level data at the beginning of most tests.

For most of the slug tests, it was observed that immediately after the slug was inserted, initial displacement was high and dropped very rapidly (within a matter of seconds), followed by a steady, linear decrease in displacement with a much lower slope. It is suspected that the initial fast decline is due to the presence of a gravel/sand filter pack around the screen and the fact that the well screens were only partially submerged, as documented in the Slug Test Summary Table in Appendix E. Under these conditions, as soon as a slug is added, water is displaced into the unsaturated part of the filter pack (above the water table). Once the slug volume is distributed or equilibrated between the well casing and filter pack, a slower decline in water level may be observed as the slug volume equilibrates with the formation (this phenomenon is described in *Applied Hydrology* [Fetter 1994]). This second decline represents aquifer response, while the first part is likely due to well construction properties. Therefore, the first section of the displacement vs. time plots was disregarded for calculation of hydraulic conductivity. Hydraulic conductivities calculated for each aquifer slug test are presented in Appendix E.

3.4.6 Tidal Study

A tidal study was conducted at AOC C6 as part of a groundwater use determination per AAC 75.350. To conduct the tidal study, AquaTroll 200 transducers were deployed in monitoring wells AP-062, AP-063, and AP-064. The pressure transducers were calibrated prior to deployment and an initial test was performed to ensure the transducers and data logger were operating properly. The tidal study was performed over a period from 6 June to 14 June 2014. Pressure, temperature, conductivity, total dissolved solids (TDS), resistivity, water density, and depth to water were measured in 10-minute intervals throughout the duration of the study period. Transducer recordings were downloaded and reviewed every few days during this time to ensure that the data were recording properly and again immediately prior to removing the transducers. Manual water level measurements were also obtained during these periodic checks to verify data readings and assist, if necessary, with any post-processing corrections (i.e., transducer slippage). The collected data were evaluated to determine the influence of tidal fluctuations in Ankau Slough on the groundwater flow regime at AOC C6 (Section 7.4.2). Measurements of temperature, conductivity, TDS, resistivity, and water density were also evaluated as part of the groundwater use determination (Section 7.4.4).

3.4.7 Decontamination Procedures

Following site reconnaissance, an appropriate onsite location for a central decontamination station was selected, with access to potable water at the Malaspina warehouse approved by a Yak-Tat Kwaan representative. The decontamination station was established on the gravel pad near the Malaspina warehouse along the northern perimeter of AOC D1. Decontamination of equipment was performed in accordance with the WP/QAPP and as described below.

Down-hole drilling equipment (i.e., augers, rods, drill bits, etc.) were transported to this station and decontaminated using a steam cleaner at the end of each field day or as needed. Water generated during decontamination was collected in a large metal tub for on-site treatment using granular activated carbon (GAC) filtration methods.

Smaller items like split-spoon samplers, hand tools, soil sampling equipment (i.e., spoons, bowls, trowels, etc.), and non-dedicated water sampling/monitoring equipment (i.e., bladder pumps, flow through cells, water level meters, transducers, PVC slug, etc.) were decontaminated between sample locations and/or samples to prevent cross-contamination. Decontamination of these smaller items consisted of washing the equipment with a mixture of potable water and Alconox, followed by a deionized or distilled water rinse. The water generated during these decontamination activities was collected in 5-gal buckets with screw-top lids and transported to the central decontamination station for GAC filtration.

Heavy equipment, such as the drill rig, excavator bucket, and tracks, was decontaminated using dry decontamination methods (i.e. removing residual soil from the bucket and tracks with shovels or brushes) between AOC locations and prior to demobilization.

3.4.8 Land Survey

A professional land surveyor registered in the State of Alaska, Doug Popham (LS-10161) with MLA, completed two land surveys during the Supplemental RI. Both surveys were conducted using duel frequency global navigation satellite system receivers, a conventional total station, a digital differential level, and associated data collector. Horizontal coordinates are provided in latitude and longitude decimal degrees using the World Geodetic System established in 1984, and vertical coordinates are provided in the North American Vertical Datum of 1988, in feet. Survey coordinates provided by MLA are included as Appendix F.

During the initial mobilization from 5 June 2014 through 10 June 2014, MLA established control points for AOCs C2, C4, C6, and D; surveyed the proposed soil borings and test pit excavations; and located existing groundwater monitoring wells. Level loops were extended from the respective control points and the wells, with turns conducted at the top of each PVC pipe. Levels were not extended from AOC D to AOCs C2, C4, and C6.

During the second mobilization from 3 July 2014 through 7 July 2014, MLA established survey control points for AOCs M3, O1, and AACS; surveyed all surface water and soil boring sampling locations at these AOCs; located the foundation for the 400 kW Post Powerhouse north of AOC M3; surveyed surface water sampling locations and temporary well points at AOCs C2 and C4; resurveyed soil boring, background, and test pit locations at AOCs C2, C4, C6, and D (if required); and surveyed additional features used in georeferencing. Additional features included concrete tank pads, concrete saddles, roads, tree lines, wetlands/pond edges, stream features, building corners, fences, access paths, and the temporary bridge crossing at the AACS.

3.5 INVESTIGATION-DERIVED WASTE

3.5.1 Liquid Waste

Liquid IDW generated during the Supplemental RI consisted of decontamination water and purge water from groundwater sampling activities. Water generated during decontamination of downhole drilling equipment (i.e., augers and rods, etc.) was collected in a large metal tub located at a central decontamination station set up at AOC D1. Water generated during decontamination of split-spoons at each boring location was collected in 5-gal buckets with screw-top lids and transported to the central decontamination station for treatment. Purge water and water generated during the decontamination of small equipment used for groundwater sampling, sediment sampling, etc. was also collected in 5-gal buckets with screw-top lids. This water was either transferred to the central decontamination station at AOC D1 or passed through a portable GAC unit at the point of generation.

Liquid IDW at the central decontamination station was treated by connecting a hose to an outlet at the bottom end of the metal tub and the other end of the hose to a GAC filter. Water in the decontamination tub was periodically gravity fed through the GAC filter, visually inspected for sheen, and discharged to the vegetated hillside north of the AOC D1 area. No sheens or odors were identified after treatment of the water, and all discharge points were at least 100 feet from surface water bodies and drinking water supply wells.

At the end of the field event, the spent GAC material and any solids remaining in the bottom of the decontamination tub were shoveled out and placed in Department of Transportation (DOT)-approved 55-gal drums with soil cuttings for disposal (discussed below).

3.5.2 Soil Cuttings

Soil cuttings generated during drilling operations were placed in DOT-approved, 55-gal open-top steel drums and staged on wooden pallets. A total of 15 drums of soil were generated: 14 at AOC D and one at AOC C6. Each drum was appropriately labeled with a non-hazardous solid waste label containing the following information:

- unique drum identification number,
- drum contents,
- accumulation date,
- generator/shipper name,
- site name,
- project number, and
- generator/shipper contact information.

Since all of the locations sampled were previously investigated, historical data were provided to the waste transportation company (Emerald Services, Inc.) to profile the waste for proper transport and disposal. The waste was characterized as POL contaminated soil, material not regulated by DOT.

Emerald Services, Inc. provided the appropriate final shipping labels, prepared the waste manifest, and coordinated with Alaska Marine Lines (AML) to provide a Conex shipping container. On 6 July 2014, the final shipping labels were placed on the drums for transport. On 8 July 2014, AECOM field personnel received the waste manifest and submitted the appropriate documentation to AML. After the manifest was signed by AML personnel, Pate Construction transported the drums from the temporary staging area at AOC D to the Conex shipping container staged at the AML facility. On 10 July 2014, the drums were transferred onto an AML barge and transported to the Columbia Ridge Landfill in Arlington, Oregon for disposal. Copies of the waste profile documentation, waste manifests and Certificate of Disposal are included in Appendix G.

3.5.3 Solid Waste

Solid wastes generated during the field effort included spent personal protective equipment (nitrile gloves, hearing protection, etc.), dedicated sampling equipment (bonded tubing, Teflon bladders, etc.), empty sample bottles, and miscellaneous trash (plastic bags, cardboard, paper towels, plastic sheeting, etc.). Wastes were stored in plastic trash bags and transported to the Yakutat Landfill for disposal as non-regulated waste.

3.6 CHEMICAL DATA QUALITY REVIEW

The following sections present the project screening levels used to evaluate field and analytical data collected for the Supplemental RI, quality control (QC) sample procedures and results, data quality review and acceptability, and electronic data deliverables (EDDs).

3.6.1 Screening Levels

Project action limits (PALs) were used to assess laboratory sensitivity and do not necessarily represent a final cleanup level; thus, they are used as initial screening criteria and indicators for data quality. The PALs and minimum and maximum laboratory limits of detection (LODs) achieved during analyses are presented in the precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCs) analysis below. References for the regulatory criteria used for the PALs are listed in Table 3-1 as follows:

Table 3-1: Regulatory References for PALs

Media	Reference for PALs
Soil	18 AAC 75.341 Method Two, Table B1 and B2, over 40 inch zone. The most stringent of 1) migration to groundwater or 2) direct contact or 3) outdoor inhalation pathways (soil ADEC cleanup level).
Groundwater	18 AAC 75.345 Table C Cleanup Levels (groundwater ADEC cleanup level).
Surface Water	The lowest of 18 AAC 70.020(b) Water Quality Criteria or 18 AAC 75.345 Table C Cleanup Levels.
Sediment	NOAA Screening Quick Reference Tables (SQuiRT) (threshold and probable effect level), per Buchman 2008 Sediment Quality Guidelines. When NOAA SQuiRT values are not available, the State soil cleanup criteria are used for screening.

AAC = Alaska Administrative Code
ADEC = Alaska Department of Environmental Conservation
NOAA = National Oceanic and Atmospheric Administration
PALs = project action limits

3.6.2 Analytical Results and Quality Assurance

All chemical laboratory analyses were performed through TATW. Ten percent of the samples were submitted to RTI in Livonia, Michigan as third party split (QA triplicate) samples. RTI subcontracted the analysis for VPH and EPH to Eurofins Lancaster Laboratories in Lancaster, Pennsylvania. The geotechnical data analyses were performed by HDL in Anchorage, Alaska.

LDC performed an independent validation of the TATW data reports and a PARCCS analysis for each sample delivery group (SDG). The AECOM Project Chemist reviewed the validation reports using summaries of the EDDs (Corps of Engineers Loading Tool [COELT] and Staged Electronic Data Deliverable [SEDD]) and presented an overall PARCCS analysis for the final report, including an evaluation of the triplicate analyses. The AECOM Project Chemist also checked calculations of the geotechnical results used for Method Three inputs.

The chemical laboratory analytical data packages for TATW and RTI (and subcontractor data) are provided in the Lab subfolder of the Supplemental folder. The geotechnical laboratory analyses are presented in Appendix H**.** To track samples within the analytical data packages or validation reports, a summary table has been provided in Appendix I. Table I-1 lists all samples collected with their associated analytical data package and associated validation report name.

Data tables presenting analytical results summarized by media, prepared to meet the requirements of the *Manual for Electronic Deliverables, Requirements for Submittals of Documents, Laboratory Data, and Other Items* (MED) (USACE 2011), are included in Appendix J.

3.6.3 Chemical Data Quality Review

Verification/Automated Validation of project data were performed as specified in the WP/QAPP by the third party validator LDC. Those reports are provided in Appendix I. Validation flags based on LDC review were applied to data presented in Appendix J and section-specific chemical data tables. The EDD-reviewed flags were used to summarize PARCCS performance. The only inconsistent findings observed were related to the independent processes used by the validator and electronic validation. For example: 1) the validator included flags based on calibration blanks and continuing verification samples, while those QC are not currently required in either EDD; 2) validator flags are based on method blanks, trip blanks and equipment blanks > LOD. EDD flagging could easily be adjusted to include any blank detection, which would be a conservative approach. However, this is only important when sample detects are slightly above the LOD, but blanks in control are slightly below; and 3) the validator flagged all metal samples in a batch with matrix spike (MS)/matrix spike duplicate (MSD) failures, while the QA plan and EDD validation protocol called for only the parent sample to be flagged (the additional flags provided by LDC validation were removed).

The AECOM Project Chemist performed an automated overview of QC data provided in the EDDs to ensure compliance with the WP/QAPP requirements by the laboratory and third party validator.

PARCCS ANALYSIS

This section serves to fulfill the guidance in ADEC Technical Memorandum, *Environmental Laboratory Data and Quality Assurance Requirements* (ADEC 2009b) for an overall PARCCS analysis for all analytical results with respect to the impact that any discrepancies have on the quality and usability of the data. The components of the automated validation reviewed the following elements of data QC as part of their PARCCS analysis:

- Holding times
- Initial calibrations
- Method blanks (MBs) (one per preparation batch)
- Surrogate spike recoveries (each sample for appropriate methods)
- MS and MSDs (5% minimum frequency and attempt one per preparatory batch)
- Laboratory control and laboratory control duplicate samples (per preparation batch)
- Reporting limits (DLs, LODs, and limits of quantitation [LOQs])
- Trip blank (TB) samples (per shipment group)

- Equipment rinsate
- Field duplicate samples and QA lab triplicates (10% frequency of primary samples)

It was determined that overall the data were of sufficient quality to be used for project purposes when applied with the recommended data qualifiers. Data tables presented in Appendix J define the laboratory SDGs for each sample.

Four summary report tables were developed from the electronic validation to support the PARCCS overview. These PDF output reports are presented as Figure 3-1 through Figure 3-4.

An overall PARCCS evaluation summary for the Supplemental RI is presented as follows:

Precision

The evaluation of precision is based on relative percent difference (RPD) calculations of replicates. The three main components of precision evaluated were laboratory precision estimated by replicate laboratory control sample (LCS)/laboratory control sample duplicate (LCSD); matrix related precision estimated by replicate matrix spikes (MS/MSD) and sample collection precision estimated by field duplicate samples. Figure 3-1 provides a frequency distribution of the number of passing and failing RPDs for the three components.

In summary, 99.0% of the LCS/LCSD RPDs (781 out of 789 replicate pairs) were in control for an RPD range of 0-30%. Any affected data were qualified with a QN flag for LCS/LCSD RPD failures; however, these failures might not be present in the final flags since other flags could override the QN flag. The ~1.0% RPD failure rate caused potential flags on 1.2% of the results (86 out of 7297 constituents reported- summarized from other queries not presented).

Summarizing MS/MSD RPDs showed that 91.1% (678 out of 744 replicate pairs) were in control for an RPD range of 0-30%. The parent sample of the MS/MSD was qualified with an MN flag for RPD failures; however, these failures might not be present in the final flags since other flags could override the MN flag. Further investigation into the MS/MSD RPD failures showed that of the 66 pairs, 4 were associated with groundwater and 62 with soil. Of those soils, 39 were associated with the soil VPH and EPH methods, which had 151 MS/MSD pairs (summarized from other queries not presented).

Summarizing field duplicate RPDs presented in Figure 3-1 showed that 87.3% (689 out of 789 replicate pairs) were in acceptable limits. Confirmed non-detections comprised 33.7% of the field duplicate pairs (266 of the replicate pairs). When one of the field replicates did not confirm as not detected (12.2% or 96 of the replicate pairs), none of the detections were at levels greater than one half of the Method Two criteria and in addition, further review showed that 83 of the 96 unconfirmed detections were less than three times the LOD. No further review was deemed necessary for discrepancies between non-detected and detected field replicate results. Figure 3-3 also summarizes a further breakdown of the failures when both the sample and replicate are detected (detections above and below 3 times the LOD). A total of 86 soil replicate pairs and 12 water replicate pairs exhibited failing RPDs when the primary sample is greater than 3 times the LOD. For the HRC calculations, the most conservative highest concentration was used. For detections, associated primary and field duplicate results are qualified with a J flag when not in control. The evaluation of field triplicates analyzed by the QA lab is discussed in the comparability section.

Accuracy

The evaluation of accuracy is based on the percent recovery (%R) calculations of spikes. The three main components of accuracy evaluated were laboratory accuracy estimated by %Rs of laboratory control samples (LCS/LCSD); matrix related accuracy estimated by %Rs of matrix spikes (MS/MSD) and surrogate spikes. Figure 3-1 provides a frequency distribution of the number of passing and failing %Rs for the three components.

In summary 96.66% of the LCS/LCSD %R were in control (1567 out of 1621 sample constituents spiked). Often high recoveries associated with sample constituent non-detections or detections below the action limit criteria are not considered an issue; therefore, QC samples exhibiting low recoveries are usually looked at closer. Further review of recoveries shows that only 31 of the 54 failing LCS/LCSD sample/constituents (~1.9% of spikes) exhibited recoveries below acceptance criteria. Those low recoveries ranged from 48.6 to 73.9% and at worst case was 77.7% of the lower control limit, suggesting that the low recovery failures did not have a major effect on data quality. Validation flags were appropriately assigned by the automated validation as follows:

- QL flags are assigned to all associated samples with spike recoveries below the lower control limit.
- QH flags are assigned to associated detected samples, with spike recoveries above the upper control limits.

Summarizing MS/MSD %R's showed that 74.26% were within control limits (1105 out of 1488 sample constituents spiked) and additional queries confirmed that less than 20% of the associated samples spiked required flagging (140 of 744 sample compounds) based on flagging requirements described below. MSs with background concentrations greater than four times the spike level are included in the frequency distribution. However, recoveries calculated when the background to spike ratio is greater than 4 (i.e. a 400 mg/kg sample concentration versus a spike added of 100 mg/kg equals a ratio of 4) are not considered representative because a reasonable and acceptable 10% variability of the compound in the matrix sample (10% of 400 mg/kg in this example equals a +/- 40 mg/kg uncertainty), used for determining spike added recoveries, can account for a +/- 40% spike recovery variability (a recovery of 60 to 140 mg/kg of the spike added of 100 mg/kg in this example). There were 383 spike failures listed in Figure 3-1 and 151 of those had background concentrations equal to or greater than 4 times the spiked amount added and are not considered failures in the flagging protocol. Validation flags were appropriately assigned by the automated validation as follows:

- ML flags are assigned to the parent sample with spike recoveries below the lower control limit.
- MH flags are assigned to the parent sample with detected constituent, with spikes recoveries above the upper control limits.

Summarizing surrogate %Rs showed that 96.6% (2489 out of 2576 sample surrogate constituents spiked) were in control. Surrogates are added to each sample for "Organic" methods to evaluate the matrix effect of constituents similar to the target constituents. Therefore, only the sample spiked is flagged. Validation flags were appropriately assigned by the automated validation as follows:

- QL flags are assigned to the associated sample with spikes recoveries below the lower control limit.
- QH flags are assigned to the associated detected sample with spikes recoveries above the upper control limits.

Representativeness

The evaluation of representativeness is based on several factors: blank contamination, cooler temperature receipt, and holding times. Blank contamination is evaluated for laboratory contamination (MBs), field operations (equipment blanks [EBs]); and volatile contamination during the lifetime of a sample (TBs). Results are evaluated based on detections in the blanks above the constituent's LOD. Sometimes detects below the LOD are meaningful but are evaluated as needed. Proper preservation and shipping of the samples to laboratory and analysis within specified holding times are also essential to ensuring sample results have not changed and represent conditions at the time of collection. Field duplicates and MS/MSDs also help determine a samples' representativeness. Figure 3-1 provides a frequency distribution of the number of passing and failing blanks.

Laboratory MBs analyzed with each batch of environmental samples showed that 94.1% of the constituents (778 of 827 tested constituents) were detected below the LOD and considered acceptable. Of the 49 MB constituents with detections above the LOD, 43 of those were associated with the VPH and EPH methods. The purpose of the sampling program was to collect samples with high concentrations of these components, therefore the minor amount of contamination in the MBs were not considered an issue. The laboratory was required to reanalyze a sample batch if MBs were > ½ of the LOQ or 1/10 of the PAL, whichever is greater. Validation flags, however, were assigned a B flag when MB constituents were detected above the LOD and associated samples were detected. If associated sample detections were detected at >10x the MB concentration, no flag was assigned.

Summarizing EB values >LOD, 78.49% (208 out of 265 sample constituents) were below the LOD. Comparison of EBs to soil samples is difficult because it is difficult to determine the mass of contamination associated with the soil samples. A similar issue can be thought of for water samples; however, contamination is more comparable than with soils. Of the 57 EB sample/constituents with detections between the LOD and LOQ, 45 were associated with VPH and EPH methods. Comments discussed in the MB section apply to EBs. Flags are not automatically assigned and are evaluated on a case by case basis.

Summarizing TB values > LOD, 75.3% (177 out of 235 sample constituents) were below the LOD. Of the 58 TB concentrations > LOD, 48 are associated with VPH and 8 associated with method AK101. These TB concentrations were not deemed to be a data quality issue by the independent validator or the AECOM Chemist. Validation flags were appropriately assigned by the automated validation as follows: B flags are assigned to the associated detected sample constituents where TBs are > LOD. Sample detects > 10x the TB concentration are not flagged.

In addition to the above, Figure 3-1 also shows the frequency distribution of the number of coolers received within various temperature ranges. All 30 coolers were received at temperatures below 6.0^{o}C. SW846 criteria states the acceptance range is 6.0^{o}C to freezing (0^{o}C). Alaska methods AK101, 102, and 103 state 2.0^{o}C to 6.0^{o}C. Samples below 2.0^{o}C were noted and documented in the ADEC checklist along with one cooler received below 0^{o}C. As long as samples were not frozen, samples received below 2.0^{o}C were considered acceptable. Figure 3-1 also evaluates the temperature for the number of sample/methods. Validators typically do not flag temperature exceedances until temperatures exceed 10^{o}C. The highest cooler receipt temperature was below 6.0^{o}C, therefore no results were flagged based on temperature.

Figure 3-2 provides an additional summary for representativeness by method. For presentation space, soils/sediments and surface waters/groundwater methods were combined. The number of field duplicates exceeded the 10% goal at 12.8%. Only 1.8% sample/methods exceeded holding times. Additional samples exceeding holding times were secondary results performed to support original data with various QC issues. The number of constituents are also summarized and the missed holding times relate to 1.5% of the constituents. Validation flags were appropriately assigned as a QL flag by the automated validation protocol to all sample constituents exceeding holding times. Figure 3-2 also provides a summary of the number of associated MS %R flags, MS RPD flags, and field duplicate flags assigned.

Comparability

The evaluation of comparability is based on several factors. Standard methods and operating procedures ensure that data are comparable. Following DOD Quality Systems Manual guidance and preparing a project QAPP was an integral part of ensuring comparability. Achieving quantitation limits that meet or approach State Criteria also ensures data comparability and is discussed further under sensitivity. The use of a referee laboratory (QA laboratory) for analysis of triplicate samples also provides a measure of comparability.

Figure 3-3 provides a distributional breakdown summary of QA and primary sample replicates. The breakdown for comparison of field replicates and QA triplicates to the primary field sample shows a worst case failure range of 37.9% for soils and 16.6% for waters. The overall percent failure rate decreases drastically to 13% (81 of 627) when evaluating failures meeting the following conditions: 1) unconfirmed non-detections where the detects are > ½ PAL and, 2) confirmed detected results where both detects are > 3x the LOD. As discussed previously, field samples and the associated duplicate sample were J flagged when an RPD was exceeded. No validation qualifiers were used for QA laboratory RPD exceedances.

Completeness

The evaluation of completeness involves estimating that the percent of proposed data collected was obtained properly and was considered useable. The ADEC has an 85% minimum completeness goal per UST Procedures Manual. With the exception of field deviations noted in Section 3.7, all intended samples were collected and analyzed. Of the 7014 data points reported by the primary laboratory, 85.7% had no QA/QC qualifiers. Although the remaining 14.3% of the data had some type of data qualifier assigned (other than non-detections or J-estimated detections below the LOQs), none of the data qualifiers assigned inhibited data usability. Additionally, the PARCCS tables provide a summary that all QA/QC requirements were met with more than 90% of each category of precision (LCS and MS RPDs), accuracy (LCS and surrogate %Rs) and MB contamination within control limits. While field replicates, MS/MSD recoveries, EBs and TBs do not clearly exceed a 90% rate, discussions have been provided to support why certain exceedances were not a problem and passing rates exceed 84% for these categories (MS/MSD recoveries). Therefore, the project met the completeness goal of 85%.

Sensitivity

The evaluation of sensitivity is based on comparing LODs to the appropriate PAL. Figure 3-4 provides a summary of primary laboratory minimum and maximum LODs by matrix, which were all below PALs. The PAL for lead in surface water is presented for a hardness of 100 milligrams of calcium carbonate per liter (mg-CaCO3/L). Hardness below 10 mg-CaCO3/L were observed; therefore, lower PALs for lead were calculated and are presented in the tables in Appendix J. These tables are programmed to highlight in yellow when the sample specific LOD is greater than the criterion. Lead in surface water samples with low hardness at AOC C2 are the only samples highlighted in yellow. All other samples had LODs below PALs.

QA REVIEW OF DECISION CRITICAL RESULTS

Samples exceeding holding times are presented in Figure 3-5. For soils, 14 samples/methods exceeded holding times due to laboratory errors. For water, six samples/methods exceeded holding times due to laboratory errors. With the exception of VPH samples, all missed soil and water holding times were exceeded by 1 to 4 days; results were flagged appropriately but not rejected. The samples were preserved properly and the minor holding time exceedances are not considered a problem regarding data quality. For example, the five BTEX groundwater samples that missed holding times were analyzed for AK101 within holding time. No GRO was detected except for one sample detected below the LOD; no BTEX constituents were detected.

All samples collected for VPH were originally analyzed within holding time. However, a detector problem was encountered that caused the loss of data for two aromatic components and required re-analysis of five samples outside of holding time. The re-analyzed VPH results were flagged and compared to corresponding GRO results. Since the sites are predominately contaminated by DRO and no GRO data were above Method Two criteria, the effects of the missed holding times were minimal and the results were only flagged.

Results for total and dissolved lead were consistent except for one sample (i.e., total greater than dissolved). All dissolved surface water lead samples were non-detections, except for one sample where the detection was below the LOD, but above the DL. Since the hardness was very low, the PAL for that minor detection was above the hardness adjusted PAL. The samples were re-digested and confirmed that the dissolved lead concentration was slightly higher than the total lead concentration.

Results for total and dissolved barium were not consistent (i.e., several dissolved samples were slightly greater than total). The differences between total and dissolved were very small and within normal analytical error. No further action was required.

Results for samples from the water supply wells (DA1-WG01-0714 and DA2-WG01-0614) were observed to have detections for several PAH constituents, DRO, GRO and RRO. All detections were below the applicable ADEC Table C groundwater cleanup levels and Environmental Protection Agency (EPA) maximum contaminant levels (MCLs). However, the presence of numerous trace level detections and concern about potential contamination to the drinking water source required further evaluation of results. Trace DRO and GRO detections were confirmed to be no different from the MB contamination observed below the LOD. Trace RRO detections were not observed in the MB, but were detected at one-half of the LOD.

All PAHs detected in water samples were reviewed further and it was observed that four of the 26 samples were detected at trace levels for most of the constituents (C4-WP01-0614, DA2-WG01-0614, AST4-4-WG01-0614 and AST7-4-WG02-0614). It was determined that evidence existed to add B flags to the PAH constituents for three of the four samples (DA2-WG01-0614, AST4-4-WG01-0614 and AST7-4-WG02-0614). These samples were analyzed after a QC spike sample containing all constituents, which could have caused carryover at trace levels. Confirming evidence was observed because one of the samples was a field duplicate and the primary sample did not contain the later eluting constituents. No B flags were added to PAH results for C4-WP01-0614 since this sample was collected from a well point installed in the source zone, soil PAH results at two nearby test pits (C4-TP02 and C4-TP05) had detections for all PAH constituents, and the sample was not analyzed after a QC sample.

3.6.4 Electronic Data Deliverables

EDDs are included as a supplemental electronic submittal and have been provided in two electronic formats: COELT Electronic Deliverable Format (EDF) 1.2a and SEDD stage 2A. For each analytical data package, the following information has been provided:

- COELT EDF 1.2a:
  - 6 text files with basic format of NPDL*.txt
  - Electronic Deliverable Consistency Checker (EDCC) 1.2 Output
- SEDD:
  - *.xml and *.dtd files; the XML files are well formed and open in Internet Explorer
  - Documentation of Instructional Set compliance
  - Documentation of passing the SEDD checker, USACE

The COELT EDCC 1.2 Output is a form entitled “Laboratory Report Project Overview” which lists the lab report number. This form cannot be generated if errors exist in the EDD. This form is the EDCC 1.2 output demonstrating that the COELT EDD is error free.

The SEDD *.xml files were checked against the USACE checker developed by USACE Chemist Michael Utley. The output for this lists errors in SEDDfilename_ValidationReport.pdf. The SEDD EDD files meet the requirements of the USACE Checker and the instructional set and are error free.

3.7 MODIFICATIONS AND DEVIATIONS FROM WORK PLAN

Supplemental RI activities were performed in general accordance with the WP/QAPP, including standard operating procedures (SOPs), and applicable field modifications. Modifications to field procedures were proposed based on site conditions encountered during the field event. Proposed modifications to the work scope were discussed and/or submitted to USACE for approval prior to implementation. In addition to modifying field procedures, deviations from the scope of work proposed in the WP/QAPP were also necessary to account for changes in site conditions. Field modifications and deviations were documented and are included in Appendix K. These modifications and deviations are summarized below.

Modifications to field procedures included:

- FM-061414-1_Rev1: Aquifer (slug) testing – Slug testing was performed using a water slug instead of a manual (PVC) slug due to the following conditions: wells thought to be 2-inch ID were actually 1-inch ID (AP-201, AP-202, AP-203, AP-205 and AP-206) and several wells had minimal water column (<5 feet) to accommodate placement of a transducer and slug. The field modification also proposed using geotechnical data (grain size, specific conductivity and bulk density) to supplement slug test data for a study area to evaluate hydraulic conductivity where conditions were not amenable to performing aquifer slug tests (e.g., damaged or destroyed wells and wells not found).
- *FM-061414-2_Rev2:* Groundwater sampling – A temporary well was installed in the source area at AOC C4 to obtain groundwater samples in lieu of sampling existing well AP-020, which was damaged. The field modification proposed using a peristaltic pump to collect groundwater samples at temporary wells where a bladder pump could not be used.

Deviations from the scope of work proposed in the WP/QAPP included:

- DV-061214-1: Soil sampling at test pits – At test pit locations with no evidence of a POL source or impacts, samples would only be collected at the water table (smear zone) for laboratory analysis. These samples were not submitted for VPH/EPH analyses. An additional test pit was excavated to obtain HRC data for the AOC C4 source area.
- DV-061214-1: Groundwater sampling – Monitoring well AP-019 and AP-020 were either destroyed or damaged to the extent that groundwater samples could not be collected. A temporary well was installed in the AOC C4 source area to obtain samples for HRC, including VPH/EPH.
- DV-062814-1: Alternate soil sample locations, intervals, and/or analyses – Several adjustments to boring locations, sample depths, and analyses were performed based on actual conditions in the field (i.e., access, proximity, field screening, etc.) Rationale for these changes were discussed with the Field Manager and TO Manager, and documented in the field logbook. Details of changes to the sampling scope at each AOC location are documented in this Deviation Form included in Appendix K.
- DV-062814-2: Well Survey – Two temporary well points installed at AOCs C2/C4 were removed once investigation activities were completed and prior to being surveyed (second mobilization). The two temporary well points were abandoned at the end of sampling activities while the drill rig was onsite, in case the well points could not be removed manually by hand or hand jack. The temporary well point riser pipe was measured from the ground surface prior to removal, and the ground surface elevation was later surveyed at the measurement point in order to obtain an elevation for the well point top of casing.
- DV-070314-1: Soil samples – Collection of up to 11 soil samples from impacted areas for HRC was proposed for the AACS, with five samples to be submitted for VPH/EPH analyses. Based on field screening and visual observations, potential fuel impacts were found in a very limited area adjacent to one concrete saddle. Therefore, only two soil samples from the single “hot spot” were submitted for VPH/EPH. This is considered a minor deviation as WP/QAPP Worksheet #17 states “Fewer samples may be collected for the HRC evaluation and delineation, based on the observed extent of contamination in the field.”
- *DV-070414-1:* Additional soil samples – Potential fuel impacts were found to extend over a relatively large area at AOC M3; therefore, additional borings were advanced for soil screening to delineate impacts. Three samples were collected and submitted for laboratory analyses to eliminate potential data gaps for lateral delineation, as opposed to only the one remaining sample proposed in the WP/QAPP.

FIGURE 3-1

PARCCS Summary Part 1: Precision (P), Accuracy (A) and Representativeness (R) Electronic Data Validation Summaries

P - Precision Evaluation Summary

Laboratory Spike Precision

LCS / LCSD RPD Distribution

Pass	RPD Group	# and % of Total	
		789	
Fail	30-50% RPD	4	0.5%
Fail	0-30% RPD	4	0.5%
OK	0-30% RPD	781	99.0%

Sample Matrix Spike Precision

MS / MSD RPD Distribution

Pass	RPD Group	# and % of Total	
		744	
Fail	>50% RPD	17	2.3%
Fail	30-50% RPD	34	4.6%
Fail	0-30% RPD	15	2.0%
OK	0-30% RPD	678	91.1%

Sample Collection Precision

Field Dupe RPD Distribution

Pass	RPD Group	# and % of Total	
		789	
Fail	FD ND not Confir	14	1.8%
OK	FD ND not Confir	82	10.4%
Fail	>50% RPD	83	10.5%
OK	>50% RPD	49	6.2%
Fail	30-50% RPD	3	0.4%
OK	30-50% RPD	54	6.8%
OK	0-30% RPD	238	30.2%
OK	FD NDs Confirm	266	33.7%

A - Accuracy Evaluation Summary

Laboratory Spike Accuracy

LCS/D % Recovery Distribution

Pass	% Rec. Group	# and % of Total	
		1621	
Fail	>150% Rec.	1	0.1%
Fail	125-150% Rec.	18	1.1%
Fail	60-125% Rec.	21	1.3%
Fail	10-60% Rec.	14	0.9%
OK	125-150% Rec.	17	1.0%
OK	60-125% Rec.	1519	93.7%
OK	10-60% Rec.	31	1.9%

Sample Matrix Spike Accuracy

MS/D % Recovery Distribution

Pass	% Rec. Group	# and % of Total	
		1488	
Fail	>150% Rec.	79	5.3%
Fail	125-150% Rec.	55	3.7%
Fail	60-125% Rec.	30	2.0%
Fail	10-60% Rec.	79	5.3%
Fail	0-10% Rec.	140	9.4%
OK	125-150% Rec.	9	0.6%
OK	60-125% Rec.	1042	70.0%
OK	10-60% Rec.	54	3.6%

Sample Surrogate Accuracy

Surr. % Recovery Distribution

Pass	% Rec. Group	# and % of Total	
		2576	
Fail	>150% Rec.	49	1.9%
Fail	125-150% Rec.	11	0.4%
Fail	60-125% Rec.	5	0.2%
Fail	10-60% Rec.	10	0.4%
Fail	0-10% Rec.	12	0.5%
OK	125-150% Rec.	76	3.0%
OK	60-125% Rec.	2384	92.5%
OK	10-60% Rec.	29	1.1%

R - Representativeness: Blank Contamination Summary and Cooler Receipt Temperature

Analytical Method Blanks (MB)

MB Detection Distribution

MB Grouping	# and % of Total	
	827	
Flag >LOQ	2	0.2%
Flag > LOD	47	5.7%
< LOD	85	10.3%
_ND's	693	83.8%

Equipment Rinse Blanks (EB)

EB Detection Distribution

MB Grouping	# and % of Total	
	265	
Flag >LOQ	11	4.2%
Flag > LOD	46	17.4%
< LOD	29	10.9%
_ND's	179	67.5%

Volatile Trip Blanks (TB)

TB Detection Distribution

MB Grouping	# and % of Total	
	235	
Flag >LOQ	17	7.2%
Flag > LOD	41	17.4%
< LOD	41	17.4%
_ND's	136	57.9%

CoolerTemperature for # of Coolers

Cooler Temperature Distribution

Cooler Temp Grouping	# and % of Total	
	34	
2-6 Deg. C - Acceptable (SW846 0-6)	22	64.7%
0-2 Deg. C - AK Method Concern	11	32.4%
<0 Deg. C - No Breakage?	1	2.9%

Cooler Temperature for # Sample / Methods

Cooler Temp. Distribution Sample/Method

Cooler Temp Grouping	# and % of Total	
	1180	
2-6 Deg. C - Acceptable (SW846 0-6)	861	73.0%
0-2 Deg. C - AK Method Concern	269	22.8%
<0 Deg. C - No Breakage?	50	4.2%

Prepared from Queries of Access Database of COELT and SEDD EDDs, AECOM, 2014

Wednesday, February 17, 2016

FIGURE 3-2

PARCCS Summary Part 2: Representativeness (R) - Electronic Data Validation - Summary by Method

R - Representativeness Sample Method Summary

# Samples Collected	# Compounds Analyzed	# Compounds Flagged
# Field Duplicates (FD)	# FD Compounds Analyzed	Matrix Spike %R and %RP
Missed Holding Times (M-HT)	# Missed HT Compounds	FD % RPD

Matrix/Method		# Smpls.	# FD's	# M-HT	#Cmpds	# FD's	# M-HT	MS %R	MS RPD	FD RPD
S	8270SIM	152	16		2736	288		19	4	68
S	AK101	200	21	7	200	20	7	7	4	14
S	AK102	189	21	2	190	20	2	8	4	8
S	AK102SG	45	5		45	5		1		
S	AK103	189	21	2	189	20	2	2	2	4
S	AK103SG	45	5		45	5				
S	D2216	203	22		406	44				
S	SW6020	6	1		6	1				
S	SW8082	6	1		60	10				2
S	SW8260B	154	16		770	75		23	4	8
S	SW9060	45	5		45	5				2
S	WDOEEPH	96	13	1	768	104	8	26	30	34
S	WDOEVPH	105	13	7	735	91	29	26	8	38
W	8270SIM	26	3		468	54		14	3	10
W	A2340C	17	3		17	2				
W	AK101	31	3		32	2				
W	AK102	25	3		25	2		2		
W	AK103	25	3		25	2				
W	SW6020	18	3		57	6				
W	SW8082	7	2		81	17				
W	SW8260B	31	3	7	160	10	35			
W	WDOEEPH	13	2	2	104	16	16	8	1	12
W	WDOEVPH	18	2	2	133	14	14	4		
Totals		1646	187	30	7297	813	113	140	60	200
% of Totals			12.8%	1.8%		12.5%	1.5%	1.9%	0.8%	2.7%

Smpls = Samples; %R = percent recovery; %RPD = percent relative percent difference; MS = matrix spike

8270SIM = PAH method; AK101,102,103 = GRO, DRO RRO methods - SG is siilica gel cleanup; D2216 = % Moisture method;

SW6020 = metals method (lead and barium); SW8082 = PCB method; SW8260B = volatile organics method including BTEX;

SW9060 = total organic carbon method; A2340C = ASTM Hardness method for waters; and,

WDOEEPH and WDOEVPH = Washington State DOE extractable (E) and volatile (V) petroleum hydrocarbon methods.

Sediments and soils are combined in Matrix = S and surface waters and groundwaters are combined in Matrix = W. Data presented for primary results only, database contains secondary or support results. QA lab results not summarized in this table.

Prepared from Queries of Access Database of COELT and SEDD EDDs, AECOM, 2014

Thursday, February 18, 2016

FIGURE 3-3

PARCCS Summary Part 3: Comparability (C) of Primary Laboratory Field Replicates

MATRIX		S			ND Not Confirm (/#Detected > 1/2 PAL)		Both Detects (/#Above RPD Criteria)		Worst Case % Fail or Not confirm
Parameter Count *			% Field Dupes	# ND Confirm	Primary is ND	FD is ND	Primary < 3x LOD	Primary > 3x LOD	
Total #	# Prim	# FD							
5,898	652	652	12.4%	176	42 /	35 /	103 / 36	296 / 86	18.7%

MATRIX		W			ND Not Confirm (/#Detected > 1/2 PAL)		Both Detects (/#Above RPD Criteria)		Worst Case % Fail or Not confirm
Parameter Count *			% Field Dupes	# ND Confirm	Primary is ND	FD is ND	Primary < 3x LOD	Primary > 3x LOD	
Total #	# Prim	# FD							
1,086	145	145	15.4%	74	12 /	8 /	15 / 5	36 / 12	11.7%

PARCCS Summary Part 3: Comparability (C) of QA (Trip) and Primary Sample

MATRIX		S			ND Not Confirm (/#Detected > 1/2 PAL)		Both Detects (/#Above RPD Criteria)		Worst Case % Fail or Not confirm
Parameter Count *			% Field Dupes	# ND Confirm	Primary is ND	QA is ND	Primary < 3x LOD	Primary > 3x LOD	
Total #	# Prim	# QA							
5,898	652	553	10.5%	163	31 /	121 / 1	48 / 23	190 / 72	37.9%

MATRIX		W			ND Not Confirm (/#Detected > 1/2 PAL)		Both Detects (/#Above RPD Criteria)		Worst Case % Fail or Not confirm
Parameter Count *			% Field Dupes	# ND Confirm	Primary is ND	QA is ND	Primary < 3x LOD	Primary > 3x LOD	
Total #	# Prim	# QA							
1,086	145	74	7.9%	42	2 /	13 /	3 / 1	14 / 8	16.6%

* % Field Dupes calculated by subtracting the number of field dupe compounds from total compounds for a true percentage.

Worst case is based on % of total failures including ND's not confirmed and > 1/2 PAL and RPD with values < 3 times LOD.

A more reasonable calculation for a failure rate would eliminate those cases.

Prepared from Queries of Access Database of COELT EDDs, AECOM, 2014

Tuesday, June 16, 2015

FIGURE 3-4

PARCCS Summary Part 4: Sensitivity (S) Electronic Data Validation Summary - Minimum and Maximum LOD Compared to Project Action Limits (PAL) for State Criteria

Analytical Method and Compound			Soils = mg/kg				Waters - mg/L			
Method	Compound	CAS #	Min LOD	Max LOD	PAL	QAPP_LOD	Min LOD	Max LOD	PAL	QAPP_LOD
8270SIM	1-METHYLNAPHTHALENE	90-12-0	0.002	0.057	6.2	0.01	0.000015	0.000031	0.00097	0.00004
8270SIM	2-METHYLNAPHTHALENE	91-57-6	0.002	0.057	6.1	0.01	0.000015	0.000031	0.027	0.00003
8270SIM	ACENAPHTHENE	83-32-9	0.002	0.057	180	0.0025	0.000015	0.000031	2.2	0.000015
8270SIM	ACENAPHTHYLENE	208-96-8	0.002	0.057	180	0.0025	0.000015	0.000031	2.2	0.000015
8270SIM	ANTHRACENE	120-12-7	0.002	0.057	3000	0.0025	0.000015	0.000031	11	0.000015
8270SIM	BENZO(G,H,I)PERYLENE	191-24-2	0.002	0.057	1100	0.0025	0.000015	0.000031	1.1	0.000015
8270SIM	BENZO[A]ANTHRACENE	56-55-3	0.002	0.057	3.6	0.0025	0.000015	0.000031	0.0012	0.000015
8270SIM	BENZO[A]PYRENE	50-32-8	0.002	0.057	0.4	0.0025	0.000015	0.000031	0.0002	0.000015
8270SIM	BENZO[B]FLUORANTHENE	205-99-2	0.002	0.057	4	0.0025	0.000015	0.000031	0.0012	0.000015
8270SIM	BENZO[K]FLUORANTHENE	207-08-9	0.002	0.057	40	0.0025	0.000015	0.000031	0.012	0.000015
8270SIM	CHRYSENE	218-01-9	0.002	0.057	360	0.0025	0.000015	0.000031	0.12	0.000015
8270SIM	DIBENZ(A,H)ANTHRACENE	53-70-3	0.002	0.057	0.4	0.0025	0.000015	0.000031	0.00012	0.000015
8270SIM	FLUORANTHENE	206-44-0	0.002	0.057	1400	0.0025	0.000015	0.000031	1.5	0.000015
8270SIM	FLUORENE	86-73-7	0.002	0.057	220	0.0025	0.000015	0.000031	1.5	0.000015
8270SIM	INDENO(1,2,3-C,D)PYRENE	193-39-5	0.002	0.057	4	0.0025	0.000015	0.000031	0.0012	0.000015
8270SIM	NAPHTHALENE	91-20-3	0.002	0.057	20	0.0025	0.000015	0.000031	0.73	0.000015
8270SIM	PHENANTHRENE	85-01-8	0.002	0.057	3000	0.0025	0.000015	0.000031	11	0.000015
8270SIM	PYRENE	129-00-0	0.002	0.057	1000	0.0025	0.000015	0.000031	1.1	0.000015
AK101	GAS RANGE ORGANICS	8006-61-9	1.1	22	260	1.1	0.044	0.044	2.2	0.044
AK102	DIESEL RANGE ORGANICS	STL00258	6.5	75	230	6.5	0.048	0.052	1.5	0.05
AK102SG	DIESEL RANGE ORGANICS	STL00258	6.6	8.4	230	6.5	--	--	--	--
AK103	RESIDUAL RANGE ORGANICS	STL00383	25	390	8300	25	0.048	0.052	1.1	0.05
AK103SG	RESIDUAL RANGE ORGANICS	STL00383	25	32	8300	25	--	--	--	--
SW6020*	BARIUM	744-39-3	--	--	--	--	0.001	0.001	2	0.001
SW6020*	LEAD	7439-92-1	0.018	0.024	35	0.02	0.00025	0.00025	0.0025+	0.00025
SW8082*	PCB-1016 (AROCHLOR 1016)	12674-11-2	0.006	0.008	0.034	0.005	0.000077	0.000082	0.0005	0.00008
SW8082*	PCB-1221 (AROCHLOR 1221)	11104-28-2	0.013	0.016	0.034	0.01	0.000077	0.000082	0.0005	0.00008
SW8082*	PCB-1232 (AROCHLOR 1232)	11141-16-5	0.013	0.016	0.034	0.01	0.000077	0.000082	0.0005	0.00008
SW8082*	PCB-1242 (AROCHLOR 1242)	53469-21-9	0.006	0.008	0.034	0.005	0.000077	0.000082	0.0005	0.00008
SW8082*	PCB-1248 (AROCHLOR 1248)	12672-29-6	0.006	0.008	0.034	0.005	0.000077	0.000082	0.0005	0.00008
SW8082*	PCB-1254 (AROCHLOR 1254)	11097-69-1	0.006	0.008	0.06	0.005	0.000077	0.000082	0.0005	0.00008
SW8082*	PCB-1260 (AROCHLOR 1260)	11096-82-5	0.006	0.008	0.034	0.005	0.000077	0.000082	0.0005	0.00008
SW8082*	TOTAL PCBS	1336-36-3	0.013	0.016	0.034	0.005	0.000077	0.000082	0.0005	0.00008
SW8260B	BENZENE	71-43-2	0.004	0.018	0.025	0.003	0.0004	0.0004	0.005	0.0004
SW8260B	ETHYLBENZENE	100-41-4	0.004	0.018	6.9	0.003	0.0004	0.0004	0.7	0.0004
SW8260B	M,P-XYLENE	179601-23-1	0.004	0.18	63	0.003	0.0004	0.0004	0.21	0.0004
SW8260B	O-XYLENE	95-47-6	0.004	0.018	63	0.003	0.0004	0.0004	1	0.0004
SW8260B	TOLUENE	108-88-3	0.004	0.018	6.5	0.003	0.0004	0.0004	0.1	0.0004

* Lead, barium and PCB criteria are for surface waters and sediments where all other criteria is soil and groundwaters.

+ Lead criterion is hardness based, the 0.0025 mg/L criteria is based on a Hardness of 100 mg-CaCO3/L.

FIGURE 3-5

Summary of Samples with Missed Holding Times (Primary Results only).

		Actual Dates (yyyymmdd)			Actual # of Days		Maximum Holding Time Criteria (Days)	
Sample ID	Method	Collected	Extracted	Analysis	Until Extraction	After Extraction	Until Extraction	After Extraction
Soils:								
C4-TP05-0.0-2.0-0614	AK101	20140612	20140712	20140712	30	0	28	28*
C4-TP05-12.0-14.0-0614	AK101	20140612	20140712	20140713	30	1	28	28*
C4-TP05-2.0-4.0-0614	AK101	20140612	20140712	20140712	30	0	28	28*
C4-TP05-4.0-6.0-0614	AK101	20140612	20140712	20140712	30	0	28	28*
C4-TP05-6.0-8.0-0614	AK101	20140612	20140712	20140712	30	0	28	28*
D3-SB06-4.0-6.0-0614	AK101	20140615	20140714	20140714	29	0	28	28*
D5-SB05-8.0-10.0-0614	AK102/AK103	20140610	20140625	20140703	15	8	14	40
D5-SB05-10.0-12.0-0614	AK102/AK103	20140610	20140625	20140703	15	8	14	40
D5-SB05-10.0-12.0-0614	WDOEEPH	20140610	20140625	20140706	15	11	14	40
AA-SB05-0.0-2.0-0714	WDOEVPH	20140703	20140711	20140806	8	26+	14	14*
AA-SB05-2.0-4.0-0714	WDOEVPH	20140703	20140711	20140806	8	26+	14	14*
AA-SB05-4.0-6.0-0714	WDOEVPH	20140703	20140711	20140806	8	26+	14	14*
C6-SB01-6.0-8.0-0614	WDOEVPH	20140627	20140711	20140806	14	26+	14	14*
C6-SB05-10.0-12.0-0614	WDOEVPH	20140627	20140711	20140806	14	26+	14	14*
Groundwaters:								
AP-201-WG01-0614	SW8260B	20140621	20140709	20140709	18	0	14	14*
AP-202-WG01-0614	SW8260B	20140623	20140709	20140709	16	0	14	14*
AP-203-WG01-0614	SW8260B	20140621	20140709	20140709	18	0	14	14*
AP-205-WG01-0614	SW8260B	20140621	20140709	20140709	18	0	14	14*
AP-206-WG01-0614	SW8260B	20140621	20140709	20140709	18	0	14	14*
AP-202-WG01-0614	WDOEVPH	20140623	20140708	20140708	15	0	14	14*
QC Samples - Soil units:								
TB01-SQ-140701	WDOEVPH	20140701	20140711	20140806	10	26+	14	14*
TB01-SQ-160614	WDOEVPH	20140616	20140701	20140701	15	0	14	14*
TB09-SQ-120614	AK101	20140612	20140712	20140712	30	0	28	28*
QC Samples - water units:								
EB01-SQ-140706	WDOEEPH	20140706	20140721	20140723	15	2	14	40
EB01-SQ-250614	WDOEEPH	20140625	20140708	20140717	13	9	14	40
EB02-SQ-140706	WDOEEPH	20140706	20140721	20140723	15	2	14	40
TB01-WQ-210614	WDOEVPH	20140621	20140707	20140707	16	0	14	14*

* Maximum holding time (MHT) criteria with * is total days from sampling till analysis, while criteria without * is days after extraction.

\+ The WDOEVPH method is a VOA method with different detectors; a detector problem caused unusable data for part of the analysis (the PID detector) and that part of the analysis required reanalysis. LCS/LCSD, MS/MSD and MB samples prepared at time of original analysis and were used 26 days later for analysis of the other fraction of WDOEVPH.

Note: Usually VOAs outside 2 times the MHT are rejected; however, the low concentration of VPH for these samples compares with the low AK101 concentrations. Recovery criteria for VPH is 70-130%, actual recoveries prepared within holding time ranged from 76 to 108% and are considered acceptable. Therefore, for the purposes of this study it didn't matter whether these results were rejected or used with validation qualifiers.

4.0 RISK EVALUATION AND ALTERNATIVE CLEANUP LEVELS DETERMINATION

Petroleum hydrocarbon contamination may pose potential risks to human health and the environment. Petroleum contaminated soil in excess of ADEC Method Two cleanup levels is present at several locations at the Former Yakutat Air Base FUDS. ADEC Method Three cleanup level approaches (described in 18 AAC 75.340) have been used to assess if these sites meet the risk criteria identified in the regulations (18 AAC 75.325) and to calculate ACLs if the risk criteria were exceeded. ADEC Method Three cleanup level approaches that have been used include both the Online Calculator and the HRC as discussed in the following sections. The risk evaluation addresses petroleum hydrocarbon-source areas (e.g. DRO and associated constituents) and does not include an evaluation of other contaminant sources such as potential sediment and/or surface water impacts of lead and PCBs at AOC C2, lead at AOC O1, and barium at AACS. These are evaluated separately using ADEC default standards, such as Alaska Water Quality Standards (WQS). It should also be noted that the site characterization and risk calculation approaches described in this report are geared toward characterizing the nature, extent, and risk posed by discrete, contiguous, NAPL source areas, and not toward the statistical characterization of a large area or industrial zone containing multiple sources.

4.1 RISK EVALUATION PROCESS

Risk assessment provides the basis for making risk management decisions regarding the suitability of a site for No DoD Action Indicated selection under the FUDS program, for receiving a “Cleanup Complete” determination from the ADEC, and for preparation of ACLs, if needed. For purposes of this report, risk evaluation performed as part of the Supplemental RI was conducted using both the Online Calculator and HRC for each of the investigated AOCs.

Use of the Online Calculator and/or HRC to evaluate human health risk involves:

- Assessing potential receptors and exposure pathways;
- Presenting and using the contaminant concentration data to derive exposure point concentrations for the constituents to be included in the risk calculations;
- Summarizing the site soil and groundwater conditions for use in the risk calculations; and
- Entering the data into the Online Calculator and/or HRC, running the calculators, and presenting the results.

A discussion of the exposure pathways and the selection of exposure point concentrations are presented below. Section 4.2.1 describes the contaminant concentration data collected to characterize each AOC and Section 4.2.2 describes the non-contaminant data (e.g. soil and hydrogeologic conditions) collected to characterize each AOC.

The procedures used to evaluate risks are consistent with the following guidance: *Risk Assessment Procedures Manual* (ADEC 2011b); *Cumulative Risk Guidance* (ADEC 2008b); *Ecoscoping Guidance, A Tool for Developing an Ecological Conceptual Site Model* (ADEC 2014); *Cleanup Levels Guidance* (ADEC 2008a); and ADEC *Implementing Guidance for the Method Three Hydrocarbon Risk Calculator* (ADEC 2011a).

4.1.1 Exposure Pathways and Receptors

Exposure pathways, both human health and ecological, were evaluated for contaminated media at each AOC. An exposure pathway evaluation identifies the means by which humans and ecological receptors come into contact with chemicals in environmental media. ADEC makes “unrestricted use” site closure decisions based on a land use scenario that assumes the site is used for residential purposes and that the primary exposure pathways are complete. Therefore, to meet ADEC “Cleanup Complete” criteria, the site must meet the ADEC risk standard (the cumulative carcinogenic risk cannot exceed 10^{-5} and the cumulative non-carcinogenic risk cannot exceed 1) assuming that the following primary exposure pathways are complete:

- Human exposure from direct contact with chemicals in soil from 0 to 15 feet bgs (incidental ingestion and dermal absorption);
- Human exposure from inhalation of chemicals through volatilization from soil and/or groundwater and migration to outdoor air;
- Human exposure from inhalation of chemicals through volatilization from soil and/or groundwater and migration to indoor air; and
- Human exposure from ingestion of chemicals in groundwater.

In addition, the site must meet the 18 AAC 75 "migration to groundwater" criteria, which indicates that the dissolution (leaching) of chemicals from soil will not cause groundwater to exceed 18 AAC 75 Table C ingestion risk based levels.

The Method Three risk evaluation performed for the Yakutat AOCs assumes that the above pathways are complete for a residential scenario to assess "Cleanup Complete" closure under the ADEC program. In addition, the HRC calculates risk for the pathways that are complete at the present time for residential and industrial/commercial scenarios. Other land use scenarios tend to have lower exposure levels and pose less risk than the residential and industrial/commercial scenarios – so, the evaluation of risk for other land use or receptor scenarios is needed only if an AOC significantly exceeds the risk standard for residential and industrial/commercial scenarios. The risks calculated for the "currently complete pathways" and for industrial and site visitor scenarios are for risk management purposes (and not to assess site closure).

A preliminary human health conceptual site model (CSM) was prepared in the WP/QAPP for each AOC in accordance with the *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). The CSM provides a graphical depiction of site conditions, identifying known or suspected sources of contamination, potential chemical transport and exposure pathways, and receptors. The human health CSMs have been updated based on observations and results of the Supplemental RI and prepared using the form downloaded from the ADEC web site. Additionally, risk to the environment/ecology has been evaluated using the ADEC Ecoscoping process (ADEC 2014). The site-specific human health and ecological scoping forms and/or graphical CSMs are included in Appendix L and discussed in Sections 5.0 through 19.0.

The left side of the graphical human health CSM lists the media which (1) may be contaminated based on the general type of release, if a site investigation has not been performed or if significant data gaps exist, or (2) are known to be contaminated based on investigation results. The site-specific CSMs for the Yakutat FUDS are filled out for the conditions that are interpreted to exist based on the data collected to date. Given that the sites have been investigated, the site-specific CSMs list the media, which are known to be contaminated as follows:

- If contaminated soil is present within 2 feet of the ground surface, then the surface soil box is checked;
- If contaminated soil is present more than 2 feet below grade, then the subsurface soil box is checked; and
- If the NAPL-contaminated soils extend into the zone of seasonal water table fluctuation or if groundwater with concentrations above ADEC Table C is present at the site, then the groundwater box is checked.

Given that dissolved phase hydrocarbons plumes tend to attenuate close to the NAPL source area, the surface water and sediment boxes are typically only checked when:

- The NAPL contaminated soil source area extends to or very close (tens of feet) to the surface water body and/or;
- Surface water and sediment samples document the presence of contamination and/or; a sheen is visible on the surface water or sediment.

The transport mechanisms section of the form lists the processes by which contaminants may move through the environment and exposure media may become contaminated. For surface or subsurface hydrocarbon contaminated soils, the primary transport mechanisms for risk evaluations include migration to groundwater and volatilization with migration to outdoor and indoor air. Surface water runoff and erosion may be significant transport mechanisms where there are exposed contaminated soils near a surface water body or relatively steep slopes with exposed contaminated soils leading to a surface water body. However, if these conditions are not present at a site, as is the case with most of the AOCs where there is continuous vegetative cover and no exposed eroding soils, then these transport mechanisms are not significant and the corresponding boxes are not checked. At hydrocarbon-contaminated sites, groundwater transport to surface water and sediment can be a significant transport mechanism. For this interaction, the transport mechanism box is checked only when the NAPL contaminated soil source area extends to, or very close to, the surface water body, because dissolved phase contaminants tend to attenuate relatively close to the NAPL source area (Bedient et al. 1999; Mace et al. 1997; Newell & Conner 1998; Rice et al. 1995). The groundwater to surface water transport mechanism-box has not been checked for AOCs where groundwater in the source area footprint meets surface water criteria and the NAPL source area does not extend to the surface water body, since surface water criteria would not be exceeded under these conditions.

At all of the AOCs investigated, hydrocarbon uptake by plants and the consequent ingestion of plants by people and animals is interpreted to be insignificant because plants tend not to accumulate hydrocarbons. Rather, plants tend to take up only hydrocarbons with an organic carbon partitioning coefficient value between about 1 and 3 (primarily the BTEX constituents). The plants rapidly transpire these constituents (ITRC 2009). In addition, BTEX concentrations presented in soil at the FUDS are very low. Similarly, the wild meat ingestion route is interpreted to be insignificant since the plants do not significantly accumulate the fuel hydrocarbons; therefore, the animals feeding on the plants are not significantly exposed. For burrowing animals and larger animals feeding on burrowing animals, the soil source areas have relatively small footprints; therefore, impacts to the populations of small burrowing animals are insignificant. For larger animals, the source area footprints are relatively small compared to the range of the larger animals; therefore, impacts to individual large animals and the population of large animals are considered insignificant.

The right side of the graphical CSM lists potential receptors and exposure pathways, and indicates whether the pathways to indicated receptors are currently complete (C), potentially complete in the future (F) or insignificant (I). Incomplete pathways are indicated by unchecked exposure pathway/route boxes. The CSM form is filled out for the exposure scenarios listed on the form (residential, industrial, site visitor, construction worker and subsistence harvester); however, risk calculations are typically only performed for the residential and industrial scenarios as indicated above.

Complete human health pathways are determined as follows:

- The soil ingestion, dermal absorption and outdoor air inhalation pathways are considered complete currently and in the future if contaminated soil is present within 15 feet of the ground surface;
- The ingestion of groundwater route is considered complete in the future at all sites and complete at the present time if there is a drinking water well currently in or near the NAPL source area at the site;

- The indoor air inhalation pathway is considered complete in the future for all AOCs and is considered complete at the present time if there is an occupied building within 30 feet of the source area soils.

Insignificant human health pathways are determined as follows:

- Groundwater pathways are considered insignificant if concentrations are less than 1/10th of Table C values; the inhalation of volatile constituents in tap water is considered insignificant in all instances;
- Surface water and sediment are considered to be insignificant if concentrations are below Alaska WQS and 1/10th ADEC Method Two direct contact criteria.
- The inhalation of fugitive dust is considered to be incomplete or insignificant at all AOCs because: 1) the majority of sites are heavily vegetated with minimal exposed soil, 2) the climate is relatively wet and dusty soil conditions rarely exist, and 3) the risk posed by the inhalation of dust is typically low compared to the risk posed by ingestion of the same soil;
- The ingestion of wild or farmed food pathways are considered insignificant as discussed previously (i.e. plants tend to not take up the hydrocarbon present at the AOCs and the source areas have relatively small footprints compared to animal population/range).

If the site presents an unacceptable risk, assuming that all pathways are complete under the residential scenario, then the results of the risk calculations for the pathways complete at the present time may be used to assess whether there is acceptable or unacceptable risk under the current land use scenario. If there is unacceptable risk at the current time, the site should become a priority for risk mitigation.

4.1.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Exposure point concentrations are the chemical concentrations that a receptor might be exposed to and are used as input to the risk calculations. Exposure point concentrations need to balance the desire to protect human health and the environment with the need to represent site conditions. Consistent with the description in the EPA document *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (EPA 2002), and as explicitly stated in the ADEC Technical Memorandum 01-004 (ADEC 2003), “the arithmetic average concentration measured in a representative group of samples collected from the exposure area is generally considered the most appropriate and representative value for use as the concentration term in environmental risk assessment.” The EPA and ADEC also point out that: (1) the arithmetic average concentration of a relatively small group of samples is only an estimate of the true mean, and (2) to protect human health, the 95% upper confidence limits (UCLs) of the mean should be used to conservatively represent the mean concentration. Therefore, to assess human health risk, the soil concentrations used as input to human health risk calculations should typically be the 95% UCLs of a representative data set that has been collected from within the exposure area. In a representative data set, the sample locations should be randomly selected (or the results of a biased sampling plan should be appropriately stratified or grouped), and the sample population should be large enough to characterize the site. Alternatively, the highest DRO, GRO, BTEX, and PAH concentrations measured at a site may be used in place of the 95% UCL of the mean, if the highest DRO, GRO, BTEX and PAH concentrations do not indicate unacceptable risk. However, if the highest measured values suggest unacceptable risk and there is data available to calculate a 95% UCL, then 95% UCL values should be calculated. In general, as the number of samples in a sample set increases, the 95% UCL value will tend to approach the mean or average concentration of the sample set. Note that most existing contaminated site data sets are likely biased high, because it is common practice to perform field-screening (based on visual, olfactory, and PID readings) to select the most heavily contaminated sampling interval for subsequent analysis. The use of a biased-high data set adds a further level of “conservatism” into the risk calculations.

In this report 95% UCLs were calculated using the EPA ProUCL software (version 4.1). ProUCL assesses the data distribution and automatically selects the most appropriate method of calculating the 95% UCL. In general, 95% UCLs were calculated for GRO, DRO, RRO, and BTEX constituents if there were sufficient detections to calculate 95% UCLs. If there were not sufficient detections to calculate 95% UCLs for the BTEX constituents, then the maximum measured concentrations were used as the exposure point concentrations. For the PAH data, if the maximum detected concentrations did not present significant risk, then the maximum detected concentrations were used as the exposure point concentrations. If the maximum detected PAH concentrations indicated significant risk and there were adequate data to calculate 95% UCLs, then the 95% UCLs were calculated and used as the exposure point concentrations. If an analyte was not detected, the maximum LOD of the source area samples was used as the exposure point concentration.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

Maximum groundwater concentrations from recent, source area monitoring well(s) data sets are typically used as the groundwater-exposure point concentrations, in accordance with ADEC guidance documents. For non-detected results, the maximum LOD was initially used in the risk calculations. However, for the carcinogenic PAHs in general, and for benzo(a)pyrene and dibenz(a,h)anthracene in particular, typical groundwater LODs can be close to or above the groundwater ingestion risk-based concentrations. In these situations, the risk calculated by using the groundwater LODs as input to the risk calculations can be a significant portion of, or can exceed the allowable risk level. An optional approach to assess the groundwater concentrations and risk associated with the non-detected PAHs is to calculate or model the groundwater concentrations. This is done using the phase partitioning equations with Raoult’s Law and the soil PAH, GRO, DRO, and RRO concentrations, and then applying the site dilution-attenuation factor (DAF). This approach is technically correct yielding more representative risk results, and typically documents that dissolved PAH concentrations may be, or must be, orders of magnitude below the groundwater LOD.

4.2 RISK EVALUATION AND ACL CALCULATION INPUT PARAMETERS

The input parameters for the Online Calculator and the HRC are listed in Table 4-1. Parameter values were predominately developed from site-specific data collected during previous investigations and the 2014 Supplemental RI. The input to and output from the Online Calculator are provided in Appendix M. The input to and output from the HRC are provided in Appendix N and summarized in tables provided at the end of each section for AOCs evaluated using the HRC (C2, C4, C6, D1, D3-D8, AACS).

4.2.1 Chemical Data

Soil and groundwater analytical data collected from each AOC are used to assess the extent of contamination, determine exposure point concentrations (Section 4.1.2), evaluate the character of the NAPL using VPH and EPH data, and assess concentration trends through time. Each AOC-specific section presents the laboratory analytical chemical results in multiple tables based on media and analyte. The tables list the data collected in the most recent investigation and historical data collected from previous investigations which may still be representative of site conditions and/or useful for documenting changes in concentration through time. These data tables contain information fundamental to the characterization of the nature and extent of contamination, risk evaluation, and assessment of the site status (i.e., “Cleanup Complete”, or “Cleanup Complete with Institutional Controls”).

Chemical data for each AOC evaluated using HRC are provided in the site-specific sections and are typically presented in the following order, based on available data:

- First HRC table: All BTEX, GRO, DRO, and RRO Soil Results – This table includes all of the BTEX, GRO, DRO, and RRO soil data (historical and 2014) collected at the site, and includes samples collected inside and outside of the source area.
- Second HRC table: Source Area BTEX, GRO, DRO, and RRO Soil Results – This table presents the BTEX, GRO, DRO, and RRO soil data which are considered representative of the NAPL-

contaminated soil and are used in the characterization of the exposure point concentrations. Note that recent and relatively old (e.g., 10 plus years) DRO and RRO data may be used to statistically characterize the exposure point concentrations, because these fractions tend to attenuate relatively slowly. In contrast, BTEX constituents tend to intrinsically attenuate significantly faster such that 5 to 10 plus year old BTEX data may no longer be representative of the source area. For this reason, only data from the 2014 investigation were used to assess the exposure point concentrations for the BTEX constituents.

- Third HRC table: PAH Soil Results – This table presents the PAH soil data. The GRO, DRO, and RRO concentrations are presented along with the PAH data to allow an assessment of whether or not the PAH is representative of the source (i.e. whether or not it is from the more heavily contaminated portions of the source area). PAHs tend not to be transported outside of the source area at concentrations exceeding risk-based levels (except for naphthalene in the vapor phase).
- Fourth HRC table: VPH and EPH Soil Results – This table presents the VPH and EPH analyses, which are typically conducted on a limited number of samples (e.g., five samples) from the more heavily contaminated portions of the NAPL-contaminated soil source area. The data are used to subdivide the GRO, DRO, and RRO concentrations into smaller aromatic and aliphatic equivalent carbon groups in order to allow more representative phase partitioning calculations. Only the VPH and EPH data from the source area are used to characterize the NAPL; therefore, if VPH and EPH samples from outside the source are analyzed, the results are presented separately from the results that are representative of the source area.
- Fifth HRC table: All BTEX, GRO, DRO and RRO Groundwater Results – This table presents all of the BTEX, GRO, DRO, and RRO groundwater chemical data (historical and 2014) collected at the site (if groundwater samples were collected at the AOC). Following ADEC guidance, if the NAPL-contaminated soils are interpreted to extend to within about 5 feet of the water table, groundwater samples were collected and used to assess groundwater ingestion risk. If NAPL-contaminated soils did not extend to within about 5 feet of the water table at a particular AOC, then a well may not have been installed or sampled. The most recent groundwater data are used to assess risk, while the historical data may be used to assess plume stability and to predict when cleanup levels may be met. If more than one source area well is sampled, the maximum recent groundwater concentrations are used as input to the risk calculations. If groundwater samples were not collected at a site, then groundwater concentrations modeled from the soils data and phase partitioning relationships, were used as input to the HRC calculations.
- Sixth HRC table: PAH Groundwater Results – This table presents the PAH groundwater chemical data (historical and 2014) collected at the site (if groundwater samples were collected at the AOC).
- Seventh HRC table: VPH and EPH Groundwater Results – If groundwater samples were analyzed for VPH and EPH the data are presented in the seventh table for the AOC. Note that toxicity data are available for the GRO, DRO, and RRO aromatic and aliphatic fractions, but not for total GRO, DRO or RRO. That is, risk is only assessed for the aromatic and aliphatic fractions of the total measurement, while the total GRO, DRO and RRO measurement includes the aromatics, aliphatics and partially degraded, polar, organic acids and alcohols. At sites where oil has migrated to the zone of seasonal water table fluctuation, it is common to measure total DRO concentrations above 1.5 milligrams per liter (mg/L) and have DRO aromatic and DRO aliphatic concentrations well below their risk-based levels. The VPH and EPH aromatic and aliphatic equivalent carbon fractions are summed within the GRO and DRO ranges to yield GRO aromatic and GRO aliphatic and DRO aromatic and DRO aliphatic concentrations, which are used as input to the risk calculations.

The HRC data tables listed above use bold font to indicate analyte detections. Two types of cell shading are used: light yellow shading is used to indicate GRO, DRO, and RRO results interpreted to be within the NAPL-contaminated soil source area; and light gray shading is used to indicate BTEX and PAH concentrations above the project screening criteria. According to the ADEC *Cumulative Risk Guidance* (ADEC 2008b), constituents present at concentrations above 1/10th of their soil direct contact or (outdoor air) inhalation cleanup levels listed in 18 AAC 75 Table B1, or above 1/10th of their groundwater ingestion cleanup levels listed in 18 AAC 75 Table C, are included in the risk calculations, while constituents present at lower concentrations may be screened out. These ADEC cumulative risk screening levels and the pathway associated with each screening level are listed in the data tables for each analyte and used to assign gray shading for the BTEX and PAH constituents. Individual constituents and GRO, DRO and RRO results above the Method Two cleanup levels have ACLs calculated using Method Three. Note that BTEX results below the Method Two screening criteria are commonly used as input to the HRC, because the data are included in the phase partitioning calculations. For the C9-C10 aromatic and C8-C10 aliphatic ranges, VPH data were used to calculate the source area hydrocarbon characterization, and for C10-C12 aromatic and aliphatic ranges, EPH data were used to calculate the source area hydrocarbon characterization.

For soil data collected in 2014, the data tables list the measured concentration if the analyte is detected, and report the LOD if the analyte is not detected. Historical data sets commonly do not contain LOD values, so the data tables list the measured concentration if the analyte was detected, and report the DL or method detection limit if the analyte was not detected. Per the ADEC technical memorandum entitled, *Guidelines for Data Reporting, Data Averaging, and Treatment of Non-Detect Values* (ADEC 2012a), only the “best results” are used as input values presented in the data tables. The “best result” value is the higher of the original or duplicate result if both results are detections; the detected value if one result is a detection and one result is a non-detection; and the lower of the original or duplicate LOD if both the original and duplicate samples did not detect the analyte.

4.2.2 Non-Contaminant HRC Input Parameters

The non-contaminant input parameters include: site-specific soil conditions; hydrogeologic conditions; climate data; source area length and vertical extent; exposure routes complete at the present time; and the building size, foundation type and foundation soil conditions used as input to the Johnson & Ettinger model. Most parameters apply to both calculators; however, soil temperature, dissolved phase half-life and groundwater seasonal low and seasonal fluctuation apply only to the HRC.

AOC-specific values, as applicable, were used as input parameters to calculate risk and soil ACLs, as described below.

Dissolved Phase Half-Life

The dissolved phase half-life describes the time required for half of the dissolved phase mass to biodegrade. Half-life values may be determined on a site-specific basis from the change in dissolved concentration downgradient of the source area. Alternatively, literature values may be used. Half-life values vary between constituents, with most fuel hydrocarbons degrading relatively readily. For this study, literature values were used for the BTEX constituents (Suarez & Rafai 1999) and conservative estimates, which minimize the importance of biodegradation, were used for the PAH constituents (Acomb 2011).

Soil Source Extent

The depth of the bottom of the source zone, top of the source zone at the downgradient edge, and length of the source zone were determined using previous and Supplemental RI screening and chemical data. The criteria defining the NAPL source zone are discussed in Section 3.3 and were used to determine soil source limits for input into the HRC. The source length was measured as the maximum length of the NAPL source zone in the direction of groundwater flow.

Geotechnical Parameters

Soil samples representative of source zone soil types were collected for bulk density, specific gravity, soil moisture, and grain size. Geotechnical laboratory reports are provided in Appendix H and a summary of geotechnical parameter results is provided in Table 4-2. AOC-wide averages were calculated for bulk density, specific gravity, and moisture for input into the calculators. Grain size was used qualitatively to check calculated hydraulic conductivity results and to obtain estimated values for sites with limited (or questionable) to no slug test data.

Total Organic Carbon

Table 4-3 summarizes TOC concentrations and fractional organic carbon (FOC) for each site to be used in the Online Calculator and the HRC. Calculations were based on the mean TOC for background soil samples collected. The maximum TOC concentration at each site, along with those containing significant hydrocarbon detections have been removed from the data set used in the calculation. The minimum TOC was also removed from the AOC D site background samples since there were more samples available for the calculation. Full results for the background samples are presented in Appendix J.

Soil Temperature

Soil temperature was estimated using *in-situ* groundwater temperatures measured by data loggers used during the slug tests, where available. At the ten sites where slug tests were performed, the groundwater temperature varied from about 4.5 to 6.6 degrees Celsius (°C) and averaged about 5.3°C. The average groundwater temperature of 5.3°C was used as input for all of the AOCs. Note that groundwater temperatures were also measured in an *ex-situ* flow through cell while collecting groundwater samples and the *ex-situ* readings were approximately 4 to 5°C higher than those measured *in-situ*. The higher temperatures likely indicate warming of the groundwater caused by the *ex-situ* measurements recorded during relatively warm summer conditions.

Precipitation

Average precipitation was derived using the literature value of 143.44 inches of annual rainfall (NOAA 2014). The infiltration rate of 0.7287 meter per year was determined based on calculating 20% of the annual precipitation.

Aquifer Thickness

The top of the aquifer was determined based on groundwater elevations measured in monitoring wells screened across the water table. Limited information is available for determining the base of the aquifer. Therefore, the ADEC default of 10 meters (32.8 feet) was used for all AOCs.

Hydraulic Conductivity

Site-specific hydraulic conductivity was calculated using aquifer (slug) test and data reduction methods as described in Section 3.4.5. Calculated hydraulic conductivity values are summarized in Table 4-4 and AQTESOLV outputs are provided in Appendix E. For sites with multiple wells and slug tests, the Bouwer & Rice hydraulic conductivity results from the following well groupings were averaged for input into the calculators:

- AOC C6: AP-062, AP-063, AP-064
- AOC D1: AP-201 and AP-202
- AOC D2, D3, and D4: AP-203, AP-205, AP-206, and AST 4-4
- AOC D5, D6, and D8: AST 5-4 and AST 6-3
- *AOC D7:* AST 7-4

At AOC C2/C4, a slug test was conducted at well AP-024 located outside the source zone due to the poor condition of the in-source monitoring well. The resulting hydraulic conductivity (0.0037 foot per day [ft/day]) is lower than expected for the predominately silty sand aquifer material. Additionally, the presence of debris would likely increase the hydraulic conductivity within the source. Therefore, a hydraulic conductivity of 0.010 ft/day is assumed based on grain size data and applying the lower conductivity range from textbook values for silty sand (Freeze & Cherry 1979).

Aquifer testing was not performed at the AACS; therefore, a text book value was used based on boring log descriptions and geotechnical results. A hydraulic conductivity value of 100 ft/day was applied for the poorly graded sand with gravel observed at the site. Average hydraulic conductivity values used are consistent with the text book ranges (Freeze & Cherry 1979).

Hydraulic Gradient

Hydraulic gradient input values are based on water table contours presented in site-specific section figures. Typically, the gradient was averaged across the entire AOC. At AOC D, groundwater contours show a cone of depression associated with water supply wells ARCO #1 and/or ARCO #2. In this case, an overall hydraulic gradient at AOC D was calculated based on the area outside the cone of influence.

Groundwater Seasonal Low and Seasonal Fluctuation

The amount of seasonal water table fluctuation and the thickness of the seasonally saturated, NAPL source zone are used in the calculation of the DAF and the migration to groundwater cleanup levels. When NAPL is present in the zone of seasonal water table fluctuation, the NAPL tends to be smeared through this zone of fluctuation. At Yakutat, the seasonal water table fluctuation was estimated based on the soil boring log visual, olfactory, and PID data; the soil sample analytical results; and the ROST (or LIF) logs. At AOCs C2, C4 and C6 the LIF and soil boring data indicates approximately 4 feet of seasonal water table fluctuation as shown in the site cross sections. At AOC D, the seasonal water table fluctuation was estimated based on smear zone data collected at AOC D7 (where the NAPL is interpreted to be smeared though the zone of seasonal fluctuation) and applied to AOCs D3 through D6 and D8. The smear zone data indicate approximately 6 feet of seasonal water table fluctuation.

Vapor Intrusion Model Input Parameters

The Johnson & Ettinger model is used to assess risk associated with the vapor intrusion pathway. The model input parameters describe the building size and foundation type (slab-on-grade versus basement) and the properties and thicknesses of the uncontaminated soils between the source area and the building foundation. Average values for Yakutat Moraine soils observed at each AOC were used for specific gravity, bulk density, moisture content, and the fraction of organic carbon. Since AOC D1 is the only site that has a building near the source area, all remaining sites used the EPA default input values for either a building with a slab on grade foundation or building with a basement, depending on the site-specific water table conditions. These input values include building size, foundation depth, perimeter crack width, and pressure differential, which are all used to evaluate future risk due to vapor intrusion. The EPA default building dimensions are conservative.

4.3 COMPARISON OF HRC AND ONLINE CALCULATOR FOR DETERMINING CLEANUP LEVELS

This section discusses some of the differences between the HRC and the Online Calculator calculation approaches and draws conclusions regarding the use of the ACL calculations provided by each approach. The HRC was designed to account for and/or correct the limitations of the Online Calculator. A summary of the most important similarities and differences in the calculation approaches used in the tools is as follows:

1. The HRC is focused on performing a forward calculation of risk and assessing if the site conditions meet the ADEC risk criteria, rather than performing a backward calculation of ACLs.
    - The forward risk calculation approach is used because the regulations require that contaminated sites meet cumulative risk criteria, and not just have contaminant concentrations below ACLs. (Note that contaminant concentrations could be below ACLs and the site could still exceed cumulative risk criteria).
    - If the site meets the ADEC risk criteria, then the calculation of ACLs is not needed, and
    - If more than one constituent contributes to cumulative risk, then there are not unique back calculated ACLs.

2. The Online Calculator and the HRC use the same basic equation to arrive at soil direct contact cleanup levels for the individual constituents and soil ingestion cleanup levels for the hydrocarbon fractions.
   - However, when back calculating total DRO soil ingestion cleanup levels, the Online Calculator assumes that the DRO is composed of 40% aromatics, while the HRC uses a site specific characterization of the aromatic fraction.
   - The Online Calculator assumption that the DRO is composed of 40% aromatics is not representative of most diesel fuels and is not conservative when the aromatic fraction is less than about 29% (when the aromatic fraction is less than 29% the aliphatic portion of the DRO drives risk). The HRC uses the site specific DRO % aromatic data (derived from the EPH test) to calculate total DRO soil ingestion cleanup levels.
   - The same type of error occurs in the Online Calculator when back calculating total GRO and total RRO soil direct contact cleanup levels.
   - In addition, there is a difference in the rounding of the soil direct contact/soil ingestion cleanup levels derived from the tools. The Online Calculator values tend to be rounded more, while the HRC values show more significant digits.
3. The Online Calculator ACLs are calculated using three-phase equations. In contrast, the HRC uses both three-phase equations and four-phase equations with Raoult's Law, makes an assessment of which phase partitioning calculations are appropriate for the site conditions, and then uses the appropriate partitioning in subsequent risk calculations and in assessing compliance with the ADEC migration to groundwater criteria.
   - This difference in calculation approach constitutes a critical difference between the Online Calculator and the HRC because the migration to groundwater cleanup levels, and to a lesser extent the outdoor air inhalation cleanup levels, are commonly the most stringent cleanup levels.
   - The differences in the phase partitioning calculation approaches are illustrated in Figure 4-1a, b. The figure shows the total DRO dissolved phase concentrations (on the y-axis) in equilibrium with DRO soil concentrations (on the x-axis) across a range of soil concentrations and fraction of organic carbon conditions that are representative of most contaminated sites. The figure shows that when four-phase partitioning with Raoult's Law is applied, the effective solubility of the DRO is relatively constant across a wide range of concentrations and that the fraction of organic carbon in the soil does not significantly affect the dissolved concentrations.
   - In contrast, the three-phase equation (as used in the Online Calculator) shows that dissolved concentrations increase linearly with increasing soil concentrations even above the solubility limit for DRO.
   - The phase partitioning calculation approach used in the HRC is consistent with the concepts presented in the EPA *Soil Screening Guidance: Technical Background Document* (EPA 1996) and with chemistry, environmental engineering and hydrogeology text books. The three-phase equation as applied in the Online Calculator is not consistent with the technical literature and violates the basic chemical concept that some organic compounds (such as fuel hydrocarbons) have solubility limits.
   - The phase partitioning concepts and calculations performed by the HRC are representative of the physical processes occurring at hydrocarbon contaminated sites, while the phase partitioning calculations performed by the Online Calculator are commonly in error by one or more orders of magnitude. The calculation approach used in the Online Calculator leads to a miss-conceptualization of the physical processes occurring at contaminated sites, which may cause remedial action to be taken where it was not warranted.
4. The Online Calculator migration to groundwater calculation assumes that the contaminant source is limited to the vadose zone. However, as documented by soil boring observations, laboratory sample results, and LIF data obtained for the site, the hydrocarbon contamination is commonly

not limited to the vadose zone. Rather, spilled hydrocarbon NAPL will tend to infiltrate toward the water table and if a large enough mass of hydrocarbon is released, it will tend to be smeared through the zone of water table fluctuation.

- According to the migration to groundwater equation in the Online Calculator, hydrocarbon from a vadose zone source is transported to the saturated zone in the dissolved phase only by the infiltrating precipitation. This calculation does not consider that, if there is NAPL in the saturated zone, the NAPL will also dissolve directly into the groundwater and the mass of hydrocarbon transported to the saturated zone by infiltrating precipitation may be less than that which dissolves directly into the groundwater from the saturated zone NAPL.
- At sites with NAPL in the saturated or seasonally saturated zone, the migration to groundwater cleanup levels derived from the Online Calculator tend to not be representative or conservative due to the vadose zone source assumption.
- In contrast, the HRC accounts for both the transport of dissolved hydrocarbon into the saturated zone by infiltrating precipitation and the hydrocarbon dissolving directly into the groundwater from NAPL in the saturated or seasonally saturated zones.

5. The Online Calculator migration to groundwater calculation relates the mixing zone depth to the source length, which limits the utility of the migration to groundwater calculation as a drinking water protection tool. At very small sites the Online Calculator may produce migration to groundwater ACLs that are overly conservative for the purpose of drinking water aquifer protection, while at large sites the Online Calculator may produce migration to groundwater ACLs that are not low enough to protect the aquifer as a drinking water source. The HRC uses a fixed mixing depth in the migration to groundwater calculation, which is interpreted by the ADEC to be protective of the shallow portion of the aquifer most vulnerable to contamination.

4.3.1 Conclusions Regarding the Comparison of the Online Calculator and the HRC

The ADEC *HRC Implementing Guidance* (2011a) compares the phase partitioning calculations performed by the HRC and the Online Calculator as follows:

> The HRC is designed for sites with petroleum contamination—specifically the petroleum fractions, BTEX, PAHs, and other constituents dissolved in petroleum—with the intention and purpose of providing an improved tool for assessing human health risk from this type of contamination. It employs a higher level of scientific rigor by applying either three-phase (dissolved, sorbed and vapor) or four-phase (dissolved, sorbed, vapor and NAPL) equilibrium partitioning to model the behavior of contaminants and calculate human health risk. In contrast, the ADEC Method Three calculator is limited to a three-phase equilibrium partitioning approach, which does not calculate accurate migration to groundwater or outdoor air inhalation cleanup levels when NAPL is present. At most sites that have petroleum contamination above the Method Two, Table B2 levels, NAPL is present.

The ADEC *HRC Implementing Guidance* (2011a) compares the dilution-attenuation portion of the migration to groundwater calculations performed by the HRC and the Online Calculator as follows:

> The HRC accounts for saturated zone sources, whereas the Online Calculator assumes that the source is in the vadose zone only. The result is that if NAPL exists below the water table, common at many fuel spill sites, the default DAF of 13.2 in the Online Calculator cannot be modified with a value that represents this site condition. In this situation, the ADEC calculator could be less conservative than the HRC. The variable DAF in the HRC is generally more representative for saturated or seasonally saturated source areas.

In conclusion, the HRC is interpreted to use calculations that represent the physical and chemical processes that occur at hydrocarbon contaminated sites better than those used in the Online Calculator. Consequently, the risk calculations and ACLs developed from the HRC are interpreted to be more representative for the AOC sites and are emphasized in the AOC-specific sections presented in this report.

4.4 HRC METHODOLOGY AND APPROACH

As discussed in the previous section, the use of the HRC is considered to be the most representative approach for evaluating risk and calculating ACLs at petroleum contaminated sites, such as the Yakutat FUDS AOCs. The HRC is an Excel™ spreadsheet model developed to assess the human health risks associated with petroleum hydrocarbon contaminated sites. An overview of the HRC process is presented below and the HRC is described in more detail in the *HRC Risk Calculator User Manual* (Geosphere 2011).

The HRC includes the following:

- Forward calculation of carcinogenic and non-carcinogenic human health risk for the following exposure routes:
  - Soil direct contact (ingestion and dermal adsorption)
  - Migration to outdoor air
  - Vapor intrusion or migration to indoor air
  - Migration to groundwater
  - Groundwater ingestion
- HRC uses the ADEC default exposure parameters and toxicity data as listed in the ADEC *Cleanup Levels Guidance* (ADEC 2008a).
- HRC may be used iteratively to estimate risk-based ACLs.
- HRC uses both an indicator constituent approach, in which the risks presented by individual constituents are calculated for each pathway, and a surrogate constituent approach, in which the risks presented by GRO, DRO, and RRO aromatic and aliphatic fractions are calculated for each pathway.
- HRC presents a "potential cumulative risk calculation," assuming that all exposure pathways are complete, and a "current cumulative risk calculation" for the pathways complete at the present time for both residential and industrial exposure scenarios. The cumulative carcinogenic and cumulative non-carcinogenic risks are calculated for the individual constituents (following ADEC guidance documents); the risk associated with GRO, DRO, and RRO aromatics and aliphatics are not included in the cumulative risk calculations.
- HRC applies either three-phase or four-phase partitioning equations, depending on whether NAPL is present. Where NAPL is present, four-phase partitioning and Raoult's Law are used to calculate the vapor pressure and effective solubility of the hydrocarbon constituents. The vapor and dissolved phase concentrations may subsequently be used in the calculation of risk associated with the outdoor and indoor inhalation pathways and leaching in the migration to groundwater pathway.
- HRC uses the Johnson and Ettinger model as implemented by the EPA to characterize risk associated with the vapor intrusion (migration-to-indoor-air) route. Risks associated with the vapor intrusion pathway may be calculated from measured soil, groundwater, or vapor concentrations.
- HRC uses a DAF that accounts for the presence of contaminated soil in either the vadose zone or saturated zone and adjusts the migration to groundwater risks accordingly.
- HRC assesses whether the subject site meets the human health risk and migration to groundwater closeout criteria contained in the ADEC regulations (18 AAC 75), and provides a

characterization of limitations on the placement of soil excavated and transported from the subject site.

- HRC is a peer-reviewed model approved by the ADEC as an alternative to the Online Calculator.

The HRC standard printout tables and a compact disc containing Excel™ files of the HRC used in the risk evaluation for the site, ProUCL calculations, and other supporting spreadsheets are provided in Appendix N. A description of the HRC tool and supporting spreadsheets contained in the Excel™ file is also included at the beginning of this appendix.

4.4.1 Forward and Backward Risk Calculations and ACLs

Human health risk calculations combine phase partitioning equations, fate and transport equations, and human exposure equations to calculate risk and/or cleanup levels. Two general types of calculations are possible: forward calculations and backward calculations. Forward calculations assess the risk caused at some exposure point within or downgradient of the contaminant source area. Backward calculations assess the concentration of a contaminant in the source area that causes or creates some (acceptable) level of risk at an exposure point in or downgradient of the contaminant source area. Forward calculations are most useful for assessing risk. Backward calculations are useful for setting screening levels.

When multiple contaminants and/or multiple exposure pathways are present, backward-calculated screening levels typically do not represent true “risk-based cleanup levels,” because the backward calculation usually only accounts for one constituent and one exposure route. Therefore, if there is more than one contaminant, the cumulative risk will likely exceed the allowable risk level when the screening level concentration for any one chemical is reached. In addition, when multiple contaminants and/or multiple exposure pathways are present, there is not a “unique” back-calculated soil cleanup level.

The HRC uses existing source area concentrations as model input and performs a forward risk calculation for each constituent and each exposure route. In addition, cumulative risks are calculated in the HRC model:

- If the risk meets the ADEC risk standard, the existing site concentrations become the site-specific “alternative cleanup levels” described in 18 AAC 75.340.
- If the risk exceeds acceptable levels, the HRC may be used iteratively to conduct backward ACL calculations, by reducing chemical concentrations used as input into the calculator in a manner reflective of a remedial approach (e.g., soil vapor extraction would tend to remove relatively volatile constituents at a much higher rate than the relatively non-volatile constituents).

4.4.2 Uncertainty Analysis

The estimation of exposure requires many assumptions to describe potential exposure situations. There are uncertainties regarding the likelihood of exposure, frequency of contact with contaminated media, the concentration of contaminants at exposure points, and the exposure period. These tend to simplify and approximate actual site conditions. In general, these assumptions are intended to be conservative by providing an overestimation of the true risk or hazard. The following assumptions have been made:

- Future soil exposure point concentrations were assumed to be equal to existing concentrations. This assumption does not account for volatilization, biodegradation, and dissolution and downgradient transport of contaminants over time; therefore, risk estimates are likely to be overestimated for future exposure scenarios.
- In the risk characterization, the assumption was made that the total risk of developing cancer from exposure to site contaminants is the sum of the risk attributed to each individual contaminant. Likewise, the potential for developing noncancerous adverse effects is the sum of the noncarcinogenic risks estimated for exposure to each individual contaminant. This approach is consistent with EPA guidance.

- For this evaluation, the noncarcinogenic risks from all COPCs were summed to obtain the hazard index (HI). The hazard quotient for individual chemicals was not segregated based on target organs; therefore, the HI could overestimate the potential for one type of noncancerous effect, because all COPCs do not affect the same target organ.
- Parameters required for implementing the Johnson and Ettinger model include soil properties (such as porosity, moisture content, and bulk density), building properties (flow rate into building), chemical properties (VOC concentrations), and exposure assumptions for the various receptor populations (i.e., workers and residents). The input values for these parameters range from default values provided in the model (e.g., physical-chemical properties) to site-specific information. These assumptions tend to simplify and approximate actual site conditions, but in general, the assumptions are considered conservative.

Figure 4-1a: Dissolved DRO Concentration as a Function of the Soil DRO Concentration and FOC Using 3-phase and 4-phase Equations

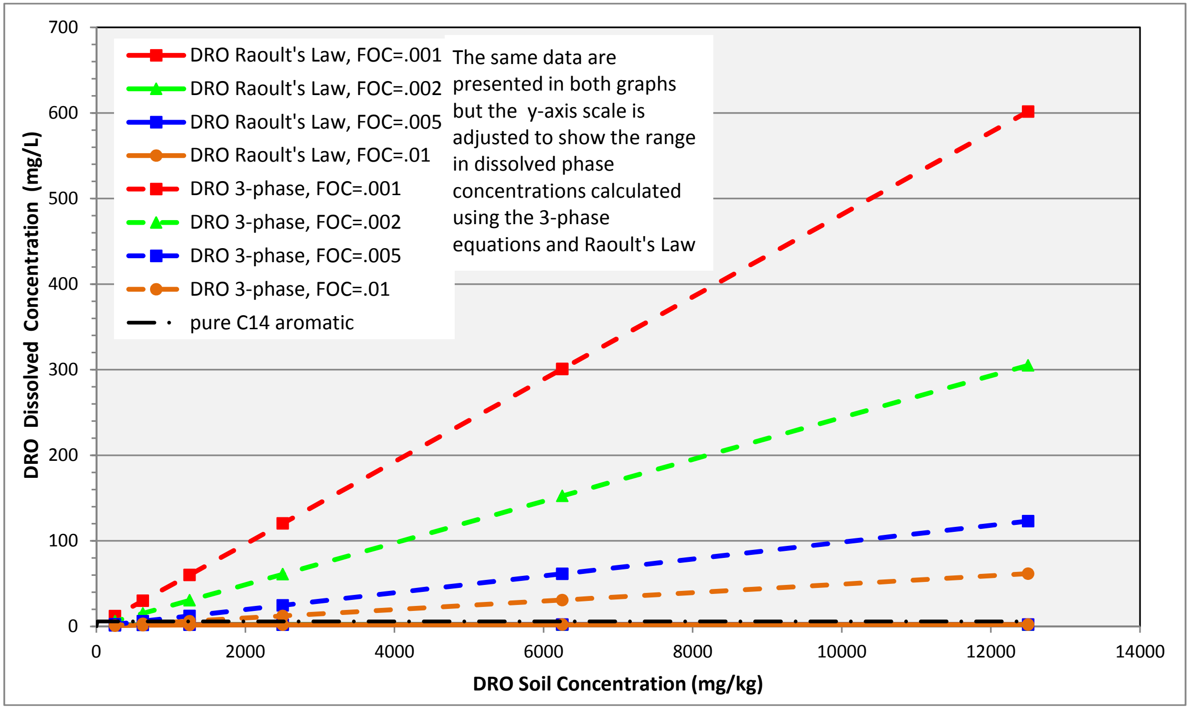
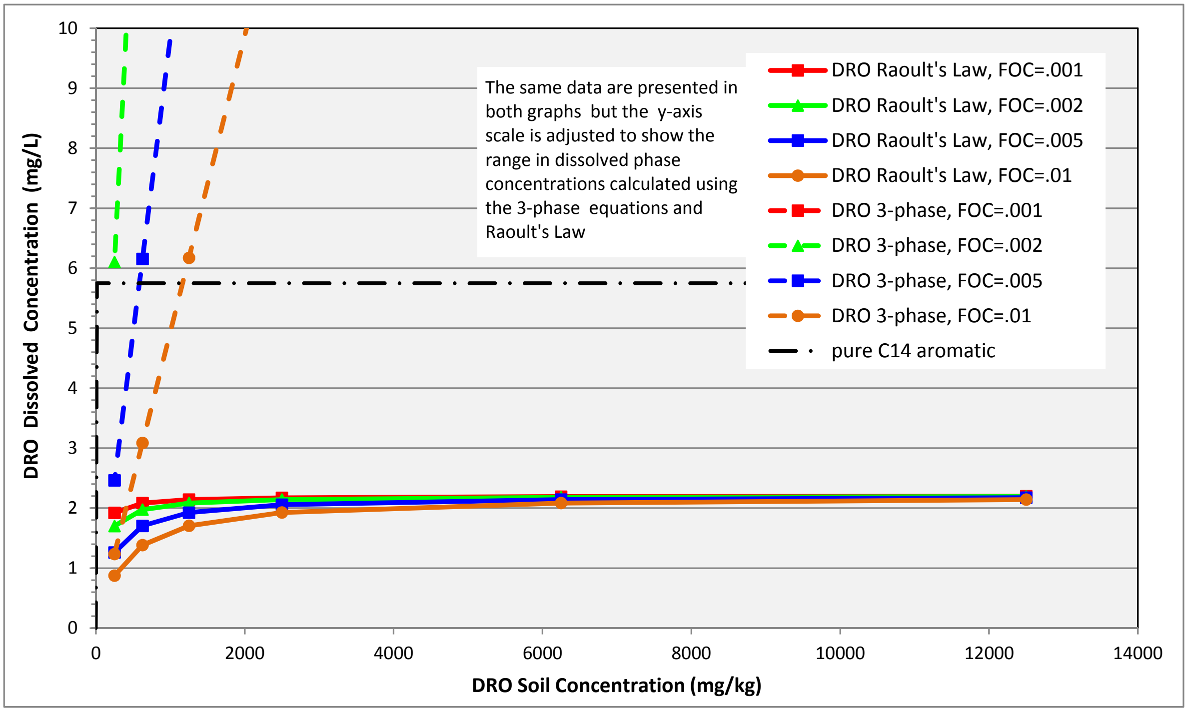


Figure 4-1b: Dissolved DRO Concentration as a Function of the Soil DRO Concentration and FOC Using 3-phase and 4-phase Equations



FOC = fractional organic carbon

Table 4-1: Method Three Online Calculator and HRC Input Parameters

Parameter	Method	Matrix	Data Source	Online Calculator	HRC
Exposure Point Concentrations					
BTEX	8260B	SO/GW	Previous/2014 SRI	—	X
GRO	AK101	SO/GW	Previous/2014 SRI	—	X
DRO	AK102	SO/GW	Previous/2014 SRI	—	X
RRO	AK103	SO/GW	Previous/2014 SRI	—	X
PAH	8270C	SO/GW	Previous/2014 SRI	—	X
EPH	NWTPH-EPH	SO/GW	2014 SRI	—	X
VPH	NWTPH-VPH	SO/GW	2014 SRI	—	X
Dissolved phase half life	Literature	SO	Literature	—	X
Soil Source Depth					
Depth to bottom of source zone	Previous RI delineation	SO/GW	Previous/2014 SRI	—	X
Depth to top of source zone at down gradient edge	Previous RI delineation	SO/GW	Previous/2014 SRI	—	X
Source Area Non-Contaminant Soil Conditions					
Soil bulk density	ASTM D-2937	SO	2014 SRI	X	X
Specific gravity	ASTM D-854	SO	2014 SRI	X	X
Soil moisture	ASTM D-2216	SO	2014 SRI	X	X
Grain size	ASTM C136-06	SO	2014 SRI	X	X
TOC	EPA 415.1 or SW-846 9060	SO	2014 SRI	X [a]	X [a]
Soil temperature	*In-situ* field test	SO	2014 SRI	—	X
Hydrogeologic Conditions					
Source length	Previous RI delineation	SO/GW	Previous/2014 SRI	X	X
Average precipitation	NOAA records	—	NOAA Records	—	X
Aquifer thickness	Boring logs, site geomorphology	GW	Previous	X	X
Hydraulic conductivity	Slug test	GW	2014 SRI	X	X
Hydraulic gradient	Potentiometric mapping	GW	Previous/2014 SRI	X	X
GW seasonal low	Historical data, if available	GW	Previous	—	X
Seasonal fluctuation	Historical data, if available	GW	Previous	—	X

[a] TOC evaluation included testing for DRO and RRO with and without silica gel cleanup.

—	Not a calculator input parameter
ASTM	American Society for Testing and Materials
BTEX	benzene, toluene, ethylbenzene, xylenes
DRO	Diesel Range Organics
EPA	Environmental Protection Agency
EPH	extractable petroleum hydrocarbons
GRO	Gasoline Range Organics
GW	groundwater
HRC	Hydrocarbon Risk Calculator
NOAA	National Oceanic and Atmospheric Administration
NWTPH	Northwest Total Petroleum Hydrocarbons
PAH	polynuclear aromatic hydrocarbons
RI	remedial investigation
RRO	Residual Range Organics
SO	soil
SRI	Supplemental Remedial Investigation
TOC	total organic carbon
VPH	volatile petroleum hydrocarbons
X	Calculator input parameter

Table 4-2: Soil Geotechnical Results

AOC	Sample ID	Date Collected (dd-mm-yyyy)	Time Collected (hhmm)	% Gravel	% Sand	% Fines	% Moisture	AppSpG (g/g)	Bulk Density (lb/ft^3)	Classification	USCS	Average % Moisture	Average AppSpG (g/g)	Average Bulk Density (lb/ft^3)
AACS	AA-BG01-2.0-4.0-0714	4-Jul-2014	1025	-	-	-	14.1	2.67	120.8	-	-	11.8	2.69	120.2
	AA-BG02-2.0-4.0-0714	4-Jul-2014	0950	22.9	72	5.1	13	2.73	111.6	Poorly graded sand w/gravel	SP			
	AA-BG03-2.0-4.0-0714	4-Jul-2014	1055	31.6	64.5	3.9	8.8	2.7	127.4	Poorly graded sand w/gravel	SP			
	AA-BG04-2.0-4.0-0714	4-Jul-2014	0905	30.8	66.4	2.9	11.3	2.64	121.1	Poorly graded sand w/gravel	SP			
C2/C4	C2-BG01-1.0-2.5-0614	26-Jun-2014	1048	0.7	97.8	1.4	13.9	-	97.6	Well graded Sand	SW	9.8	2.79	119.3
	C2-BG01-3.0-4.0-0614	26-Jun-2014	1137	33.5	48.8	17.7	9.6	2.85	123.8	Silty Sand w/gravel	SM			
	C2-BG02-0.0-2.0-0614	26-Jun-2014	1215	35.1	54.6	10.3	11.1	2.82	119	Well graded Sand w/silt and Gravel	SW-SM			
	C2-BG02-2.0-3.0-0614	26-Jun-2014	1225	26.9	49.5	23.6	9.7	2.82	119.3	Silty Sand w/gravel	SM			
	C2-BG03-0.0-2.0-0614	26-Jun-2014	1305	19.5	45	35.5	10	2.78	117.8	Silty Sand w/gravel	SM			
	C2-BG03-3.0-4.0-0614	26-Jun-2014	1310	22.1	50	27.9	7.8	2.74	128.1	Silty Sand w/gravel	SM			
	C2-BG04-0.0-2.0-0614	26-Jun-2014	1355	45	51.6	3.4	8.3	2.72	114.2	Poorly graded Gravel w/sand	GP			
	C2-BG04-3.5-4.5-0614	26-Jun-2014	1420	22.5	50.7	26.8	8.2	2.78	134.5	Silty Sand w/gravel	SM			
C6	C6-BG01-18.5-22.0-0614	28-Jun-2014	1550	54.2	43.1	2.7	6.6	2.79	-	Well graded Gravel w/sand	GW	6.5	2.78	141.1
	C6-BG01-5.0-7.0-0614	28-Jun-2014	1445	39	40.9	20.2	5.3	2.78	141.6	Silty Sand w/gravel	SM			
	C6-BG02-20.5-22.0-0614	30-Jun-2014	1449	50.3	42.7	7	6.4	2.8	143.6	Poorly graded Gravel w/silt and sand	GP-GM			
	C6-BG02-5.5-7.0-0614	30-Jun-2014	1325	36.9	33	30.1	7.3	2.75	143.8	Silty gravel w/sand	GM			
	C6-BG03-18.5-20.0-0614	30-Jun-2014	1615	61	35.1	3.8	5.6	2.74	148.5	Well graded Gravel w/sand	GW			
	C6-BG03-3.0-5.0-0614	30-Jun-2014	1545	31.3	40.2	28.5	6.7	2.83	128.1	Silty Sand w/gravel	SM			
	C6-BG04-2.0-4.0-0714	1-Jul-2014	0850	23.5	47.8	28.7	9.2	2.74	-	Silty Sand w/gravel	SM			
	C6-BG04-9.5-11.0-0714	1-Jul-2014	0940	59.3	33.3	7.3	5.2	2.77	-	Poorly graded Gravel w/silt and sand	GP-GM			
D1	D1-BG06-6.0-7.0-0614	22-Jun-2014	1705	23.1	50.9	26	7.9	-	-	Silty Sand w/gravel	SM	8.7	2.82	125.1
	D1-BG08-20.5-22.0-0614	25-Jun-2014	1050	66.5	28.2	5.2	2.3	2.87	118.1	Well graded gravel w/silt and sand	GW-GM			
	D1-BG08-6.0-9.0-0614	25-Jun-2014	1010	3.7	61.3	35.1	10.9	2.88	-	Silty sand	SM			
D2	D2-BG05-13.0-14.0-0614	22-Jun-2014	1130	61.5	31.4	7.1	3.3	2.79	98.8	Well graded gravel w/silt and sand	GW-GM			
	D2-BG05-25.5-27.0-0614	22-Jun-2014	1150	20.2	74.6	5.2	4.4	2.82	135.1	Poorly graded sand w/silt and gravel	SP-SM			
D3	D3-BG03-5.5-7.0-0614	21-Jun-2014	1418	11.9	64.9	23.1	32.6	2.82	125	Silty sand w/gravel	SM			
	D3-BG03-8.5-10.0-0614	21-Jun-2014	1430	49.8	45.8	4.4	4.2	2.81	120.4	Poorly graded gravel w/sand	GP			
	D3-BG04-10.5-12.0-0614	21-Jun-2014	1750	39.6	56	4.4	2.6	2.8	133.3	Poorly graded sand w/gravel	SP			
	D3-BG04-5.5-7.0-0614	21-Jun-2014	1732	34.4	41.9	23.7	6.7	2.77	134.7	Silty sand w/gravel	SM			
D4	D4-BG02-11.0-12.0-0614	20-Jun-2014	1545	47.8	-	-	4.8	2.97	132.2	-	-			
	D4-BG02-5.0-6.0-0614	20-Jun-2014	1535	23.7	-	-	9.4	2.76	118.6	Well graded Gravel w/silt and sand	-			
D8	D8-BG01-13.0-14.0-0614	20-Jun-2014	1050	45	-	-	5.3	2.65	137.8	-	-			
	D8-BG01-17.0-18.0-0614	20-Jun-2014	1135	15.5	-	-	18.7	2.85	-	Well graded gravel w/silt and sand	GW-GM			
	D8-BG07-10.0-12.0-0614	24-Jun-2014	1600	41.6	45.7	12.7	5.4	2.82	126.4	Silty sand w/gravel	SM			
	D8-BG07-20.0-22.0-0614	24-Jun-2014	1635	48.8	44.5	6.7	3.7	2.86	139.7	Poorly graded Gravel w/silt and sand	GP-GM			
	D8-BG07-4.0-5.5-0614	24-Jun-2014	1535	29.1	53	17.9	16.4	2.9	105.6	Silty sand w/gravel	SM			

Notes:

- = Results not provided by geotechnical lab

% = percent

AOC = area of concern

AppSpG = apparent specific gravity

g/g = grams per gram

lb/ft³ = pounds per cubic foot

USCS = Unified Soil Classification System

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Table 4-3: Background Total Organic Carbon Results

Summary of Fractional Organic Carbon (FOC) in g/g used for Method Three at Sites	
AOC	**FOC**
C2 and C4	0.003835
C6	0.004700
D1 through D8	0.005827
AACS	0.002225
Summary of Background TOC Samples used to Calculate Mean for Method Three Input	
AOC C2 and C4	
Sample ID	**mg/kg**
C2-BG01-1.0-2.5-0614	22000 [b]
C2-BG01-3.0-4.0-0614	2200
C2-BG02-0.0-2.0-0614	6800
C2-BG02-2.0-3.0-0614 [a]	770
C2-BG02-3.0-4.0-0614 - FD	940
C2-BG03-0.0-2.0-0614	3300 [c]
C2-BG03-3.0-4.0-0614	3500 [c]
C2-BG04-0.0-2.0-0614	11000
C2-BG04-3.5-4.5-0614	1300
Mean:	3835
AOC C6	
C6-BG01-17.0-18.0-0614	14000 [b]
C6-BG01-3.0-5.0-0614	4600
C6-BG02-18.0-20.0-0614	4900
C6-BG02-3.0-5.0-0614 [a]	6300
C6-BG02-5.0-7.0-0614 - FD	5600
C6-BG03-17.0-18.0-0614	2700
C6-BG03-3.0-5.0-0614	3200
C6-BG04-2.0-3.5-0714	5600
C6-BG04-8.0-9.0-0714	4400 [c]
Mean:	4700
AOC D1-D8	
D1-BG06-10.0-12.0-0614 [a]	7900
D1-BG06-12.0-14.0-0614 - FD	15000 [b]
D1-BG08-18.0-20.0-0614 [a]	4700
D1-BG08-22.0-24.0-0614 - FD	4900
D1-BG08-6.0-8.0-0614	4800
D2-BG05-12.0-14.0-0614	7000
D2-BG05-26.0-28.0-0614	7200
D3-BG03-5.5-7.0-0614	4400
D3-BG03-8.0-10.0-0614	5800
D3-BG04-10.0-12.0-0614	7200
D3-BG04-4.0-6.0-0614	5500
D4-BG02-4.0-6.0-0614	5500
D4-BG02-8.0-10.0-0614	9700
D8-BG01-12.0-14.0-0614	8500 [c]

AOC D1-D8 (cont'd)	
D8-BG01-16.5-17.0-0614	3900
D8-BG07-10.0-12.0-0614	4800
D8-BG07-20.0-22.0-0614	4100
D8-BG07-4.0-6.0-0614	2300 [b]
Mean:	5827
AACS	
AA-BG01-0.0-2.0-0714	2400
AA-BG01-2.0-4.0-0714	1600
AA-BG02-0.0-2.0-0714	2400
AA-BG02-2.0-4.0-0714	1800
AA-BG03-0.0-2.0-0714	5100 [c]
AA-BG03-2.0-4.0-0714	2100
AA-BG04-0.0-2.0-0714	3200
AA-BG04-2.0-4.0-0714 [a]	2200
AA-BG04-4.0-6.0-0714 - FD	2100
Mean:	2225

Primary Laboratory Method LOD and LOQ is 300 and 2000 mg/kg, respectively.
Divide mg/kg by 10,000 to get % TOC and by 1,000,000 to get fractional carbon in g/g.
QA lab results not used for mean, detection limits higher than primary laboratory and the only detect had a 58% RSD for the lab triplicate.
[a] FD represent primary and field duplicate sample.
[b] Remove maximum or minimum (not used for mean).
[c] DRO/RRO or GRO present (not used for mean).
% = percent
AOC = area of concern
DRO = diesel range organics
FD = field duplicate
FOC = fractional organic carbon
g/g = grams per gram
GRO = gasoline range organics
LOD = limit of detection
LOQ = limit of quantitation
mg/kg = milligrams per kilogram
QA = quality assurance
RRO = residual range organics
RSD = relative standard deviation
TOC = total organic carbon

Table 4-4: Aquifer Test Hydraulic Conductivity Results

AOC	Well	Slug Test No.	Start Date/Time	Slug in or out	Hydraulic Conductivity Bouwer & Rice (ft/day)	Hydraulic Conductivity Average per Well (ft/day)	Hydraulic Conductivity Used in HRC (ft/day)
C2/C4	AP-024	1	6/27/2014 9:07	in	0.0037	0.0037	0.010[a]
C6	AP-062	1	6/20/2014 13:37	in	0.1450	0.1350	0.5032
		2	6/20/2014 14:44	in	0.1250		
	AP-063	1	6/20/2014 12:35	in	0.4989	0.5017	
		2	6/20/2014 12:59	in	0.5045		
	AP-064	1	6/20/2014 11:37	in	0.9285	0.8729	
		2	6/20/2014 12:02	in	0.8172		
D1	AP-201	1	6/25/2014 11:40	in	0.0137	0.0182	0.0179
		2	6/25/2014 11:59	in	0.0227		
	AP-202	1	6/25/2014 13:42	in	0.0147	0.0176	
		2	6/25/2014 14:04	in	0.0204		
D2, D3, D4	AP-203	1	6/25/2014 12:42	in	0.1508	0.2151	0.1848
		2	6/25/2014 13:00	in	0.2793		
	AP-205	1	6/23/2014 17:20	in	0.1705	0.2818	
		2	6/23/2014 17:34	in	0.3930		
	AP-206	1	6/23/2014 18:13	in	0.1522	0.0936	
		2	6/23/2014 18:31	in	0.0349		
	AST 4-4	1	6/22/2014 10:19	in	-	0.1609	
		2	6/22/2014 10:38	out	0.1959		
		3	6/22/2014 11:04	in	0.1330		
		4	6/22/2014 11:22	out	0.1537		
D5, D6, D8	AST 5-4	1	6/22/2014 14:23	in	0.0183	0.0168	0.02062
		2	6/22/2014 14:32	out	0.0161		
		3	6/22/2014 14:42	in	0.0161		
		4	6/22/2014 14:49	out	-		
	AST 6-3	1	6/22/2014 12:31	in	-	0.0263	
		2	6/22/2014 12:40	out	0.0149		
		3	6/22/2014 12:58	in	-		
		4	6/22/2014 13:11	out	0.0377		
D7	AST 7-4	1	6/23/2014 8:05	in	0.2349	0.4503	0.4503
		2	6/23/2014 8:13	out	-		
		3	6/23/2014 8:29	in	0.6657		

[a] Freeze and Cherry 1979 text book conductivity value for silty sand used in HRC. The measured conductivity value appears to be low and not representative of the predominately silty sands with gravel observed at the site, as confirmed by the geotechnical results.

AOC = area of concern
ft/day = feet per day
HRC = hydrocarbon risk calculator
No. = number

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5.0 AOC C2 – POINT CARREW GARRISON AREA LANDFILL/DRUM DUMP

5.1 AREA DESCRIPTION AND BACKGROUND

AOC C2 is the location of a dumpsite located on Phipps Peninsula north of Ankau Slough, approximately 1.4 miles from Ocean Cape. Historical layout plans from 1943 show an access road leading to a powerhouse and Building No. 1035 (AOC C3). However, no landfill is shown on the drawings in association with the powerhouse, which was removed during the 1984 USACE restoration activities. The landfill is known locally as the RCA dump, but it is not known when this area was first used as a landfill (ENSR 2003a). AOC C2 is located east of the presumed powerhouse footprint and consists of a flat, relatively open area with surrounding surface water ponds and muskeg. The AOC C2 landfill is interpreted to have filled in a portion of an existing pond located directly south of the site.

A geophysical survey conducted during a RI at the former powerhouse and drum dump identified five areas with elevated magnetic and electromagnetic responses that indicate the presence of buried metal debris (ENSR 2003a). USACE utilized ROST/LIF techniques that identified the presence of fuel contamination (diesel) in the soil and provided information to define the lateral and vertical extent of these impacts. Analytical data for soil samples confirmed that DRO and RRO are present in surface and subsurface soils at concentrations exceeding the ADEC Method Two cleanup levels (USACE 2006).

Previous investigations at the site show that DRO was detected in groundwater at concentrations below the ADEC Table C cleanup level. Although below the ADEC standards, the presence of DRO in groundwater confirms that contamination is present in the saturated zone (ENSR 2003a). Additionally, a water sample collected from a trench in the landfill had PCB concentrations reported above regulatory standards (AGRA 1997).

Co-located surface water and sediment samples collected from the pond adjacent to AOC C2 indicated lead in the surface water above the NOAA SQuiRT value (ENSR 2003a).

Data collected during previous investigations were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at AOC C2. These data, along with field screening results and visual observations, were reviewed to select appropriate sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations and the estimated NAPL source area at AOC C2 are shown on Figure 5-1.

5.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC C2 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Using test pits, determine what type of debris remains in the subsurface associated with elevated geophysical responses.
- Evaluate current groundwater conditions.
- Determine whether total and dissolved lead and PCBs are present in the surface water adjacent to and upgradient of AOC C2 to determine site conditions and establish upgradient “background” levels. Compare lead concentrations in surface water to the hardness-dependent Alaska WQS.
- Evaluate the upgradient, insource, and downgradient concentrations of lead and PCBs in sediment.

5.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC C2 included test pit excavation; temporary well point installation; and collection of soil, groundwater, surface water, and sediment samples. These activities are described below by media.

5.3.1 Soil

During the Supplemental RI, eight test pits were excavated at AOC C2. Six test pits were located near the center of the strongest electromagnetic anomalies (C2-TP01 through C2-TP06) to identify buried debris and potential soil contamination. Two test pits were excavated at the locations with the highest ROST/LIF responses (C2-TP07 and C2-TP08). Test pit locations are included on Figure 5-1.

Abundant garbage and debris were uncovered just bgs at three of the six original test pit locations (C2-TP02, TP04 and TP05), as well as C2-TP07 and C2-TP08. Since evidence of soil contamination was not observed at C2-TP01, TP03 or TP06, test pits were excavated at three alternate locations (C2-TP09, TP10 and TP11) with high ROST/LIF responses. Abundant debris and evidence of POL impacts were observed at each alternate location (Figure 5-2). Debris uncovered at the site included miscellaneous garbage (e.g., glass bottles, cans, plastic bags, shoes, oil filters, tires, etc.) and construction-type debris (e.g., wood/boards, scrap metal, pipes, steel cable, etc.). Large pieces of plastic sheeting covered in oily residue were noted in test pits with discarded oil filters. Water was generally observed entering open excavations at approximately 1.5 to 3 feet bgs. Black oily droplets and/or sheen were observed on water in open excavations at C2-TP05 and C2-TP08 through TP11. Photo documentation of test pit contents is included in Appendix A and test pit logs are included in Appendix C.

Two predominant soil types were encountered in the AOC C2 area. The surficial soil consists of brown, fine to coarse sand with gravel and few cobbles and extends to approximately 4 feet bgs. The soil is coarsely bedded and grades to a gray sandy silt or silty sand, which constitutes the second soil type present at the site. Field screening samples were collected from each 1- to 2-feet lift and screened for volatile organics using a PID. Soil samples collected for laboratory analysis were selected from the target depth(s) or adjusted to the most likely contaminated depth based on field observations (e.g., PID, visual, and olfactory). Soil samples from each location were submitted for laboratory analyses; one each from C2-TP02, TP04, TP05, TP09, TP10 and TP11, and two each from C2-TP07 and TP08. These samples were analyzed for GRO, DRO, RRO, BTEX, PAHs, EPH and VPH. Field observations and screening results at the C2 test pits were used to refine the estimated limits of the NAPL source areas shown on Figure 5-1.

BACKGROUND SOIL CONDITIONS

Based on proximity and soil types observed between AOCs C2 and C4, evaluation of background soil conditions discussed in this section will apply to both AOCs. Four test pits (C2-BG01 through BG04) were advanced outside the source areas adjacent to AOCs C2 and C4 to collect background soil data (i.e., chemical, TOC and physical parameters). Background test pit locations were determined in the field from areas around the perimeter of the AOCs. Two of the originally selected locations were relocated upon encountering debris; one at the southeast edge of the site near the pond (C2-BG01A), and a second one at the western edge of the site near C2-TP03 (C2-BG01B). Soil samples were collected at background locations from depths with soil types representative of those observed as impacted in both the AOC C2 and C4 NAPL source areas. As such, two samples were collected from each test pit; one from each of the predominant soil horizons. Samples for GRO, DRO/RRO, DRO/RRO with SGC, and TOC analyses were collected from background test pits directly out of the excavator bucket from a fresh soil surface. The CME drill rig was used to advance split-spoons adjacent to the background test pits for collection of soils for physical parameters (grain size, bulk density, moisture content, and specific gravity). Results of the background chemical analyses are presented in summary tables in Appendix J. Geotechnical data are summarized in Table 4-2 and TOC results are summarized in Table 4-3 (Section 4.2). These data were used for input into the HRC to evaluate risk at AOC C2.

5.3.2 Groundwater

Proposed groundwater assessment at AOC C2 included sampling two existing monitoring wells located outside of the source zone (AP-023 and AP-024), aquifer testing of the existing monitoring wells, and installation and sampling of a temporary well in the source zone. Upon inspection, well AP-023 had approximately 5 feet of silt accumulated in the bottom and during an attempt to re-develop the well, a blockage in the PVC riser pipe at 2 to 2.5 feet was discovered preventing sampling equipment past the blockage. Use of a small diameter bailer was attempted but produced only sediment and approximately 2 inches of muddy water leaving only existing monitoring well AP-024 available for sampling.

As proposed in the WP/QAPP, a temporary well point (C2-WP01) was installed within the AOC C2 source area at C2-TP08 to obtain groundwater quality data for the HRC. The temporary well point was installed by digging a trench to a depth just above groundwater and driving a temporary screen point approximately 1 to 2 feet into the water table (a total depth of approximately 3.5 feet). Based on the depth of water entering the test pits excavated within the landfill, this well was likely installed in a perched zone that is hydraulically connected to the adjacent pond. Well locations are shown on Figure 5-1.

During purging at AP-024, the bladder pump was turned down as low as possible to minimize drawdown in the well; however, the yield at this well was very low and with only 2 feet of water present, the well was purged dry. This well was gauged periodically for several days with minimal to no recharge observed until the area had significant rainfall for an extended period. Once the well had recharged, additional purging was performed to remove a borehole volume per the SOP and again allowed to recharge prior to sampling. Similarly, the flow rate on the peristaltic pump during purging and sampling of temporary well C2-WP01 was reduced as low as possible in attempts to prevent drawdown. However, the minimal water column and low yield also resulted in purging the well point dry over a short period. Sampling was performed after the well point had recharged sufficiently. Groundwater samples from both wells were submitted for analysis of GRO, DRO, RRO, BTEX, and PAHs, and samples from C2-WP01 were also analyzed for VPH/EPH. Procedures for purging and sampling of wells AP-024 and C2-WP01 are discussed in Section 3.4.3 and Low Flow Groundwater Sample Collection Records are included in Appendix D.

Temporary well point C2-WP01 had a total well depth of 5.98 feet bgs. While there is the possibility for the use of a peristaltic pump to cause loss of volatiles using a vacuum to draw the water, very little vacuum and minimal vertical lift were required to collect samples at this shallow well point and hence very little volatilization was expected to occur during the sampling process. This is supported by the ADEC *Vapor Intrusion Guidance for Contaminated Sites* (ADEC 2012b), which states: “[peristaltic pumps] should only be used for sampling [volatile compounds in] shallow groundwater (less than 15 feet from the ground surface)”. While the volatile results (GRO, BTEX, and VPH) may be biased low, they are considered adequate for use as definitive data.

Temporary well C2-WP01 was abandoned prior to demobilizing the excavator from the site after confirmation of sample receipt from the laboratory.

AQUIFER TESTING

Subsequent to sampling, aquifer (slug) testing was performed on well AP-024 to obtain specific hydraulic conductivity values for input into the HRC. Since <5 feet of available water column was present within the screen, a water slug was used to displace the water column instead of a solid slug. A slug test was performed and evaluated following the procedures outlined in Section 3.4.5. Recovery at well AP-024 took significantly longer than other wells tested in the Yakutat area and the water level was allowed to equilibrate overnight to fully rebound. It should be noted that at the conclusion of the aquifer test, the static water level was almost 0.5 foot higher than the starting water level. As stated in the previous section, this well was gauged periodically for several days after initial purging during groundwater sampling with minimal to no recharge observed until the area had significant rainfall. Slug test data are included in Appendix E and results discussed in Section 5.4 below.

Aquifer testing was also proposed for monitoring well AP-023 at AOC C2; however, as previously discussed, this well was damaged and slug tests could not be performed.

5.3.3 Surface Water and Sediment

Five surface water samples were collected at AOC C2 to evaluate surface water conditions during the Supplemental RI. Two surface water samples were collected from the pond adjacent to AOC C2; one at the north extent of the pond along the shoreline adjacent to the C2 source area (C2-WS01) and another from the southwest portion of the pond (C2-WS02). Three background surface water samples (C2-WS03, WS04 and WS05) were collected from a pond located across a slight ridge northeast of AOC C2. This pond was selected in the field based on location and pond characteristics (e.g., similar depth and size as the AOC C2 pond). Surface water sampling locations are shown on Figure 5-1.

Previous studies showed that lead in surface water from the onsite pond and PCBs collected from a trench within the landfill exceeded the NOAA SQuiRT values; therefore, surface water samples were analyzed for PCBs, total and dissolved lead, and hardness for comparison to the Alaska WQS (18 AAC 70). Since both lead and PCB historical detections were thought to be due to suspended particulates, samples were collected with care to avoid influence from disturbed sediment particulates as described in Section 3.4.4.

After the surface water samples were collected, co-located sediment samples were collected from each of the five locations using a decontaminated hand auger. Sediment samples were analyzed for lead and PCBs for comparison to the NOAA SQuiRT values, which are used as sediment screening levels (NOAA SQuiRT values are not considered cleanup levels).

5.4 GROUNDWATER CONDITIONS

A potentiometric map was developed to evaluate groundwater flow beneath AOC C2/C4. Water level gauging could not be performed at several of the wells that had been damaged or destroyed; therefore, historical gauging data were used to prepare the groundwater contours. The groundwater potentiometric surface and estimated flow direction measured are presented on Figure 5-4. Groundwater contours show that the direction of flow is to the southeast, with a horizontal gradient calculated at approximately 0.018 foot per foot (ft/ft). However, water was observed entering test pit excavations at shallow depths (1 to 3 feet bgs). This water may be perched within the debris that was buried in the wetlands to form AOC C2 and appears to be hydraulically connected to the adjacent surface water pond.

Slug test data were evaluated using the Bouwer & Rice Method (1976) for unconfined aquifers, as well as the Hvorslev Method (1951) for comparison (Appendix E). The hydraulic conductivity calculated for AP-024 using Bouwer & Rice was 0.0037 ft/day. This value appears to be low and not representative of the predominately silty sands with gravel observed at the site, as confirmed by the geotechnical results (Table 4-2), and across aquifer material site-wide. Additionally, the presence of debris would increase the hydraulic conductivity. Based on the site-specific geotechnical data collected, a lower range textbook conductivity value of 0.010 ft/day for silty sand was applied to AOC C2. This value, along with the estimated horizontal gradient, was used as input for calculating soil ACLs for AOC C2.

5.5 ANALYTICAL RESULTS

5.5.1 Soil

A total of ten soil samples collected from eight test pits at AOC C2 were submitted for laboratory analyses. These data were collected from the most highly contaminated soils to further characterize the NAPL source zone. Results show that nine of the ten samples had DRO concentrations above the Method Two cleanup level (230 mg/kg) ranging from 320 mg/kg to 19,000 mg/kg. RRO concentrations exceeding the Method Two cleanup level (8,300 mg/kg) were detected at concentrations ranging from 12,000 mg/kg to 86,000 mg/kg in three samples. In addition to DRO and RRO, benzene exceeded the Method Two cleanup level in C2-TP04 and 1-methylnaphthalene and 2-methylnaphthalene exceeded cleanup levels in C2-TP10. Soil analytical results for the samples collected in 2014 are presented in summary tables provided in Appendix J. Sample locations are shown on Figure 5-1 and a cross sectional view of the site showing the vertical extent of impacts is presented along A-A' as Figure 5-3.

Constituent data collected within the defined NAPL source zone were used to supplement the historical data set for characterization of the contaminant source. Historical and recent (2014) POL soil data evaluated for AOC C2 are presented in Table 5-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 5-2. Historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attention of these constituents. Historical and recent PAH soil data are summarized in Table 5-3, and VPH/EPH results are presented in Table 5-4. These data were used as input in calculating soil ACLs and to evaluate risk at AOC C2 using the HRC. Note that historical sediment data collected from the bank of the on-site pond were included in the soil data set for AOC C2 (Table 5-1 through Table 5-3).

5.5.2 Groundwater

Groundwater samples were collected from one temporary well (C2-WP01) installed inside the source zone at AOC C2 and one existing monitoring well (AP-024), located outside of the source zone. For AOC C2, surface water in the adjacent pond is considered to be hydraulically connected to groundwater present within the landfill debris (sampled at C2-WP01). Hydrocarbon odors and slight sheen were noted on the purge water from the temporary well. Analytical results indicate that RRO was detected above the Table C groundwater cleanup levels at C2-WP01. Analytical results are summarized in Appendix J. Current groundwater data and the most recent historical data (where 2014 data were not available) are considered to be representative of groundwater quality conditions at AOC C2 and were compared to the Table C groundwater cleanup levels (18 AAC 75). Constituent concentrations exceeding the cleanup levels at AOC C2 are presented in Figure 5-4.

Results for C2-WP01 and AP-024 were used to supplement historical groundwater data for AOC C2. Historical and recent (2014) groundwater results for POLs, PAHs and VPH/EPH are summarized in Table 5-5 through Table 5-7, respectively.

5.5.3 Surface Water and Sediment

SURFACE WATER

Surface water samples collected at the site included one adjacent to AOC C2 (C2-WS01), one considered downgradient adjacent to AOC C4 (C2-WS02), and three background samples (C2-WS03, C2-WS04, and C2-WS05) collected from a pond northeast of the site. These samples were analyzed for PCBs, total lead, dissolved lead, and hardness.

Dissolved lead data were compared to the hardness-dependent Alaska WQS. The WQS criteria were calculated separately for the two ponds by averaging the site-specific hardness associated with each pond. Hardness in the pond adjacent to AOC C2 ranged from 8 to 20 mg/L based on samples C2-WS01 and C2-WS02. To be conservative in the calculation, the lowest hardness for the triplicates at C2-WS01 (19 mg/L) was averaged with the hardness for C2-WS02 (8 mg/L), calculating an Alaska WQS lead value of 0.00027 mg/L. Hardness in the pond northeast of AOC C2 was consistently reported as 2 mg/L, calculating an Alaska WQS lead value of 0.000030 mg/L. The only dissolved lead detection was in the sample at the southwest edge of the onsite pond at a concentration of 0.00017J mg/L, below the calculated WQS. Background results for dissolved lead in samples were all not detected. However, the LOD for these samples (0.00025 mg/L) exceeds the Alaska WQS calculated based on a very low hardness level of 2 mg/L reported for this pond. Background samples were collected during a heavy precipitation event, which may have contributed to the low surface water hardness.

Total lead data were compared to the ADEC Table C groundwater standard of 0.015 mg/L. Total lead was detected in one sample location (C2-WS01) collected from the north extent of the pond adjacent to AOC C2 at a concentration (0.00029 J mg/L) below ADEC Table C. Background results for total lead in samples were all not detected.

PCBs were not detected in surface water above the corresponding LODs.

Analytical results are presented in a summary table in Appendix J, and results for constituents with detections (lead) are presented in Figure 5-5**.**

SEDIMENT

Five sediment samples co-located with the surface water sites were analyzed for lead and PCBs for comparison to the NOAA SQuiRT values. For purposes of this RI, the NOAA SQuiRT values are used as sediment screening levels and are not considered cleanup levels. Analytical results indicate that lead detections in sediment samples are below the NOAA SQuiRT value of 35 mg/kg ranging from 2.9 to 5.3 mg/kg. Lead was detected in all sediment samples and concentrations from the pond adjacent to AOC C2 are consistent with those detected in the pond representing background. The distribution of lead concentrations in sediment is consistent with a naturally occurring source.

PCBs (Aroclor 1260) were detected in one sample at a concentration of 0.028 QH mg/kg, which is below the NOAA SQuiRT value (0.0341 mg/kg). This detection was not confirmed in the primary laboratory field replicate or the QA triplicate sample and was flagged as biased high due to a calibration non-conformance.

Analytical results are presented in a summary table in Appendix J and lead results are presented in Figure 5-5**.**

5.6 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC C2; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

5.6.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet the ADEC “Cleanup Complete” criteria, the AOC C2 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion).

The AOC C2 risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at the site at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be incomplete at the present time, because there are no occupied buildings within 30 feet of the AOC C2 source area. There is currently no exposure to groundwater at the present time, because there are no known drinking water wells within the radius of influence at the site. The exposure pathways associated with surface water and sediment are considered insignificant since current data indicate that these media meet regulatory standards and/or screening guidance.

The AOC C2 exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented on the Human Health CSM Graphic Form in Appendix L.

5.6.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each BTEX constituent and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in Table 5-2 (only 2014 data are used to characterize the source area BTEX concentrations). The source area data set for benzene, ethylbenzene, total xylenes and GRO had a limited number of relatively low concentration detections, so the maximum detected values from the source area were used as exposure point concentrations. There were adequate data to calculate 95% UCLs for toluene, DRO, and RRO, so ProUCL was used to calculate 95% UCLs for the HRC input. ProUCL formatted outputs are displayed in Table 5-8a.

Table 5-9 presents the ProUCL outlier test results for DRO and RRO, and as shown, the test indicated that the highest DRO and RRO concentrations (19,000 mg/kg and 86,000 mg/kg respectively) were statistical outliers. However, these results were carried forward into the HRC. The inclusion of the outliers in the 95% UCL calculation will tend to increase the 95% UCL value relative to the population average (i.e., the 95% UCL becomes more conservative). A quantile-quantile (Q-Q) plot and box plot of the DRO and RRO source area data are presented in Figure 5-6a and Figure 5-6b, and Figure 5-6c and Figure 5-6d, respectively. Both the Q-Q and box plots show that the highest DRO and RRO concentrations graphed significantly above the other data, which also suggests that the highest DRO and RRO results were statistical outliers.

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 5-3. All of the PAH constituents were detected in the AOC C2 source area. The maximum benzo(a)pyrene concentrations presented significant risk, so a 95% UCL was calculated (Table 5-8b.) and used as the exposure point concentration in the risk evaluation. The maximum detected concentrations for the remaining PAHs did not present significant risk; therefore, the maximum detected PAH concentrations were used as the exposure point concentrations in the risk calculations.

Ten VPH and EPH source area samples were used to characterize the bulk hydrocarbon chemistry. The HRC input values calculated from the source area VPH/EPH data are shown in Table 5-4.

The source of each HRC soil exposure point input value is documented in Table 5-10a.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

Benzene was not detected, so the maximum LOD for the sample collected from the source area well was used as the exposure point concentration. Toluene, ethylbenzene, xylene, GRO, DRO and RRO were detected; therefore, the maximum detected concentration was used as input to the HRC. In addition, the maximum GRO, DRO and RRO aromatic and aliphatic concentrations (derived from the VPH/EPH test results) were used as input to the HRC.

All of the non-carcinogenic PAHs were detected in the AOC C2 source area well, so the maximum concentrations from the 2014 sampling event were used as the exposure point concentrations. For the carcinogenic PAHs in general, and for benzo(a)pyrene and dibenz(a,h)anthracene in particular, typical groundwater LODs can be close to or above groundwater ingestion risk-based concentrations. Therefore, for the carcinogenic PAHs, the groundwater concentrations predicted or modeled by the HRC based on the soil concentration data are used as input to the risk calculations to yield more representative risk results. Since the carcinogenic PAHs were not detected in the source area well, the predicted groundwater concentrations modeled from the soils data were used as the exposure point concentrations.

The source of each HRC groundwater exposure point input value is documented in Table 5-10a.

5.6.3 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to AOC C2 is presented in Table 5-10b.

5.6.4 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results is included as Table N-1 of Appendix N and the risk posed by the site conditions is summarized in Table 5-11 and Table 5-12. Table N-1 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for AOC C2 indicate that site conditions exceed the ADEC human health risk standard established in 18 AAC 75.325 resulting in unacceptable risk. HRC results show that the risk posed by the RRO aromatic fraction exceeds the risk standard for the soil ingestion pathway and the risk standard for the groundwater ingestion pathway, assuming a residential land use scenario. The phase partitioning calculations indicate that the RRO aromatics in the groundwater exceed the risk standard due to the presence of NAPL in the groundwater sample.

Additional risk calculation results and exposure pathways evaluated for AOC C2 meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).
- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.
- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, site conditions at AOC C2 are not protective of human health under an unrestricted (residential) land use scenario.

Since unacceptable risk has been calculated for a future residential scenario, the risk to a site visitor that is representative of the current land use pattern (such as a recreational user) has been evaluated. This risk calculation assumes a site visitor would be present on the source area, in contact with soil, 24 hours a day (e.g. camping on the source) for a period of 30 days each year for 30 years. Input and output for calculating site visitor risk is provided in Table 5-13. The results indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325 for the specified site visitor scenario.

5.7 ALTERNATIVE CLEANUP LEVELS

Constituents and/or hydrocarbon fractions exceeding ADEC Method Two cleanup levels at AOC C2 include benzene, 1-methylnaphthalene, 2-methylnaphthalene, DRO and RRO. The unacceptable risk is caused by the RRO aromatics via the soil ingestion and groundwater ingestion pathways. Soil ACLs have been developed for these constituents and/or hydrocarbon fractions as shown in Table 5-14.

Benzene, 1-methylnaphthalene, 2-methylnaphthalene, DRO and RRO exceed the Method Two migration to groundwater cleanup levels. However, the migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult's Law) and dilution-attenuation calculations are applied, the AOC C2 exposure point concentrations meet the migration to groundwater criteria. Under these conditions, it is typically not necessary to calculate ACLs, but for this contract ACLs have been back calculated for site COPCs and are presented in Table 5-14. The exposure point concentrations are less than the calculated ACLs using the HRC, which demonstrates that the site meets the ADEC migration to groundwater criteria.

As described above, the unacceptable risk is caused by the RRO aromatics via the soil ingestion and groundwater ingestion pathways. The soil ingestion risk based RRO aromatics cleanup level is 2,489 mg/kg and given that the RRO is about 25% aromatics, the total RRO soil ingestion risk-based cleanup level is 10,033 mg/kg. Three discrete sample locations (C2-TP07, C2-TP08 and C2-TP10) at AOC C2 have concentrations exceeding this ACL which appear to be contiguous (Figure 5-7). Soil concentrations exceeding the HRC ACL are presented in Table 5-15.

5.8 ENVIRONMENTAL/ECOLOGICAL RISK EVALUATION

Ecological risk at AOC C2 was evaluated and a preliminary ecological CSM was developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at AOC C2 are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.
- Petroleum hydrocarbons in surface soil cover 0.24 acre, which is less than the ADEC 0.5 acre *de minimis* criterion. In addition, the overall area (the combined AOC C4 and AOC C2) is approximately 0.27 acres, still well below the *de minimis* criterion. Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.
- Historically, PCBs were detected in surface soil (E&E 1997). However, the results for PCBs appear to be an artifact of analytical imprecision and unknown bias. Sampling conducted in 2000 and reported by ENSR (2003a) sought to confirm these results but in fact indicated no detections of PCBs or other organochlorine compounds in surface soil throughout the site. Exposure from these compounds is not expected and is not considered further for soil exposure.
- Shallow (perched) groundwater from the temporary well installed in the NAPL-contaminated soil source area, which likely discharges to the adjacent pond, meets the total aromatic hydrocarbon (TAH) and total aqueous hydrocarbon (TAqH) Alaska WQS criteria. Additionally, pond surface water meets the TAH and TAqH Alaska WQS criteria.
- A single PCB detection in a pond sediment sample is at a concentration below NOAA SQuiRT screening criteria. The result was qualified as biased high and PCBs were not detected in a corresponding duplicate sample.
- All detections of lead in sediment are below the NOAA SQuiRT screening criteria. Distributions of concentrations between the site and background ponds are consistent with a naturally occurring source of lead.
- A single dissolved lead detection in pond surface water is at a concentration below the Alaska WQS most stringent (chronic) criterion calculated using site-specific hardness data.
- Risk to the environment has been evaluated using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation is not needed and AOC C2 site conditions are protective of the environment.

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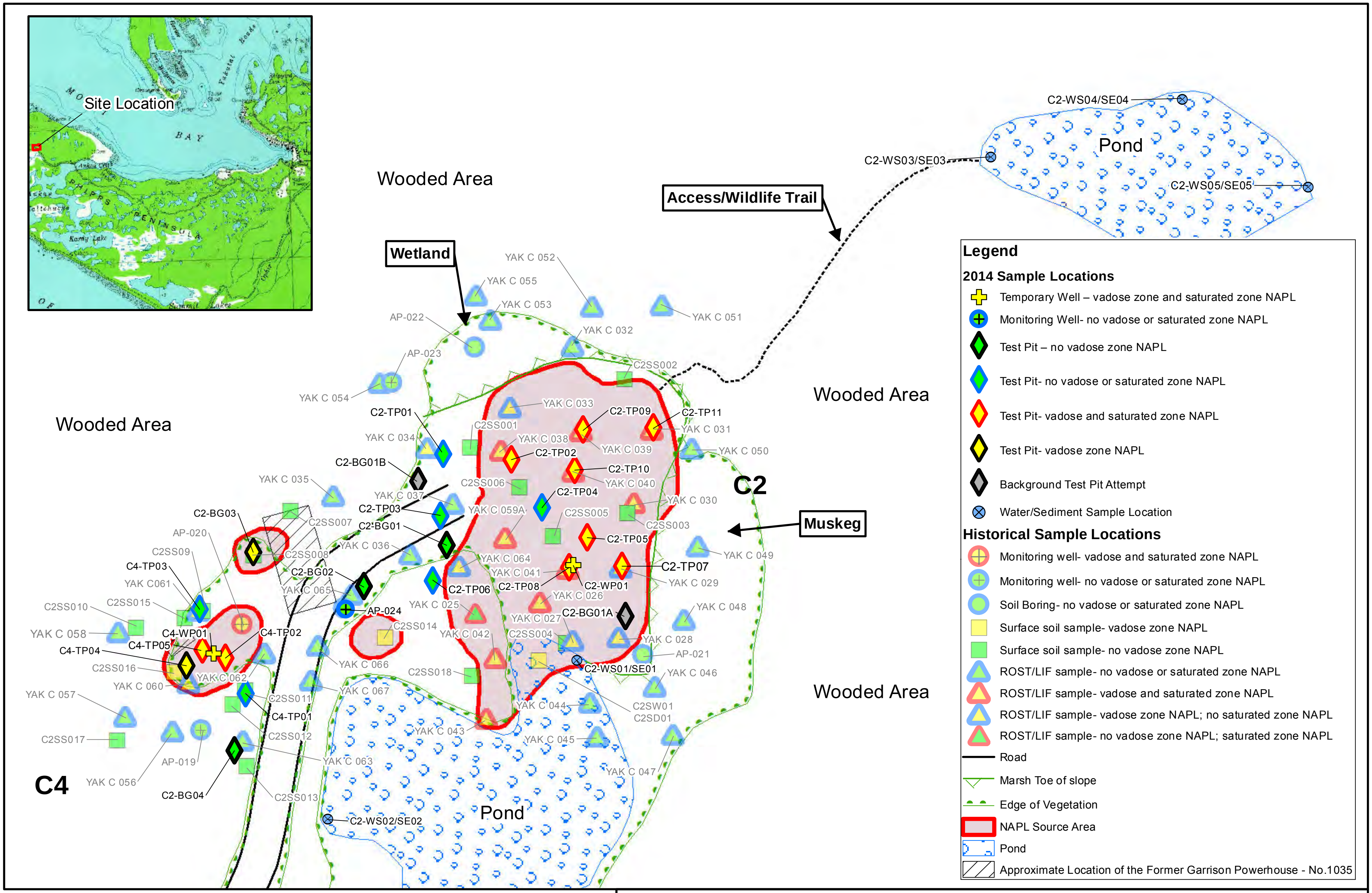

N
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FIGURE 5-1

AOCs C2 and C4
NAPL Source Areas and Sample Locations

US Army Corps
of Engineers
Alaska District

0 25 50
Feet
1 in = 59 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

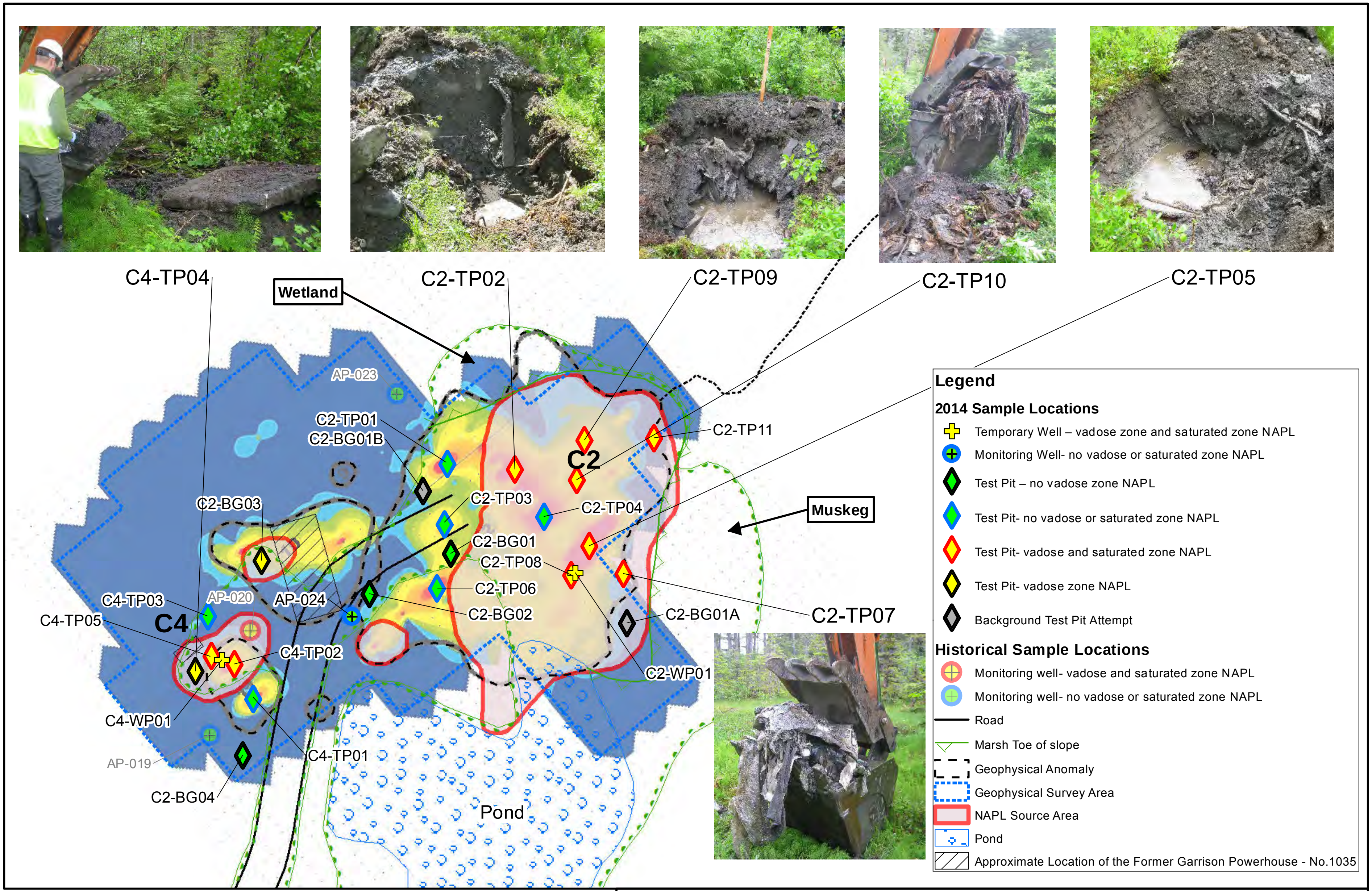


FIGURE 5-2

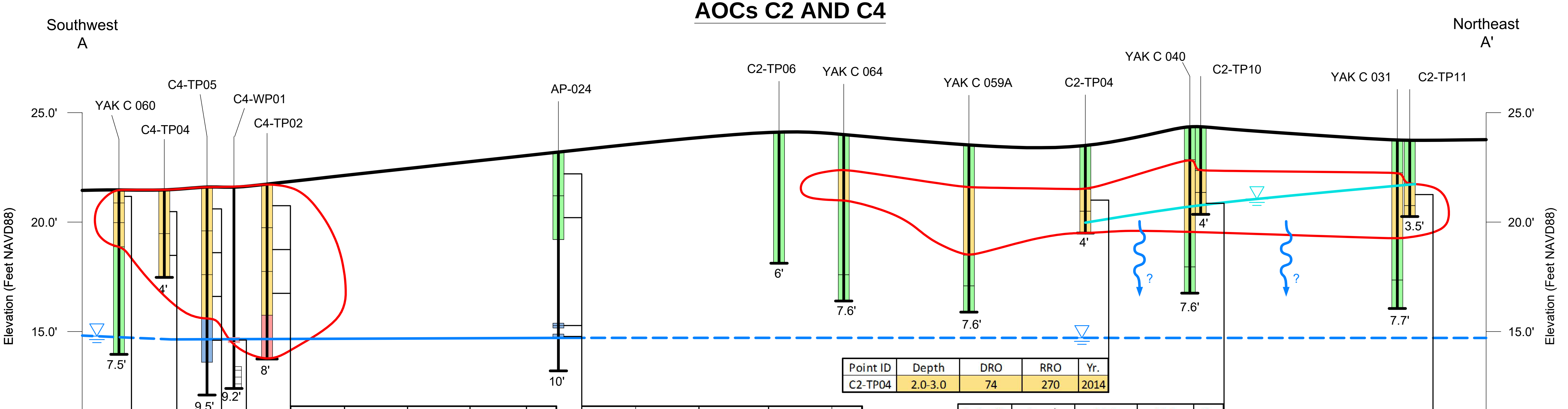
AOCs C2 and C4
Test Pit Locations and Observations

US Army Corps
of Engineers
Alaska District

0 25 50 Feet
1 in = 60 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

AOCs C2 AND C4



Point ID	Depth	DRO	RRO	Yr.
C4-TP02	2.0-4.0	310	62	2014
	4.0-6.0	910	200	2014
	6.0-8.0	420	85	2014

Point ID	Depth	DRO	RRO	Yr.
C4-WP01	8.89 (DTW)	2.1 mg/L	0.29 mg/L	2014

Point ID	Depth	DRO	RRO	Yr.
C4-TP05	0.0-2.0	4,100	1,200	2014
	2.0-4.0	7,300 J	3,600 J	2014
	4.0-6.0	1,200	46 J	2014
	6.0-8.0	170	26 J	2014

Point ID	Depth	DRO	RRO	Yr.
C4-TP04	0.0-2.0	1,000	860	2014
	2.0-4.0	550	250	2014

Point ID	Depth	DRO	RRO	Yr.
Yak C 060	0.5-1.5	1,720	656	2005

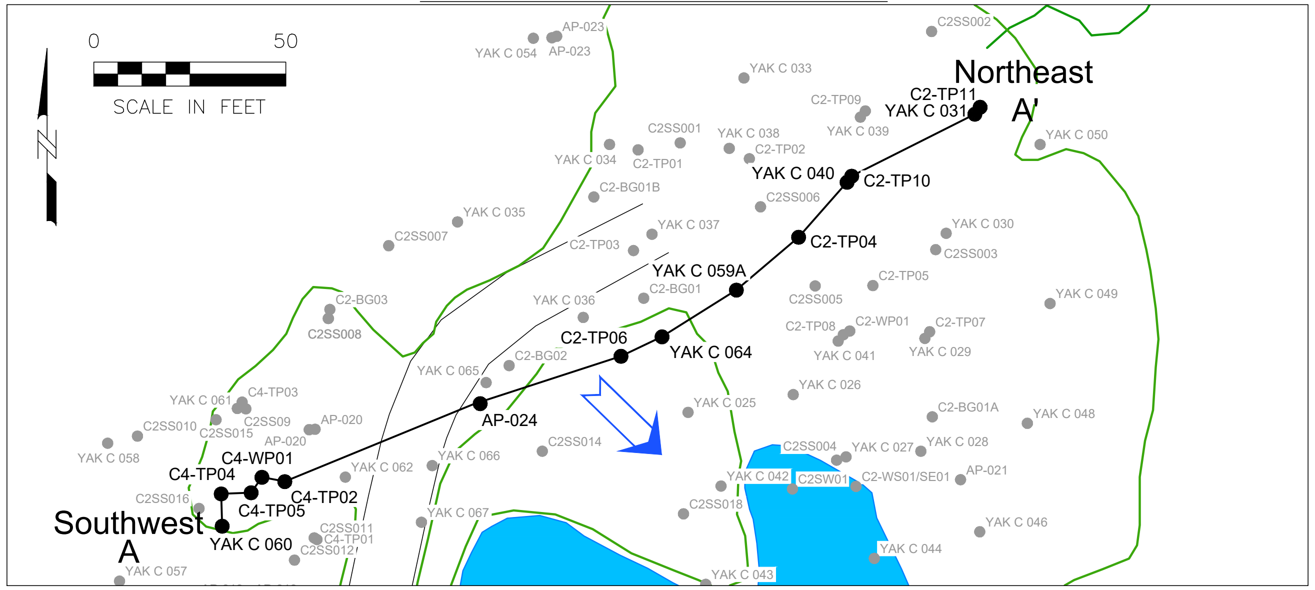
Point ID	Depth	DRO	RRO	Yr.
AP-024	0.0-2.0	ND	ND	2000
	2.0-4.0	ND	ND	2000
	11.20 (DTW)	0.064 J mg/L	NA	2000
	11.70 (DTW)	0.063 J mg/L	0.04 J mg/L	2014

Point ID	Depth	DRO	RRO	Yr.
C2-TP04	2.0-3.0	74	270	2014

Point ID	Depth	DRO	RRO	Yr.
C2-TP10	3.0-4.0	19,000	86,000	2014

Point ID	Depth	DRO	RRO	Yr.
C2-TP11	2.0-3.0	1,400 MN	6,700	2014

CROSS SECTION INDEX



LEGEND

🟩 NO VADOSE ZONE NAPL

🟨 VADOSE ZONE NAPL

🟦 NO SATURATED ZONE NAPL

🟥 SATURATED ZONE NAPL

▽ 2014 GROUNDWATER TABLE

▽ PERCHED WATER

? CONNECTION BETWEEN PERCHED WATER AND GROUNDWATER TABLE UNKNOWN

⇨ GROUNDWATER FLOW DIRECTION

— ESTIMATED VERTICAL EXTENT OF NAPL SOURCE ZONE

▤ SCREEN INTERVAL

Notes
Depth = feet below ground surface
DRO = diesel range organics
DTW = depth to water below ground surface
mg/kg = milligram per kilogram
mg/L = milligram per liter
NA = not analyzed
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
ND = not detected
ROST = rapid optical screening tool
RRO = residual range organics
Yr. = year sample was collected

All DRO and RRO results are in mg/kg unless otherwise noted on the figure. See Appendix J for result qualifiers.

Location IDs beginning with YAK identify historical ROST borings. ROST results with percent reference emitter limits >1% are considered to be above the NAPL threshold (>230 mg/kg for DRO and RRO).

5
2.5
0
0 10 20
SCALE IN FEET
(VERT. EX. = 4)

Figure: 5-3

CROSS SECTION A-A'
AOCs C2 AND C4

U.S. Army
Corps of Engineers
Alaska District

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 01/16/15

Last saved by: SCHWARTZE(2016-03-29) Last Plotted: 2016-03-29
Filename: L:\GROUP\CAD\YAKUTAT AFB\FIGURES\YAK_FIG_5-3_A-A' C2_C4.DWG

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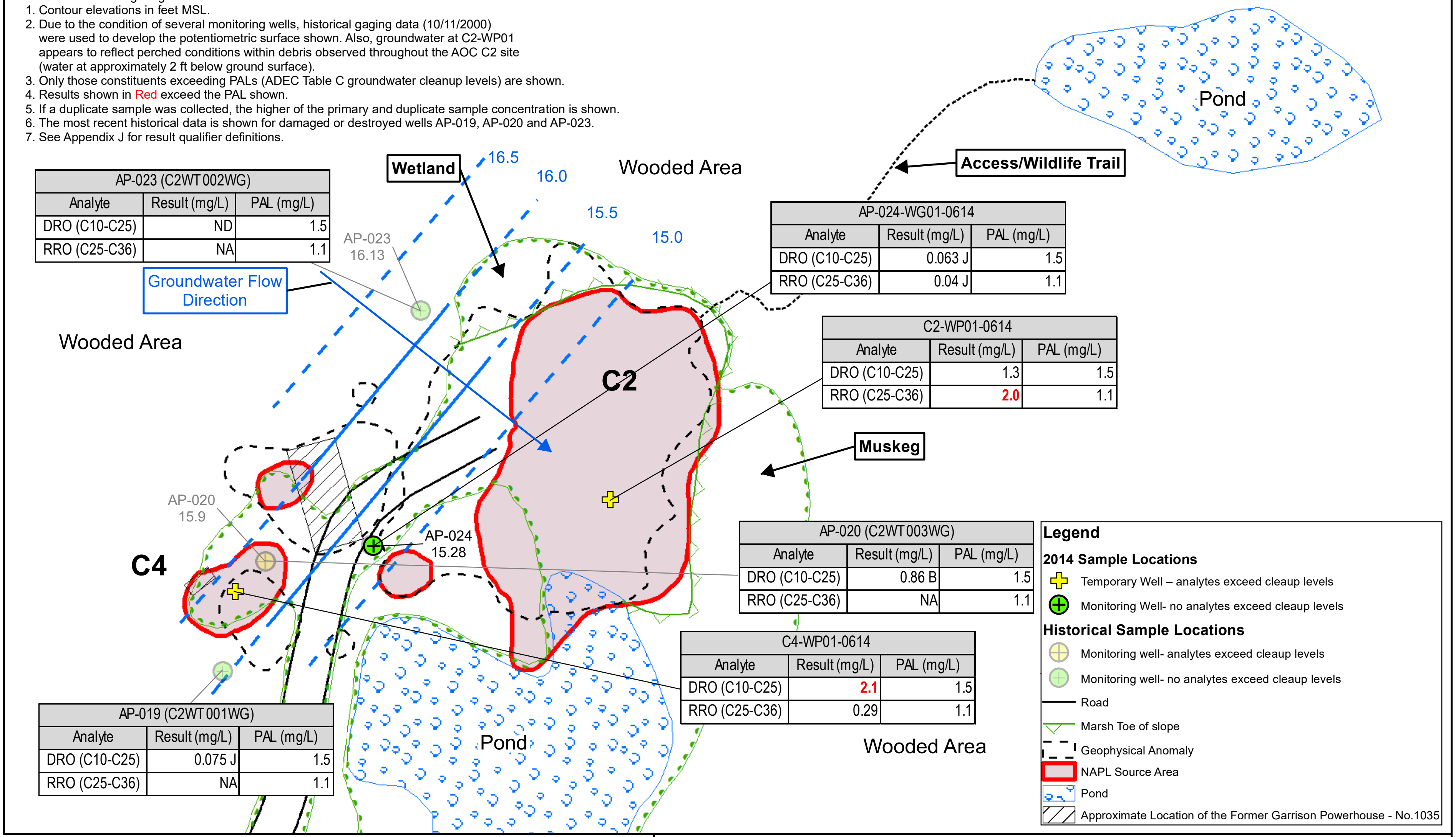
Notes:
DRO – diesel range organics
mg/L – milligrams per liter
NA - not analyzed
ND – analyte not detected
PAL – Project Action Limit
RRO – residual range organics

1. Contour elevations in feet MSL.
2. Due to the condition of several monitoring wells, historical gaging data (10/11/2000) were used to develop the potentiometric surface shown. Also, groundwater at C2-WP01 appears to reflect perched conditions within debris observed throughout the AOC C2 site (water at approximately 2 ft below ground surface).
3. Only those constituents exceeding PALs (ADEC Table C groundwater cleanup levels) are shown.
4. Results shown in Red exceed the PAL shown.
5. If a duplicate sample was collected, the higher of the primary and duplicate sample concentration is shown.
6. The most recent historical data is shown for damaged or destroyed wells AP-019, AP-020 and AP-023.
7. See Appendix J for result qualifier definitions.



AP-023 (C2WT002WG)		
Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	ND	1.5
RRO (C25-C36)	NA	1.1

AP-024-WG01-0614		
Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.063 J	1.5
RRO (C25-C36)	0.04 J	1.1

C2-WP01-0614		
Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	1.3	1.5
RRO (C25-C36)	2.0	1.1

AP-020 (C2WT003WG)		
Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.86 B	1.5
RRO (C25-C36)	NA	1.1

C4-WP01-0614		
Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	2.1	1.5
RRO (C25-C36)	0.29	1.1

AP-019 (C2WT001WG)		
Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.075 J	1.5
RRO (C25-C36)	NA	1.1

Legend

2014 Sample Locations
✚ Temporary Well – analytes exceed cleaup levels
⊕ Monitoring Well- no analytes exceed cleaup levels

Historical Sample Locations
⊕ Monitoring well- analytes exceed cleaup levels
⊕ Monitoring well- no analytes exceed cleaup levels
— Road
Marsh Toe of slope
Geophysical Anomaly
🟥 NAPL Source Area
Pond
▨ Approximate Location of the Former Garrison Powerhouse - No.1035

N
W E
S

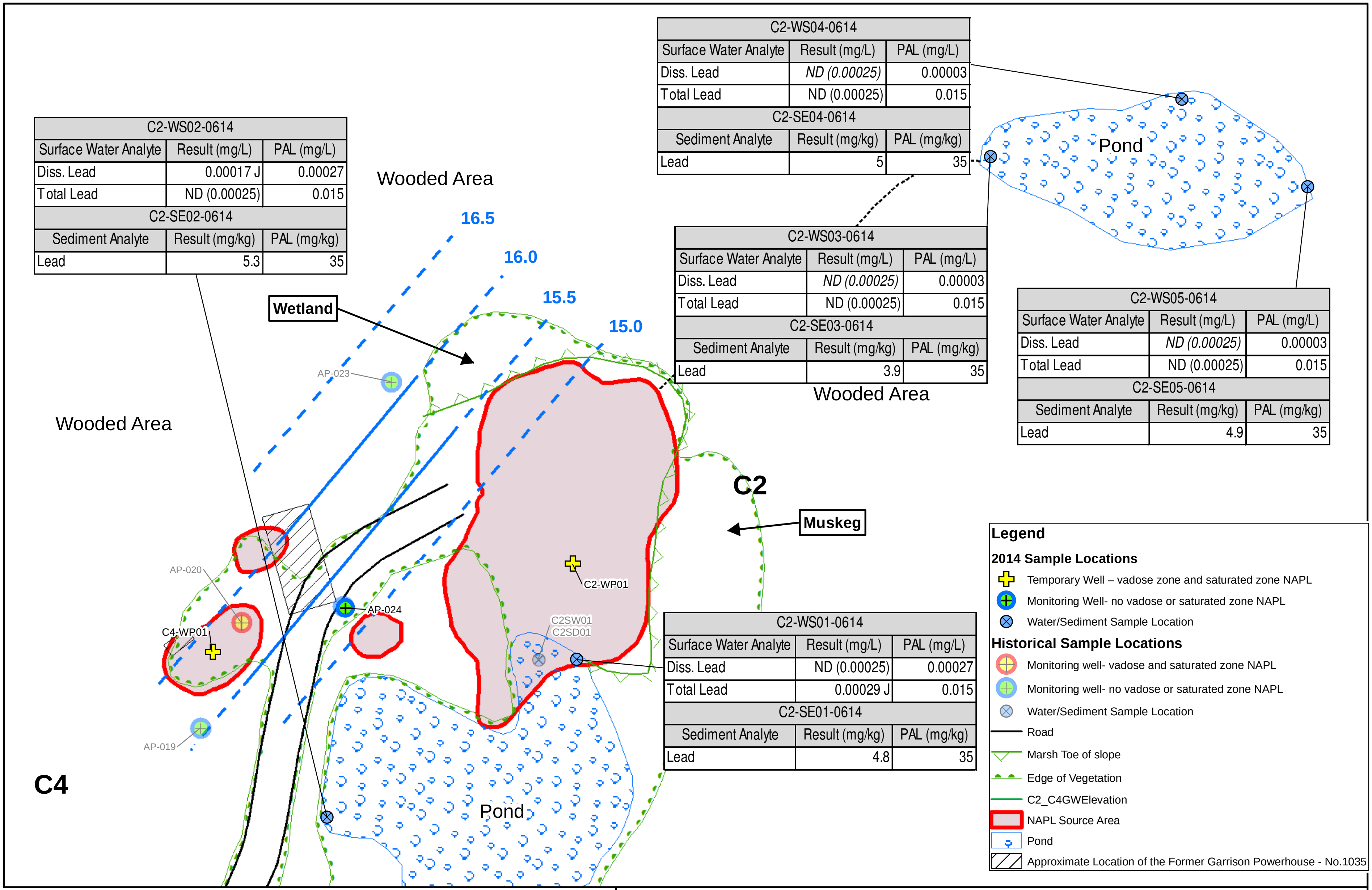
FIGURE 5-4

AOCs C2 and C4
Groundwater Analytical Results

US Army Corps
of Engineers
Alaska District

0 25 50 Feet
1 in = 60 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 3/29/2016



C2-WS04-0614		
Surface Water Analyte	Result (mg/L)	PAL (mg/L)
Diss. Lead	*ND (0.00025)*	0.00003
Total Lead	ND (0.00025)	0.015
C2-SE04-0614		
Sediment Analyte	Result (mg/kg)	PAL (mg/kg)
Lead	5	35

C2-WS02-0614		
Surface Water Analyte	Result (mg/L)	PAL (mg/L)
Diss. Lead	0.00017 J	0.00027
Total Lead	ND (0.00025)	0.015
C2-SE02-0614		
Sediment Analyte	Result (mg/kg)	PAL (mg/kg)
Lead	5.3	35

C2-WS03-0614		
Surface Water Analyte	Result (mg/L)	PAL (mg/L)
Diss. Lead	*ND (0.00025)*	0.00003
Total Lead	ND (0.00025)	0.015
C2-SE03-0614		
Sediment Analyte	Result (mg/kg)	PAL (mg/kg)
Lead	3.9	35

C2-WS05-0614		
Surface Water Analyte	Result (mg/L)	PAL (mg/L)
Diss. Lead	*ND (0.00025)*	0.00003
Total Lead	ND (0.00025)	0.015
C2-SE05-0614		
Sediment Analyte	Result (mg/kg)	PAL (mg/kg)
Lead	4.9	35

C2-WS01-0614		
Surface Water Analyte	Result (mg/L)	PAL (mg/L)
Diss. Lead	ND (0.00025)	0.00027
Total Lead	0.00029 J	0.015
C2-SE01-0614		
Sediment Analyte	Result (mg/kg)	PAL (mg/kg)
Lead	4.8	35

Legend

2014 Sample Locations
- Temporary Well – vadose zone and saturated zone NAPL
- Monitoring Well- no vadose or saturated zone NAPL
- Water/Sediment Sample Location

Historical Sample Locations
- Monitoring well- vadose and saturated zone NAPL
- Monitoring well- no vadose or saturated zone NAPL
- Water/Sediment Sample Location
- Road
- Marsh Toe of slope
- Edge of Vegetation
- C2_C4GWElevation
- NAPL Source Area
- Pond
- Approximate Location of the Former Garrison Powerhouse - No.1035

Notes:
mg/kg – milligrams per kilogram
mg/L – milligrams per liter
ND – analyte not detected above the detection limit shown in ( )
PAL - project action limit
1. Surface water PAL derived from ADEC Table C drinking water standard for total lead and hardness-dependant Alaska Water Quality Standard (chronic) for dissolved lead.
2. Sediment PAL derived from NOAA SQUIRTS (most stringent of threshold and probable effect level).
3. Italics indicate the ND value exceeds the PAL.
4. See Appendix J for result qualifier definitions.

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S

FIGURE 5-5

AOCs C2 and C4
Surface Water and Sediment Analytical Results

US Army Corps
of Engineers
Alaska District

0 25 50
Feet
1 in = 59 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

FIGURE 5-6a: AOC C2 DRO Q-Q Plot

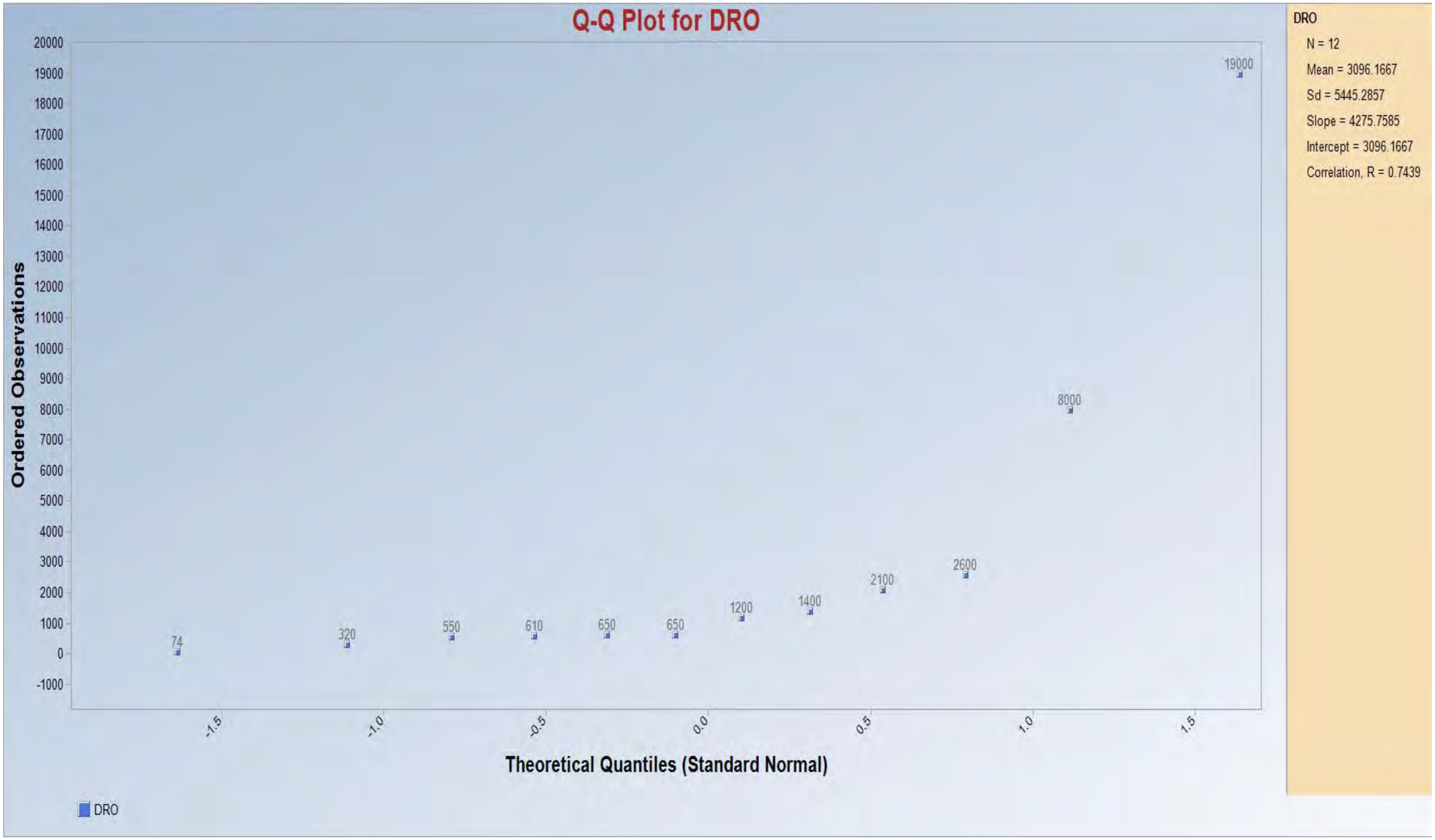


FIGURE 5-6b: AOC C2 DRO Box Plot

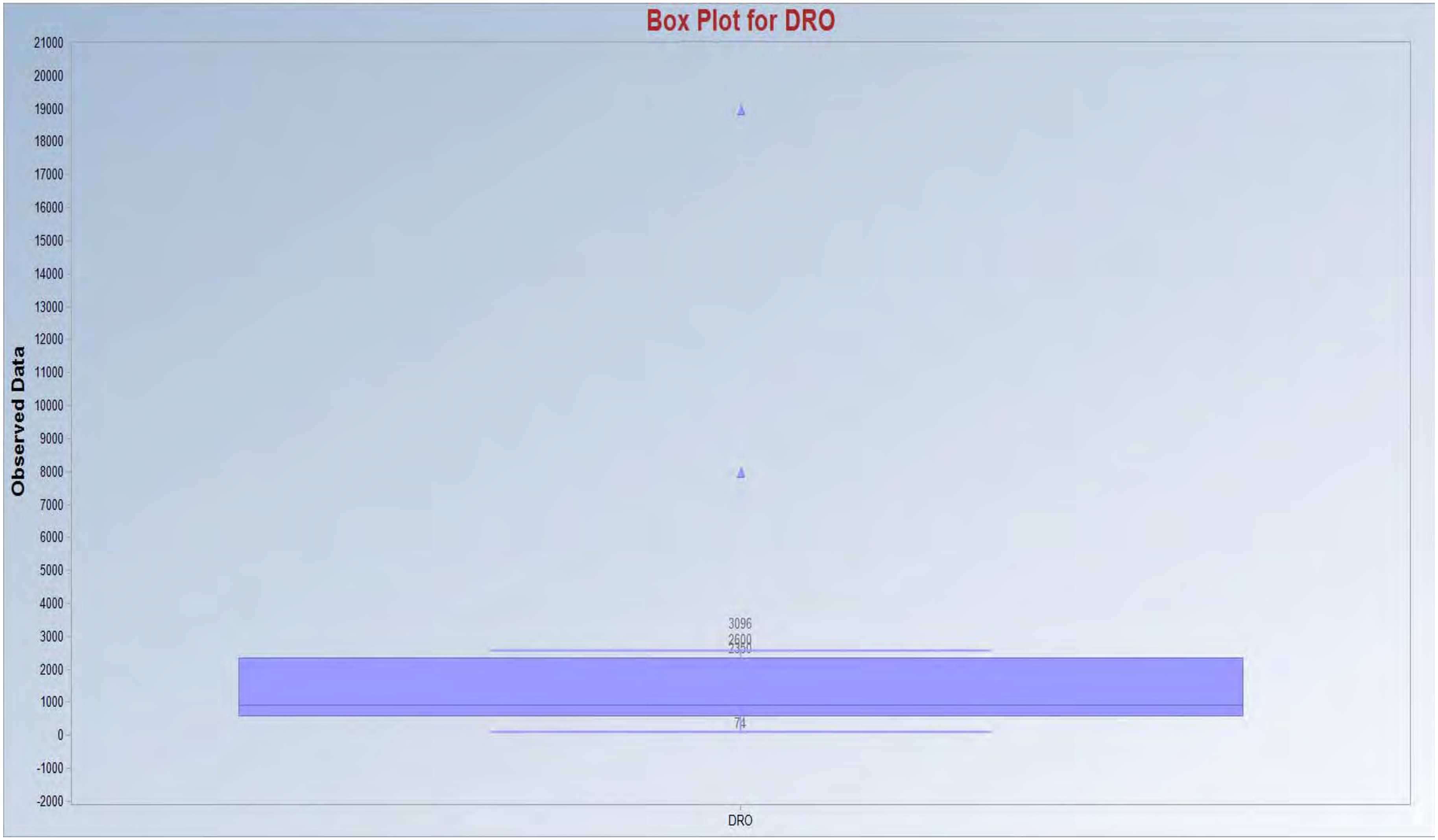


FIGURE 5-6c: AOC C2 RRO Q-Q Plot

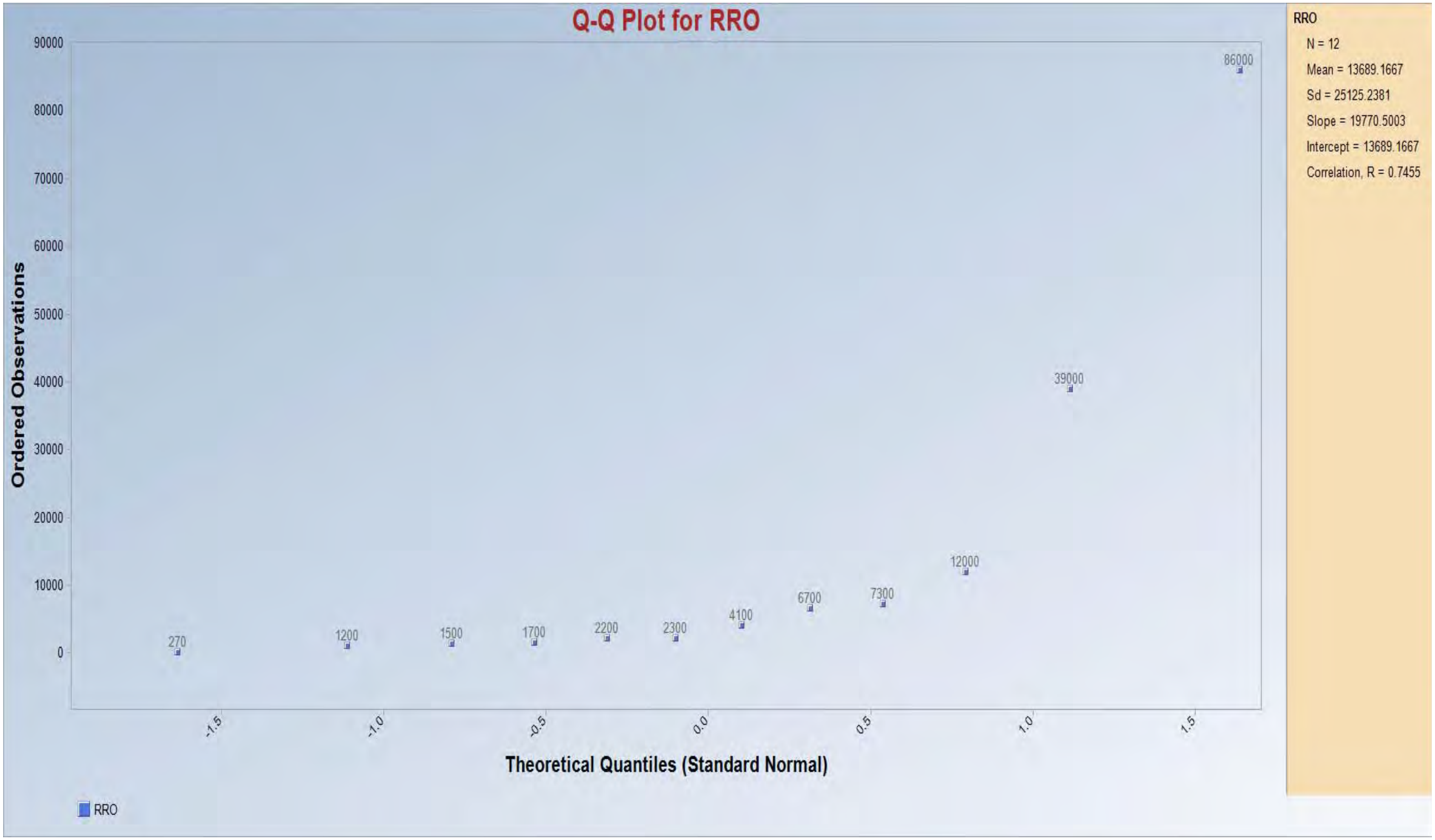
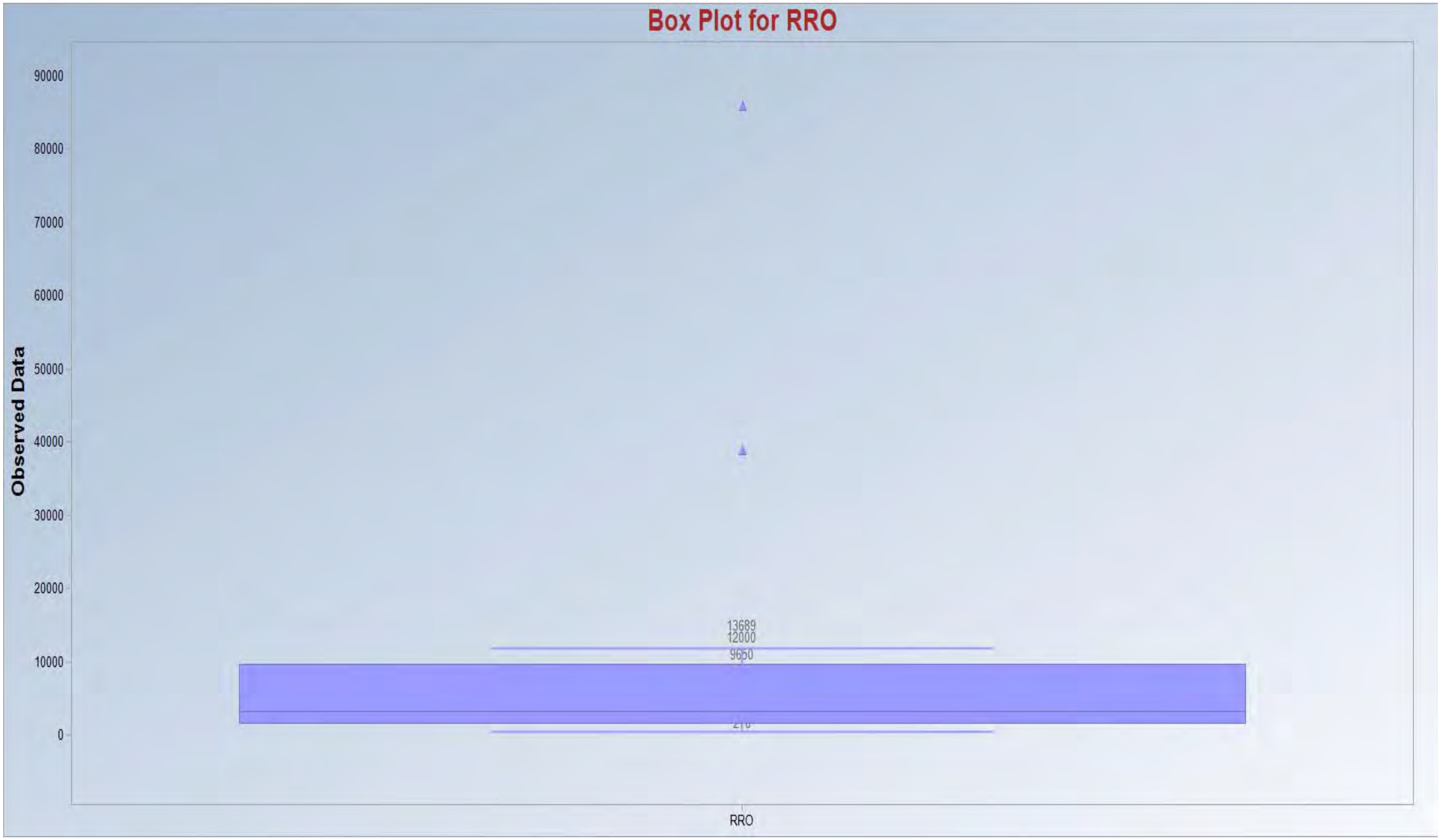


FIGURE 5-6d: AOC C2 RRO Box Plot



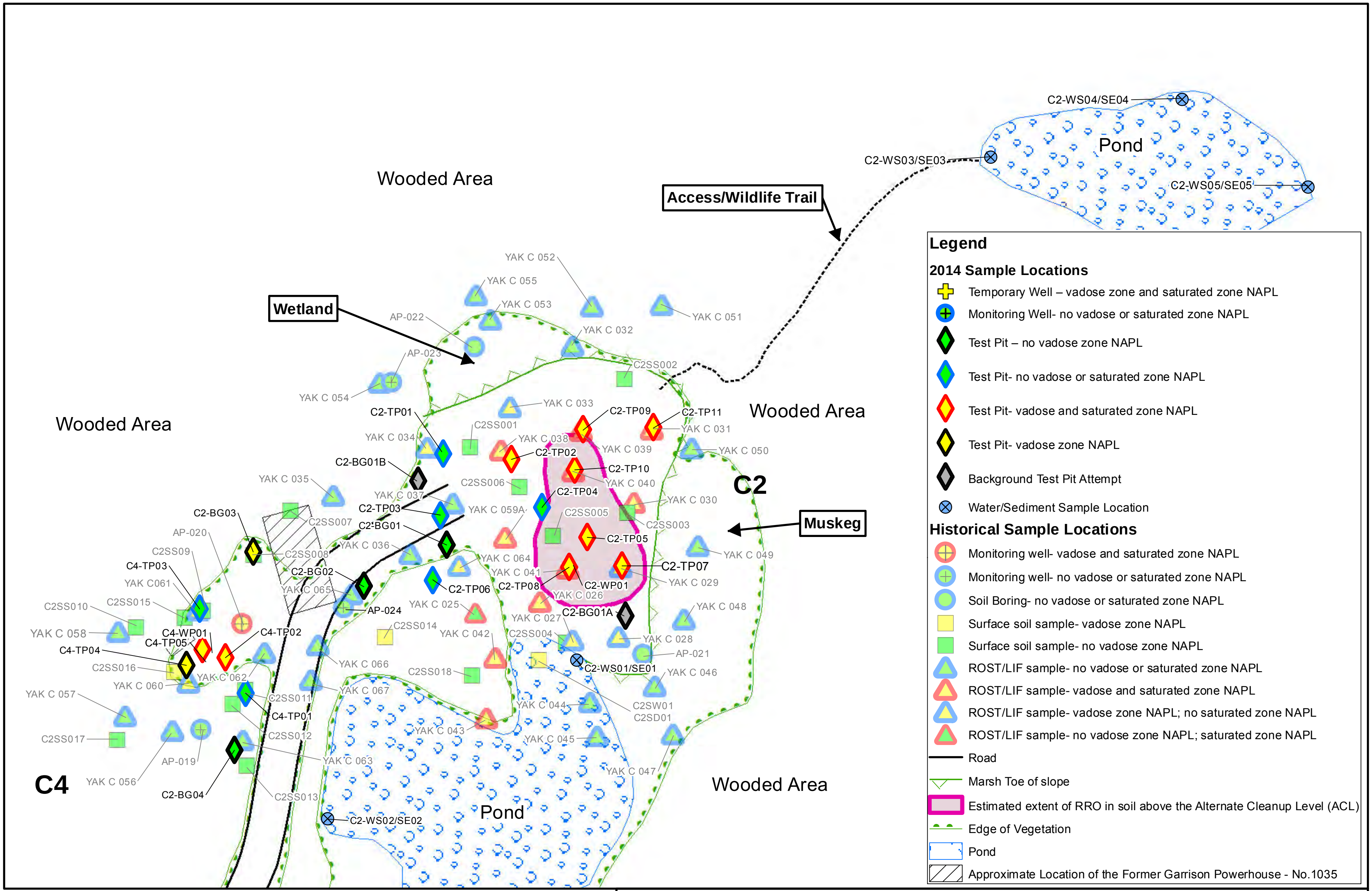


FIGURE 5-7

AOCs C2 and C4
RRO Concentrations in Soil Above the ACL

US Army Corps
of Engineers
Alaska District

0 25 50
Feet
1 in = 59 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

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Table 5-1: AOC C2 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
C2	AP-021	0-2	9/24/2000	00C2B3005SO	<1 U	<21 U	**28 J**	--	--	--	--
C2	AP-021	2-3	9/24/2000	00C2B3006SO	<1 U	<19 U	<19 U	--	--	--	--
C2	AP-022	0-2	9/24/2000	00C2B4007SO	<1 U	<20 U	<20 U	--	--	--	--
C2	AP-022	2-4	9/24/2000	00C2B4008SO	<1 U	<18 U	<17 U	--	--	--	--
C2	AP-023	0-2	9/26/2000	00C2B5009SO	<1 U	<18 U	<18 U	--	--	--	--
C2	AP-023	2-2	9/26/2000	00C2B7010SO	<1 U	<19 U	<19 U	--	--	--	--
C2	AP-023	2-4	9/26/2000	00C2B5011SO	<1 U	<18 U	<18 U	--	--	--	--
C2	AP-024	0-2	9/27/2000	00C2B6012SO	<1 U	<17 U	<17 U	--	--	--	--
C2	AP-024	2-4	9/27/2000	00C2B6013SO	<1 U	<18 U	<17 U	--	--	**0.001**	--
C2	C2-BG01	1-2.5	6/11/2014	C2-BG01-1.0-2.5-0614	<3.4 U	**41**	**140**	--	--	--	--
C2	C2-BG01	3-4	6/11/2014	C2-BG01-3.0-4.0-0614	<2.5 U	**4.8 J**	**12 J**	--	--	--	--
C2	C2-BG02	0-2	6/11/2014	C2-BG02-0.0-2.0-0614	<2.8 U	**9 J**	**28 J**	--	--	--	--
C2	C2-BG02	2-3	6/11/2014	C2-BG02-2.0-3.0-0614	**4.1**	**6.8 J**	**14 J**	--	--	--	--
C2	C2SS001	0-0	10/3/2000	00C2SS001SO	<0.79 U	<18 U	**36 B**	<0.00021 U	<0.00021 U	<0.00021 U	<0.00062 U
C2	C2SS002	0-0	10/3/2000	00C2SS002SO	<0.97 U	<21 U	<20 U	<0.00024 U	<0.00024 U	<0.00024 U	<0.00072 U
C2	C2SS003	0-0	10/3/2000	00C2SS003SO	<0.87 U	<20 U	<20 U	<0.00022 U	<0.00022 U	<0.00022 U	<0.00065 U
C2	C2SS004	0-0	10/3/2000	00C2SS004SO	<0.91 U	<19 U	<19 U	<0.00021 U	**0.0018**	<0.00021 U	**0.0049**
C2	C2SS005	0-0	10/3/2000	00C2SS005SO	<0.83 U	<18 U	<18 U	<0.00023 U	<0.00023 U	<0.00023 U	<0.00069 U
C2	C2SS006	0-0	10/3/2000	00C2SS006SO	<0.84 U	**52 B**	**150**	<0.00021 U	<0.00021 U	<0.00021 U	<0.00063 U
C2	C2SS014	0-0	10/4/2000	00C2SS014SO	<0.97 U	**1200 B**	**7300**	**0.00022 J**	<0.00021 U	<0.00021 U	<0.00062 U
C2	C2SS018	0-0	10/4/2000	00C2SS018SO	<0.83 U	<17 U	<17 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.00059 U
C2	C2SS019	0-0	10/3/2000	00C2SS019SO	<0.8 U	**52 B**	**100**	<0.00026 U	<0.00026 U	**0.00026 J**	<0.00077 U
C2	C2SS021	0-0	10/4/2000	00C2SS021SO	**1 J**	**21 J**	**54 B**	<0.00025 U	<0.00025 U	<0.00025 U	<0.00075 U
C2	C2-TP02	0-2	6/9/2014	C2-TP02-0.0-2.0-0614	**3.7 J**	**650**	**1500**	<0.011 U	<0.011 U	**0.029 J**	<0.022 U
C2	C2-TP04	2-3	6/9/2014	C2-TP04-2.0-3.0-0614	<3.4 U	**74**	**270**	**0.035**	**0.0067 J**	**0.34**	**0.04 J**
C2	C2-TP05	2-4	6/9/2014	C2-TP05-2.0-4.0-0614	**21 QH**	**2100**	**2200**	<0.013 U	**0.025 J**	**0.045 J**	**0.133**
C2	C2-TP07	1-2	6/9/2014	C2-TP07-1.0-2.0-0614	**3 J**	**650**	**4100**	<0.014 U	**0.0042 J**	**0.015 J**	**0.043 J**
C2	C2-TP07	2-3	6/9/2014	C2-TP07-2.0-3.0-0614	**19**	**8000**	**39000**	<0.018 U	**0.63**	**0.024 J**	**2.4073 , J**
C2	C2-TP08	1-2	6/9/2014	C2-TP08-1.0-2.0-0614	**12**	**320**	**1200**	<0.012 U	**0.0058 J**	**0.049 J**	**0.0255 J**
C2	C2-TP08	2-3	6/9/2014	C2-TP08-2.0-3.0-0614	**2.6 J**	**2600**	**12000**	<0.013 U	**0.011 J**	**0.074**	**0.0696 J**
C2	C2-TP09	3-4	6/10/2014	C2-TP09-3.0-4.0-0614	**2.7 J**	**550**	**1700**	<0.012 U	**0.022 J**	**0.099**	**0.087 J**
C2	C2-TP10	3-4	6/10/2014	C2-TP10-3.0-4.0-0614	**73 J**	**19000**	**86000**	<0.017 U	**0.28**	**0.16**	**28.8 J,**
C2	C2-TP11	2-3	6/10/2014	C2-TP11-2.0-3.0-0614	<2.7 U	**1400 MN**	**6700**	<0.011 U	**0.0057 MH**	**0.046 MH**	**0.0176 MH**
C2	CSD001	0-0	10/5/2000	00C2SD001SE	<8.6 U	**610 B**	**2300 B**	<0.0023 U	<0.0023 U	<0.0023 U	**0.0139 J**
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					73	19000	86000	0.035	0.63	0.34	28.8
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 5-2: AOC C2 Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
C2	C2SS014	0-0	10/4/2000	00C2SS014SO	<0.97 U	**1200 B**	**7300**	--	--	--	--
C2	C2-TP02	0-2	6/9/2014	C2-TP02-0.0-2.0-0614	**3.7 J**	**650**	**1500**	<0.011 U	<0.011 U	**0.029 J**	<0.022 U
C2	C2-TP04	2-3	6/9/2014	C2-TP04-2.0-3.0-0614	<3.4 U	**74**	**270**	**0.035**	**0.0067 J**	**0.34**	**0.04 J**
C2	C2-TP05	2-4	6/9/2014	C2-TP05-2.0-4.0-0614	**21 QH**	**2100**	**2200**	<0.013 U	**0.025 J**	**0.045 J**	**0.133**
C2	C2-TP07	1-2	6/9/2014	C2-TP07-1.0-2.0-0614	**3 J**	**650**	**4100**	<0.014 U	**0.0042 J**	**0.015 J**	**0.043 J**
C2	C2-TP07	2-3	6/9/2014	C2-TP07-2.0-3.0-0614	**19**	**8000**	**39000**	<0.018 U	**0.63**	**0.024 J**	**2.4073 , J**
C2	C2-TP08	1-2	6/9/2014	C2-TP08-1.0-2.0-0614	**12**	**320**	**1200**	<0.012 U	**0.0058 J**	**0.049 J**	**0.0255 J**
C2	C2-TP08	2-3	6/9/2014	C2-TP08-2.0-3.0-0614	**2.6 J**	**2600**	**12000**	<0.013 U	**0.011 J**	**0.074**	**0.0696 J**
C2	C2-TP09	3-4	6/10/2014	C2-TP09-3.0-4.0-0614	**2.7 J**	**550**	**1700**	<0.012 U	**0.022 J**	**0.099**	**0.087 J**
C2	C2-TP10	3-4	6/10/2014	C2-TP10-3.0-4.0-0614	**73 J**	**19000**	**86000**	<0.017 U	**0.28**	**0.16**	**28.8 J,**
C2	C2-TP11	2-3	6/10/2014	C2-TP11-2.0-3.0-0614	<2.7 U	**1400 MN**	**6700**	<0.011 U	**0.0057 MH**	**0.046 MH**	**0.0176 MH**
C2	CSD001	0-0	10/5/2000	00C2SD001SE	<8.6 U	**610 B**	**2300 B**	--	--	--	--
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					73	19000	86000	0.035	0.63	0.34	28.8
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 5-3: AOC C2 PAH Soils Results

	Site Name	C2	C2	C2	C2	C2	C2	C2	C2
	Boring, Well or Sample Location Number	AP-021	AP-021	AP-022	AP-022	AP-023	AP-023	AP-023	AP-024
	Sample Depth (feet)	0-2	2-3	0-2	2-4	0-2	2-2	2-4	0-2
	Sample Date	9/24/2000	9/24/2000	9/24/2000	9/24/2000	9/26/2000	9/26/2000	9/26/2000	9/27/2000
	Sample Name	00C2B3005SO	00C2B3006SO	00C2B4007SO	00C2B4008SO	00C2B5009SO	00C2B7010SO	00C2B5011SO	00C2B6012SO
GRO	(mg/kg)	<1 U	<1 U	<1 U	<1 U	<1 U	<1 U	<1 U	<1 U
DRO	(mg/kg)	<21 U	<19 U	<20 U	<18 U	<18 U	<19 U	<18 U	<17 U
RRO	(mg/kg)	**28 J**	<19 U	<20 U	<17 U	<18 U	<19 U	<18 U	<17 U
Acenaphthene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Acenaphthylene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Anthracene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Benzo(a)anthracene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Benzo(a)pyrene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Benzo(b)fluoranthene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Benzo(g,h,i)perylene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Benzo(k)fluoranthene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Chrysene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Fluorene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Fluoranthene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Naphthalene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Phenanthrene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
Pyrene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
2-Methylnaphthalene	(mg/kg)	<0.017 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U	<0.015 U
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	--	--	--

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 5-3: AOC C2 PAH Soils Results

Site Name		C2	C2	C2	C2	C2	C2	C2	C2
Boring, Well or Sample Location Number		AP-024	C2SS001	C2SS002	C2SS003	C2SS004	C2SS005	C2SS006	C2SS007
Sample Depth (feet)		2-4	0-0	0-0	0-0	0-0	0-0	0-0	0-0
Sample Date		9/27/2000	10/3/2000	10/3/2000	10/3/2000	10/3/2000	10/3/2000	10/3/2000	10/4/2000
Sample Name		00C2B6013SO	00C2SS001SO	00C2SS002SO	00C2SS003SO	00C2SS004SO	00C2SS005SO	00C2SS006SO	00C2SS007SO
GRO	(mg/kg)	<1 U	<0.79 U	<0.97 U	<0.87 U	<0.91 U	<0.83 U	<0.84 U	<0.79 U
DRO	(mg/kg)	<18 U	<18 U	<21 U	<20 U	<19 U	<18 U	**52 B**	<17 U
RRO	(mg/kg)	<17 U	**36 B**	<20 U	<20 U	<19 U	<18 U	**150**	**43 B**
Acenaphthene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Acenaphthylene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Anthracene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Benzo(a)anthracene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Benzo(a)pyrene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Benzo(b)fluoranthene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Benzo(g,h,i)perylene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Benzo(k)fluoranthene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Chrysene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Fluorene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Fluoranthene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Naphthalene	(mg/kg)	<0.015 U	<0.00021 U	<0.00024 U	<0.00022 U	<0.0014 U	<0.00023 U	<0.00021 U	<0.00022 U
Phenanthrene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
Pyrene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
2-Methylnaphthalene	(mg/kg)	<0.015 U	<0.015 U	<0.016 U	<0.016 U	<0.016 U	<0.015 U	<0.015 U	<0.014 U
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	--	--	--

Table 5-3: AOC C2 PAH Soils Results

Site Name		C2	C2	C2	C2	C2	C2	C2	C2
Boring, Well or Sample Location Number		C2SS014	C2SS018	C2SS019	C2SS021	C2-TP02	C2-TP04	C2-TP05	C2-TP07
Sample Depth (feet)		0-0	0-0	0-0	0-0	0-2	2-3	2-4	1-2
Sample Date		10/4/2000	10/4/2000	10/3/2000	10/4/2000	6/9/2014	6/9/2014	6/9/2014	6/9/2014
Sample Name		00C2SS014SO	00C2SS018SO	00C2SS019SO	00C2SS021SO	C2-TP02-0.0-2.0-0614	C2-TP04-2.0-3.0-0614	C2-TP05-2.0-4.0-0614	C2-TP07-1.0-2.0-0614
GRO	(mg/kg)	<0.97 U	<0.83 U	<0.8 U	**1 J**	**3.7 J**	<3.4 U	**21 QH**	**3 J**
DRO	(mg/kg)	**1200 B**	<17 U	**52 B**	**21 J**	**650**	**74**	**2100**	**650**
RRO	(mg/kg)	**7300**	<17 U	**100**	**54 B**	**1500**	**270**	**2200**	**4100**
Acenaphthene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	<0.0028 U	<0.0031 U	**0.061**	**0.0065**
Acenaphthylene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0019 J**	<0.0031 U	**0.021**	<0.0031 U
Anthracene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0029 J**	<0.0031 U	**0.1**	**0.0045 J**
Benzo(a)anthracene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0055**	<0.0031 U	**0.033**	**0.0039 J**
Benzo(a)pyrene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.007**	<0.0031 U	**0.022**	<0.0031 U
Benzo(b)fluoranthene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0073**	<0.0031 U	**0.033**	<0.0031 U
Benzo(g,h,i)perylene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0089**	<0.0031 U	**0.025**	<0.0031 U
Benzo(k)fluoranthene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0018 J**	<0.0031 U	<0.0031 U	<0.0031 U
Chrysene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0097**	<0.0031 U	**0.097**	**0.011**
Dibenzo(a,h)anthracene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	<0.0028 U	<0.0031 U	**0.0037 J**	<0.0031 U
Fluorene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0036 J**	**0.0027 J**	**0.17**	**0.01**
Fluoranthene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0055**	**0.0036 J**	**0.1**	**0.0058 J**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0042 J**	<0.0031 U	**0.012**	<0.0031 U
Naphthalene	(mg/kg)	<0.00021 U	<0.0002 U	<0.00026 U	<0.00025 U	**0.0051 J**	**0.059**	**0.069**	**0.054**
Phenanthrene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	<0.0028 U	**0.0069**	**0.6**	**0.028**
Pyrene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.015**	**0.004 J**	**0.13**	**0.02**
2-Methylnaphthalene	(mg/kg)	<0.024 U	<0.02 U	<0.021 U	<0.024 U	**0.0071**	**0.022**	**0.39**	**0.067**
1-Methylnaphthalene	(mg/kg)	--	--	--	--	**0.0056**	**0.013**	**0.43**	**0.037**

Table 5-3: AOC C2 PAH Soils Results

	Site Name	C2	C2	C2	C2	C2	C2	C2	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
	Boring, Well or Sample Location Number	C2-TP07	C2-TP08	C2-TP08	C2-TP09	C2-TP10	C2-TP11	CSD001		
	Sample Depth (feet)	2-3	1-2	2-3	3-4	3-4	2-3	0-0		
	Sample Date	6/9/2014	6/9/2014	6/9/2014	6/10/2014	6/10/2014	6/10/2014	10/5/2000		
	Sample Name	C2-TP07-2.0-3.0-0614	C2-TP08-1.0-2.0-0614	C2-TP08-2.0-3.0-0614	C2-TP09-3.0-4.0-0614	C2-TP10-3.0-4.0-0614	C2-TP11-2.0-3.0-0614	00C2SD001SE		
GRO	(mg/kg)	**19**	**12**	**2.6 J**	**2.7 J**	**73 J**	<2.7 U	<8.6 U	73	**260 C**
DRO	(mg/kg)	**8000**	**320**	**2600**	**550**	**19000**	**1400 MN**	**610 B**	19000	**230 C**
RRO	(mg/kg)	**39000**	**1200**	**12000**	**1700**	**86000**	**6700**	**2300 B**	86000	**230 H**
Acenaphthene	(mg/kg)	**0.27**	**0.0061**	**0.015**	**0.0072**	**0.72**	**0.0094**	<0.15 U	0.72	**180 F**
Acenaphthylene	(mg/kg)	**0.047**	<0.0028 U	**0.0047 J**	**0.0021 J**	**0.34**	**0.0036 J**	<0.15 U	0.34	**180 F**
Anthracene	(mg/kg)	**0.17**	**0.0026 J**	**0.016**	**0.012**	**0.46**	**0.028 MN**	<0.15 U	0.46	**1680 D**
Benzo(a)anthracene	(mg/kg)	**0.11**	<0.0028 U	**0.018**	**0.015**	**0.34**	**0.062**	<0.15 U	0.34	**0.4 D**
Benzo(a)pyrene	(mg/kg)	**0.047**	**0.0068**	**0.012**	**0.012**	**0.092**	**0.071 MH**	<0.15 U	0.092	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	**0.077**	<0.0028 U	**0.017**	**0.016**	**0.11**	**0.11**	<0.15 U	0.11	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.02 U	**0.023**	**0.019**	**0.012**	**0.067**	**0.12**	<0.15 U	0.12	**110 D**
Benzo(k)fluoranthene	(mg/kg)	**0.059**	<0.0028 U	**0.0084**	**0.003 J**	**0.051**	<0.0029 U	<0.15 U	0.059	**4 D**
Chrysene	(mg/kg)	**0.28**	<0.0028 U	**0.045**	**0.038**	**0.35**	**0.24**	<0.15 U	0.35	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.02 U	<0.0028 U	<0.0031 U	**0.004 J**	<0.019 U	<0.0029 U	<0.15 U	0.004	**0.04 D**
Fluorene	(mg/kg)	**0.6**	**0.012**	**0.032**	**0.011**	**1.6**	**0.018**	<0.15 U	1.6	**190 D**
Fluoranthene	(mg/kg)	**0.26**	**0.0075**	**0.035**	**0.028**	**0.69**	**0.083**	<0.15 U	0.69	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.02 U	**0.011**	**0.0079**	**0.0075**	**0.028 J**	**0.054**	<0.15 U	0.054	**0.4 D**
Naphthalene	(mg/kg)	**1.9**	**0.016**	**0.033**	**0.032**	**1.8**	**0.026**	**0.036**	1.9	**2.1 E**
Phenanthrene	(mg/kg)	**1.6**	**0.034**	**0.14**	**0.061**	**2.4**	**0.1**	<0.15 U	2.4	**1680 D**
Pyrene	(mg/kg)	**0.46**	**0.023**	**0.058**	**0.053**	**0.59**	**0.19**	<0.15 U	0.59	**110 D**
2-Methylnaphthalene	(mg/kg)	**1.5**	**0.043**	**0.14**	**0.016**	**14**	**0.042**	<0.15 U	14	**6.1 F**
1-Methylnaphthalene	(mg/kg)	**1**	**0.03**	**0.15**	**0.015**	**12**	**0.037**	--	12	**6.2 F**

Table 5-4a: AOC C2 Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
C2	C2-TP02	0-2	6/9/2014	C2-TP02-0.0-2.0-0614	<0.011 U	0.029 J	<0.011 U	<0.022 U	2.2 J,B	2.167	14 J,B	--	<4.6 U	<4.6 U	8.7 J	4.5 J	48 J,B
C2	C2-TP04	2-3	6/9/2014	C2-TP04-2.0-3.0-0614	0.035	0.34	0.0067 J	0.04 J	<5.4 U	5.3533	<3.1 U	--	<5.4 U	<5.4 U	<5.4 U	<5.4 U	<5.4 U
C2	C2-TP05	2-4	6/9/2014	C2-TP05-2.0-4.0-0614	<0.013 U	0.045 J	0.025 J	0.133	5.1 J,B	4.942	11 J,B	--	<5.1 U	<5.1 U	3.1 J	<5.1 U	37 J,B
C2	C2-TP07	1-2	6/9/2014	C2-TP07-1.0-2.0-0614	<0.014 U	0.015 J	0.0042 J	0.043 J	<5.6 U	5.5528	<5.6 U	--	<5.6 U	2.2 J	<5.6 U	<5.6 U	<5.6 U
C2	C2-TP07	2-3	6/9/2014	C2-TP07-2.0-3.0-0614	<0.018 U	0.024 J	0.63	2.4073 , J	9.4 J,B	6.3627	18 J,B	--	<7.4 U	3.2 J	<7.4 U	<7.4 U	25 J,B
C2	C2-TP08	1-2	6/9/2014	C2-TP08-1.0-2.0-0614	<0.012 U	0.049 J	0.0058 J	0.0255 J	2.3 J,B	2.2687	1.9 J,B	--	<4.7 U	13 J	<4.7 U	<4.7 U	17 J,B
C2	C2-TP08	2-3	6/9/2014	C2-TP08-2.0-3.0-0614	<0.013 U	0.074	0.011 J	0.0696 J	<5.1 U	5.0194	<1.8 U	--	<5.1 U	27 J	3.7 J	<5.1 U	27 J,B
C2	C2-TP09	3-4	6/10/2014	C2-TP09-3.0-4.0-0614	<0.012 U	0.099	0.022 J	0.087 J	<4.8 U	4.691	<4.2 U	--	3.1 J	4.1 J	2.9 J	<4.8 U	8 J,B
C2	C2-TP10	3-4	6/10/2014	C2-TP10-3.0-4.0-0614	<0.017 U	0.16	0.28	28.8 J,	51	21.92	67 J,B	--	<3.03 U	30 J	55.1	61 J	310 J
C2	C2-TP11	2-3	6/10/2014	C2-TP11-2.0-3.0-0614	<0.011 U	0.046 MH	0.0057 MH	0.0176 MH	<4.3 U	4.2767	<1.8 U	--	<4.3 U	13 J	4.2 J	<4.3 U	13 J,B
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.016	0.088	0.100	3.165	9.520	6.255	12.840	#DIV/0!	4.833	10.760	10.080	10.790	49.60

Table 5-4b: AOC C2 Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
C2	C2-TP02	0-2	6/9/2014	C2-TP02-0.0-2.0-0614	--	--	7.6 J	26	140	210	--	230	290	310	860	173.6	830	1003.6
C2	C2-TP04	2-3	6/9/2014	C2-TP04-2.0-3.0-0614	--	--	0.45 J	<2.5 U	22	29	--	0.63 J	2.1 J	13	21	24.95	15.73	40.68
C2	C2-TP05	2-4	6/9/2014	C2-TP05-2.0-4.0-0614	--	--	11 J	84	720	990	--	170	1000	1500	810	815	2670	3485
C2	C2-TP07	1-2	6/9/2014	C2-TP07-1.0-2.0-0614	--	--	1.3 J	3.6 J	51	350	--	3.6 J	30	130	1900	55.9	163.6	219.5
C2	C2-TP07	2-3	6/9/2014	C2-TP07-2.0-3.0-0614	--	--	30 QH	61 QH	840 QH	4200	--	80 QL	390 QL	2300	11000	931	2770	3701
C2	C2-TP08	1-2	6/9/2014	C2-TP08-1.0-2.0-0614	--	--	1.5 J	2.4 J	68	390	--	6.8 J	17	100	510	71.9	123.8	195.7
C2	C2-TP08	2-3	6/9/2014	C2-TP08-2.0-3.0-0614	--	--	2.9 J	12	250	1300	--	21 QH	160 QH	540 QH	3100	264.9	721	985.9
C2	C2-TP09	3-4	6/10/2014	C2-TP09-3.0-4.0-0614	--	--	3.7 J	4.7 J	120	510	--	59	57	200	780	128.4	316	444.4
C2	C2-TP10	3-4	6/10/2014	C2-TP10-3.0-4.0-0614	--	--	50	270	1500	4000	--	310 QL	730 QL	6400	25000	1820	7440	9260
C2	C2-TP11	2-3	6/10/2014	C2-TP11-2.0-3.0-0614	--	--	2.1 ML	7.3 J	660	5200	--	9.1 QL	94 QL	1400	8100	669.4	1503.1	2172.5
average with fraction:							11.055	47.350	437.100	1717.900		89.013	277.010	1289.300	5208.100			

Table 5-4c: AOC C2 Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.01560	0.08810	0.10014	3.16450	6.25536	11.05500	47.35000	437.10000	1717.90000	4.83300	10.76000	10.08000	89.01300	277.01000	1289.30000	5208.10000	9112
Fraction of TPH mass in A&A EC groups	1.712E-06	9.66844E-06	1.09898E-05	0.00035	0.00069	0.00121	0.00520	0.04797	0.18853	0.00053	0.00118	0.00111	0.00977	0.03040	0.14149	0.57156	1.00
GRO, DRO & RRO A&A Groups	**GRO aromatics**					**DRO aromatics**			**RRO aromatics**	**GRO aliphatics**			**DRO aliphatics**			**RRO aliphatics**	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.001056					0.054379			0.188529	0.002817			0.181662			0.571557	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.001621	0.009154	0.010406	0.328824	0.649995	0.022311	0.095559	0.882130	1.000000	0.188252	0.419117	0.392630	0.053774	0.167345	0.778881	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	0.39%
% of TPH that is DRO=	23.60%
% of TPH that is RRO=	76.01%

GRO % aromatics	0.272651551
GRO % aliphatics	0.727348449
DRO % aromatics	0.230378719
DRO % aliphatics	0.769621281
RRO % aromatics	0.248036385
RRO % aliphatics	0.751963615

Table 5-4d: AOC C2 HRC Input

input to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.272651551
DRO: fraction aromatic	0.230378719
RRO: fraction aromatic	0.248036385

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.022310572
Aromatic C12-C16	0.095559076
Aromatic C16-C21	0.882130352

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.188252249
Aliphatic C6-C8	0.419117361
Aliphatic C8-C10	0.39263039
Aliphatic C10-C12	0.053773795
Aliphatic C12-C16	0.167344983
Aliphatic C16-C21	0.778881221

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons

GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Table 5-5: AOC C2 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
C2	AP-023	NA	10/11/2000	00C2WT002WG	<0.025 U	<0.054 U	--	<0.0002 U	<0.0002 U	<0.0002 U	<0.0006 U
C2	AP-024	NA	10/11/2000	00C2WT004WG	<0.025 U	**0.064 J**	--	<0.0002 U	<0.0002 U	<0.0002 U	<0.0006 U
C2	AP-024	NA	6/24/2014	AP-024-WG01-0614	<0.044 U	**0.063 J**	**0.04 J**	<0.0004 U,QL	<0.0004 U	<0.0004 U,QL	<0.0008 U,QL
C2	C2-WP01	NA	6/18/2014	C2-WP01-0614	**0.047 J**	**1.3**	**2**	<0.0004 U	**0.00028 J**	**0.0014 QH**	**0.00389 , J**
C2	Unsure	NA	10/11/2000	00C2WT007WG	<0.025 U	--	--	<0.0002 U	<0.0002 U	<0.0002 U	<0.0006 U
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0.047	1.3	2	0.0004	0.00028	0.0014	0.00389
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:
Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
BTEX= benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

Table 5-6: AOC C2 PAH Groundwater Results

Site Name		C2	C2	C2	C2	C2	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		AP-023	AP-024	AP-024	C2-WP01	Unsure		
Sample Depth		NA	NA	NA	NA	NA		
Sample Date		10/11/2000	10/11/2000	6/24/2014	6/18/2014	10/11/2000		
Sample Name		00C2WT002WG	00C2WT004WG	AP-024-WG01-0614	C2-WP01-0614	00C2WT007WG		
GRO (mg/L)	(mg/L)	<0.025 U	<0.025 U	<0.044 U	**0.047 J**	<0.025 U	0.047	**2.2 H**
DRO (mg/L)	(mg/L)	<0.054 U	**0.064 J**	**0.063 J**	**1.3**	--	1.3	**1.5 H**
RRO (mg/L)	(mg/L)	--	--	**0.04 J**	**2**	--	2	**1.1 H**
Acenaphthene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U	**0.00005**	--	0.00005	**0.22 H**
Acenaphthylene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U,QN	**0.000016 J**	--	0.000016	**0.22 H**
Anthracene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U	**0.000015 J**	--	0.000015	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U	<0.000031 U	--	0.000031	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U,QN	<0.000031 U	--	0.000031	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U	<0.000031 U	--	0.000031	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U,QL	<0.000031 U	--	0.000031	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U	<0.000031 U	--	0.000031	**0.0012 H**
Chrysene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U	<0.000031 U	--	0.000031	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U	<0.000031 U	--	0.000031	**0.000012 H**
Fluorene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U,QL	**0.00014**	--	0.00014	**0.15 H**
Fluoranthene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U	**0.000032 J**	--	0.000032	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U,QL	<0.000031 U	--	0.000031	**0.00012 H**
Naphthalene	(mg/L)	<0.00001 U	<0.000011 U	**0.000013 B**	**0.0014**	<0.0002 U	0.0014	**0.073 H**
Phenanthrene	(mg/L)	**0.000013**	**0.000022**	<0.000015 U,QL	**0.00021**	--	0.00021	**1.1 H**
Pyrene	(mg/L)	<0.00001 U	<0.000011 U	<0.000015 U,QN	**0.000047**	--	0.000047	**0.11 H**
2-Methylnaphthalene	(mg/L)	<0.00001 U	<0.000011 U	**0.00001 J**	**0.0011**	--	0.0011	**0.015 H**
1-Methylnaphthalene	(mg/L)	--	--	**0.00001 J**	**0.0011**	--	0.0011	**0.015 H**

Notes:
Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for PAHs

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Table 5-7: AOC C2 VPH & EPH Groundwater Results

Site Name		C2	maximum value
Boring or Well Number		C2-WP01	
Sample Depth		NA	
Sample Date		6/18/2014	
Sample Name		C2-WP01-0614	
C8-C10 Aromatics V	(mg/L)	**0.012 J**	
C10-C12 Aromatics V	(mg/L)	**0.033 J**	
C12-C13 Aromatics V	(mg/L)	**--**	
C5-C6 Aliphatics V	(mg/L)	**0.011 J**	
C6-C8 Aliphatics V	(mg/L)	**0.0076 J**	
C8-C10 Aliphatics V	(mg/L)	**0.019 J**	
C10-C12 Aliphatics V	(mg/L)	<0.006 U	
Total VPH V	(mg/L)	**0.096 J**	
C8-C10 Aromatics	(mg/L)	**--**	
C10-C12 Aromatics	(mg/L)	**0.037 J**	
C12-C16 Aromatics	(mg/L)	**0.054**	
C16-C21 Aromatics	(mg/L)	**0.57**	
C21-C34 Aromatics	(mg/L)	**2.9**	
C8-C10 Aliphatics	(mg/L)	**--**	
C10-C12 Aliphatics	(mg/L)	**0.1**	
C12-C16 Aliphatics	(mg/L)	**0.32**	
C16-C21 Aliphatics	(mg/L)	**1.2**	
C21-C34 Aliphatics	(mg/L)	**10**	
GRO Aromatics (C5 to C10 aro)	(mg/L)	0.012	0.012
GRO Aliphatics (C5 to C10 ali)	(mg/L)	0.0376	0.0376
DRO Aromatics (C10 to C21)	(mg/L)	0.661	0.661
DRO Aliphatics (C10 to C21)	(mg/L)	1.62	1.62
RRO Aromatics (C21 to C34 aro)	(mg/L)	2.9	2.9
RRO Aliphatics (C21 to C34 ali)	(mg/L)	10	10
GRO (sum of C5 to C10 A&A)	(mg/L)	0.0496	0.0496
DRO (sum of C10 to C21 A&A)	(mg/L)	2.281	2.281
RRO (sum of C21 to C35 A&A)	(mg/L)	12.9	12.9
GRO (AK101)	(mg/L)	**0.047**	
DRO (AK102)	(mg/L)	**1.3**	
RRO (AK103)	(mg/L)	**2**	

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/L = milligrams per liter
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J
V = defines VPH results versus EPH results
Result = detected results for VPH, EPH, GRO, DRO and RRO bolded

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Table 5-8a: AOC C2 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

ProUCL Input File

GRO	d_GRO	DRO	d_DRO	RRO	d_RRO	Benzene	d_Benzene	Toluene	d_Toluene	Ethylbenzene	d_Ethylbenzene	Xylene	d_Xylene
0.97	0	1200	1	7300	1	0.011	0	0.029	1	0.011	0	0.022	0
3.7	1	650	1	1500	1	0.035	1	0.34	1	0.0067	1	0.04	1
3.4	0	74	1	270	1	0.013	0	0.045	1	0.025	1	0.133	1
21	1	2100	1	2200	1	0.014	0	0.015	1	0.0042	1	0.043	1
3	1	650	1	4100	1	0.018	0	0.024	1	0.63	1	2.4073	1
19	1	8000	1	39000	1	0.012	0	0.049	1	0.0058	1	0.0255	1
12	1	320	1	1200	1	0.013	0	0.074	1	0.011	1	0.0696	1
2.6	1	2600	1	12000	1	0.012	0	0.099	1	0.022	1	0.087	1
2.7	1	550	1	1700	1	0.017	0	0.16	1	0.28	1	28.8	1
73	1	19000	1	86000	1	0.011	0	0.046	1	0.0057	1	0.0176	1
2.7	0	1400	1	6700	1								
8.6	0	610	1	2300	1								

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

Benzene	0.035	maximum detected
Toluene	0.162	95%UCL
Ethylbenzene	0.63	maximum detected
Xylene	28.8	maximum detected
GRO	73	maximum detected
DRO	6992	95%UCL
RRO	32933	95%UCL

DRO

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	11
Raw Statistics		**Log-transformed Statistics**	
Minimum	74	Minimum of Log Data	4.304
Maximum	19000	Maximum of Log Data	9.852
Mean	3096	Mean of log Data	7.036
Median	925	SD of log Data	1.46
SD	5445		
Std. Error of Mean	1572		
Coefficient of Variation	1.759		
Skewness	2.714		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.577	Shapiro Wilk Test Statistic	0.965
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	5919	95% H-UCL	17701
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8544
95% Adjusted-CLT UCL (Chen-1995)	6998	97.5% Chebyshev (MVUE) UCL	11014
95% Modified-t UCL (Johnson-1978)	6124	99% Chebyshev (MVUE) UCL	15864
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.517	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	5993		
MLE of Mean	3096		
MLE of Standard Deviation	4308		
nu star	12.4		
Approximate Chi Square Value (.05)	5.491	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	5682
Adjusted Chi Square Value	4.807	95% Jackknife UCL	5919
		95% Standard Bootstrap UCL	5579
Anderson-Darling Test Statistic	0.758	95% Bootstrap-t UCL	18604
Anderson-Darling 5% Critical Value	0.776	95% Hall's Bootstrap UCL	17293
Kolmogorov-Smirnov Test Statistic	0.215	95% Percentile Bootstrap UCL	5900
Kolmogorov-Smirnov 5% Critical Value	0.257	95% BCA Bootstrap UCL	7393
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	9948
		97.5% Chebyshev(Mean, Sd) UCL	12913
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	18737
95% Approximate Gamma UCL	6992		
95% Adjusted Gamma UCL	7985		
Potential UCL to Use		Use 95% Approximate Gamma UCL	6992

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003).   For additional insight, the user may want to consult a statistician.

Table 5-8a: AOC C2 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

RRO

	General Statistics		
Number of Valid Observations	12	Number of Distinct Observations	12
Raw Statistics		Log-transformed Statistics	
Minimum	270	Minimum of Log Data	5.598
Maximum	86000	Maximum of Log Data	11.36
Mean	13689	Mean of log Data	8.352
Median	3200	SD of log Data	1.58
SD	25125		
Std. Error of Mean	7253		
Coefficient of Variation	1.835		
Skewness	2.627		
	Relevant UCL Statistics		
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.578	Shapiro Wilk Test Statistic	0.967
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	26715	95% H-UCL	102382
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	38909
95% Adjusted-CLT UCL (Chen-1995)	31496	97.5% Chebyshev (MVUE) UCL	50449
95% Modified-t UCL (Johnson-1978)	27631	99% Chebyshev (MVUE) UCL	73118
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.458	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	29911		
MLE of Mean	13689		
MLE of Standard Deviation	20235		
nu star	10.98		
Approximate Chi Square Value (.05)	4.566	Nonparametric Statistics	
Adjusted Level of Significance	0.029	95% CLT UCL	25619
Adjusted Chi Square Value	3.953	95% Jackknife UCL	26715
		95% Standard Bootstrap UCL	25074
Anderson-Darling Test Statistic	0.774	95% Bootstrap-t UCL	86387
Anderson-Darling 5% Critical Value	0.782	95% Hall's Bootstrap UCL	80122
Kolmogorov-Smirnov Test Statistic	0.227	95% Percentile Bootstrap UCL	26375
Kolmogorov-Smirnov 5% Critical Value	0.258	95% BCA Bootstrap UCL	32467
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	45304
		97.5% Chebyshev(Mean, Sd) UCL	58984
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	85856
95% Approximate Gamma UCL	32933		
95% Adjusted Gamma UCL	38033		
Potential UCL to Use		Use 95% Approximate Gamma UCL	32933

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Toluene

	General Statistics		
Number of Valid Observations	10	Number of Distinct Observations	10
Raw Statistics		Log-transformed Statistics	
Minimum	0.015	Minimum of Log Data	-4.2
Maximum	0.34	Maximum of Log Data	-1.079
Mean	0.0881	Mean of log Data	-2.849
Median	0.0475	SD of log Data	0.927
SD	0.0983		
Std. Error of Mean	0.0311		
Coefficient of Variation	1.116		
Skewness	2.231		
	Relevant UCL Statistics		
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.718	Shapiro Wilk Test Statistic	0.972
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.145	95% H-UCL	0.222
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.197
95% Adjusted-CLT UCL (Chen-1995)	0.163	97.5% Chebyshev (MVUE) UCL	0.245
95% Modified-t UCL (Johnson-1978)	0.149	99% Chebyshev (MVUE) UCL	0.341
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.999	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.0882		
MLE of Mean	0.0881		
MLE of Standard Deviation	0.0881		
nu star	19.98		
Approximate Chi Square Value (.05)	10.84	Nonparametric Statistics	
Adjusted Level of Significance	0.0267	95% CLT UCL	0.139
Adjusted Chi Square Value	9.69	95% Jackknife UCL	0.145
		95% Standard Bootstrap UCL	0.137
Anderson-Darling Test Statistic	0.437	95% Bootstrap-t UCL	0.245
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	0.358
Kolmogorov-Smirnov Test Statistic	0.223	95% Percentile Bootstrap UCL	0.143
Kolmogorov-Smirnov 5% Critical Value	0.272	95% BCA Bootstrap UCL	0.167
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.224
		97.5% Chebyshev(Mean, Sd) UCL	0.282
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.398
95% Approximate Gamma UCL	0.162		
95% Adjusted Gamma UCL	0.182		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.162

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Table 5-8b: AOC C2 PAH Soil 95% UCL Concentrations

ProUCL Input File

Benzo(a)pyrene	d_Benzo(a)pyrene
0.024	0
0.007	1
0.0031	0
0.022	1
0.0031	0
0.047	1
0.0068	1
0.012	1
0.012	1
0.092	1
0.071	1
0.15	0

ProUCL Output File

```
                              General UCL Statistics for Data Sets with Non-Detects
          User Selected Options
                     From File  WorkSheet.wst                Benzo(a)pyrene    0.0433    95%UCL
                Full Precision  OFF
         Confidence Coefficient  95%
  Number of Bootstrap Operations  10000

Benzo(a)pyrene
                                                General Statistics
                   Number of Valid Data        12                  Number of Detected Data              8
         Number of Distinct Detected Data       7                  Number of Non-Detect Data             4
                                                                   Percent Non-Detects             33.33%
                        Raw Statistics                             Log-transformed Statistics
                        Minimum Detected   0.0068                  Minimum Detected                -4.991
                        Maximum Detected    0.092                  Maximum Detected                -2.386
                        Mean of Detected   0.0337                  Mean of Detected                -3.838
                          SD of Detected   0.0327                  SD of Detected                   1.029
                      Minimum Non-Detect   0.0031                  Minimum Non-Detect              -5.776
                      Maximum Non-Detect     0.15                  Maximum Non-Detect              -1.897
Note: Data have multiple DLs - Use of KM Method is recommended     Number treated as Non-Detect        12
For all methods (except KM, DL/2, and ROS Methods),                Number treated as Detected           0
Observations < Largest ND are treated as NDs                       Single DL Non-Detect Percentage 100.00%
                         Warning:  There are only 8 Detected Values in this data
              Note:  It should be noted that even though bootstrap may be performed on this data set
                     the resulting calculations may not be reliable enough to draw conclusions
         It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.
                                                UCL Statistics
     Normal Distribution Test with Detected Values Only            Lognormal Distribution Test with Detected Values Only
                 Shapiro Wilk Test Statistic    0.823              Shapiro Wilk Test Statistic      0.898
              5% Shapiro Wilk Critical Value    0.818              5% Shapiro Wilk Critical Value   0.818
        Data appear Normal at 5% Significance Level                Data appear Lognormal at 5% Significance Level

           Assuming Normal Distribution                            Assuming Lognormal Distribution
                     DL/2 Substitution Method                      DL/2 Substitution Method
                                        Mean     0.03              Mean                            -4.221
                                          SD   0.0324              SD                               1.395
                          95% DL/2 (t) UCL   0.0468                95%  H-Stat (DL/2) UCL           0.182
        Maximum Likelihood Estimate(MLE) Method     N/A            Log ROS Method
         MLE method failed to converge properly                    Mean in Log Scale               -4.364
                                                                   SD in Log Scale                  1.238
                                                                   Mean in Original Scale          0.0245
                                                                   SD in Original Scale            0.0295
                                                                   95% t UCL                       0.0398
                                                                   95% Percentile Bootstrap UCL    0.0388
                                                                   95% BCA Bootstrap UCL           0.0419
                                                                   95% H-UCL                       0.0963
     Gamma Distribution Test with Detected Values Only             Data Distribution Test with Detected Values Only
                     k star (bias corrected)    0.868              Data appear Normal at 5% Significance Level
                                 Theta Star   0.0389
                                    nu star    13.89
                           A-D Test Statistic     0.48             Nonparametric Statistics
                        5% A-D Critical Value    0.732             Kaplan-Meier (KM) Method
                           K-S Test Statistic    0.732             Mean                            0.0267
                        5% K-S Critical Value      0.3             SD                              0.0285
   Data appear Gamma Distributed at 5% Significance Level          SE of Mean                     0.00921

                                                                   95% KM (t) UCL                  0.0433
           Assuming Gamma Distribution                             95% KM (z) UCL                  0.0419
     Gamma ROS Statistics using Extrapolated Data                  95% KM (jackknife) UCL           0.043
                                     Minimum 0.000001              95% KM (bootstrap t) UCL        0.0599
                                     Maximum    0.092              95% KM (BCA) UCL                0.0426
                                        Mean    0.024              95% KM (Percentile Bootstrap) UCL 0.0425
                                      Median    0.012              95% KM (Chebyshev) UCL          0.0669
                                          SD   0.0301              97.5% KM (Chebyshev) UCL        0.0843
                                      k star    0.303              99% KM (Chebyshev) UCL           0.118
                                  Theta star   0.0792
                                     Nu star    7.283              Potential UCLs to Use
                                     AppChi2    2.327              95% KM (t) UCL                  0.0433
                 95% Gamma Approximate UCL   0.0752                95% KM (Percentile Bootstrap) UCL 0.0425
                   95% Adjusted Gamma UCL     0.091
                                  Note: DL/2 is not a recommended method.
          Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
            These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
                               For additional insight, the user may want to consult a statistician.
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Table 5-9: AOC C2 Outlier Test Results

```
                         Outlier Tests for Selected Variables
                              User Selected Options
                                     From File     WorkSheet.wst
                                Full Precision     OFF
Test for Suspected Outliers with Dixon test        1
Test for Suspected Outliers with Rosner test       2

                          Dixon's Outlier Test for DRO
Number of data = 12
10% critical value: 0.49
5% critical value: 0.546
1% critical value: 0.642
1.  Data Value 19000 is a Potential Outlier (Upper Tail)?
Test Statistic: 0.878
For 10% significance level, 19000 is an outlier.
For 5% significance level, 19000 is an outlier.
For 1% significance level, 19000 is an outlier.

2. Data Value 74 is a Potential Outlier (Lower Tail)?
Test Statistic: 0.060
For 10% significance level, 74 is not an outlier.
For 5% significance level, 74 is not an outlier.
For 1% significance level, 74 is not an outlier.

                          Dixon's Outlier Test for RRO
Number of data = 12
10% critical value: 0.49
5% critical value: 0.546
1% critical value: 0.642
1.  Data Value 86000 is a Potential Outlier (Upper Tail)?
Test Statistic: 0.873
For 10% significance level, 86000 is an outlier.
For 5% significance level, 86000 is an outlier.
For 1% significance level, 86000 is an outlier.

2. Data Value 270 is a Potential Outlier (Lower Tail)?
Test Statistic: 0.032
For 10% significance level, 270 is not an outlier.
For 5% significance level, 270 is not an outlier.
For 1% significance level, 270 is not an outlier.
```

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Table 5-10a: AOC C2 HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	maximum detected	maximum LOD	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	95%UCL	max measured conc	
Ethylbenzene (c & nc)	maximum detected	max measured conc	
Xylenes (total) (nc)	maximum detected	max measured conc	
GRO	maximum detected	max measured conc	
DRO	95%UCL	max measured conc	
RRO	95%UCL	max measured conc	
GRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
DRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
RRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
GRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
DRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
RRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
Acenaphthene (nc)	max measured conc	max measured conc	
Acenaphthylene (nc)	max measured conc	max measured conc	
Anthracene (nc)	max measured conc	max measured conc	
Benzo(g,h,i)perylene (nc)	max measured conc	max measured conc	
Fluoranthene (nc)	max measured conc	max measured conc	
Fluorene (nc)	max measured conc	max measured conc	
Naphthalene (c & nc)	max measured conc	max measured conc	
Phenanthrene (nc)	max measured conc	max measured conc	
Pyrene (nc)	max measured conc	max measured conc	
Benzo(a)anthracene (c)	max measured conc	modeled data - all 2014 results ND	
Benzo(b)fluoranthene (c)	max measured conc	modeled data - all 2014 results ND	
Benzo(k)fluoranthene (c)	max measured conc	modeled data - all 2014 results ND	
Benzo(a)pyrene (c)	95%UCL	modeled data - all 2014 results ND	
Chrysene (c)	max measured conc	modeled data - all 2014 results ND	
Dibenz(a,h)anthracene (c)	max measured conc	modeled data - all 2014 results ND	
Indeno(1,2,3-cd)pyrene (c)	max measured conc	modeled data - all 2014 results ND	
1-Methylnaphthalene (nc)	max measured conc	max measured conc	
2-Methylnaphthalene (nc)	max measured conc	max measured conc	

Hydrocarbon Characterization Data	
Hydrocarbon Fractions	Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_5-C_6	Site specific EPH & VPH data
Aliphatic C_6-C_8	Site specific EPH & VPH data
Aliphatic C_8-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:

BTEX = benzene, toluene, ethylbenzene, xylene
(c) = carcinogen
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
(nc) = non-carcinogen
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Table 5-10b: AOC C2 HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	Input Values			Source of Data
bulk density (lbs/ft^3)	119.2875			C2 & C4 sites average value
specific gravity	2.787142857			C2 & C4 sites average value
moisture content (% by weight)	9.825			C2 & C4 sites average value
foc	0.003835			C2 & C4 sites average value
Soil temp (C)	5.3			C2 & C4 sites average value
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt			C2 & C4 sites average value
Hydrogeologic Conditions				
Source length (ft)	154			scaled from site maps
Average precipitation (in/yr)	143.44			NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	3.53E-06			based on grain size and textbook values (Freeze and Cherry 1979)
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8			estimated thickness of the aquifer based on the 2014 boring logs
Infiltration rate (m/yr)	0.7286752			20% of average precipitation
Hydraulic gradient	0.018			Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1			Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters				
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3			NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth				
depth to groundwater at seasonal low water level at downgradient end of source (ft)	8			Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	4			Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	4			Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	0			Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time				
Soil Direct Contact	1			Site specific conceptual site model
Outdoor Air	1			Site specific conceptual site model
Indoor Air	0			Site specific conceptual site model
Groundwater Ingestion	0			Site specific conceptual site model
Other Input				
ADEC Hazard ID	0			ADEC CS database
Latitude	0			ADEC CS database
Longitude	0			ADEC CS database
Width of Source (ft)	90			scaled from site maps
Area of NAPL contaminated soil source (ft^2)	13860			scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.018			Measured slope of water table
Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	119.29	119.29	119.29	C2 & C4 sites average value
specific gravity of solids	2.787143	2.787143	2.787143	C2 & C4 sites average value
moisture content (% by weight)	9.83	9.83	9.83	C2 & C4 sites average value
foc	0.003835	0.003835	0.003835	C2 & C4 sites average value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	0.1	0.1	0.1	Site Specific (depth to source minus foundation depth--distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	0.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 5-11: AOC C2 Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	8.21176E-07	0.0821	0.0105
Outdoor air inhalation	1.13341E-09	0.0001	0.0001
Indoor air inhalation (vapor intrusion)	8.20702E-08	0.0082	0.0068
Groundwater Ingestion	1.5376E-07	0.0154	0.0150
Cumulative Risk	**1E-06**	**0.1**	**0.0**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	2.47002E-06	0.2470	0.1202
Outdoor air inhalation	4.91671E-09	0.0005	0.0003
Indoor air inhalation (vapor intrusion)	3.44695E-07	0.0345	0.0284
Groundwater Ingestion	2.58317E-07	0.0258	0.0211
Cumulative Risk	**3E-06**	**0.3**	**0.20**

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 5-12: AOC C2 Summary of Bulk Fuel Hydrocarbon Risk

	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Fraction of Risk Values				
			Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor intrusion)	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	0	0.012	No Rfc	No RfC	No Rfc	<1	No Rfc
DRO Aromatics	1611	0.661	<1	<1	<1	<1	<1
RRO Aromatics	8169	2.900	<1	No RfC	No Rfc	1.892	<1
GRO Aliphatics	53	0.038	<1	<1	<1	<1	<1
DRO Aliphatics	5381	1.620	<1	<1	<1	<1	<1
RRO Aliphatics	24764	10.000	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	0	0.012	No Rfc	No Rfc	No Rfc	<1	No Rfc
DRO Aromatics	1611	0.661	<1	<1	<1	<1	<1
RRO Aromatics	8169	2.900	3.282	No Rfc	No Rfc	2.648	<1
GRO Aliphatics	53	0.038	<1	<1	<1	<1	<1
DRO Aliphatics	5381	1.620	<1	<1	<1	<1	<1
RRO Aliphatics	24764	10.000	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics

GRO = gasoline-range organics

mg/kg = milligrams per kilogram

mg/L = milligram(s) per liter

No RfC = no reference concentration available; risk standard is assumed to be met due to low volatility of the fraction

RRO = residual-range organics

Table 5-13	**Hydrocarbon Risk Calculator**	Facility Location: **AOC C2**	Facility Name: **Yakutat, Alaska**

Version 3.0, Larry Acomb, Geosphere, Inc., June 2010

Optional Site Visitor and Excavation Worker Risk Calculations

Page 1 — Exposure Parameters for Site Visitors & Excavation Worker Risk Calculations

Equation 1: Groundwater Cleanup Level For noncarcinogenic Contaminants	Site Visitor Values	Excavation Worker Optional Values	**Equation 2: Groundwater Cleanup Level for Carcinogenic Contaminants**	Site Visitor Values	Excavation Worker Optional Values	**Equation 3: Soil Direct Contact Cleanup Level For noncarcinogenic Contaminants**	Site Visitor Values	Excavation Worker Optional Values
THQ=target hazard quotient	1	1	TR=target cancer risk	0.00001	0.00001	THQ=target hazard quotient	1	1
BWa=body weight adult (kg)	70	70	Sfo=oral slope factor	specific	specific	BWc=body weight child	15	70
AT=averaging time (yrs)	30	1	BWa=body weight adult (kg)	70	70	AT=averaging time (yrs)	6	1
RfDo=oral reference dose	specific	specific	AT=averaging time (yrs)	70	70	RfDo=oral reference dose	specific	specific
EF=exposure frequency (days/yr)	30	120	EF=exposure frequency (days/yr)	30	120	EF=exposure frequency (days/yr)	30	120
ED=exposure duration (yrs)	30	1	ED=exposure duration (yrs)	30	1	ED=exposure duration (yrs)	6	1
IR=ingestion rate (L/day)	0	0.05	IR=ingestion rate (L/day)	0	0.05	IR=ingestion rate (mg/day)	200	330
A=absorption factor	1	1	A=absorption factor	1	1	RfDd=dermal reference dose	specific	specific
						SAc= surface area child (SFa for in	2800	3300
						AFc= adherence factor child (AFa f	0.2	0.3
Input Data in Yellow Highlighted Cells						ABS= absorption factor	specific	specific
						EV = event frequency (events/day)		1
Equation 4: Residential Soil Direct Contact Cleanup Level For Carcinogenic Contaminants	Site Visitor Values	**Equation 4: Industrial Site Soil Direct Contact Cleanup Level For Carcinogenic Contaminants**	Excavation Worker Optional Values	**Equation 5 : Soil Dermal Factor Equation for Carcinogens**	Site Visitor Values (Same as Residential)	**Equation 6: Age Adjusted Soil Ingestion Factor**		Site Visitor Values (Same as Residential)
TR=target cancer risk	0.00001	TR=target cancer risk	0.00001	EDc=exposure duration child	6	IF=ingestion factor age-adjusted		114.2857143
Sfo=oral slope factor	specific	Sfo=oral slope factor	specific	AFc= adherence factor child	0.2	(IR1-6)=soil ingestion rate for kids age 1 to 6 years		200
AT=averaging time (yrs)	70	AT=averaging time (yrs)	70	SAc = surface area (child)	2800	(IR7-31)=soil ingestion rate for people age 7 to 31 years		100
EF=exposure frequency (days/yr)	30	BWa=body weight adult	70	BWc=body weight child	15	(ED1-6)=exposure duration for kids age 1 to 6 years		6
IF=ingestion factor age-adjusted	114.2857143	EF=exposure frequency (days/yr)	120	EDa=exposure duration adult	30	(ED7-31)=exposure duration for people age 7 to 31 years		24
Sfd=dermal slope factor	specific	ED=exposure duration (yrs)	1	AFa= adherence factor adult	0.07	(BW1-6)=body weight for kids age 1to 6		15
ABS= absorption factor	specific	IR=ingestion rate (mg/day)	330	SAa = surface area (adult)	5700	(BW7-31)=body weight for people age 7 to 31		70
SFS= soil dermal factor	360.80	Sfd=dermal slope factor	specific	BWa=body weight adult (kg)	70			
		ABS= absorption factor	specific					
		AFa= adherence factor adult	0.3					
		SAa= surface area (adult)	3300					
		EV = event frequency (events/day)	1					
Equation 8: Soil Cleanup Level for Inhalation of noncarcinogenic Volatiles	Site Visitor Values	Excavation Worker Optional Values	**Equation 7: Soil Cleanup Level for Inhalation of Carcinogenic Volatiles in Soil**	Site Visitor Values	Excavation Worker Optional Values	Site Specific Construction Worker Q/C value from **EPA Supplemental Soil Screening Guidance equation #5-15**		
THQ=target hazard quotient	1	1	TR=target cancer risk	0.00001	0.00001			
AT=averaging time (yrs)	30	1	AT=averaging time (yrs)	70	70	Q/C	14.31406677	
RfC=inhalation reference concentration	specific	specific	URF=inhalation risk factor	specific	specific	Area of site (acres)	0.5	
EF=exposure frequency (days/yr)	30	120	EF=exposure frequency (days/yr)	30	120	A constant	2.4538	
Exposure hours per day	24	12	Exposure hours per day	24	12	B constant	17.566	
eEF=Effective Exposure Frequency	30	60	eEF=Effective Exposure Frequency	30	60	C constant	189.0426	
ED=exposure duration (yrs)	30	1	ED=exposure duration (yrs)	30	1	dispersion correction factor F_D (unitless)	0.185	
VF=volatilization factor	specific	specific	VF=volatilization factor	specific	specific			
Exposure duration ,T, in VF equation (secs)	946728000	31557600	Exposure duration ,T, in VF equation (secs)	946728000	31557600			

Table 5-13 Soil Direct Contact Risks --- Optional Site Visitor and Excavation Worker

Page 2 AOC C2 Yakutat, Alaska

1	2	3	4	5	6	7	8	9
Compounds		Sample Concentrations (mg/kg)	Site Visitor Soil Direct Contact Risk Based Level	Site Visitor Fraction of Risk Based Target Concentration (values greater than 1 exceed the risk based target)	Site Visitor Check for compliance with risk levels (0= in compliance; 1= not in compliance)	Excavation Worker Soil Direct Contact Risk Based Level	Excavation Worker Fraction of Risk Based Target Concentration (values greater than 1 exceed the risk based target)	Excavation Worker Check for compliance with risk levels (0= in compliance; 1= not in compliance)
Benzene (c & nc)	nc	0.035	3,650.	9.59E-06	0	2,581.	1.36E-05	0
Toluene (nc)	nc	0.162	73,000.	2.22E-06	0	51,616.	3.14E-06	0
Ethylbenzene (c & nc)	nc	0.63	91,250.	6.90E-06	0	64,520.	9.76E-06	0
Xylenes (total) (nc)	nc	28.8	182,500.	1.58E-04	0	129,040.	2.23E-04	0
GRO Aromatics (nc)	nc	0.00E+00	182,500.	0.00E+00	0	129,040.	0.00E+00	0
DRO Aromatics (nc)	nc	1,611.	36,500.	0.0441	0	25,808.	0.0624	0
RRO Aromatics (nc)	nc	8,169.	27,375.	0.2984	0	19,356.	0.422	0
GRO Aliphatics (nc)	nc	53.0964	4,562,500.	1.16E-05	0	3,226,010.	1.65E-05	0
DRO Aliphatics (nc)	nc	5,381.	91,250.	0.059	0	64,520.	0.0834	0
RRO Aliphatics (nc)	nc	24,764.	1,825,000.	0.0136	0	1,290,404.	0.0192	0
Acenaphthene (nc)	nc	0.72	25,182.	2.86E-05	0	17,144.	4.20E-05	0
Acenaphthylene (nc)	nc	0.34	25,182.	1.35E-05	0	17,144.	1.98E-05	0
Anthracene (nc)	nc	0.46	185,098.	2.49E-06	0	127,918.	3.60E-06	0
Benzo(g,h,i)perylene (nc)	nc	0.12	12,591.	9.53E-06	0	8,572.	1.40E-05	0
Fluoranthene (nc)	nc	0.69	16,788.	4.11E-05	0	11,429.	6.04E-05	0
Fluorene (nc)	nc	1.6	21,123.	7.57E-05	0	14,499.	1.10E-04	0
Naphthalene (c & nc)	nc	1.9	12,543.	1.51E-04	0	8,675.	2.19E-04	0
Phenanthrene (nc)	nc	2.4	185,098.	1.30E-05	0	127,918.	1.88E-05	0
Pyrene (nc)	nc	0.59	12,591.	4.69E-05	0	8,572.	6.88E-05	0
Benzene (c & nc)	c	0.035	1,355.	2.58E-05	0	8,212.	4.26E-06	0
Ethylbenzene (c & nc)	c	0.162	No Sfo	0.00E+00	0	No Sfo	0.00E+00	0
Benzo(a)anthracene (c)	c	0.34	43.979	0.0077	0	274.	0.0012	0
Benzo(b)fluoranthene (c)	c	0.11	43.979	0.0025	0	274.	4.01E-04	0
Benzo(k)fluoranthene (c)	c	0.059	440.	1.34E-04	0	2,743.	2.15E-05	0
Benzo(a)pyrene (c)	c	0.0433	4.3979	0.0098	0	27.4304	0.0016	0
Chrysene (c)	c	0.35	4,398.	7.96E-05	0	27,430.	1.28E-05	0
Dibenz(a,h)anthracene (c)	c	0.004	4.3979	9.10E-04	0	27.4304	1.46E-04	0
Indeno(1,2,3-cd)pyrene (c)	c	0.054	43.979	0.0012	0	274.	1.97E-04	0
Naphthalene (c & nc)	c	1.9	No Sfo	0.00E+00	0	No Sfo	0.00E+00	0
1-Methylnaphthalene (nc)	nc	12	2,509.	0.0048	0	1,735.	0.0069	0
2-Methylnaphthalene (nc)	nc	14	2,509.	0.0056	0	1,735.	0.0081	0
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	c							
	c							
Carcinogenic Cumulative Risk				0.0225	0		0.0036	0
noncarcinogenic Cumulative Risk				0.0109	0		0.0158	0

Values shown in the fourth and seventh columns are the normalized fraction of the risk based level, and not the carcinogenic risk level. The fraction of risk multiplied by 10^ -5 equals the carcinogenic risk level for the carcinogenic compounds. Carcinogenic compounds shown in bold.

Table 5-13

Migration to Outdoor Air Vapor Inhalation Risks --Optional Site Visitor and Excavation Worker

Page 3

AOC C2

Yakutat, Alaska

1	2	3	4	5	6	7	8	9
Compounds		Vapor Concentration in Sample (based on 3 or 4-phase partitioning, whichever is accurate, mg/L)	Site Visitor Hypothetical Soil Vapor Concentration when HQ=1 or Target Risk =10^-5 (mg/L; from 3-phase equation)	Site Visitor Fraction of Risk Based Target Concentration (values greater than 1 exceed the risk based target)	Site Visitor Check for compliance with risk levels (0= in compliance; 1= not in compliance)	Excavation Worker Target Soil Vapor Concentration (Health Based Vapor Concentration Multiplied by the VF, etc.)	Excavation Worker Fraction of Risk Based Target Concentration (values greater than 1 exceed the risk based target)	Excavation Worker Check for compliance with risk levels (0= in compliance; 1= not in compliance)
Benzene (c & nc)	nc	4.64E-04	697.	6.66E-07	0	59.4826	7.80E-06	0
Toluene (nc)	nc	6.04E-04	96,923.	6.23E-09	0	8,276.	7.30E-08	0
Ethylbenzene (c & nc)	nc	7.05E-04	15,775.	4.47E-08	0	1,347.	5.24E-07	0
Xylenes (total) (nc)	nc	0.0169	1,582.	1.07E-05	0	135.	1.25E-04	0
GRO Aromatics (nc)	nc	0.00E+00	3,697.	0.00E+00	0	316.	0.00E+00	0
DRO Aromatics (nc)	nc	0.003	719.	4.11E-06	0	61.3731	4.81E-05	0
RRO Aromatics (nc)	nc	1.41E-06	No RfC	0.00E+00	0	No RfC	0.00E+00	0
GRO Aliphatics (nc)	nc	0.7753	513,812.	1.51E-06	0	43,873.	1.77E-05	0
DRO Aliphatics (nc)	nc	0.02	11,031.	1.81E-06	0	942.	2.12E-05	0
RRO Aliphatics (nc)	nc	4.29E-06	No RfC	0.00E+00	0	No RfC	0.00E+00	0
Acenaphthene (nc)	nc	6.92E-07	No RfC	0.00E+00	0	No RfC	0.00E+00	0
Acenaphthylene (nc)	nc	1.03E-06	No RfC	0.00E+00	0	No RfC	0.00E+00	0
Anthracene (nc)	nc	1.61E-08	No RfC	0.00E+00	0	No RfC	0.00E+00	0
Benzo(g,h,i)perylene (nc)	nc	1.31E-13	No RfC	0.00E+00	0	No RfC	0.00E+00	0
Fluoranthene (nc)	nc	1.43E-09	No RfC	0.00E+00	0	No RfC	0.00E+00	0
Fluorene (nc)	nc	5.87E-07	No RfC	0.00E+00	0	No RfC	0.00E+00	0
Naphthalene (c & nc)	nc	4.49E-05	5.491	8.18E-06	0	0.4689	9.58E-05	0
Phenanthrene (nc)	nc	1.32E-07	No RfC	0.00E+00	0	No RfC	0.00E+00	0
Pyrene (nc)	nc	2.10E-09	No RfC	0.00E+00	0	No RfC	0.00E+00	0
Benzene (c & nc)	**c**	4.64E-04	69.4642	6.68E-06	0	178.	2.61E-06	0
Ethylbenzene (c & nc)	**c**	7.05E-04	335.	2.11E-06	0	857.	8.23E-07	0
Benzo(a)anthracene (c)	**c**	6.88E-11	9.88E-04	6.97E-08	0	0.0025	2.72E-08	0
Benzo(b)fluoranthene (c)	**c**	1.62E-13	2.76E-05	5.86E-09	0	7.07E-05	2.29E-09	0
Benzo(k)fluoranthene (c)	**c**	1.02E-13	2.02E-04	5.06E-10	0	5.16E-04	1.98E-10	0
Benzo(a)pyrene (c)	**c**	4.09E-14	1.06E-06	3.85E-08	0	2.72E-06	1.50E-08	0
Chrysene (c)	**c**	5.33E-11	0.0436	1.22E-09	0	0.1117	4.78E-10	0
Dibenz(a,h)anthracene (c)	**c**	5.59E-16	2.52E-08	2.22E-08	0	6.46E-08	8.66E-09	0
Indeno(1,2,3-cd)pyrene (c)	**c**	2.73E-15	4.88E-06	5.61E-10	0	1.25E-05	2.19E-10	0
Naphthalene (c & nc)	**c**	4.49E-05	1.2561	3.58E-05	0	3.2177	1.40E-05	0
1-Methylnaphthalene (nc)	nc	6.58E-05	22.9191	2.87E-06	0	1.957	3.36E-05	0
2-Methylnaphthalene (nc)	nc	6.76E-05	19.281	3.51E-06	0	1.6463	4.11E-05	0
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Carcinogenic Cumulative Risk				4.47E-05	0		1.74E-05	0
noncarcinogenic Cumulative Risk				2.60E-05	0		3.04E-04	0

Values shown in the fourth and seventh columns are the normalized fraction of the risk based level, and not the carcinogenic risk level. The fraction of risk multiplied by 10^ -5 equals the carcinogenic risk level for the carcinogenic compounds. Carcinogenic compounds shown in bold.

Table 5-13 Groundwater Ingestion Risk (Measured Concentrations) -- Optional Site Visitor and Excavation Worker

Page 4 AOC C2 Yakutat, Alaska

1	2	3	4	5	6	7	8	9	10	11	12
Compounds		Dissolved Concentration Measured in Water Sample (mg/l)	FYI Maximum Contaminant Level (mg/L)	Site Visitor Human Health Risk Based Water Concentration (mg/l)	Site Visitor Groundwater Compliance Concentration (Health Based Water Concentration in source area; mg/l)	Site Visitor Fraction of Risk Based Target Concentration (values greater than 1 exceed the risk based target; MCLs not used)	Site Visitor Check for compliance with regulatory levels (0= in compliance; 1= not in compliance)	Excavation Worker Human Health Based Water Concentration (mg/l)	Excavation Worker Groundwater Compliance Concentration (Health Based Water Concentration in source area; mg/l)	Excavation Worker FYI Fraction of Risk Based Target Concentration (values greater than 1 exceed the risk based target; MCLs not used)	Excavation Worker Check for compliance with regulatory levels (0= in compliance; 1= not in compliance)
Benzene (c & nc)	nc	4.00E-04	0.005	NA	NA	0.00E+00	0	17.0333	17.0333	2.35E-05	0
Toluene (nc)	nc	0.0014	1.	NA	NA	0.00E+00	0	341.	341.	4.11E-06	0
Ethylbenzene (c & nc)	nc	2.80E-04	0.7	NA	NA	0.00E+00	0	426.	426.	6.58E-07	0
Xylenes (total) (nc)	nc	0.0039	10.	NA	NA	0.00E+00	0	852.	852.	4.57E-06	0
GRO Aromatics (nc)	nc	0.012		NA	NA	0.00E+00	0	852.	852.	1.41E-05	0
DRO Aromatics (nc)	nc	0.661		NA	NA	0.00E+00	0	170.	170.	0.0039	0
RRO Aromatics (nc)	nc	2.9		NA	NA	0.00E+00	0	128.	128.	0.0227	0
GRO Aliphatics (nc)	nc	0.0376		NA	NA	0.00E+00	0	21,292.	21,292.	1.77E-06	0
DRO Aliphatics (nc)	nc	1.62		NA	NA	0.00E+00	0	426.	426.	0.0038	0
RRO Aliphatics (nc)	nc	10.		NA	NA	0.00E+00	0	8,517.	8,517.	0.0012	0
Acenaphthene (nc)	nc	5.00E-05		NA	NA	0.00E+00	0	256.	256.	1.96E-07	0
Acenaphthylene (nc)	nc	1.60E-05		NA	NA	0.00E+00	0	256.	256.	6.26E-08	0
Anthracene (nc)	nc	1.50E-05		NA	NA	0.00E+00	0	1,278.	1,278.	1.17E-08	0
Benzo(g,h,i)perylene (nc)	nc	3.10E-05		NA	NA	0.00E+00	0	128.	128.	2.43E-07	0
Fluoranthene (nc)	nc	3.20E-05		NA	NA	0.00E+00	0	170.	170.	1.88E-07	0
Fluorene (nc)	nc	1.40E-04		NA	NA	0.00E+00	0	170.	170.	8.22E-07	0
Naphthalene (c & nc)	nc	0.0014		NA	NA	0.00E+00	0	85.1667	85.1667	1.64E-05	0
Phenanthrene (nc)	nc	2.10E-04		NA	NA	0.00E+00	0	1,278.	1,278.	1.64E-07	0
Pyrene (nc)	nc	4.70E-05		NA	NA	0.00E+00	0	128.	128.	3.68E-07	0
Benzene (c & nc)	**c**	4.00E-04	0.005	NA	NA	0.00E+00	0	54.197	54.197	7.38E-06	0
Ethylbenzene (c & nc)	**c**	2.80E-04	0.7	NA	NA	0.00E+00	0	No Sfo	No Sfo	0.00E+00	0
Benzo(a)anthracene (c)	**c**	1.93E-14	0.001	NA	NA	0.00E+00	0	4.0833	4.0833	4.74E-15	0
Benzo(b)fluoranthene (c)	**c**	4.64E-33	0.001	NA	NA	0.00E+00	0	4.0833	4.0833	1.14E-33	0
Benzo(k)fluoranthene (c)	**c**	1.24E-32	0.001	NA	NA	0.00E+00	0	40.8333	40.8333	3.04E-34	0
Benzo(a)pyrene (c)	**c**	7.42E-33	2.00E-04	NA	NA	0.00E+00	0	0.4083	0.4083	1.82E-32	0
Chrysene (c)	**c**	2.90E-14	0.1	NA	NA	0.00E+00	0	408.	408.	7.11E-17	0
Dibenz(a,h)anthracene (c)	**c**	5.84E-89	1.00E-04	NA	NA	0.00E+00	0	0.4083	0.4083	1.43E-88	0
Indeno(1,2,3-cd)pyrene (c)	**c**	2.09E-91	0.001	NA	NA	0.00E+00	0	4.0833	4.0833	5.13E-92	0
Naphthalene (c & nc)	**c**	0.0014		NA	NA	0.00E+00	0	No Sfo	No Sfo	0.00E+00	0
1-Methylnaphthalene (nc)	nc	0.0011		NA	NA	0.00E+00	0	17.0333	17.0333	6.46E-05	0
2-Methylnaphthalene (nc)	nc	0.0011		NA	NA	0.00E+00	0	17.0333	17.0333	6.46E-05	0
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	c										
Carcinogenic Cumulative Risk						0.00E+00	0			7.38E-06	0
noncarcinogenic Cumulative Risk						0.00E+00	0			1.80E-04	0

Values shown in the seventh and eleventh columns are the normalized fraction of the risk based level, and not the carcinogenic risk level. The fraction of risk multiplied by 10^ -5 equals the carcinogenic risk level for the carcinogenic compounds. Carcinogenic compounds shown in bold.

If the groundwater is non-potable then groundwater ingestion risk is zero.

Table 5-13 Potential Cumulative Risk Assuming All Pathways Complete-- Optional Site Visitor and Excavation Worker

Page 5

AOC C2

Yakutat, Alaska

1	2	3	4	5	6	7	8	9	10	11	12
Compounds		Site Visitor Fraction of Target Soil Direct Contact Risk	Site Visitor Fraction of Target Outdoor Air Inhalation Risk	Site Visitor Fraction of Target Groundwater Ingestion Risk	Site Visitor Sum of Fraction of Risk Values	Site Visitor Check for compliance with risk levels (0= in compliance; 1= not in compliance)	Excavation Worker Fraction of Target Soil Direct Contact Risk	Excavation Worker Fraction of Target Outdoor Air Inhalation Risk	Excavation Worker Fraction of Target Groundwater Ingestion Risk	Excavation Worker Sum of Fraction of Risk Values	Excavation Worker Check for compliance with risk levels (0= in compliance; 1= not in compliance)
Benzene (c & nc)	nc	9.59E-06	6.66E-07	0.00E+00	1.03E-05	0	1.36E-05	7.80E-06	2.35E-05	4.48E-05	0
Toluene (nc)	nc	2.22E-06	6.23E-09	0.00E+00	2.23E-06	0	3.14E-06	7.30E-08	4.11E-06	7.32E-06	0
Ethylbenzene (c & nc)	nc	6.90E-06	4.47E-08	0.00E+00	6.95E-06	0	9.76E-06	5.24E-07	6.58E-07	1.09E-05	0
Xylenes (total) (nc)	nc	1.58E-04	1.07E-05	0.00E+00	1.68E-04	0	2.23E-04	1.25E-04	4.57E-06	3.53E-04	0
GRO Aromatics (nc)	nc										
DRO Aromatics (nc)	nc										
RRO Aromatics (nc)	nc										
GRO Aliphatics (nc)	nc										
DRO Aliphatics (nc)	nc										
RRO Aliphatics (nc)	nc										
Acenaphthene (nc)	nc	2.86E-05	0.00E+00	0.00E+00	2.86E-05	0	4.20E-05	0.00E+00	1.96E-07	4.22E-05	0
Acenaphthylene (nc)	nc	1.35E-05	0.00E+00	0.00E+00	1.35E-05	0	1.98E-05	0.00E+00	6.26E-08	1.99E-05	0
Anthracene (nc)	nc	2.49E-06	0.00E+00	0.00E+00	2.49E-06	0	3.60E-06	0.00E+00	1.17E-08	3.61E-06	0
Benzo(g,h,i)perylene (nc)	nc	9.53E-06	0.00E+00	0.00E+00	9.53E-06	0	1.40E-05	0.00E+00	2.43E-07	1.42E-05	0
Fluoranthene (nc)	nc	4.11E-05	0.00E+00	0.00E+00	4.11E-05	0	6.04E-05	0.00E+00	1.88E-07	6.06E-05	0
Fluorene (nc)	nc	7.57E-05	0.00E+00	0.00E+00	7.57E-05	0	1.10E-04	0.00E+00	8.22E-07	1.11E-04	0
Naphthalene (c & nc)	nc	1.51E-04	8.18E-06	0.00E+00	1.60E-04	0	2.19E-04	9.58E-05	1.64E-05	3.31E-04	0
Phenanthrene (nc)	nc	1.30E-05	0.00E+00	0.00E+00	1.30E-05	0	1.88E-05	0.00E+00	1.64E-07	1.89E-05	0
Pyrene (nc)	nc	4.69E-05	0.00E+00	0.00E+00	4.69E-05	0	6.88E-05	0.00E+00	3.68E-07	6.92E-05	0
Benzene (c & nc)	**c**	2.58E-05	6.68E-06	0.00E+00	3.25E-05	0	4.26E-06	2.61E-06	7.38E-06	1.43E-05	0
Ethylbenzene (c & nc)	**c**	0.00E+00	2.11E-06	0.00E+00	2.11E-06	0	0.00E+00	8.23E-07	0.00E+00	8.23E-07	0
Benzo(a)anthracene (c)	**c**	0.0077	6.97E-08	0.00E+00	0.0077	0	0.0012	2.72E-08	4.74E-15	0.0012	0
Benzo(b)fluoranthene (c)	**c**	0.0025	5.86E-09	0.00E+00	0.0025	0	4.01E-04	2.29E-09	1.14E-33	4.01E-04	0
Benzo(k)fluoranthene (c)	**c**	1.34E-04	5.06E-10	0.00E+00	1.34E-04	0	2.15E-05	1.98E-10	3.04E-34	2.15E-05	0
Benzo(a)pyrene (c)	**c**	0.0098	3.85E-08	0.00E+00	0.0098	0	0.0016	1.50E-08	1.82E-32	0.0016	0
Chrysene (c)	**c**	7.96E-05	1.22E-09	0.00E+00	7.96E-05	0	1.28E-05	4.78E-10	7.11E-17	1.28E-05	0
Dibenz(a,h)anthracene (c)	**c**	9.10E-04	2.22E-08	0.00E+00	9.10E-04	0	1.46E-04	8.66E-09	1.43E-88	1.46E-04	0
Indeno(1,2,3-cd)pyrene (c)	**c**	0.0012	5.61E-10	0.00E+00	0.0012	0	1.97E-04	2.19E-10	5.13E-92	1.97E-04	0
Naphthalene (c & nc)	**c**	0.00E+00	3.58E-05	0.00E+00	3.58E-05	0	0.00E+00	1.40E-05	0.00E+00	1.40E-05	0
1-Methylnaphthalene (nc)	nc	0.0048	2.87E-06	0.00E+00	0.0048	0	0.0069	3.36E-05	6.46E-05	0.007	0
2-Methylnaphthalene (nc)	nc	0.0056	3.51E-06	0.00E+00	0.0056	0	0.0081	4.11E-05	6.46E-05	0.0082	0
	nc										
	nc										
	nc										
	nc										
	nc										
	c										
	c										
	c										
	c										
	c										
	c										
	c										
Carcinogenic Cumulative Risk					0.0225	0				0.0036	0
noncarcinogenic Cumulative Risk					0.0109	0				0.0163	0

Values shown in the second through sixth and eighth through twelfth columns are the normalized fraction of the risk based level, and not the carcinogenic risk level. The fraction of risk multiplied by 10^ -5 equals the carcinogenic risk level for the carcinogenic compounds. Carcinogenic compounds shown in bold.

DRO, GRO and RRO not included in cumulative risk calculations

Table 5-13 Site Status Summary-- Optional Site Visitor and Excavation Worker Scenarios

Page 6

AOC C2

Yakutat, Alaska

1	2	3	4	5	6	7	8
		Site Visitor Cumulative Risks	Site Visitor check for GRO, DRO, RRO compliance	Excavation Worker Cumulative Risks	Excavation Worker check for GRO, DRO, RRO compliance		
Potential Carcinogenic Cumulative Fraction of Risk		**0.0225**		**0.0036**			
Potential noncarcinogenic Cumulative Risk		**0.0109**		**0.0163**			
GRO Aromatics			0		0		
DRO Aromatics			0		0		
RRO Aromatics			0		0		
GRO Aliphatics			0		0		
DRO Aliphatics			0		0		
RRO Aliphatics			0		0		
check for GRO, DRO, RRO compliance			**0**		**0**		
Site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. Site conditions are protective of human health for the specified site visitor scenario.							**0**
Site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. Site conditions are protective of human health for the specified excavation worker scenario.							**0**

Table 5-14: AOC C2 Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
Benzene (c & nc)	0.035	0.025	MTGW	0.015	MTGW	0.035	NA	0.136	MTGW
1-Methylnaphthalene (nc)	12	6.2	MTGW	6.9	MTGW	12	NA	228	Soil Direct Contact
2-Methylnaphthalene (nc)	14	6.1	MTGW	6.7	MTGW	14	NA	204	Soil Direct Contact
total DRO	19000[a]	230	MTGW	780	MTGW	6992	12500	10779	Soil Direct Contact
total RRO	86000[a]	8300	Direct Contact	8300	Ingestion	32933[a]	22000	10033	Soil Direct Contact

Notes:
[a] = Exceeds the ADEC maximum allowable concentration under Method Two, Table B2.
ACL = alternate cleanup level
(c) = carcinogen
DRO = diesel-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
MTGW = migration to groundwater
NA = not applicable
(nc) = non-carcinogen
RRO = residual-range organics

Table 5-15: AOC C2 Source Area RRO Soil Results Exceeding ACL

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	RRO (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	RRO ACL (mg/kg)
C2	C2-TP07	2-3	6/9/2014	C2-TP07-2.0-3.0-0614	39000[a]	22000	10033
C2	C2-TP08	2-3	6/9/2014	C2-TP08-2.0-3.0-0614	12000		
C2	C2-TP10	3-4	6/10/2014	C2-TP10-3.0-4.0-0614	86000[a]		

Notes:
[a] = Exceeds the ADEC maximum allowable concentration under Method 2, Table B2.
ACL = alternate cleanup level
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram

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6.0 AOC C4 – POINT CARREW GARRISON AREA SURFACE DEBRIS

6.1 AREA DESCRIPTION AND BACKGROUND

AOC C4 is located on Phipps Peninsula in a wooded area along the access trail between AOC C2 and Point Carrew Road, southwest of a former powerhouse (AOC C3). Partially buried debris, including drums and fuel cans, were observed on the ground surface at AOC C4.

Previous investigations have indicated DRO is present in soil at concentrations above the Method Two cleanup level at this AOC. A geophysical survey conducted at the former powerhouse in 2000 identified two areas with elevated magnetic and electromagnetic responses, indicating metal debris buried in the vicinity of AOC C4. Soil samples collected from the area had DRO concentrations of 1,300 mg/kg (0 to 2 feet bgs) and 2,400 mg/kg (2 to 4 feet bgs), exceeding cleanup levels (ENSR 2003a).

In 2005, USACE utilized ROST/LIF techniques which identified the presence of fuel contamination (diesel) in the soil and provided information to define the lateral and vertical extent of these impacts (USACE 2006).

Previous investigations at the site show that DRO was detected in groundwater and although concentrations were below the ADEC Table C cleanup level, the presence of DRO in groundwater confirms that contamination is also present in the saturated zone (ENSR 2003a).

Data collected during previous investigations were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at AOC C4. These data, along with field screening results and visual observations, were reviewed to select appropriate sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations and the estimated contaminant (NAPL) source areas at AOC C4, as well as C2, are shown on Figure 5-1.

6.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC C4 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Using test pits, determine what type of debris remains in the subsurface associated with elevated geophysical responses.
- Evaluate current groundwater conditions.

6.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC C4 included excavation of test pits, installation of a temporary well point, and collection of soil and groundwater samples. These activities are described below by media. Due to the close proximity to the AOC C2 site, discussions in this section will refer to Section 5.0 figures, which are inclusive of AOC C4.

6.3.1 Soil

At AOC C4, four test pits were initially excavated: two locations (C4-TP01 and C4-TP02) were selected to visually identify the type of debris in the subsurface at areas showing strong electromagnetic response; one at the location with highest ROST/LIF response (C4-TP03); and another from a previous surface soil sample location with high DRO concentrations (C4-TP04). Test pits were excavated in 1- to 2-feet lifts with samples collected from each lift and screened with a PID for volatile vapors.

No evidence of debris, a POL source, or soil impacts were observed at C4-TP01. Similarly, with the exception of a few pieces of concrete at shallow depths, there was no evidence of a POL source or impacts to soil at C4-TP03 excavated to 10 feet bgs. At test pit C4-TP02, remnants of a 55-gal drum were evident at the ground surface and two large pieces of concrete with petroleum sheen (along with other minor debris) were observed in the top 4 feet of the excavation. Soils extending to the water table (approximately 7 to 8 feet bgs) had a slight hydrocarbon odor. The location of C4-TP04 was adjacent to a low lying drainage area with standing water. A large concrete slab located just bgs was encountered during test pit excavation at this location (Figure 5-2), and a few pieces of wood and slight hydrocarbon odor were noted beneath the pad. Perched water was encountered at shallow depths, and adjacent standing water prohibited extending this excavation below 4 feet bgs. Since no impacts were found in C4-TP01 and TP03, a fifth test pit was excavated between C4-TP02 and TP04 to obtain source zone data for the HRC. A large piece of rusted metal was uncovered in C4-TP05 and a diesel-like odor was noted in soils to approximately 8 feet bgs. Test pit locations for AOC C4 are shown on Figure 5-1 and Figure 5-2**,** and test pit logs are included in Appendix C.

Soils encountered at AOC C4 were similar to those observed at AOC C2 and consisted of two predominant soil types. The surficial soils consist of brown, fine to coarse sand with gravel and few cobbles. This soil is coarsely bedded extending to approximately 4 feet bgs and grades to gray sandy silt or silty sand with few cobbles and small boulders. As verified by field screening, the two target samples from C4-TP04 and three samples from C4-TP02 were submitted for laboratory analysis. However, since POL impacts were not noted in test pits C4-TP01 and TP03, only the sample immediately above the estimated water table (smear zone) from each test pit was submitted for analysis. To supplement data for HRC, four samples from C4-TP05 were submitted for laboratory analysis. All samples were analyzed for GRO, DRO, RRO, BTEX and PAHs, and samples from C4-TP02, TP04 and TP05 were also analyzed for VPH and EPH. Field observations and screening results at the C4 test pits were used to refine the estimated limits of the NAPL source areas shown on Figure 5-1.

BACKGROUND SOIL CONDITIONS

Because AOCs C2 and C4 are adjacent to each other and the soil types observed are similar, evaluation of background soil conditions apply to both sites. Refer to Section 5.3.1 for a discussion of background soil sampling activities.

6.3.2 Groundwater

Proposed groundwater assessment at AOC C4 included sampling of two existing monitoring wells located inside (AP-020) and outside (AP-019) of the source zone; however, both wells were damaged beyond repair for sampling purposes. In order to obtain groundwater data for HRC within the AOC C4 source zone, a temporary well was installed at the location of C4-TP05 (C4-WP01). The temporary well point was installed by digging a trench to a depth just above groundwater and driving a temporary screen point approximately 1 to 2 feet into the water table (Section 3.4.3). Well locations are shown on Figure 5-1.

During purging and sampling at C4-WP01, the flow rate on the peristaltic pump was reduced as low as possible in attempts to prevent groundwater drawdown within the well screen. However, the minimal water column and low yield resulted in purging the well point dry over a short period. Sampling was performed after C4-WP01 had recharged sufficiently with groundwater collected and analyzed for GRO, DRO, RRO, BTEX, PAHs, and VPH/EPH. The temporary well was abandoned prior to demobilization of the excavator from the site after confirmation of sample receipt from the laboratory. Procedures for purging and sampling the temporary well points are discussed in Section 3.4.3, and Low Flow Groundwater Sample Collection Records are included in Appendix D.

Temporary well point C4-WP01 had a total well depth of 11.1 feet bgs. While there is the possibility for the use of a peristaltic pump to cause loss of volatiles using a vacuum to draw the water, very little vacuum and minimal vertical lift were required to collect samples at this shallow well point; thus, very little volatilization was expected to occur during the sampling process. This is supported by the ADEC *Vapor Intrusion Guidance for Contaminated Sites* (ADEC 2012b), which states: "[peristaltic pumps] should only be used for sampling [volatile compounds in] shallow groundwater (less than 15 feet from the ground surface)". While the volatile results (GRO, BTEX, and VPH) may be biased low, they are considered adequate for use as definitive data.

AQUIFER TESTING

Aquifer testing was proposed for two existing monitoring wells at AOC C4. However, these wells were either damaged (AP-020) or destroyed (AP-019) and the slug tests could not be performed.

6.4 GROUNDWATER CONDITIONS

A potentiometric map was developed to evaluate groundwater flow beneath the AOC C2/C4 area. Water level gauging could not be performed at several wells that had been damaged or destroyed; therefore, historical gauging data were used to prepare the groundwater contours. The groundwater potentiometric surface and estimated flow direction measured are presented on Figure 5-4. Groundwater contours show that the direction of shallow flow in the vicinity of AOC C4 is to the southeast, with a horizontal gradient of approximately 0.018 ft/ft.

Since several wells at AOC C2/C4 were damaged or destroyed, aquifer testing could only be performed at well AP-024. Therefore, a hydraulic conductivity value of 0.010 ft/day estimated for well AP-024 (located northeast of AOC C4) was used for input in the HRC for AOC C4. Refer to Section 5.4 for a discussion on aquifer test results for AP-024.

6.5 ANALYTICAL RESULTS

6.5.1 Soil

Eleven soil samples collected from five test pits at AOC C4 were submitted for laboratory analyses. These data were collected from the most highly contaminated soils to further characterize the NAPL source zone. Results show that eight samples from three test pits (C4-TP02, TP04 and TP05) had DRO concentrations above the Method Two cleanup level with concentrations ranging from 310 mg/kg to 7,300 mg/kg. Additionally, benzo(a)pyrene exceeded the Method Two cleanup level in C4-TP05. Soil analytical results for the samples collected in 2014 are presented in summary tables provided in Appendix J. Sample locations are shown on Figure 5-1 and a cross sectional view of the site showing the vertical extent of impacts is presented along A-A’ as Figure 5-3.

Constituent data collected within the defined source zone were used to supplement the historical data set for characterization of the NAPL source zone. Historical and recent (2014) POL data evaluated for the AOC C4 area are presented in Table 6-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 6-2. Historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attention of these constituents. PAH soil data are presented in Table 6-3, and VPH/EPH results are presented in Table 6-4. These data were used as input in calculating soil ACLs and to evaluate risk at AOC C4 using the HRC.

6.5.2 Groundwater

Groundwater samples were collected from temporary well C4-WP01 installed inside the source zone at AOC C4. Hydrocarbon odors and slight sheen were noted on the purge water from the temporary well. Analytical results indicate that DRO was detected above the Table C cleanup level in groundwater. Analytical results are summarized in Appendix J. Current groundwater data and the most recent historical data (where 2014 data were not available) are considered to be representative of groundwater quality conditions at the site and were compared to the Table C groundwater cleanup levels (18 AAC 75). Constituent concentrations exceeding the cleanup levels at AOC C4 are presented in Figure 5-4.

Results from C4-WP01 were used to supplement historical groundwater data from AOC C4. Historical and recent (2014) groundwater results for POLs, PAHs, and VPH/EPH are presented in Table 6-5 through Table 6-7, respectively.

6.6 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC C4; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

6.6.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet ADEC "Cleanup Complete" criteria, the AOC C4 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion).

The AOC C4 risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at the site at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be incomplete at the present time, because there are no occupied buildings within 30 feet of the AOC C4 source area. There is currently no exposure to groundwater at the present time, because there are no known drinking water wells within the radius of influence at the site. The exposure pathways associated with surface water and sediment are considered insignificant since current data indicate that these media meet regulatory standards and/or screening guidance. Further, migration from the site to the adjacent pond via runoff is unlikely since soil impacts at AOC C4 are localized in a depression west of the access road, which acts as a berm or divide between the site and the adjacent pond.

The AOC C4 exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC's *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

6.6.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each hydrocarbon constituent (BTEX 2014 data only) and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in Table 6-2. The source area data set for toluene, total xylenes and GRO had a limited number of relatively low concentration detections, so the maximum detected values from the source area were used as exposure point concentrations. Benzene and ethylbenzene were not detected; therefore, the LOD values were used as the exposure point concentrations. There were adequate data to calculate 95% UCLs for DRO and RRO; therefore, ProUCL was used to calculate 95% UCLs for HRC input. ProUCL formatted outputs are displayed in Table 6-8a.

Table 6-9 presents the ProUCL outlier test results for DRO and RRO, and as shown, the tests indicated that the highest DRO and RRO concentrations (7,300 mg/kg and 3,600 mg/kg respectively) are statistical outliers. However, these results were carried forward into the HRC. The inclusion of the outliers in the 95% UCL calculation will tend to increase the 95% UCL value relative to the population average (i.e., the 95% UCL becomes more conservative). A Q-Q plot and box plot of the DRO and RRO source area data are presented in Figure 6-1a and Figure 6-1b and Figure 6-1c and Figure 6-1d, respectively. The Q-Q and box plots show that the highest DRO and RRO concentrations graph significantly above the other data, which also suggests that the highest DRO and RRO results are statistical outliers.

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 6-3. Benzo(a)anthracene, benzo(a)pyrene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene at AOC C4 had maximum concentrations that presented a significant fraction of risk and had a sufficient number of detections to calculate 95% UCLs; therefore, the 95% UCL concentrations were calculated and used as exposure point concentrations (Table 6-8b). The maximum detected concentrations were used as the exposure point concentrations for the remaining PAH constituents at AOC C4.

Nine VPH and EPH source area samples were used to characterize the bulk hydrocarbon chemistry. The HRC input values, calculated from the source area VPH/EPH data, are shown in Table 6-4.

The source of each HRC soil exposure point input value is documented in Table 6-10a.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

Benzene and ethylbenzene were not detected; therefore, the maximum LODs for the samples collected from the source area well were used as the exposure point concentrations. Toluene, xylene, GRO, DRO and RRO were detected in groundwater, so the maximum detected concentrations were used as input to the HRC. In addition, the maximum GRO, DRO and RRO aromatic and aliphatic concentrations (derived from the VPH/EPH test results) were used as input to the HRC.

All of the PAH constituents were detected during the 2014 groundwater sampling event; therefore, the maximum detected concentrations were used as the exposure point concentrations in the HRC risk evaluation.

The source of each HRC groundwater exposure point input value is documented in Table 6-10a.

6.6.3 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for the risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to AOC C4 is presented in Table 6-10b.

6.6.4 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results is included as Table N-2 of Appendix N and the risk posed by site conditions is summarized in Table 6-11 and Table 6-12. Table N-2 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for AOC C4 indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and assuming that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).
- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aromatic and aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.
- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, the site conditions are protective of human health under an unrestricted (residential) land use scenario.

6.7 ALTERNATIVE CLEANUP LEVELS

Constituents and/or hydrocarbon fractions exceeding the ADEC Method Two cleanup levels at AOC C4 include benzo(a)pyrene and DRO. Soil ACLs have been developed for these constituents and/or hydrocarbon fractions as shown in Table 6-13.

Benzo(a)pyrene exceeds the soil direct contact cleanup level and DRO exceeds the Method Two migration to groundwater cleanup levels. The benzo(a)pyrene soil direct contact cleanup level in the regulations is correctly calculated, so there is not an alternative risk based cleanup level that can be calculated. However, the 95% UCL concentration is below the risk based concentration indicating that the site meets the standard for the soil direct contact exposure route. DRO concentrations exceed the migration to groundwater cleanup level; however, the migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult's Law) and dilution-attenuation calculations are applied, the DRO exposure point concentration meets the migration to groundwater criteria. Under these conditions, it is typically not necessary to calculate ACLs, but for this contract ACLs have been back calculated for site COPCs and are presented in Table 6-13. The exposure point concentrations at AOC C4 are less than the calculated ACLs using the HRC, which demonstrates that the site meets the ADEC migration to groundwater criteria.

6.8 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at AOC C4 was evaluated and a preliminary ecological CSM developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. Detected constituents (metals) are included in the ecoscoping discussion below; however, since these compounds were not detected above the ADEC Method Two soil cleanup levels, they were not discussed in previous sections.

A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at the AOC C4 site are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.
- Petroleum hydrocarbons in surface soil cover 0.03 acre, which is less than the ADEC 0.5 acre *de minimis* criterion. In addition, the overall area (the combined AOC C4 and AOC C2) is approximately 0.27 acres, still well below the *de minimis* criterion. Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.
- Low levels of several bioaccumulative metals have been detected in surface soil (ENSR 2003a). However, these metals are likely attributed to natural conditions and, therefore, are not considered further in the evaluation.
- Overland migration of surface impacts via runoff/erosion to the nearest surface water body (e.g., nearby pond) is unlikely based on the surface contamination being localized within a depression across the access road, which acts as a berm or divide between the site and the adjacent pond.
- Groundwater from the well installed in the NAPL-contaminated soil source area meets the TAH and TAqH Alaska WQS criteria. Any possible groundwater discharge from the site to surface water would be downgradient of the source, indicating ambient water quality criteria at groundwater discharge points must be met (i.e., dissolved concentrations would not increase downgradient of the soil source). Groundwater is unlikely to result in a surface-water sheen because this can only be created when the NAPL contaminated soil source area extends to the groundwater discharge location. In addition, groundwater connection from AOC C4 to the pond is unlikely. The groundwater elevation measured at AOC C4 relative to the water elevations measured at AOC C2 and the pond indicates that the pond may be perched above a regional aquifer identified at AOC C4, or a groundwater recharge point.

Risk to the environment has been evaluated using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation is not needed and AOC C4 site conditions are protective of the environment.

FIGURE 6-1a: AOC C4 DRO Q-Q Plot

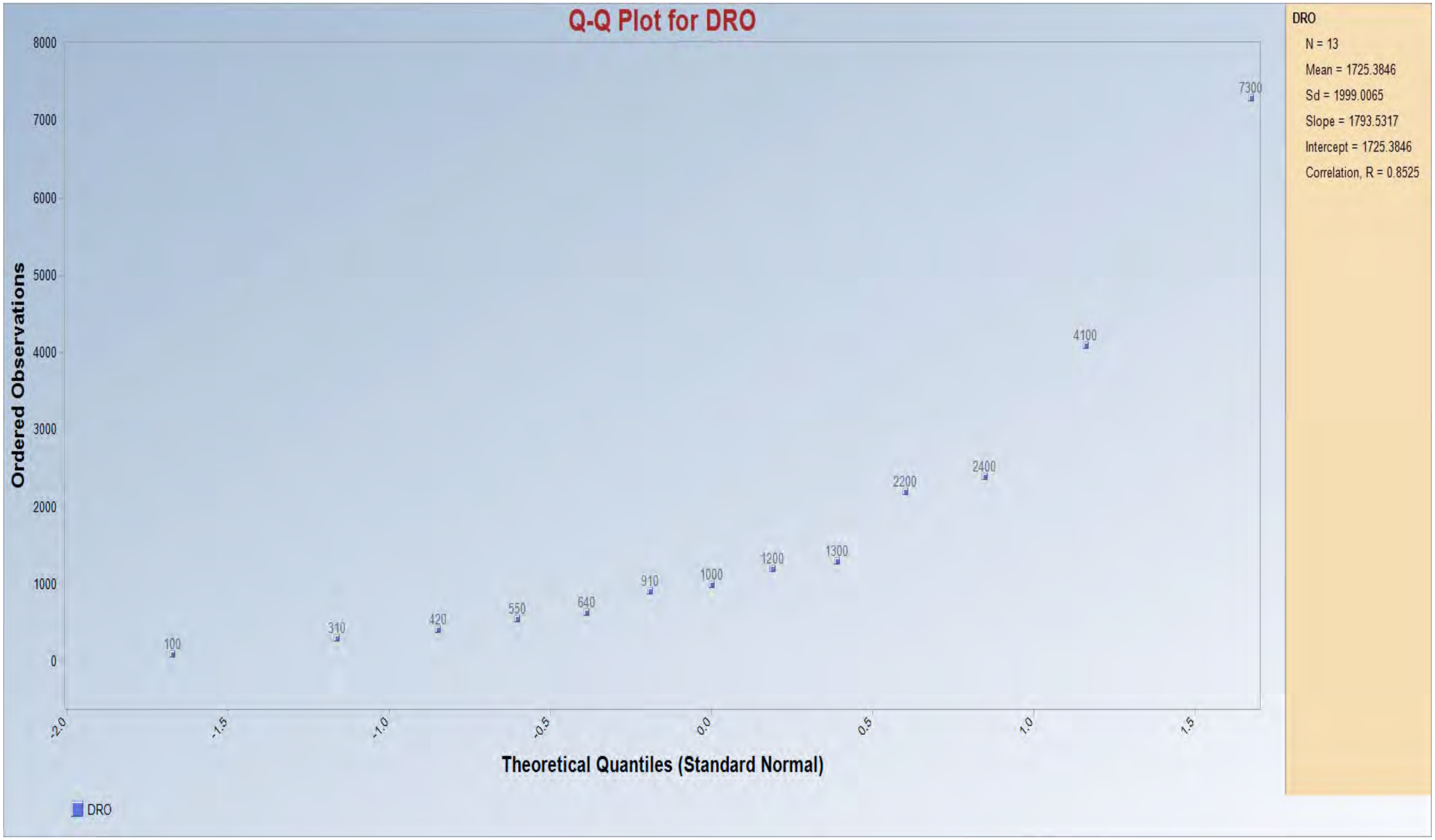

FIGURE 6-1b: AOC C4 DRO Box Plot

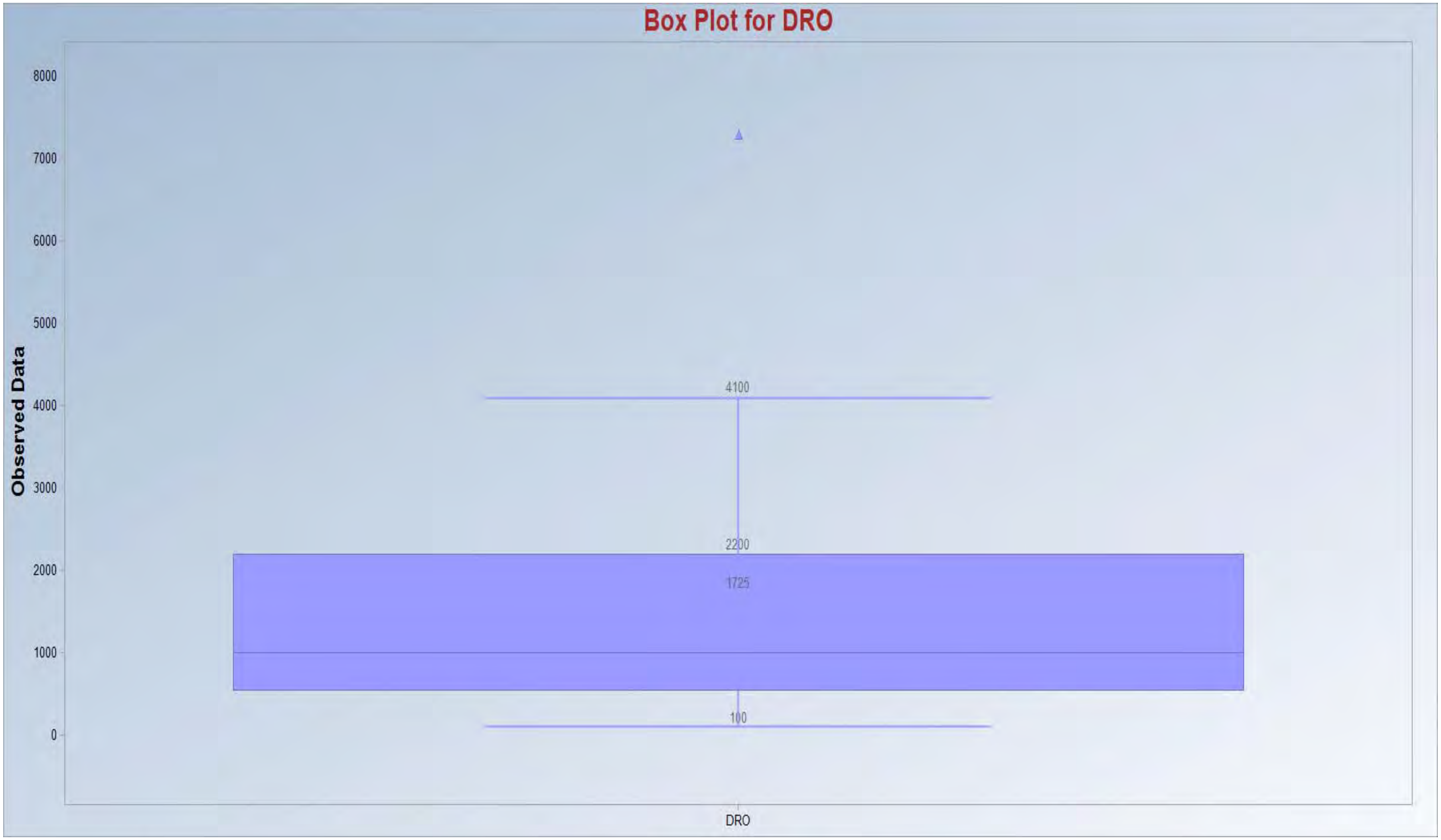

FIGURE 6-1c: AOC C4 RRO Q-Q Plot

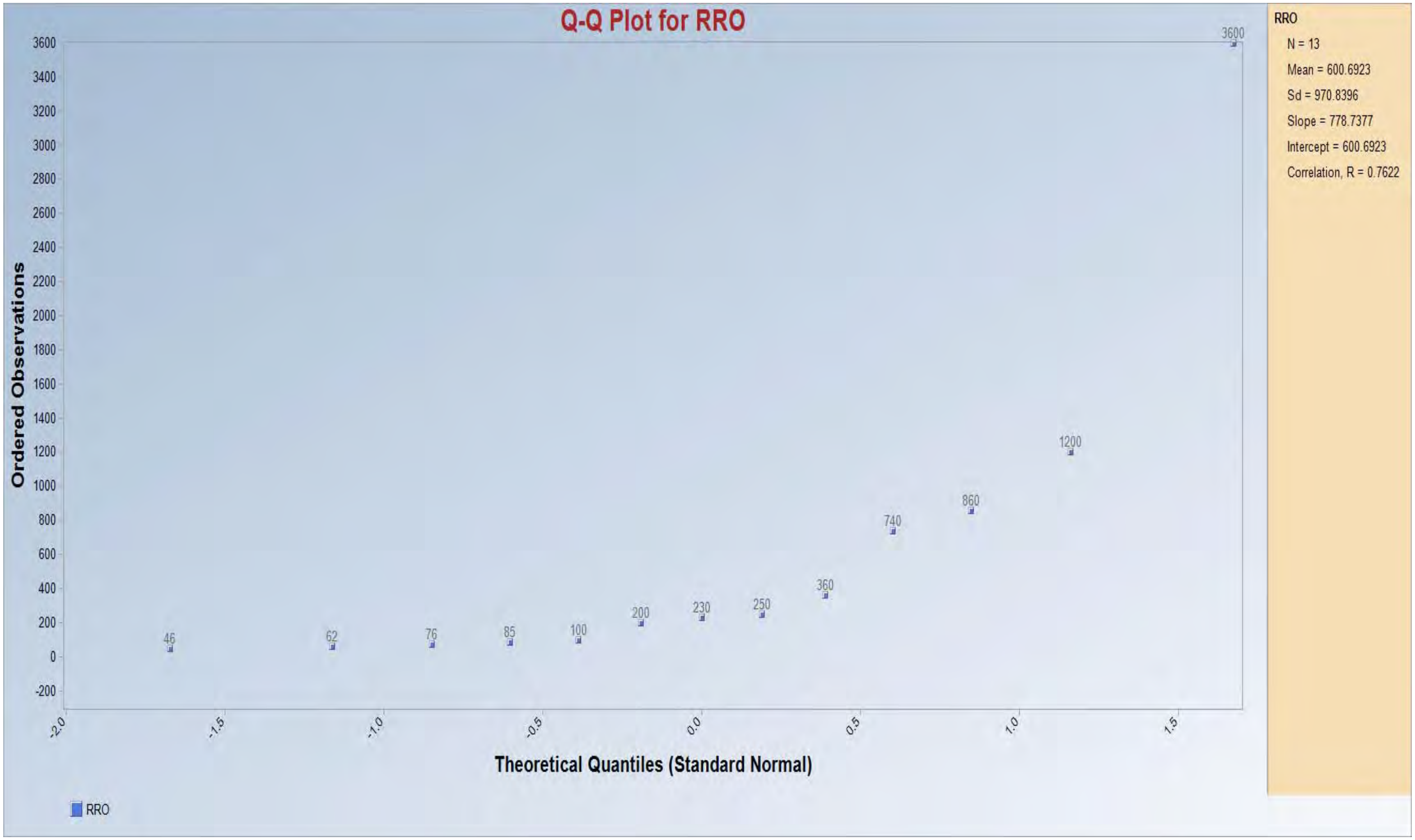

FIGURE 6-1d: AOC C4 RRO Q-Q Plot

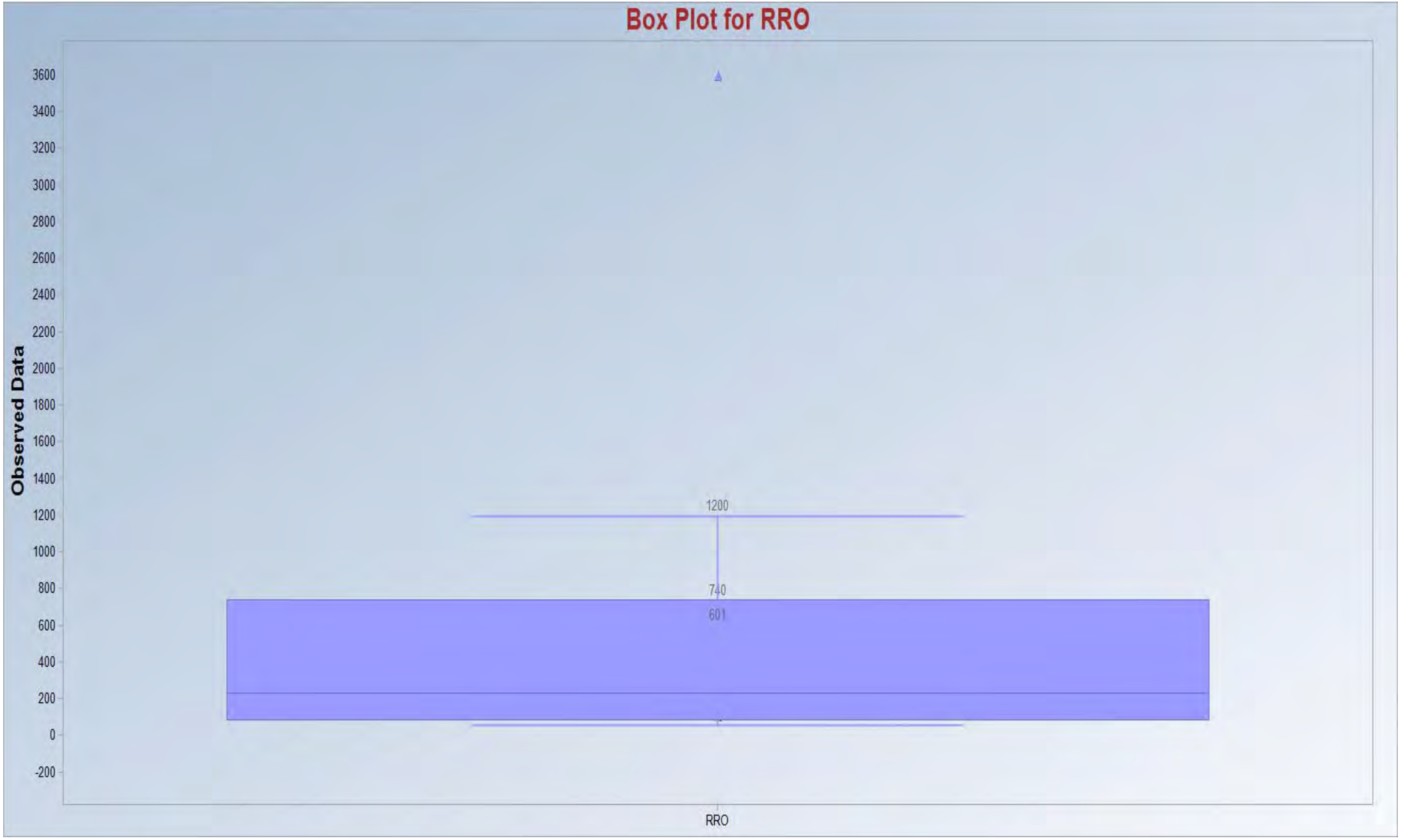

Table 6-1: AOC C4 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
C4	AP-019	0-2	9/24/2000	00C2B1001SO	<1 U	<19 U	<19 U	--	--	--	--
C4	AP-019	2-4	9/24/2000	00C2B1002SO	<1 U	<21 U	<20 U	--	--	--	**0.001 U,**
C4	AP-020	0-2	9/24/2000	00C2B2003SO	**5**	**1300**	**76**	<0.13 U	<0.13 U	<0.13 U	<0.39 U
C4	AP-020	2-4	9/24/2000	00C2B2004SO	**3**	**2400**	**100**	<0.15 U	<0.15 U	**0.001**	<0.151 U
C2	AP-023	0-2	9/26/2000	00C2B5009SO	<1 U	<18 U	<18 U	--	--	--	--
C2	AP-023	2-4	9/26/2000	00C2B5011SO	<1 U	<18 U	<18 U	--	--	--	--
C2	AP-024	0-2	9/27/2000	00C2B6012SO	<1 U	<17 U	<17 U	--	--	--	--
C2	AP-024	2-4	9/27/2000	00C2B6013SO	<1 U	<18 U	<17 U	--	--	**0.001**	--
C2	C2-BG01	1-2.5	6/11/2014	C2-BG01-1.0-2.5-0614	<3.4 U	**41**	**140**	--	--	--	--
C2	C2-BG01	3-4	6/11/2014	C2-BG01-3.0-4.0-0614	<2.5 U	**4.8 J**	**12 J**	--	--	--	--
C2	C2-BG02	0-2	6/11/2014	C2-BG02-0.0-2.0-0614	<2.8 U	**9 J**	**28 J**	--	--	--	--
C2	C2-BG02	2-3	6/11/2014	C2-BG02-2.0-3.0-0614	**4.1**	**6.8 J**	**14 J**	--	--	--	--
C4	C2-BG03	0-2	6/12/2014	C2-BG03-0.0-2.0-0614	<2.6 U	**100**	**360**	--	--	--	--
C4	C2-BG03	3-4	6/12/2014	C2-BG03-3.0-4.0-0614	**2.3 J**	**640**	**740**	--	--	--	--
C4	C2-BG04	0-2	6/12/2014	C2-BG04-0.0-2.0-0614	**6.5**	**14 J**	**33 J**	--	--	--	--
C4	C2-BG04	3.5-4.5	6/12/2014	C2-BG04-3.5-4.5-0614	<2.6 U	<7.1 U	<27 U	--	--	--	--
C4	C2SS007	0-0	10/4/2000	00C2SS007SO	<0.79 U	<17 U	**43 B**	<0.00022 U	<0.00022 U	<0.00022 U	<0.00065 U
C2	AP-023	2-2	9/26/2000	00C2B7010SO	<1 U	<19 U	<19 U	--	--	--	--
C4	C2SS008	0-0	10/4/2000	00C2SS008SO	<0.74 U	<16 U	<16 U	<0.00018 U	<0.00018 U	<0.00018 U	<0.00053 U
C4	C2SS009	0-0	10/4/2000	00C2SS009SO	<0.83 U	<17 U	<17 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.00059 U
C4	C2SS010	0-0	10/4/2000	00C2SS010SO	<1 U	**76 B**	<19 U	<0.00019 U	<0.00019 U	<0.00019 U	<0.00057 U
C4	C2SS011	0-0	10/4/2000	00C2SS011SO	<0.88 U	<19 U	<19 U	<0.00026 U	<0.00026 U	<0.00026 U	<0.00078 U
C4	C2SS012	0-0	10/4/2000	00C2SS012SO	<0.97 U	<23 U	<23 U	<0.00028 U	<0.00028 U	<0.00028 U	<0.00084 U
C4	C2SS013	0-0	10/4/2000	00C2SS013SO	<1 U	**37 JB**	**130**	<0.00024 U	<0.00024 U	**0.00033 J**	<0.00071 U
C4	C2SS015	0-0	10/4/2000	00C2SS015SO	**1.5 J**	<20 U	<20 U	**0.0003 J**	<0.00025 U	<0.00025 U	<0.00075 U
C4	C2SS016	0-0	10/4/2000	00C2SS016SO	<1.2 U	**2200**	**230**	<0.00035 U	<0.00035 U	<0.00035 U	<0.00105 U
C4	C2SS017	0-0	10/4/2000	00C2SS017SO	<0.92 U	<20 U	<20 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00062 U
C4	C4-TP01	6-8	6/11/2014	C4-TP01-6.0-8.0-0614	**7.5**	<7.5 U	<29 U	<0.012 U	<0.012 U	<0.012 U	<0.024 U
C4	C4-TP02	2-4	6/11/2014	C4-TP02-10.0-12.0-0614	**17**	**310**	**62**	<0.011 U,MN	<0.011 U,MN	<0.011 U,MN	**0.3864 J**
C4	C4-TP02	4-6	6/10/2014	C4-TP02-4.0-6.0-0614	**43**	**910**	**200**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
C4	C4-TP02	6-8	6/10/2014	C4-TP02-6.0-8.0-0614	**18**	**420**	**85**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
C4	C4-TP03	9-10	6/10/2014	C4-TP03-9.0-10.0-0614	**5 J**	**8.3 J**	**24 J**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
C4	C4-TP04	0-2	6/10/2014	C4-TP04-0.0-2.0-0614	**5.3 J**	**1000**	**860**	<0.016 U	<0.016 U	**0.0067 J**	**0.0236 J**
C4	C4-TP04	2-4	6/10/2014	C4-TP04-2.0-4.0-0614	<3.1 U	**550**	**250**	<0.012 U	<0.012 U	**0.0054 J**	<0.024 U
C4	C4-TP05	0-2	6/12/2014	C4-TP05-0.0-2.0-0614	**16 QL**	**4100**	**1200**	<0.013 U	<0.013 U	<0.013 U	<0.026 U
C4	C4-TP05	2-4	6/12/2014	C4-TP05-12.0-14.0-0614	**63 QN**	**7300 J**	**3600 J**	<0.014 U	<0.014 U	<0.014 U	**0.667 J**
C4	C4-TP05	4-6	6/12/2014	C4-TP05-4.0-6.0-0614	**18 QN**	**1200**	**46 J**	<0.011 U	<0.011 U	<0.011 U	<0.022 U
C4	C4-TP05	6-8	6/12/2014	C4-TP05-6.0-8.0-0614	**31 QL**	**170**	**26 J**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					63	7300	3600	0.0003	0.15	0.0067	0.667
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 6-2: AOC C4 Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
C4	AP-020	0-2	9/24/2000	00C2B2003SO	**5**	**1300**	**76**	--	--	--	--
C4	AP-020	2-4	9/24/2000	00C2B2004SO	**3**	**2400**	**100**	--	--	--	--
C4	C2-BG03	0-2	6/12/2014	C2-BG03-0.0-2.0-0614	<2.6 U	**100**	**360**	--	--	--	--
C4	C2-BG03	3-4	6/12/2014	C2-BG03-3.0-4.0-0614	**2.3 J**	**640**	**740**	--	--	--	--
C4	C2SS016	0-0	10/4/2000	00C2SS016SO	<1.2 U	**2200**	**230**	--	--	--	--
C4	C4-TP02	2-4	6/11/2014	C4-TP02-10.0-12.0-0614	**17**	**310**	**62**	<0.011 U,MN	<0.011 U,MN	<0.011 U,MN	**0.3864 J**
C4	C4-TP02	4-6	6/10/2014	C4-TP02-4.0-6.0-0614	**43**	**910**	**200**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
C4	C4-TP02	6-8	6/10/2014	C4-TP02-6.0-8.0-0614	**18**	**420**	**85**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
C4	C4-TP04	0-2	6/10/2014	C4-TP04-0.0-2.0-0614	**5.3 J**	**1000**	**860**	<0.016 U	<0.016 U	**0.0067 J**	**0.0236 J**
C4	C4-TP04	2-4	6/10/2014	C4-TP04-2.0-4.0-0614	<3.1 U	**550**	**250**	<0.012 U	<0.012 U	**0.0054 J**	<0.024 U
C4	C4-TP05	0-2	6/12/2014	C4-TP05-0.0-2.0-0614	**16 QL**	**4100**	**1200**	<0.013 U	<0.013 U	<0.013 U	<0.026 U
C4	C4-TP05	2-4	6/12/2014	C4-TP05-12.0-14.0-0614	**63 QN**	**7300 J**	**3600 J**	<0.014 U	<0.014 U	<0.014 U	**0.667 J**
C4	C4-TP05	4-6	6/12/2014	C4-TP05-4.0-6.0-0614	**18 QN**	**1200**	**46 J**	<0.011 U	<0.011 U	<0.011 U	<0.022 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					63	7300	3600	0.016	0.016	0.0067	0.667
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 6-3: AOC C4 PAH Soils Results

Site Name		C4	C4	C4	C4	C4	C4	C4	C4
Boring, Well or Sample Location		AP-019	AP-020	AP-020	C2SS008	C2SS009	C2SS010	C2SS011	C2SS012
Sample Depth (feet)		2-4	0-2	2-4	0-0	0-0	0-0	0-0	0-0
Sample Date		9/24/2000	9/24/2000	9/24/2000	10/4/2000	10/4/2000	10/4/2000	10/4/2000	10/4/2000
Sample Name		00C2B1002SO	00C2B2003SO	00C2B2004SO	00C2SS008SO	00C2SS009SO	00C2SS010SO	00C2SS011SO	00C2SS012SO
GRO	(mg/kg)	<1 U	**5**	**3**	<0.74 U	<0.83 U	<1 U	<0.88 U	<0.97 U
DRO	(mg/kg)	<21 U	**1300**	**2400**	<16 U	<17 U	**76 B**	<19 U	<23 U
RRO	(mg/kg)	<20 U	**76**	**100**	<16 U	<17 U	<19 U	<19 U	<23 U
Acenaphthene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Acenaphthylene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Anthracene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Benzo(a)anthracene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Benzo(a)pyrene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Benzo(b)fluoranthene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	**0.032**	<0.024 U	<0.025 U	<0.027 U
Benzo(g,h,i)perylene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Benzo(k)fluoranthene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Chrysene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Fluorene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Fluoranthene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	**0.025**	<0.024 U	<0.025 U	<0.027 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Naphthalene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.00018 U	<0.0002 U	<0.00024 U	<0.00026 U	<0.00028 U
Phenanthrene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
Pyrene	(mg/kg)	<0.017 U	<0.014 U	**0.048**	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
2-Methylnaphthalene	(mg/kg)	<0.017 U	<0.014 U	<0.015 U	<0.02 U	<0.021 U	<0.024 U	<0.025 U	<0.027 U
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	--	--	--

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbon
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 6-3: AOC C4 PAH Soils Results

Site Name		C4	C4	C4	C4	C4	C4	C4	C4
Boring, Well or Sample Location		C2SS013	C2SS015	C2SS016	C2SS017	C4-TP01	C4-TP02	C4-TP02	C4-TP02
Sample Depth (feet)		0-0	0-0	0-0	0-0	6-8	2-4	4-6	6-8
Sample Date		10/4/2000	10/4/2000	10/4/2000	10/4/2000	6/11/2014	6/11/2014	6/10/2014	6/10/2014
Sample Name		00C2SS013SO	00C2SS015SO	00C2SS016SO	00C2SS017SO	C4-TP01-6.0-8.0-0614	C4-TP02-10.0-12.0-0614	C4-TP02-4.0-6.0-0614	C4-TP02-6.0-8.0-0614
GRO	(mg/kg)	<1 U	**1.5 J**	<1.2 U	<0.92 U	**7.5**	**17**	**43**	**18**
DRO	(mg/kg)	**37 JB**	<20 U	**2200**	<20 U	<7.5 U	**310**	**910**	**420**
RRO	(mg/kg)	**130**	<20 U	**230**	<20 U	<29 U	**62**	**200**	**85**
Acenaphthene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.011**	**0.037**	<0.0028 U
Acenaphthylene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.0057**	**0.018**	**0.0055 J**
Anthracene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.0081**	**0.031**	<0.0028 U
Benzo(a)anthracene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.0017 J**	<0.0027 U	**0.0025 J**
Benzo(a)pyrene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	<0.0028 U	**0.0019 J**	<0.0028 U
Benzo(b)fluoranthene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.0018 J**	**0.0032 J**	**0.0025 J**
Benzo(g,h,i)perylene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	<0.0028 U	**0.0019 J**	<0.0028 U
Benzo(k)fluoranthene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	<0.0028 U	<0.0027 U	<0.0028 U
Chrysene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.003 J**	<0.0027 U	**0.004 J**
Dibenzo(a,h)anthracene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	<0.0028 U	<0.0027 U	<0.0028 U
Fluorene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.036**	**0.097**	**0.011**
Fluoranthene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.0051 J**	**0.014**	**0.0028 J**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	<0.0028 U	**0.0021 J**	<0.0028 U
Naphthalene	(mg/kg)	<0.00024 U	<0.00025 U	<0.00035 U	<0.00021 U	<0.0029 U	**0.0038 J**	**0.016**	<0.0028 U
Phenanthrene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.077**	**0.23**	**0.017**
Pyrene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.0036 J**	**0.012**	**0.0045 J**
2-Methylnaphthalene	(mg/kg)	<0.024 U	<0.024 U	<0.028 U	<0.022 U	<0.0029 U	**0.014 J**	**0.04**	**0.011**
1-Methylnaphthalene	(mg/kg)	--	--	--	--	<0.0029 U	**0.022**	**0.061**	**0.014**

Table 6-3: AOC C4 PAH Soils Results

Site Name		C4	C4	C4	C4	C4	C4	C4	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location		C4-TP03	C4-TP04	C4-TP04	C4-TP05	C4-TP05	C4-TP05	C4-TP05		
Sample Depth (feet)		9-10	0-2	2-4	0-2	2-4	4-6	6-8		
Sample Date		6/10/2014	6/10/2014	6/10/2014	6/12/2014	6/12/2014	6/12/2014	6/12/2014		
Sample Name		C4-TP03-9.0-10.0-0614	C4-TP04-0.0-2.0-0614	C4-TP04-2.0-4.0-0614	C4-TP05-0.0-2.0-0614	C4-TP05-12.0-14.0-0614	C4-TP05-4.0-6.0-0614	C4-TP05-6.0-8.0-0614		
GRO	(mg/kg)	**5 J**	**5.3 J**	<3.1 U	**16 QL**	**63 QN**	**18 QN**	**31 QL**	63	**260 C**
DRO	(mg/kg)	**8.3 J**	**1000**	**550**	**4100**	**7300 J**	**1200**	**170**	7300	**230 C**
RRO	(mg/kg)	**24 J**	**860**	**250**	**1200**	**3600 J**	**46 J**	**26 J**	3600	**230 H**
Acenaphthene	(mg/kg)	<0.0026 U	**0.037**	**0.03**	<0.0031 U	**0.14**	**0.12**	**0.024**	0.14	**180 F**
Acenaphthylene	(mg/kg)	<0.0026 U	**0.015**	**0.012**	<0.0031 U	**0.09**	**0.067**	**0.013**	0.09	**180 F**
Anthracene	(mg/kg)	<0.0026 U	**0.019**	**0.019**	<0.0031 U	**0.19**	**0.047**	<0.0025 U	0.19	**1680 D**
Benzo(a)anthracene	(mg/kg)	<0.0026 U	**0.02**	**0.015**	**0.33**	**0.53**	**0.0036 J**	**0.0018 J**	0.53	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.0026 U	**0.018**	**0.011**	**0.38**	**0.52**	**0.0025 J**	<0.0025 U	0.52	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	<0.0026 U	**0.034**	**0.016**	**0.58**	**0.82 J**	**0.0041 J**	**0.0019 J**	0.82	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.0026 U	**0.014**	**0.0061**	**0.27**	**0.36**	<0.0027 U	<0.0025 U	0.36	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.0026 U	**0.012**	**0.0056 J**	**0.21**	**0.32**	**0.0022 J**	<0.0025 U	0.32	**4 D**
Chrysene	(mg/kg)	<0.0026 U	**0.023**	**0.015**	**0.44**	**0.66**	**0.007**	**0.0029 J**	0.66	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.0026 U	**0.0043 J**	**0.0022 J**	**0.084**	**0.12**	<0.0027 U	<0.0025 U	0.12	**0.04 D**
Fluorene	(mg/kg)	<0.0026 U	**0.15**	**0.15**	<0.0031 U	**0.31**	**0.47**	**0.081**	0.47	**190 D**
Fluoranthene	(mg/kg)	<0.0026 U	**0.067**	**0.048**	**0.81 MH**	**1.5**	**0.032**	**0.0079**	1.5	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0026 U	**0.02**	**0.0093**	**0.39**	**0.54**	**0.0019 J**	<0.0025 U	0.54	**0.4 D**
Naphthalene	(mg/kg)	<0.0026 U	**0.073**	**0.042**	**0.073**	**0.21 J**	**0.039**	**0.0049 J**	0.21	**2.1 E**
Phenanthrene	(mg/kg)	**0.0028 J**	**0.21**	**0.26**	**0.54**	**1.3 J**	**1.3**	**0.12**	1.3	**1680 D**
Pyrene	(mg/kg)	<0.0026 U	**0.064**	**0.033**	**0.95 MH**	**1.4**	**0.024**	**0.0058**	1.4	**110 D**
2-Methylnaphthalene	(mg/kg)	<0.0026 U	**0.19**	**0.16**	**0.41**	**0.57 J**	**2.6**	**0.085**	2.6	**6.1 F**
1-Methylnaphthalene	(mg/kg)	<0.0026 U	**0.23**	**0.18**	**0.43**	**0.77**	**1.8**	**0.15**	1.8	**6.2 F**

Table 6-4a: AOC C4 Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
C4	C4-TP02	2-4	6/11/2014	C4-TP02-10.0-12.0-0614	<0.011 U,MN	<0.011 U,MN	<0.011 U,MN	0.3864 J	15.7	15.3026	8.9 J,B	--	<1.91 U	<1.91 U	24.1	<4.2 U	50 J,B
C4	C4-TP02	4-6	6/10/2014	C4-TP02-4.0-6.0-0614	<0.01 U	<0.01 U	<0.01 U	<0.02 U	12 J,B	11.97	47 J,B	--	<4.2 U	<4.2 U	8 J	49	290
C4	C4-TP02	6-8	6/10/2014	C4-TP02-6.0-8.0-0614	<0.01 U	<0.01 U	<0.01 U	<0.02 U	5 J,B	4.97	19 J,B	--	<4.2 U	2.8 J	<4.2 U	3.5 J	110 J
C4	C4-TP04	0-2	6/10/2014	C4-TP04-0.0-2.0-0614	<0.016 U	0.0067 J	<0.016 U	0.0236 J	<6.4 U	6.3604	<3.5 U	--	<6.4 U	<6.4 U	<6.4 U	<6.4 U	<6.4 U
C4	C4-TP04	2-4	6/10/2014	C4-TP04-2.0-4.0-0614	<0.012 U	0.0054 J	<0.012 U	<0.024 U	<5 U	4.964	<1.9 U	--	2.5 J	2.6 J	<5 U	<5 U	<5 U
C4	C4-TP05	0-2	6/12/2014	C4-TP05-0.0-2.0-0614	<0.013 U	<0.013 U	<0.013 U	<0.026 U	6.4 J,B	6.361	21 J,B	--	<2.5 U	14 J,B	6.5 J	16 J	140 B
C4	C4-TP05	2-4	6/12/2014	C4-TP05-12.0-14.0-0614	<0.014 U	<0.014 U	<0.014 U	0.667 J	29	28.319	74 J,B	--	<2.94 U	39 J	46.9	37 J	480 J
C4	C4-TP05	4-6	6/12/2014	C4-TP05-4.0-6.0-0614	<0.011 U	<0.011 U	<0.011 U	<0.022 U	4.2 J,B	4.167	14 J,B	--	0.91 J	1.9 J,B	6.9 J	16	88 J,B
C4	C4-TP05	6-8	6/12/2014	C4-TP05-6.0-8.0-0614	<0.01 U	<0.01 U	<0.01 U	<0.02 U	0.81 J,B	0.78	2.7 J,B	--	4.7 J	<1.9 U	1.3 J	<1.9 U	8.8 J,B
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.012	0.010	0.012	0.134	9.390	9.244	21.333	#DIV/0!	3.362	8.301	12.144	15.444	130.91

Table 6-4b: AOC C4 Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
C4	C4-TP02	2-4	6/11/2014	C4-TP02-10.0-12.0-0614	--	--	1 J	9.3	37 J	8.1	--	14	84	86	23	47.3	184	231.3
C4	C4-TP02	4-6	6/10/2014	C4-TP02-4.0-6.0-0614	--	--	6.2	50	190	42	--	68	350	360	100	246.2	778	1024.2
C4	C4-TP02	6-8	6/10/2014	C4-TP02-6.0-8.0-0614	--	--	1.2 J	12	49	9.5	--	30	150	140	39	62.2	320	382.2
C4	C4-TP04	0-2	6/10/2014	C4-TP04-0.0-2.0-0614	--	--	3 J	31	190	90	--	34	420	770	300	224	1224	1448
C4	C4-TP04	2-4	6/10/2014	C4-TP04-2.0-4.0-0614	--	--	2 J	19	81	31	--	16	160	230	85	102	406	508
C4	C4-TP05	0-2	6/12/2014	C4-TP05-0.0-2.0-0614	--	--	3.1 QL	70	620	170	--	41 QL	890	1200 QH	380 QH	693.1	2131	2824.1
C4	C4-TP05	2-4	6/12/2014	C4-TP05-12.0-14.0-0614	--	--	10 QL	160	960	290	--	260	2100	2500	850	1130	4860	5990
C4	C4-TP05	4-6	6/12/2014	C4-TP05-4.0-6.0-0614	--	--	4.7 QL	58	250	19	--	26 QL	280	330 QH	28 QH	312.7	636	948.7
C4	C4-TP05	6-8	6/12/2014	C4-TP05-6.0-8.0-0614	--	--	0.25 QL	5.1 J	39	5.2 J	--	1.2 QL	39	69 QH	8.7 QH	44.35	109.2	153.55
average with fraction:							3.494	46.044	268.444	73.867		54.467	497.000	631.667	201.522			

Table 6-4c: AOC C4 Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.01189	0.01012	0.01189	0.13433	9.24378	3.49444	46.04444	268.44444	73.86667	3.36222	8.30111	12.14444	54.46667	497.00000	631.66667	201.52222	1810
Fraction of TPH mass in A&A EC groups	6.56944E-06	5.59324E-06	6.56944E-06	0.00007	0.00511	0.00193	0.02544	0.14833	0.04082	0.00186	0.00459	0.00671	0.03010	0.27463	0.34904	0.11136	1.00
GRO, DRO & RRO A&A Groups	GRO aromatics					DRO aromatics			RRO aromatics	GRO aliphatics			DRO aliphatics			RRO aliphatics	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.005201					0.175708			0.040817	0.013155			0.653764			0.111355	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.001263	0.001075	0.001263	0.014273	0.982126	0.010989	0.144801	0.844209	1.000000	0.141224	0.348672	0.510104	0.046036	0.420071	0.533893	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	1.84%	GRO % aromatics	0.283325434
% of TPH that is DRO=	82.95%	GRO % aliphatics	0.716674566
% of TPH that is RRO=	15.22%	DRO % aromatics	0.211831192
		DRO % aliphatics	0.788168808
		RRO % aromatics	0.26822675
		RRO % aliphatics	0.73177325

Table 6-4d: AOC C4 HRC Input

input to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.283325434
DRO: fraction aromatic	0.211831192
RRO: fraction aromatic	0.26822675

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.010989395
Aromatic C12-C16	0.14480144
Aromatic C16-C21	0.844209165

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.14122369
Aliphatic C6-C8	0.348672236
Aliphatic C8-C10	0.510104074
Aliphatic C10-C12	0.04603595
Aliphatic C12-C16	0.420070998
Aliphatic C16-C21	0.533893052

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons

GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Table 6-5: AOC C4 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
C4	AP-019	NA	10/11/2000	00C2WT001WG	<0.025 U	**0.075 J**	**--**	<0.0002 U	<0.0002 U	<0.0002 U	<0.0006 U
C4	AP-020	NA	10/11/2000	00C2WT003WG	<0.025 U	**0.86 B**	**--**	<0.0002 U	<0.0002 U	<0.0002 U	<0.0006 U
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0.018	2.1	0.29	0.0004	0.0004	0.00069	0.00063
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:
Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
BTEX= benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

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Table 6-6: AOC C4 PAH Groundwater Results

Site Name		C4	C4	C4	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		AP-019	AP-020	C4-WP01		
Sample Depth		NA	NA	NA		
Sample Date		10/11/2000	10/11/2000	6/26/2014		
Sample Name		00C2WT001WG	00C2WT003WG	C4-WP01-0614		
GRO	(mg/L)	<0.025 U	<0.025 U	**0.018 J**	0.018	**2.2 H**
DRO	(mg/L)	**0.075 J**	**0.86 B**	**2.1**	2.1	**1.5 H**
RRO	(mg/L)	**--**	**--**	**0.29**	0.29	**1.1 H**
Acenaphthene	(mg/L)	<0.00001 U	<0.0000095 U	**0.00023**	0.00023	**0.22 H**
Acenaphthylene	(mg/L)	<0.00001 U	<0.0000095 U	**0.000093 QN**	0.000093	**0.22 H**
Anthracene	(mg/L)	<0.00001 U	<0.0000095 U	**0.000048**	0.000048	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.00001 U	<0.0000095 U	**0.000026**	0.000026	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.00001 U	<0.0000095 U	**0.000023 QN**	0.000023	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.00001 U	<0.0000095 U	**0.000045**	0.000045	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.00001 U	<0.0000095 U	**0.000019 QL**	0.000019	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.00001 U	<0.0000095 U	**0.000014 J**	0.000014	**0.0012 H**
Chrysene	(mg/L)	<0.00001 U	<0.0000095 U	**0.00003**	0.00003	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.00001 U	<0.0000095 U	**0.0000065 J**	0.0000065	**0.000012 H**
Fluorene	(mg/L)	<0.00001 U	<0.0000095 U	**0.00078 QL**	0.00078	**0.15 H**
Fluoranthene	(mg/L)	<0.00001 U	<0.0000095 U	**0.0001**	0.0001	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.00001 U	<0.0000095 U	**0.000027 QL**	0.000027	**0.00012 H**
Naphthalene	(mg/L)	<0.00001 U	<0.0000095 U	**0.0031**	0.0031	**0.073 H**
Phenanthrene	(mg/L)	<0.00001 U	<0.0000095 U	**0.0006 QL**	0.0006	**1.1 H**
Pyrene	(mg/L)	<0.00001 U	<0.0000095 U	**0.000079 QN**	0.000079	**0.11 H**
2-Methylnaphthalene	(mg/L)	<0.00001 U	<0.0000095 U	**0.0039**	0.0039	**0.015 H**
1-Methylnaphthalene	(mg/L)	**--**	**--**	**0.0035**	0.0035	**0.015 H**

Notes:
Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Table 6-7: AOC C4 VPH & EPH Groundwater Results

Site Name		C4	maximum value
Boring or Well Number		C4-WP01	
Sample Depth		NA	
Sample Date		6/26/2014	
Sample Name		C4-WP01-0614	
C8-C10 Aromatics V	(mg/L)	<0.006 U	
C10-C12 Aromatics V	(mg/L)	<0.0091 U	
C12-C13 Aromatics V	(mg/L)	**--**	
C5-C6 Aliphatics V	(mg/L)	<0.006 U	
C6-C8 Aliphatics V	(mg/L)	**0.0046 J,B**	
C8-C10 Aliphatics V	(mg/L)	**0.0033 J**	
C10-C12 Aliphatics V	(mg/L)	<0.006 U,QL	
Total VPH V	(mg/L)	**0.058 J,B**	
C8-C10 Aromatics	(mg/L)	**--**	
C10-C12 Aromatics	(mg/L)	**0.017 J**	
C12-C16 Aromatics	(mg/L)	**0.043 J**	
C16-C21 Aromatics	(mg/L)	**0.072 B**	
C21-C34 Aromatics	(mg/L)	**0.043 J**	
C8-C10 Aliphatics	(mg/L)	**--**	
C10-C12 Aliphatics	(mg/L)	**0.093**	
C12-C16 Aliphatics	(mg/L)	**0.27**	
C16-C21 Aliphatics	(mg/L)	**0.27**	
C21-C34 Aliphatics	(mg/L)	**0.23**	
GRO Aromatics (C5 to C10 aro)	(mg/L)	0.006	0.006
GRO Aliphatics (C5 to C10 ali)	(mg/L)	0.0139	0.0139
DRO Aromatics (C10 to C21)	(mg/L)	0.132	0.132
DRO Aliphatics (C10 to C21)	(mg/L)	0.633	0.633
RRO Aromatics (C21 to C34 aro)	(mg/L)	0.043	0.043
RRO Aliphatics (C21 to C34 ali)	(mg/L)	0.23	0.23
GRO (sum of C5 to C10 A&A)	(mg/L)	0.0199	0.0199
DRO (sum of C10 to C21 A&A)	(mg/L)	0.765	0.765
RRO (sum of C21 to C35 A&A)	(mg/L)	0.273	0.273
GRO (AK101)	(mg/L)	**0.018**	
DRO (AK102)	(mg/L)	**2.1**	
RRO (AK103)	(mg/L)	**0.29**	

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/L = milligrams per liter
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
V = defines VPH results versus EPH results
Result = detected results for VPH, EPH, GRO, DRO and RRO bolded

Table 6-8a: AOC C4 BTEX, GRO, DRO & RRO Soils 95% UCL Concentrations

ProUCL Input File

GRO	d_GRO	DRO	d_DRO	RRO	d_RRO	Benzene	d_Benzene	Toluene	d_Toluene	Ethylbenzene	d_Ethylbenzene	Xylene	d_Xylene
5	1	1300	1	76	1								
3	1	2400	1	100	1								
2.6	0	100	1	360	1								
2.3	1	640	1	740	1								
1.2	0	2200	1	230	1								
17	1	310	1	62	1	0.011	0	0.011	0	0.011	0	0.3864	1
43	1	910	1	200	1	0.01	0	0.01	0	0.01	0	0.02	0
18	1	420	1	85	1	0.01	0	0.01	0	0.01	0	0.02	0
5.3	1	1000	1	860	1	0.016	0	0.0067	1	0.016	0	0.0236	1
3.1	0	550	1	250	1	0.012	0	0.0054	1	0.012	0	0.024	0
16	1	4100	1	1200	1	0.013	0	0.013	0	0.013	0	0.026	0
63	1	7300	1	3600	1	0.014	0	0.014	0	0.014	0	0.667	1
18	1	1200	1	46	1	0.011	0	0.011	0	0.011	0	0.022	0

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options		Benzene	0.016	maximum LOD
From File	WorkSheet.wst	Toluene	0.0067	maximum detected conc
Full Precision	OFF	Ethylbenzene	0.016	maximum LOD
Confidence Coefficient	95%	Xylene	0.667	maximum detected conc
Number of Bootstrap Operations	10000	GRO	63	maximum detected conc
		DRO	3056	95%UCL
		RRO	1223	95%UCL

DRO

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Raw Statistics		**Log-transformed Statistics**	
Minimum	100	Minimum of Log Data	4.605
Maximum	7300	Maximum of Log Data	8.896
Mean	1725	Mean of log Data	6.91
Median	1000	SD of log Data	1.134
SD	1999		
Std. Error of Mean	554.4		
Coefficient of Variation	1.159		
Skewness	2.141		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.742	Shapiro Wilk Test Statistic	0.99
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2714	95% H-UCL	5230
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4421
95% Adjusted-CLT UCL (Chen-1995)	2989	97.5% Chebyshev (MVUE) UCL	5568
95% Modified-t UCL (Johnson-1978)	2768	99% Chebyshev (MVUE) UCL	7819
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.863	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1998		
MLE of Mean	1725		
MLE of Standard Deviation	1857		
nu star	22.45		
Approximate Chi Square Value (.05)	12.68	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	2637
Adjusted Chi Square Value	11.64	95% Jackknife UCL	2714
		95% Standard Bootstrap UCL	2607
Anderson-Darling Test Statistic	0.268	95% Bootstrap-t UCL	3959
Anderson-Darling 5% Critical Value	0.757	95% Hall's Bootstrap UCL	6752
Kolmogorov-Smirnov Test Statistic	0.17	95% Percentile Bootstrap UCL	2682
Kolmogorov-Smirnov 5% Critical Value	0.243	95% BCA Bootstrap UCL	3012
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4142
		97.5% Chebyshev(Mean, Sd) UCL	5188
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	7242
95% Approximate Gamma UCL	3056		
95% Adjusted Gamma UCL	3328		
Potential UCL to Use		Use 95% Approximate Gamma UCL	3056

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

RRO

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Raw Statistics		**Log-transformed Statistics**	
Minimum	46	Minimum of Log Data	3.829
Maximum	3600	Maximum of Log Data	8.189
Mean	600.7	Mean of log Data	5.548
Median	230	SD of log Data	1.313
SD	970.8		
Std. Error of Mean	269.3		
Coefficient of Variation	1.616		
Skewness	2.832		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.605	Shapiro Wilk Test Statistic	0.948
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1081	95% H-UCL	2221
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1504
95% Adjusted-CLT UCL (Chen-1995)	1270	97.5% Chebyshev (MVUE) UCL	1918
95% Modified-t UCL (Johnson-1978)	1116	99% Chebyshev (MVUE) UCL	2731
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.597	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1006		
MLE of Mean	600.7		
MLE of Standard Deviation	777.5		
nu star	15.52		
Approximate Chi Square Value (.05)	7.625	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	1044
Adjusted Chi Square Value	6.851	95% Jackknife UCL	1081
		95% Standard Bootstrap UCL	1034
Anderson-Darling Test Statistic	0.645	95% Bootstrap-t UCL	1877
Anderson-Darling 5% Critical Value	0.774	95% Hall's Bootstrap UCL	2603
Kolmogorov-Smirnov Test Statistic	0.205	95% Percentile Bootstrap UCL	1069
Kolmogorov-Smirnov 5% Critical Value	0.247	95% BCA Bootstrap UCL	1351
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1774
		97.5% Chebyshev(Mean, Sd) UCL	2282
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3280
95% Approximate Gamma UCL	1223		
95% Adjusted Gamma UCL	1361		
Potential UCL to Use		Use 95% Approximate Gamma UCL	1223

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Table 6-8b: AOC C4 PAH Soils 95% UCL Concentrations

ProUCL Input File

Benzo(a) anthracene	_dBenzo(a)a nthracene	Benzo(a) pyrene	_dBenzo(a)p yrene	Benzo(b) fluoranthene	_dBenzo(b) fluoranthene	Dibenzo(a,h)a nthracene	_dDibenzo(a,h) anthracene	Indeno(1,2,3- cd)pyrene	_dIndeno(1,2, 3-cd)pyrene
0.014	0	0.014	0	0.014	0	0.014	0	0.014	0
0.015	0	0.015	0	0.015	0	0.015	0	0.015	0
0.028	0	0.028	0	0.028	0	0.028	0	0.028	0
0.0017	1	0.0028	0	0.0018	1	0.0028	0	0.0028	0
0.0027	0	0.0019	1	0.0032	1	0.0027	0	0.0021	1
0.0025	1	0.0028	0	0.0025	1	0.0028	0	0.0028	0
0.02	1	0.018	1	0.034	1	0.0043	1	0.02	1
0.015	1	0.011	1	0.016	1	0.0022	1	0.0093	1
0.33	1	0.38	1	0.58	1	0.084	1	0.39	1
0.53	1	0.52	1	0.82	1	0.12	1	0.54	1
0.0036	1	0.0025	1	0.0041	1	0.0027	0	0.0019	1

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options				
From File	WorkSheet.wst	Benzo(a)anthracene	0.185	95%UCL
Full Precision	OFF	Benzo(a)pyrene	0.193	95%UCL
Confidence Coefficient	95%	Benzo(b)fluoranthene	0.516	95%UCL
Number of Bootstrap Operations	10000	Dibenzo(a,h)anthracene	0.0453	95%UCL
		Indeno(1,2,3-cd)pyrene	0.196	95%UCL

Benzo(a)anthracene

General Statistics

Number of Valid Data	11	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	4
		Percent Non-Detects	36.36%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0017	Minimum Detected	-6.377
Maximum Detected	0.53	Maximum Detected	-0.635
Mean of Detected	0.129	Mean of Detected	-3.979
SD of Detected	0.214	SD of Detected	2.309
Minimum Non-Detect	0.0027	Minimum Non-Detect	-5.915
Maximum Non-Detect	0.028	Maximum Non-Detect	-3.576
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	9
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	81.82%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.677	Shapiro Wilk Test Statistic	0.878
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0848	Mean	-4.417
SD	0.177	SD	1.967
95% DL/2 (t) UCL	0.181	95% H-Stat (DL/2) UCL	1.965
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-4.714
		SD in Log Scale	2.077
		Mean in Original Scale	0.0831
		SD in Original Scale	0.177
		95% t UCL	0.18
		95% Percentile Bootstrap UCL	0.178
		95% BCA Bootstrap UCL	0.207
		95% H-UCL	2.573
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.294	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.438		
nu star	4.122		
A-D Test Statistic	0.678	**Nonparametric Statistics**	
5% A-D Critical Value	0.776	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.776	Mean	0.0833
5% K-S Critical Value	0.333	SD	0.169
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0551
		95% KM (t) UCL	0.183
Assuming Gamma Distribution		95% KM (z) UCL	0.174
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.18
Minimum	0.000001	95% KM (bootstrap t) UCL	1.968
Maximum	0.53	95% KM (BCA) UCL	0.185
Mean	0.0821	95% KM (Percentile Bootstrap) UCL	0.177
Median	0.0025	95% KM (Chebyshev) UCL	0.323
SD	0.178	97.5% KM (Chebyshev) UCL	0.427
k star	0.171	99% KM (Chebyshev) UCL	0.631
Theta star	0.48		
Nu star	3.762	Potential UCLs to Use	
AppChi2	0.63	95% KM (BCA) UCL	0.185
95% Gamma Approximate UCL	0.49		
95% Adjusted Gamma UCL	0.676		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Benzo(a)pyrene

General Statistics

Number of Valid Data	11	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	5
		Percent Non-Detects	45.45%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0019	Minimum Detected	-6.266
Maximum Detected	0.52	Maximum Detected	-0.654
Mean of Detected	0.156	Mean of Detected	-3.734
SD of Detected	0.232	SD of Detected	2.422
Minimum Non-Detect	0.0028	Minimum Non-Detect	-5.878
Maximum Non-Detect	0.028	Maximum Non-Detect	-3.576

Table 6-8b: AOC C4 PAH Soils 95% UCL Concentrations

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	9
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	81.82%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.716	Shapiro Wilk Test Statistic	0.874
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0877	Mean	-4.516
SD	0.182	SD	2.046
95% DL/2 (t) UCL	0.187	95% H-Stat (DL/2) UCL	2.659
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-4.728
		SD in Log Scale	2.098
		Mean in Original Scale	0.0862
		SD in Original Scale	0.183
		95% t UCL	0.186
		95% Percentile Bootstrap UCL	0.18
		95% BCA Bootstrap UCL	0.213
		95% H-UCL	2.838
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.29	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.537		
nu star	3.479		
A-D Test Statistic	0.59	Nonparametric Statistics	
5% A-D Critical Value	0.758	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.758	Mean	0.0865
5% K-S Critical Value	0.354	SD	0.174
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0575
		95% KM (t) UCL	0.191
Assuming Gamma Distribution		95% KM (z) UCL	0.181
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.186
Minimum	0.000001	95% KM (bootstrap t) UCL	2.278
Maximum	0.52	95% KM (BCA) UCL	0.193
Mean	0.0849	95% KM (Percentile Bootstrap) UCL	0.183
Median	0.0019	95% KM (Chebyshev) UCL	0.337
SD	0.183	97.5% KM (Chebyshev) UCL	0.445
k star	0.158	99% KM (Chebyshev) UCL	0.658
Theta star	0.538		
Nu star	3.471	Potential UCLs to Use	
AppChi2	0.524	95% KM (BCA) UCL	0.193
95% Gamma Approximate UCL	0.561		
95% Adjusted Gamma UCL	0.785		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Benzo(b)fluoranthene

General Statistics

Number of Valid Data	11	Number of Detected Data	8
Number of Distinct Detected Data	8	Number of Non-Detect Data	3
		Percent Non-Detects	27.27%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0018	Minimum Detected	-6.32
Maximum Detected	0.82	Maximum Detected	-0.198
Mean of Detected	0.183	Mean of Detected	-3.977
SD of Detected	0.326	SD of Detected	2.432
Minimum Non-Detect	0.014	Minimum Non-Detect	-4.269
Maximum Non-Detect	0.028	Maximum Non-Detect	-3.576
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	8
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	3
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	72.73%

Warning: There are only 8 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.629	Shapiro Wilk Test Statistic	0.845
5% Shapiro Wilk Critical Value	0.818	5% Shapiro Wilk Critical Value	0.818
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.135	Mean	-4.176
SD	0.284	SD	2.071
95% DL/2 (t) UCL	0.291	95% H-Stat (DL/2) UCL	4.258
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-4.421
		SD in Log Scale	2.175
		Mean in Original Scale	0.134
		SD in Original Scale	0.285
		95% t UCL	0.29
		95% Percentile Bootstrap UCL	0.281
		95% BCA Bootstrap UCL	0.335
		95% H-UCL	5.838

Table 6-8b: AOC C4 PAH Soils 95% UCL Concentrations

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.272
Theta Star	0.671
nu star	4.358
A-D Test Statistic	0.9
5% A-D Critical Value	0.797
K-S Test Statistic	0.797
5% K-S Critical Value	0.317

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.82
Mean	0.133
Median	0.0032
SD	0.286
k star	0.18
Theta star	0.74
Nu star	3.949
AppChi2	0.702
95% Gamma Approximate UCL	0.748
95% Adjusted Gamma UCL	1.021

Data Distribution Test with Detected Values Only

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.134
SD	0.272
SE of Mean	0.0876
95% KM (t) UCL	0.293
95% KM (z) UCL	0.278
95% KM (jackknife) UCL	0.29
95% KM (bootstrap t) UCL	3.711
95% KM (BCA) UCL	0.284
95% KM (Percentile Bootstrap) UCL	0.281
95% KM (Chebyshev) UCL	0.516
97.5% KM (Chebyshev) UCL	0.681
99% KM (Chebyshev) UCL	1.006

Potential UCLs to Use

95% KM (Chebyshev) UCL	0.516

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Dibenzo(a,h)anthracene

General Statistics

Number of Valid Data	11	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	7
		Percent Non-Detects	63.64%

Raw Statistics

Minimum Detected	0.0022
Maximum Detected	0.12
Mean of Detected	0.0526
SD of Detected	0.0589
Minimum Non-Detect	0.0027
Maximum Non-Detect	0.028

Log-transformed Statistics

Minimum Detected	-6.119
Maximum Detected	-2.12
Mean of Detected	-4.041
SD of Detected	2.036
Minimum Non-Detect	-5.915
Maximum Non-Detect	-3.576

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	9
Number treated as Detected	2
Single DL Non-Detect Percentage	81.82%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.855
5% Shapiro Wilk Critical Value	0.748

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0222
SD	0.0404
95% DL/2 (t) UCL	0.0443
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.847
5% Shapiro Wilk Critical Value	0.748

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-5.15
SD	1.629
95% H-Stat (DL/2) UCL	0.202

Log ROS Method

Mean in Log Scale	-5.55
SD in Log Scale	1.702
Mean in Original Scale	0.0203
SD in Original Scale	0.0412
95% t UCL	0.0428
95% Percentile Bootstrap UCL	0.0416
95% BCA Bootstrap UCL	0.0487
95% H-UCL	0.184

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.309
Theta Star	0.17
nu star	2.469
A-D Test Statistic	0.479
5% A-D Critical Value	0.678
K-S Test Statistic	0.678
5% K-S Critical Value	0.409

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.12
Mean	0.0191
Median	0.000001
SD	0.0418
k star	0.152
Theta star	0.126
Nu star	3.334
AppChi2	0.478
95% Gamma Approximate UCL	0.133
95% Adjusted Gamma UCL	N/A

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0206
SD	0.0391
SE of Mean	0.0136
95% KM (t) UCL	0.0453
95% KM (z) UCL	0.043
95% KM (jackknife) UCL	0.0423
95% KM (bootstrap t) UCL	0.0392
95% KM (BCA) UCL	0.12
95% KM (Percentile Bootstrap) UCL	0.0905
95% KM (Chebyshev) UCL	0.08
97.5% KM (Chebyshev) UCL	0.106
99% KM (Chebyshev) UCL	0.156

Potential UCLs to Use

95% KM (t) UCL	0.0453
95% KM (Percentile Bootstrap) UCL	0.0905

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Table 6-8b: AOC C4 PAH Soils 95% UCL Concentrations

Indeno(1,2,3-cd)pyrene			
	General Statistics		
Number of Valid Data	11	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	5
		Percent Non-Detects	45.45%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0019	Minimum Detected	-6.266
Maximum Detected	0.54	Maximum Detected	-0.616
Mean of Detected	0.161	Mean of Detected	-3.763
SD of Detected	0.241	SD of Detected	2.48
Minimum Non-Detect	0.0028	Minimum Non-Detect	-5.878
Maximum Non-Detect	0.028	Maximum Non-Detect	-3.576
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	9
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	81.82%
	Warning: There are only 6 Detected Values in this data		
	Note: It should be noted that even though bootstrap may be performed on this data set		
	the resulting calculations may not be reliable enough to draw conclusions		
	It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.		
	UCL Statistics		
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.718	Shapiro Wilk Test Statistic	0.868
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0904	Mean	-4.531
SD	0.188	SD	2.074
95% DL/2 (t) UCL	0.193	95% H-Stat (DL/2) UCL	3.034
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-4.779
		SD in Log Scale	2.148
		Mean in Original Scale	0.0889
		SD in Original Scale	0.189
		95% t UCL	0.192
		95% Percentile Bootstrap UCL	0.186
		95% BCA Bootstrap UCL	0.221
		95% H-UCL	3.518
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.285	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.563		
nu star	3.421		
A-D Test Statistic	0.583	Nonparametric Statistics	
5% A-D Critical Value	0.759	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.759	Mean	0.0891
5% K-S Critical Value	0.355	SD	0.18
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0595
		95% KM (t) UCL	0.197
Assuming Gamma Distribution		95% KM (z) UCL	0.187
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.192
Minimum	0.000001	95% KM (bootstrap t) UCL	2.346
Maximum	0.54	95% KM (BCA) UCL	0.196
Mean	0.0876	95% KM (Percentile Bootstrap) UCL	0.188
Median	0.0019	95% KM (Chebyshev) UCL	0.348
SD	0.19	97.5% KM (Chebyshev) UCL	0.461
k star	0.157	99% KM (Chebyshev) UCL	0.681
Theta star	0.558		
Nu star	3.456	Potential UCLs to Use	
AppChi2	0.519	95% KM (BCA) UCL	0.196
95% Gamma Approximate UCL	0.583		
95% Adjusted Gamma UCL	0.816		
	Note: DL/2 is not a recommended method.		
	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.		
	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).		
	For additional insight, the user may want to consult a statistician.		

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Table 6-9: AOC C4 Outlier Test Results

Outlier Tests for Selected Variables

User Selected Options

From File WorkSheet.wst
Full Precision OFF
Test for Suspected Outliers with Dixon test 1
Test for Suspected Outliers with Rosner test 2

Dixon's Outlier Test for DRO

Number of data = 13
10% critical value: 0.467
5% critical value: 0.521
1% critical value: 0.615

1. Data Value 7300 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.701
For 10% significance level, 7300 is an outlier.
For 5% significance level, 7300 is an outlier.
For 1% significance level, 7300 is an outlier.

2. Data Value 100 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.080
For 10% significance level, 100 is not an outlier.
For 5% significance level, 100 is not an outlier.
For 1% significance level, 100 is not an outlier.

Dixon's Outlier Test for RRO

Number of data = 13
10% critical value: 0.467
5% critical value: 0.521
1% critical value: 0.615

1. Data Value 3600 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.774
For 10% significance level, 3600 is an outlier.
For 5% significance level, 3600 is an outlier.
For 1% significance level, 3600 is an outlier.

2. Data Value 46 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.026
For 10% significance level, 46 is not an outlier.
For 5% significance level, 46 is not an outlier.
For 1% significance level, 46 is not an outlier.

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Table 6-10a: AOC C4 HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	maximum LOD	maximum LOD	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	maximum detected conc	max measured conc	
Ethylbenzene (c & nc)	maximum LOD	maximum LOD	
Xylenes (total) (nc)	maximum detected conc	max measured conc	
GRO	maximum detected conc	max measured conc	
DRO	95%UCL	max measured conc	
RRO	95%UCL	max measured conc	
GRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
DRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
RRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
GRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
DRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
RRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
Acenaphthene (nc)	max measured conc	max measured conc	
Acenaphthylene (nc)	max measured conc	max measured conc	
Anthracene (nc)	max measured conc	max measured conc	
Benzo(g,h,i)perylene (nc)	max measured conc	max measured conc	
Fluoranthene (nc)	max measured conc	max measured conc	
Fluorene (nc)	max measured conc	max measured conc	
Naphthalene (c & nc)	max measured conc	max measured conc	
Phenanthrene (nc)	max measured conc	max measured conc	
Pyrene (nc)	max measured conc	max measured conc	
Benzo(a)anthracene (c)	95%UCL	max measured conc	
Benzo(b)fluoranthene (c)	95%UCL	max measured conc	
Benzo(k)fluoranthene (c)	max measured conc	max measured conc	
Benzo(a)pyrene (c)	95%UCL	max measured conc	
Chrysene (c)	max measured conc	max measured conc	
Dibenz(a,h)anthracene (c)	95%UCL	max measured conc	
Indeno(1,2,3-cd)pyrene (c)	95%UCL	max measured conc	
1-Methylnaphthalene (nc)	max measured conc	max measured conc	
2-Methylnaphthalene (nc)	max measured conc	max measured conc	

Hydrocarbon Characterization Data	
Hydrocarbon Fractions	Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_5-C_6	Site specific EPH & VPH data
Aliphatic C_6-C_8	Site specific EPH & VPH data
Aliphatic C_8-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:

BTEX = benzene, toluene, ethylbenzene, xylene

(c) = carcinogen

DRO = diesel-range organics

EPH = extractable petroleum hydrocarbons

GRO = gasoline-range organics

mg/kg = milligrams per kilogram

(nc) = non-carcinogen

RRO = residual-range organics

VPH = volatile petroleum hydrocarbons

Table 6-10b: AOC C4 HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	**Input Values**			**Source of Data**
bulk density (lbs/ft^3)	119.2875			C2 & C4 sites average value
specific gravity	2.787142857			C2 & C4 sites average value
moisture content (% by weight)	9.825			C2 & C4 sites average value
foc	0.003835			C2 & C4 sites average value
Soil temp (C)	5.3			C2 & C4 sites average value
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt			C2 & C4 sites average value
Hydrogeologic Conditions				
Source length (ft)	35			scaled from site maps
Average precipitation (in/yr)	143.44			NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	3.53E-06			based on grain size and textbook values (Freeze and Cherry 1979)
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8			estimated thickness of the aquifer based on the 2014 boring logs
Infiltration rate (m/yr)	0.7286752			20% of average precipitation
Hydraulic gradient	0.018			Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1			Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters				
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3			NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth				
depth to groundwater at seasonal low water level at downgradient end of source (ft)	10			Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	4			Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	10			Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	0			Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time				
Soil Direct Contact	1			Site specific conceptual site model
Outdoor Air	1			Site specific conceptual site model
Indoor Air	0			Site specific conceptual site model
Groundwater Ingestion	0			Site specific conceptual site model
Other Input				
ADEC Hazard ID	0			ADEC CS database
Latitude	0			ADEC CS database
Longitude	0			ADEC CS database
Width of Source (ft)	80			scaled from site maps
Area of NAPL contaminated soil source (ft^2)	2800			scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.018			Measured slope of water table
Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	119.29	119.29	119.29	C2 & C4 sites average value
specific gravity of solids	2.787143	2.787143	2.787143	C2 & C4 sites average value
moisture content (% by weight)	9.83	9.83	9.83	C2 & C4 sites average value
foc	0.003835	0.003835	0.003835	C2 & C4 sites average value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	0.1	0.1	0.1	Site Specific (depth to source minus foundation depth-- distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	6.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 6-11: AOC C4 Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	2.76175E-06	0.2762	0.0021
Outdoor air inhalation	9.13301E-10	0.0001	0.0000
Indoor air inhalation (vapor intrusion)	7.42104E-09	0.0007	0.0002
Groundwater Ingestion	2.16754E-06	0.2168	0.0421
Cumulative Risk	**5E-06**	**0.5**	**0.0**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	8.30176E-06	0.8302	0.0225
Outdoor air inhalation	3.96187E-09	0.0004	0.0000
Indoor air inhalation (vapor intrusion)	3.11684E-08	0.0031	0.0008
Groundwater Ingestion	3.64146E-06	0.3641	0.0590
Cumulative Risk	**1E-05**	**1.0**	**0.10**

Notes:
Fraction of Risk values equal to or less than one meet the ADEC risk standard
Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 6-12: AOC C4 Summary of Bulk Fuel Hydrocarbon Risks

	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Fraction of Risk Values				
			Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	17	0.006	<1	<1	<1	<1	<1
DRO Aromatics	647	0.132	<1	<1	<1	<1	<1
RRO Aromatics	328	0.043	<1	No RfC	No Rfc	<1	<1
GRO Aliphatics	45	0.014	<1	<1	<1	<1	<1
DRO Aliphatics	2409	0.633	<1	<1	<1	<1	<1
RRO Aliphatics	895	0.230	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	17	0.006	<1	<1	<1	<1	<1
DRO Aromatics	647	0.132	<1	<1	<1	<1	<1
RRO Aromatics	328	0.043	<1	No Rfc	No Rfc	<1	<1
GRO Aliphatics	45	0.014	<1	<1	<1	<1	<1
DRO Aliphatics	2409	0.633	<1	<1	<1	<1	<1
RRO Aliphatics	895	0.230	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics

GRO = gasoline-range organics

mg/kg = milligrams per kilogram

Table 6-13: AOC C4 Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
Benzo(a)pyrene (c)	0.52	0.4	Direct Contact	0.4	MTGW	0.19	NA	0.261	Soil Direct Contact
total DRO	7300	230	MTGW	780	MTGW	3056	12500	10525	Soil Direct Contact

Notes:
ACL = alternate cleanup level
(c) = carcinogen
DRO = diesel-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
MTGW = migration to groundwater
NA = not applicable
(nc) = non-carcinogen

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7.0 AOC C6 – POINT CARREW GARRISON 50,000 GALLON DIESEL OIL TANK – NO. 1094

7.1 AREA DESCRIPTION AND BACKGROUND

AOC C6 is located in heavily vegetated old-growth forest on Phipps Peninsula at Point Carrew, just west of the bridge over Ankau Slough. AOC C6 is the former location of an aboveground, 50,000-gal wood stave reserve diesel fuel tank. The tank and associated piping were removed at some time in the past. The only remaining feature of the former tank currently evident at the site is the concrete tank pad.

According to previous data obtained from the site, DRO is present in vadose and saturated zone soils above ADEC cleanup levels. Results of previous investigations also show DRO detected in groundwater at concentrations above the ADEC Table C cleanup level (ENSR 2003b and BCC-J 2007).

Historical data were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at the site. These data, along with field screening results and visual observations, were reviewed to select appropriate RI sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations and the estimated NAPL source area at AOC C6 are shown on Figure 7-1.

7.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC C6 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Evaluate current groundwater conditions.
- Determine the tidal influence of Ankau Slough on groundwater quality and flow conditions at AOC C6.

7.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC C6 included advancement of soil borings, collection of soil and groundwater samples, aquifer (slug) testing and a tidal study. These activities are described below by media.

7.3.1 Soil

Six supplemental soil borings were advanced within the source zone at AOC C6 to collect vadose and saturated zone soil data for the HRC evaluation. Two borings were advanced adjacent to the eastern and southern edge of the concrete tank pad and four borings were advanced further to the east and southeast, within the estimated source zone. Soil boring logs are included in Appendix C.

Soils encountered at the site generally consist of fine silty sands with some clayey sand zones at shallow depths, which overlay fine to coarse sands and gravel that coarsen with depth. Field screening samples were collected from above and below the target interval and screened for volatile organics using a PID. Soil samples collected for laboratory analysis were selected from the most highly contaminated interval within each target range based on field observations (e.g., PID, visual, and olfactory). Soil samples from each location were submitted for laboratory analyses; one from both C6-SB01 and SB06, and two each from C6-SB02 through SB05. The majority of samples were analyzed for GRO, DRO, RRO, BTEX, PAHs, VPH and EPH, with only the deeper sample from C6-SB04 and SB05 submitted for VPH/EPH analyses. Field observations and screening results were used to refine the estimated limits of the NAPL source area as depicted on Figure 7-1.

BACKGROUND SOIL CONDITIONS

Soil borings were advanced outside the estimated NAPL source area to collect background soil data (i.e., chemical, TOC and physical parameters) for input into the HRC. Background boring locations were determined in the field from areas around the perimeter of AOC C6, with additional considerations given for access to upgradient areas. Two of the originally selected locations (C6-BG01A and BG01B) advanced southwest of the tank pad were relocated when metal debris and petroleum odors were encountered. Soil samples from background borings were collected from depths with soil types representative of those observed as impacted within the NAPL source area. As such, two samples were collected from each boring; one from each of two predominant soil horizons. Samples were analyzed for GRO, DRO/RRO, DRO/RRO with SGC, TOC, and physical parameters (grain size, bulk density, moisture content, and specific gravity). Results of the background chemical analyses are presented in summary tables in Appendix J. Geotechnical data are summarized in Table 4-2 and TOC results are summarized in Table 4-3 (Section 4.2.2).

7.3.2 Groundwater

Groundwater assessment at the site included sampling of one monitoring well (AP-064) upgradient of the former AST and two downgradient wells (AP-062 and AP-063) located inside the estimated source area (Figure 7-1). Groundwater samples were collected using bladder pumps with dedicated bladders and analyzed for GRO, DRO, RRO, BTEX, and PAHs. The sample collected from AP-062 was also analyzed for VPH/EPH for the HRC evaluation. Low Flow Groundwater Sample Collection Records are included in Appendix D.

AQUIFER TESTING

Subsequent to sampling, two slug tests were performed on each of the three site monitoring wells to obtain hydraulic conductivity values for input into the HRC. Since <5 feet of available water column was present within the screen intervals, a water slug was used to displace the water column instead of a solid slug. These tests were performed and evaluated following the procedures outlined in Section 3.4.5. Slug test data are included in Appendix E and results discussed in Section 7.4.1 below.

A tidal study was also completed at AOC C6 to determine the tidal influence of the Ankau Slough on groundwater at this site. Tidal effects were evaluated for influence on groundwater flow direction and groundwater quality via saltwater intrusion for a possible 18 AAC 75.350 groundwater use determination. The tidal study was performed by deploying pressure transducers to near-bottom depths in the three monitoring wells for an approximate nine day period and recording conductivity and water level measurements at select time intervals. Data from each of the transducers were downloaded and reviewed in the field to ensure proper data collection during the study. Tidal study results are discussed below in Sections 7.4.2 and 7.4.3.

7.4 GROUNDWATER CONDITIONS

7.4.1 Aquifer Tests

Slug test data were reduced using AQTESOLV software for subsequent evaluation using the Bouwer & Rice Method (1976) for unconfined aquifers, as well as the Hvorslev Method (1951) for comparison (AQTESOLV 2014). Hydraulic conductivities calculated at AOC C6 using Bouwer & Rice are presented in Table 4-4 and range from 0.125 ft/day to 0.928 ft/day. An average hydraulic conductivity value of 0.50 ft/day was used for evaluating risk and calculating ACLs for the site.

7.4.2 Tidal Influences

A study to evaluate tidal influence on groundwater was performed at the site over the period from 6 June through 14 June 2014. This period was selected to incorporate both the neap (least tidal variation) and spring (greatest tidal variation) tidal cycles that occurred during the timing of the field investigation. Groundwater fluctuations over the study period were measured in three wells (AP-062, AP-063, AP-064) using synchronized vented pressure transducers. Groundwater level and electrical conductivity/salinity measurements were collected to determine tidal interactions with groundwater, including evaluating groundwater flow and possible saltwater intrusion.

EVALUATION OF HYDROGRAPHS

Figure 7-3 provides groundwater elevations measured in the three monitoring wells during the study period, as well as Yakutat tide station water levels measured in Yakutat Bay (NOAA Tide Station 9453220 Yakutat) over the same period. When compared to surface water levels collected within Yakutat Bay, groundwater levels at each monitoring well exhibit similar sinusoidal fluctuations as those measured within the bay. Groundwater response to changes in tide displayed time-lags of approximately 3.5, 3.9, and 4.2 hours for monitoring wells AP-062, AP-064, and AP-063, respectively. Variation in groundwater levels generally displayed an inverse relationship to groundwater tidal time-response with tidal fluctuations typically greatest at AP-062, then AP-064, and lowest at AP-063. Changes in groundwater levels between tide cycles varied between 0.05 and 0.3 foot.

On average, groundwater elevations increased during the study period from 6 June through 14 June 2014. This is likely attributed to one or two rain events, each with approximately 1.2 inches of precipitation occurring toward the beginning and end of the study. The average increase in the groundwater level is greatest at AP-064, with a change of approximately 0.3 foot.

7.4.3 Groundwater Data Filtering

Quantifying the ground water table and flow direction in coastal areas is necessary to understand substance movement and saltwater intrusion. For contaminated site studies, an accurate understanding of groundwater flow direction is especially important. However, coastal groundwater tables fluctuate with the ocean tide. Thus, traditional methods to characterize hydrologic and chemical conditions at tidally-influenced contaminated sites, such as using a cursory knowledge of hydrologic setting and single-time groundwater level measurements, are not useful (Marquis & Smith 1993). This is because tidally influenced groundwater gradients and direction often vary widely and a single-time groundwater level observation infers only the flow at a single point in time, not the net or mean effect of tidally-influenced changes in the water table. A data filtering method, per Serfes (1991), has been applied to evaluate the net or mean groundwater flow at the tidally influenced AOC C6 site.

Sinusoidally fluctuating groundwater levels in aquifers that are hydrologically connected to surface water are the result of gravitational interaction between the earth, moon and sun. Even though longer-term cycles— including climatic factors, lunar monthly and semimonthly components— can affect tidally-influenced groundwater levels, the most important and persistent cycles are shorter-term daily and semi-daily tidal fluctuations. The filtering method applied in this study cancels out the major lunar and solar frequencies associated with the shorter-term tidal cycles.

Mean groundwater elevations were determined for wells AP-062, AP-063 and AP-064 using the 71 hour filtering method described by Serfes (1991). The data used for the filtering method were from a select portion of the tidal study collected from 9 June to 12 June 2014. These days were selected because this period was between the neap (ended on 7 June) and spring tide (started on 14 June) and there was negligible precipitation interference. The site received only 0.02 inch of precipitation during this period. Thus, the observation mostly eliminated the shorter-term daily and semi-daily tidal fluctuations. It should be noted that the filtering method used below does not filter the longer period frequencies associated with the semilunar monthly tidal component. The lack of filtering opportunities of this component and slope of the site can lead to an inaccurate groundwater flow determination for this unconfined aquifer. However, as the study was conducted 3 days after neap tide and 2 days prior to the spring tide, and the site location is very close to the coast, the lack of filtering of the longer period semilunar monthly component and slope characteristics are believed to have had minimal impact on the groundwater elevation data collected during the study.

The 71 hour Serfes (1991) filtering method involved calculating a set of moving averages using a filtering interval of 24 consecutive hourly groundwater level measurements. Several sequences of moving averages were calculated to achieve a single mean elevation for the median of 71 hours (hour 36) as follows:

Let the consecutive hourly groundwater level observations be O (1), O (2), O (3), . . . , O (71):

the first sequence of means (X_i) is

$X_i = \frac{\sum_{n=0}^{23} O_i + n}{24}$ where i = 1,2,3, ... , 48;

The second sequence of means (Y_j) is

$Y_j = \frac{\sum_{i=0}^{23} X_i + j}{24}$ where j = 1,2,3, ... , 25;

and the mean elevation (M) at hour 36 is

$$M = \frac{\sum_{j=1}^{25} Y_j}{24}$$

Figure 7-4 provides hydrographs showing the 71-hour filtering process for each monitoring well, including X_i and Y_j sequences and the mean groundwater elevation M. The results of the 71 hour Serfes (1991) filtering method yield a net flow direction to the south to southeast with a mean groundwater gradient of 0.00192 ft/ft (Figure 7-6).

GROUNDWATER QUALITY

Electrical conductivity and calculated salinity results were obtained from the three study wells to evaluate the groundwater quality and determine if saltwater intrusion occurs at the site. Groundwater electrical conductivity ranged from 244.0 to 417.6 microsiemens per centimeter (µS/cm) with concentrations greatest in wells closest to the tidelands. Electrical conductivity increased slightly with time in all wells, with changes of less than 1% in AP-062 and AP-063 and 7% in AP-064. Electrical conductivity did not change with diurnal tide fluctuations, but rather increased with average groundwater level rise (Figure 7-5). Measured electrical conductivity concentrations are well below ocean water electrical conductivity (approximately 50,000 µS/cm) and are consistent with measurements at AOCs with minimal to no tidal influences (AOC C2/C4, AOC D). This indicates that tidal influence at AOC C6 does not include saltwater intrusion of groundwater within the portion of the aquifer bisected by site monitoring well screens (approximate upper 5 feet of aquifer).

Salinity was calculated based on electrical conductivity measurements and therefore shows the same trends. The apparent salinity ranged from 0.2 to 0.3 parts per thousand (ppt). Again, these values are well below sea water conditions, which generally consist of 35,000 ppt salinity.

While MCLs have not been promulgated for groundwater electrical conductivity or salinity values, the EPA has established National Secondary Drinking Water Regulations that set non-mandatory water quality standards, including a standard for TDS at a concentration of 500 mg/L. Although TDS were not directly measured, the specific conductance (electrical conductivity normalized to 25 ºC) of groundwater is directly related to TDS based on the assumption that TDS in water consist mainly of ionic constituents that conduct electricity (Wood 1976, Hem 1985, Lloyd and Heathcote 1985). Using this relationship, TDS can be approximated by the following (Lloyd and Heathcote 1985):

$TDS = k_e EC$

Where TDS are expressed in mg/L and EC is the specific conductance in µS/cm. The correlation factor k_e typically varies between 0.55 and 0.8 (Atekwana et al. 2004).

When conservatively assuming a 0.8 correlation factor, calculated TDS based on AOC C6 measured specific conductance, ranges from 319 to 546 mg/L. The calculated TDS values are below the EPA secondary standard of 500 mg/L with the exception of groundwater at monitoring well AP-062, which had a maximum TDS of 546 mg/L.

7.4.4 350 Groundwater Determination

The land use, physical and chemical characteristics of the aquifer, and other factors promulgated under 18 AAC 75.350 were evaluated to determine whether groundwater at AOC C6 is a current or reasonably anticipated drinking water source. Below, a discussion is provided for each element of 18 AAC 75.350 and ultimately demonstrates that groundwater at AOC C6 is neither a current nor reasonably anticipated drinking water source.

According to 18 AAC 75.350, Groundwater Use, subject to 18 AAC 75.345(c), groundwater at the site is considered to be a drinking water source unless a responsible person demonstrates or the department determines that:

(1) The groundwater is not (A) used for a private or public drinking water system; (B) within the zone of contribution of an active private or public drinking water system; or (C) within a recharge area for a private or public drinking water well, a wellhead protection area, or a sole source aquifer.

The EPA defines a sole or principal source aquifer as an aquifer or aquifer system which supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer, and for which there is no alternative source or combination of alternative drinking water sources which could physically, legally and economically supply those dependent upon the aquifer (EPA 2012).

Groundwater at the site is not used for any known drinking water system, and groundwater on Phipps Cape is not within the zone of contribution of an active private or public drinking water system. The topography at AOC C6 slopes to the south, toward Ankau Slough. Because AOC C6 is situated on a peninsula, the site is surrounded by ocean on three sides and a saltwater slough on the fourth side. The only known public drinking water system is located in the City of Yakutat which is separated from the site by Monti Bay and Ankau Slough (USGS 1995). The groundwater at AOC C6 is not within a recharge area for any known private or public drinking water well, wellhead protection area, or a sole source aquifer (EPA 2013).

(2) The groundwater is not a reasonably expected potential future source of drinking water, based on an evaluation of:

(A) The availability of the groundwater as a drinking water source, including depth to groundwater, the storativity and transmissivity of the aquifer, the presence of permafrost, and other relevant information.

Glacial deposits at the AOC C6 site contain layers of both well graded and poorly graded sand, sand with gravel, and silty sand. Soil boring logs from the site indicate that groundwater was encountered between 7 feet bgs and 19.5 feet bgs in poorly graded to well graded, silty fine to medium sand. The results of the 71 hour Serfes (1991) filtering method, discussed in Section 7.4.3, yields a net groundwater flow direction to the south-southeast, toward Ankau Slough, with a mean groundwater gradient of 0.00192 ft/ft (see Figure 7-6).

Groundwater is available at the site in the shallow unconfined aquifer. Using the ADEC default aquifer thickness of 10 meters (32 feet) and the site-specific hydraulic conductivity of 0.5 ft/day yields a calculated transmissivity of 16 feet squared per day (ft^2/day) or 1.5 meters squared per day (m^2/day). The common transmissivity range for dominant aquifers in Alaska, composed of glacial and alluvial deposits, is 100-10,000 m^2/day (Driscoll 1986). If an aquifer has a transmissivity less than 12.4 m^2/day, it can supply only enough water for domestic wells or other low yield uses. When the transmissivity is 124 m^2/day or more, well yields can be adequate for industrial, municipal, or irrigation purposes (Driscoll 1986). In general, storativity in unconfined aquifers ranges from 0.1 to 0.3 (AQTESOLV 2014).

(B) Actual or potential quality of the groundwater, including organic and inorganic substances, and as affected by background, saltwater intrusion, and known or existing area wide contamination.

Electrical conductivity and calculated salinity results were obtained from the three study wells at the AOC C6 site to evaluate groundwater quality and determine if saltwater intrusion occurs (Section 7.4.2). These results indicate that tidal influence at AOC C6 does not include saltwater intrusion of groundwater within the portion of the aquifer.

However, TDS in groundwater from well AP-062 (546 mg/L) exceed the EPA Secondary Drinking Water standard for TDS (500 mg/L). It should be noted that AP-062 is the deepest installed monitoring well at AOC C6. No data were obtained from deeper in the aquifer, and it is possible that saltwater intrusion could occur deeper in the aquifer. A study reported in the USGS Open File Report 94-713 (USGS 1995) at Ocean Cape, indicated that pumping of a well near the Gulf of Alaska, at Ocean Cape, at a rate greater than 1.26 liters per second caused infiltration of sea water into the well making it unusable for drinking water. Ocean Cape is 1-3/16 miles west of the site on the tip of the peninsula on which AOC C6 is situated.

(C) The existence and enforceability of institutional controls (ICs) described in 18 AAC 75.375 or municipal ordinances or comprehensive plans that prohibit or limit access to the groundwater for use as drinking water.

The land is currently owned by Yak-Tat Kwaan Inc. There are no known ICs or municipal ordinances or comprehensive plans that prohibit or limit access to groundwater use as a drinking water source established on this land. Although there are no municipal or corporation ICs, there is a naturally occurring IC as the site is surrounded by salt water which prevents its connection with any other aquifers.

(D) Land use of the site and neighboring property, using the factors in EPA's Land Use in the Comprehensive Environmental Response, Compensation, and Liability Act Remedy Selection Process, adopted by reference in 18 AAC 75.340.

The site and surrounding area are currently wooded and undeveloped. Current site land use is predominately for native subsistence and recreational activities (e.g., picnicking, site-seeing, hiking, surfing, berry picking, hunting, clamming, etc.). The site is currently owned by Yak-Tat Kwaan Inc., so potential future land use could conceivably be residential. No properties neighbor the site for approximately 1 mile to the south and approximately 2 miles to the east. The City of Yakutat is located approximately 3.5 miles to the east, and is separated from the site by Monti Bay.

(E) The need for a drinking water source and the availability of an alternative source.

Presently, there is no need for water at the site as the area is neither residential nor industrial and is undeveloped.

The Yakutat area receives on average over 155 inches of rainfall per year. A gravity fed cistern system water supply is a reasonable alternative to the groundwater supply when added to the fact that the area is not supplied by electrical power. Additionally, the USGS Overview of Environmental and Hydrogeologic Conditions at Yakutat (USGS 1995) states that alternative drinking-water supplies are available from both surface and groundwater sources in the Yakutat area.

(F) Whether the groundwater is exempt under 40 Code of Federal Regulations (CFR) 146.4, revised as of July 1, 1997, and adopted by reference.

40 CFR §146.3, Exempted Aquifer, applies only to those aquifers that meet the criteria for an “underground source of drinking water” in 40 CFR §146.4. The CFR definition of “underground source of drinking water” means an aquifer or its portion:

- Which supplies any public water system (which the aquifer at the site doesn’t); or
- Which contains a sufficient quantity of ground water to supply a public water system (which the aquifer at the site potentially could); and
- Currently supplies drinking water for human consumption (which the aquifer at the site doesn’t); or
- Contains fewer than 10,000 mg/l TDS (which the groundwater at the site does); and
- Which is not an exempted aquifer.

Although the AOC C6 aquifer meets the criteria of an underground source of drinking water as defined in 40 CFR §146.4, it does not meet all of the exemption criteria in 18 AAC 75.350, Groundwater Use, and therefore may not be classified as an exempt aquifer.

(3) The groundwater affected by the hazardous substance will not be transported to groundwater that is a source of drinking water, or that is a reasonably expected potential future source of drinking water, in concentrations in the receiving groundwater that exceed the groundwater cleanup levels; in reviewing the demonstration required under this paragraph, the department will consider.

(A) The areal extent of the affected groundwater.

Analytical results indicate that DRO exceeds the ADEC Table C groundwater cleanup level at the site. DRO was detected in groundwater at 6.84 mg/L. The areal extent of groundwater contamination is shown on Figure 7-1.

(B) The distance to any existing or reasonably anticipated future water supply well.

Currently there are no known water supply wells within one mile of the site, which is estimated to be a reasonable distance because the site is on a peninsula surrounded by salt water on all sides. AOC C6 is situated 7/8 mile east of the Gulf of Alaska and 7/8 mile south of Yakutat Bay. Monti Bay is approximately ½ mile to the east and Ankau Slough is approximately 1/8 mile south of the site. The City of Yakutat drinking water wells are located approximately 3.5 miles east-southeast of the site, but are separated by Monti Bay.

(C) The likelihood of an aquifer connection due to well construction practices in the area where the site is located.

No wells were installed during the 2014 investigation at AOC C6. Previous environmental investigations at the site were conducted under USACE contract, which would have followed ADEC well installation guidance at the time of installation. Therefore, it is unlikely that historical wells at the site compromised the underlying aquifer quality. Additionally, there are no drinking water supply wells within 3.5 miles of the site, so potential aquifer connections due to drinking water well construction practices would not occur.

(D) The physical and chemical characteristics of the hazardous substance.

The contamination at the site includes DRO contaminated soil and water. DRO concentrations in soil range from up to 1,220 mg/kg in surface soil to 5,880 mg/kg in subsurface soil. DRO was previously detected in groundwater at 6.84 mg/L; recent concentrations (2014) in the same well were detected at 2.1 mg/L. DRO in both soil and groundwater tends to biodegrade over time. DRO has low volatility and at normal temperatures diesel fuel generates vapors only at low concentrations.

(E) The hydrogeological characteristics of the site Register 211, October 2014 ENVIRONMENTAL CONSERVATION 93.

As indicated above, groundwater is available at the site in a shallow unconfined aquifer in glacial moraine deposits and was encountered between 7 and 19.5 feet bgs. The aquifer is assumed to be 32 feet thick and has a transmissivity of 16 ft^2/day. Storativity in unconfined aquifers ranges from 0.1 to 0.3 (AQTESOLV 2014).

(F) The presence of discontinuities in the affected geologic stratum at the site.

No discontinuities were observed in the AOC C6 geologic stratum.

(G) The local climate.

Yakutat's climate is dominated by its proximity to the coast. Meteorological data for Yakutat from 1981 to 2014 indicate a monthly daily average temperature of 54.4°F in July and 28.1°F in January, with a maximum summer temperature of 88°F recorded in August 2004 and a minimum winter temperature of -24°F recorded in December 1964. Usually, extreme temperature durations are only 4.9 days of below zero lows and 4 days of above 70°F highs annually. Unlike typical south-central Alaska weather extremes, a day with a subzero high has never been recorded in Yakutat.

Maritime conditions often are cloudy and wet. Average annual precipitation is 155 inches, with precipitation falling an average of 240 days per year. June is the driest month, with an average of 6.39 inches of precipitation. September and October are the two wettest months, with an average of 21.11 and 22.01 inches of precipitation, respectively. January has the greatest snowfall, with an average of 31.3 inches. Average snow depths during the winter and early spring months are typically less than 15 inches (NOAA 2014).

(H) The degree of confidence in any predictive modeling performed.

No predictive groundwater modeling has been performed. Limited information from the monitoring wells and subsurface soil samples has been used to describe the shallow aquifer characteristics in the preceding sections.

(I) Other relevant information; ADEC will request additional information if the department determines that the information is necessary to protect human health, safety, or welfare, or the environment.

Numerous surface water bodies are present surrounding the site. The site is surrounded by marine waters on three sides and a saltwater slough on the forth side in the immediate vicinity of the site.

The preceding paragraphs demonstrate that:

- The groundwater at AOC C6 is not a current source of drinking water.
- The groundwater at AOC C6 is not an expected potential future source of drinking water.
- The groundwater at AOC C6 is not within a recharge area for a private or public drinking water well, a wellhead protection area, or a sole source aquifer.

This determination is made in recognition that:

- The groundwater is not used for a private or public drinking water system.
- The groundwater is not within the zone of contribution of an active private or public drinking water system.
- The groundwater at AOC C6 is physically divided from developed areas by seawater on three sides and Ankau Slough on the fourth side; thus, it is not within a recharge area for a private or public drinking water well, a wellhead protection area, or a sole source aquifer.
- The groundwater at AOC C6 is not a reasonably expected potential future source of drinking water based on a low estimated aquifer transmissivity, an evaluation of climate, availability of rainwater collection potential in cisterns, surface water quality in Yakutat, and lack of electricity serving the entire peninsula.

Electrical conductivity data indicates that saltwater intrusion is not occurring in the shallow portion of the aquifer and salinity data indicate that the aquifer may have suitable qualities for drinking; however, one of the wells at the site (AP-062) exceeds the EPA Secondary Drinking Water standard for TDS. It should be noted that AP-062 is the deepest well installed at AOC C6 and no data exists from deeper depths; therefore, it is possible that saltwater intrusion could occur deeper in the aquifer.

7.5 ANALYTICAL RESULTS

7.5.1 Soil

A total of ten soil samples were collected from six soil borings at the site (Figure 7-1) and submitted for laboratory analyses. These data were collected from the most highly contaminated soils to further characterize the NAPL source zone. Results show that seven of the ten samples had DRO concentrations above the Method Two cleanup level ranging from 560 mg/kg to 2,900 mg/kg. No other constituent concentrations exceeded Method Two cleanup levels for soil. Soil analytical results for the samples collected in 2014 are presented in summary tables provided in Appendix J. A cross sectional view of the site showing the vertical extent of impacts has also been prepared and is presented along A-A’ as Figure 7-2.

Constituent data collected within the defined source zone were used to supplement the historical data set for characterization of the NAPL source zone. Historical and recent (2014) POL data evaluated for the AOC C6 area are presented in Table 7-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 7-2. Historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attention of these constituents. PAH soil data are presented in Table 7-3, and VPH/EPH results are presented in Table 7-4. These data were used as input in calculating soil ACLs and to evaluate risk at the site using the HRC.

7.5.2 Groundwater

Groundwater assessment at the site included sampling three existing monitoring wells, one upgradient (AP-064) and two located inside the estimated source area (AP-062 and AP-063). Analytical results indicate that DRO was detected above the Table C groundwater cleanup level in the sample from AP-062. No constituent concentrations were reported above regulatory standards at AP-063 or AP-064. Groundwater analytical results are summarized in Appendix J. These data are considered to be representative of current groundwater quality conditions at the site and were compared to the Table C groundwater cleanup levels (18 AAC 75). Constituent concentrations exceeding the cleanup levels at AOC C6 are presented in Figure 7-6.

Results for wells AP-062, AP-063 and AP-064 were used to supplement historical groundwater data for AOC C6. Historical and recent (2014) groundwater results for POLs, PAHs and VPH/EPH are summarized in Table 7-5 through Table 7-7, respectively.

7.6 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC C6; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

7.6.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet ADEC "Cleanup Complete" criteria, the AOC C6 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion). Section 7.4.47.4.4 indicates groundwater is not a current or reasonably expected potential future source of drinking water; however, the risk evaluation was still conducted assuming the groundwater pathway is complete to determine if the site could be eligible for a "Cleanup Complete" designation (i.e. without Land Use Controls as may be needed should a "350" determination be granted without further risk evaluation).

The AOC C6 risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at the site at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be incomplete at the present time, because there are no occupied buildings within 30 feet of the AOC C6 source area. There is currently no exposure to groundwater at the present time, because there are no known drinking water wells within the radius of influence at the site. Additionally, results of a groundwater use determination for the site (Section 7.4.4) indicate that "groundwater at the site is neither a current nor reasonably anticipated drinking water source." Contaminant migration from groundwater to surface water is considered incomplete since the NAPL source area does not extend to the surface water body (Ankau Slough) and source area groundwater results meet Alaska WQS criteria for TAH and TAqH (i.e. any downgradient dissolved phase migration of groundwater could not cause surface water to exceed criteria).

The AOC C6 exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

7.6.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each hydrocarbon constituent (BTEX 2014 data only) and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in Table 7-2. The source area data set for toluene, ethylbenzene, and total xylenes had a limited number of relatively low concentration detections, so the maximum detected values from the source area were used as exposure point concentrations. Benzene was not detected; therefore, the LOD value was used as the exposure point concentration. There were adequate data to calculate 95% UCLs for GRO, DRO, and RRO; therefore, ProUCL was used to calculate 95% UCLs for the HRC input. ProUCL formatted outputs are displayed in Table 7-8.

Table 7-9 presents the ProUCL outlier test results for DRO, and as shown, the test indicated that the highest DRO concentration measured at the site (4,700 mg/kg) was not a statistical outlier. A Q-Q plot and box plot of the DRO source area data are presented in Figure 7-7a, b. The Q-Q and box plots show that the highest DRO concentration did not plot significantly above the other data, confirming that the highest DRO result was not a statistical outlier.

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 7-3. Benzo(g,h,i)perylene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene were not detected at the site; therefore, the maximum LOD values were used as the exposure point concentrations. The maximum detected concentrations were used as the exposure point concentrations for the remaining PAH constituents; 95% UCLs were not calculated for PAHs at AOC C6.

Seven VPH and EPH source area samples were used to characterize the bulk hydrocarbon chemistry. The HRC input values calculated from the source area VPH/EPH data are shown in Table 7-4.

The source of each HRC soil exposure point input value is documented in Table 7-10a.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

Benzene was not detected at the site, so the maximum LOD for the sample collected from the source area well was used as the exposure point concentration. Toluene, ethylbenzene, xylene, GRO, DRO and RRO were detected; therefore, the maximum detected concentration was used as input to the HRC. In addition, the maximum GRO, DRO and RRO aromatic and aliphatic concentrations (derived from the VPH/EPH test results) were used as input to the HRC.

All of the non-carcinogenic PAHs, except for benzo(g,h,i)perylene and pyrene, were detected at AOC C6, so the maximum detected concentrations were used as the exposure point concentrations for these PAHs. Benzo(g,h,i)perylene and pyrene were not detected; therefore, the maximum LOD values were used as the exposure point concentrations. The carcinogenic PAHs were not detected, but the maximum LOD values presented a significant fraction of risk; therefore, the groundwater concentrations predicted or modeled by the HRC, based on the soil concentration data, were used as input to the risk calculations. The modeled concentrations yield more representative risk results.

The source of each HRC groundwater exposure point input value is documented in Table 7-10a.

7.6.3 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to AOC C6 is presented in Table 7-10b.

7.6.4 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results is included as Table N-3 of Appendix N and the risk posed by the site conditions is summarized in Table 7-11 and Table 7-12. Table N-3 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for AOC C6 indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and assuming that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).

- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aromatic and aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.
- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, the site conditions are protective of human health under an unrestricted (residential) land use scenario.

7.7 ALTERNATIVE CLEANUP LEVELS

DRO concentrations measured at AOC C6 exceed the ADEC Method Two soil cleanup level which is based on the migration to groundwater route. Soil ACLs have been developed for DRO as shown in Table 7-13. The migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult's Law) and dilution-attenuation calculations are applied, the AOC C6 exposure point concentrations meet the migration to groundwater criteria. Under these conditions it is typically not necessary to calculate an ACL, but for this contract an ACL for DRO has been back calculated and is presented in Table 7-13. The exposure point concentrations at AOC C6 are less than the ACL calculated using the HRC, documenting that the site meets the ADEC migration to groundwater criteria.

7.8 ENVIRONMENTAL/ECOLOGICAL RISK EVALUATION

Ecological risk at AOC C6 was evaluated and a preliminary ecological CSM developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at AOC C6 are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.
- Petroleum hydrocarbons in soil at the site cover 0.34 acre, less than the ADEC 0.5 acre *de minimis* criterion. Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.
- Overland migration of surface impacts via runoff/erosion to the nearest surface water body (Ankau Slough) is unlikely based on a lack of surface flow paths and heavy organic ground cover of the area.
- Groundwater from wells installed in the NAPL-contaminated soil source area meets the TAH and TAqH Alaska WQS criteria. Any possible discharge of groundwater from the site to surface water would be downgradient of the source, indicating ambient water quality criteria at the Ankau Slough must be met (i.e. dissolved concentrations would not increase downgradient of the soil source). Groundwater is unlikely to result in a surface-water sheen since this can only be created when the NAPL contaminated soil source area extends to the groundwater discharge location. Additionally, the daily tidal cycling likely inhibits groundwater contaminant migration based on daily gradient reversals and a shallow net groundwater gradient (0.002 ft/ft).
- Risk to the environment has been evaluated using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation is not needed and AOC C6 site conditions are protective of the environment.

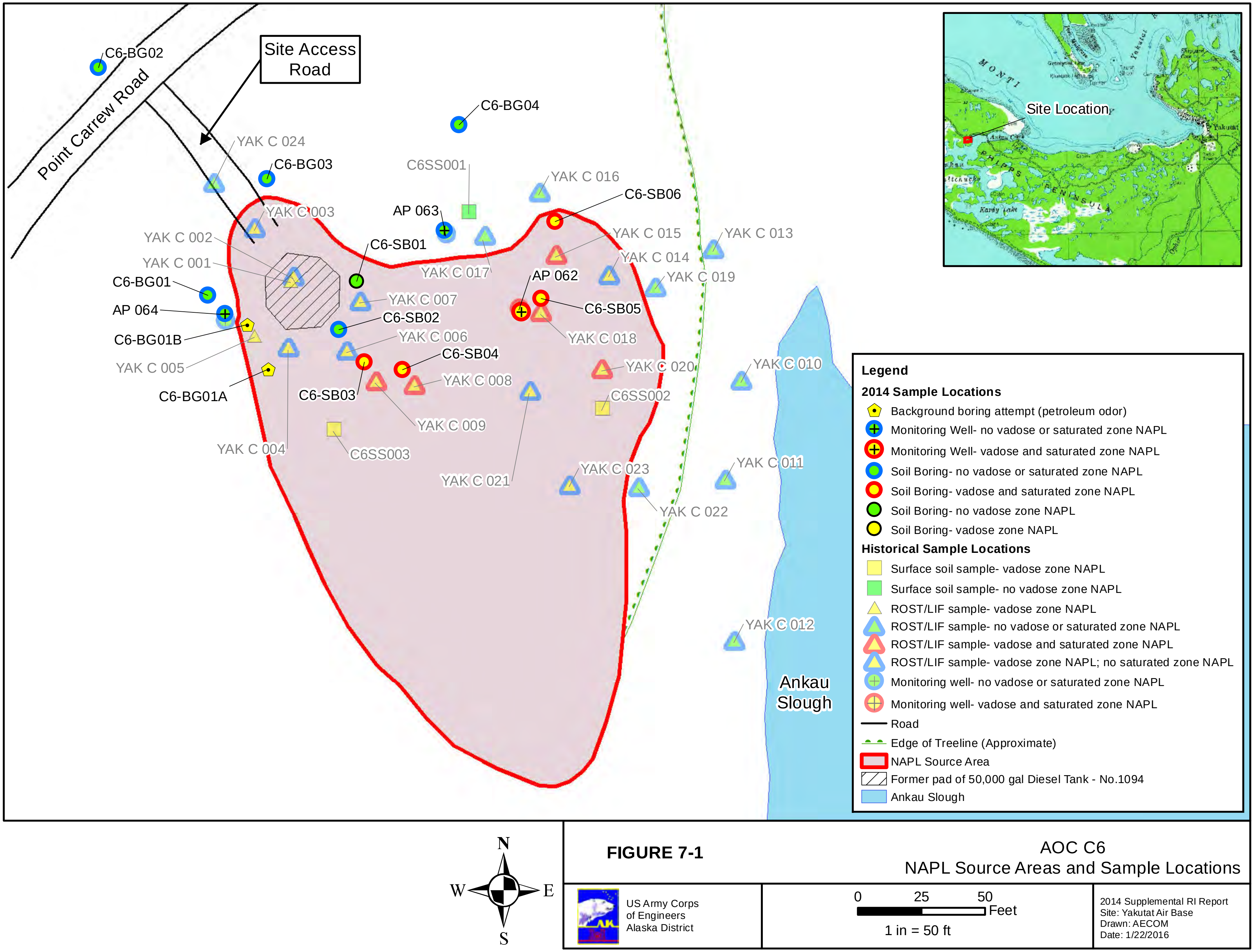

FIGURE 7-1

AOC C6
NAPL Source Areas and Sample Locations

US Army Corps
of Engineers
Alaska District

0 25 50
Feet
1 in = 50 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

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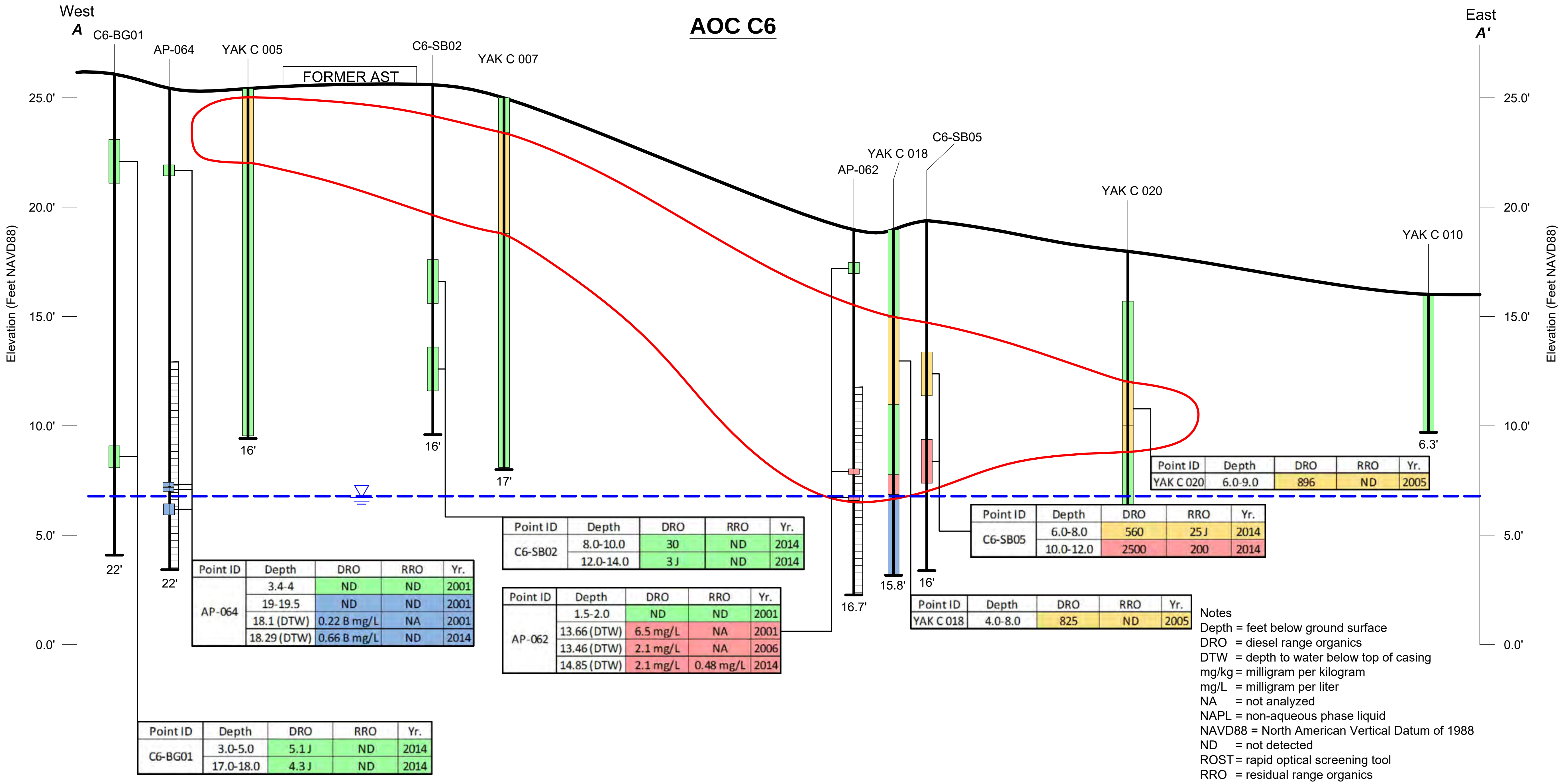


Point ID	Depth	DRO	RRO	Yr.
C6-BG01	3.0-5.0	5.1 J	ND	2014
	17.0-18.0	4.3 J	ND	2014

Point ID	Depth	DRO	RRO	Yr.
AP-064	3.4-4	ND	ND	2001
	19-19.5	ND	ND	2001
	18.1 (DTW)	0.22 B mg/L	NA	2001
	18.29 (DTW)	0.66 B mg/L	ND	2014

Point ID	Depth	DRO	RRO	Yr.
C6-SB02	8.0-10.0	30	ND	2014
	12.0-14.0	3 J	ND	2014

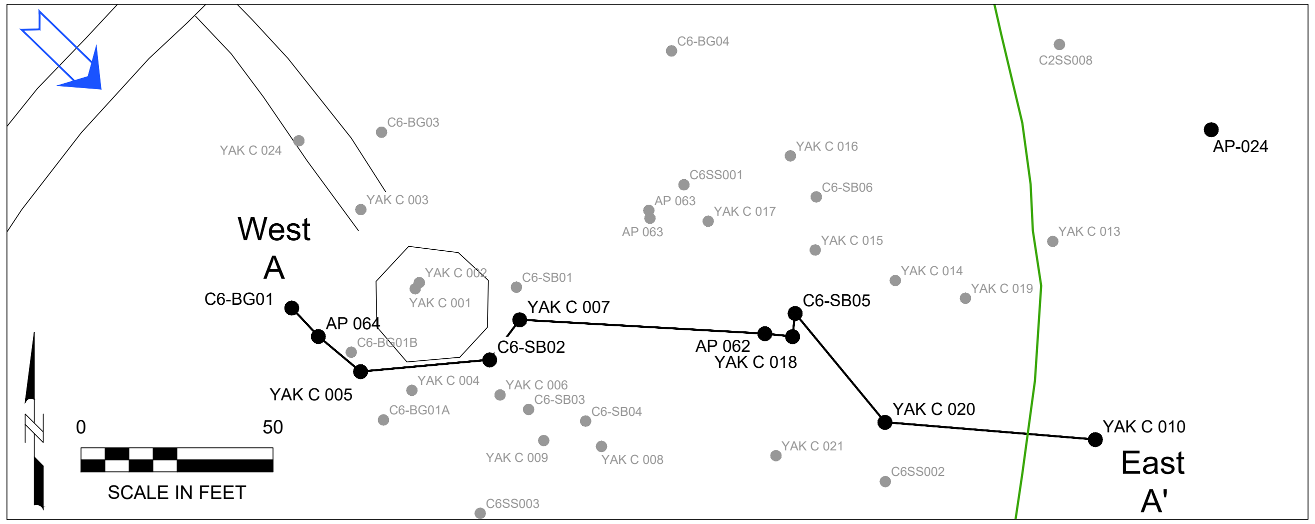
Point ID	Depth	DRO	RRO	Yr.
AP-062	1.5-2.0	ND	ND	2001
	13.66 (DTW)	6.5 mg/L	NA	2001
	13.46 (DTW)	2.1 mg/L	NA	2006
	14.85 (DTW)	2.1 mg/L	0.48 mg/L	2014

Point ID	Depth	DRO	RRO	Yr.
YAK C 018	4.0-8.0	825	ND	2005

Point ID	Depth	DRO	RRO	Yr.
C6-SB05	6.0-8.0	560	25 J	2014
	10.0-12.0	2500	200	2014

Point ID	Depth	DRO	RRO	Yr.
YAK C 020	6.0-9.0	896	ND	2005

CROSS SECTION INDEX



LEGEND

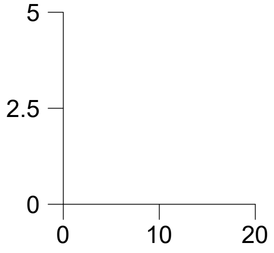
- 🟩 NO VADOSE ZONE NAPL
- 🟨 VADOSE ZONE NAPL
- 🟦 NO SATURATED ZONE NAPL
- 🟥 SATURATED ZONE NAPL
- ▽ 2014 MEAN GROUNDWATER ELEVATION
- ⇨ GROUNDWATER FLOW DIRECTION
- — ESTIMATED VERTICAL EXTENT OF NAPL SOURCE ZONE
- ▤ SCREEN INTERVAL

Notes
Depth = feet below ground surface
DRO = diesel range organics
DTW = depth to water below top of casing
mg/kg = milligram per kilogram
mg/L = milligram per liter
NA = not analyzed
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
ND = not detected
ROST = rapid optical screening tool
RRO = residual range organics
Yr. = year sample was collected

All DRO and RRO results are in mg/kg unless otherwise noted on the figure. See Appendix J for result qualifiers.

Location IDs beginning with YAK identify historical ROST borings. ROST results with percent reference emitter limits >1% are considered to be above the NAPL threshold (>230 mg/kg for DRO and RRO).

Mean Groundwater Elevations per Serfes 1991 71-hour filtering process



SCALE IN FEET
(VERT. EX. = 4)

Figure: 7-2

CROSS SECTION A-A'
AOC C6

U.S. Army
Corps of Engineers
Alaska District

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawin: AECOM
Date: 01/16/15

Last saved by: SCHWARTZE(2016-03-29)   Last Plotted: 2016-03-29
Filename: L:\GROUP\CAD\YAKUTAT AFB\FIGURES\YAK_FIG_7-2_ A-A' C6.DWG

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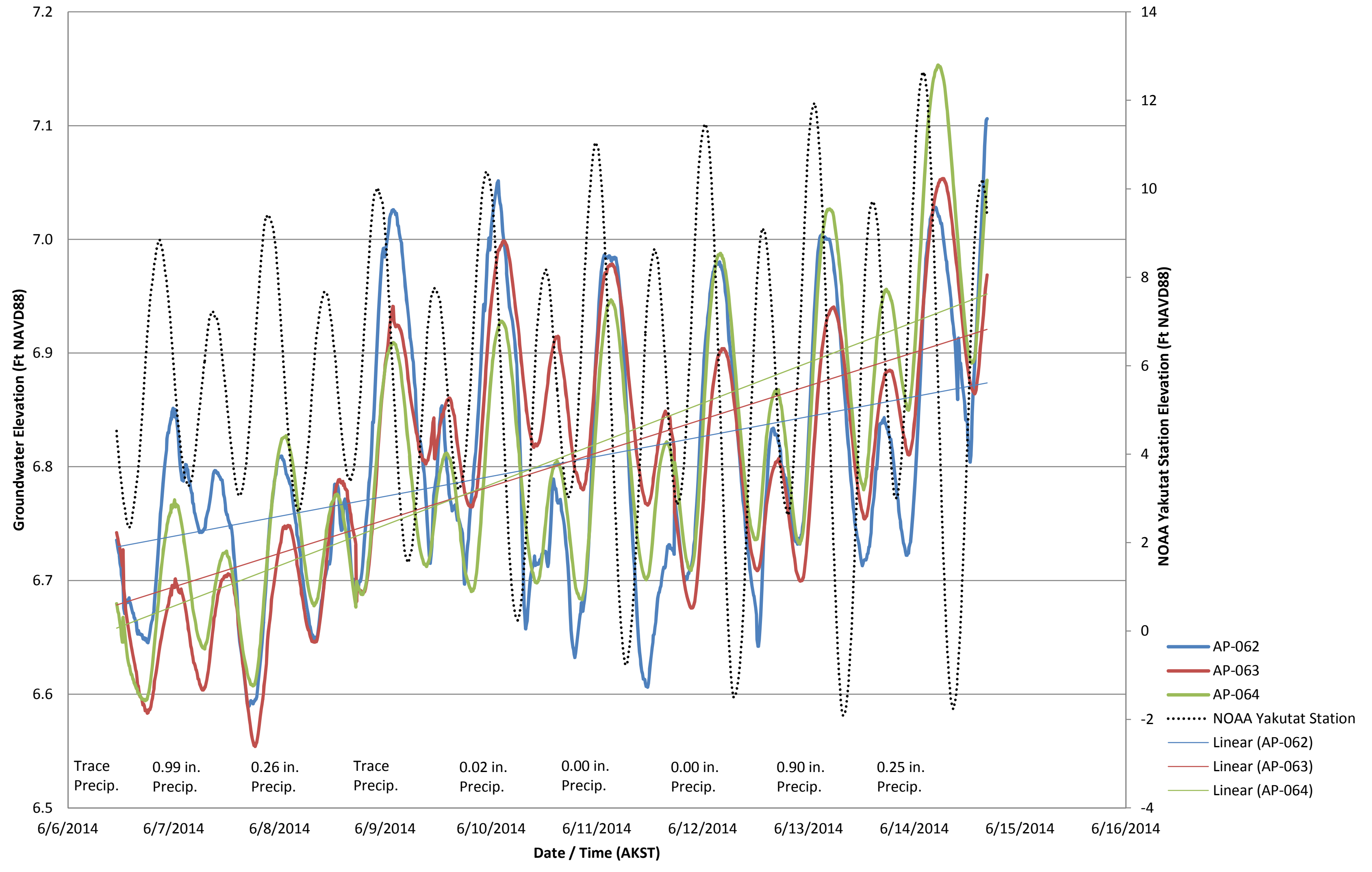
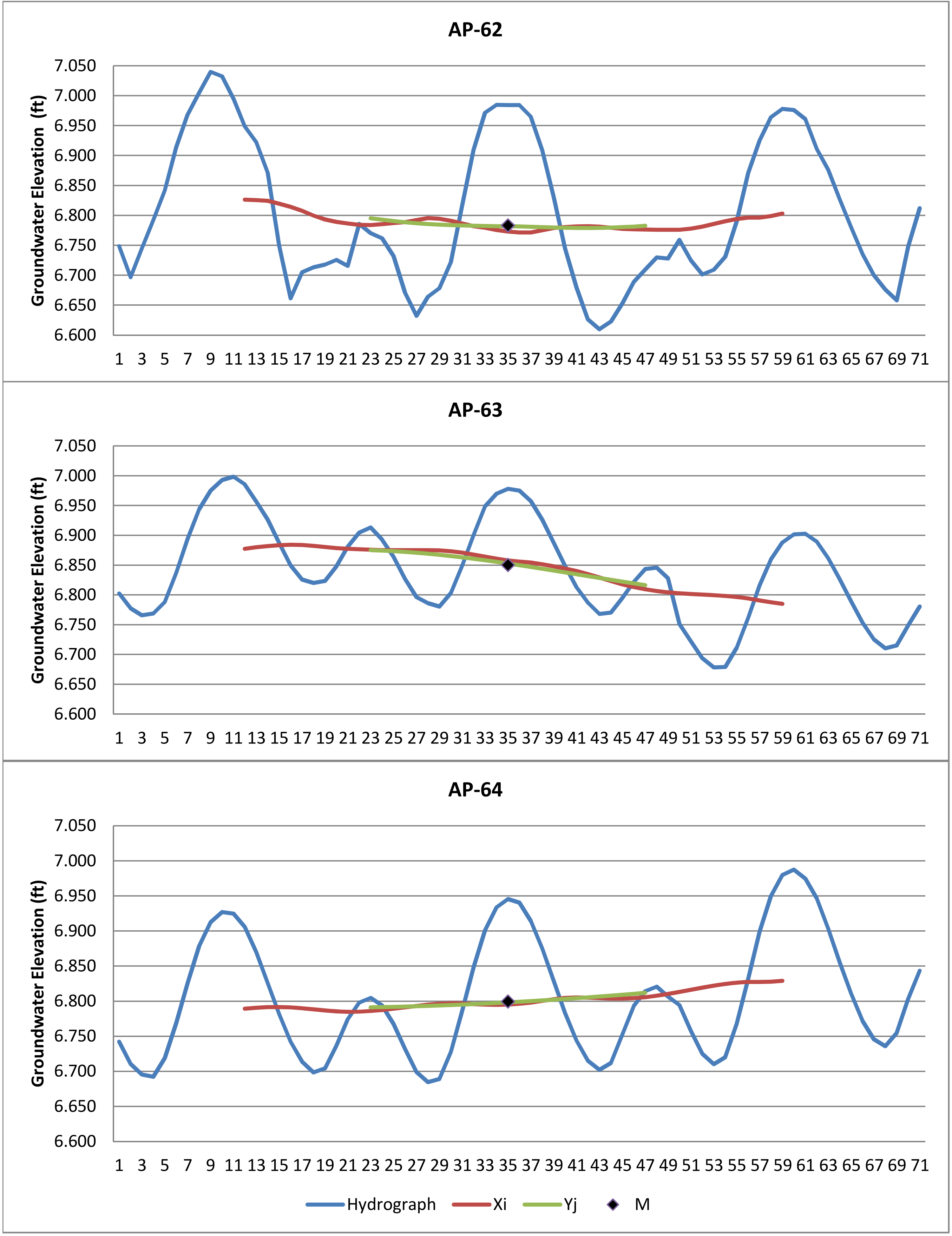


FIGURE 7-3: AOC C6 Groundwater Elevations and Yakutat Tide Station Water Levels

FIGURE 7-4: Hydrographs Showing the 71-Hour Filtering Process



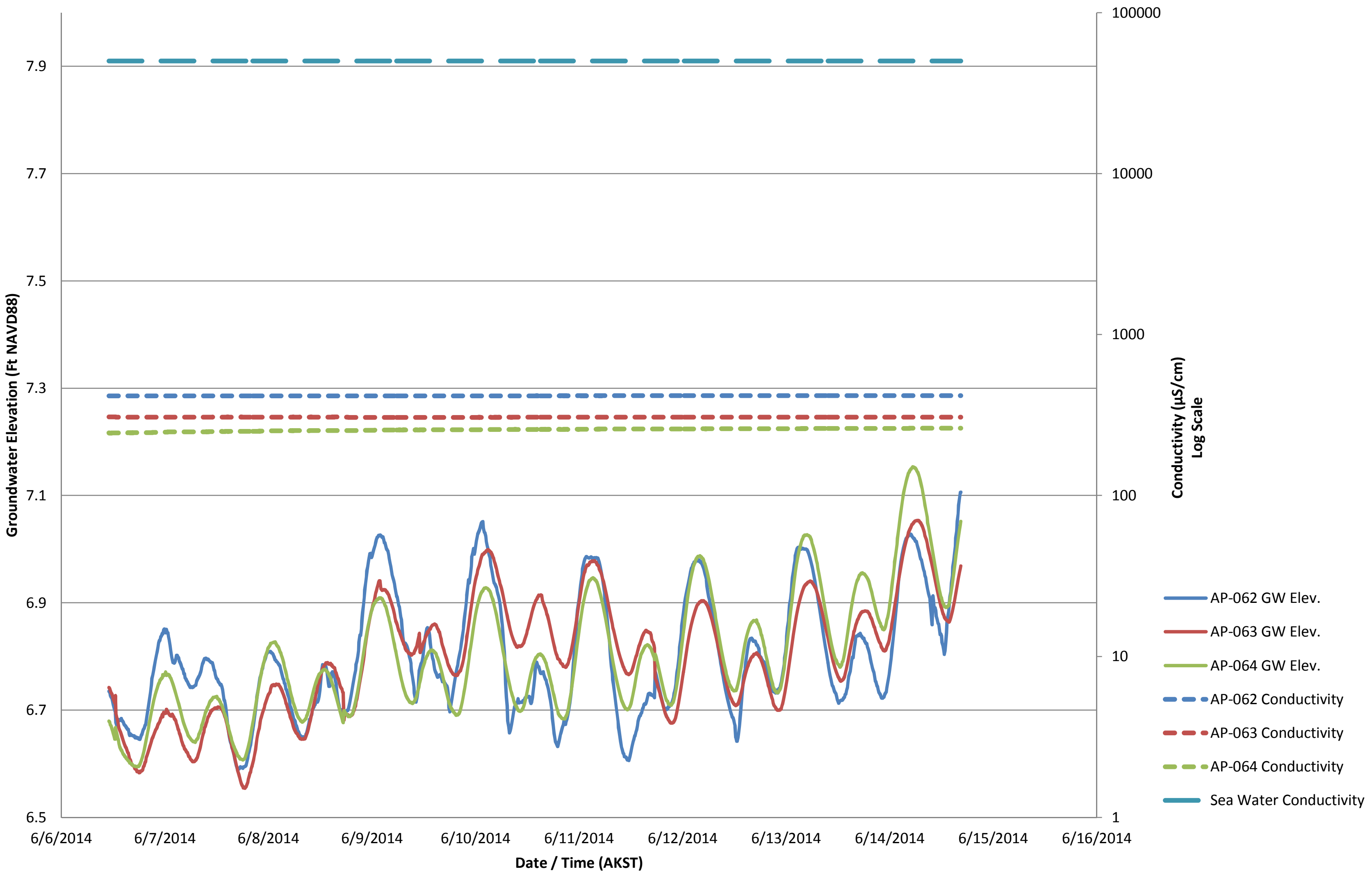
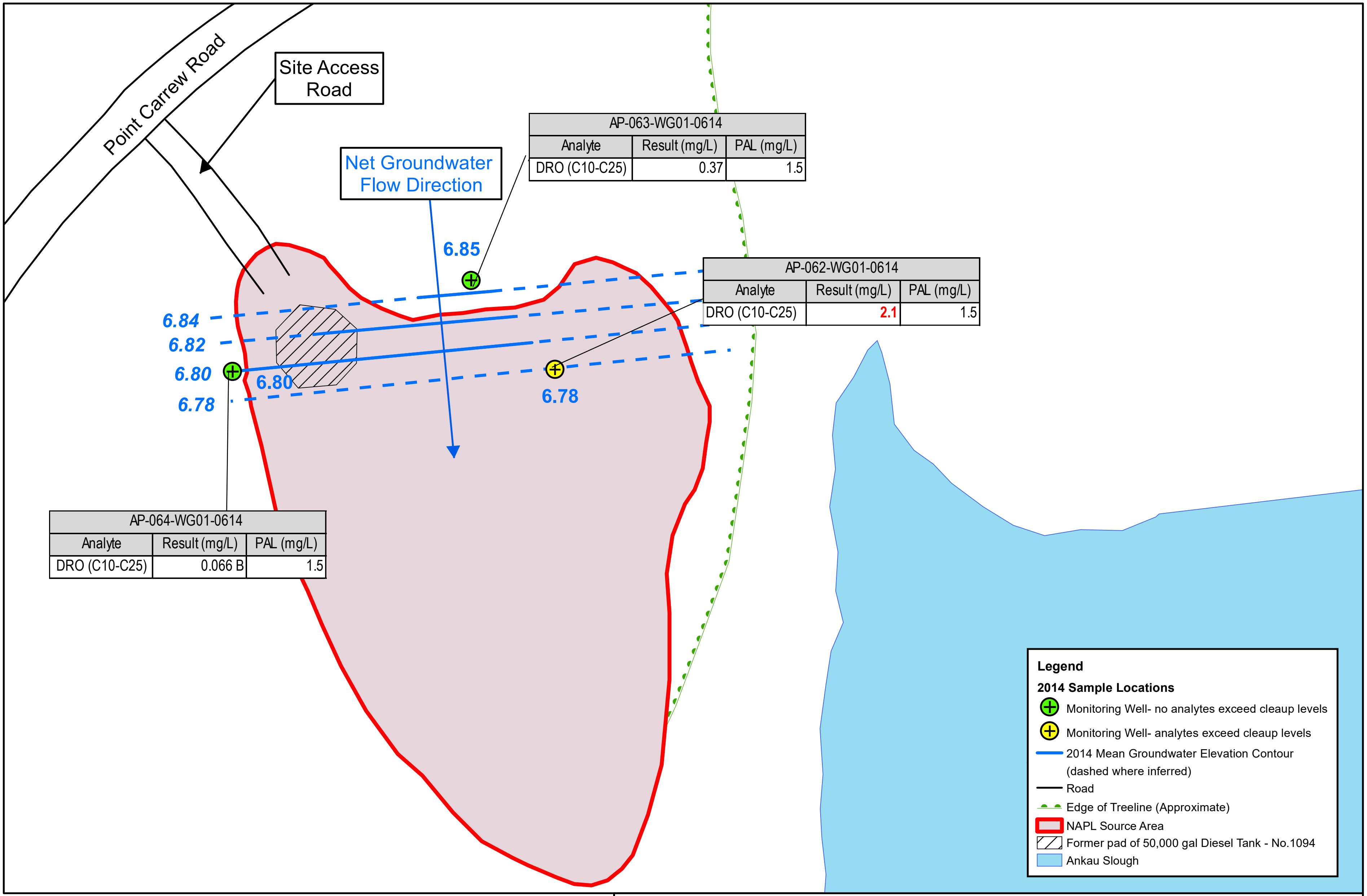


FIGURE 7-5: AOC C6 Groundwater Elevations and Conductivity



AP-063-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.37	1.5

AP-062-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	2.1	1.5

AP-064-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.066 B	1.5

Notes:
DRO – diesel range organics
mg/L – milligrams per liter
PAL - project action limit
1. Only those constituents exceeding ADEC Method Two cleanup levels are shown.
2. If a duplicate sample was collected, the higher of the primary and duplicate sample concentration is shown.
3. Results shown in Red exceed the Project Action Limit (PAL).
4. Mean groundwater elevations per Serfes 1991 71-hour filtering process.

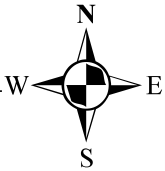


FIGURE 7-6

AOC C6
Groundwater Analytical Results

US Army Corps
of Engineers
Alaska District

7-20

0 25 50 Feet
1 in = 50 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 3/29/2016

FIGURE 7-7a: AOC C6 DRO Q-Q Plot

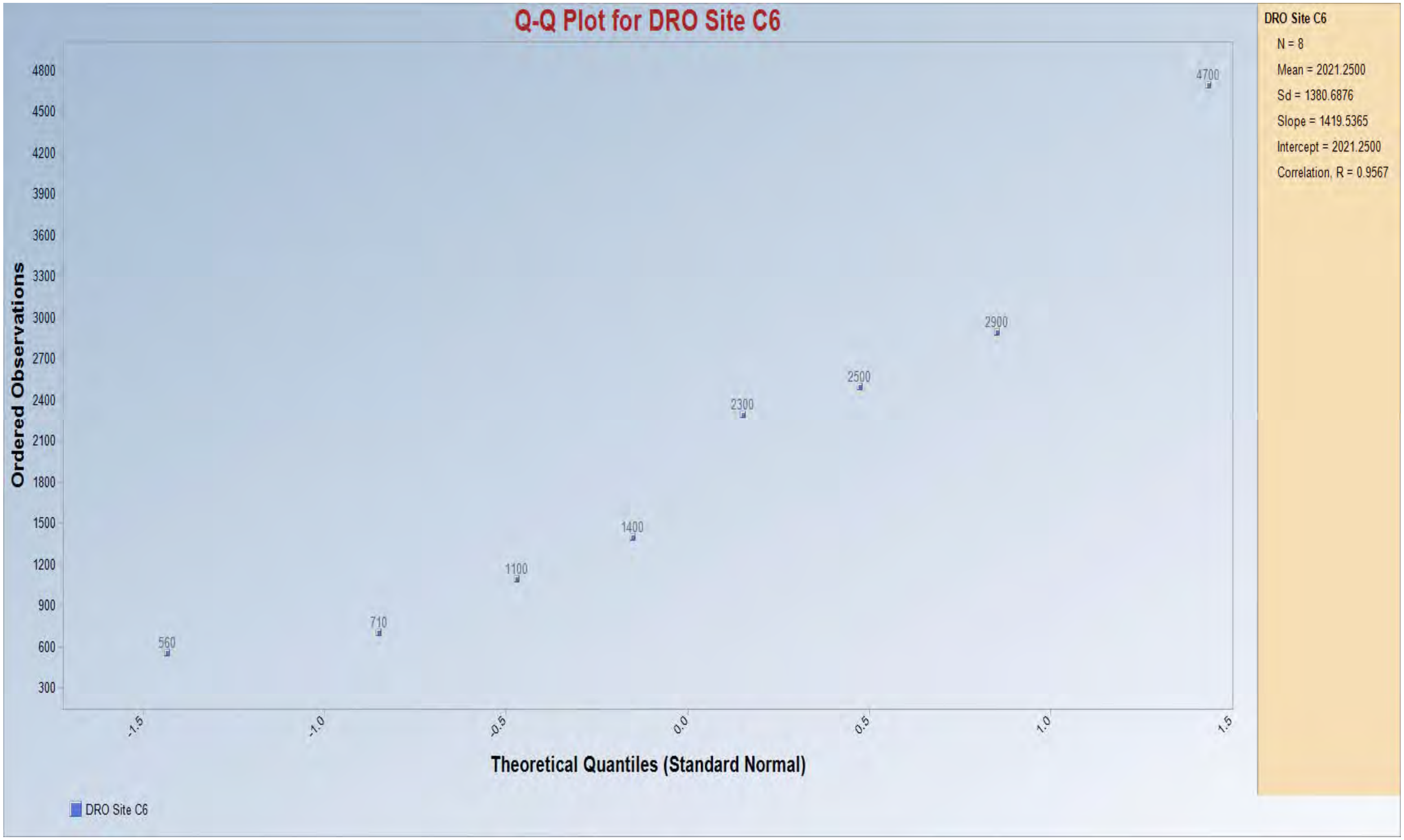


FIGURE 7-7b: AOC C6 DRO Box Plot

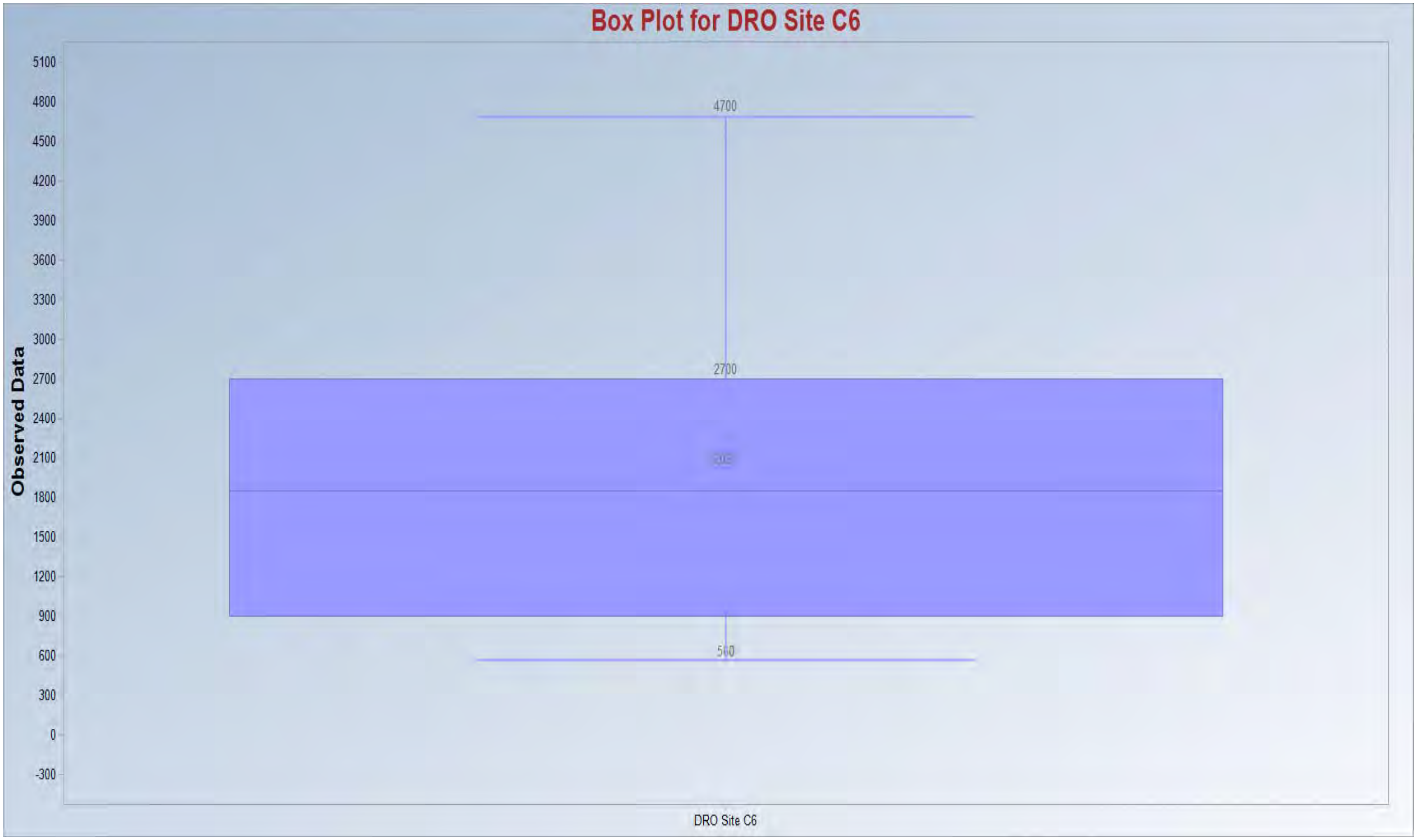


Table 7-1: AOC C6 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
C6	AP-062	1.5-2	7/29/2001	01C6B1001SO	<1.1 U	<21 U	<23 U	<0.0089 U	<0.0089 U	<0.0089 U	<0.0269 U
C6	AP-062	5-5.5	7/29/2001	01C6B1002SO	**11**	**4700 B**	**320**	<0.0086 U	<0.0086 U	<0.0086 U	<0.0256 U
C6	AP-063	4.5-5	7/29/2001	01C6B2003SO	**1.3**	**190 B**	**19 J**	<0.0051 U	<0.0051 U	<0.0051 U	<0.0151 U
C6	AP-063	11-11.5	7/29/2001	01C6B2004SO	<0.96 U	<18 U	<19 U	<0.0069 U	<0.0069 U	<0.0069 U	<0.0209 U
C6	AP-064	3.5-4	7/29/2001	01C6B3005SO	**0.86 J**	<18 U	<19 U	<0.0039 U	<0.0039 U	<0.0039 U	<0.0117 U
C6	AP-064	19-19.5	7/29/2001	01C6B3006SO	<0.56 U	<19 U	<20 U	<0.0046 U	<0.0046 U	<0.0046 U	<0.0139 U
C6	C6-BG01	3-5	6/28/2014	C6-BG01-3.0-5.0-0614	**4.8 B**	**5.1 J**	<27 U	--	--	--	--
C6	C6-BG01	17-18	6/28/2014	C6-BG01-17.0-18.0-0614	**5.3 B**	**4.3 J**	<25 U	--	--	--	--
C6	C6-BG02	3-5	6/30/2014	C6-BG02-3.0-5.0-0614	**11 J**	**6.2 J**	**4.1 J**	--	--	--	--
C6	C6-BG02	18-20	6/30/2014	C6-BG02-18.0-20.0-0614	**2.1 B**	**5.2 J**	<27 U	--	--	--	--
C6	C6-BG03	3-5	6/30/2014	C6-BG03-3.0-5.0-0614	<2.6 U	**6.9 J**	<28 U	--	--	--	--
C6	C6-BG03	17-18	6/30/2014	C6-BG03-17.0-18.0-0614	<2 U	**4.8 J**	<26 U	--	--	--	--
C6	C6-BG04	2-3.5	7/1/2014	C6-BG04-2.0-3.5-0714	<2.5 U	**15 MH**	**31 J**	--	--	--	--
C6	C6-BG04	8-9	7/1/2014	C6-BG04-8.0-9.0-0714	<2.3 U	**5.6 J**	<27 U	--	--	--	--
C6	C6-SB01	6-8	6/27/2014	C6-SB01-6.0-8.0-0614	**1.9 B**	**120**	<27 U	<0.01 U	**0.016 J**	<0.01 U	**0.03 J**
C6	C6-SB02	8-10	6/27/2014	C6-SB02-8.0-10.0-0614	**2.9 B**	**30**	<26 U	<0.0097 U	**0.0062 J**	<0.0097 U	**0.0177 J**
C6	C6-SB02	12-14	6/27/2014	C6-SB02-12.0-14.0-0614	**1.6 B**	**3 J**	<27 U	<0.0082 U	<0.0082 U	<0.0082 U	**0.0122 J**
C6	C6-SB03	2-4	6/28/2014	C6-SB03-2.0-4.0-0614	**44 QH**	**1400**	**51 J**	<0.0075 U	**0.046**	<0.0075 U	**0.07 , J**
C6	C6-SB03	15-17	6/28/2014	C6-SB03-15.0-17.0-0614	**73 QH**	**2300**	**100**	<0.011 U	**0.0073 J**	<0.011 U	<0.022 U
C6	C6-SB04	5-7	6/28/2014	C6-SB04-5.0-7.0-0614	**140 QH**	**2900**	**110**	<0.01 U	**0.073**	**0.0062 J**	**0.13**
C6	C6-SB04	13-15	6/28/2014	C6-SB04-13.0-15.0-0614	**12**	**710**	**30 J**	<0.0097 U	**0.0042 J**	<0.0097 U	<0.0194 U
C6	C6-SB05	6-8	6/27/2014	C6-SB05-6.0-8.0-0614	**41**	**560**	**25 J**	<0.0094 U	**0.004 J**	**0.0035 J**	**0.0103 J**
C6	C6-SB05	10-12	6/27/2014	C6-SB05-10.0-12.0-0614	**30 MN**	**2500**	**200**	<0.0088 U	**0.0071 J**	**0.0029 J**	**0.0123 J**
C6	C6-SB06	7-9	6/27/2014	C6-SB06-7.0-9.0-0614	**8.2 B**	**1100**	**49 J**	<0.0099 U	**0.0071 J**	<0.0099 U	**0.0217 J**
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					140	4700	320	0.011	0.073	0.0062	0.13
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 7-2: AOC C6 Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
C6	AP-062	5-5.5	7/29/2001	01C6B1002SO	**11**	**4700 B**	**320**	--	--	--	--
C6	C6-SB03	2-4	6/28/2014	C6-SB03-2.0-4.0-0614	**44 QH**	**1400**	**51 J**	<0.0075 U	**0.046**	<0.0075 U	**0.07 , J**
C6	C6-SB03	15-17	6/28/2014	C6-SB03-15.0-17.0-0614	**73 QH**	**2300**	**100**	<0.011 U	**0.0073 J**	<0.011 U	<0.022 U
C6	C6-SB04	5-7	6/28/2014	C6-SB04-5.0-7.0-0614	**140 QH**	**2900**	**110**	<0.01 U	**0.073**	**0.0062 J**	**0.13**
C6	C6-SB04	13-15	6/28/2014	C6-SB04-13.0-15.0-0614	**12**	**710**	**30 J**	<0.0097 U	**0.0042 J**	<0.0097 U	<0.0194 U
C6	C6-SB05	6-8	6/27/2014	C6-SB05-6.0-8.0-0614	**41**	**560**	**25 J**	<0.0094 U	**0.004 J**	**0.0035 J**	**0.0103 J**
C6	C6-SB05	10-12	6/27/2014	C6-SB05-10.0-12.0-0614	**30 MN**	**2500**	**200**	<0.0088 U	**0.0071 J**	**0.0029 J**	**0.0123 J**
C6	C6-SB06	7-9	6/27/2014	C6-SB06-7.0-9.0-0614	**8.2 B**	**1100**	**49 J**	<0.0099 U	**0.0071 J**	<0.0099 U	**0.0217 J**
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					140	4700	320	0.011	0.073	0.0062	0.13
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 7-3: AOC C6 PAH Soils Results

Site Name		C6	C6	C6	C6	C6	C6	C6	C6
Boring, Well or Sample Location Number		AP-062	AP-062	AP-063	AP-063	AP-064	AP-064	C6-SB01	C6-SB02
Sample Depth (feet)		1.5-2	5-5.5	4.5-5	11-11.5	3.5-4	19-19.5	6-8	8-10
Sample Date		7/29/2001	7/29/2001	7/29/2001	7/29/2001	7/29/2001	7/29/2001	6/27/2014	6/27/2014
Sample Name		01C6B1001SO	01C6B1002SO	01C6B2003SO	01C6B2004SO	01C6B3005SO	01C6B3006SO	C6-SB01-6.0-8.0-0614	C6-SB02-8.0-10.0-0614
GRO	(mg/kg)	<1.1 U	**11**	**1.3**	<0.96 U	**0.86 J**	<0.56 U	**1.9 B**	**2.9 B**
DRO	(mg/kg)	<21 U	**4700 B**	**190 B**	<18 U	<18 U	<19 U	**120**	**30**
RRO	(mg/kg)	<23 U	**320**	**19 J**	<19 U	<19 U	<20 U	<27 U	<26 U
Acenaphthene	(mg/kg)	<0.00077 U	<0.0077 U	**0.085**	<0.00057 U	<0.00066 U	<0.00062 U	**0.011**	**0.0049 J**
Acenaphthylene	(mg/kg)	<0.00068 U	<0.0068 U	<0.0006 U	<0.0005 U	<0.00058 U	<0.00055 U	**0.0038 J**	<0.0027 U
Anthracene	(mg/kg)	<0.00039 U	<0.0039 U	<0.00035 U	<0.00029 U	<0.00033 U	<0.00032 U	**0.0077**	<0.0027 U
Benzo(a)anthracene	(mg/kg)	<0.00095 U	<0.0095 U	<0.00084 U	<0.0007 U	<0.00081 U	<0.00076 U	<0.0027 U	<0.0027 U
Benzo(a)pyrene	(mg/kg)	<0.00091 U	<0.0091 U	<0.00081 U	<0.00067 U	<0.00078 U	<0.00073 U	<0.0027 U	<0.0027 U
Benzo(b)fluoranthene	(mg/kg)	<0.00033 U	<0.0033 U	<0.00029 U	<0.00024 U	<0.00028 U	<0.00027 U	<0.0027 U	<0.0027 U
Benzo(g,h,i)perylene	(mg/kg)	<0.00026 U	<0.0026 U	<0.00023 U	<0.00019 U	<0.00022 U	<0.00021 U	<0.0027 U	<0.0027 U
Benzo(k)fluoranthene	(mg/kg)	<0.00068 U	<0.0068 U	<0.0006 U	<0.0005 U	<0.00058 U	<0.00055 U	<0.0027 U	<0.0027 U
Chrysene	(mg/kg)	<0.00091 U	<0.0091 U	**0.003**	<0.00067 U	<0.00078 U	<0.00073 U	**0.0018 J**	**0.0023 J**
Dibenzo(a,h)anthracene	(mg/kg)	<0.00036 U	<0.0036 U	<0.00032 U	<0.00027 U	<0.00031 U	<0.00029 U	<0.0027 U	<0.0027 U
Fluorene	(mg/kg)	<0.00072 U	**2.3**	**0.26**	<0.00053 U	<0.00062 U	<0.00058 U	**0.049**	**0.023**
Fluoranthene	(mg/kg)	<0.00072 U	<0.0072 U	<0.00064 U	<0.00053 U	<0.00062 U	<0.00058 U	**0.0024 J**	**0.0021 J**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.00036 U	<0.0036 U	<0.00032 U	<0.00027 U	<0.00031 U	<0.00029 U	<0.0027 U	<0.0027 U
Naphthalene	(mg/kg)	<0.00073 U	<0.0073 U	<0.00064 U	**0.0013**	<0.00062 U	<0.00059 U	**0.012**	**0.0076**
Phenanthrene	(mg/kg)	<0.00033 U	**3.9**	**0.24**	**0.0015**	<0.00028 U	<0.00027 U	**0.057**	**0.0083**
Pyrene	(mg/kg)	<0.00051 U	<0.0051 U	**0.02**	<0.00038 U	<0.00044 U	<0.00041 U	**0.0019 J**	<0.0027 U
2-Methylnaphthalene	(mg/kg)	<0.00024 U	<0.0024 U	<0.00021 U	<0.00018 U	<0.00021 U	<0.0002 U	**0.022**	**0.012**
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	--	**0.03**	**0.0043 J**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbon
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 7-3: AOC C6 PAH Soils Results

Site Name		C6	C6	C6	C6	C6	C6	C6
Boring, Well or Sample Location Number		C6-SB02	C6-SB03	C6-SB03	C6-SB04	C6-SB04	C6-SB05	C6-SB05
Sample Depth (feet)		12-14	2-4	15-17	5-7	13-15	6-8	10-12
Sample Date		6/27/2014	6/28/2014	6/28/2014	6/28/2014	6/28/2014	6/27/2014	6/27/2014
Sample Name		C6-SB02-12.0-14.0-0614	C6-SB03-2.0-4.0-0614	C6-SB03-15.0-17.0-0614	C6-SB04-5.0-7.0-0614	C6-SB04-13.0-15.0-0614	C6-SB05-6.0-8.0-0614	C6-SB05-10.0-12.0-0614
GRO	(mg/kg)	**1.6 B**	**44 QH**	**73 QH**	**140 QH**	**12**	**41**	**30 MN**
DRO	(mg/kg)	**3 J**	**1400**	**2300**	**2900**	**710**	**560**	**2500**
RRO	(mg/kg)	<27 U	**51 J**	**100**	**110**	**30 J**	**25 J**	**200**
Acenaphthene	(mg/kg)	**0.0032 J**	**0.21**	**0.11**	**0.35**	**0.0066**	**0.0078**	**0.17**
Acenaphthylene	(mg/kg)	<0.0027 U	**0.092**	**0.046**	**0.15**	**0.0092**	**0.0062**	**0.04**
Anthracene	(mg/kg)	<0.0027 U	**0.072**	**0.076**	**0.16**	**0.016**	**0.046**	**0.054**
Benzo(a)anthracene	(mg/kg)	<0.0027 U	**0.0062**	**0.004 J**	**0.0082**	**0.0022 J**	<0.0026 U	**0.0042 J**
Benzo(a)pyrene	(mg/kg)	<0.0027 U	<0.0029 U	<0.0027 U	<0.0027 U	<0.0027 U	<0.0026 U	<0.0026 U
Benzo(b)fluoranthene	(mg/kg)	<0.0027 U	**0.0017 J**	**0.0025 J**	**0.0032 J**	<0.0027 U	<0.0026 U	**0.0021 J**
Benzo(g,h,i)perylene	(mg/kg)	<0.0027 U	<0.0029 U	<0.0027 U	<0.0027 U	<0.0027 U	<0.0026 U	<0.0026 U
Benzo(k)fluoranthene	(mg/kg)	<0.0027 U	<0.0029 U	<0.0027 U	<0.0027 U	<0.0027 U	<0.0026 U	<0.0026 U
Chrysene	(mg/kg)	<0.0027 U	**0.017**	**0.018**	**0.029**	**0.0064**	**0.0041 J**	**0.014**
Dibenzo(a,h)anthracene	(mg/kg)	<0.0027 U	<0.0029 U	<0.0027 U	<0.0027 U	<0.0027 U	<0.0026 U	<0.0026 U
Fluorene	(mg/kg)	**0.024**	**0.81**	**0.47**	**2.2**	**0.029**	**0.052**	**0.65**
Fluoranthene	(mg/kg)	<0.0027 U	**0.041**	**0.043**	**0.083**	**0.013**	**0.0041 J**	**0.035**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0027 U	<0.0029 U	<0.0027 U	<0.0027 U	<0.0027 U	<0.0026 U	<0.0026 U
Naphthalene	(mg/kg)	**0.0055**	**1**	**0.039**	**1.1**	**0.01**	<0.0026 U	**0.043**
Phenanthrene	(mg/kg)	**0.0025 J**	**1.8**	**0.8**	**2.7**	**0.024**	**0.18**	**0.79 MH**
Pyrene	(mg/kg)	<0.0027 U	**0.043**	**0.041**	**0.076**	**0.014**	**0.0087**	**0.034**
2-Methylnaphthalene	(mg/kg)	**0.0025 J**	**3.6**	**0.14**	**1.4**	**0.084**	**0.051**	**0.14 MN**
1-Methylnaphthalene	(mg/kg)	**0.0017 J**	**2.9**	**0.35**	**5.4**	**0.043**	**0.02**	**0.18**

Table 7-3: AOC C6 PAH Soils Results

Site Name		C6	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		C6-SB06		
Sample Depth (feet)		7-9		
Sample Date		6/27/2014		
Sample Name		C6-SB06-7.0-9.0-0614		
GRO	(mg/kg)	**8.2 B**	140	**260 C**
DRO	(mg/kg)	**1100**	4700	**230 C**
RRO	(mg/kg)	**49 J**	320	**230 H**
Acenaphthene	(mg/kg)	**0.11 J**	0.35	**180 F**
Acenaphthylene	(mg/kg)	**0.035 J**	0.15	**180 F**
Anthracene	(mg/kg)	**0.11 J**	0.16	**1680 D**
Benzo(a)anthracene	(mg/kg)	<0.0026 U	0.0082	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.0026 U	0.0091	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	<0.0026 U	0.0032	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.0026 U	0.0029	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.0026 U	0.0068	**4 D**
Chrysene	(mg/kg)	**0.0092**	0.029	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.0026 U	0.0036	**0.04 D**
Fluorene	(mg/kg)	**0.49 J**	2.3	**190 D**
Fluoranthene	(mg/kg)	**0.018**	0.083	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0026 U	0.0036	**0.4 D**
Naphthalene	(mg/kg)	**0.027 J**	1.1	**2.1 E**
Phenanthrene	(mg/kg)	**0.56**	3.9	**1680 D**
Pyrene	(mg/kg)	**0.019 J**	0.076	**110 D**
2-Methylnaphthalene	(mg/kg)	**0.057 J**	3.6	**6.1 F**
1-Methylnaphthalene	(mg/kg)	**0.17 J**	5.4	**6.2 F**

Table 7-4a: AOC C6 Non-Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
C6	C6-SB01	6-8	6/27/2014	C6-SB01-6.0-8.0-0614	<0.01 U	<0.01 U	0.016 J	0.03 J	52 QL	51.954	5 QL	--	<0.38 U,QN	<0.38 U,QN	4	3.7 B	41 QL
C6	C6-SB02	8-10	6/27/2014	C6-SB02-8.0-10.0-0614	<0.0097 U	<0.0097 U	0.0062 J	0.0177 J	2.8 B	2.7761	4.2 B	--	<0.36 U,QN	<0.36 U,QN	<0.36 U	<0.36 U	11 J,B

Table 7-4b: AOC C6 Non-Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
C6	C6-SB01	6-8	6/27/2014	C6-SB01-6.0-8.0-0614	--	--	0.84 J	4.5 J	12	3.3 J	--	4.7 J	24	24	5.6	17.34	52.7	70.04
C6	C6-SB02	8-10	6/27/2014	C6-SB02-8.0-10.0-0614	--	--	0.25 J	<2.2 U	3.9 J	2.4 J	--	1.9 J	8.3	9.8	5.7	6.35	20	26.35

Table 7-4c: AOC C6 Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
C6	C6-SB03	15-17	6/28/2014	C6-SB03-15.0-17.0-0614	<0.011 U	<0.011 U	0.0073 J	<0.022 U	3.7 B	3.6707	15 B	--	0.21 J,QH	<0.42 U	2.7 J	15 QH	37
C6	C6-SB03	2-4	6/28/2014	C6-SB03-2.0-4.0-0614	<0.0075 U	<0.0075 U	0.046	0.07 , J	3.4 B	3.284	15 B	--	0.11 J,QH	0.18 J	2.7	12 QH	34
C6	C6-SB04	13-15	6/28/2014	C6-SB04-13.0-15.0-0614	<0.0097 U	<0.0097 U	0.0042 J	<0.0194 U	7.4 B	7.3764	6.2 B	--	0.47 J,QH	<0.36 U	<0.36 U	6.2 QH	18 B
C6	C6-SB05	10-12	6/27/2014	C6-SB05-10.0-12.0-0614	<0.0088 U	0.0029 J	0.0071 J	0.0123 J	24 QL	23.9806	20 QL	--	<0.33 U,QN	<0.33 U,QN	<0.33 U	13 ML	99 QL
C6	C6-SB05	6-8	6/27/2014	C6-SB05-6.0-8.0-0614	<0.0094 U	0.0035 J	0.004 J	0.0103 J	15 QH	14.9857	21 QH	--	0.12 J,QH	0.33 J,QH	1.7 J,QH	14 QH	270 QH
C6	C6-SB06	7-9	6/27/2014	C6-SB06-7.0-9.0-0614	<0.0099 U	<0.0099 U	0.0042 J	0.0111 J	9.94	9.9247	6 B,J	--	<0.37 U,QN	<0.37 U,QN	<0.37 U	3.1 B,J	87
C6	C6-SB06	7-9	6/27/2014	C6-SB06-7.0-9.0-0614	<0.0099 U	<0.0099 U	0.0071 J	0.0217 J	13 J	12.9712	6.8 J	--	<0.37 U,QN	0.48 J,QN	<0.37 U	3.1 B,J	87
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.009	0.008	0.011	0.024	10.920	10.885	12.857	#DIV/0!	0.283	0.353	1.219	9.486	90.29

Table 7-4d: AOC C6 Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
C6	C6-SB03	15-17	6/28/2014	C6-SB03-15.0-17.0-0614	--	--	18	94	290	43	--	110	550	520	100	402	1180	1582
C6	C6-SB03	2-4	6/28/2014	C6-SB03-2.0-4.0-0614	--	--	17	70	170	24	--	86	410	380	69	257	876	1133
C6	C6-SB04	13-15	6/28/2014	C6-SB04-13.0-15.0-0614	--	--	1.6 J	20	77	13	--	33	210	200	37	98.6	443	541.6
C6	C6-SB05	10-12	6/27/2014	C6-SB05-10.0-12.0-0614	--	--	16 MH	84	280	43	--	120	630	610	110 ML	380	1360	1740
C6	C6-SB05	6-8	6/27/2014	C6-SB05-6.0-8.0-0614	--	--	4.1 J	32	100	16	--	44	210	190	33	136.1	444	580.1
C6	C6-SB06	7-9	6/27/2014	C6-SB06-7.0-9.0-0614	--	--	11 J	53	150	32	--	54	390	430	84	214	874	1088
C6	C6-SB06	7-9	6/27/2014	C6-SB06-7.0-9.0-0614	--	--	11 J	53	150	32	--	54	390	430	84	214	874	1088
average with fraction:							11.243	58.000	173.857	29.000		71.571	398.571	394.286	73.857			

Table 7-4e: AOC C6 Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.00946	0.00777	0.01141	0.02383	10.88476	11.24286	58.00000	173.85714	29.00000	0.28286	0.35286	1.21857	71.57143	398.57143	394.28571	73.85714	1223
Fraction of TPH mass in A&A EC groups	7.73162E-06	6.35348E-06	9.33167E-06	0.00002	0.00890	0.00919	0.04742	0.14214	0.02371	0.00023	0.00029	0.00100	0.05851	0.32585	0.32235	0.06038	1.00
GRO, DRO & RRO A&A Groups	**GRO aromatics**					**DRO aromatics**			**RRO aromatics**	**GRO aliphatics**			**DRO aliphatics**			**RRO aliphatics**	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.008942					0.198745			0.023709	0.001516			0.706708			0.060381	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.000865	0.000711	0.001044	0.002179	0.995202	0.046248	0.238585	0.715167	1.000000	0.152542	0.190293	0.657165	0.082796	0.461081	0.456123	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	1.05%	GRO % aromatics	0.855037826
% of TPH that is DRO=	90.55%	GRO % aliphatics	0.144962174
% of TPH that is RRO=	8.41%	DRO % aromatics	0.219497723
		DRO % aliphatics	0.780502277
		RRO % aromatics	0.281944444
		RRO % aliphatics	0.718055556

Table 7-4f: AOC C6 HRC Input

input to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.855037826
DRO: fraction aromatic	0.219497723
RRO: fraction aromatic	0.281944444

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.04624787
Aromatic C12-C16	0.238584944
Aromatic C16-C21	0.715167186

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.152542373
Aliphatic C6-C8	0.190292758
Aliphatic C8-C10	0.657164869
Aliphatic C10-C12	0.082796232
Aliphatic C12-C16	0.461080813
Aliphatic C16-C21	0.456122955

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Table 7-5: AOC C6 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
C6	AP-062	NA	10/1/2001	01C6W1003WG	**0.0591**	**6.5**	**--**	**0.00178**	<0.0000766 U	**0.000304 J**	**0.0003303 J**
C6	AP-062	NA	9/2/2006	C6MWAP-0621WG	**--**	**2.1**	**--**	**--**	**--**	**--**	**--**
C6	AP-062	NA	6/16/2014	AP-062-WG01-0614	**0.03 J**	**2.1**	**0.48**	<0.0004 U	**0.00015 J**	**0.00017 QH**	**0.00065 J**
C6	AP-063	NA	10/1/2001	01C6W2002WG	<0.025 U	**0.923 B**	**--**	<0.000065 U	<0.0000766 U	<0.0000727 U	<0.0002413 U
C6	AP-063	NA	6/16/2014	AP-063-WG01-0614	**0.027 J**	**0.37**	**0.07 J**	**0.0004 NP**	**0.0004 NP**	**0.0004 NP**	**0.0008 NP**
C6	AP-064	NA	10/1/2001	01C6W3001WG	<0.025 U	**0.22 B**	**--**	**0.000238 J**	<0.0000766 U	<0.0000727 U	<0.0002413 U
C6	AP-064	NA	6/16/2014	AP-064-WG01-0614	**0.019 J**	**0.066 B**	<0.048 U	<0.0004 U	<0.0004 U	<0.0004 U	**0.00064 J**
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0.03	2.1	0.48	0.0004	0.0004	0.0004	0.0008
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:
Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
BTEX= benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

Table 7-6: AOC C6 PAH Groundwater Results

Site Name		C6	C6	C6	C6	C6	C6	C6	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		AP-062	AP-062	AP-062	AP-063	AP-063	AP-064	AP-064		
Sample Depth		NA	NA	NA	NA	NA	NA	NA		
Sample Date		10/1/2001	9/2/2006	6/16/2014	10/1/2001	6/16/2014	10/1/2001	6/16/2014		
Sample Name		01C6W1003WG	C6MWAP-0621WG	AP-062-WG01-0614	01C6W2002WG	AP-063-WG01-0614	01C6W3001WG	AP-064-WG01-0614		
GRO	(mg/L)	**0.0591**	--	**0.03 J**	<0.025 U	**0.027 J**	<0.025 U	**0.019 J**	0.03	**2.2 H**
DRO	(mg/L)	**6.5**	**2.1**	**2.1**	**0.923 B**	**0.37**	**0.22 B**	**0.066 B**	2.1	**1.5 H**
RRO	(mg/L)	--	--	**0.48**	--	**0.07 J**	--	<0.048 U	0.48	**1.1 H**
Acenaphthene	(mg/L)	**0.00101**	--	**0.00026 J**	<0.000016 U	<0.00003 U	<0.0000015 U	<0.00003 U	0.00026	**0.22 H**
Acenaphthylene	(mg/L)	<0.0000152 U	--	**0.000032 J**	<0.0000155 U	<0.00003 U	<0.0000015 U	<0.00003 U	0.000032	**0.22 H**
Anthracene	(mg/L)	<0.0000152 U	--	**0.000034 MN**	<0.0000155 U	<0.00003 U	<0.0000015 U	<0.00003 U	0.000034	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.0000436 U	--	<0.00002 U	<0.0000445 U	<0.00003 U	<0.0000043 U	<0.00003 U	0.00003	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.0000468 U	--	<0.00002 U	<0.0000477 U	<0.00003 U	<0.0000046 U	<0.00003 U	0.00003	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.0000291 U	--	<0.00002 U	<0.0000296 U	<0.00003 U	<0.0000029 U	<0.00003 U	0.00003	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.0000341 U	--	<0.00002 U	<0.0000348 U	<0.00003 U	<0.0000034 U	<0.00003 U	0.00003	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.0000382 U	--	<0.00002 U	<0.0000389 U	<0.00003 U	<0.0000038 U	<0.00003 U	0.00003	**0.0012 H**
Chrysene	(mg/L)	<0.0000245 U	--	<0.00002 U	<0.0000249 U	<0.00003 U	<0.0000024 U	<0.00003 U	0.00003	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.0000268 U	--	<0.00003 U	<0.0000274 U	<0.00003 U	<0.0000026 U	<0.00003 U	0.00003	**0.000012 H**
Fluorene	(mg/L)	**0.00419**	--	**0.00085 J**	<0.0000138 U	<0.00003 U	**0.000012**	<0.00003 U	0.00085	**0.15 H**
Fluoranthene	(mg/L)	<0.0000188 U	--	**0.000039 MN**	<0.0000191 U	<0.00003 U	<0.0000018 U	<0.00003 U	0.000039	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.0000303 U	--	<0.00002 U	<0.0000309 U	<0.00003 U	<0.000003 U	<0.00003 U	0.00003	**0.00012 H**
Naphthalene	(mg/L)	**0.00171**	--	**0.000089 B**	<0.0000222 U	<0.00003 U	**0.0000219**	<0.00003 U	0.000089	**0.073 H**
Phenanthrene	(mg/L)	**0.00142**	--	**0.00018**	<0.0000226 U	<0.00003 U	**0.0000229**	<0.00003 U	0.00018	**1.1 H**
Pyrene	(mg/L)	<0.0000136 U	--	<0.00002 U	<0.0000138 U	<0.00003 U	<0.0000013 U	<0.00003 U	0.00003	**0.11 H**
2-Methylnaphthalene	(mg/L)	**0.00752**	--	<0.00002 U	<0.0000155 U	**0.000018 J**	**0.0000449**	<0.00003 U	0.000018	**0.015 H**
1-Methylnaphthalene	(mg/L)	--	--	**0.00024 J**	--	**0.000013 J**	--	<0.00003 U	0.00024	**0.015 H**

Notes:
DRO = diesel-range organics
GRO = gasoline-range organics
RRO = residual-range organics
NA = not applicable
-- = not analyzed
mg/L = milligrams per liter
PAH = polycyclic aromatic hydrocarbons
Screening level source: H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for PAHs

Bold = The analyte was detected.
Shading = The result is above the screening criteria.
U = not detected
UJ = not detected, detection limit estimated
J = estimated value
B = analyte detected in the method blank (when used as a flag in a sample result)
JB= estimated value and analyte detected in the method blank (when used as a flag in a sample result)
Additional flags are defined in Appendix J

Table 7-7: AOC C6 All VPH & EPH Groundwater Results

Site Name		C6	maximum value
Boring or Well Number		AP-062	
Sample Depth		NA	
Sample Date		6/16/2014	
Sample Name		AP-062-WG01-0614	
C8-C10 Aromatics V	(mg/L)	<0.006 U	
C10-C12 Aromatics V	(mg/L)	<0.015 U	
C12-C13 Aromatics V	(mg/L)	**--**	
C5-C6 Aliphatics V	(mg/L)	**0.006 U,J**	
C6-C8 Aliphatics V	(mg/L)	**0.022 J**	
C8-C10 Aliphatics V	(mg/L)	**0.0051 J**	
C10-C12 Aliphatics V	(mg/L)	<0.006 U	
Total VPH V	(mg/L)	**0.082 J**	
C8-C10 Aromatics	(mg/L)	**--**	
C10-C12 Aromatics	(mg/L)	**0.035 J**	
C12-C16 Aromatics	(mg/L)	**0.092**	
C16-C21 Aromatics	(mg/L)	**0.18**	
C21-C34 Aromatics	(mg/L)	**0.037 J**	
C8-C10 Aliphatics	(mg/L)	**--**	
C10-C12 Aliphatics	(mg/L)	**0.036 J**	
C12-C16 Aliphatics	(mg/L)	**0.19**	
C16-C21 Aliphatics	(mg/L)	**0.18**	
C21-C34 Aliphatics	(mg/L)	**0.03**	
GRO Aromatics (C5 to C10 aro)	(mg/L)	0.006	0.006
GRO Aliphatics (C5 to C10 ali)	(mg/L)	0.0331	0.0331
DRO Aromatics (C10 to C21)	(mg/L)	0.307	0.307
DRO Aliphatics (C10 to C21)	(mg/L)	0.406	0.406
RRO Aromatics (C21 to C34 aro)	(mg/L)	0.037	0.037
RRO Aliphatics (C21 to C34 ali)	(mg/L)	0.03	0.03
GRO (sum of C5 to C10 A&A)	(mg/L)	0.0391	0.0391
DRO (sum of C10 to C21 A&A)	(mg/L)	0.713	0.713
RRO (sum of C21 to C35 A&A)	(mg/L)	0.067	0.067
GRO (AK101)	(mg/L)	**0.03**	
DRO (AK102)	(mg/L)	**2.1**	
RRO (AK103)	(mg/L)	**0.48**	

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/L = milligrams per liter
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
V = defines VPH results versus EPH results
Result = detected results for VPH, EPH, GRO, DRO and RRO bolded

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Table 7-8: AOC C6 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

C6 ProUCL Input File

GRO	d_GRO	DRO	d_DRO	RRO	d_RRO	Benzene	d_Benzene	Toluene	d_Toluene	Ethylbenzene	d_Ethylbenzene	Xylene	d_Xylene
11	1	4700	1	320	1								
73	1	2300	1	100	1	0.011	0	0.011	0	0.0073	1	0.022	0
44	1	1400	1	51	1	0.0075	0	0.0075	0	0.046	1	0.07	1
12	1	710	1	30	1	0.0097	0	0.0097	0	0.0042	1	0.0194	0
140	1	2900	1	110	1	0.01	0	0.0062	1	0.073	1	0.13	1
30	1	2500	1	200	1	0.0088	0	0.0029	1	0.0071	1	0.0123	1
41	1	560	1	25	1	0.0094	0	0.0035	1	0.004	1	0.0103	1
8.2	1	1100	1	49	1	0.0099	0	0.0099	0	0.0071	1	0.0217	1

C6 ProUCL Output File

```
                          General UCL Statistics for Data Sets with Non-Detects
              User Selected Options                      Benzene      0.011   maximum LOD
                          From File  WorkSheet.wst       Toluene      0.0062  maximum detected conc
                     Full Precision  OFF                 Ethylbenzene 0.073   maximum detected conc
             Confidence Coefficient  95%                 Xylene       0.13    maximum detected conc
   Number of Bootstrap Operations  10000                 GRO          93.26   95%UCL
                                                         DRO          2946    95%UCL
                                                         RRO          179.1   95%UCL
GRO
                                          General Statistics
               Number of Valid Observations  8                   Number of Distinct Observations  8
               Raw Statistics                                    Log-transformed Statistics
                                    Minimum  8.2                              Minimum of Log Data  2.104
                                    Maximum  140                              Maximum of Log Data  4.942
                                       Mean  44.9                                Mean of log Data  3.39
                                     Median  35.5                                  SD of log Data  0.995
                                         SD  44.16
                          Std. Error of Mean  15.61
                    Coefficient of Variation  0.983
                                    Skewness  1.67
                             Warning:  There are only 8 Values in this data
         Note:  It should be noted that even though bootstrap methods may be performed on this data set,
                     the resulting calculations may not be reliable enough to draw conclusions
       The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.
                                        Relevant UCL Statistics
            Normal Distribution Test                              Lognormal Distribution Test
                 Shapiro Wilk Test Statistic  0.817                      Shapiro Wilk Test Statistic  0.945
                 Shapiro Wilk Critical Value  0.818                      Shapiro Wilk Critical Value  0.818
       Data not Normal at 5% Significance Level           Data appear Lognormal at 5% Significance Level
            Assuming Normal Distribution                          Assuming Lognormal Distribution
                        95% Student's-t UCL  74.48                                     95% H-UCL  175.9
         95% UCLs (Adjusted for Skewness)                                95% Chebyshev (MVUE) UCL  115.2
          95% Adjusted-CLT UCL (Chen-1995)  80.43                      97.5% Chebyshev (MVUE) UCL  145.6
        95% Modified-t UCL (Johnson-1978)  76.02                        99% Chebyshev (MVUE) UCL  205.4
            Gamma Distribution Test                                      Data Distribution
                      k star (bias corrected)  0.926      Data appear Gamma Distributed at 5% Significance Level
                                  Theta Star  48.5
                                 MLE of Mean  44.9
                   MLE of Standard Deviation  46.66
                                     nu star  14.81
            Approximate Chi Square Value (.05)  7.132                     Nonparametric Statistics
                 Adjusted Level of Significance  0.0195                              95% CLT UCL  70.58
                      Adjusted Chi Square Value  5.838                         95% Jackknife UCL  74.48
                                                                      95% Standard Bootstrap UCL  69.08
           Anderson-Darling Test Statistic  0.301                            95% Bootstrap-t UCL  103.1
         Anderson-Darling 5% Critical Value  0.731                        95% Hall's Bootstrap UCL  201.3
       Kolmogorov-Smirnov Test Statistic  0.203                     95% Percentile Bootstrap UCL  70.78
      Kolmogorov-Smirnov 5% Critical Value  0.3                             95% BCA Bootstrap UCL  77.38
   Data appear Gamma Distributed at 5% Significance Level           95% Chebyshev(Mean, Sd) UCL  113
                                                                  97.5% Chebyshev(Mean, Sd) UCL  142.4
            Assuming Gamma Distribution                             99% Chebyshev(Mean, Sd) UCL  200.2
              95% Approximate Gamma UCL  93.26
                 95% Adjusted Gamma UCL  113.9

             Potential UCL to Use                               Use 95% Approximate Gamma UCL  93.26
    Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
       These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
                  and Singh and Singh (2003).   For additional insight, the user may want to consult a statistician.

DRO
                                          General Statistics
               Number of Valid Observations  8                   Number of Distinct Observations  8
               Raw Statistics                                    Log-transformed Statistics
                                    Minimum  560                              Minimum of Log Data  6.328
                                    Maximum  4700                             Maximum of Log Data  8.455
                                       Mean  2021                                Mean of log Data  7.392
                                     Median  1850                                  SD of log Data  0.733
                                         SD  1381
                          Std. Error of Mean  488.1
                    Coefficient of Variation  0.683
                                    Skewness  0.987
                             Warning:  There are only 8 Values in this data
         Note:  It should be noted that even though bootstrap methods may be performed on this data set,
                     the resulting calculations may not be reliable enough to draw conclusions
       The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.
```

Table 7-8: AOC C6 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.914	Shapiro Wilk Test Statistic	0.963
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	2946	95% H-UCL	4620
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4387
95% Adjusted-CLT UCL (Chen-1995)	3006	97.5% Chebyshev (MVUE) UCL	5402
95% Modified-t UCL (Johnson-1978)	2974	99% Chebyshev (MVUE) UCL	7396
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.601	Data appear Normal at 5% Significance Level	
Theta Star	1263		
MLE of Mean	2021		
MLE of Standard Deviation	1598		
nu star	25.61		
Approximate Chi Square Value (.05)	15.08	Nonparametric Statistics	
Adjusted Level of Significance	0.0195	95% CLT UCL	2824
Adjusted Chi Square Value	13.08	95% Jackknife UCL	2946
		95% Standard Bootstrap UCL	2773
Anderson-Darling Test Statistic	0.215	95% Bootstrap-t UCL	3230
Anderson-Darling 5% Critical Value	0.723	95% Hall's Bootstrap UCL	3221
Kolmogorov-Smirnov Test Statistic	0.162	95% Percentile Bootstrap UCL	2800
Kolmogorov-Smirnov 5% Critical Value	0.297	95% BCA Bootstrap UCL	2933
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4149
		97.5% Chebyshev(Mean, Sd) UCL	5070
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6878
95% Approximate Gamma UCL	3433		
95% Adjusted Gamma UCL	3957		
Potential UCL to Use		Use 95% Student's-t UCL	2946

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

RRO

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Raw Statistics		Log-transformed Statistics	
Minimum	25	Minimum of Log Data	3.219
Maximum	320	Maximum of Log Data	5.768
Mean	110.6	Mean of log Data	4.352
Median	75.5	SD of log Data	0.899
SD	102.2		
Std. Error of Mean	36.14		
Coefficient of Variation	0.924		
Skewness	1.48		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.826	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	179.1	95% H-UCL	343.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	263.6
95% Adjusted-CLT UCL (Chen-1995)	190.3	97.5% Chebyshev (MVUE) UCL	330.5
95% Modified-t UCL (Johnson-1978)	182.2	99% Chebyshev (MVUE) UCL	461.7
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.057	Data appear Normal at 5% Significance Level	
Theta Star	104.7		
MLE of Mean	110.6		
MLE of Standard Deviation	107.6		
nu star	16.91		
Approximate Chi Square Value (.05)	8.607	Nonparametric Statistics	
Adjusted Level of Significance	0.0195	95% CLT UCL	170.1
Adjusted Chi Square Value	7.161	95% Jackknife UCL	179.1
		95% Standard Bootstrap UCL	165.3
Anderson-Darling Test Statistic	0.322	95% Bootstrap-t UCL	261.6
Anderson-Darling 5% Critical Value	0.728	95% Hall's Bootstrap UCL	487.2
Kolmogorov-Smirnov Test Statistic	0.217	95% Percentile Bootstrap UCL	168.1
Kolmogorov-Smirnov 5% Critical Value	0.299	95% BCA Bootstrap UCL	185
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	268.1
		97.5% Chebyshev(Mean, Sd) UCL	336.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	470.2
95% Approximate Gamma UCL	217.3		
95% Adjusted Gamma UCL	261.2		
Potential UCL to Use		Use 95% Student's-t UCL	179.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Table 7-9: AOC C6 Outlier Test Results

Outlier Tests for Selected Variables

From File	WorkSheet.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers with Rosner test	1

Dixon's Outlier Test for DRO

Number of data = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683

1. Data Value 4700 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.451

For 10% significance level, 4700 is not an outlier.
For 5% significance level, 4700 is not an outlier.
For 1% significance level, 4700 is not an outlier.

2. Data Value 560 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.064

For 10% significance level, 560 is not an outlier.
For 5% significance level, 560 is not an outlier.
For 1% significance level, 560 is not an outlier.

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Table 7-10a: AOC C6 HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	maximum LOD	max LOD, ND in 2014	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	maximum detected conc	max measured conc in 2014	
Ethylbenzene (c & nc)	maximum detected conc	max measured conc in 2014	
Xylenes (total) (nc)	maximum detected conc	max measured conc in 2014	
GRO	95%UCL	max measured conc in 2014	
DRO	95%UCL	max measured conc in 2014	
RRO	95%UCL	max measured conc in 2014	
GRO aromatics	site specific VPH & EPH data	max measured conc in 2014	
DRO aromatics	site specific VPH & EPH data	max measured conc in 2014	
RRO aromatics	site specific VPH & EPH data	max measured conc in 2014	
GRO aliphatics	site specific VPH & EPH data	max measured conc in 2014	
DRO aliphatics	site specific VPH & EPH data	max measured conc in 2014	
RRO aliphatics	site specific VPH & EPH data	max measured conc in 2014	
Acenaphthene (nc)	max measured conc	max measured conc	
Acenaphthylene (nc)	max measured conc	max measured conc	
Anthracene (nc)	max measured conc	max measured conc	
Benzo(g,h,i)perylene (nc)	max LOD, all results ND	max LOD, all results ND	
Fluoranthene (nc)	max measured conc	max measured conc	
Fluorene (nc)	max measured conc	max measured conc	
Naphthalene (c & nc)	max measured conc	max measured conc	
Phenanthrene (nc)	max measured conc	max measured conc	
Pyrene (nc)	max measured conc	max LOD, all results ND	
Benzo(a)anthracene (c)	max measured conc	modeled from soils data	
Benzo(b)fluoranthene (c)	max measured conc	modeled from soils data	
Benzo(k)fluoranthene (c)	max LOD, all results ND	modeled from soils data	
Benzo(a)pyrene (c)	max LOD, all results ND	modeled from soils data	
Chrysene (c)	max measured conc	modeled from soils data	
Dibenz(a,h)anthracene (c)	max LOD, all results ND	modeled from soils data	
Indeno(1,2,3-cd)pyrene (c)	max LOD, all results ND	modeled from soils data	
1-Methylnaphthalene (nc)	max measured conc	max measured conc	
2-Methylnaphthalene (nc)	max measured conc	max measured conc	

Hydrocarbon Characterization Data	
Hydrocarbon Fractions	**Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)**
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_5-C_6	Site specific EPH & VPH data
Aliphatic C_6-C_8	Site specific EPH & VPH data
Aliphatic C_8-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:
BTEX = benzene, toluene, ethylbenzene, xylene
(c) = carcinogen
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
(nc) = non-carcinogen
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Table 7-10b: AOC C6 HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	**Input Values**			**Source of Data**
bulk density (lbs/ft^3)	141.12			Site C6 average value
specific gravity	2.775			Site C6 average value
moisture content (% by weight)	6.5375			Site C6 average value
foc	0.0047			Site C6 average value
Soil temp (C)	5.3			Site C6 average groundwater temperature
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt			Site C6 typical texture
Hydrogeologic Conditions				
Source length (ft)	195			scaled from site maps
Average precipitation (in/yr)	143.44			NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	1.78E-04			Site C6 average value
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8			Typical thickness of the aquifer based on the 2013 boring logs
Infiltration rate (m/yr)	0.7286752			20% of average precipitation
Hydraulic gradient	0.00192			Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1			Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters				
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3			NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth				
depth to groundwater at seasonal low water level at downgradient end of source (ft)	18.3			Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	4			Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	18.3			Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	2			Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time				
Soil Direct Contact	1			Site specific conceptual site model
Outdoor Air	1			Site specific conceptual site model
Indoor Air	0			Site specific conceptual site model
Groundwater Ingestion	0			Site specific conceptual site model
Other Input				
ADEC Hazard ID	0			ADEC CS database
Latitude	0			ADEC CS database
Longitude	0			ADEC CS database
Width of Source (ft)	110			scaled from site maps
Area of NAPL contaminated soil source (ft^2)	21450			scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.00192			Measured slope of water table
Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	141.12	141.12	141.12	Site C6 average value
specific gravity of solids	2.775	2.775	2.775	Site C6 average value
moisture content (% by weight)	6.54	6.54	6.54	Site C6 average value
foc	0.001	0.001	0.001	ADEC default input value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	0.5	0.5	1	Site Specific (depth to source minus foundation depth--distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	6.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 7-11: AOC C6 Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	1.19079E-07	0.0119	0.0037
Outdoor air inhalation	9.41404E-12	0.0000	0.0000
Indoor air inhalation (vapor intrusion)	2.15273E-09	0.0002	0.0000
Groundwater Ingestion	1.56337E-07	0.0156	0.0041
Cumulative Risk	**3E-07**	**0.0**	**0.0**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	3.58489E-07	0.0358	0.0423
Outdoor air inhalation	4.08378E-11	0.0000	0.0000
Indoor air inhalation (vapor intrusion)	9.04145E-09	0.0009	0.0001
Groundwater Ingestion	2.62647E-07	0.0263	0.0058
Cumulative Risk	**1E-06**	**0.1**	**0.05**

Notes:
Fraction of Risk values equal to or less than one meet the ADEC risk standard
Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 7-12: AOC C6 Summary of Bulk Fuel Hydrocarbon Risk

			Fraction of Risk Values				
	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor intrusion)	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	80	0.006	<1	<1	<1	<1	<1
DRO Aromatics	647	0.307	<1	<1	<1	<1	<1
RRO Aromatics	50	0.037	<1	No RfC	No Rfc	<1	<1
GRO Aliphatics	14	0.033	<1	<1	<1	<1	<1
DRO Aliphatics	2299	0.406	<1	<1	<1	<1	<1
RRO Aliphatics	129	0.030	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	80	0.006	<1	<1	<1	<1	<1
DRO Aromatics	647	0.307	<1	<1	<1	<1	<1
RRO Aromatics	50	0.037	<1	No Rfc	No Rfc	<1	<1
GRO Aliphatics	14	0.033	<1	<1	<1	<1	<1
DRO Aliphatics	2299	0.406	<1	<1	<1	<1	<1
RRO Aliphatics	129	0.030	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics

GRO = gasoline-range organics

mg/kg = milligrams per kilogram

mg/L = milligram(s) per liter

No RfC = no reference concentration available; risk standard is assumed to be met due to low volatility of the fraction

RRO = residual-range organics

Table 7-13: AOC C6 Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
total DRO	5800	230	MTGW	950	MTGW	2946	12500	10628	Soil Direct Contact

Notes:
ACL = alternate cleanup level
(c) = carcinogen
DRO = diesel-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
MTGW = migration to groundwater
(nc) = non-carcinogen

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8.0 AOC D1 – ARMY DOCK AREA – FORMER 1000 BBL TANK – NO. 836

8.1 AREA DESCRIPTION AND BACKGROUND

AOC D1 is the site of former Tank No. 836 (AST1) within the historical Army Dock area tank farm. The tank farm served as the primary fuel off-loading and storage site for World War II military activities in Yakutat. Eight ASTs (ASTs 1–8) with tank capacities ranging from 20,000 to 80,000 gal and associated piping were used to store and transfer diesel fuel from the dock at Monti Bay. Former AST1 was located at the northwest portion of AOC D, which is situated over a moraine consisting primarily of slightly silty and gravelly sands. A 2-story office/warehouse building (Malaspina Investments Office and Warehouse) is currently located on a gravel lot/storage yard near the former tank location. This facility includes an apartment, office, warehouse, and construction storage yard. The AST and associated piping at this location have been removed, and there was no evidence of the former tank pad present.

Analytical data collected from the site during previous RIs indicate that DRO is present in vadose and saturated zone soils at varying depths between 5 and 47 feet bgs. Soil samples collected from borings advanced during installation of in-source monitoring wells had DRO concentrations up to 7,300 mg/kg at a depth of 47 feet bgs. DRO was detected in groundwater samples at a maximum concentration of 0.189 mg/L (S&W 2006a). This concentration is below the ADEC Table C cleanup level (1.5 mg/L); however, the presence of DRO in groundwater and subsurface soils near the smear zone indicates that contamination likely has impacted saturated zone soils. ROST/LIF data indicate that vadose zone contamination is present north, south, east-northeast, and west of the AOC D1 footprint (USACE 2006).

Data collected during the previous investigations were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at AOC D1. These data, along with field screening results and visual observations, were reviewed to select appropriate sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations and the estimated NAPL source area at AOC D1 are shown on Figure 8-1.

8.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC D1 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Evaluate current groundwater conditions.

8.3 SUMMARY OF FIELD WORK

The Supplemental RI included implementing a site-specific sampling approach for each AST at AOC D. Supplemental RI activities performed at AOC D1 included advancement of soil borings, collection of soil and groundwater samples, and aquifer (slug) testing. These activities are described below by media.

8.3.1 Soil

Based on historical data and the estimated NAPL source area, six soil borings were advanced to depths ranging from 10 to 52 feet bgs to collect data for the HRC. Subsurface soils in this area consist primarily of fine to coarse sands and gravel with occasional layers of fine sands with silt and clayey sand. Soil boring logs are included in Appendix C.

Field screening samples were collected from above and below the target sample intervals and screened for volatile organics using a PID. Soil samples collected for laboratory analysis were selected from the target depth(s) or adjusted to the most likely contaminated depth based on field observations (e.g., PID, visual, and olfactory). Soil samples for laboratory analyses were collected from three depth intervals in borings D1-SB01 and SB04, two depth intervals in borings D1-SB03 and SB06, and one depth interval in

D1-SB02 and SB05. With the exception of samples from D1-SB03, all samples were analyzed for GRO, DRO, RRO, BTEX, PAHs, VPH and EPH. Per the WP/QAPP, samples from D1-SB03 were analyzed for DRO/RRO only. Field observations and screening results were used to refine the estimated limits of the NAPL source area shown on Figure 8-2.

BACKGROUND SOIL CONDITIONS

Eight soil borings were advanced outside the NAPL source area to collect background soil data (i.e., chemical, TOC and physical parameters) at AOC D. Boring locations were selected in the field to ensure coverage of the entire AOC D area. Background boring locations (D8-BG01, D8-BG07, D4-BG02, D3-BG03, D3-BG04, D2-BG05, D1-BG06 and D1-BG08) are shown on Figure 8-1, Figure 11-1 and Figure 12-1. Physical constraints such as the rugged terrain (e.g., old growth trees, boulders, steep inclines/banks) and underground utilities limited access to drilling locations. Several background boring locations at AOC D were moved because either: 1) field screening indicated evidence of contamination in soil, 2) utilities were encountered, or 3) the lithology differed from the source zone soil type(s). Additional attempts to collect background soils included one boring between AST1 and AST2, one at AST3, two at AST4, two at AST5, and one between AST5 and AST8. Background borings were attempted until representative samples were obtained from a total of eight different background locations throughout AOC D.

Background soil samples were collected from depths with soil types similar to those impacted within the AOC D contaminant soil source areas. Where feasible, two samples representative of the two primary soil types identified at AOC D were collected from each boring. Samples were analyzed for GRO, DRO/RRO, DRO/RRO with SGC, TOC, and physical parameters (grain size, bulk density, moisture content, and specific gravity). Results of the background chemical analyses are presented in summary tables in Appendix J. Geotechnical data are summarized in Table 4-2 and TOC results are summarized in Table 4-3 (Section 4.2). These data were used for input into the HRC to evaluate risk due to contaminants in soil at AOC D.

8.3.2 Groundwater

Groundwater assessment proposed for AOC D1 included sampling of three existing monitoring wells (AP-200, AP-201 and 202). Monitoring well AP-200 installed at the front of the Malaspina building was covered by gravel, and after several attempts, could not be located. Groundwater samples were collected from AP-201 and AP-202 using a bladder pump with dedicated bladders and analyzed for GRO, DRO, RRO, BTEX, and PAHs. The samples collected from well AP-202 were also analyzed for VPH and EPH for HRC input. Well locations are shown on Figure 8-1 and Low Flow Groundwater Sample Collection Records are included in Appendix D.

AQUIFER TESTING

Subsequent to sampling, aquifer (slug) tests were performed on monitoring wells AP-201 and AP-202 to obtain hydraulic conductivity values for input into the HRC. Due to the small diameter of the AP-designated wells (1-inch ID), a water slug was used to displace the water column instead of a solid slug. These tests were performed and evaluated following the procedures outlined in Section 3.4.5. Slug test data are included in Appendix E and results are discussed in Section 8.4 below.

Aquifer tests were proposed for well AP-200; however, as stated above, this well was covered with gravel and could not be located.

8.4 GROUNDWATER CONDITIONS

A full round of water levels were measured in the existing monitoring wells at AOC D on 21 June 2014. These data were used to develop groundwater contours to determine groundwater flow conditions at the site. The groundwater potentiometric surface and estimated flow direction measured for the AOC D area are presented on Figure 8-3. Groundwater contours show that the overall groundwater flow direction at AOC D is to the northwest, with an assumed localized cone of depression in the vicinity of City of Yakutat pumping wells ARCO #1 and/or ARCO #2. Horizontal gradients were measured for various areas of the site, with an overall average gradient estimated at 0.0085 ft/ft for AOC D.

Slug test data were reduced using AQTESOLV software for subsequent evaluation using the Bouwer & Rice Method for unconfined aquifers, as well as the Hvorslev Method for comparison. Hydraulic conductivities calculated at AOC D1 using Bouwer & Rice are presented in Table 4-4. The average hydraulic conductivity of 0.018 ft/day was used as input in the HRC.

8.5 ANALYTICAL RESULTS

8.5.1 Soil

A total of 12 soil samples were collected from six soil borings at the site and submitted for laboratory analyses. In general, the sampling targeted the most highly contaminated soils to further characterize the NAPL soil source area. Results show that nine of the 12 samples had DRO concentrations above the Method Two cleanup level ranging from 350 mg/kg to 28,000 mg/kg. In addition to DRO, concentrations of 1-methylnaphthalene in one soil sample and 2-methylnaphthalene in three soil samples exceeded Method Two cleanup levels. No other analytes were reported at concentrations above Method Two cleanup levels. Soil analytical results for the samples collected in 2014 are presented in summary tables provided in Appendix J. Sample locations are shown on Figure 8-1 and a cross sectional view of the site showing the vertical extent of impacts is presented along A-A’ as Figure 8-2.

Constituent data collected within the defined NAPL source zone were used to supplement the historical data set for characterization of the contaminant source zone. Historical and recent (2014) POL soil data evaluated for the AOC D1 area are presented in Table 8-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 8-2. Historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attention of these constituents. PAH soil data are presented in Table 8-3, and VPH/EPH results are presented in Table 8-4. These data were used as input in calculating soil ACLs and to evaluate risk at AOC D1 using the HRC.

8.5.2 Groundwater

Groundwater assessment at the site included collecting samples from monitoring wells AP-201 and AP-202. Analytical results indicate that, although hydrocarbon constituents are present in groundwater at AOC D1, the concentrations detected did not exceed the Table C groundwater cleanup levels. Analytical results are summarized in Appendix J.

Results for AP-201 and AP-202 were used to supplement historical groundwater data for AOC D1. Historical and recent (2014) groundwater results for POLs, PAHs and VPH/EPH are summarized in Table 8-5 through Table 8-7, respectively.

8.6 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC D1; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

8.6.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet the ADEC “Cleanup Complete” criteria, the AOC D1 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion).

The AOC D1 risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at the site at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be complete at the present time, because there is an occupied building within 30 feet of the AOC D1 source area. However, this is a commercial building/business and would not apply to a residential scenario. There is currently no exposure to groundwater at the present time, because there are no known drinking water wells within the radius of influence at the site. The subsurface soil NAPL source area extends toward a pond located south of AOC D1. The potential for surface runoff to the adjacent pond is a possibility based on the lack of vegetation; however, surface soil contamination is limited in quantity and concentration and mostly distributed around the former AST, which is over 150 feet from the pond.

The AOC D1 exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

8.6.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each hydrocarbon constituent (BTEX 2014 data only) and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in Table 8-2. The source area data set for BTEX constituents had a limited number of relatively low concentration detections, so the maximum detected values from the source area were used as exposure point concentrations. There were adequate data to calculate 95% UCLs for GRO, DRO, and RRO; therefore, ProUCL was used to calculate 95% UCLs for the HRC input. ProUCL formatted outputs are displayed in Table 8-8.

Table 8-9 presents the ProUCL outlier test results for DRO, and as shown, the test indicated that the highest DRO concentration measured at the site (28,000 mg/kg) was a statistical outlier. However, these results were carried forward into the HRC. The inclusion of the outliers in the 95% UCL calculation will tend to increase the 95% UCL value relative to the population average (i.e., the 95% UCL becomes more conservative). A Q-Q plot and box plot of the DRO source area data are presented in Figure 8-4a and Figure 8-4b. Both the Q-Q and box plots show that the highest DRO concentration graphed significantly above the other data, which also suggests that the highest DRO result was a statistical outlier.

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 8-3. Benzo(g,h,i)perylene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene were not detected at AOC D1; therefore, the maximum LOD values were used as the exposure point concentrations. The maximum detected concentrations were used as the exposure point concentrations for the remaining PAH constituents; 95% UCLs were not calculated at AOC D1.

Eight VPH and EPH source area samples were used to characterize the bulk hydrocarbon chemistry. The HRC input values calculated from the source area VPH/EPH data are shown in Table 8-4.

The source of each HRC soil exposure point input value is documented in Table 8-10a.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

BTEX and GRO were not detected at the site, so the maximum LOD for the samples collected from the source area well were used as the exposure point concentrations. RRO and DRO were detected at AOC D1; therefore, the maximum detected concentrations were used as input to the HRC. In addition, the maximum GRO, DRO and RRO aromatic and aliphatic concentrations (derived from the VPH/EPH test results) were used as input to the HRC.

For the PAH constituents that were detected during the 2014 groundwater sampling event, the maximum detected concentrations were used as the exposure point concentrations in the HRC risk evaluation. For the PAH constituents that were not detected during the 2014 groundwater sampling event, the maximum

LOD values were used as the exposure point concentrations, if the maximum LOD values did not cause significant risk (e.g. greater than about 10% of the risk standard). At AOC D1, a mixture of maximum measured concentrations and maximum LOD values was used as the exposure point concentration for the non-carcinogenic PAHs. For the carcinogenic PAHs in general, and for benzo(a)pyrene and dibenz(a,h)anthracene in particular, typical groundwater LODs can be close to or above groundwater ingestion risk-based concentrations. Therefore, for the carcinogenic PAHs, the groundwater concentrations predicted or modeled by the HRC, based on the soil concentration data, are often used as input to the risk calculations to yield more representative risk results. None of the carcinogenic PAHs were detected at the site, so the modeled dissolved phase concentrations were used as the exposure point concentration.

The source of each HRC groundwater exposure point input value is documented in Table 8-10a.

8.6.3 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to AOC D1 is presented in Table 8-10b.

8.6.4 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results is included as Table N-4 of Appendix N and the risk posed by the site conditions is summarized in Table 8-11 and Table 8-12. Table N-4 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for AOC D1 indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).
- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aromatic and aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.
- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, the site conditions are protective of human health under an unrestricted (residential) land use scenario.

8.7 ALTERNATIVE CLEANUP LEVELS

Constituents and/or hydrocarbon fractions exceeding ADEC Method Two cleanup levels at AOC D1 include benzene, 1-methylnaphthalene, 2-methylnaphthalene and DRO. Note that the benzene exceedance is from the 2004 sampling effort and is not considered representative of current site conditions. Soil ACLs have been developed for these constituents and/or hydrocarbon fractions as shown in Table 8-13.

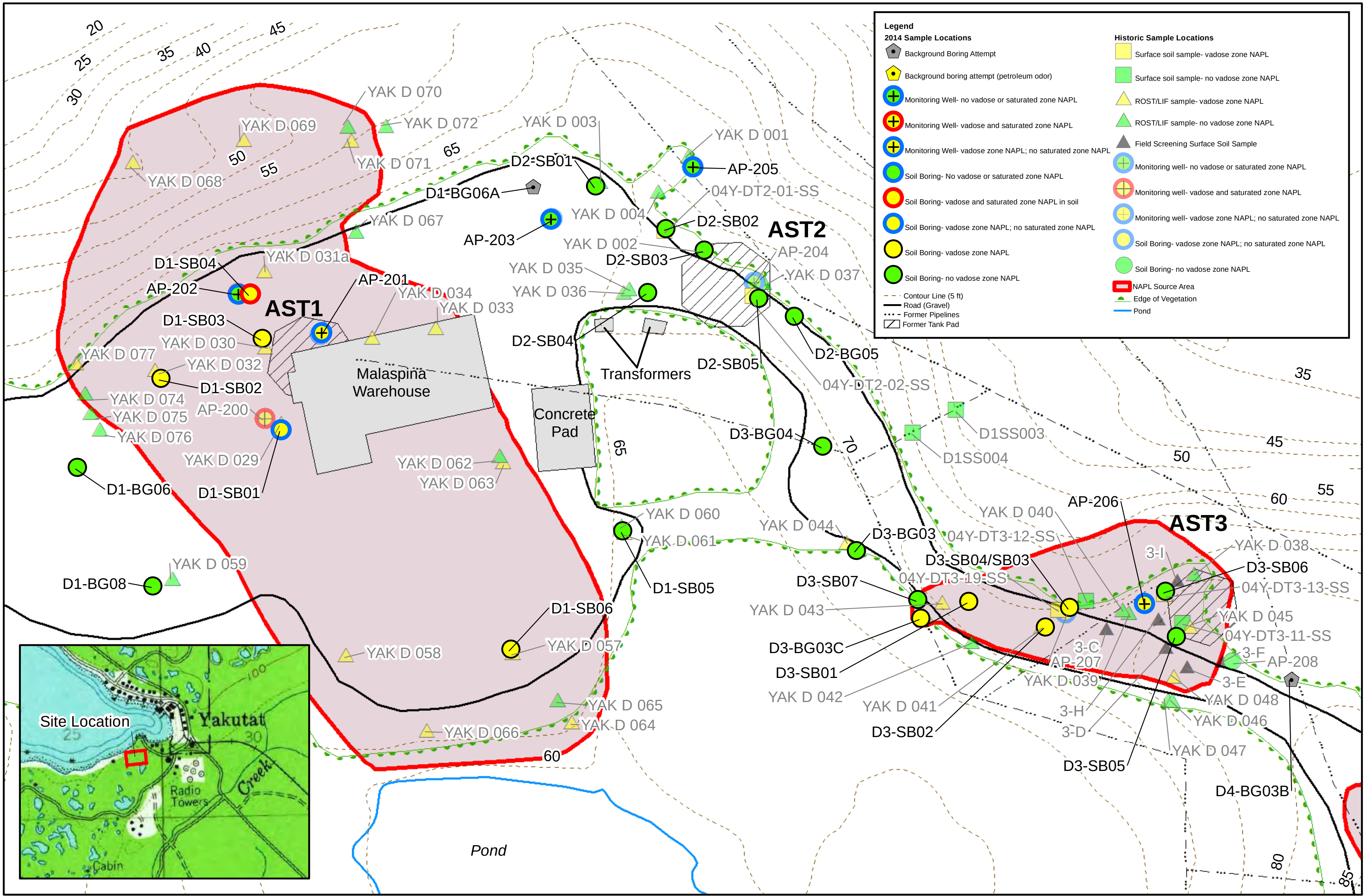
Benzene, 1-methylnaphthalene, 2-methylnaphthalene and DRO exceed the Method Two migration to groundwater cleanup levels. However, the migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult's Law) and dilution-attenuation calculations are applied, the AOC D1 exposure point concentrations meet the migration to groundwater criteria. Under these conditions it is typically not necessary to calculate ACLs, but for this contract ACLs have been back calculated for site COPCs and are presented in Table 8-13. The exposure point concentrations at AOC D1 are less than the ACLs calculated using the HRC, documenting that the site meets the ADEC migration to groundwater criteria.

8.8 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at the AOC D area was evaluated and a preliminary ecological CSM was developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following conditions support the determination that conditions at AOC D1 are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.
- Surface runoff to the adjacent pond is possible, but surface soil contamination is limited and over 150 feet from the pond.
- While Monti Bay is located north of the site, groundwater results indicate petroleum hydrocarbons are not migrating to the marine environment at concentrations above Alaska WQS for TAH or TAqH.
- Petroleum hydrocarbons in surface soil at AOC D cover 0.11 acre (excluding AOC D7). The impacted surface soil areas are less than the ADEC 0.5 acre *de minimis* criterion. Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.
- A separate site with fuel contamination is located downgradient of AOC D, approximately 200 feet north of former AST 1 (D1). The contamination may be associated with former AST fuel piping or other sources. Based on the site proximity to AOC D, a consideration was made to carry this site forward for analysis of overall contaminant quantity. However, further review of site conditions indicates that the property consists of a 2.5 acre open gravel lot with approximately six buildings in a commercial/industrial setting. Unlike AOC D, which has forested habitat adjacent to or within the boundaries of the AOC D site, the site north of AOC D is highly developed with minimal vegetation and somewhat isolated on an apparently artificially filled peninsula. These conditions do not support habitat for valued species. Therefore, this site will not be considered further.
- Risk to the environment has been evaluated for the AOC D area (in entirety) using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation of AOC D1 is not needed and site conditions are protective of the environment.



N
W E
S

FIGURE 8-1

AOC D1, AOC D2, AOC D3
NAPL Source Areas and Sample Locations

US Army Corps
of Engineers
Alaska District

0 30 60
Feet
1 in = 60 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

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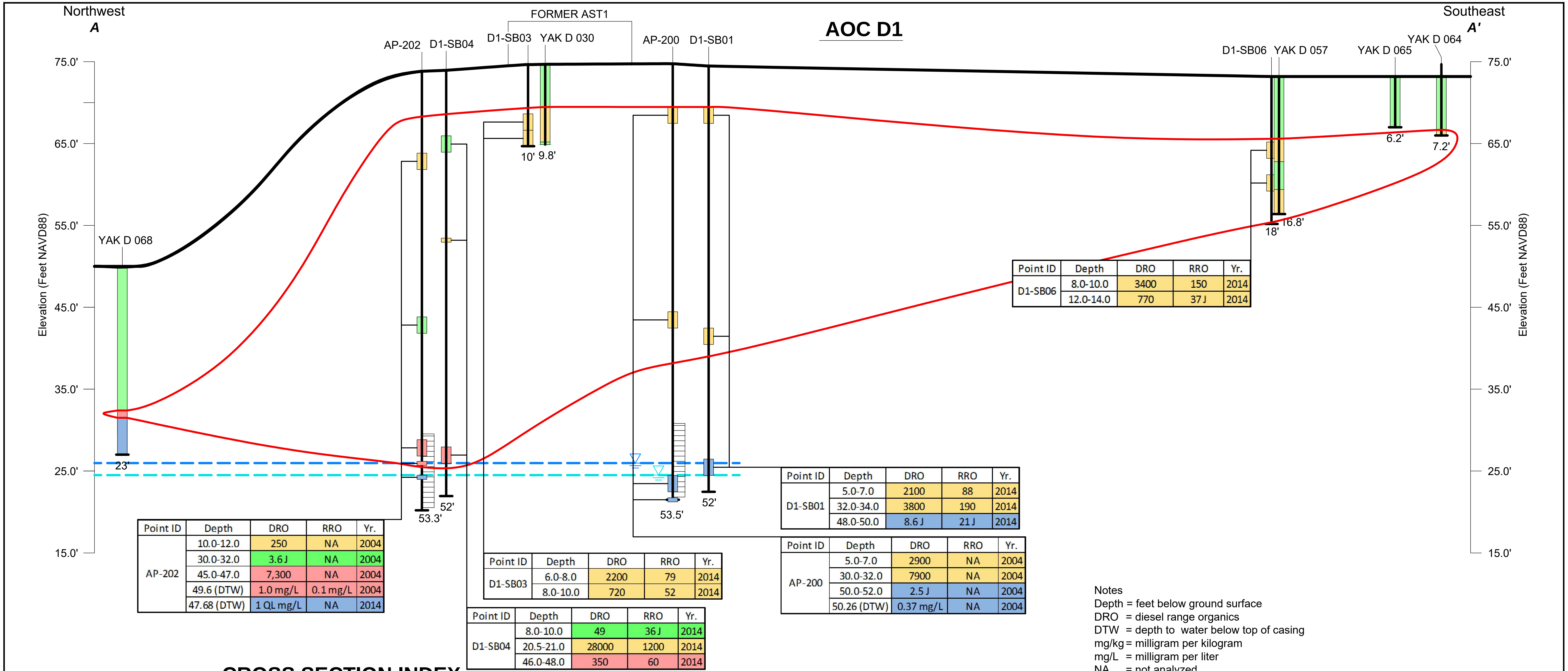
Last saved by: SCHWARTZE(2016-03-29) Last Plotted: 2016-03-29
Filename: L:\GROUP\CAD\YAKUTAT AFB\FIGURES\YAK_FIG_8-2_ A-A' D-AST1.DWG



Point ID	Depth	DRO	RRO	Yr.
AP-202	10.0-12.0	250	NA	2004
	30.0-32.0	3.6 J	NA	2004
	45.0-47.0	7,300	NA	2004
	49.6 (DTW)	1.0 mg/L	0.1 mg/L	2004
	47.68 (DTW)	1 QL mg/L	NA	2014

Point ID	Depth	DRO	RRO	Yr.
D1-SB03	6.0-8.0	2200	79	2014
	8.0-10.0	720	52	2014

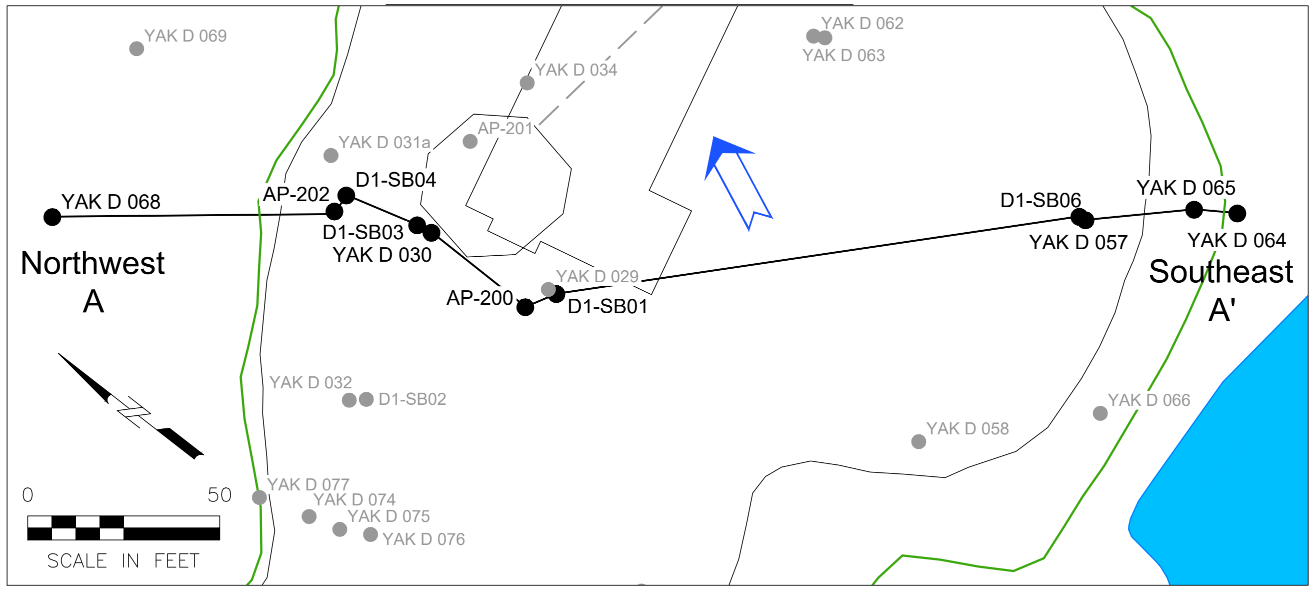
Point ID	Depth	DRO	RRO	Yr.
D1-SB04	8.0-10.0	49	36 J	2014
	20.5-21.0	28000	1200	2014
	46.0-48.0	350	60	2014

Point ID	Depth	DRO	RRO	Yr.
D1-SB01	5.0-7.0	2100	88	2014
	32.0-34.0	3800	190	2014
	48.0-50.0	8.6 J	21 J	2014

Point ID	Depth	DRO	RRO	Yr.
AP-200	5.0-7.0	2900	NA	2004
	30.0-32.0	7900	NA	2004
	50.0-52.0	2.5 J	NA	2004
	50.26 (DTW)	0.37 mg/L	NA	2004

Point ID	Depth	DRO	RRO	Yr.
D1-SB06	8.0-10.0	3400	150	2014
	12.0-14.0	770	37 J	2014

CROSS SECTION INDEX



LEGEND

- 🟩 NO VADOSE ZONE NAPL
- 🟨 VADOSE ZONE NAPL
- 🟦 NO SATURATED ZONE NAPL
- 🟥 SATURATED ZONE NAPL
- ▽ 2004 GROUNDWATER ELEVATION
- ▽ 2014 GROUNDWATER ELEVATION
- ⇨ GROUNDWATER FLOW DIRECTION
- — ESTIMATED VERTICAL EXTENT OF NAPL SOURCE ZONE
- ▥ SCREEN INTERVAL

Notes
Depth = feet below ground surface
DRO = diesel range organics
DTW = depth to water below top of casing
mg/kg = milligram per kilogram
mg/L = milligram per liter
NA = not analyzed
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
ROST = rapid optical screening tool
RRO = residual range organics
Yr. = year sample was collected

All DRO and RRO results are in mg/kg unless otherwise noted on the figure. See Appendix J for result qualifiers.

Location IDs beginning with YAK identify historical ROST borings. ROST results with percent reference emitter limits >1% are considered to be above the NAPL threshold (>230 mg/kg for DRO and RRO).

12
6
0
0 12 24
SCALE IN FEET
(VERT. EX. = 2)

Figure: 8-2

CROSS SECTION A-A'
AOC D1

U.S. Army
Corps of Engineers
Alaska District

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 01/16/15

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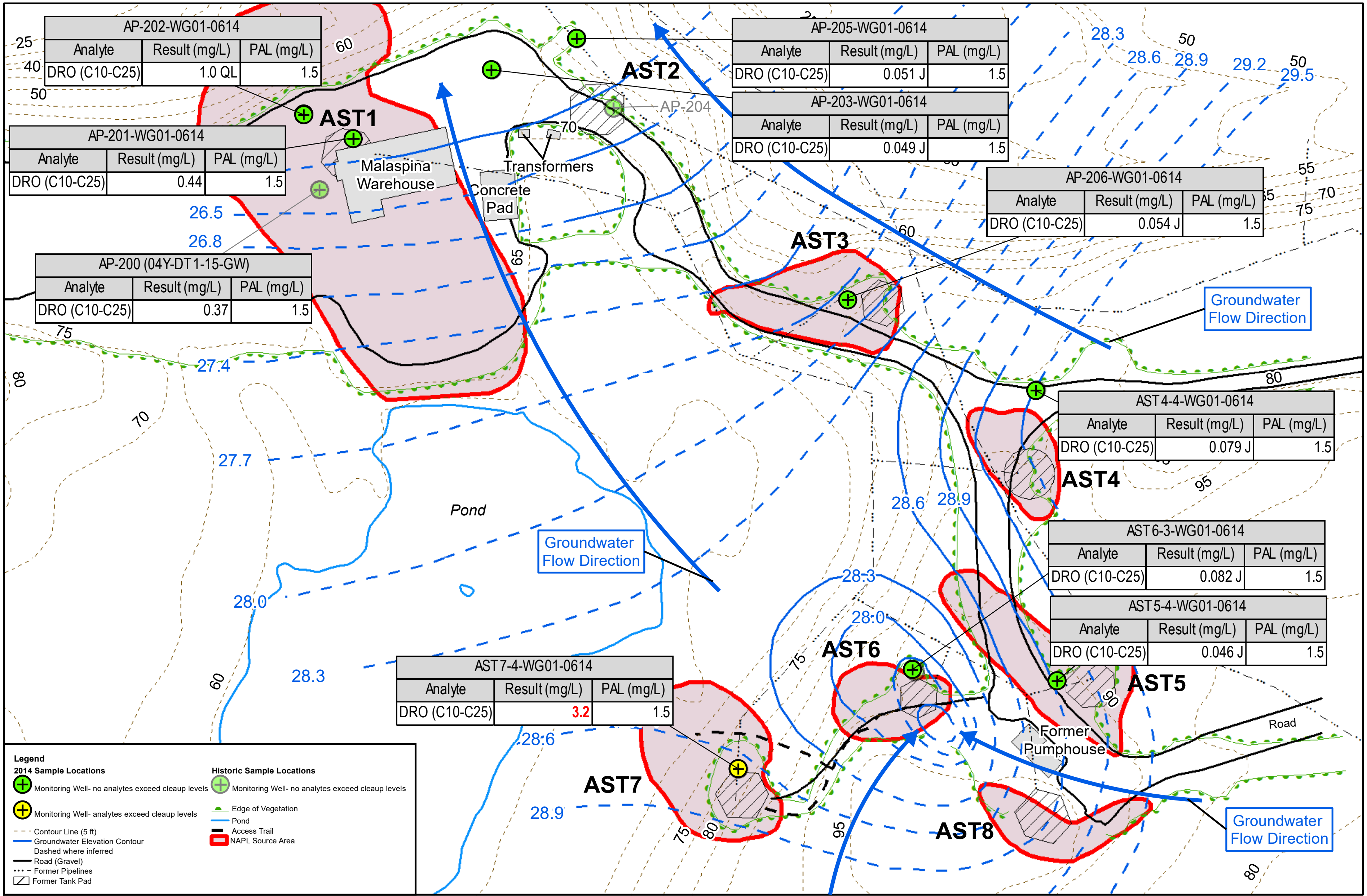

AP-202-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	1.0 QL	1.5

AP-201-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.44	1.5

AP-200 (04Y-DT1-15-GW)

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.37	1.5

AP-205-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.051 J	1.5

AP-203-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.049 J	1.5

AP-206-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.054 J	1.5

AST4-4-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.079 J	1.5

AST6-3-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.082 J	1.5

AST5-4-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	0.046 J	1.5

AST7-4-WG01-0614

Analyte	Result (mg/L)	PAL (mg/L)
DRO (C10-C25)	3.2	1.5

Notes:
DRO – diesel range organics
mg/L – milligrams per liter
PAL – Project Action Limit
1. Only those constituents exceeding the PAL (ADEC Table C groundwater cleanup levels) are shown.
2. Results shown in Red exceed the PAL shown.
3. If a duplicate sample was collected, the higher of the primary and duplicate sample concentration is shown.
4. The most recent historical data is shown for well AP-200 (not found).
5. See Appendix J for result qualifier definitions.

FIGURE 8-3

AOC D
Groundwater Analytical Results

US Army Corps
of Engineers
Alaska District

0 30 60
Feet
1 in = 100 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 3/29/2016

FIGURE 8-4a: AOC D1 DRO Q-Q Plot

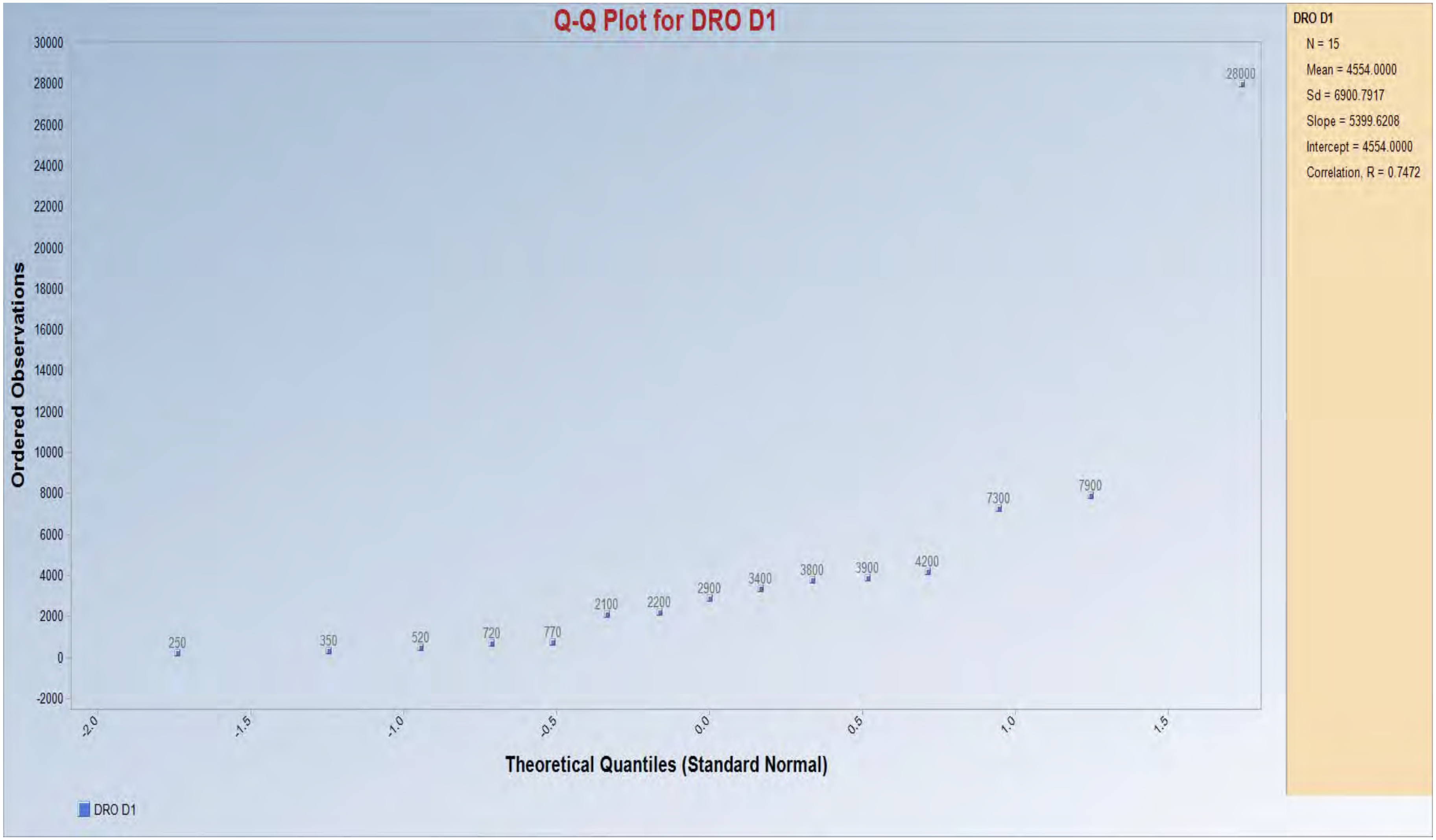

FIGURE 8-4b: AOC D1 DRO Box Plot

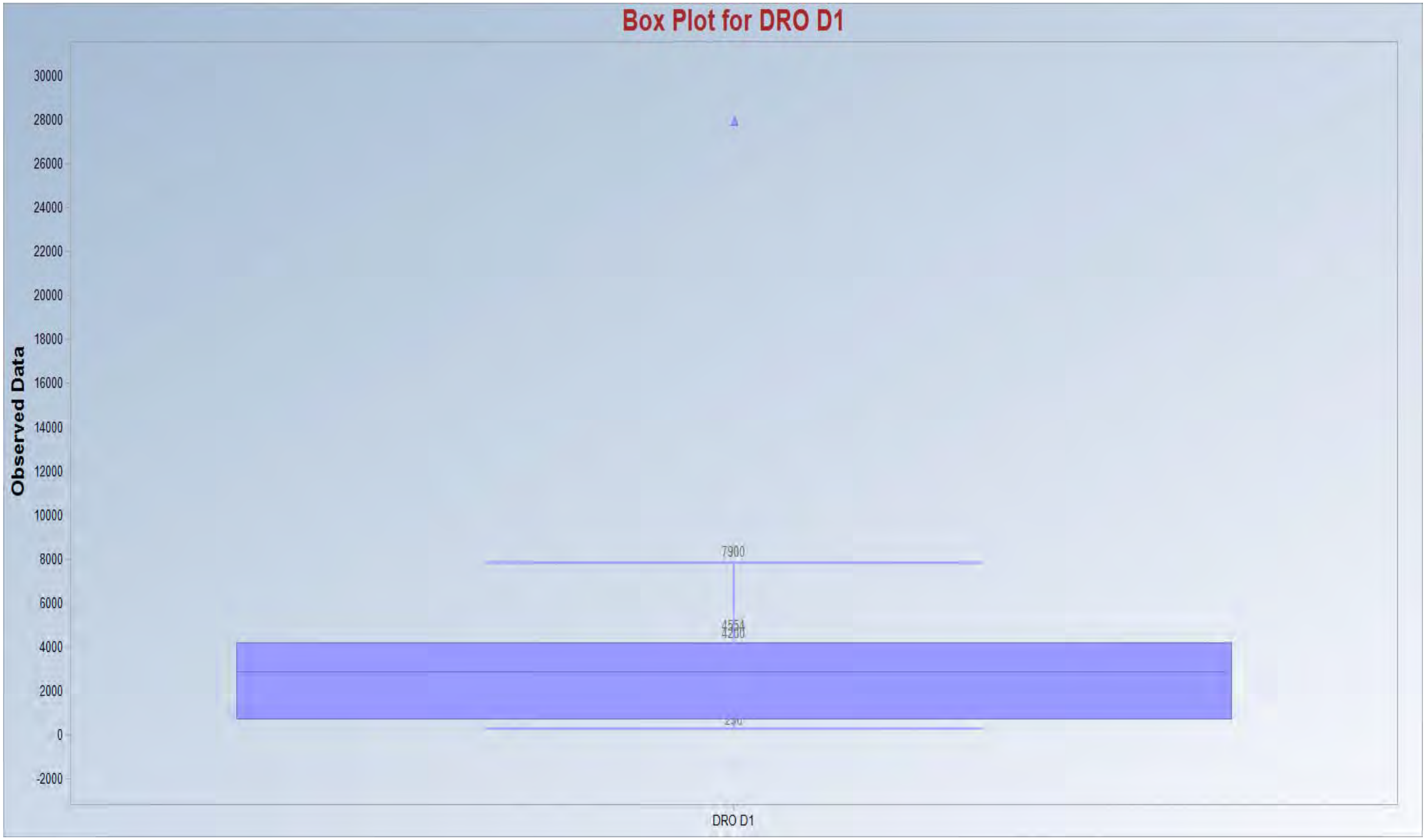

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Table 8-1: AOC D1 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D1	04Y-DT1-01-SS	0-0	8/5/2004	04Y-DT1-01-SS	<0.22 U	**6.1**	--	<0.0008 U	**0.003 J**	**0.0045 J**	--
D1	04Y-DT1-02-SS	0-0	8/5/2004	04Y-DT1-02-SS	<0.12 U	**10**	--	**0.024**	**0.037**	**0.2**	--
D1	04Y-DT1-03-SS	0-0	8/5/2004	04Y-DT1-03-SS	<0.43 U	**79**	--	**0.0062 J**	**0.0031 J**	**0.012 J**	--
D1	AP-200	5-7	8/5/2004	04Y-DT1-04-SO	<1.1 U	**2900**	--	<0.0041 U	**0.1**	**0.039**	--
D1	AP-200	30-32	8/5/2004	04Y-DT1-05-SO	<0.81 U	**7900**	--	**0.0029 J**	**0.026**	**0.021 J**	--
D1	AP-200	50-52	8/5/2004	04Y-DT1-06-SO	<0.23 U	**2.5 J**	--	<0.0008 U	**0.0022 J**	**0.0057 J**	--
D1	AP-201	15-17	8/6/2004	04Y-DT1-07-SO	<1.1 U	**4200**	--	**0.004 J**	<0.0037 U	**0.026**	--
D1	AP-201	25-27	8/6/2004	04Y-DT1-08-SO	<0.96 U	**520**	--	**0.0034 J**	<0.0032 U	**0.015 J**	--
D1	AP-201	45-47	8/6/2004	04Y-DT1-09-SO	<0.21 U	**4.1**	--	<0.0007 U	**0.0007 J**	**0.0055 J**	--
D1	AP-202	10-12	8/7/2004	04Y-DT1-10-SO	<0.26 U	**250**	--	**0.0034 J**	**0.0035 J**	**0.014**	--
D1	AP-202	30-32	8/7/2004	04Y-DT1-13-SO	<0.2 U	**3.6 J**	--	<0.0007 U	**0.0054 J**	**0.006 J**	--
D1	AP-202	45-47	8/7/2004	04Y-DT1-14-SO	**1.8**	**7300**	--	<0.0063 U	**0.013 J**	<0.0077 U	--
D1	D1-BG06	10-12	6/22/2014	D1-BG06-10.0-12.0-0614	**1.4**	**5.7 J**	**9.8**	--	--	--	--
D1	D1-BG08	6-8	6/25/2014	D1-BG08-6.0-8.0-0614	**2.2 B**	**6.9 J**	<27 U	--	--	--	--
D1	D1-BG08	18-20	6/25/2014	D1-BG08-18.0-20.0-0614	**2.5 H**	**3.4 J**	**3.4 J**	--	--	--	--
D1	D1-SB01	5-7	6/17/2014	D1-SB01-5.0-7.0-0614	**73 B,QH**	**2100**	**88**	**0.0075 QL**	**0.2**	<0.0098 U	**0.3298**
D1	D1-SB01	32-34	6/17/2014	D1-SB01-32.0-34.0-0614	**24 B**	**3800**	**190**	<0.0093 U,QL	<0.0093 U	<0.0093 U	**0.0353 J**
D1	D1-SB01	48-50	6/17/2014	D1-SB01-48.0-50.0-0614	**3.3 B**	**8.6 J**	**21 J**	<0.0099 U,QL	<0.0099 U	<0.0099 U	<0.0198 U
D1	D1-SB02	11-13	6/17/2014	D1-SB02-11.0-13.0-0614	**47 B**	**3900**	**150**	<0.011 U,QL	<0.011 U	<0.011 U	<0.022 U
D1	D1-SB03	6-8	6/18/2014	D1-SB03-6.0-8.0-0614	--	**2200**	**79**	--	--	--	--
D1	D1-SB03	8-10	6/18/2014	D1-SB03-8.0-10.0-0614	--	**720**	**52**	--	--	--	--
D1	D1-SB04	8-10	6/16/2014	D1-SB04-10.0-12.0-0614	**10 B**	**49**	**36 J**	**0.0037 QL**	**0.0037 J**	**0.0067 J**	**0.0126 J**
D1	D1-SB04	20.5-21	6/16/2014	D1-SB04-20.5-21.0-0614	**39 B**	**28000**	**1200**	**0.0048 QL**	**0.1**	**0.0055 J**	**0.29**
D1	D1-SB04	46-48	6/16/2014	D1-SB04-46.0-48.0-0614	**2.5 B**	**350**	**60**	<0.008 U,QL	<0.008 U	<0.008 U	<0.016 U
D1	D1-SB05	8-10	6/18/2014	D1-SB05-10.0-12.0-0614	**6.9**	**160 J**	**5 J**	<0.0099 U,QL	**0.0058 J**	<0.0099 U	**0.0173 J**
D1	D1-SB06	8-10	6/18/2014	D1-SB06-8.0-10.0-0614	**67 B,QH**	**3400**	**150**	<0.0098 U,QL	**0.013 J**	<0.0098 U	**0.0288 J**
D1	D1-SB06	12-14	6/18/2014	D1-SB06-12.0-14.0-0614	**4.7 NP**	**770**	**37 J**	<0.009 U,QL	<0.009 U	<0.009 U	<0.018 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					73	28000	1200	0.024	0.2	0.2	0.3298
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 8-2: AOC D1 Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D1	AP-200	5-7	8/5/2004	04Y-DT1-04-SO	<1.1 U	**2900**	**--**	**--**	**--**	**--**	**--**
D1	AP-200	30-32	8/5/2004	04Y-DT1-05-SO	<0.81 U	**7900**	**--**	**--**	**--**	**--**	**--**
D1	AP-201	15-17	8/6/2004	04Y-DT1-07-SO	<1.1 U	**4200**	**--**	**--**	**--**	**--**	**--**
D1	AP-201	25-27	8/6/2004	04Y-DT1-08-SO	<0.96 U	**520**	**--**	**--**	**--**	**--**	**--**
D1	AP-202	10-12	8/7/2004	04Y-DT1-10-SO	<0.26 U	**250**	**--**	**--**	**--**	**--**	**--**
D1	AP-202	45-47	8/7/2004	04Y-DT1-14-SO	**1.8**	**7300**	**--**	**--**	**--**	**--**	**--**
D1	D1-SB01	5-7	6/17/2014	D1-SB01-5.0-7.0-0614	**73 B,QH**	**2100**	**88**	**0.0075 QL**	**0.2**	<0.0098 U	**0.3298**
D1	D1-SB01	32-34	6/17/2014	D1-SB01-32.0-34.0-0614	**24 B**	**3800**	**190**	<0.0093 U,QL	<0.0093 U	<0.0093 U	**0.0353 J**
D1	D1-SB02	11-13	6/17/2014	D1-SB02-11.0-13.0-0614	**47 B**	**3900**	**150**	<0.011 U,QL	<0.011 U	<0.011 U	<0.022 U
D1	D1-SB03	6-8	6/18/2014	D1-SB03-6.0-8.0-0614	**--**	**2200**	**79**	**--**	**--**	**--**	**--**
D1	D1-SB03	8-10	6/18/2014	D1-SB03-8.0-10.0-0614	**--**	**720**	**52**	**--**	**--**	**--**	**--**
D1	D1-SB04	20.5-21	6/16/2014	D1-SB04-20.5-21.0-0614	**39 B**	**28000**	**1200**	**0.0048 QL**	**0.1**	**0.0055 J**	**0.29**
D1	D1-SB04	46-48	6/16/2014	D1-SB04-46.0-48.0-0614	**2.5 B**	**350**	**60**	<0.008 U,QL	<0.008 U	<0.008 U	<0.016 U
D1	D1-SB06	8-10	6/18/2014	D1-SB06-8.0-10.0-0614	**67 B,QH**	**3400**	**150**	<0.0098 U,QL	**0.013 J**	<0.0098 U	**0.0288 J**
D1	D1-SB06	12-14	6/18/2014	D1-SB06-12.0-14.0-0614	**4.7 NP**	**770**	**37 J**	<0.009 U,QL	<0.009 U	<0.009 U	<0.018 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					73	28000	1200	0.0075	0.2	0.0055	0.3298
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 8-3: AOC D1 PAH Soils Results

Site Name		D1	D1	D1	D1	D1	D1	D1
Boring, Well or Sample Location Number		04Y-DT1-02-SS	AP-200	AP-200	AP-201	AP-202	D1-SB01	D1-SB01
Sample Depth (feet)		0-0	5-7	30-32	45-47	10-12	5-7	32-34
Sample Date		8/5/2004	8/5/2004	8/5/2004	8/6/2004	8/7/2004	6/17/2014	6/17/2014
Sample Name		04Y-DT1-02-SS	04Y-DT1-04-SO	04Y-DT1-05-SO	04Y-DT1-09-SO	04Y-DT1-10-SO	D1-SB01-5.0-7.0-0614	D1-SB01-32.0-34.0-0614
GRO	(mg/kg)	<0.12 U	<1.1 U	<0.81 U	<0.21 U	<0.26 U	**73 B,QH**	**24 B**
DRO	(mg/kg)	**10**	**2900**	**7900**	**4.1**	**250**	**2100**	**3800**
RRO	(mg/kg)	--	--	--	--	--	**88**	**190**
Acenaphthene	(mg/kg)	<0.00022 U	<0.0022 U	<0.0021 U	<0.00021 U	<0.0021 U	**0.45**	<0.0026 U
Acenaphthylene	(mg/kg)	<0.00065 U	<0.0067 U	<0.0063 U	<0.00063 U	<0.0062 U	**0.14**	**0.026**
Anthracene	(mg/kg)	<0.00028 U	**0.13**	**0.16**	<0.00027 U	<0.0026 U	**0.16**	<0.0026 U
Benzo(a)anthracene	(mg/kg)	<0.00056 U	<0.0057 U	<0.0054 U	<0.00054 U	<0.0054 U	**0.0069**	<0.0026 U
Benzo(a)pyrene	(mg/kg)	<0.00096 U	<0.0099 U	<0.0093 U	<0.00093 U	<0.0092 U	<0.0026 U	<0.0026 U
Benzo(b)fluoranthene	(mg/kg)	<0.00036 U	<0.0037 U	<0.0035 U	<0.00035 U	<0.0035 U	**0.0029 J**	**0.0039 J**
Benzo(g,h,i)perylene	(mg/kg)	<0.0005 U	<0.0051 U	<0.0048 U	<0.00048 U	<0.0048 U	<0.0026 U	<0.0026 U
Benzo(k)fluoranthene	(mg/kg)	<0.00023 U	<0.0023 U	<0.0022 U	<0.00022 U	<0.0022 U	<0.0026 U	<0.0026 U
Chrysene	(mg/kg)	<0.00027 U	<0.0028 U	<0.0026 U	<0.00026 U	<0.0026 U	**0.031**	**0.024**
Dibenzo(a,h)anthracene	(mg/kg)	<0.00036 U	<0.0036 U	<0.0034 U	<0.00034 U	<0.0034 U	<0.0026 U	<0.0026 U
Fluorene	(mg/kg)	<0.00026 U	**1.4**	<0.0025 U	<0.00025 U	<0.0025 U	**0.98**	<0.0026 U
Fluoranthene	(mg/kg)	**0.0032**	**0.022**	<0.0062 U	<0.00062 U	<0.0061 U	**0.031**	<0.0026 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.00049 U	<0.0051 U	<0.0048 U	<0.00048 U	<0.0047 U	<0.0026 U	<0.0026 U
Naphthalene	(mg/kg)	<0.00033 U	**0.98**	**0.19**	<0.00032 U	<0.0031 U	**2.7**	**0.032**
Phenanthrene	(mg/kg)	<0.00031 U	**1.5**	**0.59**	**0.0024**	**0.024**	**4.2**	<0.0026 U
Pyrene	(mg/kg)	**0.0025**	**0.063**	**0.083**	<0.00037 U	<0.0037 U	**0.06**	**0.054**
2-Methylnaphthalene	(mg/kg)	<0.0055 U	**3.6**	**1**	<0.0054 U	<0.053 U	**11**	**0.13**
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	**4.7**	**0.18**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
PAH = polycyclic aromatic hydrocarbons

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 8-3: AOC D1 PAH Soils Results

Site Name		D1	D1	D1	D1	D1	D1	D1
Boring, Well or Sample Location Number		D1-SB01	D1-SB02	D1-SB03	D1-SB03	D1-SB04	D1-SB04	D1-SB04
Sample Depth (feet)		48-50	11-13	6-8	8-10	8-10	20.5-21	46-48
Sample Date		6/17/2014	6/17/2014	6/18/2014	6/18/2014	6/16/2014	6/16/2014	6/16/2014
Sample Name		D1-SB01-48.0-50.0-0614	D1-SB02-11.0-13.0-0614	D1-SB03-6.0-8.0-0614	D1-SB03-8.0-10.0-0614	D1-SB04-10.0-12.0-0614	D1-SB04-20.5-21.0-0614	D1-SB04-46.0-48.0-0614
GRO	(mg/kg)	**3.3 B**	**47 B**	--	--	**10 B**	**39 B**	**2.5 B**
DRO	(mg/kg)	**8.6 J**	**3900**	**2200**	**720**	**49**	**28000**	**350**
RRO	(mg/kg)	**21 J**	**150**	**79**	**52**	**36 J**	**1200**	**60**
Acenaphthene	(mg/kg)	<0.0027 U	**0.092**	**0.14**	**0.015**	<0.00069 U	**1.2**	<0.0026 U
Acenaphthylene	(mg/kg)	<0.0027 U	**0.091**	**0.065**	**0.0087**	<0.00069 U	**0.85**	<0.0026 U
Anthracene	(mg/kg)	<0.0027 U	**0.15**	**0.074**	<0.0026 U	<0.00069 U	**0.65**	<0.0026 U
Benzo(a)anthracene	(mg/kg)	<0.0027 U	**0.0067**	**0.0043 J**	<0.0026 U	<0.00069 U	**0.037 J**	<0.0026 U
Benzo(a)pyrene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0026 U	<0.00069 U	<0.057 U	<0.0026 U
Benzo(b)fluoranthene	(mg/kg)	<0.0027 U	**0.0034 J**	**0.0033 J**	<0.0026 U	<0.00069 U	<0.057 U	<0.0026 U
Benzo(g,h,i)perylene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0026 U	<0.00069 U	<0.057 U	<0.0026 U
Benzo(k)fluoranthene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0026 U	<0.00069 U	<0.057 U	<0.0026 U
Chrysene	(mg/kg)	<0.0027 U	**0.034**	**0.019**	<0.0026 U	<0.00069 U	**0.18**	<0.0026 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0026 U	<0.00069 U	<0.057 U	<0.0026 U
Fluorene	(mg/kg)	<0.0027 U	**0.36**	**0.55**	**0.062**	<0.00069 U	**6.6**	<0.0026 U
Fluoranthene	(mg/kg)	<0.0027 U	**0.021**	**0.043**	<0.0026 U	**0.0017 J**	**0.28**	**0.003 J**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0026 U	<0.00069 U	<0.057 U	<0.0026 U
Naphthalene	(mg/kg)	<0.0027 U	**0.17**	**0.53**	**0.015 B**	**0.0019**	**3.8**	<0.0026 U
Phenanthrene	(mg/kg)	<0.0027 U	**0.99**	**1.2**	**0.084**	**0.0039 J**	**9.9**	**0.0054**
Pyrene	(mg/kg)	<0.0027 U	**0.065**	**0.052**	**0.0037 J**	**0.002 J**	**0.41**	<0.0026 U
2-Methylnaphthalene	(mg/kg)	<0.0027 U	**2**	**2.5**	**0.13**	**0.01**	**22**	**0.0032 J**
1-Methylnaphthalene	(mg/kg)	<0.0027 U	**1.6**	**1.1**	**0.11**	**0.0029 J**	**13**	<0.0026 U

Table 8-3: AOC D1 PAH Soils Results

Site Name		D1	D1	D1	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		D1-SB05	D1-SB06	D1-SB06		
Sample Depth (feet)		8-10	8-10	12-14		
Sample Date		6/18/2014	6/18/2014	6/18/2014		
Sample Name		D1-SB05-10.0-12.0-0614	D1-SB06-8.0-10.0-0614	D1-SB06-12.0-14.0-0614		
GRO	(mg/kg)	**6.9**	**67 B,QH**	**4.7 NP**	73	**260 C**
DRO	(mg/kg)	**160 J**	**3400**	**770**	28000	**230 C**
RRO	(mg/kg)	**5 J**	**150**	**37 J**	1200	**230 H**
Acenaphthene	(mg/kg)	**0.032 J**	**0.53**	**0.12**	1.2	**180 F**
Acenaphthylene	(mg/kg)	**0.0037 J**	**0.24**	**0.034**	0.85	**180 F**
Anthracene	(mg/kg)	**0.01**	**0.23**	**0.049**	0.65	**1680 D**
Benzo(a)anthracene	(mg/kg)	<0.00075 U	<0.028 U	**0.0021 J**	0.037	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.00075 U	<0.028 U	<0.0026 U	0.057	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	**0.0017 J**	<0.028 U	**0.002 J**	0.0039	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.00075 U	<0.028 U	<0.0026 U	0.057	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.00075 U	<0.028 U	<0.0026 U	0.057	**4 D**
Chrysene	(mg/kg)	**0.0032 J**	**0.038 J**	**0.009**	0.18	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.00075 U	<0.028 U	<0.0026 U	0.057	**0.04 D**
Fluorene	(mg/kg)	**0.15 J**	**2.3**	**0.53**	6.6	**190 D**
Fluoranthene	(mg/kg)	**0.0018 J**	**0.094**	**0.011**	0.28	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.00075 U	<0.028 U	<0.0026 U	0.057	**0.4 D**
Naphthalene	(mg/kg)	**0.0047 B**	**0.3**	**0.075**	3.8	**2.1 E**
Phenanthrene	(mg/kg)	**0.12 J**	**3.4**	**0.88**	9.9	**1680 D**
Pyrene	(mg/kg)	**0.0023 J**	**0.074**	**0.025**	0.41	**110 D**
2-Methylnaphthalene	(mg/kg)	**0.029 J**	**7.7**	**1.5**	22	**6.1 F**
1-Methylnaphthalene	(mg/kg)	**0.043 J**	**3.1**	**0.58**	13	**6.2 F**

Table 8-4a: AOC D1 Non-Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D1	D1-SB01	48-50	6/17/2014	D1-SB01-48.0-50.0-0614	<0.0099 U,QL	<0.0099 U	<0.0099 U	<0.0198 U	<1.9 U	1.8703	<1.1 U	--	<1.9 U,QL	0.68 J,B	<1.9 U	<1.9 U	<1.9 U
D1	D1-SB04	8-10	6/16/2014	D1-SB04-10.0-12.0-0614	0.0037 QL	0.0067 J	0.0037 J	0.0126 J	15.1 J	15.0837	1.6 J,B	--	1.7 U,J	1.9 J,B	1.7 J	<1.5 U	1.7 U,J

Table 8-4b: AOC D Non-Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D1	D1-SB01	48-50	6/17/2014	D1-SB01-48.0-50.0-0614	--	--	0.18 J	<2.2 U	<2.2 U	<2.2 U	--	0.9 J	1.7 J	1.9 J	<2.2 U	4.58	4.5	9.08
D1	D1-SB04	8-10	6/16/2014	D1-SB04-10.0-12.0-0614	--	--	0.24 J	<1 U	5.6	4.6 J	--	1.2 J	8.2	29	11	6.84	38.4	45.24

Table 8-4c: AOC D1 Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D1	D1-SB01	32-34	6/17/2014	D1-SB01-32.0-34.0-0614	<0.0093 U,QL	<0.0093 U	<0.0093 U	0.0353 J	16 B	15.9554	48 B	--	<1.8 U	7.6 J,B	5 J	37	240
D1	D1-SB01	5-7	6/17/2014	D1-SB01-5.0-7.0-0614	0.0075 QL	<0.0098 U	0.2	0.3298	40 J,B	39.4702	110 J,B	--	<9.4 U	6.7 J,B	13 J	82	580
D1	D1-SB02	11-13	6/17/2014	D1-SB02-11.0-13.0-0614	<0.011 U,QL	<0.011 U	<0.011 U	<0.022 U	48 QH	47.967	140 QH	--	6.4 J,QH	6.4 J,QH	59 QH	57 QH	570 QH
D1	D1-SB04	20.5-21	6/16/2014	D1-SB04-20.5-21.0-0614	0.0048 QL	0.0055 J	0.1	0.29	20 J,B	19.61	56 J,B	--	5.8 J	4.2 J,B	10 J	20 J	320 J
D1	D1-SB04	46-48	6/16/2014	D1-SB04-46.0-48.0-0614	<0.008 U,QL	<0.008 U	<0.008 U	<0.016 U	4.8 J,B	4.776	2.1 J,B	--	<1.2 U	1.1 J,B	<1.2 U	<1.2 U	14 J,B
D1	D1-SB05	8-10	6/18/2014	D1-SB05-10.0-12.0-0614	<0.0099 U,QL	<0.0099 U	0.0058 J	0.0173 J	6.14	6.1169	1.9 J,B	--	0.54 J,QL	0.37 U,J	2.91 J	0.79 J	11 J,B
D1	D1-SB06	12-14	6/18/2014	D1-SB06-12.0-14.0-0614	<0.009 U,QL	<0.009 U	<0.009 U	<0.018 U	7.9 J,B	7.873	39 J,B	--	<1.7 U,QL	<1.7 U	5.2 J	29	190
D1	D1-SB06	8-10	6/18/2014	D1-SB06-8.0-10.0-0614	<0.0098 U,QL	<0.0098 U	0.013 J	0.0288 J	29 B	28.9582	120 B	--	<1.8 U,QL	2.5 J,B	29	48	450
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.009	0.009	0.045	0.095	21.480	21.341	64.625	#DIV/0!	3.580	3.821	15.664	34.374	296.88

Table 8-4d: AOC D1 Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D1	D1-SB01	32-34	6/17/2014	D1-SB01-32.0-34.0-0614	--	--	7.1	79	360	68	--	180	1400	1200 NP	260	446.1	2780	3226.1
D1	D1-SB01	5-7	6/17/2014	D1-SB01-5.0-7.0-0614	--	--	17	110	270	35	--	140	810	680	100	397	1630	2027
D1	D1-SB02	11-13	6/17/2014	D1-SB02-11.0-13.0-0614	--	--	14	84	290	48	--	250	1400	1200	220	388	2850	3238
D1	D1-SB04	20.5-21	6/16/2014	D1-SB04-20.5-21.0-0614	--	--	490	1700	3800	470	--	1300	5400	4300	550	5990	11000	16990
D1	D1-SB04	46-48	6/16/2014	D1-SB04-46.0-48.0-0614	--	--	0.24 J	<2.1 U	32	16	--	3.6 J	110	200	46	34.34	313.6	347.94
D1	D1-SB05	8-10	6/18/2014	D1-SB05-10.0-12.0-0614	--	--	0.6 J	3.2 J	8.1	1.8 J	--	4.6 J	21	18	3.1 J	11.9	43.6	55.5
D1	D1-SB06	12-14	6/18/2014	D1-SB06-12.0-14.0-0614	--	--	9.1	45	130	21	--	41	220	240	43	184.1	501	685.1
D1	D1-SB06	8-10	6/18/2014	D1-SB06-8.0-10.0-0614	--	--	69	310	740	140 ML	--	280	1400	1300	330	1119	2980	4099
average with fraction:							75.880	291.663	703.763	99.975		274.900	1345.125	1142.250	194.013			

Table 8-4e: AOC D1 Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.00866	0.00904	0.04451	0.09465	21.34084	75.88000	291.66250	703.76250	99.97500	3.58000	3.82125	15.66375	274.90000	1345.12500	1142.25000	194.01250	4172
Fraction of TPH mass in A&A EC groups	2.07628E-06	2.16616E-06	1.0669E-05	0.00002	0.00512	0.01819	0.06991	0.16868	0.02396	0.00086	0.00092	0.00375	0.06589	0.32241	0.27378	0.04650	1.00
GRO, DRO & RRO A&A Groups	**GRO aromatics**					**DRO aromatics**			**RRO aromatics**	**GRO aliphatics**			**DRO aliphatics**			**RRO aliphatics**	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.005153					0.256777			0.023963	0.005528			0.662078			0.046502	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.000403	0.000420	0.002071	0.004403	0.992703	0.070830	0.272250	0.656921	1.000000	0.155214	0.165673	0.679113	0.099519	0.486963	0.413518	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	1.07%	GRO % aromatics	0.482414665
% of TPH that is DRO=	91.89%	GRO % aliphatics	0.517585335
% of TPH that is RRO=	7.05%	DRO % aromatics	0.279452887
		DRO % aliphatics	0.720547113
		RRO % aromatics	0.340065479
		RRO % aliphatics	0.659934521

Table 8-4f: AOC D1 HRC Input

input to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.482414665
DRO: fraction aromatic	0.279452887
RRO: fraction aromatic	0.340065479

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.070829502
Aromatic C12-C16	0.272249733
Aromatic C16-C21	0.656920765

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.155214
Aliphatic C6-C8	0.165673
Aliphatic C8-C10	0.679113
Aliphatic C10-C12	0.099519
Aliphatic C12-C16	0.486963
Aliphatic C16-C21	0.413518

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons

GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Table 8-5: AOC D1 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
D1	AP-200	NA	8/22/2004	04Y-DT1-15-GW	<0.003 U	**0.37**	--	<0.00015 U	<0.00018 U	<0.00024 U	--
D1	AP-201	NA	8/22/2004	04Y-DT1-16-GW	**0.0081 J**	**0.12**	--	<0.00015 U	<0.00018 U	<0.00024 U	--
D1	AP-201	NA	6/21/2014	AP-201-WG01-0614	<0.044 U	**0.44**	**0.099 J**	<0.0004 U,QL	<0.0004 U,QL	<0.0004 U,QL	<0.0008 U,QL
D1	AP-202	NA	8/22/2004	04Y-DT1-19-GW	<0.003 U	**0.18**	--	<0.00015 U	<0.00018 U	<0.00024 U	--
D1	AP-202	NA	6/23/2014	AP-202-WG01-0614	<0.044 U	**1 QL**	**0.1**	<0.0004 U,QL	<0.0004 U,QL	<0.0004 U,QL	<0.0008 U,QL
D1	D1SD004	NA	9/29/2001	01D1SD004WS	<0.025 U	--	--	<0.000065 U	<0.0000766 U	**0.0000749 J**	<0.0002413 U
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0.044	1	0.1	0.0004	0.0004	0.0004	0.0008
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:
Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
BTEX= benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

Table 8-6: AOC D1 PAH Groundwater Results

	Site Name	D1	D1	D1	D1	D1	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
	Boring, Well or Sample Location Number	AP-200	AP-201	AP-201	AP-202	AP-202		
	Sample Depth	NA	NA	NA	NA	NA		
	Sample Date	8/22/2004	8/22/2004	6/21/2014	8/22/2004	6/23/2014		
	Sample Name	04Y-DT1-15-GW	04Y-DT1-16-GW	AP-201-WG01-0614	04Y-DT1-19-GW	AP-202-WG01-0614		
GRO	(mg/L)	<0.003 U	**0.0081 J**	<0.044 U	<0.003 U	<0.044 U	0.044	**2.2 H**
DRO	(mg/L)	**0.37**	**0.12**	**0.44**	**0.18**	**1 QL**	1	**1.5 H**
RRO	(mg/L)	**--**	**--**	**0.099 J**	**--**	**0.1**	0.1	**1.1 H**
Acenaphthene	(mg/L)	<0.000013 U	<0.000013 U	**0.000011 J**	<0.000013 U	**0.000022 ML**	0.000022	**0.22 H**
Acenaphthylene	(mg/L)	<0.000011 U	<0.000011 U	<0.000015 U	<0.000011 U	**0.0000072 B**	0.0000072	**0.22 H**
Anthracene	(mg/L)	<0.000013 U	<0.000013 U	**0.0000092 B**	<0.000013 U	<0.000015 U	0.0000092	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.000023 U	<0.000023 U	<0.000015 U	<0.000023 U	<0.000015 U	0.000015	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.000013 U	<0.000013 U	<0.000015 U	<0.000013 U	<0.000015 U	0.000015	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.000029 U	<0.000029 U	<0.000015 U	<0.000029 U	<0.000015 U	0.000015	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.000015 U	<0.000015 U	<0.000015 U	<0.000015 U	<0.000015 U,ML	0.000015	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.000018 U	<0.000018 U	<0.000015 U	<0.000018 U	<0.000015 U,ML	0.000015	**0.0012 H**
Chrysene	(mg/L)	<0.000011 U	<0.000011 U	<0.000015 U	<0.000011 U	<0.000015 U,ML	0.000015	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.000019 U	<0.000019 U	<0.000015 U	<0.000019 U	<0.000015 U,ML	0.000015	**0.000012 H**
Fluorene	(mg/L)	<0.000014 U	<0.000014 U	**0.0000069 J**	<0.000014 U	<0.000015 U,ML	0.0000069	**0.15 H**
Fluoranthene	(mg/L)	<0.000027 U	<0.000027 U	<0.000015 U	<0.000027 U	<0.000015 U	0.000015	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.000015 U	<0.000015 U	<0.000015 U	<0.000015 U	<0.000015 U,ML	0.000015	**0.00012 H**
Naphthalene	(mg/L)	<0.000035 U	<0.000035 U	**0.000028 B**	<0.000035 U	**0.00023 ML**	0.00023	**0.073 H**
Phenanthrene	(mg/L)	<0.000035 U	<0.000035 U	<0.000015 U	<0.000035 U	<0.000015 U,ML	0.000015	**1.1 H**
Pyrene	(mg/L)	<0.000031 U	<0.000031 U	<0.000015 U	<0.000031 U	**0.000013 ML**	0.000013	**0.11 H**
2-Methylnaphthalene	(mg/L)	<0.000014 U	<0.000014 U	<0.000015 U	<0.000014 U	<0.000015 U,ML	0.000015	**0.015 H**
1-Methylnaphthalene	(mg/L)	**--**	**--**	**0.0000084 J**	**--**	**0.000066 ML**	0.000066	**0.015 H**

Notes:
Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for PAHs

Table 8-7: AOC D1 All VPH & EPH Groundwater Results

Site Name		D1	maximum value
Boring or Well Number		AP-202	
Sample Depth		NA	
Sample Date		6/23/2014	
Sample Name		AP-202-WG01-0614	
C8-C10 Aromatics V	(mg/L)	<0.006 U,QL	
C10-C12 Aromatics V	(mg/L)	<0.0039 U,QL	
C12-C13 Aromatics V	(mg/L)	--	
C5-C6 Aliphatics V	(mg/L)	<0.006 U,QL	
C6-C8 Aliphatics V	(mg/L)	**0.0034 J,QL**	
C8-C10 Aliphatics V	(mg/L)	**0.0085 J,QL**	
C10-C12 Aliphatics V	(mg/L)	**0.0082 J,QL**	
Total VPH V	(mg/L)	**0.086 J,QL**	
C8-C10 Aromatics	(mg/L)	--	
C10-C12 Aromatics	(mg/L)	**0.0048 QL**	
C12-C16 Aromatics	(mg/L)	**0.021 J**	
C16-C21 Aromatics	(mg/L)	**0.039 J**	
C21-C34 Aromatics	(mg/L)	**0.017 J**	
C8-C10 Aliphatics	(mg/L)	--	
C10-C12 Aliphatics	(mg/L)	**0.0056 QL**	
C12-C16 Aliphatics	(mg/L)	**0.014 ML**	
C16-C21 Aliphatics	(mg/L)	**0.034 J**	
C21-C34 Aliphatics	(mg/L)	**0.022**	
GRO Aromatics (C5 to C10 aro)	(mg/L)	0.006	0.006
GRO Aliphatics (C5 to C10 ali)	(mg/L)	0.0179	0.0179
DRO Aromatics (C10 to C21)	(mg/L)	0.0648	0.0648
DRO Aliphatics (C10 to C21)	(mg/L)	0.0536	0.0536
RRO Aromatics (C21 to C34 aro)	(mg/L)	0.017	0.017
RRO Aliphatics (C21 to C34 ali)	(mg/L)	0.022	0.022
GRO (sum of C5 to C10 A&A)	(mg/L)	0.0239	0.0239
DRO (sum of C10 to C21 A&A)	(mg/L)	0.1184	0.1184
RRO (sum of C21 to C35 A&A)	(mg/L)	0.039	0.039
GRO (AK101)	(mg/L)	0.044	
DRO (AK102)	(mg/L)	**1**	
RRO (AK103)	(mg/L)	**0.1**	

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/L = milligrams per liter
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
V = defines VPH results versus EPH results
Result = detected results for VPH, EPH, GRO, DRO and RRO bolded

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Table 8-8: AOC D1 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

D1 ProUCL Input File

GRO	d_GRO	DRO	d_DRO	RRO	d_RRO	Benzene	d_Benzene	Toluene	d_Toluene	Ethylbenzene	d_Ethylbenzene	Xylene	d_Xylene
0.81	0	7900	1	190	1	0.0093	0	0.0093	0	0.0093	0	0.0353	1
1.1	0	2900	1	88	1	0.0075	1	0.0098	0	0.2	1	0.3298	1
1.1	0	4200	1	150	1	0.011	0	0.011	0	0.011	0	0.022	0
0.96	0	520	1	79	1	0.0048	1	0.0055	1	0.1	1	0.29	1
0.26	0	250	1	52	1	0.008	0	0.008	0	0.008	0	0.016	0
1.8	1	7300	1	1200	1	0.009	0	0.009	0	0.009	0	0.018	0
24	1	3800	1	60	1	0.0098	0	0.0098	0	0.013	1	0.0288	1
73	1	2100	1	37	1								
47	1	3900	1	150	1								
39	1	2200	1										
2.5	1	720	1										
4.7	1	28000	1										
67	1	350	1										
		770	1										
		3400	1										

D1 ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

Benzene	0.0075	maximum detected conc
Toluene	0.0055	maximum detected conc
Ethylbenzene	0.2	maximum detected conc
Xylene	0.3298	maximum detected conc
GRO	34.24	95%UCL
DRO	8306	95%UCL
RRO	760.6	95%UCL

GRO

General Statistics

Number of Valid Data	13	Number of Detected Data	8
Number of Distinct Detected Data	8	Number of Non-Detect Data	5
		Percent Non-Detects	38.46%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	1.8	Minimum Detected	0.588
Maximum Detected	73	Maximum Detected	4.29
Mean of Detected	32.38	Mean of Detected	2.78
SD of Detected	28.71	SD of Detected	1.521
Minimum Non-Detect	0.26	Minimum Non-Detect	-1.347
Maximum Non-Detect	1.1	Maximum Non-Detect	0.0953
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	8
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	38.46%

Warning: There are only 8 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.891	Shapiro Wilk Test Statistic	0.85
5% Shapiro Wilk Critical Value	0.818	5% Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	20.09	Mean	1.336
SD	27.25	SD	2.256
95% DL/2 (t) UCL	33.56	95% H-Stat (DL/2) UCL	1590
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	9.916	Mean in Log Scale	1.359
SD	37.73	SD in Log Scale	2.217
95% MLE (t) UCL	28.57	Mean in Original Scale	20.09
95% MLE (Tiku) UCL	30.67	SD in Original Scale	27.25
		95% t UCL	33.56
		95% Percentile Bootstrap UCL	32.74
		95% BCA Bootstrap UCL	33.99
		95% H UCL	1331
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.611	Data appear Normal at 5% Significance Level	
Theta Star	52.96		
nu star	9.781		
A-D Test Statistic	0.501	**Nonparametric Statistics**	
5% A-D Critical Value	0.741	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.741	Mean	20.62
5% K-S Critical Value	0.303	SD	25.79
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	7.647
		95% KM (t) UCL	34.24
Assuming Gamma Distribution		95% KM (z) UCL	33.19
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	33.72
Minimum	0.000001	95% KM (bootstrap t) UCL	37.47
Maximum	73	95% KM (BCA) UCL	36.23
Mean	19.92	95% KM (Percentile Bootstrap) UCL	34.85
Median	2.5	95% KM (Chebyshev) UCL	53.95
SD	27.38	97.5% KM (Chebyshev) UCL	68.37
k star	0.144	99% KM (Chebyshev) UCL	96.7
Theta star	138.6		
Nu star	3.738	Potential UCLs to Use	
AppChi2	0.621	95% KM (t) UCL	34.24
95% Gamma Approximate UCL	119.9	95% KM (Percentile Bootstrap) UCL	34.85
95% Adjusted Gamma UCL	158.8		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Table 8-8: AOC D1 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

DRO

General Statistics			
Number of Valid Observations	15	Number of Distinct Observations	15
Raw Statistics		**Log-transformed Statistics**	
Minimum	250	Minimum of Log Data	5.521
Maximum	28000	Maximum of Log Data	10.24
Mean	4554	Mean of log Data	7.685
Median	2900	SD of log Data	1.293
SD	6901		
Std. Error of Mean	1782		
Coefficient of Variation	1.515		
Skewness	3.156		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.586	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	7692	95% H-UCL	15349
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	12089
95% Adjusted-CLT UCL (Chen-1995)	9036	97.5% Chebyshev (MVUE) UCL	15336
95% Modified-t UCL (Johnson-1978)	7934	99% Chebyshev (MVUE) UCL	21714
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.687	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	6631		
MLE of Mean	4554		
MLE of Standard Deviation	5495		
nu star	20.6		
Approximate Chi Square Value (.05)	11.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	7485
Adjusted Chi Square Value	10.46	95% Jackknife UCL	7692
		95% Standard Bootstrap UCL	7372
Anderson-Darling Test Statistic	0.468	95% Bootstrap-t UCL	12699
Anderson-Darling 5% Critical Value	0.773	95% Hall's Bootstrap UCL	18601
Kolmogorov-Smirnov Test Statistic	0.179	95% Percentile Bootstrap UCL	7717
Kolmogorov-Smirnov 5% Critical Value	0.23	95% BCA Bootstrap UCL	9593
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	12321
		97.5% Chebyshev(Mean, Sd) UCL	15681
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	22282
95% Approximate Gamma UCL	8306		
95% Adjusted Gamma UCL	8974		
Potential UCL to Use		Use 95% Approximate Gamma UCL	8306

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

RRO

General Statistics			
Number of Valid Observations	9	Number of Distinct Observations	8
Raw Statistics		**Log-transformed Statistics**	
Minimum	37	Minimum of Log Data	3.611
Maximum	1200	Maximum of Log Data	7.09
Mean	222.9	Mean of log Data	4.762
Median	88	SD of log Data	1.027
SD	370.1		
Std. Error of Mean	123.4		
Coefficient of Variation	1.66		
Skewness	2.888		

Warning: There are only 9 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.519	Shapiro Wilk Test Statistic	0.87
Shapiro Wilk Critical Value	0.829	Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	452.3	95% H-UCL	657.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	467
95% Adjusted-CLT UCL (Chen-1995)	552.7	97.5% Chebyshev (MVUE) UCL	589.8
95% Modified-t UCL (Johnson-1978)	472.1	99% Chebyshev (MVUE) UCL	830.9
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.678	Data appear Lognormal at 5% Significance Level	
Theta Star	328.5		
MLE of Mean	222.9		
MLE of Standard Deviation	270.6		
nu star	12.21		
Approximate Chi Square Value (.05)	5.367	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0231	95% CLT UCL	425.8
Adjusted Chi Square Value	4.449	95% Jackknife UCL	452.3
		95% Standard Bootstrap UCL	412.9
Anderson-Darling Test Statistic	1.039	95% Bootstrap-t UCL	1429
Anderson-Darling 5% Critical Value	0.746	95% Hall's Bootstrap UCL	1312
Kolmogorov-Smirnov Test Statistic	0.306	95% Percentile Bootstrap UCL	460.6
Kolmogorov-Smirnov 5% Critical Value	0.288	95% BCA Bootstrap UCL	585.1
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	760.6
		97.5% Chebyshev(Mean, Sd) UCL	993.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1450
95% Approximate Gamma UCL	507.2		
95% Adjusted Gamma UCL	611.9		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	760.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Table 8-9: AOC D1 Outlier Test Results

Outlier Tests for Selected Variables

From File	WorkSheet.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers with Rosner test	1

Dixon's Outlier Test for DRO D1

Number of data = 15
10% critical value: 0.472
5% critical value: 0.525
1% critical value: 0.616

1. Data Value 28000 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.753

For 10% significance level, 28000 is an outlier.
For 5% significance level, 28000 is an outlier.
For 1% significance level, 28000 is an outlier.

2. Data Value 250 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.038

For 10% significance level, 250 is not an outlier.
For 5% significance level, 250 is not an outlier.
For 1% significance level, 250 is not an outlier.

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Table 8-10a: AOC D1 HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	maximum detected conc	max LOD in 2014	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	maximum detected conc	max LOD in 2014	
Ethylbenzene (c & nc)	maximum detected conc	max LOD in 2014	
Xylenes (total) (nc)	maximum detected conc	max LOD in 2014	
GRO	95%UCL	max LOD in 2014	
DRO	95%UCL	max measured conc in 2014	
RRO	95%UCL	max measured conc in 2014	
GRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
DRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
RRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
GRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
DRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
RRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
Acenaphthene (nc)	max measured conc	max measured conc in 2014	
Acenaphthylene (nc)	max measured conc	max measured conc in 2014	
Anthracene (nc)	max measured conc	max measured conc in 2014	
Benzo(g,h,i)perylene (nc)	max LOD in 2014	max LOD in 2014	
Fluoranthene (nc)	max measured conc	max LOD in 2014	
Fluorene (nc)	max measured conc	max measured conc in 2014	
Naphthalene (c & nc)	max measured conc	max measured conc in 2014	
Phenanthrene (nc)	max measured conc	max LOD in 2014	
Pyrene (nc)	max measured conc	max detection limit in 2014	
Benzo(a)anthracene (c)	max measured conc	modeled based on soil data	
Benzo(b)fluoranthene (c)	max measured conc	modeled based on soil data	
Benzo(k)fluoranthene (c)	max LOD in 2014	modeled based on soil data	
Benzo(a)pyrene (c)	max LOD in 2014	modeled based on soil data	
Chrysene (c)	max measured conc	modeled based on soil data	
Dibenz(a,h)anthracene (c)	max LOD in 2014	modeled based on soil data	
Indeno(1,2,3-cd)pyrene (c)	max LOD in 2014	modeled based on soil data	
1-Methylnaphthalene (nc)	max measured conc	max measured conc in 2014	
2-Methylnaphthalene (nc)	max measured conc	max LOD in 2014	

Hydrocarbon Characterization Data	
Hydrocarbon Fractions	**Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)**
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_5-C_6	Site specific EPH & VPH data
Aliphatic C_6-C_8	Site specific EPH & VPH data
Aliphatic C_8-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:
BTEX = benzene, toluene, ethylbenzene, xylene
(c) = carcinogen
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
(nc) = non-carcinogen
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Table 8-10b: AOC D1 HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	**Input Values**	**Source of Data**
bulk density (lbs/ft^3)	125.0538462	Site D1 average value
specific gravity	2.824666667	Site D1 average value
moisture content (% by weight)	8.6625	Site D1 average value
foc	0.005826667	D sites average Value
Soil temp (C)	5.3	Site C6 average groundwater temperature
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt	Site D1 average value
Hydrogeologic Conditions		
Source length (ft)	315	scaled from site maps
Average precipitation (in/yr)	143.44	NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	6.31E-06	Site D1 average value
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8	estimated thickness of the aquifer based on the 2014 boring logs
Infiltration rate (m/yr)	0.7286752	20% of average precipitation
Hydraulic gradient	0.0085	Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1	Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters		
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3	NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth		
depth to groundwater at seasonal low water level at downgradient end of source (ft)	48	Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	6	Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	48	Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	5	Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time		
Soil Direct Contact	1	Site specific conceptual site model
Outdoor Air	1	Site specific conceptual site model
Indoor Air	0	Site specific conceptual site model
Groundwater Ingestion	0	Site specific conceptual site model
Other Input		
ADEC Hazard ID	0	ADEC CS database
Latitude	0	ADEC CS database
Longitude	0	ADEC CS database
Width of Source (ft)	66	scaled from site maps
Area of NAPL contaminated soil source (ft^2)	20790	scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.0085	Measured slope of water table

Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	125.05	125.05	125.05	Site D1 average value
specific gravity of solids	2.824667	2.824667	2.824667	Site D1 average value
moisture content (% by weight)	8.66	8.66	8.66	Site D1 average value
foc	0.005827	0.005827	0.005827	D sites average Value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	1	1	3	Site Specific (depth to source minus foundation depth-- distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	6.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 8-11: AOC D1 Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	1.03644E-06	0.1036	0.0144
Outdoor air inhalation	4.92048E-11	0.0000	0.0000
Indoor air inhalation (vapor intrusion)	3.62348E-09	0.0004	0.0001
Groundwater Ingestion	1.69433E-07	0.0169	0.0029
Cumulative Risk	**1E-06**	**0.1**	**0.0**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	3.11559E-06	0.3116	0.1624
Outdoor air inhalation	2.13448E-10	0.0000	0.0000
Indoor air inhalation (vapor intrusion)	1.52186E-08	0.0015	0.0002
Groundwater Ingestion	2.84647E-07	0.0285	0.0040
Cumulative Risk	**3E-06**	**0.3**	**0.20**

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 8-12: AOC D1 Summary of Bulk Fuel Hydrocarbon Risk

	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Fraction of Risk Values				
			Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor intrusion)	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	16	0.005	<1	<1	<1	<1	<1
DRO Aromatics	2321	0.065	<1	<1	<1	<1	<1
RRO Aromatics	259	0.017	<1	No RfC	No Rfc	<1	<1
GRO Aliphatics	18	0.015	<1	<1	<1	<1	<1
DRO Aliphatics	5985	0.054	<1	<1	<1	<1	<1
RRO Aliphatics	502	0.022	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	16	0.005	<1	<1	<1	<1	<1
DRO Aromatics	2321	0.065	<1	<1	<1	<1	<1
RRO Aromatics	259	0.017	<1	No Rfc	No Rfc	<1	<1
GRO Aliphatics	18	0.015	<1	<1	<1	<1	<1
DRO Aliphatics	5985	0.054	<1	<1	<1	<1	<1
RRO Aliphatics	502	0.022	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics

GRO = gasoline-range organics

mg/kg = milligrams per kilogram

mg/L = milligram(s) per liter

No RfC = no reference concentration available; risk standard is assumed to be met due to low volatility of the fraction

RRO = residual-range organics

Table 8-13: AOC D1 Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
Benzene (c & nc)	0.04	0.025	MTGW	0.021	MTGW	0.01	NA	0.049	MTGW
1-Methylnaphthalene (nc)	13	6.2	MTGW	10	MTGW	13	NA	116	MTGW
2-Methylnaphthalene (nc)	22	6.1	MTGW	10	MTGW	22	NA	96	MTGW
total DRO	28000[a]	230	MTGW	1200	MTGW	8306	12500	11513	Soil Direct Contact

Notes:

[a] = Exceeds the ADEC maximum allowable concentration under Method Two, Table B2.

ACL = alternate cleanup level

(c) = carcinogen

HRC = hydrocarbon risk calculator

mg/kg = milligrams per kilogram

MTGW = migration to groundwater

NA = not applicable

(nc) = non-carcinogen

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9.0 AOC D2 – ARMY DOCK AREA – FORMER 500 BBL TANK – NO. 835

9.1 AREA DESCRIPTION AND BACKGROUND

AOC D2 is the site of former Tank No. 835 (AST2) within the historical Army Dock area tank farm. The tank farm served as the primary fuel off-loading and storage site for World War II military activities in Yakutat. Eight ASTs (ASTs 1–8) with tank capacities ranging from 20,000 to 80,000 gal and associated piping were used to store and transfer diesel fuel from the dock at Monti Bay. Former AST2 was located at the northwest portion of AOC D, near former AST1 and an existing 2-story office/warehouse building (Malaspina building). The AST and associated piping at this location have been removed, and there was no evidence of the former tank pad present. Miscellaneous metal debris piles (steel tank bands and pipe stands) are present in the vegetation at the edge of the access road near the former location of AST2.

Analytical data collected from the site during previous RIs indicate that DRO was present in surface soils, with one location showing a concentration at the Method Two cleanup level of 230 mg/kg and another exceeding the cleanup level with a concentration of 5,800 mg/kg (S&W 2006a). ROST/LIF samples collected northwest of the AST2 footprint indicated potential fuel contamination in the vadose zone between 1.6 and 34.6 feet bgs; however, the maximum LIF response values were low, ranging from 1.45 to 2.55 %RE (USACE 2006). Subsurface soil and groundwater samples collected from three in-source soil borings/groundwater monitoring wells did not contain POLs above the ADEC Method Two cleanup levels (S&W 2006a).

Data collected during the previous investigations were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at AOC D2. These data, along with field screening results and visual observations, were reviewed to select appropriate sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations are shown on Figure 8-1.

9.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC D2 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source area and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Evaluate current groundwater conditions.

9.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC D2 included advancement of soil borings, collection of soil and groundwater samples, and aquifer (slug) testing. These activities are described below by media.

9.3.1 Soil

Soil contamination at AOC D2 appears to be limited to isolated surface soil locations. The Supplemental RI included advancing five soil borings at these isolated areas to evaluate current soil conditions; two borings (D2-SB02 and SB05) at former surface sample locations with historical DRO contamination and three borings (D2-SB01, SB03 and SB04) at ROST/LIF locations with low responses indicating a potential fuel signature (Figure 8-1). Boring depths ranged from 4 to 23 feet bgs. Subsurface soils at the site consist primarily of fine to coarse and fine to medium sands and gravel, with occasional layers of fine silty sand at the surface. Soil boring logs are included in Appendix C.

Field screening samples were collected from above and below the target depth intervals and screened for volatile organics using a PID. Soil samples collected for laboratory analysis were selected from the target depth(s) or adjusted to the most likely contaminated depth based on field observations (e.g., PID, visual, and olfactory). Two soil samples were collected from boring D2-SB01, and one sample was collected from each of the remaining borings (D2-SB02 through SB05). All samples were analyzed for GRO, DRO, RRO, BTEX and PAHs, and samples from shallow soil at D2-SB02 and SB05 were also analyzed for VPH and EPH. Samples from borings D2-SB01, SB03 and SB04 were not selected for VPH/EPH analysis because fuel contamination was not anticipated in these borings based on minimal LIF response.

BACKGROUND SOIL CONDITIONS

Soil samples collected outside the AOC D NAPL source areas were analyzed to assess the geophysical properties (e.g., grain size, bulk density, moisture content, and specific gravity) and the naturally occurring organic carbon content of soils at the site. Refer to Section 8.3.1 for a discussion on background sampling activities at AOC D.

9.3.2 Groundwater

Groundwater assessment at the site included sampling of existing monitoring wells AP-203 and AP-205. The scope of work included collecting groundwater at AP-204; however, this well was located at the edge of the access road in a heavily vegetated area with metal debris piles, and after several attempts, could not be located. Groundwater samples were collected using a bladder pump with dedicated bladders and analyzed for GRO, DRO, RRO, BTEX, and PAHs. Well locations are shown on Figure 8-1 and Low Flow Groundwater Sample Collection Records are included in Appendix D.

AQUIFER TESTING

Subsequent to sampling, slug tests were performed at monitoring wells AP-203 and AP-205 to obtain hydraulic conductivity values for input into the HRC. Due to the small diameter of the AP-designated wells (1-inch ID), a water slug was used to displace the water column instead of a solid slug. Slug tests were performed and evaluated following the procedures outlined in Section 3.4.5. Slug test data are included in Appendix E and results are discussed in Section 9.4 below.

Aquifer tests were proposed for well AP-204; however, as stated above, this well could not be located.

9.4 GROUNDWATER CONDITIONS

As discussed in Section 8.4, groundwater contours were developed for the AOC D area and show an overall groundwater flow direction to the northwest, with an apparent localized cone of depression in the vicinity of City of Yakutat water supply wells ARCO #1 and/or ARCO #2. Horizontal gradients across AOC D were averaged with a resulting gradient estimated at 0.0085 ft/ft.

Since limited data were available, hydraulic conductivity values calculated for the four wells at AOC D2, AOC D3 and AOC D4 were averaged based on site proximity. An overall hydraulic conductivity of 0.184 ft/day was calculated for the site (Table 4-4).

9.5 ANALYTICAL RESULTS

9.5.1 Soil

A total of six soil samples were collected from five soil borings at the site and submitted for laboratory analyses. Three of the borings were advanced at ROST/LIF locations with potential fuel signatures; however, LIF responses were low, with a maximum response of only 2.55 %RE. Analytical results (Appendix J) confirmed that hydrocarbon contamination is not present above Method Two cleanup levels in the targeted soils. Soil samples collected to evaluate current conditions at two locations with historical surface soil impacts indicated that constituent concentrations in surface soil do not exceed Method Two cleanup levels. Based on current soil data, hydrocarbon impacts do not appear to be present in AOC D2 soil at concentrations above the Method Two cleanup levels. Historical and recent (2014) POL soil data evaluated for AOC D2 are presented in Table 9-1 and PAH soil data are presented in Table 9-2.

9.5.2 Groundwater

Groundwater assessment at the site included sampling existing monitoring wells AP-203 and AP-205. Analytical results indicate that constituent concentrations detected in groundwater did not exceed the Table C groundwater cleanup levels. Based on current groundwater quality conditions (Appendix J), groundwater at the site does not appear to be impacted by former operations. Historical and recent (2014) groundwater results for POLs and PAHs are summarized in Table 9-3 and Table 9-4, respectively.

9.6 RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are not currently present at AOC D2; therefore, evaluation of risk to human health and/or the environment (ecological) were not required for this site.

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Table 9-1: AOC D2 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D2	04Y-DT2-01-SS	0-0	8/6/2004	04Y-DT2-01-SS	**5.6 J**	**5800**	--	**0.026 J**	**0.018 J**	**0.025 J**	--
D2	04Y-DT2-02-SS	0-0	8/6/2004	04Y-DT2-02-SS	**0.24 J**	**230**	--	<0.0009 U	**0.0017 J**	**0.0056 J**	--
D2	04Y-DT2-03-SS	0-0	8/6/2004	04Y-DT2-03-SS	<0.19 U	**2.6 J**	--	**0.0014 J**	<0.0006 U	**0.0055 J**	--
D2	AP-203	10-12	8/10/2004	04Y-DT2-04-SO	<0.2 U	**1.3 J**	--	**0.0014**	<0.0007 U	<0.0009 U	--
D2	AP-203	25-27	8/10/2004	04Y-DT2-05-SO	<0.21 U	**6.4**	--	<0.0008 U	<0.0007 U	**0.0061 J**	--
D2	AP-203	45-47	8/10/2004	04Y-DT2-06-SO	<0.19 U	**2 J**	--	**0.0023 J**	<0.0006 U	**0.0059 J**	--
D2	AP-204	10-12	8/10/2004	04Y-DT2-07-SS	<0.18 U	**4.3**	--	**0.0015 J**	<0.0006 U	**0.0029 J**	--
D2	AP-204	30-32	8/11/2004	04Y-DT2-08-SO	<0.2 U	**1.8 J**	--	**0.0028 J**	**0.0027 J**	**0.0035 J**	--
D2	AP-204	55-57	8/11/2004	04Y-DT2-09-SO	<0.13 U	**2.2 J**	--	<0.0005 U	<0.0004 U	**0.0044**	--
D2	AP-205	5-7	8/12/2004	04Y-DT2-10-SO	<0.18 U	**2 J**	--	**0.0036 J**	<0.0006 U	**0.004 J**	--
D2	AP-205	25-27	8/12/2004	04Y-DT2-11-SO	<0.19 U	**2.1 J**	--	**0.0027 J**	<0.0007 U	**0.005 J**	--
D2	AP-205	50-52	8/12/2004	04Y-DT2-14-SO	<0.19 U	**1.4 J**	--	**0.0019 J**	**0.0023 J**	**0.0041 J**	--
D2	D1SS003	0-0	9/28/2001	01D1SS003SO	<0.978 U	<22.2 U	<23.8 U	<0.0078 U	<0.0078 U	<0.0078 U	<0.0234 U
D2	D1SS004	0-0	9/28/2001	01D1SS004SO	<0.784 U	**65.6 B**	**55.3**	<0.00579 U	<0.00579 U	<0.00579 U	<0.01739 U
D2	D2-BG05	12-14	6/22/2014	D2-BG05-12.0-14.0-0614	**2.7 B**	**2.8 J**	<26 U	--	--	--	--
D2	D2-BG05	26-28	6/22/2014	D2-BG05-26.0-28.0-0614	**1.8 B**	**3.2 J**	<26 U	--	--	--	--
D2	D2-SB01	8-10	6/15/2014	D2-SB01-8.0-10.0-0614	**1.2 B**	**8.2 J**	**17 QN**	<0.0048 U	<0.0048 U	**0.0025 J**	<0.0096 U
D2	D2-SB01	17-19	6/15/2014	D2-SB01-17.0-19.0-0614	<2.4 U	**8.7 J**	**18 QN**	<0.0097 U	<0.0097 U	<0.0097 U	<0.0194 U
D2	D2-SB02	0-2	6/16/2014	D2-SB02-0.0-2.0-0614	**14 B**	**7.2 ML**	**27 J**	<0.006 U	<0.006 U	**0.0024 J**	**0.0104 J**
D2	D2-SB03	3-5	6/16/2014	D2-SB03-3.0-5.0-0614	**34 B**	**140**	**54**	<0.0057 U	<0.0057 U	**0.0026 J**	**0.0098 J**
D2	D2-SB04	6-8	6/15/2014	D2-SB04-6.0-8.0-0614	<1.7 U	**7.4 J**	**16 QN**	**0.0033 J**	<0.007 U	**0.0024 J**	<0.014 U
D2	D2-SB05	2-4	6/16/2014	D2-SB05-2.0-4.0-0614	**10 B**	**10 J**	**24 J**	<0.006 U	<0.006 U	<0.006 U	<0.012 U
D2	D2SS005	0-0	9/25/2001	01D2SS005SO	<0.999 U	--	--	<0.202 U	<0.202 U	<0.202 U	<0.607 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					34	5800	55.3	0.026	0.018	0.025	0.0104
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:

Bold = detected analyte

Shading = result above screening criteria.

Yellow = NAPL-contaminated soil source area.

-- = not analyzed

BTEX = benzene, toluene, ethylbenzene & xylenes

DRO = diesel-range organics

GRO = gasoline-range organics

HRC = hydrocarbon risk calculator

mg/kg = milligrams per kilogram

NA = not applicable

RRO = residual-range organics

Data qualifiers:

B = analyte detected in blank

J = estimated value

JB = estimated value & analyte detected in blank

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level sources:

A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion

B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation

C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater

D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact

E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation

F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater

H = Source delineation criteria not related to ADEC regulatory levels

Table 9-2: AOC D2 PAH Soils Results

Site Name		D2	D2	D2	D2	D2	D2	D2	D2
Boring, Well or Sample Location Number		04Y-DT2-01-SS	AP-203	AP-204	AP-205	D1SS003	D1SS004	D2-SB01	D2-SB01
Sample Depth (feet)		0-0	45-47	30-32	25-27	0-0	0-0	8-10	17-19
Sample Date		8/6/2004	8/10/2004	8/11/2004	8/12/2004	9/28/2001	9/28/2001	6/15/2014	6/15/2014
Sample Name		04Y-DT2-01-SS	04Y-DT2-06-SO	04Y-DT2-08-SO	04Y-DT2-11-SO	01D1SS003SO	01D1SS004SO	D2-SB01-8.0-10.0-0614	D2-SB01-17.0-19.0-0614
GRO	(mg/kg)	**5.6 J**	<0.19 U	<0.2 U	<0.19 U	<0.978 U	<0.784 U	**1.2 B**	<2.4 U
DRO	(mg/kg)	**5800**	**2 J**	**1.8 J**	**2.1 J**	<22.2 U	**65.6 B**	**8.2 J**	**8.7 J**
RRO	(mg/kg)	--	--	--	--	<23.8 U	**55.3**	**17 QN**	**18 QN**
Acenaphthene	(mg/kg)	<0.0022 U	<0.0021 U	<0.00025 U	<0.00021 U	<0.000744 U	<0.00083 U	<0.0026 U	<0.0026 U
Acenaphthylene	(mg/kg)	<0.0065 U	<0.0063 U	<0.00076 U	<0.00063 U	<0.000656 U	<0.000731 U	<0.0026 U	<0.0026 U
Anthracene	(mg/kg)	**0.11**	<0.0027 U	<0.00032 U	<0.00027 U	<0.000379 U	**0.00486**	<0.0026 U	<0.0026 U
Benzo(a)anthracene	(mg/kg)	<0.0056 U	<0.0054 U	<0.00065 U	<0.00054 U	<0.000917 U	**0.00319 J**	<0.0026 U	<0.0026 U
Benzo(a)pyrene	(mg/kg)	<0.0097 U	<0.0094 U	<0.0011 U	<0.00093 U	<0.000883 U	<0.000984 U	<0.0026 U	<0.0026 U
Benzo(b)fluoranthene	(mg/kg)	<0.0037 U	<0.0035 U	<0.00042 U	<0.00035 U	<0.00032 U	<0.000357 U	<0.0026 U	<0.0026 U
Benzo(g,h,i)perylene	(mg/kg)	<0.0051 U	<0.0049 U	<0.00058 U	<0.00048 U	<0.000248 U	<0.000277 U	<0.0026 U	<0.0026 U
Benzo(k)fluoranthene	(mg/kg)	<0.0023 U	<0.0022 U	<0.00027 U	<0.00022 U	<0.000656 U	<0.000731 U	<0.0026 U	<0.0026 U
Chrysene	(mg/kg)	<0.0028 U	<0.0027 U	<0.00032 U	<0.00026 U	<0.000883 U	**0.0102**	<0.0026 U	<0.0026 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.0036 U	<0.0035 U	<0.00041 U	<0.00034 U	<0.00035 U	<0.000391 U	<0.0026 U	<0.0026 U
Fluorene	(mg/kg)	<0.0027 U	<0.0026 U	<0.00031 U	<0.00025 U	<0.000702 U	**0.0144**	<0.0026 U	<0.0026 U
Fluoranthene	(mg/kg)	**0.025**	<0.0063 U	<0.00075 U	<0.00062 U	<0.000702 U	**0.0057**	<0.0026 U	<0.0026 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.005 U	<0.0048 U	<0.00057 U	<0.00048 U	<0.00035 U	<0.000391 U	<0.0026 U	<0.0026 U
Naphthalene	(mg/kg)	<0.0033 U	<0.0032 U	<0.00038 U	<0.00032 U	**0.00406**	**0.163**	<0.0026 U	<0.0026 U
Phenanthrene	(mg/kg)	**0.058**	<0.003 U	<0.00036 U	<0.0003 U	**0.00165**	**0.102**	**0.0051 J**	**0.003 J**
Pyrene	(mg/kg)	**0.076**	<0.0038 U	<0.00045 U	<0.00038 U	<0.000496 U	<0.000553 U	<0.0026 U	<0.0026 U
2-Methylnaphthalene	(mg/kg)	<0.056 U	<0.054 U	<0.0065 U	<0.0054 U	**0.00421**	**0.278**	<0.0026 U	<0.0026 U
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	--	<0.0026 U	<0.0026 U

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 9-2: AOC D2 PAH Soils Results

Site Name		D2	D2	D2	D2	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		D2-SB02	D2-SB03	D2-SB04	D2-SB05		
Sample Depth (feet)		0-2	3-5	6-8	2-4		
Sample Date		6/16/2014	6/16/2014	6/15/2014	6/16/2014		
Sample Name		D2-SB02-0.0-2.0-0614	D2-SB03-3.0-5.0-0614	D2-SB04-6.0-8.0-0614	D2-SB05-2.0-4.0-0614		
GRO	(mg/kg)	**14 B**	**34 B**	<1.7 U	**10 B**	34	**260 C**
DRO	(mg/kg)	**7.2 ML**	**140**	**7.4 J**	**10 J**	5800	**230 C**
RRO	(mg/kg)	**27 J**	**54**	**16 QN**	**24 J**	55.3	**230 H**
Acenaphthene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.0028	**180 F**
Acenaphthylene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.0065	**180 F**
Anthracene	(mg/kg)	<0.0027 U	**0.0022 J**	<0.0025 U	<0.0028 U	0.11	**1680 D**
Benzo(a)anthracene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.00319	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.0097	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.0037	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.0051	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.0028	**4 D**
Chrysene	(mg/kg)	**0.002 J**	<0.0027 U	<0.0025 U	<0.0028 U	0.0102	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.0036	**0.04 D**
Fluorene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.0144	**190 D**
Fluoranthene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.025	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.005	**0.4 D**
Naphthalene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.163	**2.1 E**
Phenanthrene	(mg/kg)	**0.0035 J**	**0.0043 J**	**0.0038 J**	**0.0032 J**	0.102	**1680 D**
Pyrene	(mg/kg)	<0.0027 U	**0.0019 J**	<0.0025 U	<0.0028 U	0.076	**110 D**
2-Methylnaphthalene	(mg/kg)	**0.0023 J**	**0.0045 J**	<0.0025 U	<0.0028 U	0.278	**6.1 F**
1-Methylnaphthalene	(mg/kg)	<0.0027 U	<0.0027 U	<0.0025 U	<0.0028 U	0.0028	**6.2 F**

Table 9-3: AOC D2 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
D2	AP-203	NA	8/23/2004	04Y-DT2-15-GW	**0.0065 J**	<0.025 U	--	<0.00015 U	<0.00018 U	<0.00024 U	--
D2	AP-203	NA	8/31/2004	04Y-DT2-20-GW	--	--	--	--	--	--	--
D2	AP-203	NA	6/21/2014	AP-203-WG01-0614	**0.022 J**	**0.049 J**	<0.05 U	<0.0004 U,QL	<0.0004 U,QL	<0.0004 U,QL	<0.0008 U,QL
D2	AP-204	NA	8/24/2004	04Y-DT2-16-GW	<0.003 U	<0.023 U	--	<0.00015 U	<0.00018 U	<0.00024 U	--
D2	AP-205	NA	8/29/2004	04Y-DT2-17-GW	<0.003 U	<0.023 U	--	<0.00015 U	<0.00018 U	<0.00024 U	--
D2	AP-205	NA	6/21/2014	AP-205-WG01-0614	<0.044 U	**0.051 J**	<0.048 U	<0.0004 U,QL	<0.0004 U,QL	<0.0004 U,QL	<0.0008 U,QL
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0.022	0.051	0.05	0.0004	0.0004	0.0004	0.0008
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

Table 9-4: AOC D2 PAH Groundwater Results

	Site Name	D2	D2	D2	D2	D2	D2	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
	Boring, Well or Sample Location Number	AP-203	AP-203	AP-203	AP-204	AP-205	AP-205		
	Sample Depth	NA	NA	NA	NA	NA	NA		
	Sample Date	8/23/2004	8/31/2004	6/21/2014	8/24/2004	8/29/2004	6/21/2014		
	Sample Name	04Y-DT2-15-GW	04Y-DT2-20-GW	AP-203-WG01-0614	04Y-DT2-16-GW	04Y-DT2-17-GW	AP-205-WG01-0614		
GRO	(mg/L)	**0.0065 J**	--	**0.022 J**	<0.003 U	<0.003 U	<0.044 U	0.022	**2.2 H**
DRO	(mg/L)	<0.025 U	--	**0.049 J**	<0.023 U	<0.023 U	**0.051 J**	0.051	**1.5 H**
RRO	(mg/L)	--	--	<0.05 U	--	--	<0.048 U	0.05	**1.1 H**
Acenaphthene	(mg/L)	<0.000013 U	<0.000011 U	<0.000015 U	<0.000013 U	<0.000011 U	<0.000015 U	0.000015	**0.22 H**
Acenaphthylene	(mg/L)	<0.000011 U	<0.0000095 U	<0.000015 U	<0.000011 U	**0.000011 J**	<0.000015 U	0.000015	**0.22 H**
Anthracene	(mg/L)	<0.000013 U	<0.000011 U	<0.000015 U	<0.000013 U	<0.000011 U	<0.000015 U	0.000015	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.000023 U	<0.000019 U	<0.000015 U	<0.000023 U	**0.000022 J**	<0.000015 U	0.000015	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.000013 U	<0.000011 U	<0.000015 U	<0.000013 U	**0.000011 J**	<0.000015 U	0.000015	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.000029 U	<0.000025 U	<0.000015 U	<0.000029 U	<0.000026 U	<0.000015 U	0.000015	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.000015 U	<0.000013 U	<0.000015 U	<0.000015 U	<0.000013 U	<0.000015 U	0.000015	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.000018 U	<0.000015 U	<0.000015 U	<0.000018 U	<0.000016 U	<0.000015 U	0.000015	**0.0012 H**
Chrysene	(mg/L)	<0.000011 U	<0.0000096 U	<0.000015 U	<0.000011 U	**0.000011 J**	<0.000015 U	0.000015	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.000019 U	<0.000016 U	<0.000015 U	<0.000019 U	<0.000017 U	<0.000015 U	0.000015	**0.000012 H**
Fluorene	(mg/L)	<0.000014 U	<0.000012 U	**0.0000096 J**	<0.000014 U	<0.000012 U	<0.000015 U	0.0000096	**0.15 H**
Fluoranthene	(mg/L)	<0.000027 U	<0.000024 U	<0.000015 U	<0.000027 U	<0.000024 U	<0.000015 U	0.000015	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.000015 U	<0.000013 U	<0.000015 U	<0.000015 U	<0.000013 U	<0.000015 U	0.000015	**0.00012 H**
Naphthalene	(mg/L)	<0.000035 U	<0.00003 U	<0.000015 U	<0.000035 U	<0.000031 U	<0.000015 U	0.000015	**0.073 H**
Phenanthrene	(mg/L)	<0.000035 U	<0.00003 U	<0.000015 U	<0.000035 U	<0.000031 U	<0.000015 U	0.000015	**1.1 H**
Pyrene	(mg/L)	<0.000031 U	<0.000027 U	<0.000015 U	<0.000031 U	<0.000028 U	<0.000015 U	0.000015	**0.11 H**
2-Methylnaphthalene	(mg/L)	<0.000014 U	<0.000012 U	**0.0000069 J**	<0.000014 U	**0.000022 J**	<0.000015 U	0.0000069	**0.015 H**
1-Methylnaphthalene	(mg/L)	--	--	<0.000015 U	--	--	<0.000015 U	0.000015	**0.015 H**

Notes:

Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

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10.0 AOC D3 – ARMY DOCK AREA – FORMER 500 BBL TANK – NO. 834

10.1 AREA DESCRIPTION AND BACKGROUND

AOC D3 is the site of former Tank No. 834 (AST3) within the historical Army Dock area tank farm. The tank farm served as the primary fuel off-loading and storage site for World War II military activities in Yakutat. Eight ASTs (ASTs 1–8) with tank capacities ranging from 20,000 to 80,000 gal and associated piping were used to store and transfer diesel fuel to the dock at Monti Bay. The former location of AST3 was along the gravel road leading from Ocean Cape Road down to the existing Malaspina warehouse. The AST and associated piping at this location have been removed, and the only visible evidence of the former AST is part of a small concrete tank pad.

Analytical data collected during previous RIs at the site indicate that DRO was present in surface and subsurface soils at maximum concentrations of 3,100 mg/kg and 6,600 mg/kg, respectively. Subsurface soil contamination was detected in analytical samples to a depth of 12 feet bgs (S&W 2006a). Four ROST/LIF probe locations had diesel fuel signatures detected at depths from 1.4 to 10.9 feet bgs, with the highest responses occurring southwest and south of the AST3 footprint (USACE 2006).

Data collected during the previous investigations were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at AOC D3. These data, along with field screening results and visual observations, were reviewed to select appropriate sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations and the estimated NAPL source area at AOC D3 are shown in conjunction with AOC D1 and AOC D2 areas on Figure 8-1.

10.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC D3 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Evaluate current groundwater conditions.

10.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC D3 included advancement of soil borings, collection of soil and groundwater samples, and aquifer (slug) testing. These activities are described below by media.

10.3.1 Soil

Based on historical data and the estimated NAPL source area, seven soil borings were advanced to depths ranging from 6 to 15 feet bgs to collect data for the HRC evaluation; six at locations with historically high contaminant levels or LIF responses (D3-SB01 through SB06) and one approximately 10 feet west of the location with the highest LIF response (D3-SB07). Because of the close proximity of borings D3-SB03 and SB04 (less than 3 feet apart), only one boring was advanced at this location. Subsurface soils in this area consisted primarily of fine to medium sands with gravel, and occasional layers of silty fine sand. Soil boring logs are included in Appendix C.

Field screening samples were collected from above and below the target sample intervals and screened for volatile organics using a PID. Soil samples collected for laboratory analysis were selected from the target depth(s) or adjusted to the most likely contaminated depth based on field observations (e.g., PID, visual, and olfactory). Soil samples for laboratory analyses were collected from three depths at D3-SB04 (combined with SB03), two depths at D3-SB01 and SB05, and one depth at D3-SB02, SB06 and SB07. All samples were analyzed for GRO, DRO, RRO, BTEX and PAHs, and one sample each from borings D3-SB01, SB03/SB04, SB05 and SB06 were also analyzed for VPH and EPH. The sample from the deeper target depth at D3-SB04 was not proposed to be analyzed for VPH/EPH; however, since this interval had the highest screening value (PID) at the boring location, this sample was also analyzed for input into the HRC. Field observations and screening results were used to refine the estimated limits of the NAPL source area shown on Figure 8-1.

BACKGROUND SOIL CONDITIONS

Soil samples collected outside the AOC D NAPL source areas were analyzed to assess the geophysical properties (e.g., grain size, bulk density, moisture content, and specific gravity) and the naturally occurring organic carbon content of soil at the site. Refer to Section 8.3.1 for a discussion on background sampling activities at AOC D.

10.3.2 Groundwater

Groundwater assessment for the site included sampling of existing monitoring well AP-206. Groundwater samples were collected using a bladder pump with a dedicated bladder, and analyzed for GRO, DRO, RRO, BTEX, and PAHs. The well location is shown on Figure 8-1 and Low Flow Groundwater Sample Collection Records are included in Appendix D.

AQUIFER TESTING

Subsequent to sampling, aquifer (slug) tests were performed at monitoring well AP-206 to obtain hydraulic conductivity values for input into the HRC. Due to the small diameter of the AP-designated wells (1-inch ID), a water slug was used to displace the water column instead of a solid slug. These tests were performed and evaluated following the procedures outlined in Section 3.4.5. Slug test data are included in Appendix E and results are discussed in Section 10.4 below.

10.4 GROUNDWATER CONDITIONS

As discussed in Section 8.4, groundwater contours were developed for the AOC D area (Figure 8-3) and show an overall groundwater flow direction to the northwest, with an apparent localized cone of depression in the vicinity of City of Yakutat water supply wells ARCO #1 and/or ARCO #2. Horizontal gradients across AOC D were averaged with a resulting gradient estimated at 0.0085 ft/ft.

Since limited data were available, hydraulic conductivity values calculated for the four wells at AOC D2, AOC D3 and AOC D4 were averaged, based on site proximity. An overall hydraulic conductivity of 0.184 ft/day was used as input into the HRC for the site (Table 4-4).

10.5 ANALYTICAL RESULTS

10.5.1 Soil

A total of ten soil samples were collected from six soil borings at the site and submitted for laboratory analyses. Results show that eight of the ten samples had DRO concentrations above the Method Two cleanup level ranging from 340 mg/kg to 4,700 mg/kg. In addition to DRO, concentrations of 2-methylnaphthalene exceeded Method Two cleanup levels in soil from one boring location. No other analytes were reported at concentrations above Method Two cleanup levels at AOC D3. Soil analytical results for the samples collected in 2014 are presented in summary tables provided in Appendix J. Sample locations are shown on Figure 8-1 and a cross sectional view of the site showing the vertical extent of impacts is presented along A-A’ as Figure 10-1.

Constituent data collected within the defined NAPL source zone were used to supplement the historical data set for characterizing the contaminant source zone. Historical and recent (2014) POL soil data evaluated for the AOC D3 area are presented in Table 10-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 10-2. Historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attention of these constituents. PAH soil data are presented in Table 10-3, and VPH/EPH results are presented in Table 10-4. These data were used as input to calculate soil ACLs and evaluate risk at AOC D3 using the HRC.

10.5.2 Groundwater

Groundwater samples were collected from monitoring well AP-206 and analyzed for GRO, DRO, RRO, BTEX, and PAHs. Analytical results indicate that constituent concentrations detected in groundwater at AOC D3 did not exceed the Table C groundwater cleanup levels. Analytical results are summarized in Appendix J.

Results for AP-206 were used to supplement historical groundwater data for the AOC D3 area. Historical and recent (2014) groundwater results for POLs and PAHs are summarized in Table 10-5 and Table 10-6, respectively.

10.6 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC D3; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

10.6.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet the ADEC “Cleanup Complete” criteria, the AOC D3 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion).

The AOC D3 risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at the site at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be incomplete at the present time, because there are no occupied buildings within 30 feet of the AOC D3 source area. There is currently no exposure to groundwater at the present time, because there are no known drinking water wells within the radius of influence at the site. Additionally, future groundwater exposure is considered to be insignificant based on groundwater data and soil impacts limited to the vadose zone. Surface water and sediment pathways are considered incomplete based on the unlikely potential for surface runoff or sediment transport to nearby surface water bodies.

The AOC D3 exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

10.6.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each hydrocarbon constituent (BTEX 2014 data only) and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in Table 10-2. The source area data set for benzene, toluene, and total xylenes had a limited number of relatively low concentration detections; therefore, the maximum detected values from the source area were used as exposure point concentrations. There were no detections of ethylbenzene, so the maximum source area LOD was used as the exposure point concentration. There were adequate data to calculate 95% UCLs for GRO, DRO, and RRO; therefore, ProUCL was used to calculate 95% UCLs for the HRC input. ProUCL formatted outputs are displayed in Table 10-7.

Table 10-8 presents the ProUCL outlier test results for DRO, and as shown, the test indicated that the highest DRO concentration measured at the site (6,600 mg/kg) was not a statistical outlier. A Q-Q plot and box plot of the DRO source area data are presented in Figure 10-2a and Figure 10-2b. Both the Q-Q and box plots show that the highest DRO concentration did not graph significantly above the other data, which also suggests that the highest DRO result was not a statistical outlier.

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 10-3. Benzo(g,h,i)perylene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene were not detected at the site, so the maximum LOD values were used as the exposure point concentrations. The maximum detected concentrations were used as the exposure point concentrations for the remaining PAH constituents.

Five VPH and EPH source area soil samples were used to characterize the bulk hydrocarbon chemistry. The HRC input values calculated from the source area VPH/EPH data are shown in Table 10-4.

The source of each HRC soil exposure point input value is documented in Table 10-9a.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

BTEX and GRO were not detected at the site; therefore, the maximum LOD for the samples collected from the source area well was used as the exposure point concentration. RRO and DRO were detected, so the maximum detected concentrations were used as input to the HRC. VPH and EPH analysis were not performed at AOC D3, so the GRO, DRO and RRO aromatic and aliphatic concentrations used as input to the HRC were modeled using the soils data.

None of the PAH constituents were detected during the 2014 groundwater sampling event; therefore, the maximum LOD values were used as the exposure point concentrations for the non-carcinogenic PAHs. For the carcinogenic PAHs, the groundwater concentrations predicted or modeled by the HRC based on the soil concentration data were used as input to the risk calculations. The modeled concentrations yield more representative risk results.

The source of each HRC groundwater exposure point input value is documented in Table 10-9a.

10.6.3 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to AOC D3 is presented in Table 10-9b.

10.6.4 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results is included as Table N-5 of Appendix N and the risk posed by the site conditions is summarized in Table 10-10 and Table 10-11. Table N-5 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for AOC D3 indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).
- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aromatic and aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.

- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, the site conditions are protective of human health under an unrestricted (residential) land use scenario.

10.7 ALTERNATIVE CLEANUP LEVELS

Constituents and/or hydrocarbon fractions exceeding the ADEC Method Two cleanup levels at AOC D3 include benzene, 2-methylnaphthalene and DRO. Note that the benzene exceedance is from the 2004 sampling effort and is not considered representative of current site conditions. Soil ACLs have been developed for these constituents and/or hydrocarbon fractions as shown in Table 10-12.

Benzene, 2-methylnaphthalene and DRO exceed the Method Two migration to groundwater cleanup levels. However, the migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult's Law) and dilution-attenuation calculations are applied, the AOC D3 exposure point concentrations meet the migration to groundwater criteria. Under these conditions, it is typically not necessary to calculate ACLs, but for this contract ACLs have been back calculated for site COPCs and are presented in Table 10-12. The exposure point concentrations at AOC D3 are less than the ACLs calculated using the HRC, documenting that the site meets the ADEC migration to groundwater criteria.

10.8 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at AOC D was evaluated and a preliminary ecological CSM was developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at AOC D3 are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.
- There is not significant surface water runoff or sediment transport from the site to surface water bodies (e.g. nearby pond) based on topography, vegetative cover, and limited surface soil contamination.
- While Monti Bay is located north of the site, groundwater results indicate petroleum hydrocarbons are not migrating to the marine environment at concentrations above Alaska WQS for TAH or TAqH.
- Petroleum hydrocarbons in surface soil at AOC D (D1 – D8) cover 0.31 acre. The impacted surface soil areas are less than the ADEC 0.5 acre *de minimis* criterion. Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.
- Risk to the environment has been evaluated for the AOC D area (in entirety) using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation of AOC D3 is not needed and site conditions are protective of the environment.

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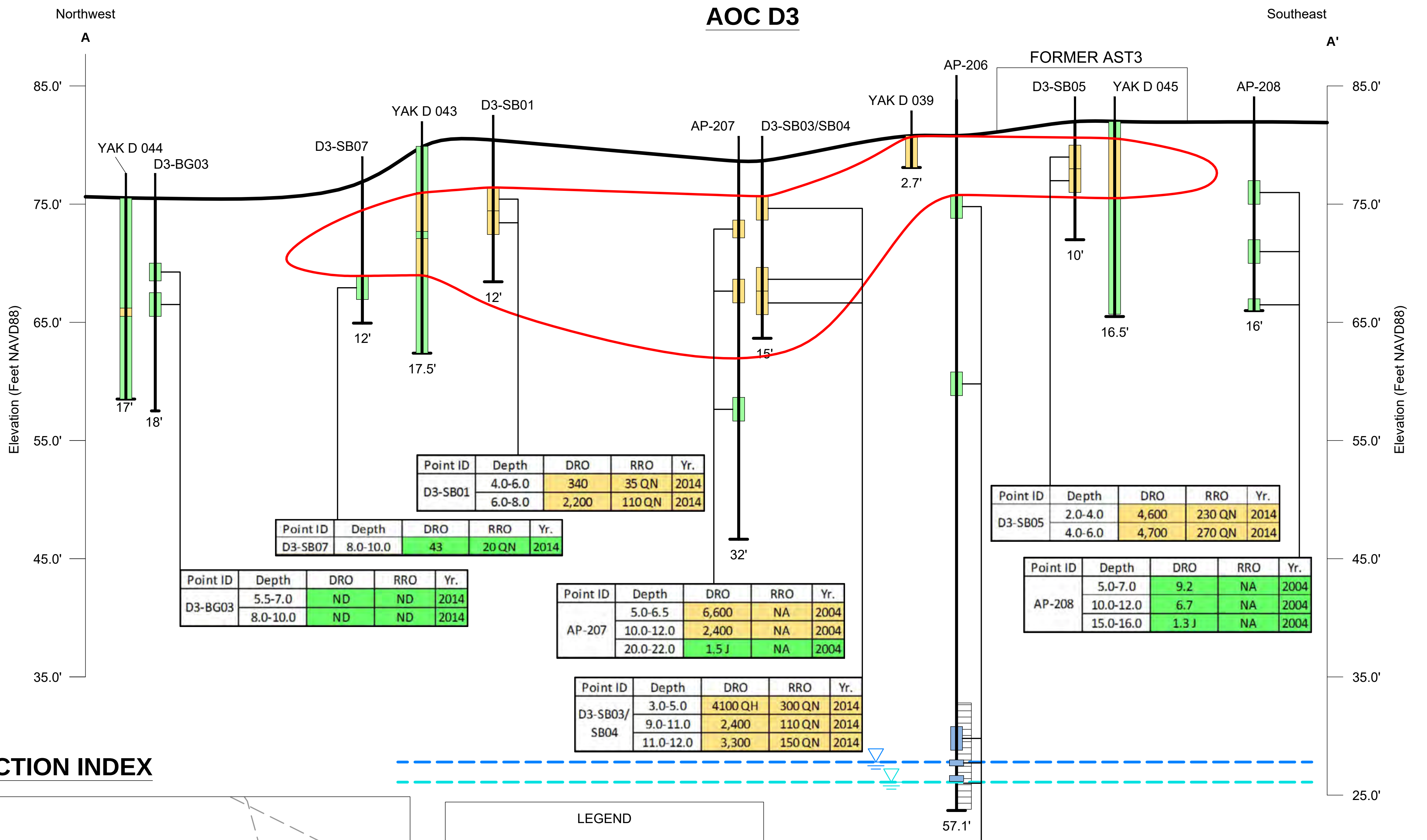
AOC D3



Point ID	Depth	DRO	RRO	Yr.
D3-SB01	4.0-6.0	340	35 QN	2014
	6.0-8.0	2,200	110 QN	2014

Point ID	Depth	DRO	RRO	Yr.
D3-SB07	8.0-10.0	43	20 QN	2014

Point ID	Depth	DRO	RRO	Yr.
D3-BG03	5.5-7.0	ND	ND	2014
	8.0-10.0	ND	ND	2014

Point ID	Depth	DRO	RRO	Yr.
AP-207	5.0-6.5	6,600	NA	2004
	10.0-12.0	2,400	NA	2004
	20.0-22.0	1.5 J	NA	2004

Point ID	Depth	DRO	RRO	Yr.
D3-SB03/ SB04	3.0-5.0	4100 QH	300 QN	2014
	9.0-11.0	2,400	110 QN	2014
	11.0-12.0	3,300	150 QN	2014

Point ID	Depth	DRO	RRO	Yr.
D3-SB05	2.0-4.0	4,600	230 QN	2014
	4.0-6.0	4,700	270 QN	2014

Point ID	Depth	DRO	RRO	Yr.
AP-208	5.0-7.0	9.2	NA	2004
	10.0-12.0	6.7	NA	2004
	15.0-16.0	1.3 J	NA	2004

Point ID	Depth	DRO	RRO	Yr.
AP-206	5.0-7.0	100	NA	2004
	20.0-22.0	1.3 J	NA	2004
	50.0-52.0	ND	NA	2004
	57.74 (DTW)	ND	NA	2004
	56.02 (DTW)	0.054 mg/L	0.033 mg/L	2014

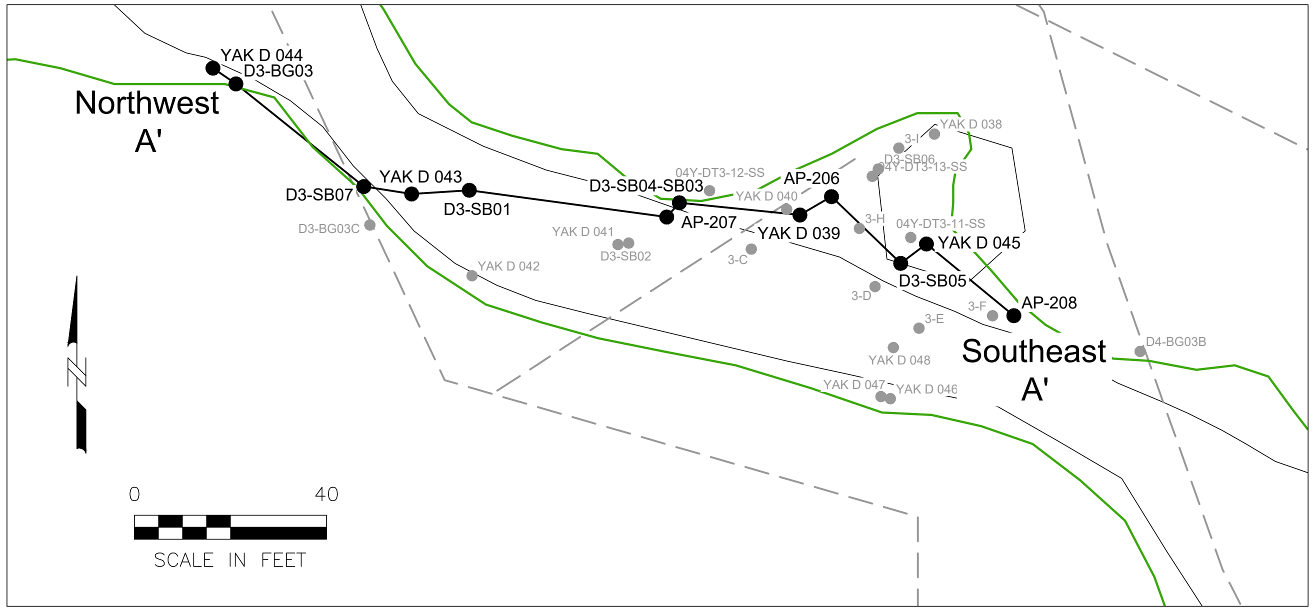
10
5
0
0 10 20
SCALE IN FEET
(VERT. EX. = 2)

Notes
Depth = feet below ground surface
DRO = diesel range organics
DTW = depth to water below top of casing
mg/kg = milligram per kilogram
mg/L = milligram per liter
NA = not analyzed
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
ND = not detected
RRO = residual range organics
ROST = rapid optical screening tool
Yr. = year sample was collected

All DRO and RRO results are in mg/kg unless otherwise noted on the figure. See Appendix J for result qualifiers.

Location IDs beginning with YAK identify historical ROST borings. ROST results with percent reference emitter limits >1% are considered to be above the NAPL threshold (>230 mg/kg for DRO and RRO).

CROSS SECTION INDEX



LEGEND
🟩 NO VADOSE ZONE NAPL
🟨 VADOSE ZONE NAPL
🟦 NO SATURATED ZONE NAPL
🟥 SATURATED ZONE NAPL
2004 GROUNDWATER ELEVATION
2014 GROUNDWATER ELEVATION
⇨ GROUNDWATER FLOW DIRECTION
ESTIMATED VERTICAL EXTENT OF NAPL SOURCE ZONE
SCREEN INTERVAL

Figure: 10-1

CROSS SECTION A-A'
AOC D3

U.S. Army
Corps of Engineers
Alaska District

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 01/16/15

Last saved by: SCHWARTZE(2016-03-29) Last Plotted: 2016-03-29
Filename: L:\GROUP\CAD\YAKUTAT AFB\FIGURES\YAK_FIG_10-1_ A-A' D-AST3.DWG

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FIGURE 10-2a: AOC D3 DRO Q-Q Plot

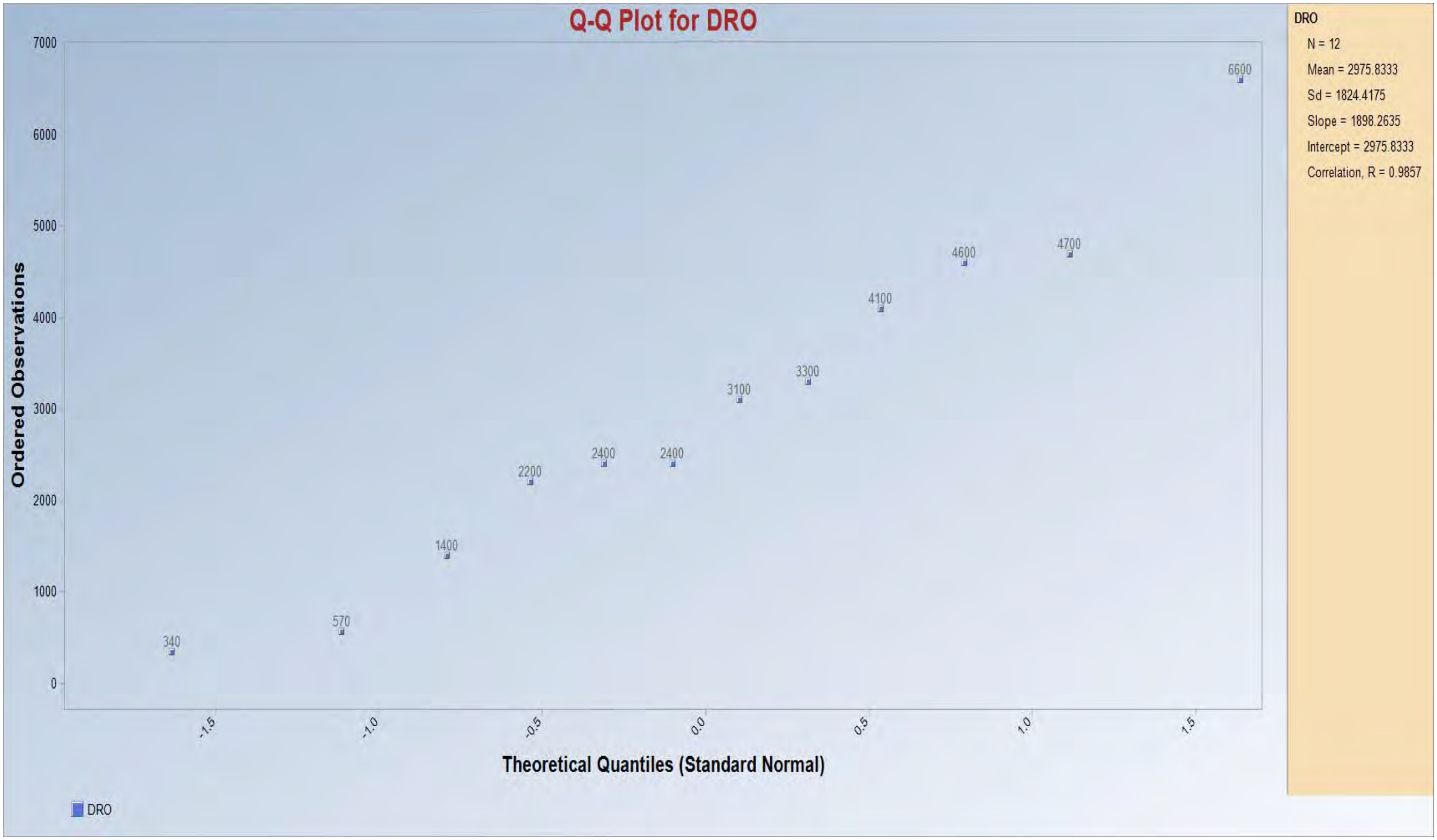

FIGURE 10-2b: AOC D3 DRO Box Plot

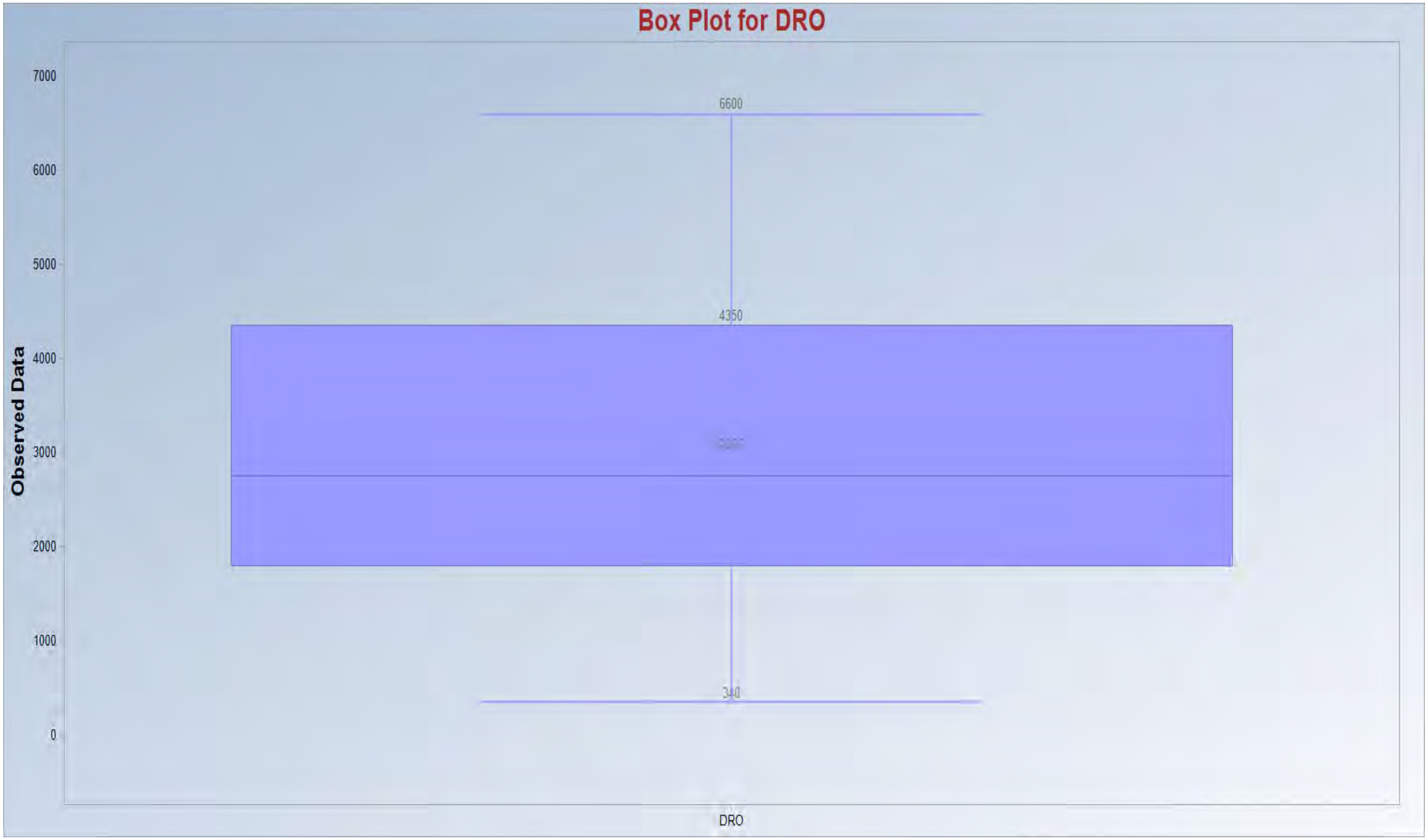

Table 10-1: AOC D3 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D3	04Y-DT3-11-SS	0-1	8/23/2004	04Y-DT3-11-SS	**0.48 J**	**120**	--	<0.0008 U	<0.0008 U	**0.0047 J**	--
D3	04Y-DT3-12-SS	0-1	8/23/2004	04Y-DT3-12-SS	**1.8**	**4.1 J**	--	**0.0012 J**	**0.0013 J**	**0.0049 J**	--
D3	04Y-DT3-13-SS	0-1	8/23/2004	04Y-DT3-13-SS	**3.4 J**	**3100**	--	<0.0023 U	<0.0021 U	**0.01 J**	--
D3	04Y-DT3-19-SS	0-1	8/26/2004	04Y-DT3-19-SS	**0.86 J**	**570**	--	<0.001 U	**0.0045 J**	**0.0057 J**	--
D3	AP-206	5-7	8/16/2004	04Y-DT3-01-SO	**4.9**	**100**	--	**0.0095 J**	<0.0022 U	**0.013 J**	--
D3	AP-206	20-22	8/16/2004	04Y-DT3-02-SO	**0.46 J**	**1.3 J**	--	**0.019**	**0.0021 J**	**0.037**	--
D3	AP-206	50-52	8/16/2004	04Y-DT3-03-SO	<0.17 U	<0.67 U	--	**0.0031 J**	<0.0006 U	**0.004 J**	--
D3	AP-207	5-6.5	8/17/2004	04Y-DT3-04-SO	**33**	**6600**	--	**0.018 J**	**0.022 J**	**0.044**	--
D3	AP-207	10-12	8/18/2004	04Y-DT3-07-SO	**15**	**2400**	--	**0.0029 J**	**0.0071 J**	**0.016 J**	--
D3	AP-207	20-22	8/18/2004	04Y-DT3-08-SO	<0.24 U	**1.5 J**	--	**0.0092**	**0.0018 J**	**0.035**	--
D3	AP-208	5-7	8/25/2004	04Y-DT3-14-SO	<0.23 U	**9.2**	--	<0.0008 U	<0.0008 U	**0.0048 J**	--
D3	AP-208	10-12	8/25/2004	04Y-DT3-15-SO	<0.23 U	**6.7**	--	**0.002 J**	**0.0028 J**	**0.0052 J**	--
D3	AP-208	15-16	8/25/2004	04Y-DT3-18-SO	<0.27 U	**1.3 J**	--	**0.0022 J**	<0.0009 U	**0.0069 J**	--
D3	D3-BG03	5.5-7	6/21/2014	D3-BG03-5.5-7.0-0614	**10 B**	<7.4 U	<28 U	--	--	--	--
D3	D3-BG03	8-10	6/21/2014	D3-BG03-8.0-10.0-0614	**2.6 B**	<6.9 U	<26 U	--	--	--	--
D3	D3-BG04	4-6	6/21/2014	D3-BG04-4.0-6.0-0614	<2.4 U	<6.9 U	<27 U	--	--	--	--
D3	D3-BG04	10-12	6/21/2014	D3-BG04-10.0-12.0-0614	**2.1 B**	**2.9 J**	<26 U	--	--	--	--
D3	D3-SB01	4-6	6/14/2014	D3-SB01-4.0-6.0-0614	**16**	**340**	**35 QN**	**0.0042 J**	<0.0096 U	<0.0096 U	<0.0192 U
D3	D3-SB01	6-8	6/14/2014	D3-SB01-6.0-8.0-0614	**76 QH**	**2200**	**110 QN**	<0.012 U	<0.012 U	<0.012 U	**0.4328 J**
D3	D3-SB02	4-6	6/14/2014	D3-SB02-4.0-6.0-0614	**13**	**1400**	**90 QN**	<0.0079 U	<0.0079 U	<0.0079 U	<0.0158 U
D3	D3-SB04	3-5	6/14/2014	D3-SB04-3.0-5.0-0614	**5.4 B**	**4100 QH**	**300 QN**	**0.0051 J**	<0.0089 U	<0.0089 U	**0.0219 J**
D3	D3-SB04	9-11	6/14/2014	D3-SB04-11.0-13.0-0614	**26**	**2400**	**110 QN**	**0.015 J**	<0.0095 U	**0.013 J**	**0.0575**
D3	D3-SB04	11-12	6/14/2014	D3-SB04-11.0-12.0-0614	**37**	**3300**	**150 QN**	**0.0076 J**	<0.0086 U	<0.0086 U	<0.0172 U
D3	D3-SB05	2-4	6/15/2014	D3-SB05-2.0-4.0-0614	**210 QH**	**4600**	**230 QN**	<0.0092 U	<0.0092 U	<0.0092 U	<0.0184 U
D3	D3-SB05	4-6	6/15/2014	D3-SB05-4.0-6.0-0614	**130 QH**	**4700**	**270 QN**	<0.0099 U	<0.0099 U	<0.0099 U	<0.0198 U
D3	D3-SB06	4-6	6/15/2014	D3-SB06-4.0-6.0-0614	**1.9 B,QL**	**83**	**24 QN**	<0.0085 U	<0.0085 U	<0.0085 U	<0.017 U
D3	D3-SB07	8-10	6/14/2014	D3-SB07-8.0-10.0-0614	**7.6 B**	**43**	**20 QN**	<0.0096 U	<0.0096 U	<0.0096 U	<0.0192 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					210	6600	300	0.019	0.022	0.044	0.4328
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 10-2: AOC D3 Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D3	04Y-DT3-13-SS	0-1	8/23/2004	04Y-DT3-13-SS	**3.4 J**	**3100**	--	--	--	--	--
D3	04Y-DT3-19-SS	0-1	8/26/2004	04Y-DT3-19-SS	**0.86 J**	**570**	--	--	--	--	--
D3	AP-207	5-6.5	8/17/2004	04Y-DT3-04-SO	**33**	**6600**	--	--	--	--	--
D3	AP-207	10-12	8/18/2004	04Y-DT3-07-SO	**15**	**2400**	--	--	--	--	--
D3	D3-SB01	4-6	6/14/2014	D3-SB01-4.0-6.0-0614	**16**	**340**	**35 QN**	**0.0042 J**	<0.0096 U	<0.0096 U	<0.0192 U
D3	D3-SB01	6-8	6/14/2014	D3-SB01-6.0-8.0-0614	**76 QH**	**2200**	**110 QN**	<0.012 U	<0.012 U	<0.012 U	**0.4328 J**
D3	D3-SB02	4-6	6/14/2014	D3-SB02-4.0-6.0-0614	**13**	**1400**	**90 QN**	<0.0079 U	<0.0079 U	<0.0079 U	<0.0158 U
D3	D3-SB04	3-5	6/14/2014	D3-SB04-3.0-5.0-0614	**5.4 B**	**4100 QH**	**300 QN**	**0.0051 J**	<0.0089 U	<0.0089 U	**0.0219 J**
D3	D3-SB04	9-11	6/14/2014	D3-SB04-11.0-13.0-0614	**26**	**2400**	**110 QN**	**0.015 J**	<0.0095 U	**0.013 J**	**0.0575**
D3	D3-SB04	11-12	6/14/2014	D3-SB04-11.0-12.0-0614	**37**	**3300**	**150 QN**	**0.0076 J**	<0.0086 U	<0.0086 U	<0.0172 U
D3	D3-SB05	2-4	6/15/2014	D3-SB05-2.0-4.0-0614	**210 QH**	**4600**	**230 QN**	<0.0092 U	<0.0092 U	<0.0092 U	<0.0184 U
D3	D3-SB05	4-6	6/15/2014	D3-SB05-4.0-6.0-0614	**130 QH**	**4700**	**270 QN**	<0.0099 U	<0.0099 U	<0.0099 U	<0.0198 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					210	6600	300	0.015	0.012	0.013	0.4328
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 10-3: AOC D3 PAH Soils Results

Site Name		D3	D3	D3	D3	D3	D3	D3	D3	D3
Boring, Well or Sample Location Number		04Y-DT3-13-SS	04Y-DT3-19-SS	AP-206	AP-207	AP-207	AP-208	D3-SB01	D3-SB01	D3-SB02
Sample Depth (feet)		0-1	0-1	5-7	5-6.5	10-12	15-16	4-6	6-8	4-6
Sample Date		8/23/2004	8/26/2004	8/16/2004	8/17/2004	8/18/2004	8/25/2004	6/14/2014	6/14/2014	6/14/2014
Sample Name		04Y-DT3-13-SS	04Y-DT3-19-SS	04Y-DT3-01-SO	04Y-DT3-04-SO	04Y-DT3-07-SO	04Y-DT3-18-SO	D3-SB01-4.0-6.0-0614	D3-SB01-6.0-8.0-0614	D3-SB02-4.0-6.0-0614
GRO	(mg/kg)	**3.4 J**	**0.86 J**	**4.9**	**33**	**15**	<0.27 U	**16**	**76 QH**	**13**
DRO	(mg/kg)	**3100**	**570**	**100**	**6600**	**2400**	**1.3 J**	**340**	**2200**	**1400**
RRO	(mg/kg)	--	--	--	--	--	--	**35 QN**	**110 QN**	**90 QN**
Acenaphthene	(mg/kg)	<0.0047 U	<0.00022 U	<0.00022 U	<0.002 U	**0.38**	<0.00021 U	**0.005 J**	**0.21**	<0.0027 U
Acenaphthylene	(mg/kg)	<0.014 U	<0.00067 U	<0.00066 U	<0.006 U	**0.18**	<0.00063 U	**0.0031 J**	**0.066**	**0.0087**
Anthracene	(mg/kg)	<0.006 U	<0.00029 U	<0.00028 U	<0.0026 U	<0.0029 U	<0.00027 U	**0.0054**	**0.11**	<0.0027 U
Benzo(a)anthracene	(mg/kg)	<0.012 U	<0.00058 U	<0.00057 U	<0.0052 U	<0.0059 U	<0.00054 U	<0.0027 U	**0.0043 J**	<0.0027 U
Benzo(a)pyrene	(mg/kg)	<0.021 U	<0.00099 U	<0.00099 U	<0.0089 U	<0.01 U	<0.00093 U	<0.0027 U	<0.0028 U	<0.0027 U
Benzo(b)fluoranthene	(mg/kg)	<0.0079 U	<0.00038 U	<0.00037 U	<0.0034 U	<0.0038 U	<0.00035 U	<0.0027 U	**0.0025 J**	**0.0035 J**
Benzo(g,h,i)perylene	(mg/kg)	<0.011 U	<0.00052 U	<0.00051 U	<0.0046 U	<0.0053 U	<0.00048 U	<0.0027 U	<0.0028 U	<0.0027 U
Benzo(k)fluoranthene	(mg/kg)	<0.005 U	<0.00024 U	<0.00023 U	<0.0021 U	<0.0024 U	<0.00022 U	<0.0027 U	<0.0028 U	<0.0027 U
Chrysene	(mg/kg)	<0.0059 U	**0.0048**	<0.00028 U	<0.0025 U	**0.023**	<0.00026 U	**0.0019 J**	**0.019**	**0.008**
Dibenzo(a,h)anthracene	(mg/kg)	<0.0077 U	<0.00037 U	<0.00036 U	<0.0033 U	<0.0038 U	<0.00034 U	<0.0027 U	<0.0028 U	<0.0027 U
Fluorene	(mg/kg)	<0.0057 U	<0.00027 U	<0.00027 U	<0.0024 U	**1.4**	<0.00025 U	**0.02**	**1.5 J**	**0.0069**
Fluoranthene	(mg/kg)	<0.014 U	<0.00066 U	<0.00066 U	<0.0059 U	<0.0068 U	<0.00062 U	**0.0026 J**	**0.068 J**	**0.0026 J**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.011 U	<0.00051 U	<0.00051 U	<0.0046 U	<0.0052 U	<0.00048 U	<0.0027 U	<0.0028 U	<0.0027 U
Naphthalene	(mg/kg)	<0.0071 U	**0.0089**	**0.02**	<0.003 U	<0.0035 U	**0.0031**	<0.0027 U	**0.32 J**	**0.0056 B**
Phenanthrene	(mg/kg)	<0.0067 U	<0.00032 U	**0.025**	<0.0029 U	**2**	**0.0021**	**0.043**	**2.1**	**0.023**
Pyrene	(mg/kg)	<0.0084 U	<0.0004 U	<0.0004 U	**0.096**	**0.088**	<0.00038 U	**0.0024 J**	**0.049**	**0.023**
2-Methylnaphthalene	(mg/kg)	<0.12 U	<0.0057 U	**0.039**	<0.051 U	**4.5**	<0.0054 U	**0.035**	**3.2**	**0.023**
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	--	**0.032**	**1.6**	**0.019**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 10-3: AOC D3 PAH Soils Results

Site Name		D3	D3	D3	D3	D3	D3	D3	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		D3-SB04	D3-SB04	D3-SB04	D3-SB05	D3-SB05	D3-SB06	D3-SB07		
Sample Depth (feet)		3-5	9-11	11-12	2-4	4-6	4-6	8-10		
Sample Date		6/14/2014	6/14/2014	6/14/2014	6/15/2014	6/15/2014	6/15/2014	6/14/2014		
Sample Name		D3-SB04-3.0-5.0-0614	D3-SB04-11.0-13.0-0614	D3-SB04-11.0-12.0-0614	D3-SB05-2.0-4.0-0614	D3-SB05-4.0-6.0-0614	D3-SB06-4.0-6.0-0614	D3-SB07-8.0-10.0-0614		
GRO	(mg/kg)	**5.4 B**	**26**	**37**	**210 QH**	**130 QH**	**1.9 B,QL**	**7.6 B**	210	**260 C**
DRO	(mg/kg)	**4100 QH**	**2400**	**3300**	**4600**	**4700**	**83**	**43**	6600	**230 C**
RRO	(mg/kg)	**300 QN**	**110 QN**	**150 QN**	**230 QN**	**270 QN**	**24 QN**	**20 QN**	300	**230 H**
Acenaphthene	(mg/kg)	<0.0026 U	**0.15 J**	**0.19**	**0.39**	**0.39**	**0.0038 J**	**0.0057**	0.39	**180 F**
Acenaphthylene	(mg/kg)	**0.015**	**0.051**	**0.073**	**0.16**	**0.15**	**0.0028 J**	<0.0027 U	0.18	**180 F**
Anthracene	(mg/kg)	**0.01**	**0.12 J**	**0.15**	**0.2 MH**	**0.24**	<0.0029 U	**0.0026 J**	0.24	**1680 D**
Benzo(a)anthracene	(mg/kg)	<0.0026 U	**0.0056**	**0.0051 J**	**0.0096**	**0.012**	<0.0029 U	<0.0027 U	0.012	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.0026 U	<0.0027 U	<0.0028 U	<0.0027 U	<0.0028 U	<0.0029 U	<0.0027 U	0.021	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	**0.0047 J**	**0.0033 J**	**0.0025 J**	**0.0047 J**	**0.0061**	<0.0029 U	<0.0027 U	0.0061	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.0026 U	<0.0027 U	<0.0028 U	<0.0027 U	<0.0028 U	<0.0029 U	<0.0027 U	0.011	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.0026 U	<0.0027 U	<0.0028 U	<0.0027 U	<0.0028 U	<0.0029 U	<0.0027 U	0.005	**4 D**
Chrysene	(mg/kg)	**0.023**	**0.023**	**0.027**	**0.043**	**0.053**	**0.0022 J**	<0.0027 U	0.053	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.0026 U	<0.0027 U	<0.0028 U	<0.0027 U	<0.0028 U	<0.0029 U	<0.0027 U	0.0077	**0.04 D**
Fluorene	(mg/kg)	<0.0026 U	**0.83 J**	**0.95**	**1.6 ML**	**1.6**	**0.03**	**0.028**	1.6	**190 D**
Fluoranthene	(mg/kg)	<0.0026 U	**0.067 J**	**0.055**	**0.087**	**0.1**	**0.0018 J**	<0.0027 U	0.1	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0026 U	<0.0027 U	<0.0028 U	<0.0027 U	<0.0028 U	<0.0029 U	<0.0027 U	0.011	**0.4 D**
Naphthalene	(mg/kg)	**0.0076 B**	**0.19 J**	**0.054**	**1.2 ML**	**1.7**	**0.027**	**0.019 B**	1.7	**2.1 E**
Phenanthrene	(mg/kg)	**0.038**	**1.7**	**2.1**	**2.8 ML**	**3.7**	**0.05**	**0.024**	3.7	**1680 D**
Pyrene	(mg/kg)	**0.059**	**0.051**	**0.06**	**0.088**	**0.1**	**0.0033 J**	<0.0027 U	0.1	**110 D**
2-Methylnaphthalene	(mg/kg)	**0.02**	**0.43 J**	**0.24**	**9.6**	**12**	**0.054**	**0.023**	12	**6.1 F**
1-Methylnaphthalene	(mg/kg)	<0.0026 U	**0.32**	**0.48**	**3.2 ML**	**2.9**	**0.017**	**0.011**	3.2	**6.2 F**

Table 10-4a: AOC D3 Non-Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D3	D3-SB06	4-6	6/15/2014	D3-SB06-4.0-6.0-0614	<0.0085 U	<0.0085 U	<0.0085 U	<0.017 U	<3.4 U	3.3745	<1.2 U	--	2.7 J,B	2.1 J,B	<3.4 U	<3.4 U	2 J,B

Table 10-4b: AOC D3 Non-Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D3	D3-SB06	4-6	6/15/2014	D3-SB06-4.0-6.0-0614	--	--	0.26 J	<2.3 U	4.3 J	1.9 J	--	2.8 J	14	18	4.9 J	6.86	34.8	41.66

Table 10-4c: AOC D3 Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D3	D3-SB01	6-8	6/14/2014	D3-SB01-6.0-8.0-0614	<0.012 U	<0.012 U	<0.012 U	0.4328 J	64 J	63.5552	220 J	--	<2.02 U	9 J	104	110	900 J
D3	D3-SB04	11-12	6/14/2014	D3-SB04-11.0-12.0-0614	0.0076 J	<0.0086 U	<0.0086 U	<0.0172 U	21 J,B	20.9742	79 J,B	--	4.1 J,B	3 J,B	24	66	400
D3	D3-SB04	3-5	6/14/2014	D3-SB04-3.0-5.0-0614	0.0051 J	<0.0089 U	<0.0089 U	0.0219 J	8.1 J,B	8.0692	68 J,B	--	<3.6 U	4.2 J,B	8.1 J	57	350
D3	D3-SB04	9-11	6/14/2014	D3-SB04-11.0-13.0-0614	0.015 J	0.013 J	<0.0095 U	0.0575	5 J,B	4.933	30 J,B	--	3.8 U,J	<2.26 U	5.5 J,B	29 J	170 J
D3	D3-SB05	4-6	6/15/2014	D3-SB05-4.0-6.0-0614	<0.0099 U	<0.0099 U	<0.0099 U	<0.0198 U	33 B	32.9703	130 B	--	2.4 J,B	6.2 J	38 MH	87 ML	590 ML
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.010	0.010	0.010	0.110	26.220	26.100	105.400	#DIV/0!	3.184	4.932	35.920	69.800	482.00

Table 10-4d: AOC D3 Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D3	D3-SB01	6-8	6/14/2014	D3-SB01-6.0-8.0-0614	--	--	23 J	120	370	68	--	110	670	660	120	513	1440	1953
D3	D3-SB04	11-12	6/14/2014	D3-SB04-11.0-12.0-0614	--	--	22	120	360	58	--	160	800	720	160	502	1680	2182
D3	D3-SB04	3-5	6/14/2014	D3-SB04-3.0-5.0-0614	--	--	1.3 J	28	430	140	--	110	1400	1600	510	459.3	3110	3569.3
D3	D3-SB04	9-11	6/14/2014	D3-SB04-11.0-13.0-0614	--	--	8.8	83	310	57	--	130	730	650	120	401.8	1510	1911.8
D3	D3-SB05	4-6	6/15/2014	D3-SB05-4.0-6.0-0614	--	--	42	220	630	110 MN	--	230	1600	1500	370	892	3330	4222
average with fraction:							19.420	114.200	420.000	86.600		148.000	1040.000	1026.000	256.000			

Table 10-4e: AOC D3 Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.00992	0.01048	0.00978	0.10984	26.10038	19.42000	114.20000	420.00000	86.60000	3.18400	4.93200	35.92000	148.00000	1040.00000	1026.00000	256.00000	3180
Fraction of TPH mass in A&A EC groups	3.11901E-06	3.29508E-06	3.07499E-06	0.00003	0.00821	0.00611	0.03591	0.13205	0.02723	0.00100	0.00155	0.01129	0.04653	0.32699	0.32259	0.08049	1.00
GRO, DRO & RRO A&A Groups	**GRO aromatics**					**DRO aromatics**			**RRO aromatics**	**GRO aliphatics**			**DRO aliphatics**			**RRO aliphatics**	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.008250					0.174067			0.027228	0.013846			0.696118			0.080491	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.000378	0.000399	0.000373	0.004186	0.994664	0.035078	0.206279	0.758643	1.000000	0.072304	0.111999	0.815696	0.066847	0.469738	0.463415	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	2.21%
% of TPH that is DRO=	87.02%
% of TPH that is RRO=	10.77%

GRO % aromatics	0.373388506
GRO % aliphatics	0.626611494
DRO % aromatics	0.200034687
DRO % aliphatics	0.799965313
RRO % aromatics	0.252772913
RRO % aliphatics	0.747227087

Table 10-4f: AOC D3 HRC Input

input to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.373388506
DRO: fraction aromatic	0.200034687
RRO: fraction aromatic	0.252772913

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.035078212
Aromatic C12-C16	0.206278675
Aromatic C16-C21	0.758643113

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.072304478
Aliphatic C6-C8	0.111999273
Aliphatic C8-C10	0.815696249
Aliphatic C10-C12	0.066847335
Aliphatic C12-C16	0.469738031
Aliphatic C16-C21	0.463414634

Notes:

-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons

GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Table 10-5: AOC D3 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
D3	AP-206	NA	8/29/2004	04Y-DT3-22-GW	**0.0092 J**	<0.024 U	**--**	<0.00015 U	<0.00018 U	**0.0013**	**--**
D3	AP-206	NA	6/21/2014	AP-206-WG01-0614	<0.044 U	**0.054 J**	**0.033 J**	<0.0004 U,QL	<0.0004 U,QL	<0.0004 U,QL	<0.0008 U,QL
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0.044	0.054	0.033	0.0004	0.0004	0.0004	0.0008
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:

Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
RRO = residual-range organics

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

Table 10-6: AOC D3 PAH Groundwater Results

Site Name		D3	D3	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		AP-206	AP-206		
Sample Depth		NA	NA		
Sample Date		8/29/2004	6/21/2014		
Sample Name		04Y-DT3-22-GW	AP-206-WG01-0614		
GRO	(mg/L)	**0.0092 J**	<0.044 U	0.044	**2.2 H**
DRO	(mg/L)	<0.024 U	**0.054 J**	0.054	**1.5 H**
RRO	(mg/L)	**--**	**0.033 J**	0.033	**1.1 H**
Acenaphthene	(mg/L)	<0.000011 U	<0.000015 U	0.000015	**0.22 H**
Acenaphthylene	(mg/L)	<0.0000098 U	<0.000015 U	0.000015	**0.22 H**
Anthracene	(mg/L)	<0.000011 U	<0.000015 U	0.000015	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.00002 U	<0.000015 U	0.000015	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.000011 U	<0.000015 U	0.000015	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.000026 U	<0.000015 U	0.000015	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.000013 U	<0.000015 U	0.000015	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.000016 U	<0.000015 U	0.000015	**0.0012 H**
Chrysene	(mg/L)	**0.000011 J**	<0.000015 U	0.000015	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.000017 U	<0.000015 U	0.000015	**0.000012 H**
Fluorene	(mg/L)	<0.000012 U	<0.000015 U	0.000015	**0.15 H**
Fluoranthene	(mg/L)	<0.000024 U	<0.000015 U	0.000015	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.000013 U	<0.000015 U	0.000015	**0.00012 H**
Naphthalene	(mg/L)	<0.000031 U	<0.000015 U	0.000015	**0.073 H**
Phenanthrene	(mg/L)	<0.000031 U	<0.000015 U	0.000015	**1.1 H**
Pyrene	(mg/L)	<0.000028 U	<0.000015 U	0.000015	**0.11 H**
2-Methylnaphthalene	(mg/L)	<0.000012 U	<0.000015 U	0.000015	**0.015 H**
1-Methylnaphthalene	(mg/L)	**--**	<0.000015 U	0.000015	**0.015 H**

Notes:
Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for PAHs

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Table 10-7: AOC D3 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

ProUCL Input File

GRO	d_GRO	DRO	d_DRO	RRO	d_RRO	Benzene	d_Benzene	Toluene	d_Toluene	Ethylbenzene	d_Ethylbenzene	Xylene	d_Xylene
3.4	1	3100	1	35	1								
0.86	1	570	1	110	1								
15	1	2400	1	90	1								
33	1	6600	1	150	1								
16	1	340	1	300	1	0.0042	1	0.0096	0	0.0096	0	0.0192	0
76	1	2200	1	110	1	0.012	0	0.012	0	0.012	0	0.4328	1
13	1	1400	1	230	1	0.0079	0	0.0079	0	0.0079	0	0.0158	0
37	1	3300	1	270	1	0.0076	1	0.0086	0	0.0086	0	0.0172	0
5.4	1	4100	1			0.0051	1	0.0089	0	0.0089	0	0.0219	1
26	1	2400	1			0.015	1	0.013	1	0.0095	0	0.0575	1
210	1	4600	1			0.0092	0	0.0092	0	0.0092	0	0.0184	0
130	1	4700	1			0.0099	0	0.0099	0	0.0099	0	0.0198	0

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

```
      User Selected Options                   Benzene      0.015    maximum detected conc
                  From File  WorkSheet.wst    Toluene      0.013    maximum detected conc
             Full Precision  OFF              Ethylbenzene 0.012    maximum LOD
     Confidence Coefficient  95%              Xylene       0.4328   maximum detected conc
       Number of Bootstrap   10000            GRO          101.2     95%UCL
                 Operations                   DRO          3922      95%UCL
                                              RRO          225       95%UCL
```

GRO

```
                                         General Statistics
         Number of Valid Observations 12                          Number of Distinct Observations 12
         Raw Statistics                                          Log-transformed Statistics
                              Minimum 0.86                                Minimum of Log Data -0.151
                              Maximum 210                                 Maximum of Log Data 5.347
                                 Mean 47.14                                  Mean of log Data 2.976
                               Median 21                                       SD of log Data 1.555
                                   SD 63.2
                    Std. Error of Mean 18.24
              Coefficient of Variation 1.341
                              Skewness 1.962

                                       Relevant UCL Statistics
        Normal Distribution Test                                 Lognormal Distribution Test
            Shapiro Wilk Test Statistic 0.729                        Shapiro Wilk Test Statistic 0.977
           Shapiro Wilk Critical Value 0.859                        Shapiro Wilk Critical Value 0.859
  Data not Normal at 5% Significance Level                 Data appear Lognormal at 5% Significance Level

       Assuming Normal Distribution                             Assuming Lognormal Distribution
                  95% Student's-t UCL 79.9                                          95% H-UCL 429.9
     95% UCLs (Adjusted for Skewness)                                95% Chebyshev (MVUE) UCL 172.4
   95% Adjusted-CLT UCL (Chen-1995) 88.19                          97.5% Chebyshev (MVUE) UCL 223.3
   95% Modified-t UCL (Johnson-1978) 81.63                           99% Chebyshev (MVUE) UCL 323.2

        Gamma Distribution Test                                        Data Distribution
             k star (bias corrected) 0.574          Data appear Gamma Distributed at 5% Significance Level
                          Theta Star 82.19
                         MLE of Mean 47.14
           MLE of Standard Deviation 62.25
                             nu star 13.76
      Approximate Chi Square Value (.05) 6.41                      Nonparametric Statistics
         Adjusted Level of Significance 0.029                                 95% CLT UCL 77.15
            Adjusted Chi Square Value 5.662                              95% Jackknife UCL 79.9
                                                                 95% Standard Bootstrap UCL 75.66
         Anderson-Darling Test Statistic 0.244                         95% Bootstrap-t UCL 128.2
      Anderson-Darling 5% Critical Value 0.77                     95% Hall's Bootstrap UCL 195.8
     Kolmogorov-Smirnov Test Statistic 0.164                 95% Percentile Bootstrap UCL 79.05
   Kolmogorov-Smirnov 5% Critical Value 0.256                      95% BCA Bootstrap UCL 88.75
 Data appear Gamma Distributed at 5% Significance Level    95% Chebyshev(Mean, Sd) UCL 126.7
                                                              97.5% Chebyshev(Mean, Sd) UCL 161.1
        Assuming Gamma Distribution                             99% Chebyshev(Mean, Sd) UCL 228.7
         95% Approximate Gamma UCL 101.2
            95% Adjusted Gamma UCL 114.6

           Potential UCL to Use                                Use 95% Approximate Gamma UCL 101.2
```

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

DRO

```
                                         General Statistics
         Number of Valid Observations 12                          Number of Distinct Observations 11
         Raw Statistics                                          Log-transformed Statistics
                              Minimum 340                                 Minimum of Log Data 5.829
                              Maximum 6600                                Maximum of Log Data 8.795
                                 Mean 2976                                   Mean of log Data 7.735
                               Median 2750                                     SD of log Data 0.879
                                   SD 1824
                    Std. Error of Mean 526.7
              Coefficient of Variation 0.613
                              Skewness 0.386

                                       Relevant UCL Statistics
        Normal Distribution Test                                 Lognormal Distribution Test
            Shapiro Wilk Test Statistic 0.969                        Shapiro Wilk Test Statistic 0.883
           Shapiro Wilk Critical Value 0.859                        Shapiro Wilk Critical Value 0.859
  Data appear Normal at 5% Significance Level              Data appear Lognormal at 5% Significance Level

       Assuming Normal Distribution                             Assuming Lognormal Distribution
                  95% Student's-t UCL 3922                                          95% H-UCL 6897
     95% UCLs (Adjusted for Skewness)                                95% Chebyshev (MVUE) UCL 7019
   95% Adjusted-CLT UCL (Chen-1995) 3905                           97.5% Chebyshev (MVUE) UCL 8658
   95% Modified-t UCL (Johnson-1978) 3931                            99% Chebyshev (MVUE) UCL 11877
```

Table 10-7: AOC D3 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

Gamma Distribution Test

k star (bias corrected) 1.595
Theta Star 1865
MLE of Mean 2976
MLE of Standard Deviation 2356
nu star 38.29
Approximate Chi Square Value (.05) 25.12
Adjusted Level of Significance 0.029
Adjusted Chi Square Value 23.5

Anderson-Darling Test Statistic 0.359
Anderson-Darling 5% Critical Value 0.741
Kolmogorov-Smirnov Test Statistic 0.182
Kolmogorov-Smirnov 5% Critical Value 0.248
Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 4536
95% Adjusted Gamma UCL 4848

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 3842
95% Jackknife UCL 3922
95% Standard Bootstrap UCL 3797
95% Bootstrap-t UCL 4013
95% Hall's Bootstrap UCL 4038
95% Percentile Bootstrap UCL 3823
95% BCA Bootstrap UCL 3883
95% Chebyshev(Mean, Sd) UCL 5272
97.5% Chebyshev(Mean, Sd) UCL 6265
99% Chebyshev(Mean, Sd) UCL 8216

Potential UCL to Use Use 95% Student's-t UCL 3922

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

RRO

General Statistics

Number of Valid Observations 8
Number of Distinct Observations 7

Raw Statistics

Minimum 35
Maximum 300
Mean 161.9
Median 130
SD 94.26
Std. Error of Mean 33.33
Coefficient of Variation 0.582
Skewness 0.346

Log-transformed Statistics

Minimum of Log Data 3.555
Maximum of Log Data 5.704
Mean of log Data 4.901
SD of log Data 0.705

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.93
Shapiro Wilk Critical Value 0.818
Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.924
Shapiro Wilk Critical Value 0.818
Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 225

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 221
95% Modified-t UCL (Johnson-1978) 225.7

Assuming Lognormal Distribution

95% H-UCL 358.5
95% Chebyshev (MVUE) UCL 350
97.5% Chebyshev (MVUE) UCL 429.5
99% Chebyshev (MVUE) UCL 585.6

Gamma Distribution Test

k star (bias corrected) 1.861
Theta Star 86.97
MLE of Mean 161.9
MLE of Standard Deviation 118.7
nu star 29.78
Approximate Chi Square Value (.05) 18.32
Adjusted Level of Significance 0.0195
Adjusted Chi Square Value 16.09

Anderson-Darling Test Statistic 0.28
Anderson-Darling 5% Critical Value 0.722
Kolmogorov-Smirnov Test Statistic 0.17
Kolmogorov-Smirnov 5% Critical Value 0.296
Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 263.1
95% Adjusted Gamma UCL 299.6

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 216.7
95% Jackknife UCL 225
95% Standard Bootstrap UCL 213.6
95% Bootstrap-t UCL 230.5
95% Hall's Bootstrap UCL 220.9
95% Percentile Bootstrap UCL 214.4
95% BCA Bootstrap UCL 215
95% Chebyshev(Mean, Sd) UCL 307.1
97.5% Chebyshev(Mean, Sd) UCL 370
99% Chebyshev(Mean, Sd) UCL 493.5

Potential UCL to Use Use 95% Student's-t UCL 225

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Table 10-8: AOC D3 Outlier Test Results

Outlier Tests for Selected Variables

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers with Rosner test	1

Dixon's Outlier Test for DRO

Number of data = 12
10% critical value: 0.49
5% critical value: 0.546
1% critical value: 0.642

1. Data Value 6600 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.332

For 10% significance level, 6600 is not an outlier.
For 5% significance level, 6600 is not an outlier.
For 1% significance level, 6600 is not an outlier.

2. Data Value 340 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.243

For 10% significance level, 340 is not an outlier.
For 5% significance level, 340 is not an outlier.
For 1% significance level, 340 is not an outlier.

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Table 10-9a: AOC D3 HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	maximum detected conc	max LOD, ND in 2014	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	maximum detected conc	max LOD, ND in 2014	
Ethylbenzene (c & nc)	max LOD, ND in 2014	max LOD, ND in 2014	
Xylenes (total) (nc)	maximum detected conc	max LOD, ND in 2014	
GRO	95%UCL	max LOD, ND in 2014	
DRO	95%UCL	max measured conc in 2014	
RRO	95%UCL	max measured conc in 2014	
GRO aromatics	site specific VPH & EPH data	modeled from soils data	
DRO aromatics	site specific VPH & EPH data	modeled from soils data	
RRO aromatics	site specific VPH & EPH data	modeled from soils data	
GRO aliphatics	site specific VPH & EPH data	modeled from soils data	
DRO aliphatics	site specific VPH & EPH data	modeled from soils data	
RRO aliphatics	site specific VPH & EPH data	modeled from soils data	
Acenaphthene (nc)	max measured conc	max LOD in 2014	
Acenaphthylene (nc)	max measured conc	max LOD in 2014	
Anthracene (nc)	max measured conc	max LOD in 2014	
Benzo(g,h,i)perylene (nc)	max DL (pre-2014) or LOD (2014)	max LOD in 2014	
Fluoranthene (nc)	max measured conc	max LOD in 2014	
Fluorene (nc)	max measured conc	max LOD in 2014	
Naphthalene (c & nc)	max measured conc	max LOD in 2014	
Phenanthrene (nc)	max measured conc	max LOD in 2014	
Pyrene (nc)	max measured conc	max LOD in 2014	
Benzo(a)anthracene (c)	max measured conc	modeled from soils data	
Benzo(b)fluoranthene (c)	max measured conc	modeled from soils data	
Benzo(k)fluoranthene (c)	max DL (pre-2014) or LOD (2014)	modeled from soils data	
Benzo(a)pyrene (c)	max DL (pre-2014) or LOD (2014)	modeled from soils data	
Chrysene (c)	max measured conc	modeled from soils data	
Dibenz(a,h)anthracene (c)	max DL (pre-2014) or LOD (2014)	modeled from soils data	
Indeno(1,2,3-cd)pyrene (c)	max DL (pre-2014) or LOD (2014)	modeled from soils data	
1-Methylnaphthalene (nc)	max measured conc	max LOD in 2014	
2-Methylnaphthalene (nc)	max measured conc	max LOD in 2014	

Hydrocarbon Characterization Data

Hydrocarbon Fractions	Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_5-C_6	Site specific EPH & VPH data
Aliphatic C_6-C_8	Site specific EPH & VPH data
Aliphatic C_8-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:
BTEX = benzene, toluene, ethylbenzene, xylene
(c) = carcinogen
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
(nc) = non-carcinogen
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Table 10-9b: AOC D3 HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	**Input Values**			**Source of Data**
bulk density (lbs/ft^3)	125.0538462			D sites average value
specific gravity	2.824666667			D sites average value
moisture content (% by weight)	8.6625			D sites average value
foc	0.005826667			D sites average value
Soil temp (C)	5.3			D sites average value
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt			D sites average value
Hydrogeologic Conditions				
Source length (ft)	106			scaled from site maps
Average precipitation (in/yr)	143.44			NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	6.52E-05			average value of D2, D3, and D4
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8			estimated thickness of the aquifer based on the 2014 boring logs
Infiltration rate (m/yr)	0.7286752			20% of average precipitation
Hydraulic gradient	0.0085			Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1			Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters				
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3			NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth				
depth to groundwater at seasonal low water level at downgradient end of source (ft)	55			Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	6			Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	12			Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	0			Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time				
Soil Direct Contact	1			Site specific conceptual site model
Outdoor Air	1			Site specific conceptual site model
Indoor Air	0			Site specific conceptual site model
Groundwater Ingestion	0			Site specific conceptual site model
Other Input				
ADEC Hazard ID	0			ADEC CS database
Latitude	0			ADEC CS database
Longitude	0			ADEC CS database
Width of Source (ft)	66			scaled from site maps
Area of NAPL contaminated soil source (ft^2)	6996			scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.0085			Measured slope of water table
Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	125.05	125.05	125.05	D sites average value
specific gravity of solids	2.824667	2.824667	2.824667	D sites average value
moisture content (% by weight)	8.66	8.66	8.66	D sites average value
foc	0.005827	0.005827	0.005827	D sites average value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	0.1	0.1	0.1	Site Specific (depth to source minus foundation depth--distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	6.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 10-10: AOC D3 Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	2.64046E-07	0.0264	0.0061
Outdoor air inhalation	5.25114E-09	0.0005	0.0002
Indoor air inhalation (vapor intrusion)	1.66308E-07	0.0166	0.0062
Groundwater Ingestion	1.5376E-07	0.0154	0.0024
Cumulative Risk	**1E-06**	**0.1**	**0.0**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	7.94421E-07	0.0794	0.0697
Outdoor air inhalation	2.27792E-08	0.0023	0.0009
Indoor air inhalation (vapor intrusion)	6.98493E-07	0.0698	0.0259
Groundwater Ingestion	2.58317E-07	0.0258	0.0034
Cumulative Risk	**2E-06**	**0.2**	**0.10**

Notes:
Fraction of Risk values equal to or less than one meet the ADEC risk standard
Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 10-11: AOC D3 Summary of Bulk Fuel Hydrocarbon Risk

	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Fraction of Risk Values				
			Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor intrusion)	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	37	0.000	<1	<1	<1	<1	<1
DRO Aromatics	785	0.000	<1	<1	<1	<1	<1
RRO Aromatics	57	0.000	<1	No RfC	No Rfc	<1	<1
GRO Aliphatics	63	0.000	<1	<1	<1	<1	<1
DRO Aliphatics	3137	0.000	<1	<1	<1	<1	<1
RRO Aliphatics	168	0.000	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	37	0.000	<1	<1	<1	<1	<1
DRO Aromatics	785	0.000	<1	<1	<1	<1	<1
RRO Aromatics	57	0.000	<1	No Rfc	No Rfc	<1	<1
GRO Aliphatics	63	0.000	<1	<1	<1	<1	<1
DRO Aliphatics	3137	0.000	<1	<1	1.070	<1	<1
RRO Aliphatics	168	0.000	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics

GRO = gasoline-range organics

mg/kg = milligrams per kilogram

Table 10-12: AOC D3 Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
Benzene (c & nc)	0.04	0.025	MTGW	0.021	MTGW	0.015	NA	0.11	MTGW
2-Methylnaphthalene (nc)	12	6.1	MTGW	10	MTGW	12	NA	118	MTGW
total DRO	6600	230	MTGW	1200	MTGW	3922	12500	10370	Soil Direct Contact

Notes:
ACL = alternate cleanup level
(c) = carcinogen
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
MTGW = migration to groundwater
NA = not applicable
(nc) = non-carcinogen

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11.0 AOC D4 – ARMY DOCK AREA – FORMER 1000 BBL TANK – NO. 833

11.1 AREA DESCRIPTION AND BACKGROUND

AOC D4 is the site of former Tank No. 833 (AST4) within the historical Army Dock area tank farm. The tank farm served as the primary fuel off-loading and storage site for World War II military activities in Yakutat. Eight ASTs (ASTs 1–8) with tank capacities ranging from 20,000 to 80,000 gal and associated piping were used to store and transfer diesel fuel to the dock at Monti Bay. The former location of AST4 was along the gravel road leading from Ocean Cape Road down to the existing Malaspina warehouse, immediately southwest of the current Delta Western tank farm. The AST and associated piping at this location have been removed, and there was no evidence of the former tank pad present.

Two surface soil samples previously collected at the site had DRO concentrations of 320 mg/kg and 400 mg/kg at 1 foot bgs. Four subsurface soil samples had DRO concentrations ranging from 5,200 mg/kg to 614 mg/kg. DRO was detected from 2 to 12 feet bgs, with the highest concentrations occurring between 5 and 12 feet bgs (S&W 2006a). DRO was not detected in groundwater samples collected from monitoring well AST 4-4, north of the source area (S&W 2006b).

Data collected during the previous investigations were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at AOC D4. These data, along with field screening results and visual observations, were reviewed to select appropriate sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations and the estimated NAPL source area at AOC D4 are shown on Figure 11-1.

11.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC D4 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Evaluate current groundwater conditions.

11.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC D4 included advancement of soil borings, collection of soil and groundwater samples, and aquifer (slug) testing. These activities are described below by media.

11.3.1 Soil

Historical data shows that contamination at AOC D4 appears to be limited to the vadose zone extending to a maximum depth of 14 feet bgs. Based on these data, six soil borings were advanced to depths ranging from 4 to 17 feet bgs to collect data for the HRC; two borings north of the former AST pad (D4-SB01 and SB02), three within the footprint of the former AST (D4-SB03, SB04 and SB06), and one south of the former AST (D4-SB05). Subsurface soils at the site consist primarily of fine, silty sand and poorly graded, fine to medium sands with some gravel. Soil boring logs are included in Appendix C.

Field screening samples were collected from above and below the target interval and screened for volatile organics using a PID. Soil samples collected for laboratory analysis were selected from the target depth(s) or adjusted to the most likely contaminated depth based on field observations (e.g., PID, visual, and olfactory). Soil samples were collected from three depths at D4-SB04, two depths at D4-SB03 and SB06, and one depth at D4-SB01, SB02 and SB05. All samples were analyzed for GRO, DRO, RRO, BTEX, and PAHs, and samples from D4-SB01, SB03, SB04 (two only) and SB05 were submitted for VPH and EPH analyses. Due to the low field screening results in the target sample for D4-SB01, the sample from 2 to 4 feet bgs at D4-SB06 was also analyzed for VPH/EPH to supplement the data for the HRC.

Field observations and screening results were used to refine the estimated limits of the NAPL source area shown on Figure 11-1.

BACKGROUND SOIL CONDITIONS

Soil samples collected outside the AOC D NAPL source areas were analyzed to assess the geophysical properties (e.g., grain size, bulk density, moisture content, and specific gravity) and the naturally occurring organic carbon content of soils at the site. Refer to Section 8.3.1 for a discussion on background sampling activities at AOC D.

11.3.2 Groundwater

Groundwater assessment for the site included sampling of existing monitoring well AST4-4. Groundwater samples were collected using a bladder pump with a dedicated bladder and analyzed for GRO, DRO, RRO, BTEX, and PAHs. Well locations are shown on Figure 11-1 and Low Flow Groundwater Sample Collection Records are included in Appendix D.

AQUIFER TESTING

Subsequent to sampling, slug tests were performed on monitoring well AST4-4 to obtain hydraulic conductivity values for input into the HRC. These tests were conducted using a solid slug to displace the water column, and were performed and evaluated following the procedures outlined in Section 3.4.5. Slug test data are included in Appendix E and results are discussed in Section 11.4 below.

11.4 GROUNDWATER CONDITIONS

As discussed in Section 8.4, groundwater contours were developed for the AOC D area (Figure 8-3) and show an overall groundwater flow direction to the northwest, with an apparent localized cone of depression in the vicinity of City of Yakutat water supply wells ARCO #1 and/or ARCO #2. Horizontal gradients across AOC D were averaged with a resulting gradient estimated at 0.0085 ft/ft.

Since limited data were available, hydraulic conductivity values calculated for the four wells at AOC D2, AOC D3 and AOC D4 were averaged, based on site proximity. An overall hydraulic conductivity of 0.184 ft/day was used as input in the HRC for the site.

11.5 ANALYTICAL RESULTS

11.5.1 Soil

A total of ten soil samples were collected from six soil borings at the site and submitted for laboratory analyses. These data were collected from the most highly contaminated soils identified in this area to supplement historical data for input in evaluating risk. Results show that eight of the ten samples had DRO concentrations above the Method Two cleanup level ranging from 480 mg/kg to 4,500 mg/kg. Concentrations of 1-methylnaphthalene in one soil sample and 2-methylnaphthalene in two soil samples also exceeded Method Two cleanup levels. No other analytes were reported at concentrations above Method Two cleanup levels at AOC D4. Soil analytical results for the samples collected in 2014 are presented in summary tables provided in Appendix J. Sample locations are shown on Figure 11-1 and a cross sectional view of the site showing the vertical extent of impacts is presented along A-A’ as Figure 11-2.

Constituent data collected within the defined source zone were used to supplement the historical data set for characterization of the NAPL source zone. Historical and recent (2014) POL data evaluated for the AOC D4 area are presented in Table 11-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 11-2. Historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attention of these constituents. PAH soil data are presented in Table 11-3, and VPH/EPH results are presented in Table 11-4. These data were used as input in calculating soil ACLs and to evaluate risk at AOC D4 using the HRC.

11.5.2 Groundwater

Groundwater assessment at the site included sampling monitoring well AST4-4. Analytical results indicate that constituent concentrations detected in groundwater at the site did not exceed the Table C groundwater cleanup levels. Analytical results are summarized in Appendix J.

Results for AST4-4 were used to supplement historical groundwater data for the AOC D4 area. Historical and recent (2014) groundwater results for POLs and PAHs are summarized in Table 11-5 and Table 11-6, respectively.

11.6 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC D4; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

11.6.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet the ADEC “Cleanup Complete” criteria, the AOC D4 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion).

The AOC D4 risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at the site at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be incomplete at the present time, because there are no occupied buildings within 30 feet of the site. The groundwater ingestion exposure route is considered to be complete at the present time, due to the possible influence of the pumping wells on groundwater flow in this area (Figure 8-3). Water samples from these pumping wells and AOC D4 monitoring well AST4-4 show all chemical results below 1/10th of the Table C drinking water standard. Current and future groundwater exposure is considered to be insignificant based on groundwater data results and AOC D4 soil impacts limited to the vadose zone. Surface water and sediment pathways are considered incomplete based on the unlikely potential for surface runoff or sediment transport to nearby surface water bodies.

The AOC D4 exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

11.6.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each hydrocarbon constituent (BTEX 2014 data only) and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in Table 11-2. The source area data set for BTEX constituents had a limited number of relatively low concentration detections; therefore, the maximum detected values from the source area were used as exposure point concentrations. There were adequate data to calculate 95% UCLs for GRO, DRO, and RRO, so ProUCL was used to calculate 95% UCLs for the HRC input. ProUCL formatted outputs are displayed in Table 11-7.

Table 11-8 presents the ProUCL outlier test results for DRO, and as shown, the test indicated that the highest DRO concentration measured at the site (4,500 mg/kg) was not a statistical outlier. A Q-Q plot and box plot of the DRO source area data are presented in Figure 11-3a and Figure 11-3b. Both the Q-Q and box plots show that the highest DRO concentration did not graph significantly above the other data, which also suggests that the highest DRO result was not a statistical outlier.

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 11-3. All of the PAHs were detected at the site, so the maximum detected PAH concentrations were used as the exposure point concentrations.

Eight VPH and EPH source area samples were used to characterize the bulk hydrocarbon chemistry. The HRC input values calculated from the source area VPH/EPH data are shown in Table 11-4.

The source of each HRC soil exposure point input value is documented in Table 11-9a.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

Benzene, toluene and ethylbenzene were not detected at the site; therefore, the maximum LOD for the samples collected from the source area well was used as the exposure point concentration. Xylene, GRO, DRO and RRO were detected at the site, so the maximum detected concentration was used as input to the HRC. VPH and EPH analysis were not performed on groundwater from AOC D4, so the GRO, DRO and RRO aromatic and aliphatic concentrations used as input to the HRC were modeled using the soils data.

All of the PAH constituents were detected during the 2014 groundwater sampling event; therefore, the maximum detected concentrations were used as the exposure point concentrations in the HRC risk evaluation.

The source of each HRC groundwater exposure point input value is documented in Table 11-9a.

11.6.3 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to AOC D4 is presented in Table 11-9b.

11.6.4 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results is included as Table N-6 of Appendix N and the risk posed by the site conditions is summarized in Table 11-10 and Table 11-11. Table N-6 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for AOC D4 indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).
- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aromatic and aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.
- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, the site conditions are protective of human health under an unrestricted (residential) land use scenario.

11.7 ALTERNATIVE CLEANUP LEVELS

Constituents and/or hydrocarbon fractions exceeding ADEC Method Two cleanup levels at AOC D4 include 1-methylnaphthalene, 2-methylnaphthalene and DRO. Soil ACLs have been developed for these constituents and/or hydrocarbon fractions as shown in Table 11-12.

DRO, 1-methylnaphthalene, and 2-methylnaphthalene exceed the Method Two migration to groundwater cleanup levels. However, the migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult's Law) and dilution-attenuation calculations are applied, the AOC D4 exposure point concentrations meet the migration to groundwater criteria. Under these conditions, it is typically not necessary to calculate ACLs, but for this contract ACLs have been back calculated for site COPCs and are presented in Table 11-12. The exposure point concentrations at AOC D4 are less than the ACLs calculated using the HRC, documenting that the site meets the ADEC migration to groundwater criteria.

11.8 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at AOC D was evaluated and a preliminary ecological CSM was developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at AOC D4 are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.
- There is not significant surface water runoff or sediment transport from the site to surface water bodies (e.g. nearby pond) based on topography, vegetative cover, and lack of surface soil contamination.
- While Monti Bay is located north of the site, groundwater results indicate petroleum hydrocarbons are not migrating to the marine environment at concentrations above Alaska WQS for TAH or TAqH.
- Petroleum hydrocarbons in surface soil at AOC D (D1 – D8) cover 0.31 acre. The impacted surface soil areas are less than the ADEC 0.5 acre *de minimis* criterion. Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.
- Risk to the environment has been evaluated for the AOC D area (in entirety) using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation of the AOC D4 area is not needed and site conditions are protective of the environment.

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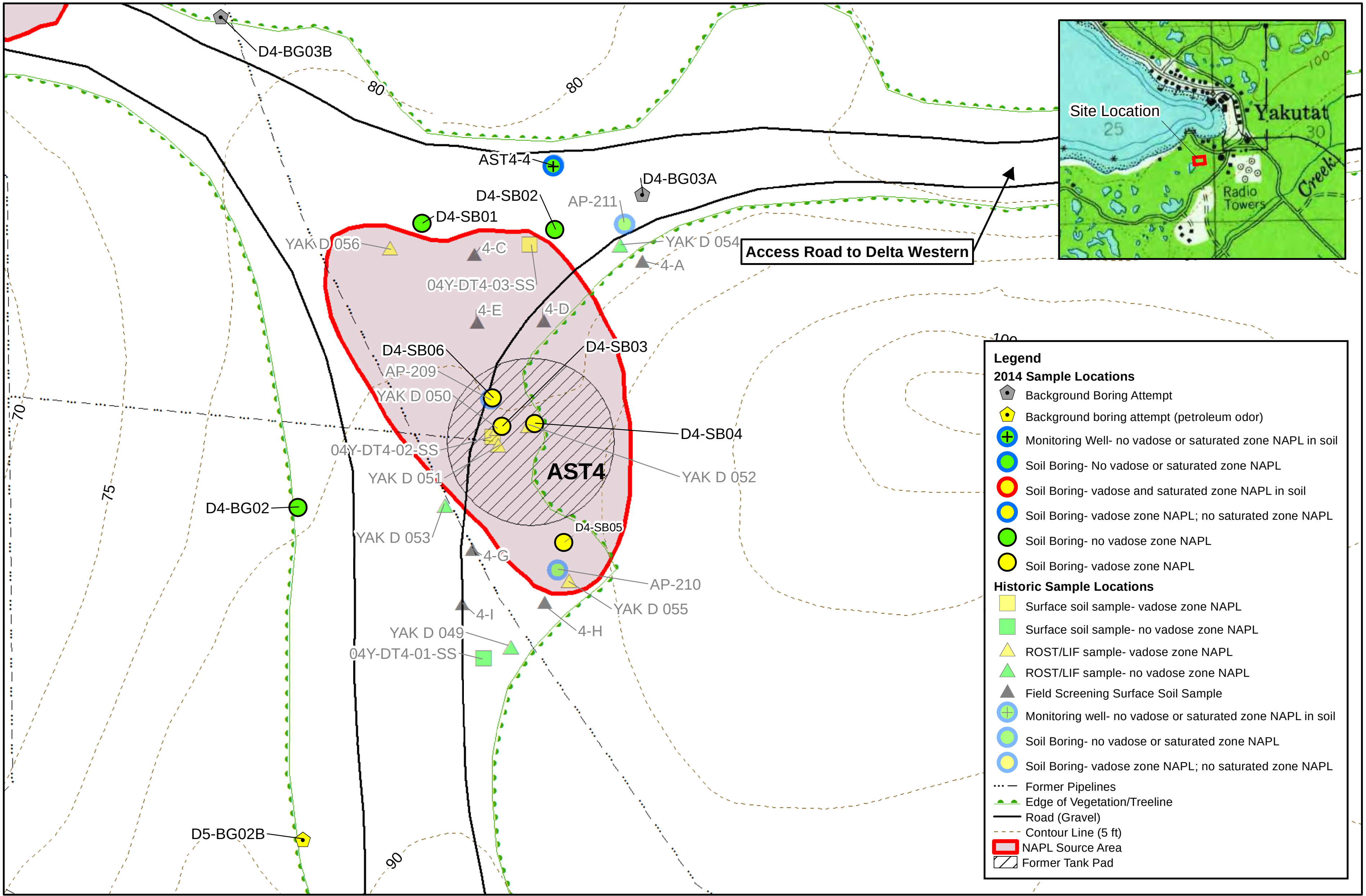

N
W E
S

FIGURE 11-1

AOC D4
NAPL Source Areas and Sample Locations

US Army Corps
of Engineers
Alaska District

0 15 30 Feet
1 in = 30 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

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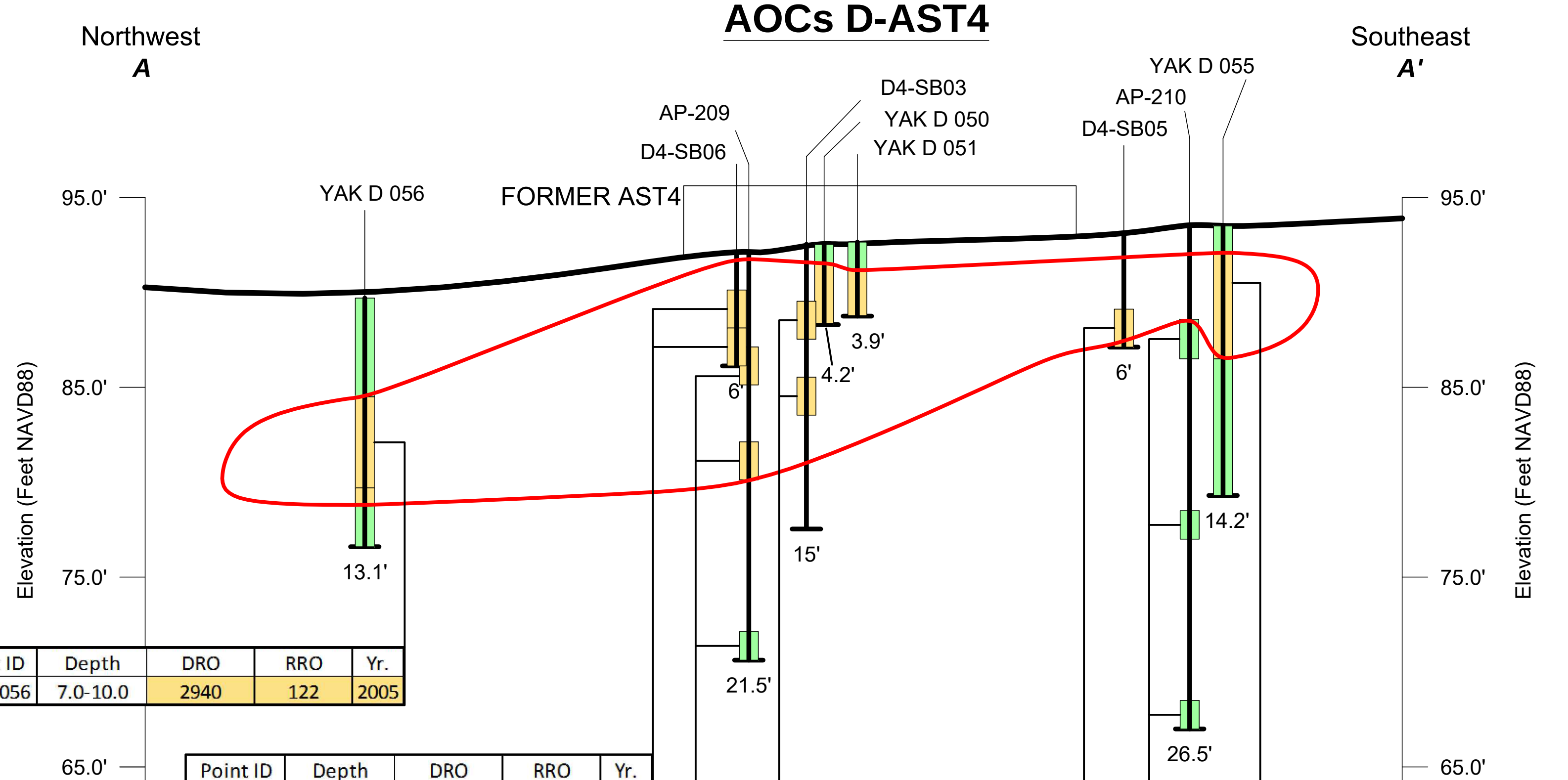
AOCs D-AST4



Point ID	Depth	DRO	RRO	Yr.
YAK D 056	7.0-10.0	2940	122	2005

Point ID	Depth	DRO	RRO	Yr.
D4-SB06	2.0-4.0	1200	110	2014
	4.0-6.0	2900	180	2014

Point ID	Depth	DRO	RRO	Yr.
AP-209	5.0-7.0	4400	NA	2004
	10.0-12.0	1300	NA	2004
	20.0-21.5	1.6 J	NA	2004

Point ID	Depth	DRO	RRO	Yr.
D4-SB03	3.0-5.0	4500	340	2014
	7.0-9.0	580	38 J	2014

Point ID	Depth	DRO	RRO	Yr.
YAK D 055	2.0-5.0	614	ND	2005

Point ID	Depth	DRO	RRO	Yr.
AP-210	5.0-7.0	3.8 J	NA	2004
	15.0-16.5	1.4 J	NA	2004
	25.0-26.5	1.3 J	NA	2004

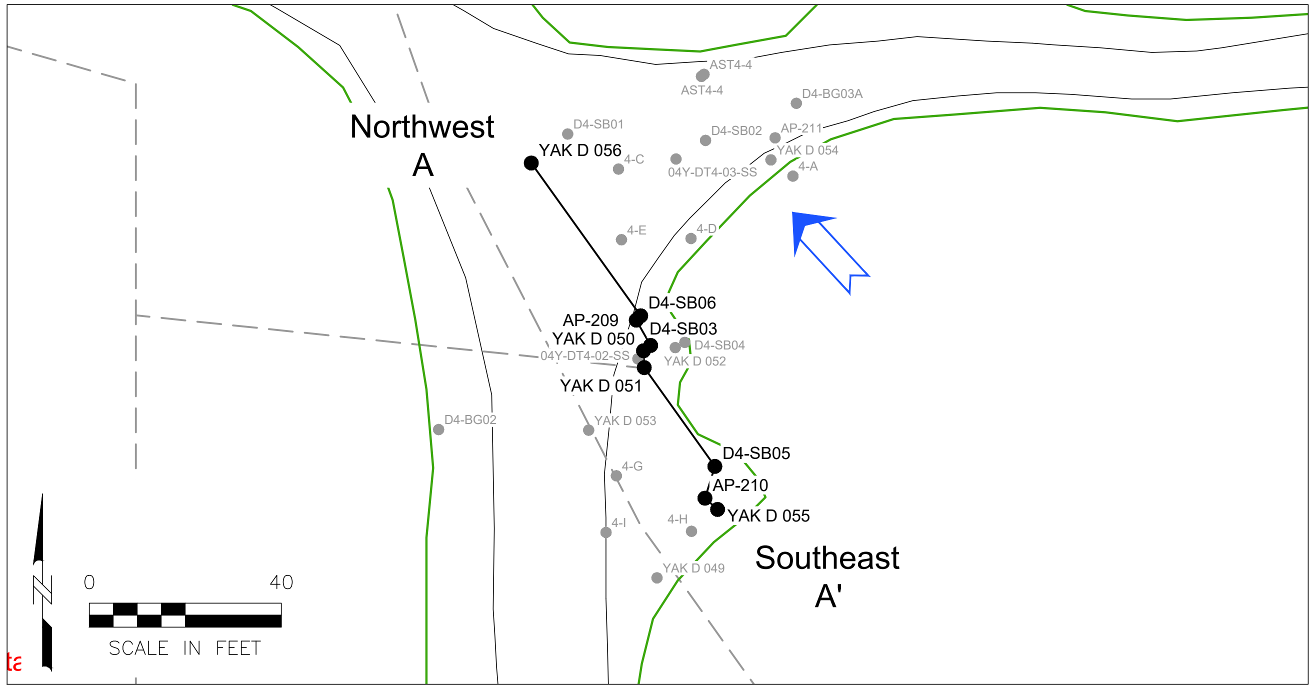
Point ID	Depth	DRO	RRO	Yr.
D4-SB05	4.0-6.0	1900	89	2014

Notes
Depth = feet below ground surface
DRO = diesel range organics
mg/kg = milligram per kilogram
mg/L = milligram per liter
NA = not analyzed
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
ROST = rapid optical screening tool
RRO = residual range organics
Yr. = year sample was collected

All DRO and RRO results are in mg/kg unless otherwise noted on the figure. See Appendix J for result qualifiers.

Location IDs beginning with YAK identify historical ROST borings. ROST results with percent reference emitter limits >1% are considered to be above the NAPL threshold (>230 mg/kg for DRO and RRO).

CROSS SECTION INDEX



LEGEND

🟩 NO VADOSE ZONE NAPL
🟨 VADOSE ZONE NAPL
🟦 NO SATURATED ZONE NAPL
🟥 SATURATED ZONE NAPL
⇨ GROUNDWATER FLOW DIRECTION
— ESTIMATED VERTICAL EXTENT OF NAPL SOURCE ZONE

Figure: 11-2

CROSS SECTION A-A'
AOC D-AST4

U.S. Army
Corps of Engineers
Alaska District

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawin: AECOM
Date: 01/16/15

Last saved by: SCHWARTZE(2016-03-29) Last Plotted: 2016-03-29
Filename: L:\GROUP\CAD\YAKUTAT AFB\FIGURES\YAK_FIG_11-2_ A-A' D-AST4.DWG

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FIGURE 11-3a: AOC D4 DRO Q-Q Plot

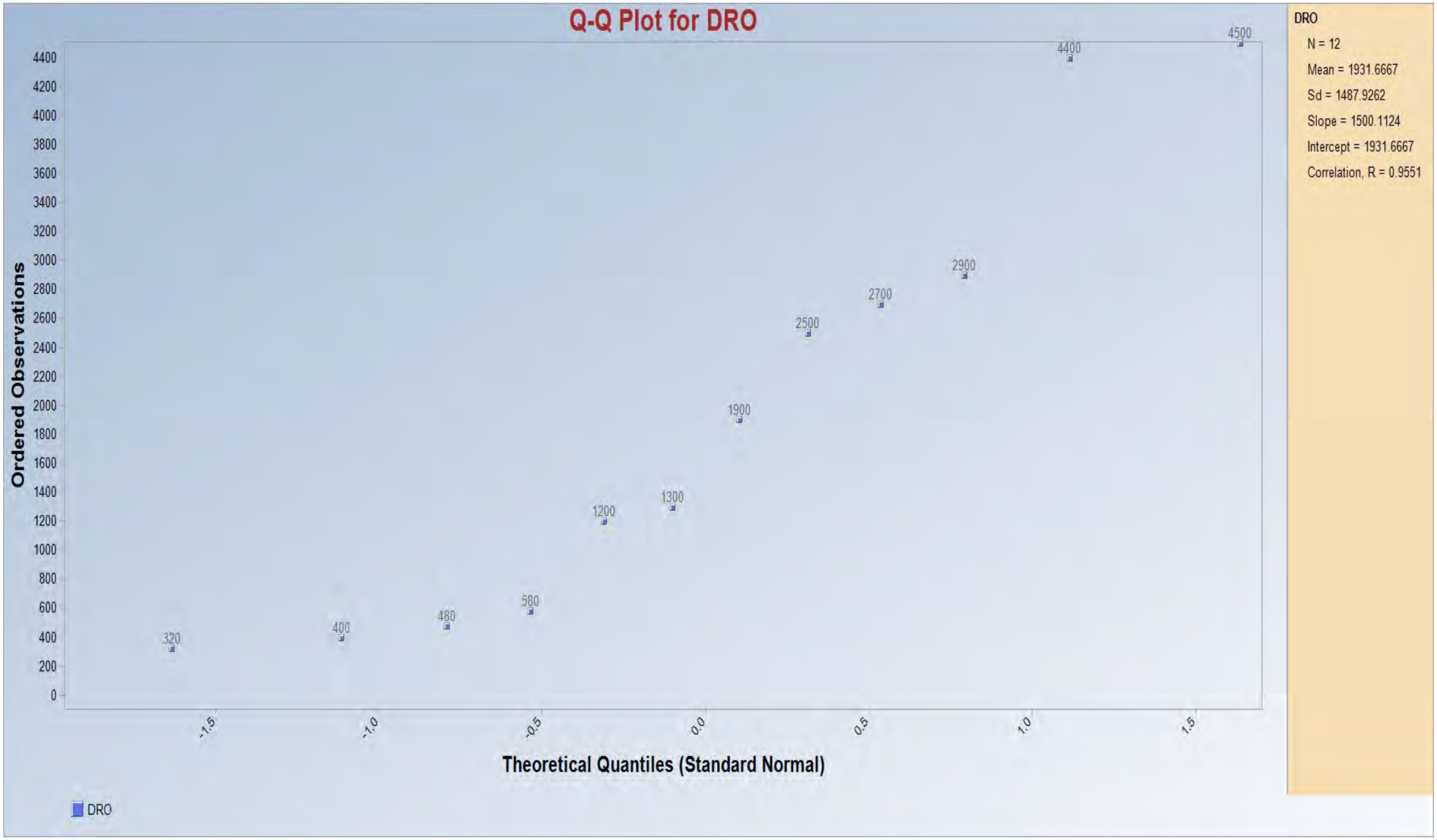

FIGURE 11-3b: AOC D4 DRO Box Plot

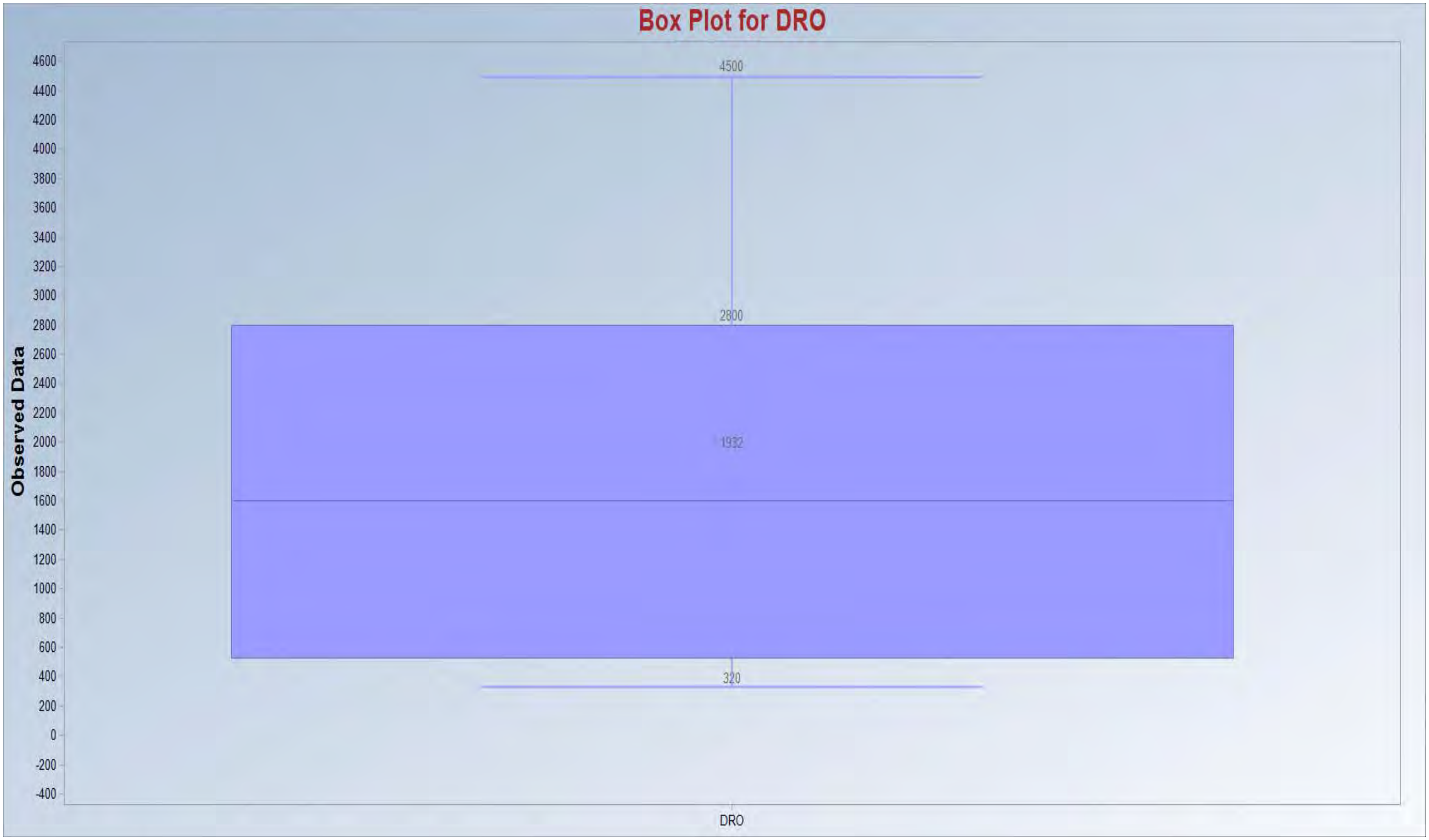

Table 11-1: AOC D4 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D4	04Y-DT4-01-SS	0-0	8/17/2004	04Y-DT4-01-SS	**0.82 J**	**33**	**--**	<0.0008 U	**0.0024 J**	**0.0048 J**	**--**
D4	04Y-DT4-02-SS	0-0	8/17/2004	04Y-DT4-02-SS	<0.25 U	**320**	**--**	<0.0009 U	**0.0025 J**	**0.0069 J**	**--**
D4	04Y-DT4-03-SS	0-0	8/17/2004	04Y-DT4-03-SS	**4.3**	**400**	**--**	**0.002 J**	**0.0012**	**0.0067**	**--**
D4	AP-209	5-7	8/19/2004	04Y-DT4-04-SO	**19**	**4400**	**--**	<0.0027 U	**0.019**	**0.025**	**--**
D4	AP-209	10-12	8/19/2004	04Y-DT4-07-SO	<0.22 U	**1300**	**--**	**0.0017 J**	**0.0033 J**	**0.0059 J**	**--**
D4	AP-209	20-21.5	8/19/2004	04Y-DT4-08-SO	<0.18 U	**1.6 J**	**--**	<0.0006 U	**0.0012 J**	**0.0048 J**	**--**
D4	AP-210	5-7	8/19/2004	04Y-DT4-09-SO	<0.21 U	**3.8 J**	**--**	<0.0008 U	**0.0053 J**	**0.004 J**	**--**
D4	AP-210	15-16.5	8/19/2004	04Y-DT4-10-SO	<0.19 U	**1.4 J**	**--**	<0.0007 U	**0.002 J**	**0.0053 J**	**--**
D4	AP-210	25-26.5	8/19/2004	04Y-DT4-11-SO	<0.21 U	**1.3 J**	**--**	**0.0052 J**	<0.0007 U	**0.0069 J**	**--**
D4	AP-211	15-17	8/23/2004	04Y-DT4-12-SO	**0.47 J**	<0.65 U	**--**	**0.0014 J**	<0.0006 U	**0.0032 J**	**--**
D4	AP-211	30-32	8/23/2004	04Y-DT4-13-SO	<0.25 U	<0.64 U	**--**	<0.0009 U	**0.0028 J**	**0.0058 J**	**--**
D4	AP-211	40-42	8/23/2004	04Y-DT4-14-SO	<0.21 U	**1.4 J**	**--**	**0.0017 J**	**0.0015 J**	**0.0048 J**	**--**
D4	AST4-4	47-48.8	9/20/2005	05Y-DT4-05-SO	**0.795 J**	<1.98 U	**--**	<0.00452 U	<0.00905 U	<0.0174 U	<0.02645 U
D4	AST4-4	52-54	9/21/2005	05Y-DT4-06-SO	**0.881 J**	**2.06 J**	**--**	<0.00422 U	<0.00843 U	<0.0162 U	<0.02463 U
D4	AST4-4	57-59	9/21/2005	05Y-DT4-07-SO	**0.499 J**	<2.13 U	**--**	**0.00593 J**	<0.00685 U	<0.0132 U	<0.02005 U
D4	D4-BG02	4-6	6/20/2014	D4-BG02-4.0-6.0-0614	**3.9 B**	<7.1 U	<27 U	**--**	**--**	**--**	**--**
D4	D4-BG02	8-10	6/20/2014	D4-BG02-8.0-10.0-0614	**1.6 B**	**6 J**	<26 U	**--**	**--**	**--**	**--**
D4	D4-SB01	8-9	6/18/2014	D4-SB01-8.0-9.0-0614	**6.9 B**	**140**	<29 U	<0.011 U,QL	<0.011 U	<0.011 U	<0.022 U
D4	D4-SB02	0-2	6/19/2014	D4-SB02-0.0-2.0-0614	**1.8 B**	**8.5 J**	<28 U	**0.0029 QL**	<0.0062 U	<0.0062 U	**0.027 J**
D4	D4-SB03	3-5	6/19/2014	D4-SB03-3.0-5.0-0614	**74 B,QH**	**4500**	**340**	<0.011 U,QL	<0.011 U	<0.011 U	<0.022 U
D4	D4-SB03	7-9	6/19/2014	D4-SB03-7.0-9.0-0614	**50 B,QH**	**580**	**38 J**	<0.009 U,QL	<0.009 U	<0.009 U	<0.018 U
D4	D4-SB04	3-5	6/19/2014	D4-SB04-3.0-5.0-0614	**4.9 B**	**2700**	**130**	**0.0054 QL**	**0.0068 J**	<0.011 U	**0.026 J**
D4	D4-SB04	9-11	6/19/2014	D4-SB04-9.0-11.0-0614	**59 B,QH**	**2500**	**150**	**0.0039 QL**	**0.012 J**	<0.0088 U	**0.0368 J**
D4	D4-SB04	13-15	6/19/2014	D4-SB04-13.0-15.0-0614	**15 B**	**480**	**75**	**0.0056 QL**	<0.01 U	<0.01 U	<0.02 U
D4	D4-SB05	4-6	6/19/2014	D4-SB05-4.0-6.0-0614	**24 B**	**1900**	**89**	<0.0094 U	<0.0094 U	<0.0094 U	<0.0188 U
D4	D4-SB06	2-4	6/19/2014	D4-SB06-2.0-4.0-0614	**28 B**	**1200 ML**	**110**	<0.012 U	<0.012 U	**0.0073 J**	<0.024 U
D4	D4-SB06	4-6	6/19/2014	D4-SB06-4.0-6.0-0614	**44 B**	**2900**	**180**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					74	4500	340	0.00593	0.019	0.025	0.0368
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
BTEX= benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
RRO = residual-range organics
mg/kg = milligrams per kilogram
HRC = hydrocarbon risk calculator
NA = not applicable
-- = not analyzed

Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
U = not detected
UJ = not detected, detection limit estimated
J = estimated value
B = analyte detected in blank
JB= estimated value & analyte detected in blank
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 11-2: AOC D4 Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D4	04Y-DT4-02-SS	0-0	8/17/2004	04Y-DT4-02-SS	<0.25 U	**320**	--	--	--	--	--
D4	04Y-DT4-03-SS	0-0	8/17/2004	04Y-DT4-03-SS	**4.3**	**400**	--	--	--	--	--
D4	AP-209	5-7	8/19/2004	04Y-DT4-04-SO	**19**	**4400**	--	--	--	--	--
D4	AP-209	10-12	8/19/2004	04Y-DT4-07-SO	<0.22 U	**1300**	--	--	--	--	--
D4	D4-SB03	3-5	6/19/2014	D4-SB03-3.0-5.0-0614	**74 B,QH**	**4500**	**340**	<0.011 U,QL	<0.011 U	<0.011 U	<0.022 U
D4	D4-SB03	7-9	6/19/2014	D4-SB03-7.0-9.0-0614	**50 B,QH**	**580**	**38 J**	<0.009 U,QL	<0.009 U	<0.009 U	<0.018 U
D4	D4-SB04	3-5	6/19/2014	D4-SB04-3.0-5.0-0614	**4.9 B**	**2700**	**130**	**0.0054 QL**	**0.0068 J**	<0.011 U	**0.026 J**
D4	D4-SB04	9-11	6/19/2014	D4-SB04-9.0-11.0-0614	**59 B,QH**	**2500**	**150**	**0.0039 QL**	**0.012 J**	<0.0088 U	**0.0368 J**
D4	D4-SB04	13-15	6/19/2014	D4-SB04-13.0-15.0-0614	**15 B**	**480**	**75**	**0.0056 QL**	<0.01 U	<0.01 U	<0.02 U
D4	D4-SB05	4-6	6/19/2014	D4-SB05-4.0-6.0-0614	**24 B**	**1900**	**89**	<0.0094 U	<0.0094 U	<0.0094 U	<0.0188 U
D4	D4-SB06	2-4	6/19/2014	D4-SB06-2.0-4.0-0614	**28 B**	**1200 ML**	**110**	<0.012 U	<0.012 U	**0.0073 J**	<0.024 U
D4	D4-SB06	4-6	6/19/2014	D4-SB06-4.0-6.0-0614	**44 B**	**2900**	**180**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					74	4500	340	0.0056	0.012	0.0073	0.0368
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
BTEX= benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
RRO = residual-range organics
mg/kg = milligrams per kilogram
HRC = hydrocarbon risk calculator
NA = not applicable
-- = not analyzed

Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
U = not detected
UJ = not detected, detection limit estimated
J = estimated value
B = analyte detected in blank
JB= estimated value & analyte detected in blank
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 11-3: AOC D4 PAH Soils Results

Site Name		D4	D4	D4	D4	D4	D4	D4	D4
Boring, Well or Sample Location Number		04Y-DT4-03-SS	AP-209	AP-209	AP-210	AP-211	AP-211	AST4-4	AST4-4
Sample Depth (feet)		0-0	5-7	20-21.5	25-26.5	15-17	40-42	47-48.8	52-54
Sample Date		8/17/2004	8/19/2004	8/19/2004	8/19/2004	8/23/2004	8/23/2004	9/20/2005	9/21/2005
Sample Name		04Y-DT4-03-SS	04Y-DT4-04-SO	04Y-DT4-08-SO	04Y-DT4-11-SO	04Y-DT4-12-SO	04Y-DT4-14-SO	05Y-DT4-05-SO	05Y-DT4-06-SO
GRO	(mg/kg)	**4.3**	**19**	<0.18 U	<0.21 U	**0.47 J**	<0.21 U	**0.795 J**	**0.881 J**
DRO	(mg/kg)	**400**	**4400**	**1.6 J**	**1.3 J**	<0.65 U	**1.4 J**	<1.98 U	**2.06 J**
RRO	(mg/kg)	--	--	--	--	--	--	--	--
Acenaphthene	(mg/kg)	<0.00042 U	<0.0044 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00299 U	<0.0032 U
Acenaphthylene	(mg/kg)	<0.0013 U	**0.15**	<0.00064 U	<0.00063 U	<0.00062 U	<0.00064 U	<0.00299 U	<0.0032 U
Anthracene	(mg/kg)	<0.00054 U	<0.0057 U	<0.00027 U	<0.00027 U	<0.00027 U	<0.00027 U	<0.00299 U	<0.0032 U
Benzo(a)anthracene	(mg/kg)	<0.0011 U	<0.011 U	<0.00055 U	<0.00054 U	<0.00054 U	<0.00055 U	<0.00299 U	<0.0032 U
Benzo(a)pyrene	(mg/kg)	<0.0019 U	<0.02 U	<0.00094 U	<0.00093 U	<0.00092 U	<0.00095 U	<0.00299 U	<0.0032 U
Benzo(b)fluoranthene	(mg/kg)	<0.00071 U	<0.0075 U	<0.00036 U	<0.00035 U	<0.00035 U	<0.00036 U	<0.00299 U	<0.0032 U
Benzo(g,h,i)perylene	(mg/kg)	<0.00098 U	<0.01 U	<0.00049 U	<0.00049 U	<0.00048 U	<0.00049 U	<0.00299 U	<0.0032 U
Benzo(k)fluoranthene	(mg/kg)	<0.00044 U	<0.0047 U	<0.00022 U	<0.00022 U	<0.00022 U	<0.00022 U	<0.00299 U	<0.0032 U
Chrysene	(mg/kg)	**0.0042**	<0.0056 U	<0.00027 U	<0.00027 U	<0.00026 U	<0.00027 U	<0.00299 U	<0.0032 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.00069 U	<0.0073 U	<0.00035 U	<0.00035 U	<0.00034 U	<0.00035 U	<0.00299 U	<0.0032 U
Fluorene	(mg/kg)	<0.00051 U	**1.3**	**0.0035**	<0.00026 U	<0.00025 U	<0.00026 U	<0.00299 U	<0.0032 U
Fluoranthene	(mg/kg)	<0.0013 U	<0.013 U	<0.00063 U	<0.00062 U	<0.00061 U	<0.00063 U	<0.00299 U	<0.0032 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.00096 U	<0.01 U	<0.00048 U	<0.00048 U	<0.00047 U	<0.00048 U	<0.00299 U	<0.0032 U
Naphthalene	(mg/kg)	<0.00064 U	**0.44**	**0.0021**	<0.00032 U	<0.00031 U	<0.00032 U	<0.00299 U	<0.0032 U
Phenanthrene	(mg/kg)	<0.0006 U	**1.1**	**0.0049**	**0.0035**	<0.0003 U	<0.0003 U	<0.00299 U	<0.0032 U
Pyrene	(mg/kg)	**0.025**	**0.1**	<0.00038 U	<0.00038 U	<0.00037 U	<0.00038 U	<0.00299 U	<0.0032 U
2-Methylnaphthalene	(mg/kg)	<0.011 U	**2.1**	<0.0054 U	<0.0054 U	<0.0053 U	<0.0055 U	<0.00299 U	**0.0055 J**
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	--	<0.00299 U	**0.00444 J**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 11-3: AOC D4 PAH Soil Results

Site Name		D4	D4	D4	D4	D4	D4	D4
Boring, Well or Sample Location Number		AST4-4	D4-SB01	D4-SB02	D4-SB03	D4-SB03	D4-SB04	D4-SB04
Sample Depth (feet)		57-59	8-9	0-2	3-5	7-9	3-5	9-11
Sample Date		9/21/2005	6/18/2014	6/19/2014	6/19/2014	6/19/2014	6/19/2014	6/19/2014
Sample Name		05Y-DT4-07-SO	D4-SB01-8.0-9.0-0614	D4-SB02-0.0-2.0-0614	D4-SB03-3.0-5.0-0614	D4-SB03-7.0-9.0-0614	D4-SB04-3.0-5.0-0614	D4-SB04-9.0-11.0-0614
GRO	(mg/kg)	**0.499 J**	**6.9 B**	**1.8 B**	**74 B,QH**	**50 B,QH**	**4.9 B**	**59 B,QH**
DRO	(mg/kg)	<2.13 U	**140**	**8.5 J**	**4500**	**580**	**2700**	**2500**
RRO	(mg/kg)	--	<29 U	<28 U	**340**	**38 J**	**130**	**150**
Acenaphthene	(mg/kg)	<0.00344 U	**0.03**	<0.0028 U	**0.049**	**0.033**	**0.38**	**0.17**
Acenaphthylene	(mg/kg)	<0.00344 U	**0.0061**	<0.0028 U	**0.053**	**0.021**	**0.17**	**0.056**
Anthracene	(mg/kg)	<0.00344 U	**0.011**	<0.0028 U	**0.17**	**0.023**	**0.13**	**0.1**
Benzo(a)anthracene	(mg/kg)	<0.00344 U	<0.0029 U	<0.0028 U	<0.003 U	<0.0027 U	**0.0063**	**0.0055**
Benzo(a)pyrene	(mg/kg)	<0.00344 U	<0.0029 U	<0.0028 U	<0.003 U	<0.0027 U	<0.003 U	<0.0027 U
Benzo(b)fluoranthene	(mg/kg)	<0.00344 U	**0.0017 J**	**0.0025 J**	**0.0071**	<0.0027 U	**0.0043 J**	**0.0028 J**
Benzo(g,h,i)perylene	(mg/kg)	<0.00344 U	<0.0029 U	<0.0028 U	<0.003 U	<0.0027 U	<0.003 U	<0.0027 U
Benzo(k)fluoranthene	(mg/kg)	<0.00344 U	<0.0029 U	<0.0028 U	<0.003 U	<0.0027 U	<0.003 U	<0.0027 U
Chrysene	(mg/kg)	<0.00344 U	**0.0042 J**	**0.0032 J**	**0.049**	**0.0064**	**0.032**	**0.021**
Dibenzo(a,h)anthracene	(mg/kg)	<0.00344 U	<0.0029 U	<0.0028 U	<0.003 U	<0.0027 U	<0.003 U	<0.0027 U
Fluorene	(mg/kg)	<0.00344 U	**0.12**	<0.0028 U	**0.39**	**0.16**	**1.6**	**0.75**
Fluoranthene	(mg/kg)	<0.00344 U	**0.007**	<0.0028 U	**0.073**	**0.01**	**0.071**	**0.05**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.00344 U	<0.0029 U	<0.0028 U	<0.003 U	<0.0027 U	<0.003 U	<0.0027 U
Naphthalene	(mg/kg)	<0.00344 U	**0.047**	**0.0066 B**	**0.15**	**0.039**	**1.1**	**0.35**
Phenanthrene	(mg/kg)	<0.00344 U	**0.18**	**0.0089**	**0.54**	**0.11**	**2.9**	**1.2**
Pyrene	(mg/kg)	<0.00344 U	**0.0067**	<0.0028 U	**0.1**	**0.013**	**0.065**	**0.048**
2-Methylnaphthalene	(mg/kg)	**0.00708 J**	**0.11**	**0.0063**	**0.33**	**0.06**	**15**	**0.49**
1-Methylnaphthalene	(mg/kg)	**0.00583 J**	**0.05**	**0.0038 J**	**0.31**	**0.071**	**8.3**	**0.69**

Table 11-3: AOC D4 PAH Soil Results

	Site Name	D4	D4	D4	D4	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
	Boring, Well or Sample Location Number	D4-SB04	D4-SB05	D4-SB06	D4-SB06		
	Sample Depth (feet)	13-15	4-6	2-4	4-6		
	Sample Date	6/19/2014	6/19/2014	6/19/2014	6/19/2014		
	Sample Name	D4-SB04-13.0-15.0-0614	D4-SB05-4.0-6.0-0614	D4-SB06-2.0-4.0-0614	D4-SB06-4.0-6.0-0614		
GRO	(mg/kg)	**15 B**	**24 B**	**28 B**	**44 B**	74	**260 C**
DRO	(mg/kg)	**480**	**1900**	**1200 ML**	**2900**	4500	**230 C**
RRO	(mg/kg)	**75**	**89**	**110**	**180**	340	**230 H**
Acenaphthene	(mg/kg)	<0.0027 U	**0.086**	**0.063**	**0.16**	0.38	**180 F**
Acenaphthylene	(mg/kg)	**0.007**	**0.032**	**0.038**	**0.076**	0.17	**180 F**
Anthracene	(mg/kg)	<0.0027 U	**0.034**	**0.057**	**0.061**	0.17	**1680 D**
Benzo(a)anthracene	(mg/kg)	<0.0027 U	<0.0028 U	**0.0026 J**	**0.0048 J**	0.0063	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.0027 U	<0.0028 U	**0.002 J**	**0.0026 J**	0.0026	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	<0.0027 U	**0.0028 J**	**0.0046 J**	**0.0053 J**	0.0071	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.0027 U	<0.0028 U	**0.002 J**	**0.0026 J**	0.0026	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.0027 U	<0.0028 U	<0.003 U	**0.0024 J**	0.0024	**4 D**
Chrysene	(mg/kg)	**0.0042 J**	**0.012**	**0.012**	**0.021**	0.049	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.0027 U	<0.0028 U	<0.003 U	**0.0018 J**	0.0018	**0.04 D**
Fluorene	(mg/kg)	<0.0027 U	**0.38**	**0.25**	**0.78**	1.6	**190 D**
Fluoranthene	(mg/kg)	**0.0017 J**	**0.018**	**0.021**	**0.038**	0.073	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0027 U	<0.0028 U	**0.002 J**	**0.003 J**	0.003	**0.4 D**
Naphthalene	(mg/kg)	**0.0021 B**	**0.039**	**0.098**	**0.9**	1.1	**2.1 E**
Phenanthrene	(mg/kg)	**0.013**	**0.46**	**0.39**	**1.1**	2.9	**1680 D**
Pyrene	(mg/kg)	<0.0027 U	**0.021**	**0.03**	**0.053**	0.1	**110 D**
2-Methylnaphthalene	(mg/kg)	**0.0041 J**	**0.11**	**0.62**	**3.1**	15	**6.1 F**
1-Methylnaphthalene	(mg/kg)	**0.0023 B**	**0.15**	**0.32**	**1.6**	8.3	**6.2 F**

Table 11-4a: AOC D4 Non-Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D4	D4-SB01	8-9	6/18/2014	D4-SB01-8.0-9.0-0614	<0.011 U,QL	<0.011 U	<0.011 U	<0.022 U	1.9 J,B	1.867	8.1 J,B	--	<2 U,QL	0.66 J,B	<2 U	3.6 J	35 J,B

Table 11-4b: AOC D4 Non-Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D4	D4-SB01	8-9	6/18/2014	D4-SB01-8.0-9.0-0614	--	--	1.7 J	8.2	23	5.8	--	11	50	52	13	32.9	113	145.9

Table 11-4c: AOC D4 Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D4	D4-SB01	8-9	6/18/2014	D4-SB01-8.0-9.0-0614	<0.011 U,QL	<0.011 U	<0.011 U	<0.022 U	1.9 J,B	1.867	8.1 J,B	--	<2 U,QL	0.66 J,B	<2 U	3.6 J	35 J,B
D4	D4-SB03	3-5	6/19/2014	D4-SB03-3.0-5.0-0614	<0.011 U,QL	<0.011 U	<0.011 U	<0.022 U	21 B	20.967	84 B	--	<2.1 U,QL	1.6 J,B	21	49	350
D4	D4-SB03	7-9	6/19/2014	D4-SB03-7.0-9.0-0614	<0.009 U,QL	<0.009 U	<0.009 U	<0.018 U	18 B	17.973	49 B	--	8.5 J,QL	0.6 J,B	6.1 J	31	230
D4	D4-SB04	3-5	6/19/2014	D4-SB04-3.0-5.0-0614	0.0054 QL	<0.011 U	0.0068 J	0.026 J	2 J,B	1.9672	3.3 J,B	--	<0.41 U,QL	0.19 J,B	<0.41 U	2.2 J	17 J,B
D4	D4-SB04	9-11	6/19/2014	D4-SB04-9.0-11.0-0614	0.0039 QL	<0.0088 U	0.012 J	0.0368 J	19 B	18.9512	75 B	--	<1.6 U,QL	<1.6 U	18	39	300
D4	D4-SB04	13-15	6/19/2014	D4-SB04-13.0-15.0-0614	0.0056 QL	<0.01 U	<0.01 U	<0.02 U	--	--	--	--	--	--	--	--	--
D4	D4-SB05	4-6	6/19/2014	D4-SB05-4.0-6.0-0614	<0.0094 U	<0.0094 U	<0.0094 U	<0.0188 U	14 J,B	13.9718	80 J,B	--	<8.8 U	<8.8 U	12 J	76	400 J
D4	D4-SB06	2-4	6/19/2014	D4-SB06-2.0-4.0-0614	<0.012 U	0.0073 J	<0.012 U	<0.024 U	12 J,B	11.964	53 J,B	--	<2.2 U	<2.2 U,MN	9.5 J	40 ML	260 ML
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.008	0.010	0.010	0.023	12.557	12.523	50.343	#DIV/0!	3.659	2.236	9.859	34.400	227.43

Table 11-4d: AOC D4 Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D4	D4-SB01	8-9	6/18/2014	D4-SB01-8.0-9.0-0614	--	--	1.7 J	8.2	23	5.8	--	11	50	52	13	32.9	113	145.9
D4	D4-SB03	3-5	6/19/2014	D4-SB03-3.0-5.0-0614	--	--	29	250	1000	290	--	300	2200	1900	530	1279	4400	5679
D4	D4-SB03	7-9	6/19/2014	D4-SB03-7.0-9.0-0614	--	--	1.1 J	7.5	38	9.6	--	21	180	200	39	46.6	401	447.6
D4	D4-SB04	3-5	6/19/2014	D4-SB04-3.0-5.0-0614	--	--	27	130	260	41	--	140	710	610	120	417	1460	1877
D4	D4-SB04	9-11	6/19/2014	D4-SB04-9.0-11.0-0614	--	--	11	63	210	40	--	150	780	690	160	284	1620	1904
D4	D4-SB04	13-15	6/19/2014	D4-SB04-13.0-15.0-0614	--	--	0.2 J	1.3 J	49	24	--	2.1 J	130	300	81	50.5	432.1	482.6
D4	D4-SB05	4-6	6/19/2014	D4-SB05-4.0-6.0-0614	--	--	5.7	31	140	24	--	45	250	260	39	176.7	555	731.7
D4	D4-SB06	2-4	6/19/2014	D4-SB06-2.0-4.0-0614	--	--	7.5 MN	48 MN	200	42	--	56	300	290	54 ML	255.5	646	901.5
average with fraction:							10.400	67.375	240.000	59.550		90.638	575.000	537.750	129.500			

Table 11-4e: AOC D4 Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.00841	0.00969	0.01015	0.02345	12.52303	10.40000	67.37500	240.00000	59.55000	3.65857	2.23571	9.85857	90.63750	575.00000	537.75000	129.50000	1739
Fraction of TPH mass in A&A EC groups	4.83883E-06	5.5722E-06	5.83823E-06	0.00001	0.00720	0.00598	0.03875	0.13805	0.03425	0.00210	0.00129	0.00567	0.05213	0.33074	0.30931	0.07449	1.00
GRO, DRO & RRO A&A Groups	**GRO aromatics**					**DRO aromatics**			**RRO aromatics**	**GRO aliphatics**			**DRO aliphatics**			**RRO aliphatics**	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.007233					0.182783			0.034253	0.009061			0.692183			0.074488	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.000669	0.000770	0.000807	0.001865	0.995889	0.032728	0.212021	0.755251	1.000000	0.232248	0.141924	0.625828	0.075319	0.477818	0.446864	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	1.63%	GRO % aromatics	0.443903999
% of TPH that is DRO=	87.50%	GRO % aliphatics	0.556096001
% of TPH that is RRO=	10.87%	DRO % aromatics	0.208902731
		DRO % aliphatics	0.791097269
		RRO % aromatics	0.314996033
		RRO % aliphatics	0.685003967

Table 11-4f: AOC D4 HRC Input

input to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.443903999
DRO: fraction aromatic	0.208902731
RRO: fraction aromatic	0.314996033

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.032727559
Aromatic C12-C16	0.212021084
Aromatic C16-C21	0.755251357

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.232248118
Aliphatic C6-C8	0.141924367
Aliphatic C8-C10	0.625827514
Aliphatic C10-C12	0.075318632
Aliphatic C12-C16	0.477817827
Aliphatic C16-C21	0.446863541

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons

GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Table 11-5: AOC D4 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
D4	AST4-4	NA	9/27/2005	05Y-DT4-08-GW	<0.028 U	<0.0625 U	--	<0.00012 U	<0.00031 U	<0.00031 U	<0.00093 U
D4	AST4-4	NA	6/7/2014	AST4-4-WG01-0614	**0.019 J**	**0.079 J**	**0.098**	<0.0004 U	<0.0004 U	<0.0004 U	**0.00064 J**
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0.019	0.079	0.098	0.0004	0.0004	0.0004	0.00064
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:

Bold = The analyte was detected.

Shading = The result is above the screening criteria.

-- = not analyzed

BTEX= benzene, toluene, ethylbenzene & xylenes

DRO = diesel-range organics

GRO = gasoline-range organics

mg/L = milligrams per liter

NA = not applicable

RRO = residual-range organics

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)

J = estimated value

JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level source:

H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

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Table 11-6: AOC D4 PAH Groundwater Results

Site Name		D4	D4	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		AST4-4	AST4-4		
Sample Depth		NA	NA		
Sample Date		9/27/2005	6/7/2014		
Sample Name		05Y-DT4-08-GW	AST4-4-WG01-0614		
GRO	(mg/L)	<0.028 U	**0.019 J**	0.019	**2.2 H**
DRO	(mg/L)	<0.0625 U	**0.079 J**	0.079	**1.5 H**
RRO	(mg/L)	**--**	**0.098**	0.098	**1.1 H**
Acenaphthene	(mg/L)	<0.0000155 U	**0.000012 QL**	0.000012	**0.22 H**
Acenaphthylene	(mg/L)	<0.0000155 U	**0.000012 QL**	0.000012	**0.22 H**
Anthracene	(mg/L)	<0.0000155 U	**0.000018 J**	0.000018	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.0000155 U	**0.00002**	0.00002	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.0000155 U	**0.000013 J**	0.000013	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.0000155 U	**0.000013 J**	0.000013	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.0000155 U	**0.000011 J**	0.000011	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.0000155 U	**0.000014 J**	0.000014	**0.0012 H**
Chrysene	(mg/L)	<0.0000155 U	**0.000018 J**	0.000018	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.0000103 U	**0.000011 J**	0.000011	**0.000012 H**
Fluorene	(mg/L)	<0.0000155 U	**0.000013 QL**	0.000013	**0.15 H**
Fluoranthene	(mg/L)	<0.0000155 U	**0.000018 J**	0.000018	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.0000155 U	**0.000012 J**	0.000012	**0.00012 H**
Naphthalene	(mg/L)	<0.000032 U	**0.000016 QL**	0.000016	**0.073 H**
Phenanthrene	(mg/L)	<0.0000155 U	**0.000022 QL**	0.000022	**1.1 H**
Pyrene	(mg/L)	<0.0000155 U	**0.000016 J**	0.000016	**0.11 H**
2-Methylnaphthalene	(mg/L)	<0.0000155 U	**0.000016 QL**	0.000016	**0.015 H**
1-Methylnaphthalene	(mg/L)	<0.0000155 U	**0.000014 QL**	0.000014	**0.015 H**

Notes:

Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
PAH = polycyclic aromatic hydrocarbon
RRO = residual-range organics

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for PAHs

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Table 11-7: AOC D4 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

ProUCL Input File

GRO	d_GRO	DRO	d_DRO	RRO	d_RRO	Benzene	d_Benzene	Toluene	d_Toluene	Ethylbenzene	d_Ethylbenzene	Xylene	d_Xylene
0.25	0	320	1	340	1								
4.3	1	400	1	38	1								
0.22	0	1300	1	75	1								
19	1	4400	1	130	1								
74	1	4500	1	150	1	0.011	0	0.011	0	0.011	0	0.022	0
50	1	580	1	89	1	0.009	0	0.009	0	0.009	0	0.018	0
15	1	480	1	110	1	0.0056	1	0.01	0	0.01	0	0.02	0
4.9	1	2700	1	180	1	0.0054	1	0.011	0	0.0068	1	0.026	1
59	1	2500	1			0.0039	1	0.0088	0	0.012	1	0.037	1
24	1	1900	1			0.0094	0	0.0094	0	0.0094	0	0.019	0
28	1	1200	1			0.012	0	0.0073	1	0.012	0	0.024	0
44	1	2900	1			0.01	0	0.01	0	0.01	0	0.02	0

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options		Benzene	0.0056	maximum detected conc
From File	WorkSheet.wst	Toluene	0.0073	maximum detected conc
Full Precision	OFF	Ethylbenzene	0.012	maximum detected conc
Confidence Coefficient	95%	Xylene	0.0368	maximum detected conc
Number of Bootstrap Operations	10000	GRO	40.09	95%UCL
		DRO	2703	95%UCL
		RRO	201	95%UCL

GRO

General Statistics

Number of Valid Data	12	Number of Detected Data	10
Number of Distinct Detected Data	10	Number of Non-Detect Data	2
		Percent Non-Detects	16.67%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	4.3	Minimum Detected	1.459
Maximum Detected	74	Maximum Detected	4.304
Mean of Detected	32.22	Mean of Detected	3.129
SD of Detected	23.57	SD of Detected	0.985
Minimum Non-Detect	0.22	Minimum Non-Detect	-1.514
Maximum Non-Detect	0.25	Maximum Non-Detect	-1.386
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	2
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	10
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	16.67%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Test Statistic	0.909
5% Shapiro Wilk Critical Value	0.842	5% Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	26.87	Mean	2.25
SD	24.71	SD	2.238
95% DL/2 (t) UCL	39.68	95% H-Stat (DL/2) UCL	4687
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	24.38	Mean in Log Scale	2.753
SD	27.4	SD in Log Scale	1.251
95% MLE (t) UCL	38.59	Mean in Original Scale	27.25
95% MLE (Tiku) UCL	38.78	SD in Original Scale	24.28
		95% t UCL	39.84
		95% Percentile Bootstrap UCL	38.61
		95% BCA Bootstrap UCL	39.64
		95% H UCL	123.2
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.187	**Data appear Normal at 5% Significance Level**	
Theta Star	27.14		
nu star	23.75		
A-D Test Statistic	0.256	**Nonparametric Statistics**	
5% A-D Critical Value	0.738	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.738	Mean	27.57
5% K-S Critical Value	0.271	SD	22.91
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	6.972
		95% KM (t) UCL	40.09
Assuming Gamma Distribution		95% KM (z) UCL	39.03
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	39.93
Minimum	0.000001	95% KM (bootstrap t) UCL	41.93
Maximum	74	95% KM (BCA) UCL	39.72
Mean	26.85	95% KM (Percentile Bootstrap) UCL	39.35
Median	21.5	95% KM (Chebyshev) UCL	57.96
SD	24.74	97.5% KM (Chebyshev) UCL	71.11
k star	0.235	99% KM (Chebyshev) UCL	96.94
Theta star	114.1		
Nu star	5.645	**Potential UCLs to Use**	
AppChi2	1.461	95% KM (t) UCL	40.09
95% Gamma Approximate UCL	103.7	95% KM (Percentile Bootstrap) UCL	39.35
95% Adjusted Gamma UCL	130.3		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table 11-7: AOC D4 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

DRO

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12
Raw Statistics		**Log-transformed Statistics**	
Minimum	320	Minimum of Log Data	5.768
Maximum	4500	Maximum of Log Data	8.412
Mean	1932	Mean of log Data	7.217
Median	1600	SD of log Data	0.942
SD	1488		
Std. Error of Mean	429.5		
Coefficient of Variation	0.77		
Skewness	0.648		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.892	Shapiro Wilk Test Statistic	0.916
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2703	95% H-UCL	4716
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4572
95% Adjusted-CLT UCL (Chen-1995)	2724	97.5% Chebyshev (MVUE) UCL	5675
95% Modified-t UCL (Johnson-1978)	2716	99% Chebyshev (MVUE) UCL	7843
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.239	**Data appear Normal at 5% Significance Level**	
Theta Star	1558		
MLE of Mean	1932		
MLE of Standard Deviation	1735		
nu star	29.75		
Approximate Chi Square Value (.05)	18.29	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	2638
Adjusted Chi Square Value	16.93	95% Jackknife UCL	2703
		95% Standard Bootstrap UCL	2608
Anderson-Darling Test Statistic	0.365	95% Bootstrap-t UCL	2831
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	2784
Kolmogorov-Smirnov Test Statistic	0.168	95% Percentile Bootstrap UCL	2618
Kolmogorov-Smirnov 5% Critical Value	0.249	95% BCA Bootstrap UCL	2700
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3804
		97.5% Chebyshev(Mean, Sd) UCL	4614
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6205
95% Approximate Gamma UCL	3141		
95% Adjusted Gamma UCL	3393		
Potential UCL to Use		Use 95% Student's-t UCL	2703

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

RRO

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Raw Statistics		**Log-transformed Statistics**	
Minimum	38	Minimum of Log Data	3.638
Maximum	340	Maximum of Log Data	5.829
Mean	139	Mean of log Data	4.756
Median	120	SD of log Data	0.648
SD	92.52		
Std. Error of Mean	32.71		
Coefficient of Variation	0.666		
Skewness	1.623		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.866	Shapiro Wilk Test Statistic	0.988
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	201	95% H-UCL	272.8
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	280.1
95% Adjusted-CLT UCL (Chen-1995)	212.9	97.5% Chebyshev (MVUE) UCL	341.1
95% Modified-t UCL (Johnson-1978)	204.1	99% Chebyshev (MVUE) UCL	460.9
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.927	**Data appear Normal at 5% Significance Level**	
Theta Star	72.12		
MLE of Mean	139		
MLE of Standard Deviation	100.1		
nu star	30.84		
Approximate Chi Square Value (.05)	19.15	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	192.8
Adjusted Chi Square Value	16.86	95% Jackknife UCL	201
		95% Standard Bootstrap UCL	189
Anderson-Darling Test Statistic	0.193	95% Bootstrap-t UCL	241.9
Anderson-Darling 5% Critical Value	0.722	95% Hall's Bootstrap UCL	469.3
Kolmogorov-Smirnov Test Statistic	0.131	95% Percentile Bootstrap UCL	192.5
Kolmogorov-Smirnov 5% Critical Value	0.296	95% BCA Bootstrap UCL	207.3
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	281.6
		97.5% Chebyshev(Mean, Sd) UCL	343.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	464.5
95% Approximate Gamma UCL	223.8		
95% Adjusted Gamma UCL	254.2		
Potential UCL to Use		Use 95% Student's-t UCL	201

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Table 11-8: AOC D4 Outlier Test Results

```
                         Outlier Tests for Selected Variables
                              User Selected Options
                                    From File   WorkSheet.wst
                               Full Precision   OFF
           Test for Suspected Outliers with Dixon test   1
          Test for Suspected Outliers with Rosner test   1


                       Dixon's Outlier Test for DRO

Number of data = 12
10% critical value: 0.49
5% critical value: 0.546
1% critical value: 0.642

1.  Data Value 4500 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.390

For 10% significance level, 4500 is not an outlier.
For 5% significance level, 4500 is not an outlier.
For 1% significance level, 4500 is not an outlier.

2. Data Value 320 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.039

For 10% significance level, 320 is not an outlier.
```

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Table 11-9a: AOC D4 HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	maximum detected conc	max LOD, ND in 2014	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	maximum detected conc	max LOD, ND in 2014	
Ethylbenzene (c & nc)	maximum detected conc	max LOD, ND in 2014	
Xylenes (total) (nc)	maximum detected conc	max measured conc in 2014	
GRO	95%UCL	max measured conc in 2014	
DRO	95%UCL	max measured conc in 2014	
RRO	95%UCL	max measured conc in 2014	
GRO aromatics	site specific VPH & EPH data	modeled from soils data	
DRO aromatics	site specific VPH & EPH data	modeled from soils data	
RRO aromatics	site specific VPH & EPH data	modeled from soils data	
GRO aliphatics	site specific VPH & EPH data	modeled from soils data	
DRO aliphatics	site specific VPH & EPH data	modeled from soils data	
RRO aliphatics	site specific VPH & EPH data	modeled from soils data	
Acenaphthene (nc)	max measured conc	max measured conc in 2014	
Acenaphthylene (nc)	max measured conc	max measured conc in 2014	
Anthracene (nc)	max measured conc	max measured conc in 2014	
Benzo(g,h,i)perylene (nc)	max measured conc	max measured conc in 2014	
Fluoranthene (nc)	max measured conc	max measured conc in 2014	
Fluorene (nc)	max measured conc	max measured conc in 2014	
Naphthalene (c & nc)	max measured conc	max measured conc in 2014	
Phenanthrene (nc)	max measured conc	max measured conc in 2014	
Pyrene (nc)	max measured conc	max measured conc in 2014	
Benzo(a)anthracene (c)	max measured conc	max measured conc in 2014	
Benzo(b)fluoranthene (c)	max measured conc	max measured conc in 2014	
Benzo(k)fluoranthene (c)	max measured conc	max measured conc in 2014	
Benzo(a)pyrene (c)	max measured conc	max measured conc in 2014	
Chrysene (c)	max measured conc	max measured conc in 2014	
Dibenz(a,h)anthracene (c)	max measured conc	max measured conc in 2014	
Indeno(1,2,3-cd)pyrene (c)	max measured conc	max measured conc in 2014	
1-Methylnaphthalene (nc)	max measured conc	max measured conc in 2014	
2-Methylnaphthalene (nc)	max measured conc	max measured conc in 2014	

Hydrocarbon Characterization Data	
Hydrocarbon Fractions	Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_5-C_6	Site specific EPH & VPH data
Aliphatic C_6-C_8	Site specific EPH & VPH data
Aliphatic C_8-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:
BTEX = benzene, toluene, ethylbenzene, xylene
(c) = carcinogen
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
(nc) = non-carcinogen
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Table 11-9b: AOC D4 HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	**Input Values**			**Source of Data**
bulk density (lbs/ft^3)	125.0538462			D sites average value
specific gravity	2.824666667			D sites average value
moisture content (% by weight)	8.6625			D sites average value
foc	0.005826667			D sites average value
Soil temp (C)	5.3			D sites average value
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt			D sites average value
Hydrogeologic Conditions				
Source length (ft)	85			scaled from site maps
Average precipitation (in/yr)	143.44			NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	6.52E-05			average value of D2, D3, and D4
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8			estimated thickness of the aquifer based on the 2014 boring logs
Infiltration rate (m/yr)	0.7286752			20% of average precipitation
Hydraulic gradient	0.0085			Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1			Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters				
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3			NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth				
depth to groundwater at seasonal low water level at downgradient end of source (ft)	61			Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	6			Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	15			Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	0			Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time				
Soil Direct Contact	1			Site specific conceptual site model
Outdoor Air	1			Site specific conceptual site model
Indoor Air	0			Site specific conceptual site model
Groundwater Ingestion	0			Site specific conceptual site model
Other Input				
ADEC Hazard ID	0			ADEC CS database
Latitude	0			ADEC CS database
Longitude	0			ADEC CS database
Width of Source (ft)	51			scaled from site maps
Area of NAPL contaminated soil source (ft^2)	4335			scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.0085			Measured slope of water table
Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	125.05	125.05	125.05	D sites average value
specific gravity of solids	2.824667	2.824667	2.824667	D sites average value
moisture content (% by weight)	8.66	8.66	8.66	D sites average value
foc	0.005827	0.005827	0.005827	D sites average value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	0.1	0.1	0.1	Site Specific (depth to source minus foundation depth-- distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	6.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 11-10: AOC D4 Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	5.09236E-08	0.0051	0.0092
Outdoor air inhalation	4.09061E-09	0.0004	0.0003
Indoor air inhalation (vapor intrusion)	9.34876E-08	0.0093	0.0033
Groundwater Ingestion	1.6159E-06	0.1616	0.0024
Cumulative Risk	**2E-06**	**0.2**	**0.0**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	1.53353E-07	0.0153	0.1045
Outdoor air inhalation	1.77449E-08	0.0018	0.0010
Indoor air inhalation (vapor intrusion)	3.92648E-07	0.0393	0.0140
Groundwater Ingestion	2.71472E-06	0.2715	0.0034
Cumulative Risk	**3E-06**	**0.3**	**0.10**

Notes:
Fraction of Risk values equal to or less than one meet the ADEC risk standard
Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 11-11: AOC D4 Summary of Bulk Fuel Hydrocarbon Risk

	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Fraction of Risk Values				
			Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor intrusion)	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	18	0.000	<1	<1	<1	<1	<1
DRO Aromatics	565	0.000	<1	<1	<1	<1	<1
RRO Aromatics	63	0.000	<1	No RfC	No Rfc	<1	<1
GRO Aliphatics	22	0.000	<1	<1	<1	<1	<1
DRO Aliphatics	2138	0.000	<1	<1	<1	<1	<1
RRO Aliphatics	138	0.000	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	18	0.000	<1	<1	<1	<1	<1
DRO Aromatics	565	0.000	<1	<1	<1	<1	<1
RRO Aromatics	63	0.000	<1	No Rfc	No Rfc	<1	<1
GRO Aliphatics	22	0.000	<1	<1	<1	<1	<1
DRO Aliphatics	2138	0.000	<1	<1	<1	<1	<1
RRO Aliphatics	138	0.000	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics

GRO = gasoline-range organics

mg/kg = milligrams per kilogram

mg/L = milligram(s) per liter

No RfC = no reference concentration available; risk standard is assumed to be met due to low volatility of the fraction

RRO = residual-range organics

Table 11-12: AOC D4 Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
1-Methylnaphthalene (nc)	8.3	6.2	MTGW	11	MTGW	8.3	NA	104	MTGW
2-Methylnaphthalene (nc)	15	6.1	MTGW	11	MTGW	15	NA	87	MTGW
total DRO	4500	230	MTGW	1200	MTGW	2703	12500	10486	Soil Direct Contact

Notes:

ACL = alternate cleanup level
(c) = carcinogen
DRO = diesel-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
MTGW = migration to groundwater
NA = not applicable
(nc) = non-carcinogen

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12.0 AOC D5 – ARMY DOCK AREA – FORMER 2000 BBL TANK – NO. 830

12.1 AREA DESCRIPTION AND BACKGROUND

AOC D5 is the site of former Tank No. 830 (AST5) within the historical Army Dock area tank farm. The tank farm served as the primary fuel off-loading and storage site for World War II military activities in Yakutat. Eight ASTs (ASTs 1–8) with tank capacities ranging from 20,000 to 80,000 gal and associated piping were used to store and transfer diesel fuel to the dock at Monti Bay. Former ASTs 5 through 8 were installed at the southern portion of the tank farm, at significantly higher elevations than ASTs 1 and 2. Former AST5 was located east of the access road to AOC D, across from the pump house currently used for the Yakutat public water system. Two public water supply wells (ARCO #1 and ARCO #2) are located adjacent to the pump house. The AST and associated piping at this location have been removed, and the concrete tank pad is the only visible evidence remaining.

Three surface soil samples previously collected at the site had DRO concentrations ranging from 380 mg/kg to 13,000, mg/kg. Four subsurface soil samples had DRO detected to a maximum depth of 17 feet bgs, with concentrations ranging from 480 mg/kg to 3,800 mg/kg. The highest concentrations were detected between 5 and 7 feet bgs (S&W 2006a). Petroleum hydrocarbons were not detected in groundwater samples collected from monitoring well AP-214, which is located approximately 10 feet west of the AOC D5 source area (S&W 2006b).

Data from previous investigations were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at AOC D5. These data, along with field screening results and visual observations, were reviewed to select appropriate sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations and the estimated NAPL source area at AOC D5 are shown in conjunction with AOC D6 and AOC D8 on Figure 12-1.

12.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC D5 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Evaluate current groundwater conditions.

12.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC D5 included advancement of soil borings, collection of soil and groundwater samples, and aquifer (slug) testing. These activities are described below by media.

12.3.1 Soil

Supplemental RI activities at the site included advancing seven soil borings to collect HRC data; four borings on the southwest side of the concrete tank pad (D5-SB01 through SB04A) and three just off the northeast edge of the tank pad (D5-SB05 through SB07). One of the borings (D5-SB04A) was advanced at a historical surface soil “hot spot” location with a previous DRO concentration of 13,000 mg/kg. Three step-out borings (D5-SB04B, SB04C and SB04D) were advanced approximately 5 feet away from the original boring to delineate the “hot spot” laterally (Figure 12-1). Due to the close proximity of D5-SB02 and D5-SB04C, only one boring was advanced at this area (designated D5-SB02). Borings were advanced to depths ranging from 4 to 25 feet bgs, with soils generally consisting of fine sands and silt grading to fine to coarse sand with gravel at depth. Some gravel fill is present (adjacent to the tank pad) with clay and clayey sand noted in borings on the northeast side of the pad. Soil boring logs are included in Appendix C.

Field screening samples were collected from above and below the target depth intervals and screened for volatile organics using a PID. Soil samples collected for laboratory analysis were selected from the target depth(s) or adjusted to the most likely contaminated depth based on field observations (e.g., PID, visual, and olfactory). Three soil samples at D5-SB03, two samples from D5-SB02, and one sample from each of the remaining borings were submitted for analysis. The 0 to 2 feet sample from D5-SB02 was submitted in place of the step-out D5-SB04C surface soil sample. All samples were analyzed for GRO, DRO, RRO, BTEX and PAHs, and samples from D5-SB02 (18-20 feet), SB04A, SB05, SB06 and SB07 were also analyzed for VPH and EPH. Field observations and screening results were used to refine the estimated limits of the NAPL source area shown on Figure 12-1.

BACKGROUND SOIL CONDITIONS

Soil samples collected outside the AOC D NAPL source areas were analyzed to assess the geophysical properties (e.g., grain size, bulk density, moisture content, and specific gravity) and the naturally occurring organic carbon content of soils at the site. Refer to Section 8.3.1 for a discussion on background sampling activities at AOC D.

12.3.2 Groundwater

Groundwater assessment for the site included sampling of existing monitoring well AST5-4. Well locations for AOC D5, AOC D6 and AOC D8 are shown on Figure 12-1. Groundwater samples were collected using a bladder pump with a dedicated bladder and analyzed for GRO, DRO, RRO, BTEX, and PAHs. Low Flow Groundwater Sample Collection Records are included in Appendix D.

AQUIFER TESTING

Subsequent to sampling, slug tests were performed on monitoring well AST5-4 to obtain hydraulic conductivity values for input into the HRC. These tests were conducted using a solid slug to displace the water column, and were performed and evaluated following the procedures outlined in Section 3.4.5. Slug test data are included in Appendix E and results are discussed in Section 12.4 below.

12.4 GROUNDWATER CONDITIONS

As discussed in Section 8.4, groundwater contours were developed for the AOC D area (Figure 8-3) and show an overall groundwater flow direction to the northwest, with an apparent localized cone of depression in the vicinity of City of Yakutat water supply wells ARCO #1 and/or ARCO #2. Horizontal gradients across AOC D were averaged with a resulting gradient estimated at 0.0085 ft/ft.

Since limited data were available, hydraulic conductivity values calculated for the wells at AOC D5 and AOC D6 were averaged based on site proximity. An overall hydraulic conductivity of 0.021 ft/day was used as input in the HRC for the site (Table 4-4).

12.5 ANALYTICAL RESULTS

12.5.1 Soil

A total of 12 soil samples were collected from nine soil borings at the site and submitted for laboratory analyses. These data were collected from the most highly contaminated soils identified in this area for input in evaluating risk, and at two step-out locations to define surface soil impacts. Results show that 11 of the 12 samples had DRO concentrations above the Method Two cleanup level ranging from 480 mg/kg to 5,700 mg/kg. In addition to DRO, concentrations of 1-methylnaphthalene and 2-methylnaphthalene in two soil samples exceeded Method Two cleanup levels. No other analytes were reported at concentrations above Method Two cleanup levels. Soil analytical results for the samples collected in 2014 are presented in summary tables provided in Appendix J. Sample locations are shown on Figure 12-1 and cross sectional views of the site showing the vertical extent of impacts are presented along A-A’ as Figure 12-2 and C-C’ as Figure 12-4.

Constituent data collected within the defined source zone were used to supplement the historical data set for characterization of the NAPL source zone. Historical and recent (2014) POL data evaluated for AOC D5 are presented in Table 12-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 12-2. The location of the historical maximum DRO concentration (04Y-DT5-02-SS), which exceeded the ADEC maximum allowable concentration at 13,000 mg/kg, was resampled in 2014. The 2014 samples had much lower DRO concentrations at 2,500 to 2,600 mg/kg and are considered representative of current conditions. Consequently, the 2004 historical maximum concentration was not included in the 95% UCL calculation. Additionally, historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attention of these constituents. PAH soil data are presented in Table 12-3, and VPH/EPH results are presented in Table 12-4. These data were used as input in calculating soil ACLs and to evaluate risk at AOC D5 using the HRC.

12.5.2 Groundwater

Groundwater assessment at the site included sampling monitoring well AST5-4. Analytical results indicate that constituent concentrations detected did not exceed the Table C groundwater cleanup levels. Analytical results are summarized in Appendix J.

Results for AST5-4 were used to supplement historical groundwater data for the AOC D5 area. Historical and recent (2014) groundwater results for POLs and PAHs are summarized in Table 12-5 and Table 12-6, respectively.

12.6 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC D5; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

12.6.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet the ADEC “Cleanup Complete” criteria, the AOC D5 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion).

The AOC D5 risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at the site at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be complete for a site worker scenario at the present time, because there is an occupied building within approximately 30 feet of the AOC D5 source area. The building is a pump house for the Public Works Department and is only entered for periodic maintenance, which constitutes a lower exposure level than the residential and/or industrial scenarios. The groundwater ingestion exposure route is considered to be complete at the present time, due to the possible influence of the pumping wells on groundwater flow in this area (Figure 8-3). Water samples from these wells show all chemical results below 1/10th of the Table C drinking water standard. Surface water and sediment pathways are considered incomplete based on the unlikely potential for surface runoff or sediment transport to nearby surface water bodies.

The AOC D5 exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

12.6.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each hydrocarbon constituent (BTEX 2014 data only) and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in Table 12-2. The source area data set for toluene, ethylbenzene, and total xylenes had a limited number of relatively low concentration detections; therefore, the maximum detected values from the source area were used as exposure point concentrations. Benzene was not detected in the source area in 2014, so the maximum source area LOD was used as the exposure point concentration. There were adequate data to calculate 95% UCLs for GRO, DRO, and RRO, so ProUCL was used to calculate 95% UCLs for the HRC input. ProUCL formatted outputs are displayed in Table 12-7.

Table 12-8 presents the ProUCL outlier test results for DRO, and as shown, the test indicated that the highest DRO concentration included in the 95% UCL calculation (5,700 mg/kg) was not a statistical outlier. A Q-Q plot and box plot of the DRO source area data are presented in Figure 12-5a and Figure 12-5b, respectively. Both the Q-Q and box plots show that the highest DRO concentration did not graph significantly above the other data, which also suggests that the highest DRO result was not a statistical outlier.

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 12-3. All PAH constituents were detected at the site; therefore, the maximum detected PAH concentrations were used as the exposure point concentrations; 95% UCLs were not calculated.

Four VPH and EPH source area samples were used to characterize the bulk hydrocarbon chemistry. The HRC input values calculated from the source area VPH/EPH data are shown in Table 12-4.

The source of each HRC soil exposure point input value is documented in Table 12-9a.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

Benzene, toluene, ethylbenzene and GRO were not detected at the site; therefore, the maximum LOD for the samples collected from the source area well was used as the exposure point concentration. Xylene, DRO and RRO were detected, so the maximum detected concentration was used as input to the HRC. VPH and EPH analysis were not performed at AOC D5; therefore, the GRO, DRO and RRO aromatic and aliphatic concentrations used as input to the HRC were modeled using the soils data.

For the PAH constituents that were detected during the 2014 groundwater sampling event, the maximum detected concentrations were used as the exposure point concentrations in the HRC risk evaluation. For the non-carcinogenic PAH constituents that were not detected during the 2014 groundwater sampling event, the maximum LOD values were used as the exposure point concentrations. None of the carcinogenic PAHs were detected in groundwater, so the groundwater concentrations predicted or modeled by the HRC based on the soil concentration data were used as input to the risk calculations. The modeled concentrations yield more representative risk results.

The source of each HRC groundwater exposure point input value is documented in Table 12-9a.

12.6.3 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to AOC D5 is presented in Table 12-9b.

12.6.4 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results is included as Table N-7 of Appendix N and the risk posed by the site conditions is summarized in Table 12-10 and Table 12-11. Table N-7 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for AOC D5 indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).
- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aromatic and aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.
- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, the site conditions are protective of human health under an unrestricted (residential) land use scenario.

12.7 ALTERNATIVE CLEANUP LEVELS

Constituents and/or hydrocarbon fractions exceeding ADEC Method Two cleanup levels at AOC D5 include 1-methylnaphthalene, 2-methylnaphthalene and DRO. Soil ACLs have been developed for these constituents and/or hydrocarbon fractions as shown in Table 12-12.

1-methylnaphthalene, 2-methylnaphthalene and DRO exceed the Method Two migration to groundwater cleanup levels. However, the migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult's Law) and dilution-attenuation calculations are applied, the AOC D5 exposure point concentrations meet the migration to groundwater criteria. Under these conditions it is typically not necessary to calculate ACLs, but for this contract ACLs have been back calculated for site COPCs and are presented in Table 12-12. The exposure point concentrations at AOC D5 are less than the ACLs calculated using the HRC, documenting that the site meets the ADEC migration to groundwater criteria.

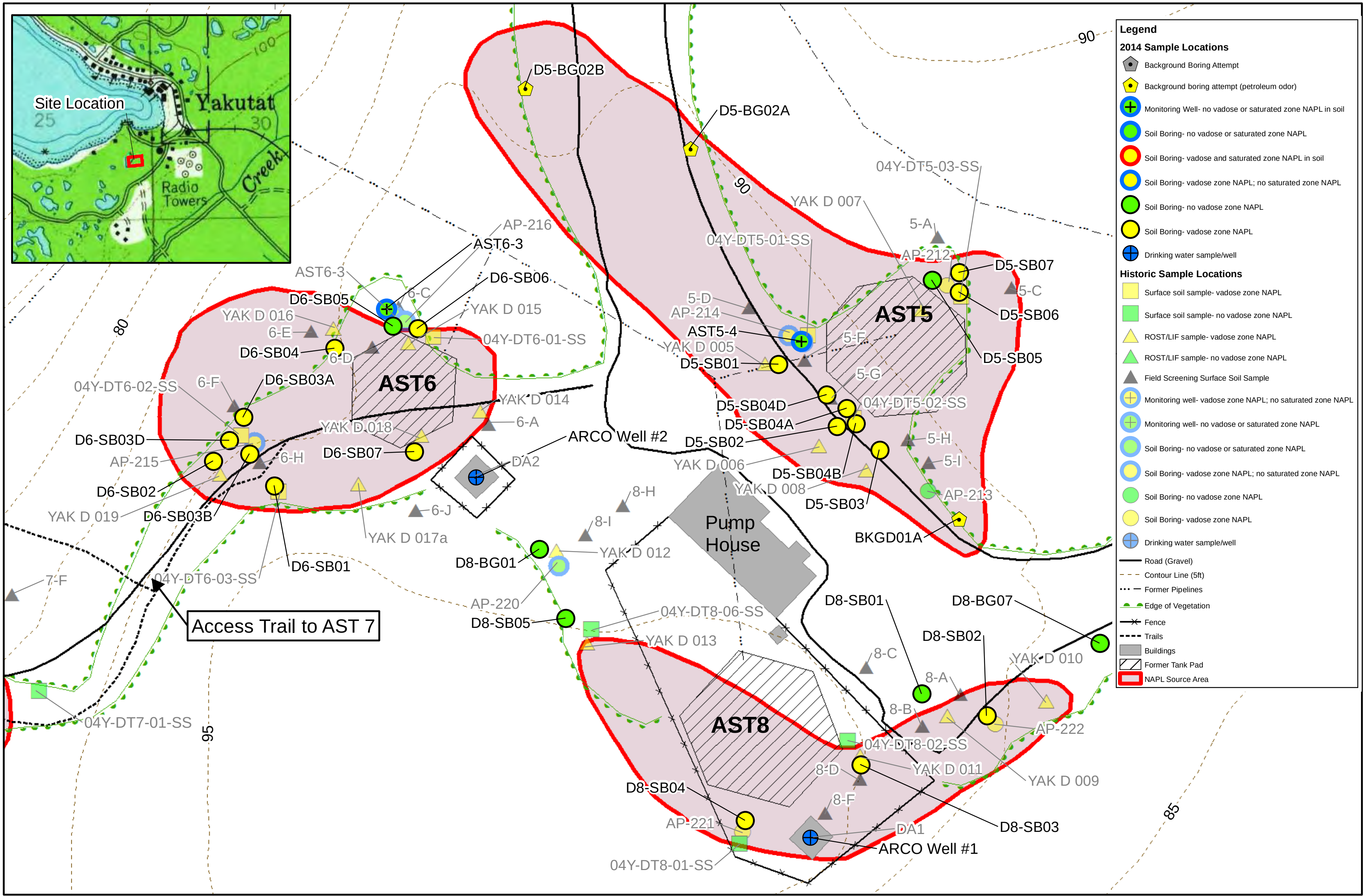
12.8 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at AOC D was evaluated and a preliminary ecological CSM developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at AOC D5 are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.
- There is not significant surface water runoff or sediment transport from the site to surface water bodies (e.g. nearby pond) based on topography, vegetative cover, and the lack of surface soil contamination.

- While Monti Bay is located north of the site, groundwater results indicate petroleum hydrocarbons are not migrating to the marine environment at concentrations above Alaska WQS for TAH or TAqH.
- Petroleum hydrocarbons in surface soil at AOC D (D1 – D8) cover 0.31 acre. The impacted surface soil areas are less than the ADEC 0.5 acre *de minimis* criterion. Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.
- Risk to the environment has been evaluated for the AOC D area (in entirety) using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation of AOC D5 is not needed and site conditions are protective of the environment.



N
W
E
S

FIGURE 12-1

AOC D5, AOC D6, AOC D8
NAPL Source Areas and Sample Locations

US Army Corps
of Engineers
Alaska District

0 20 40
Feet
1 in = 35 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

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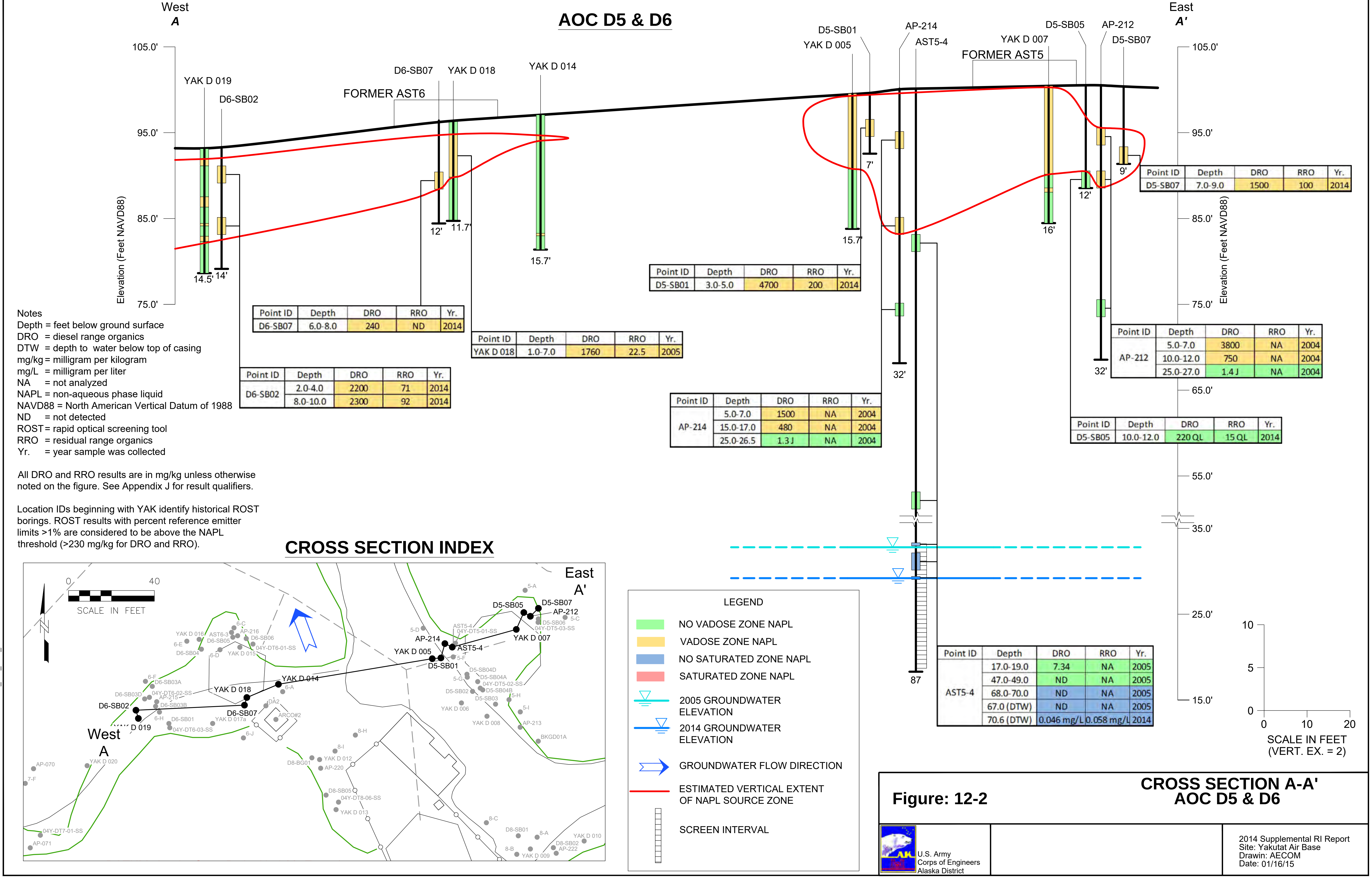
AOC D5 & D6



Point ID	Depth	DRO	RRO	Yr.
D6-SB07	6.0-8.0	240	ND	2014

Point ID	Depth	DRO	RRO	Yr.
YAK D 018	1.0-7.0	1760	22.5	2005

Point ID	Depth	DRO	RRO	Yr.
D6-SB02	2.0-4.0	2200	71	2014
	8.0-10.0	2300	92	2014

Point ID	Depth	DRO	RRO	Yr.
D5-SB01	3.0-5.0	4700	200	2014

Point ID	Depth	DRO	RRO	Yr.
AP-214	5.0-7.0	1500	NA	2004
	15.0-17.0	480	NA	2004
	25.0-26.5	1.3 J	NA	2004

Point ID	Depth	DRO	RRO	Yr.
D5-SB07	7.0-9.0	1500	100	2014

Point ID	Depth	DRO	RRO	Yr.
AP-212	5.0-7.0	3800	NA	2004
	10.0-12.0	750	NA	2004
	25.0-27.0	1.4 J	NA	2004

Point ID	Depth	DRO	RRO	Yr.
D5-SB05	10.0-12.0	220 QL	15 QL	2014

Point ID	Depth	DRO	RRO	Yr.
AST5-4	17.0-19.0	7.34	NA	2005
	47.0-49.0	ND	NA	2005
	68.0-70.0	ND	NA	2005
	67.0 (DTW)	ND	NA	2005
	70.6 (DTW)	0.046 mg/L	0.058 mg/L	2014

Notes
Depth = feet below ground surface
DRO = diesel range organics
DTW = depth to water below top of casing
mg/kg = milligram per kilogram
mg/L = milligram per liter
NA = not analyzed
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
ND = not detected
ROST = rapid optical screening tool
RRO = residual range organics
Yr. = year sample was collected

All DRO and RRO results are in mg/kg unless otherwise noted on the figure. See Appendix J for result qualifiers.

Location IDs beginning with YAK identify historical ROST borings. ROST results with percent reference emitter limits >1% are considered to be above the NAPL threshold (>230 mg/kg for DRO and RRO).

LEGEND

🟩 NO VADOSE ZONE NAPL
🟨 VADOSE ZONE NAPL
🟦 NO SATURATED ZONE NAPL
🟥 SATURATED ZONE NAPL
2005 GROUNDWATER ELEVATION
2014 GROUNDWATER ELEVATION
GROUNDWATER FLOW DIRECTION
ESTIMATED VERTICAL EXTENT OF NAPL SOURCE ZONE
SCREEN INTERVAL

Figure: 12-2

CROSS SECTION A-A'
AOC D5 & D6

U.S. Army
Corps of Engineers
Alaska District

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 01/16/15

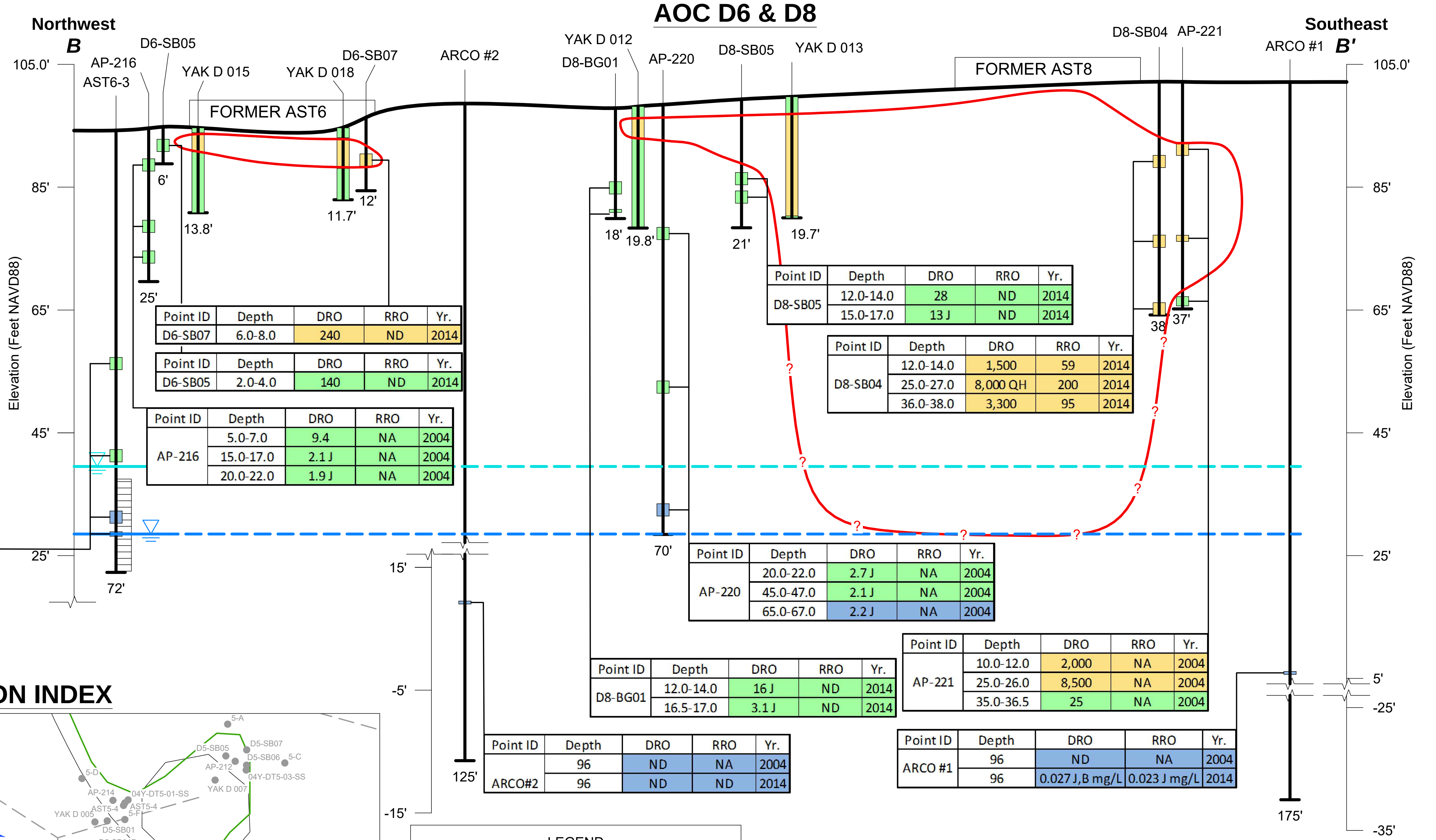
Last saved by: SCHWARTZE(2016-03-29) Last Plotted: 2016-03-29
Filename: L:\GROUP\CAD\YAKUTAT AFB\FIGURES\YAK_FIG_12-2_ A-A' D-AST5 & AST6.DWG

Notes
Depth = feet below ground surface
DRO = diesel range organics
DTW = depth to water below top of casing
mg/kg = milligram per kilogram
mg/L = milligram per liter
NA = not analyzed
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
ROST = rapid optical screening tool
RRO = residual range organics
Yr. = year sample was collected

All DRO and RRO results are in mg/kg unless otherwise noted on the figure. See Appendix J for result qualifiers.

Location IDs beginning with YAK identify historical ROST borings. ROST results with percent reference emitter limits >1% are considered to be above the NAPL threshold (>230 mg/kg for DRO and RRO).

AOC D6 & D8



Point ID	Depth	DRO	RRO	Yr.
D6-SB07	6.0-8.0	240	ND	2014

Point ID	Depth	DRO	RRO	Yr.
D6-SB05	2.0-4.0	140	ND	2014

Point ID	Depth	DRO	RRO	Yr.
AP-216	5.0-7.0	9.4	NA	2004
	15.0-17.0	2.1 J	NA	2004
	20.0-22.0	1.9 J	NA	2004

Point ID	Depth	DRO	RRO	Yr.
AST6-3	37.0-39.0	5.75 J	NA	2005
	52.0-54.0	7.81 J	NA	2005
	62.0-64.0	2.38 J	NA	2005
	65.43 (DTW)	ND	NA	2005
	68.95 (DTW)	0.082 J mg/L	0.08 J mg/L	2014

Point ID	Depth	DRO	RRO	Yr.
D8-SB05	12.0-14.0	28	ND	2014
	15.0-17.0	13 J	ND	2014

Point ID	Depth	DRO	RRO	Yr.
D8-SB04	12.0-14.0	1,500	59	2014
	25.0-27.0	8,000 QH	200	2014
	36.0-38.0	3,300	95	2014

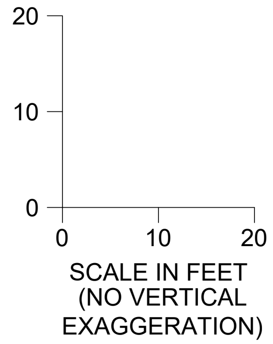
Point ID	Depth	DRO	RRO	Yr.
AP-220	20.0-22.0	2.7 J	NA	2004
	45.0-47.0	2.1 J	NA	2004
	65.0-67.0	2.2 J	NA	2004

Point ID	Depth	DRO	RRO	Yr.
AP-221	10.0-12.0	2,000	NA	2004
	25.0-26.0	8,500	NA	2004
	35.0-36.5	25	NA	2004

Point ID	Depth	DRO	RRO	Yr.
D8-BG01	12.0-14.0	16 J	ND	2014
	16.5-17.0	3.1 J	ND	2014

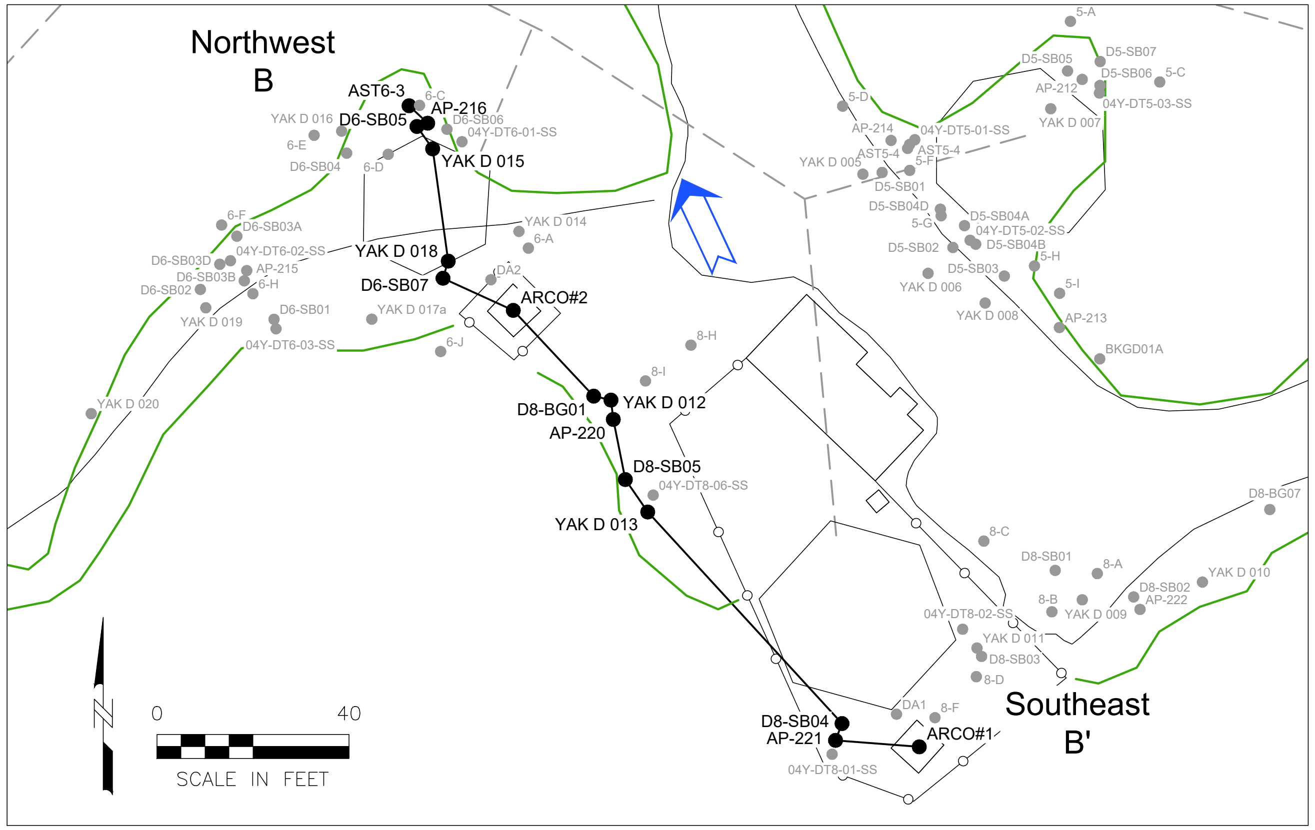
Point ID	Depth	DRO	RRO	Yr.
ARCO#2	96	ND	NA	2004
	96	ND	ND	2014

Point ID	Depth	DRO	RRO	Yr.
ARCO #1	96	ND	NA	2004
	96	0.027 J,B mg/L	0.023 J mg/L	2014



SCALE IN FEET
(NO VERTICAL EXAGGERATION)

CROSS SECTION INDEX



LEGEND

🟩	NO VADOSE ZONE NAPL
🟨	VADOSE ZONE NAPL
🟦	NO SATURATED ZONE NAPL
🟥	SATURATED ZONE NAPL
▽	SEASONAL HIGH GROUNDWATER ELEVATION
▽	SEASONAL LOW GROUNDWATER ELEVATION
⇨	GROUNDWATER FLOW DIRECTION
—	ESTIMATED VERTICAL EXTENT OF NAPL SOURCE ZONE
—?—	VERTICAL EXTENT OF NAPL SOURCE ZONE UNKNOWN
▤	SCREEN INTERVAL

Figure: 12-3

CROSS SECTION B-B'
AOC D6 & D8

U.S. Army
Corps of Engineers
Alaska District

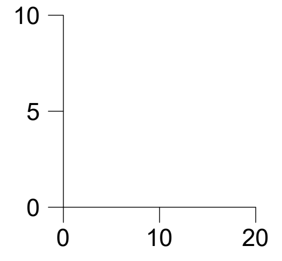
2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 01/16/15

Last saved by: SCHWARTZE(2016-03-29) Last Plotted: 2016-03-29
Filename: L:\GROUP\CAD\YAKUTAT AFB\FIGURES\YAK_FIG_12-3_ B-B' D-AST6 & AST8.DWG

Notes
Depth = feet below ground surface
DRO = diesel range organics
mg/kg = milligram per kilogram
mg/L = milligram per liter
NA = not analyzed
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
ND = not detected
ROST = rapid optical screening tool
RRO = residual range organics
Yr. = year sample was collected

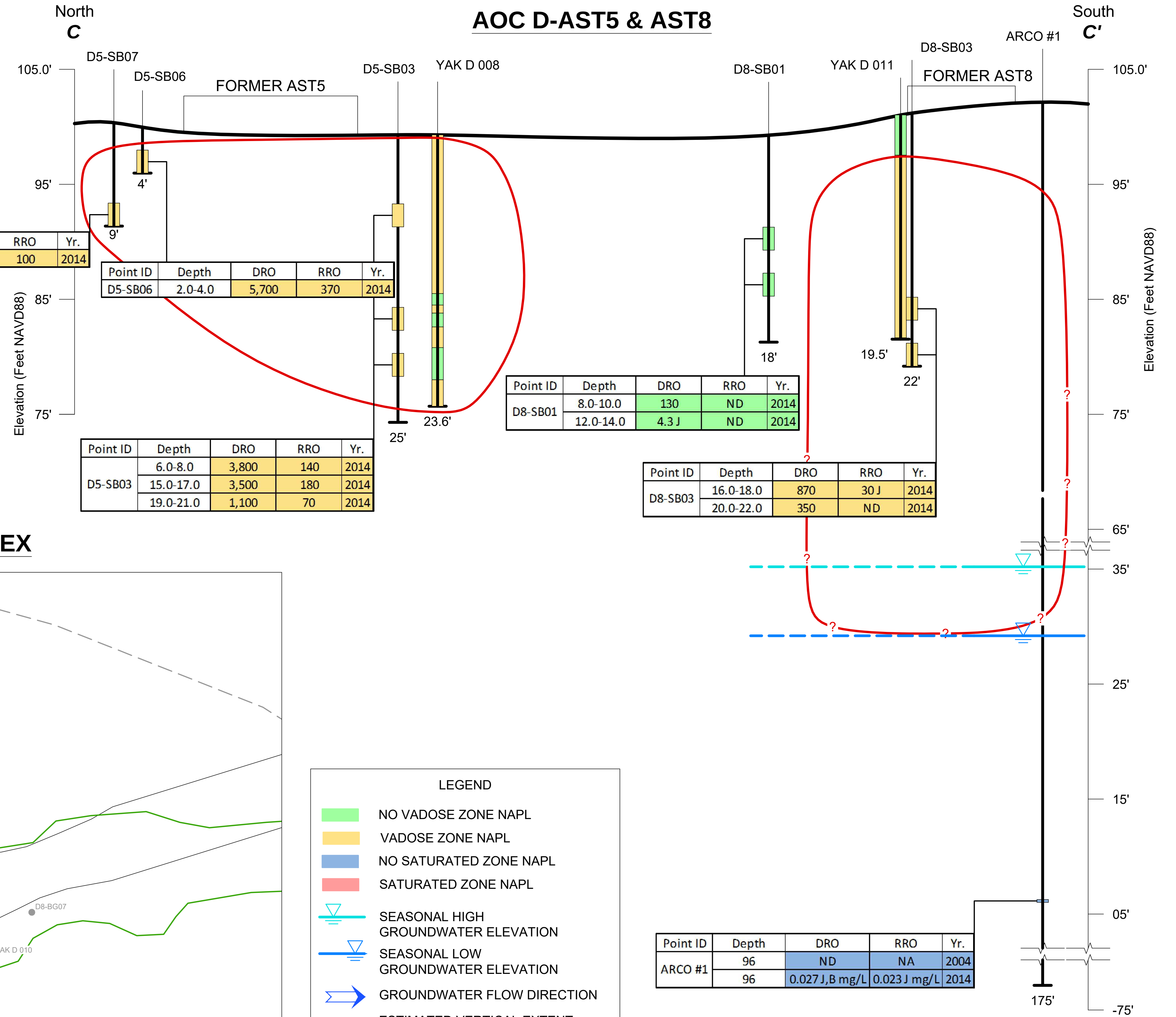
All DRO and RRO results are in mg/kg unless otherwise noted on the figure. See Appendix J for result qualifiers.

Location IDs beginning with YAK identify historical ROST borings. ROST results with percent reference emitter limits >1% are considered to be above the NAPL threshold (>230 mg/kg for DRO and RRO).



SCALE IN FEET
(VERT. EX. = 2)

AOC D-AST5 & AST8



Point ID	Depth	DRO	RRO	Yr.
D5-SB07	7.0-9.0	1,500	100	2014

Point ID	Depth	DRO	RRO	Yr.
D5-SB06	2.0-4.0	5,700	370	2014

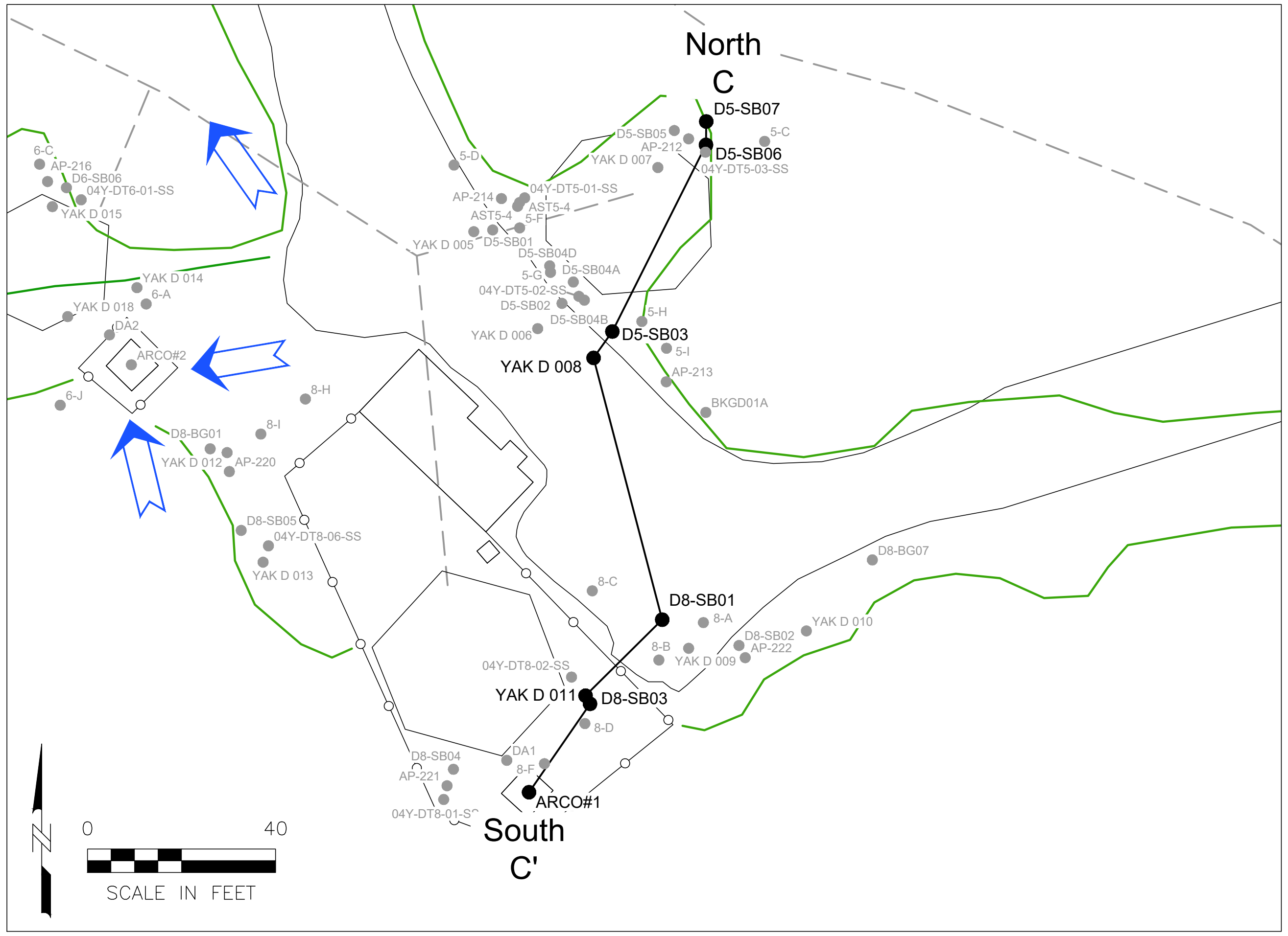
Point ID	Depth	DRO	RRO	Yr.
D5-SB03	6.0-8.0	3,800	140	2014
	15.0-17.0	3,500	180	2014
	19.0-21.0	1,100	70	2014

Point ID	Depth	DRO	RRO	Yr.
D8-SB01	8.0-10.0	130	ND	2014
	12.0-14.0	4.3 J	ND	2014

Point ID	Depth	DRO	RRO	Yr.
D8-SB03	16.0-18.0	870	30 J	2014
	20.0-22.0	350	ND	2014

Point ID	Depth	DRO	RRO	Yr.
ARCO #1	96	ND	NA	2004
	96	0.027 J,B mg/L	0.023 J mg/L	2014

CROSS SECTION INDEX



LEGEND	
🟩	NO VADOSE ZONE NAPL
🟨	VADOSE ZONE NAPL
🟦	NO SATURATED ZONE NAPL
🟥	SATURATED ZONE NAPL
▽	SEASONAL HIGH GROUNDWATER ELEVATION
▽	SEASONAL LOW GROUNDWATER ELEVATION
⇨	GROUNDWATER FLOW DIRECTION
—	ESTIMATED VERTICAL EXTENT OF NAPL SOURCE ZONE
—?—	VERTICAL EXTENT OF NAPL SOURCE ZONE UNKNOWN
▯	SCREEN INTERVAL

Figure: 12-4

CROSS SECTION C-C'
AOC D-AST5 & AST8

U.S. Army
Corps of Engineers
Alaska District

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawin: AECOM
Date: 01/16/15

Last saved by: SCHWARTZE(2016-03-29) Last Plotted: 2016-03-29
Filename: L:\GROUP\CAD\YAKUTAT AFB\FIGURES\YAK_FIG_12-4_ C-C' D-AST5 & AST8.DWG

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Figure 12-5a: AOC D5 DRO Q-Q Plot

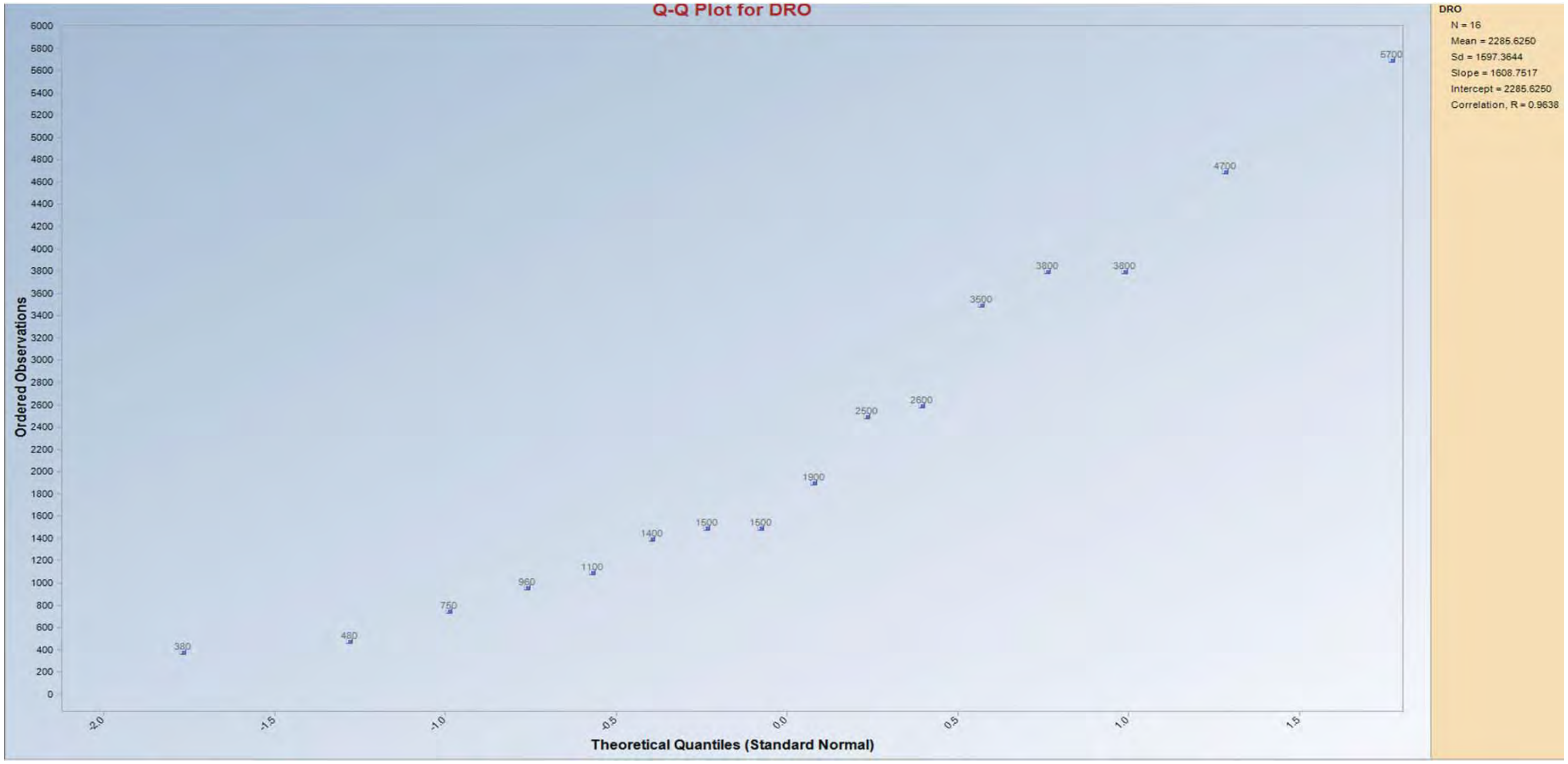

FIGURE 12-5b: AOC D5 DRO Box Plot

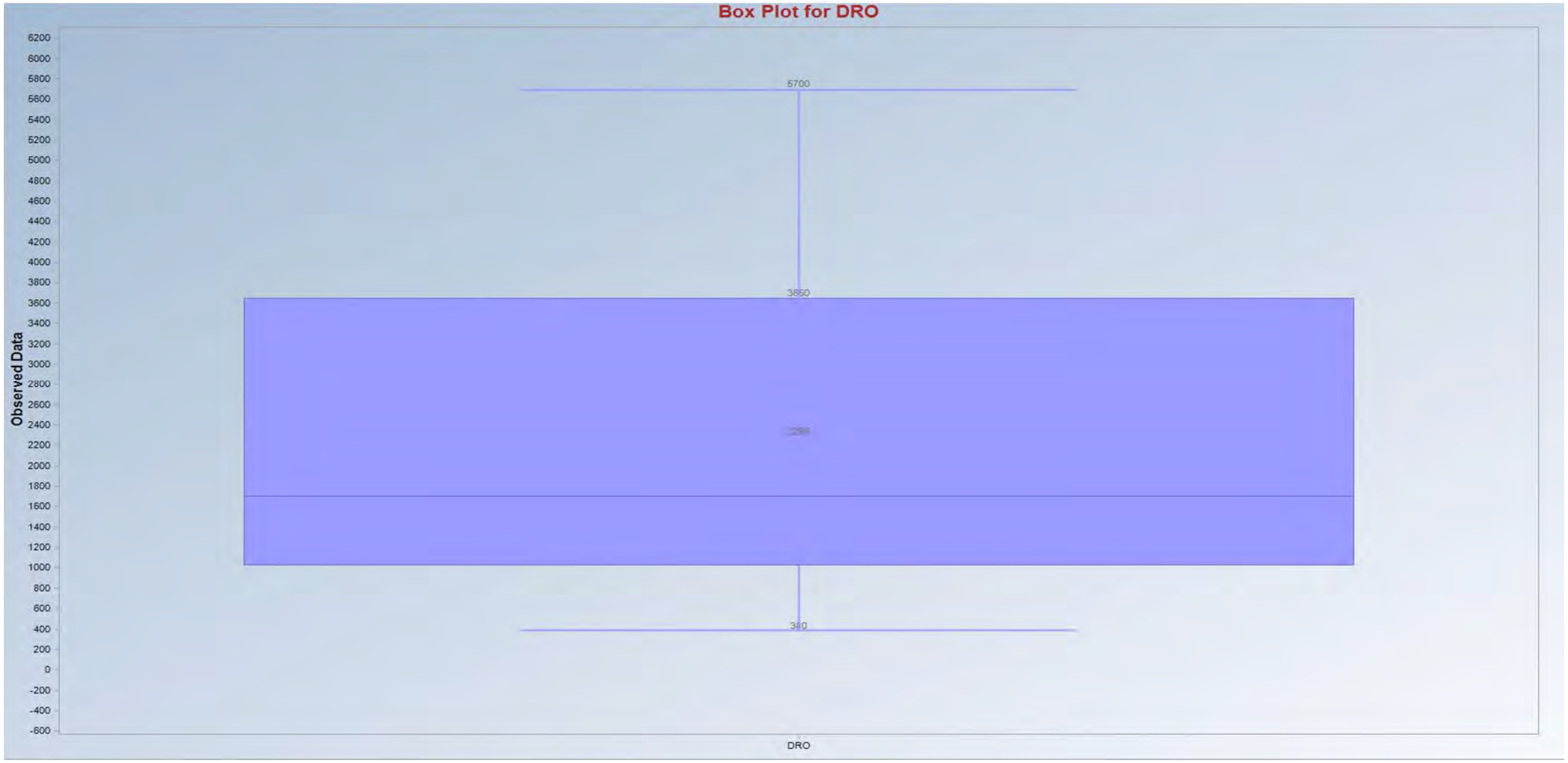

Table 12-1: AOC D5 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D5	04Y-DT5-01-SS	0-1	8/17/2004	04Y-DT5-01-SS	**0.52 J**	**380**	--	**0.0016 J**	**0.0041 J**	**0.0099**	--
D5	04Y-DT5-02-SS	0-1	8/17/2004	04Y-DT5-02-SS	**1.2**	**13000**	--	<0.0005 U	**0.0011 J**	**0.0045 J**	--
D5	04Y-DT5-03-SS	0-1	8/17/2004	04Y-DT5-03-SS	**0.61 J**	**1900**	--	<0.0006 U	<0.0005 U	**0.0044 J**	--
D5	AP-212	5-7	8/20/2004	04Y-DT5-06-SO	**13**	**3800**	--	<0.0032 U	<0.003 U	**0.014 J**	--
D5	AP-212	10-12	8/20/2004	04Y-DT5-07-SO	**13**	**750**	--	<0.0006 U	**0.031**	**0.016 J**	--
D5	AP-212	25-27	8/20/2004	04Y-DT5-10-SO	<0.22 U	**1.4 J**	--	<0.0008 U	<0.0007 U	**0.0037 J**	--
D5	AP-213	10-12	8/20/2004	04Y-DT5-11-SO	<0.15 U	**1.4 J**	--	<0.0006 U	**0.0019 J**	**0.0026 J**	--
D5	AP-213	20-22	8/20/2004	04Y-DT5-12-SO	<0.18 U	**1.7 J**	--	<0.0006 U	**0.0052 J**	**0.0025 J**	--
D5	AP-213	30-31.5	8/20/2004	04Y-DT5-13-SO	<0.19 U	**1.3 J**	--	<0.0007 U	<0.0006 U	**0.003 J**	--
D5	AP-214	5-7	8/24/2004	04Y-DT5-14-SO	**16**	**1500**	--	<0.0033 U	<0.0031 U	**0.01 J**	--
D5	AP-214	15-17	8/24/2004	04Y-DT5-15-SO	**3.8**	**480**	--	<0.0007 U	<0.0007 U	**0.0045**	--
D5	AP-214	25-26.5	8/24/2004	04Y-DT5-16-SO	<0.25 U	**1.3 J**	--	**0.0022 J**	**0.0027 J**	**0.006 J**	--
D5	AST5-4	17-19	9/25/2005	05Y-DT5-02-SO	**0.54 J**	**7.34 J**	--	<0.0013 U	**0.0085 JB**	**0.0066 JB**	**0.0207 JB**
D5	AST5-4	47-49	9/26/2005	05Y-DT5-07-SO	<0.38 U	<2.04 U	--	<0.00297 U	<0.00593 U	<0.0114 U	<0.01733 U
D5	AST5-4	68-70	9/26/2005	05Y-DT5-11-SO	<0.286 U	<1.9 U	--	<0.00223 U	<0.00446 U	<0.00858 U	<0.01304 U
D5	D5-SB01	3-5	6/10/2014	D5-SB01-3.0-5.0-0614	**66 QH**	**4700**	**200**	<0.0099 U	**0.062**	<0.0099 U	**0.2599**
D5	D5-SB02	0-2	6/11/2014	D5-SB02-0.0-2.0-0614	**24 B,QH**	**1400**	**98**	<0.009 U	<0.009 U	<0.009 U	<0.018 U
D5	D5-SB02	18-20	6/11/2014	D5-SB02-18.0-20.0-0614	**10 B**	**960**	**56**	<0.0089 U	**0.022 J**	**0.0088 J**	**0.0388 J**
D5	D5-SB03	6-8	6/10/2014	D5-SB03-6.0-8.0-0614	**35 B**	**3800**	**140**	<0.0087 U	**0.094**	<0.0087 U	**0.0727**
D5	D5-SB03	15-17	6/10/2014	D5-SB03-15.0-17.0-0614	**17 B**	**3500**	**180**	<0.006 U	**0.055 QH**	<0.006 U	**0.058 QH**
D5	D5-SB03	19-21	6/10/2014	D5-SB03-19.0-21.0-0614	**9.4 B**	**1100**	**70**	<0.0088 U	<0.0088 U	<0.0088 U	<0.0176 U
D5	D5-SB04	0-2	6/11/2014	D5-SB04D-0.0-2.0-0614	**6.1 B**	**2600**	**160**	<0.011 U	<0.011 U	**0.0064 J**	<0.022 U
D5	D5-SB04	2-4	6/11/2014	D5-SB04A-2.0-4.0-0614	**18 B,QH**	**2500**	**94**	<0.0088 U	**0.015 J**	**0.0043 MH**	**0.063 J**
D5	D5-SB05	10-12	6/10/2014	D5-SB05-10.0-12.0-0614	**23 B**	**220 QL**	**15 QL**	<0.0098 U	**0.0316**	**0.0054 J**	**0.0371 J**
D5	D5-SB06	2-4	6/10/2014	D5-SB06-2.0-4.0-0614	**49 B**	**5700**	**370**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
D5	D5-SB07	7-9	6/10/2014	D5-SB07-7.0-9.0-0614	**33 B**	**1500**	**100**	<0.0099 U	**0.08**	<0.0099 U	**0.0859**
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					66	13000	370	0.0022	0.094	0.016	0.2599
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
BTEX= benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
RRO = residual-range organics
mg/kg = milligrams per kilogram
HRC = hydrocarbon risk calculator
NA = not applicable
-- = not analyzed

Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
U = not detected
UJ = not detected, detection limit estimated
J = estimated value
B = analyte detected in blank
JB= estimated value & analyte detected in blank
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 12-2: AOC D5 Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D5	04Y-DT5-01-SS	0-1	8/17/2004	04Y-DT5-01-SS	**0.52 J**	**380**	--	--	--	--	--
D5	04Y-DT5-03-SS	0-1	8/17/2004	04Y-DT5-03-SS	**0.61 J**	**1900**	--	--	--	--	--
D5	AP-212	5-7	8/20/2004	04Y-DT5-06-SO	**13**	**3800**	--	--	--	--	--
D5	AP-212	10-12	8/20/2004	04Y-DT5-07-SO	**13**	**750**	--	--	--	--	--
D5	AP-214	5-7	8/24/2004	04Y-DT5-14-SO	**16**	**1500**	--	--	--	--	--
D5	AP-214	15-17	8/24/2004	04Y-DT5-15-SO	**3.8**	**480**	--	--	--	--	--
D5	D5-SB01	3-5	6/10/2014	D5-SB01-3.0-5.0-0614	**66 QH**	**4700**	**200**	<0.0099 U	**0.062**	<0.0099 U	**0.2599**
D5	D5-SB02	0-2	6/11/2014	D5-SB02-0.0-2.0-0614	**24 B,QH**	**1400**	**98**	<0.009 U	<0.009 U	<0.009 U	<0.018 U
D5	D5-SB02	18-20	6/11/2014	D5-SB02-18.0-20.0-0614	**10 B**	**960**	**56**	<0.0089 U	**0.022 J**	**0.0088 J**	**0.0388 J**
D5	D5-SB03	6-8	6/10/2014	D5-SB03-6.0-8.0-0614	**35 B**	**3800**	**140**	<0.0087 U	**0.094**	<0.0087 U	**0.0727**
D5	D5-SB03	15-17	6/10/2014	D5-SB03-15.0-17.0-0614	**17 B**	**3500**	**180**	<0.006 U	**0.055 QH**	<0.006 U	**0.058 QH**
D5	D5-SB03	19-21	6/10/2014	D5-SB03-19.0-21.0-0614	**9.4 B**	**1100**	**70**	<0.0088 U	<0.0088 U	<0.0088 U	<0.0176 U
D5	D5-SB04	0-2	6/11/2014	D5-SB04D-0.0-2.0-0614	**6.1 B**	**2600**	**160**	<0.011 U	<0.011 U	**0.0064 J**	<0.022 U
D5	D5-SB04	2-4	6/11/2014	D5-SB04A-2.0-4.0-0614	**18 B,QH**	**2500**	**94**	<0.0088 U	**0.015 J**	**0.0043 MH**	**0.063 J**
D5	D5-SB06	2-4	6/10/2014	D5-SB06-2.0-4.0-0614	**49 B**	**5700**	**370**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
D5	D5-SB07	7-9	6/10/2014	D5-SB07-7.0-9.0-0614	**33 B**	**1500**	**100**	<0.0099 U	**0.08**	<0.0099 U	**0.0859**
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					66	5700	370	0.011	0.094	0.0088	0.2599
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
BTEX= benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
RRO = residual-range organics
mg/kg = milligrams per kilogram
HRC = hydrocarbon risk calculator
NA = not applicable
-- = not analyzed

Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
U = not detected
UJ = not detected, detection limit estimated
J = estimated value
B = analyte detected in blank
JB= estimated value & analyte detected in blank
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 12-3: AOC D5 PAH Soils Results

Site Name		D5	D5	D5	D5	D5	D5	D5	D5
Boring, Well or Sample Location Number		AP-212	AP-212	AP-213	AP-214	AP-214	AST5-4	AST5-4	AST5-4
Sample Depth (feet)		5-7	25-27	10-12	5-7	25-26.5	17-19	47-49	68-70
Sample Date		8/20/2004	8/20/2004	8/20/2004	8/24/2004	8/24/2004	9/25/2005	9/26/2005	9/26/2005
Sample Name		04Y-DT5-06-SO	04Y-DT5-10-SO	04Y-DT5-11-SO	04Y-DT5-14-SO	04Y-DT5-16-SO	05Y-DT5-02-SO	05Y-DT5-07-SO	05Y-DT5-11-SO
GRO	(mg/kg)	**13**	<0.22 U	<0.15 U	**16**	<0.25 U	**0.54 J**	<0.38 U	<0.286 U
DRO	(mg/kg)	**3800**	**1.4 J**	**1.4 J**	**1500**	**1.3 J**	**7.34 J**	<2.04 U	<1.9 U
RRO	(mg/kg)	--	--	--	--	--	--	--	--
Acenaphthene	(mg/kg)	<0.0022 U	<0.00021 U	<0.00022 U	<0.0021 U	<0.00021 U	**0.00243 J**	<0.0152 U	<0.015 U
Acenaphthylene	(mg/kg)	<0.0067 U	<0.00063 U	<0.00067 U	<0.0064 U	<0.00062 U	<0.00102 U	<0.0152 U	<0.015 U
Anthracene	(mg/kg)	**0.056**	<0.00027 U	<0.00029 U	<0.0027 U	<0.00026 U	<0.00044 U	<0.0152 U	<0.015 U
Benzo(a)anthracene	(mg/kg)	<0.0058 U	<0.00055 U	<0.00058 U	<0.0055 U	<0.00053 U	**0.00102 J**	<0.0152 U	<0.015 U
Benzo(a)pyrene	(mg/kg)	<0.0099 U	<0.00094 U	<0.001 U	<0.0095 U	<0.00092 U	<0.000503 U	<0.0152 U	<0.015 U
Benzo(b)fluoranthene	(mg/kg)	<0.0037 U	<0.00036 U	<0.00038 U	<0.0036 U	<0.00035 U	<0.00061 U	<0.0152 U	<0.015 U
Benzo(g,h,i)perylene	(mg/kg)	<0.0052 U	<0.00049 U	<0.00052 U	<0.0049 U	<0.00048 U	<0.00145 U	<0.0152 U	<0.015 U
Benzo(k)fluoranthene	(mg/kg)	<0.0023 U	<0.00022 U	<0.00024 U	<0.0022 U	<0.00022 U	**0.000448 J**	<0.0152 U	<0.015 U
Chrysene	(mg/kg)	<0.0028 U	<0.00027 U	<0.00028 U	<0.0027 U	<0.00026 U	**0.000632 J**	<0.0152 U	<0.015 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.0037 U	<0.00035 U	<0.00037 U	<0.0035 U	<0.00034 U	<0.00126 U	<0.0152 U	<0.015 U
Fluorene	(mg/kg)	**0.47**	<0.00026 U	<0.00027 U	**0.61**	<0.00025 U	**0.0026 J**	<0.0152 U	<0.015 U
Fluoranthene	(mg/kg)	<0.0066 U	<0.00063 U	<0.00066 U	<0.0063 U	<0.00061 U	<0.000431 U	<0.0152 U	<0.015 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0051 U	<0.00048 U	<0.00051 U	<0.0049 U	<0.00047 U	<0.00127 U	<0.0152 U	<0.015 U
Naphthalene	(mg/kg)	**0.37**	<0.00032 U	<0.00034 U	<0.0032 U	<0.00031 U	**0.00247 J**	<0.0152 U	<0.015 U
Phenanthrene	(mg/kg)	**0.59**	<0.0003 U	<0.00032 U	**0.83**	<0.0003 U	**0.00557**	<0.0152 U	<0.015 U
Pyrene	(mg/kg)	<0.004 U	<0.00038 U	<0.0004 U	**0.071**	<0.00037 U	**0.000895 J**	<0.0152 U	<0.015 U
2-Methylnaphthalene	(mg/kg)	**2**	<0.0054 U	<0.0057 U	<0.055 U	<0.0053 U	**0.00233 J**	<0.0152 U	<0.015 U
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	**0.00121 J**	<0.0152 U	<0.015 U

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 12-3: AOC D5 PAH Soil Results (cont.)

Site Name		D5	D5	D5	D5	D5	D5	D5	D5
Boring, Well or Sample Location Number		D5-SB01	D5-SB02	D5-SB02	D5-SB03	D5-SB03	D5-SB03	D5-SB04	D5-SB04
Sample Depth (feet)		3-5	0-2	18-20	6-8	15-17	19-21	0-2	2-4
Sample Date		6/10/2014	6/11/2014	6/11/2014	6/10/2014	6/10/2014	6/10/2014	6/11/2014	6/11/2014
Sample Name		D5-SB01-3.0-5.0-0614	D5-SB02-0.0-2.0-0614	D5-SB02-18.0-20.0-0614	D5-SB03-6.0-8.0-0614	D5-SB03-15.0-17.0-0614	D5-SB03-19.0-21.0-0614	D5-SB04D-0.0-2.0-0614	D5-SB04A-2.0-4.0-0614
GRO	(mg/kg)	**66 QH**	**24 B,QH**	**10 B**	**35 B**	**17 B**	**9.4 B**	**6.1 B**	**18 B,QH**
DRO	(mg/kg)	**4700**	**1400**	**960**	**3800**	**3500**	**1100**	**2600**	**2500**
RRO	(mg/kg)	**200**	**98**	**56**	**140**	**180**	**70**	**160**	**94**
Acenaphthene	(mg/kg)	**0.74**	**0.044**	**0.046**	**0.55**	**0.28**	**0.2**	**0.022**	**0.71**
Acenaphthylene	(mg/kg)	**0.31**	**0.036**	**0.017**	**0.21**	**0.077**	**0.039**	**0.04**	**0.23**
Anthracene	(mg/kg)	**0.24**	**0.031**	<0.0025 U	**0.13**	**0.13**	**0.037**	**0.074**	**0.19**
Benzo(a)anthracene	(mg/kg)	<0.026 U	<0.0027 U	**0.0062**	**0.022 J**	**0.0063**	**0.0033 J**	**0.0031 J**	**0.0027 J**
Benzo(a)pyrene	(mg/kg)	<0.026 U	<0.0027 U	**0.0038 J**	<0.026 U	**0.0022 J**	<0.0026 U	<0.0027 U	<0.0027 U
Benzo(b)fluoranthene	(mg/kg)	<0.026 U	**0.003 J**	**0.0051**	<0.026 U	**0.0031 J**	**0.0035 J**	**0.004 J**	**0.0016 J**
Benzo(g,h,i)perylene	(mg/kg)	<0.026 U	<0.0027 U	**0.0034 J**	<0.026 U	<0.0025 U	<0.0026 U	<0.0027 U	<0.0027 U
Benzo(k)fluoranthene	(mg/kg)	<0.026 U	<0.0027 U	**0.0043 J**	<0.026 U	<0.0025 U	<0.0026 U	<0.0027 U	<0.0027 U
Chrysene	(mg/kg)	**0.051 J**	**0.0093**	**0.015**	**0.037 J**	**0.028**	**0.013**	**0.016**	**0.028 J**
Dibenzo(a,h)anthracene	(mg/kg)	<0.026 U	<0.0027 U	**0.0034 J**	<0.026 U	<0.0025 U	<0.0026 U	<0.0027 U	<0.0027 U
Fluorene	(mg/kg)	**2.8**	**0.14**	**0.077**	**1.8**	**0.95**	**0.36**	**0.16**	**3.4**
Fluoranthene	(mg/kg)	**0.091**	**0.011**	**0.012**	**0.084**	**0.067**	**0.028**	**0.022**	**0.055 J**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.026 U	<0.0027 U	**0.0037 J**	<0.026 U	<0.0025 U	<0.0026 U	<0.0027 U	<0.0027 U
Naphthalene	(mg/kg)	**2.6**	**0.017 B**	**0.068**	**2.1**	**0.73**	**0.12**	**0.028**	**3.2**
Phenanthrene	(mg/kg)	**3.8**	**0.29**	**0.051**	**2.3**	**1.6**	**0.44**	**0.33**	**4.1**
Pyrene	(mg/kg)	**0.08**	**0.017**	**0.03**	**0.084**	**0.07**	**0.031**	**0.04**	**0.041 J**
2-Methylnaphthalene	(mg/kg)	**17**	**0.48**	**0.03**	**1**	**2.8**	**0.34**	**0.48**	**15**
1-Methylnaphthalene	(mg/kg)	**9.8**	**0.44**	**0.06**	**1.5**	**2.8**	**0.38**	**0.35**	**6**

Table 12-3: AOC D5 PAH Soil Results (cont.)

	Site Name	D5	D5	D5	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
	Boring, Well or Sample Location Number	D5-SB05	D5-SB06	D5-SB07		
	Sample Depth (feet)	10-12	2-4	7-9		
	Sample Date	6/10/2014	6/10/2014	6/10/2014		
	Sample Name	D5-SB05-10.0-12.0-0614	D5-SB06-2.0-4.0-0614	D5-SB07-7.0-9.0-0614		
GRO	(mg/kg)	**23 B**	**49 B**	**33 B**	66	**260 C**
DRO	(mg/kg)	**220 QL**	**5700**	**1500**	5700	**230 C**
RRO	(mg/kg)	**15 QL**	**370**	**100**	370	**230 H**
Acenaphthene	(mg/kg)	**0.045 J**	**0.38**	**0.22**	0.74	**180 F**
Acenaphthylene	(mg/kg)	**0.016 J**	**0.18**	**0.062**	0.31	**180 F**
Anthracene	(mg/kg)	**0.0073**	**0.13**	**0.039**	0.24	**1680 D**
Benzo(a)anthracene	(mg/kg)	**0.0017 J**	**0.013**	**0.0039 J**	0.022	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.00071 U	<0.0028 U	<0.0028 U	0.0038	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	<0.00071 U	**0.0066**	**0.0023 J**	0.0066	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.00071 U	<0.0028 U	<0.0028 U	0.0034	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.00071 U	<0.0028 U	<0.0028 U	0.0043	**4 D**
Chrysene	(mg/kg)	**0.0036 J**	**0.053**	**0.015**	0.053	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.00071 U	<0.0028 U	<0.0028 U	0.0034	**0.04 D**
Fluorene	(mg/kg)	**0.11 J**	**0.91**	**0.32**	3.4	**190 D**
Fluoranthene	(mg/kg)	**0.0041 J**	**0.06**	**0.018**	0.091	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.00071 U	<0.0028 U	<0.0028 U	0.0037	**0.4 D**
Naphthalene	(mg/kg)	**0.14 J**	**0.09**	**0.062**	3.2	**2.1 E**
Phenanthrene	(mg/kg)	**0.12 J**	**2.1**	**0.55**	4.1	**1680 D**
Pyrene	(mg/kg)	**0.0044 J**	**0.072**	**0.021**	0.39	**110 D**
2-Methylnaphthalene	(mg/kg)	**0.5 J**	**4.7**	**0.98**	17	**6.1 F**
1-Methylnaphthalene	(mg/kg)	**0.5 J**	**6.5**	**1.2**	9.8	**6.2 F**

Table 12-4a: AOC D5 Non-Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D5	D5-SB05	10-12	6/10/2014	D5-SB05-10.0-12.0-0614	<0.0098 U	0.0054 J	0.0316	0.0371 J	65 B,J	64.9313	38 B,J	--	4 U,J	<1.81 U	82 J	71 J	400 J

Table 12-4b: AOC D5 Non-Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D5	D5-SB05	10-12	6/10/2014	D5-SB05-10.0-12.0-0614	--	--	1.4 J	9.9	28	6.5 QL	--	6.3	44	42	15 QN	39.3	92.3	131.6

Table 12-4c: AOC D5 Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D5	D5-SB02	18-20	6/11/2014	D5-SB02-18.0-20.0-0614	<0.0089 U	0.0088 J	0.022 J	0.0388 J	21 J,B	20.9392	62 J,B	--	<3.6 U	<3.6 U,QN	18 J	45	290
D5	D5-SB04	2-4	6/11/2014	D5-SB04A-2.0-4.0-0614	<0.0088 U	0.0043 MH	0.015 J	0.063 J	18 J,B	17.922	68 J,B	--	<4.1 U	<4.1 U,QN	13 J,ML	58 ML	320 ML
D5	D5-SB06	2-4	6/10/2014	D5-SB06-2.0-4.0-0614	<0.01 U	<0.01 U	<0.01 U	<0.02 U	36 B	35.97	150 B	--	<4.2 U	5.7 J,QN	41	79	700
D5	D5-SB07	7-9	6/10/2014	D5-SB07-7.0-9.0-0614	<0.0099 U	<0.0099 U	0.08	0.0859	2.4 J,B	2.2341	7.4 J,B	--	<0.37 U	<0.37 U	1.1 J	5.9	37 B
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.009	0.008	0.032	0.052	19.350	19.266	71.850	#DIV/0!	3.068	3.443	18.275	46.975	336.75

Table 12-4d: AOC D5 Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D5	D5-SB02	18-20	6/11/2014	D5-SB02-18.0-20.0-0614	--	--	4 J	41	170	33	--	26	230	260	55	215	516	731
D5	D5-SB04	2-4	6/11/2014	D5-SB04A-2.0-4.0-0614	--	--	34	350	750	65 ML	--	110	1300	1100	100 ML	1134	2510	3644
D5	D5-SB06	2-4	6/10/2014	D5-SB06-2.0-4.0-0614	--	--	56	430	890	160	--	200	1400	1100	240	1376	2700	4076
D5	D5-SB07	7-9	6/10/2014	D5-SB07-7.0-9.0-0614	--	--	14	84	200	47	--	60	310	250	60	298	620	918
average with fraction:							27.000	226.250	502.500	76.250		99.000	810.000	677.500	113.750			

Table 12-4e: AOC D5 Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.00940	0.00825	0.03175	0.05193	19.26633	27.00000	226.25000	502.50000	76.25000	3.06750	3.44250	18.27500	99.00000	810.00000	677.50000	113.75000	2576
Fraction of TPH mass in A&A EC groups	3.6485E-06	3.20214E-06	1.23234E-05	0.00002	0.00748	0.01048	0.08782	0.19504	0.02960	0.00119	0.00134	0.00709	0.03843	0.31439	0.26296	0.04415	1.00
GRO, DRO & RRO A&A Groups	**GRO aromatics**					**DRO aromatics**			**RRO aromatics**	**GRO aliphatics**			**DRO aliphatics**			**RRO aliphatics**	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.007517					0.293335			0.029596	0.009620			0.615781			0.044151	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.000485	0.000426	0.001639	0.002681	0.994768	0.035726	0.299371	0.664902	1.000000	0.123764	0.138894	0.737341	0.062402	0.510558	0.427041	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	1.71%
% of TPH that is DRO=	90.91%
% of TPH that is RRO=	7.37%

GRO % aromatics	0.43865204
GRO % aliphatics	0.56134796
DRO % aromatics	0.322659836
DRO % aliphatics	0.677340164
RRO % aromatics	0.401315789
RRO % aliphatics	0.598684211

Table 12-4f: AOC D5 HRC Input

nput to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.43865204
DRO: fraction aromatic	0.322659836
RRO: fraction aromatic	0.401315789

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.0357261
Aromatic C12-C16	0.299371485
Aromatic C16-C21	0.664902415

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.123764374
Aliphatic C6-C8	0.138894493
Aliphatic C8-C10	0.737341134
Aliphatic C10-C12	0.062401513
Aliphatic C12-C16	0.510557832
Aliphatic C16-C21	0.427040656

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons

GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated

Table 12-5: AOC D5 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
D5	AST5-4	NA	10/2/2005	05Y-DT5-12-GW	<0.028 U	**0.0993 J**	**--**	<0.00012 U	<0.00031 U	<0.00031 U	<0.00093 U
D5	AST5-4 Tr-Eff	NA	10/3/2005	05Y-DT5-13-EW	<0.028 U	**0.173 J**	**--**	<0.00012 U	<0.00031 U	<0.00031 U	<0.00093 U
D5	AST5-4	NA	6/8/2014	AST5-4-WG01-0614	<0.044 U	**0.046 J**	**0.058 J**	<0.0004 U	<0.0004 U	<0.0004 U	**0.00069 QH**
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0	0	0	0	0	0	0
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:

Bold = The analyte was detected.

Shading = The result is above the screening criteria.

-- = not analyzed

BTEX= benzene, toluene, ethylbenzene & xylenes

DRO = diesel-range organics

GRO = gasoline-range organics

mg/L = milligrams per liter

NA = not applicable

RRO = residual-range organics

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)

J = estimated value

JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level source:

H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

Table 12-6: AOC D5 PAH Groundwater Results

Site Name		D5	D5	D5	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		AST5-4	AST5-4 Tr-Eff	AST5-4		
Sample Depth		NA	NA	NA		
Sample Date		10/2/2005	10/3/2005	6/8/2014		
Sample Name		05Y-DT5-12-GW	05Y-DT5-13-EW	AST5-4-WG01-0614		
GRO	(mg/L)	<0.028 U	<0.028 U	<0.044 U	0.044	**2.2 H**
DRO	(mg/L)	**0.0993 J**	**0.173 J**	**0.046 J**	0.046	**1.5 H**
RRO	(mg/L)	--	--	**0.058 J**	0.058	**1.1 H**
Acenaphthene	(mg/L)	<0.0000156 U	**0.0000272 J**	<0.000015 U,QL	0.000015	**0.22 H**
Acenaphthylene	(mg/L)	<0.0000156 U	**0.0000741**	<0.000015 U,QL	0.000015	**0.22 H**
Anthracene	(mg/L)	<0.0000156 U	<0.0000153 U	<0.000015 U	0.000015	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.0000156 U	<0.0000153 U	<0.000015 U	0.000015	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.0000156 U	<0.0000153 U	<0.000015 U	0.000015	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.0000156 U	<0.0000153 U	<0.000015 U	0.000015	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.0000156 U	<0.0000153 U	<0.000015 U	0.000015	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.0000156 U	<0.0000153 U	<0.000015 U	0.000015	**0.0012 H**
Chrysene	(mg/L)	<0.0000156 U	<0.0000153 U	<0.000015 U	0.000015	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.0000104 U	<0.0000102 U	<0.000015 U	0.000015	**0.000012 H**
Fluorene	(mg/L)	<0.0000156 U	**0.000117**	<0.000015 U,QL	0.000015	**0.15 H**
Fluoranthene	(mg/L)	<0.0000156 U	<0.0000153 U	<0.000015 U	0.000015	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.0000156 U	<0.0000153 U	<0.000015 U	0.000015	**0.00012 H**
Naphthalene	(mg/L)	<0.0000323 U	**0.000952**	**0.000013 QL**	0.000013	**0.073 H**
Phenanthrene	(mg/L)	**0.0000297 J**	**0.000112**	**0.0000068 QL**	0.0000068	**1.1 H**
Pyrene	(mg/L)	<0.0000156 U	<0.0000153 U	<0.000015 U	0.000015	**0.11 H**
2-Methylnaphthalene	(mg/L)	<0.0000156 U	**0.000186**	**0.0000059 QL**	0.0000059	**0.015 H**
1-Methylnaphthalene	(mg/L)	<0.0000156 U	**0.00018**	<0.000015 U,QL	0.000015	**0.015 H**

Notes:
Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for PAHs

Table 12-7: AOC D5 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

ProUCL Input File

GRO	d_GRO	DRO	d_DRO	RRO	d_RRO	Benzene	d_Benzene	Toluene	d_Toluene	Ethylbenzene	d_Ethylbenzene	Xylene	d_Xylene
0.52	1												
1.2	1	380	1										
0.61	1	1900	1										
13	1	750	1										
13	1	3800	1										
3.8	1	480	1										
16	1	1500	1										
66	1	4700	1	200	1	0.0099	0	0.0099	0	0.062	1	0.2599	1
24	1	1400	1	98	1	0.009	0	0.009	0	0.009	0	0.018	0
10	1	960	1	56	1	0.0089	0	0.0088	1	0.022	1	0.0388	1
17	1	3500	1	180	1	0.006	0	0.006	0	0.055	1	0.058	1
9.4	1	1100	1	70	1	0.0088	0	0.0088	0	0.0088	0	0.0176	0
35	1	3800	1	140	1	0.0087	0	0.0087	0	0.094	1	0.0727	1
6.1	1	2600	1	160	1	0.011	0	0.0064	1	0.011	0	0.022	0
18	1	2500	1	94	1	0.0088	0	0.0043	1	0.015	1	0.063	1
49	1	5700	1	370	1	0.01	0	0.01	0	0.01	0	0.02	0
33	1	1500	1	100	1	0.0099	0	0.0099	0	0.08	1	0.0859	1

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

Benzene	0.011	maximum LOD
Toluene	0.0088	maximum detected conc
Ethylbenzene	0.094	maximum detected conc
Xylene	0.2599	maximum detected conc
GRO	31.17	95%UCL
DRO	2986	95%UCL
RRO	210	95%UCL

GRO

General Statistics

Number of Valid Observations	17
Raw Statistics	
Minimum	0.52
Maximum	66
Mean	18.57
Median	13
SD	18.09
Std. Error of Mean	4.387
Coefficient of Variation	0.974
Skewness	1.42

Number of Distinct Observations	16
Log-transformed Statistics	
Minimum of Log Data	-0.654
Maximum of Log Data	4.19
Mean of log Data	2.274
SD of log Data	1.438

Relevant UCL Statistics

Normal Distribution Test	
Shapiro Wilk Test Statistic	0.859
Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level	
Assuming Normal Distribution	
95% Student's-t UCL	26.23
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL (Chen-1995)	27.4
95% Modified-t UCL (Johnson-1978)	26.48

Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.9
Shapiro Wilk Critical Value	0.892
Data appear Lognormal at 5% Significance Level	
Assuming Lognormal Distribution	
95% H-UCL	91.9
95% Chebyshev (MVUE) UCL	67.75
97.5% Chebyshev (MVUE) UCL	86.46
99% Chebyshev (MVUE) UCL	123.2

Gamma Distribution Test	
k star (bias corrected)	0.783
Theta Star	23.72
MLE of Mean	18.57
MLE of Standard Deviation	20.99
nu star	26.61
Approximate Chi Square Value (.05)	15.85
Adjusted Level of Significance	0.0346
Adjusted Chi Square Value	14.98
Anderson-Darling Test Statistic	0.249
Anderson-Darling 5% Critical Value	0.77
Kolmogorov-Smirnov Test Statistic	0.122
Kolmogorov-Smirnov 5% Critical Value	0.216
Data appear Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
95% Approximate Gamma UCL	31.17
95% Adjusted Gamma UCL	32.97

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics	
95% CLT UCL	25.78
95% Jackknife UCL	26.23
95% Standard Bootstrap UCL	25.63
95% Bootstrap-t UCL	29.37
95% Hall's Bootstrap UCL	30.79
95% Percentile Bootstrap UCL	25.81
95% BCA Bootstrap UCL	27.17
95% Chebyshev(Mean, Sd) UCL	37.69
97.5% Chebyshev(Mean, Sd) UCL	45.97
99% Chebyshev(Mean, Sd) UCL	62.22

Potential UCL to Use	Use 95% Approximate Gamma UCL 31.17

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Table 12-7: AOC D5 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

DRO

	General Statistics		
Number of Valid Observations	16	Number of Distinct Observations	14
Raw Statistics		**Log-transformed Statistics**	
Minimum	380	Minimum of Log Data	5.94
Maximum	5700	Maximum of Log Data	8.648
Mean	2286	Mean of log Data	7.466
Geometric Mean	1748	SD of log Data	0.806
Median	1700		
SD	1597		
Std. Error of Mean	399.3		
Coefficient of Variation	0.699		
Skewness	0.757		
	Relevant UCL Statistics		
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.92	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2986	95% H-UCL	4002
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4577
95% Adjusted-CLT UCL (Chen-1995)	3023	97.5% Chebyshev (MVUE) UCL	5537
95% Modified-t UCL (Johnson-1978)	2998	99% Chebyshev (MVUE) UCL	7424
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.68	Data appear Normal at 5% Significance Level	
Theta Star	1361		
MLE of Mean	2286		
MLE of Standard Deviation	1764		
nu star	53.75		
Approximate Chi Square Value (.05)	37.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0335	95% CLT UCL	2942
Adjusted Chi Square Value	36.39	95% Jackknife UCL	2986
		95% Standard Bootstrap UCL	2930
Anderson-Darling Test Statistic	0.213	95% Bootstrap-t UCL	3089
Anderson-Darling 5% Critical Value	0.75	95% Hall's Bootstrap UCL	3056
Kolmogorov-Smirnov Test Statistic	0.124	95% Percentile Bootstrap UCL	2939
Kolmogorov-Smirnov 5% Critical Value	0.218	95% BCA Bootstrap UCL	3021
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4026
		97.5% Chebyshev(Mean, Sd) UCL	4780
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6259
95% Approximate Gamma UCL (Use when n >= 40)	3241		
95% Adjusted Gamma UCL (Use when n < 40)	3376		
Potential UCL to Use		Use 95% Student's-t UCL	2986

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

RRO

	General Statistics		
Number of Valid Observations	10	Number of Distinct Observations	10
Raw Statistics		**Log-transformed Statistics**	
Minimum	56	Minimum of Log Data	4.025
Maximum	370	Maximum of Log Data	5.914
Mean	146.8	Mean of log Data	4.843
Median	120	SD of log Data	0.555
SD	91.57		
Std. Error of Mean	28.96		
Coefficient of Variation	0.624		
Skewness	1.762		
	Relevant UCL Statistics		
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.832	Shapiro Wilk Test Statistic	0.971
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	199.9	95% H-UCL	226.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	259.2
95% Adjusted-CLT UCL (Chen-1995)	211.7	97.5% Chebyshev (MVUE) UCL	308.4
95% Modified-t UCL (Johnson-1978)	202.6	99% Chebyshev (MVUE) UCL	405
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.572	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	57.09		
MLE of Mean	146.8		
MLE of Standard Deviation	91.54		
nu star	51.43		
Approximate Chi Square Value (.05)	35.96	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0267	95% CLT UCL	194.4
Adjusted Chi Square Value	33.72	95% Jackknife UCL	199.9
		95% Standard Bootstrap UCL	192.1
Anderson-Darling Test Statistic	0.295	95% Bootstrap-t UCL	234
Anderson-Darling 5% Critical Value	0.731	95% Hall's Bootstrap UCL	402.5
Kolmogorov-Smirnov Test Statistic	0.192	95% Percentile Bootstrap UCL	196
Kolmogorov-Smirnov 5% Critical Value	0.268	95% BCA Bootstrap UCL	209.4
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	273
		97.5% Chebyshev(Mean, Sd) UCL	327.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	434.9
95% Approximate Gamma UCL	210		
95% Adjusted Gamma UCL	223.9		
Potential UCL to Use		Use 95% Approximate Gamma UCL	210

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Table 12-8: AOC D5 Outlier Test Results

Outlier Tests for Selected Variables

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers with Rosner test	1

Dixon's Outlier Test for DRO

Number of data = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Data Value 5700 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.384

For 10% significance level, 5700 is not an outlier.
For 5% significance level, 5700 is not an outlier.
For 1% significance level, 5700 is not an outlier.

2. Data Value 380 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.108

For 10% significance level, 380 is not an outlier.
For 5% significance level, 380 is not an outlier.
For 1% significance level, 380 is not an outlier.

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Table 12-9a: AOC D5 HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	max LOD, ND in 2014	max LOD, ND in 2014	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	maximum detected conc	max LOD, ND in 2014	
Ethylbenzene (c & nc)	maximum detected conc	max LOD, ND in 2014	
Xylenes (total) (nc)	maximum detected conc	max measured conc in 2014	
GRO	95%UCL	max LOD, ND in 2014	
DRO	95%UCL	max measured conc in 2014	
RRO	95%UCL	max measured conc in 2014	
GRO aromatics	site specific VPH & EPH data	modeled from soils data	
DRO aromatics	site specific VPH & EPH data	modeled from soils data	
RRO aromatics	site specific VPH & EPH data	modeled from soils data	
GRO aliphatics	site specific VPH & EPH data	modeled from soils data	
DRO aliphatics	site specific VPH & EPH data	modeled from soils data	
RRO aliphatics	site specific VPH & EPH data	modeled from soils data	
Acenaphthene (nc)	max measured conc	max LOD, ND in 2014	
Acenaphthylene (nc)	max measured conc	max LOD, ND in 2014	
Anthracene (nc)	max measured conc	max LOD, ND in 2014	
Benzo(g,h,i)perylene (nc)	max measured conc	max LOD, ND in 2014	
Fluoranthene (nc)	max measured conc	max LOD, ND in 2014	
Fluorene (nc)	max measured conc	max LOD, ND in 2014	
Naphthalene (c & nc)	max measured conc	max measured conc in 2014	
Phenanthrene (nc)	max measured conc	max measured conc in 2014	
Pyrene (nc)	max measured conc	max LOD, ND in 2014	
Benzo(a)anthracene (c)	max measured conc	modeled from soils data	
Benzo(b)fluoranthene (c)	max measured conc	modeled from soils data	
Benzo(k)fluoranthene (c)	max measured conc	modeled from soils data	
Benzo(a)pyrene (c)	max measured conc	modeled from soils data	
Chrysene (c)	max measured conc	modeled from soils data	
Dibenz(a,h)anthracene (c)	max measured conc	modeled from soils data	
Indeno(1,2,3-cd)pyrene (c)	max measured conc	modeled from soils data	
1-Methylnaphthalene (nc)	max measured conc	max LOD, ND in 2014	
2-Methylnaphthalene (nc)	max measured conc	max measured conc in 2014	

Hydrocarbon Characterization Data

Hydrocarbon Fractions	Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_5-C_6	Site specific EPH & VPH data
Aliphatic C_6-C_8	Site specific EPH & VPH data
Aliphatic C_8-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:
BTEX = benzene, toluene, ethylbenzene, xylene
(c) = carcinogen
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
(nc) = non-carcinogen
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Table 12-9b: AOC D5 HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	**Input Values**			**Source of Data**
bulk density (lbs/ft^3)	125.0538462			D sites average value
specific gravity	2.824666667			D sites average value
moisture content (% by weight)	8.6625			D sites average value
foc	0.005826667			D sites average value
Soil temp (C)	5.3			D sites average value
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt			D sites average value
Hydrogeologic Conditions				
Source length (ft)	180			scaled from site maps
Average precipitation (in/yr)	143.44			NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	7.27E-06			average value of D5 and D6
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8			estimated thickness of the aquifer based on the 2014 boring logs
Infiltration rate (m/yr)	0.7286752			20% of average precipitation
Hydraulic gradient	0.0085			Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1			Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters				
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3			NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth				
depth to groundwater at seasonal low water level at downgradient end of source (ft)	71			Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	6			Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	21			Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	0			Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time				
Soil Direct Contact	1			Site specific conceptual site model
Outdoor Air	1			Site specific conceptual site model
Indoor Air	0			Site specific conceptual site model
Groundwater Ingestion	0			Site specific conceptual site model
Other Input				
ADEC Hazard ID	0			ADEC CS database
Latitude	0			ADEC CS database
Longitude	0			ADEC CS database
Width of Source (ft)	50			scaled from site maps
Area of NAPL contaminated soil source (ft^2)	9000			scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.0085			Measured slope of water table
Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	125.05	125.05	125.05	D sites average value
specific gravity of solids	2.824667	2.824667	2.824667	D sites average value
moisture content (% by weight)	8.66	8.66	8.66	D sites average value
foc	0.005827	0.005827	0.005827	D sites average value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	0.1	0.1	0.1	Site Specific (depth to source minus foundation depth--distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	6.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 12-10: AOC D5 Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	8.76985E-08	0.0088	0.0109
Outdoor air inhalation	1.06615E-08	0.0011	0.0005
Indoor air inhalation (vapor intrusion)	1.92065E-07	0.0192	0.0055
Groundwater Ingestion	1.5376E-07	0.0154	0.0024
Cumulative Risk	**4E-07**	**0.0**	**0.0**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	2.64169E-07	0.0264	0.1233
Outdoor air inhalation	4.6249E-08	0.0046	0.0017
Indoor air inhalation (vapor intrusion)	8.06672E-07	0.0807	0.0230
Groundwater Ingestion	2.58317E-07	0.0258	0.0033
Cumulative Risk	**1E-06**	**0.1**	**0.20**

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 12-11: AOC D5 Summary of Bulk Fuel Hydrocarbon Risk

	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Fraction of Risk Values				
			Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor intrusion)	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	13	0.000	<1	<1	<1	<1	<1
DRO Aromatics	963	0.000	<1	<1	<1	<1	<1
RRO Aromatics	84	0.000	<1	No RfC	No Rfc	<1	<1
GRO Aliphatics	17	0.000	<1	<1	<1	<1	<1
DRO Aliphatics	2023	0.000	<1	<1	<1	<1	<1
RRO Aliphatics	126	0.000	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	13	0.000	<1	<1	<1	<1	<1
DRO Aromatics	963	0.000	<1	<1	<1	<1	<1
RRO Aromatics	84	0.000	<1	No Rfc	No Rfc	<1	<1
GRO Aliphatics	17	0.000	<1	<1	<1	<1	<1
DRO Aliphatics	2023	0.000	<1	<1	<1	<1	<1
RRO Aliphatics	126	0.000	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics

GRO = gasoline-range organics

mg/kg = milligrams per kilogram

mg/L = milligram(s) per liter

No RfC = no reference concentration available; risk standard is assumed to be met due to low volatility of the fraction

RRO = residual-range organics

Table 12-12: AOC D5 Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
1-Methylnaphthalene (nc)	10	6.2	MTGW	10	MTGW	9.8	NA	116	MTGW
2-Methylnaphthalene (nc)	17	6.1	MTGW	10	MTGW	17	NA	96	MTGW
total DRO	5700[a]	230	MTGW	1200	MTGW	2986	12500	10284	Soil Direct Contact

Notes:

[a] = Historical maximum concentration (13000 mg/kg) not considered representative of current conditions as discussed in Section 12.5.1.

ACL = alternate cleanup level
(c) = carcinogen
DRO = diesel-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
MTGW = migration to groundwater
NA = not applicable
(nc) = non-carcinogen

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13.0 AOC D6 – ARMY DOCK AREA – FORMER 1000 BBL TANK – NO. 831

13.1 AREA DESCRIPTION AND BACKGROUND

AOC D6 is the site of former Tank No. 831 (AST6) within the historical Army Dock area tank farm. The tank farm served as the primary fuel off-loading and storage site for World War II military activities in Yakutat. Eight ASTs (ASTs 1–8) with tank capacities ranging from 20,000 to 80,000 gal and associated piping were used to store and transfer diesel fuel to the dock at Monti Bay. Former ASTs 5 through 8 were installed at the southern portion of the tank farm, at significantly higher elevations than ASTs 1 and 2. ASTs 6, 7 and 8 were located west of the access road, with a cleared trail extending west from AST 6 to AST 7. Former AST6 was located north of the current City of Yakutat pump house and associated water supply wells (ARCO #1 and ARCO #2). The AST and associated piping at this location have been removed, but the concrete tank pad, steel tank bands and a few pipe stands are still present at the site.

Three surface soil samples previously collected at the site had DRO concentrations ranging from 1,700 mg/kg to 13,000 mg/kg. Subsurface soil samples that were collected from 10 to 12 feet bgs and 15 to 16.5 feet bgs had DRO concentrations of 1,400 mg/kg and 450 mg/kg, respectively (S&W 2006a). POLs were not detected in groundwater samples from monitoring well AST 6-3, or in drinking water samples previously collected from the City of Yakutat water supply wells (S&W 2006b).

Data from previous investigations were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at AOC D6. These data, along with field screening results and visual observations, were reviewed to select appropriate sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations and the estimated NAPL source area at AOC D6 are shown in conjunction with the AOC D5 and AOC D8 areas on Figure 12-1.

13.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC D6 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Evaluate current groundwater conditions.

13.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC D6 included advancement of soil borings, collection of soil and groundwater samples, and aquifer (slug) testing. These activities are described below by media.

13.3.1 Soil

Historical data indicate that vadose zone soil at the site is impacted with DRO, and one “hot spot” with DRO concentrations of 13,000 mg/kg in surface soil is present southwest of the tank pad. Seven soil borings were advanced to collect soil samples for the HRC evaluation: three southwest of the AST6 tank pad (D6-SB01, SB02 and SB03A) along the cleared access trail to the AST7 tank pad, and four at the perimeter of the AST6 tank pad (D6-SB04 through SB07). Three step-out borings (D6-SB03B, SB03C and SB03D) were advanced to determine if DRO in surface soil at D6-SB03A is an isolated “hot spot”. Soils at the site generally consist of fine sands and silty sands at shallow depths grading to fine to coarse sand with variable gravel below approximately 8 feet bgs. Some artificial fill is present (adjacent to the tank pad). Soil boring logs are included in Appendix C.

Field screening samples were collected from above and below the target depth intervals and screened for volatile organics using a PID. Soil samples collected for laboratory analysis were selected from the target depth(s) or adjusted to the most likely contaminated depth based on field observations (e.g., PID, visual, and olfactory). Two soil samples were collected from D6-SB02 and one sample was collected from each of the remaining borings for laboratory analysis. Because the field screening data for D6-SB03D indicated higher impacts than the original hot spot at SB03A, D6-SB02 was considered a step-out from SB03D. PID results showed increasing concentrations at both D6-SB02 (0-2 feet) and SB03B. All samples were analyzed for GRO, DRO, RRO, BTEX and PAHs. Samples from D5-SB01, SB03A, SB04, SB06 and SB07 were also analyzed for VPH and EPH, and since field screening results showed the highest impacts at D6-SB03B, this sample was also analyzed for VPH/EPH. Field observations and screening results were used to refine the estimated limits of the NAPL source area shown on Figure 12-1.

BACKGROUND SOIL CONDITIONS

Soil samples collected outside the AOC D NAPL source areas were analyzed to assess the geophysical properties (e.g., grain size, bulk density, moisture content, and specific gravity) and the naturally occurring organic carbon content of soils at the site. Refer to Section 8.3.1 for a discussion on background sampling activities at AOC D.

13.3.2 Groundwater

Groundwater assessment for the site included sampling of existing monitoring well AST6-3 (Figure 12-1). Groundwater samples were collected using a bladder pump with a dedicated bladder and analyzed for GRO, DRO, RRO, BTEX, and PAHs. Low Flow Groundwater Sample Collection Records are included in Appendix D.

AQUIFER TESTING

Subsequent to sampling, slug tests were performed on monitoring well AST6-3 to obtain hydraulic conductivity values for input into the HRC. These tests were conducted using a solid slug to displace the water column, and were performed and evaluated following the procedures outlined in Section 3.4.5. Slug test data are included in Appendix E and results are discussed in Section 13.4 below.

13.3.3 Groundwater Conditions

As discussed in Section 8.4, groundwater contours were developed for the AOC D area (Figure 8-3) and show an overall groundwater flow direction to the northwest, with an apparent localized cone of depression in the vicinity of City of Yakutat water supply wells ARCO #1 and/or ARCO #2. Horizontal gradients across AOC D were averaged with a resulting gradient estimated at 0.0085 ft/ft.

Since limited data were available, hydraulic conductivity values calculated for the wells at AOC D5 and AOC D6 were averaged based on site proximity. An overall hydraulic conductivity of 0.021 ft/day was used as input in the HRC for the site (Table 4-4).

13.4 ANALYTICAL RESULTS

13.4.1 Soil

A total of ten soil samples were collected from nine soil borings at the site and submitted for laboratory analyses. These data were collected from the most highly contaminated soils identified in this area for input in evaluating risk, and at two step-out locations to define surface soil impacts. Results show that nine of the ten samples had DRO concentrations above the Method Two cleanup level ranging from 240 mg/kg to 2,800 mg/kg. In addition to DRO, 2-methylnaphthalene was reported at concentrations above the Method Two cleanup level in one sample. No other analytes were reported at concentrations above the Method Two cleanup levels at AOC D6. Soil analytical results for the samples collected in 2014 are presented in summary tables provided in Appendix J. Sample locations are shown on Figure 12-1 and cross sectional views of the site showing the vertical extent of impacts are presented along A-A’ as Figure 12-2 and B-B’ as Figure 12-3.

Constituent data collected within the defined source zone were used to supplement the historical data set for characterization of the NAPL source zone. Historical and recent (2014) POL data evaluated for AOC

D6 are presented in Table 13-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 13-2. The location of the historical maximum DRO concentration (04Y-DT6-02-SS), which exceeded the ADEC maximum allowable concentration at 13,000 mg/kg, was resampled in 2014. The 2014 samples had much lower DRO concentrations ranging from 360 to 1,700 mg/kg and are considered representative of current conditions. Consequently, the 2004 historical maximum concentration was not included in the 95% UCL calculation. Additionally, historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attention of these constituents. PAH soil data are presented in Table 13-3, and VPH/EPH results are presented in Table 13-4. These data were used as input in calculating soil ACLs and to evaluate risk at AOC D6 using the HRC.

13.4.2 Groundwater

Groundwater assessment at the site included sampling monitoring well AST6-3. Analytical results indicate that the constituent concentrations detected did not exceed the Table C groundwater cleanup levels. Analytical results are summarized in Appendix J.

Results for AST6-3 were used to supplement historical groundwater data for AOC D6. Historical and recent (2014) groundwater results for POLs and PAHs are summarized in Table 13-5 and Table 13-6, respectively.

13.5 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC D6; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

13.5.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet the ADEC “Cleanup Complete” criteria, the AOC D6 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion).

The AOC D6 risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at AOC D6 at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be incomplete at the present time, because there are no occupied buildings within 30 feet of the AOC D6 source area. The groundwater ingestion exposure route is considered to be complete at the present time due to the presence of a water supply well (ARCO #2) near the source area footprint (Figure 12-1) and possible influence of the water supply pumping wells (ARCO #1 and/or ARCO #2) on groundwater flow in this area (Figure 8-3). Water samples from these wells show all chemical results below 1/10th of the Table C drinking water standard. Surface water and sediment pathways are considered incomplete based on the unlikely potential for surface runoff or sediment transport to nearby surface water bodies.

The AOC D6 exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

13.5.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each hydrocarbon constituent (BTEX 2014 data only) and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in

Table 13-2. The source area data set for toluene, ethylbenzene, and total xylenes had a limited number of relatively low concentration detections; therefore, the maximum detected values from the source area were used as exposure point concentrations. Benzene was not detected at AOC D6 in 2014; therefore, the maximum LOD was used as the exposure point concentration. There were adequate data to calculate 95% UCLs for GRO, DRO, and RRO, so ProUCL was used to calculate 95% UCLs for the HRC input. ProUCL formatted outputs are displayed in Table 13-7a.

Table 13-8 presents the ProUCL outlier test results for DRO, and as shown, the test indicated that the highest DRO concentration included in the 95% UCL calculation (5,600 mg/kg) was a statistical outlier. A Q-Q plot and box plot of the DRO source area data are presented in Figure 13-1a and Figure 13-1b. Both the Q-Q and box plots show that the highest DRO concentration graphed significantly above the other data, which also suggests that the highest DRO result was a statistical outlier.

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 13-3. Adequate data were available to calculate a 95% UCL for naphthalene. Benzo(g,h,i)perylene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were not detected at the site, so the maximum LOD values were used as the exposure point concentrations (Table 13-7b). The maximum detected concentrations were used as the exposure point concentrations for the remaining PAH constituents.

Seven VPH and EPH source area samples were used to characterize the bulk hydrocarbon chemistry. The HRC input values calculated from the source area VPH/EPH data are shown in Table 13-4.

The source of each HRC soil exposure point input value is documented in Table 13-9a.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

Benzene and toluene were not detected at the site, so the maximum LODs for the samples collected from the source area well were used as the exposure point concentrations. Ethylbenzene, xylene, GRO, DRO and RRO were detected at the site; therefore, the maximum detected concentrations were used as input to the HRC. VPH and EPH analyses were not performed at AOC D6, so the GRO, DRO and RRO aromatic and aliphatic concentrations used as input to the HRC were modeled using the soils data.

Naphthalene was the only PAH constituent detected during the 2014 groundwater sampling event, and the maximum detected concentration was used as the exposure point concentration in the HRC. For the non-carcinogenic PAH constituents that were not detected during the 2014 groundwater sampling event, the maximum LOD values were used as the exposure point concentrations. For the carcinogenic PAHs, the groundwater concentrations predicted or modeled by the HRC, based on the soil concentration data, were used as input to the risk calculations (to yield more representative risk results).

The source of each HRC groundwater exposure point input value is documented in Table 13-9a.

13.5.3 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to AOC D6 is presented in Table 13-9b.

13.5.4 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results is included as Table N-8 of Appendix N and the risk posed by site conditions is summarized in Table 13-10 and Table 13-11. Table N-8 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for AOC D6 indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).
- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aromatic and aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.
- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, the site conditions are protective of human health under an unrestricted (residential) land use scenario.

13.6 ALTERNATIVE CLEANUP LEVELS

Constituents and/or hydrocarbon fractions exceeding the ADEC Method Two cleanup levels at AOC D6 include 2-methylnaphthalene and DRO. Soil ACLs have been developed for these constituents and/or hydrocarbon fractions as shown in Table 13-12.

DRO and 2-methylnaphthalene exceed the Method Two migration to groundwater cleanup levels. However, the migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult’s Law) and dilution-attenuation calculations are applied, the AOC D6 exposure point concentrations meet the migration to groundwater criteria. Under these conditions, it is typically not necessary to calculate ACLs, but for this contract ACLs have been back calculated for site COPCs and are presented in Table 13-12. The exposure point concentrations at AOC D6 are less than the ACLs calculated using the HRC, documenting that the site meets the ADEC migration to groundwater criteria.

13.7 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at AOC D was evaluated and a preliminary ecological CSM was developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at AOC D6 are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.
- There is not significant surface water runoff or sediment transport from the site to surface water bodies (e.g. nearby pond) based on topography, vegetative cover, and a lack of surface soil contamination.
- While Monti Bay is located north of the site, groundwater results indicate petroleum hydrocarbons are not migrating to the marine environment at concentrations above Alaska WQS for TAH or TAqH.
- Petroleum hydrocarbons in surface soil at AOC D (D1 – D8) cover 0.31 acre. The impacted surface soil areas are less than the ADEC 0.5 acre *de minimis* criterion. Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.

- Risk to the environment has been evaluated for the AOC D area (in entirety) using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation of AOC D6 is not needed and site conditions are protective of the environment.

Figure 13-1a: AOC D6 DRO Q-Q Plot

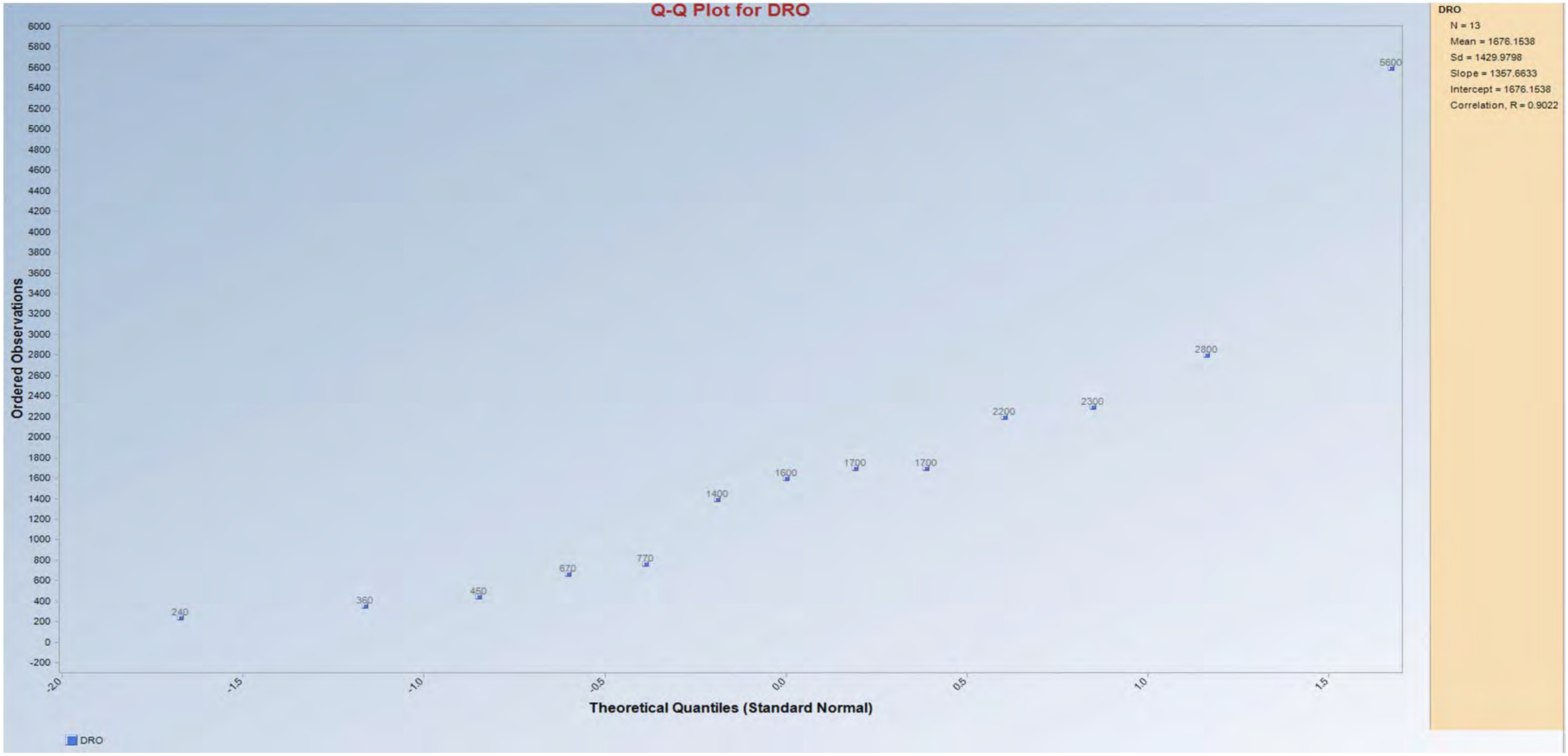

FIGURE 13-1b: AOC D6 DRO Box Plot

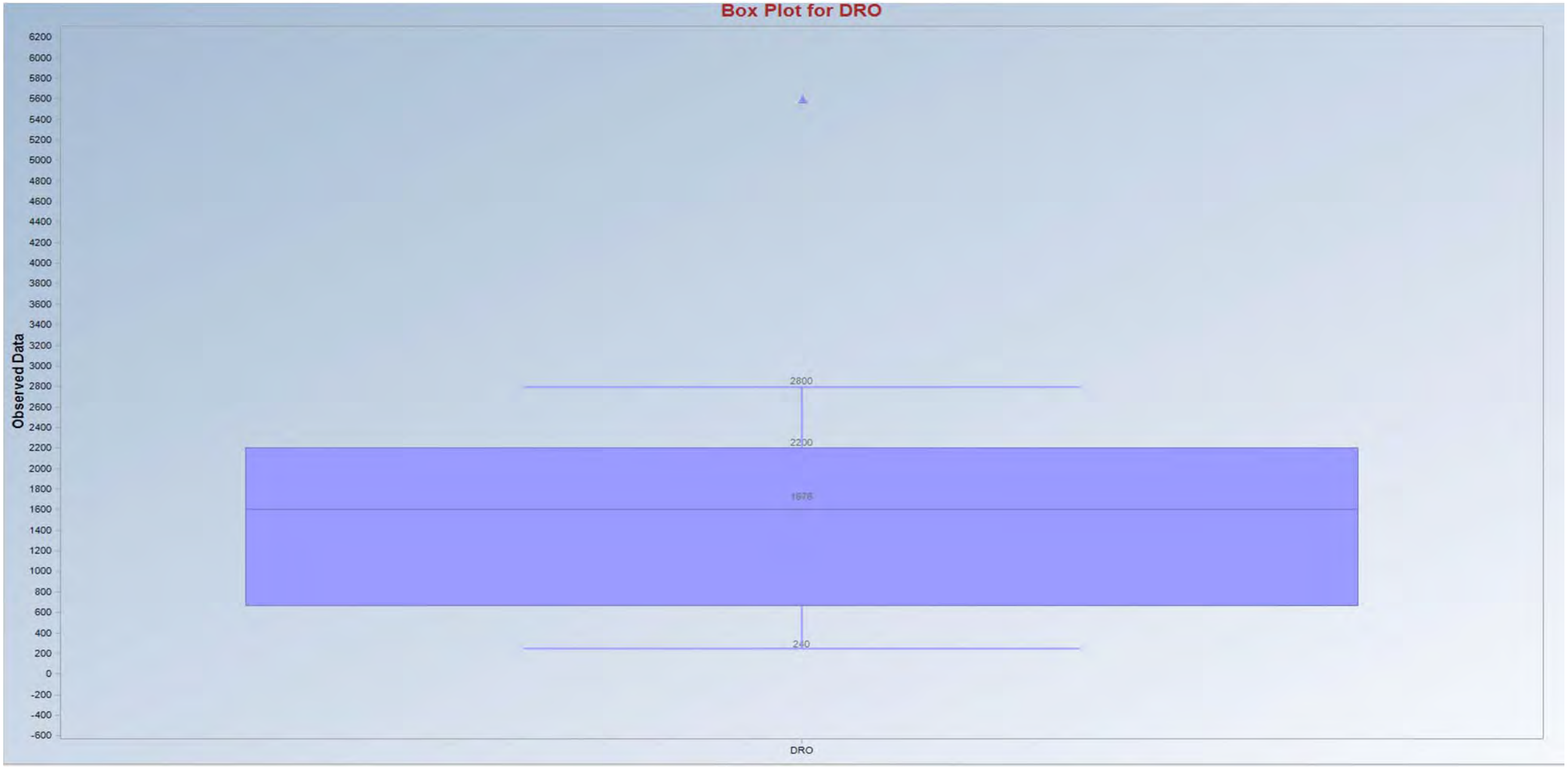

Table 13-1: AOC D6 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D6	04Y-DT6-01-SS	0-1	8/12/2004	04Y-DT6-01-SS	<0.2 U	**1700**	--	<0.0007 U	<0.0007 U	<0.0009 U	--
D6	04Y-DT6-02-SS	0-1	8/12/2004	04Y-DT6-02-SS	**1.1 J**	**13000**	--	<0.0009 U	<0.0009 U	**0.0077 J**	--
D6	04Y-DT6-03-SS	0-1	8/12/2004	04Y-DT6-03-SS	<0.29 U	**5600**	--	<0.001 U	<0.001 U	**0.0031 J**	--
D6	AP-215	10-12	8/14/2004	04Y-DT6-04-SO	**5.5**	**1400**	--	<0.0022 U	<0.002 U	**0.0077 J**	--
D6	AP-215	15-16.5	8/14/2004	04Y-DT6-05-SO	**3.3 J**	**450**	--	**0.02 J**	<0.0032 U	<0.0042 U	--
D6	AP-215	25-26.5	8/14/2004	04Y-DT6-06-SO	<0.22 U	**1.6 J**	--	<0.0008 U	**0.0016 J**	**0.0027 J**	--
D6	AP-216	5-7	8/16/2004	04Y-DT6-07-SO	<0.19 U	**9.4**	--	<0.0007 U	<0.0006 U	**0.004 J**	--
D6	AP-216	15-17	8/16/2004	04Y-DT6-08-SO	<0.18 U	**2.1 J**	--	<0.0007 U	**0.0032 J**	**0.0053 J**	--
D6	AP-216	20-22	8/16/2004	04Y-DT6-09-SO	**1.6**	**1.9 J**	--	<0.0007 U	**0.0034 J**	**0.0058 J**	--
D6	AST6-3	37-39	9/22/2005	05Y-DT6-04-SO	<0.373 U	**5.75 J**	--	<0.00362 U	<0.00723 U	<0.0139 U	<0.02113 U
D6	AST6-3	52-54	9/22/2005	05Y-DT6-06-SO	**0.652 J**	**7.81 J**	--	<0.00432 U	<0.00864 U	<0.0166 U	<0.02524 U
D6	AST6-3	62-64	9/23/2005	05Y-DT6-08-SO	**0.419 J**	**2.38 J**	--	<0.00316 U	<0.00633 U	<0.0122 U	<0.01853 U
D6	D1SD001	0-0	9/28/2001	01D1SD001SE	<1.27 U	<21.5 U	<23 U	<0.00958 U	<0.00958 U	<0.00958 U	<0.02878 U
D6	D1SD002	0-0	9/28/2001	01D1SD002SE	<0.494 U	<19.8 U	<21.2 U	<0.00563 U	<0.00563 U	<0.00563 U	<0.01693 U
D6	D1SD003	0-0	9/28/2001	01D1SD003SE	<1.15 U	<23.3 U	<25 U	<0.00885 U	<0.00885 U	**0.00893 J**	**0.03065 J**
D6	D1SS001	0-0	9/28/2001	01D1SS001SO	<1.03 U	<19.9 U	<21.4 U	<0.0069 U	<0.0069 U	<0.0069 U	<0.0207 U
D6	D1SS002	0-0	9/28/2001	01D1SS002SO	<0.651 U	<19.2 U	<20.6 U	<0.00549 U	<0.00549 U	<0.00549 U	<0.01649 U
D6	D1SS005	0-0	9/29/2001	01D1SS005SO	<1.31 U	<20.5 U	<22 U	<0.00994 U	<0.00994 U	<0.00994 U	<0.02984 U
D6	D1SS006	0-0	9/29/2001	01D1SS006SO	<0.997 U	<21.4 U	<22.9 U	<0.00843 U	<0.00843 U	<0.00843 U	<0.02533 U
D6	D6-SB01	2-4	6/12/2014	D6-SB01-2.0-4.0-0614	**37**	**2800**	**120**	<0.01 U	**0.0043 J**	<0.01 U	<0.02 U
D6	D6-SB02	2-4	6/12/2014	D6-SB02-2.0-4.0-0614	**24**	**2200**	**71**	<0.0087 U,QL	**0.0088 QL**	**0.0028 QL**	**0.0192 QL**
D6	D6-SB02	8-10	6/12/2014	D6-SB02-8.0-10.0-0614	**30**	**2300**	**92**	<0.0094 U,QL	**0.0062 QL**	**0.0051 QL**	**0.0254 QL**
D6	D6-SB04	3-5	6/12/2014	D6-SB04-3.0-5.0-0614	**13**	**1600**	**33 J**	<0.0073 U,ML	**0.0077 ML**	<0.0073 U,ML	**0.0273 ML**
D6	D6-SB05	2-4	6/12/2014	D6-SB05-2.0-4.0-0614	**4.1 B**	**140**	<27 U	<0.0084 U	**0.0025 J**	<0.0084 U	<0.0168 U
D6	D6-SB06	2-4	6/12/2014	D6-SB06-2.0-4.0-0614	**28**	**670**	**22 J**	<0.0091 U	**0.006 J**	<0.0091 U	<0.0182 U
D6	D6-SB07	6-8	6/12/2014	D6-SB07-6.0-8.0-0614	**6.5 B**	**240**	<27 U	<0.009 U	<0.009 U	<0.009 U	<0.018 U
D6	D6-SB3A	2-4	6/13/2014	D6-SB3A-2.0-4.0-0614	**2.4 B**	**360**	**37 J**	<0.0095 U	**0.0069 J**	<0.0095 U	<0.019 U
D6	D6-SB3B	2-4	6/13/2014	D6-SB3B-2.0-4.0-0614	**32**	**1700**	**63**	<0.0082 U	**0.0073 J**	<0.0082 U	**0.0391 J**
D6	D6-SB3D	0.5-2	6/12/2014	D6-SB3D-0.5-2.0-0614	**28**	**770**	**60**	<0.011 U	**0.006 J**	**0.0036 J**	**0.0152 J**
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					37	13000	120	0.02	0.0088	0.00893	0.0391
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:

Bold = detected analyte

Shading = result above screening criteria.

Yellow = NAPL-contaminated soil source area.

-- = not analyzed

BTEX = benzene, toluene, ethylbenzene & xylenes

DRO = diesel-range organics

GRO = gasoline-range organics

HRC = hydrocarbon risk calculator

mg/kg = milligrams per kilogram

NA = not applicable

RRO = residual-range organics

Data qualifiers:

B = analyte detected in blank

J = estimated value

JB = estimated value & analyte detected in blank

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level sources:

A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion

B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation

C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater

D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact

E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation

F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater

H = Source delineation criteria not related to ADEC regulatory levels

Table 13-2: AOC D6 Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D6	04Y-DT6-01-SS	0-1	8/12/2004	04Y-DT6-01-SS	<0.2 U	**1700**	**--**	**--**	**--**	**--**	**--**
D6	04Y-DT6-02-SS	0-1	8/12/2004	04Y-DT6-02-SS	**1.1 J**	**13000**	**--**	**--**	**--**	**--**	**--**
D6	04Y-DT6-03-SS	0-1	8/12/2004	04Y-DT6-03-SS	<0.29 U	**5600**	**--**	**--**	**--**	**--**	**--**
D6	AP-215	10-12	8/14/2004	04Y-DT6-04-SO	**5.5**	**1400**	**--**	**--**	**--**	**--**	**--**
D6	AP-215	15-16.5	8/14/2004	04Y-DT6-05-SO	**3.3 J**	**450**	**--**	**--**	**--**	**--**	**--**
D6	D6-SB01	2-4	6/12/2014	D6-SB01-2.0-4.0-0614	**37**	**2800**	**120**	<0.01 U	**0.0043 J**	<0.01 U	<0.02 U
D6	D6-SB02	2-4	6/12/2014	D6-SB02-2.0-4.0-0614	**24**	**2200**	**71**	<0.0087 U,QL	**0.0088 QL**	**0.0028 QL**	**0.0192 QL**
D6	D6-SB02	8-10	6/12/2014	D6-SB02-8.0-10.0-0614	**30**	**2300**	**92**	<0.0094 U,QL	**0.0062 QL**	**0.0051 QL**	**0.0254 QL**
D6	D6-SB04	3-5	6/12/2014	D6-SB04-3.0-5.0-0614	**13**	**1600**	**33 J**	<0.0073 U,ML	**0.0077 ML**	<0.0073 U,ML	**0.0273 ML**
D6	D6-SB06	2-4	6/12/2014	D6-SB06-2.0-4.0-0614	**28**	**670**	**22 J**	<0.0091 U	**0.006 J**	<0.0091 U	<0.0182 U
D6	D6-SB07	6-8	6/12/2014	D6-SB07-6.0-8.0-0614	**6.5 B**	**240**	<27 U	<0.009 U	<0.009 U	<0.009 U	<0.018 U
D6	D6-SB3A	2-4	6/13/2014	D6-SB3A-2.0-4.0-0614	**2.4 B**	**360**	**37 J**	<0.0095 U	**0.0069 J**	<0.0095 U	<0.019 U
D6	D6-SB3B	2-4	6/13/2014	D6-SB3B-2.0-4.0-0614	**32**	**1700**	**63**	<0.0082 U	**0.0073 J**	<0.0082 U	**0.0391 J**
D6	D6-SB3D	0.5-2	6/12/2014	D6-SB3D-0.5-2.0-0614	**28**	**770**	**60**	<0.011 U	**0.006 J**	**0.0036 J**	**0.0152 J**
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					37	13000	120	0.011	0.0088	0.0051	0.0391
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:

Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:

B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:

A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 13-3: AOC D6 PAH Soils Results

Site Name		D6	D6	D6	D6	D6	D6	D6	D6
Boring, Well or Sample Location Number		04Y-DT6-02-SS	AP-215	AP-216	AST6-3	AST6-3	AST6-3	D1SD001	D1SD002
Sample Depth (feet)		0-1	25-26.5	20-22	37-39	52-54	62-64	0-0	0-0
Sample Date		8/12/2004	8/14/2004	8/16/2004	9/22/2005	9/22/2005	9/23/2005	9/28/2001	9/28/2001
Sample Name		04Y-DT6-02-SS	04Y-DT6-06-SO	04Y-DT6-09-SO	05Y-DT6-04-SO	05Y-DT6-06-SO	05Y-DT6-08-SO	01D1SD001SE	01D1SD002SE
GRO	(mg/kg)	**1.1 J**	<0.22 U	**1.6**	<0.373 U	**0.652 J**	**0.419 J**	<1.27 U	<0.494 U
DRO	(mg/kg)	**13000**	**1.6 J**	**1.9 J**	**5.75 J**	**7.81 J**	**2.38 J**	<21.5 U	<19.8 U
RRO	(mg/kg)	--	--	--	--	--	--	<23 U	<21.2 U
Acenaphthene	(mg/kg)	<0.0027 U	<0.00022 U	<0.00022 U	<0.00176 U	<0.00161 U	<0.00165 U	<0.000696 U	<0.000791 U
Acenaphthylene	(mg/kg)	<0.0082 U	<0.00067 U	<0.00065 U	<0.00176 U	<0.00161 U	<0.00165 U	<0.000613 U	<0.000696 U
Anthracene	(mg/kg)	<0.0035 U	<0.00028 U	<0.00028 U	<0.00176 U	<0.00161 U	<0.00165 U	<0.000354 U	<0.000403 U
Benzo(a)anthracene	(mg/kg)	<0.0071 U	<0.00057 U	<0.00056 U	<0.00176 U	<0.00161 U	<0.00165 U	<0.000858 U	<0.000974 U
Benzo(a)pyrene	(mg/kg)	<0.012 U	<0.00099 U	<0.00097 U	<0.00176 U	<0.00161 U	<0.00165 U	**0.00197**	<0.000938 U
Benzo(b)fluoranthene	(mg/kg)	<0.0046 U	<0.00037 U	<0.00037 U	<0.00176 U	<0.00161 U	<0.00165 U	<0.000299 U	<0.00034 U
Benzo(g,h,i)perylene	(mg/kg)	<0.0063 U	<0.00051 U	<0.0005 U	<0.00176 U	<0.00161 U	<0.00165 U	<0.000232 U	<0.000264 U
Benzo(k)fluoranthene	(mg/kg)	<0.0029 U	<0.00023 U	<0.00023 U	<0.00176 U	<0.00161 U	<0.00165 U	**0.00323**	<0.000696 U
Chrysene	(mg/kg)	<0.0034 U	<0.00028 U	<0.00027 U	<0.00176 U	<0.00161 U	<0.00165 U	<0.000825 U	<0.000938 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.0045 U	<0.00036 U	<0.00036 U	<0.00176 U	<0.00161 U	<0.00165 U	<0.000328 U	<0.000372 U
Fluorene	(mg/kg)	<0.0033 U	<0.00027 U	<0.00027 U	<0.00176 U	<0.00161 U	<0.00165 U	**0.0187**	**0.00176**
Fluoranthene	(mg/kg)	<0.0081 U	<0.00066 U	<0.00065 U	<0.00176 U	<0.00161 U	<0.00165 U	**0.00183**	<0.000746 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0062 U	<0.00051 U	<0.0005 U	<0.00176 U	<0.00161 U	<0.00165 U	<0.000328 U	<0.000372 U
Naphthalene	(mg/kg)	<0.0041 U	<0.00034 U	<0.00033 U	<0.00176 U	<0.00161 U	<0.00165 U	**0.019**	<0.000748 U
Phenanthrene	(mg/kg)	<0.0039 U	<0.00032 U	**0.0025**	**0.00179 J**	**0.00165 J**	<0.00165 U	**0.0143**	**0.00479**
Pyrene	(mg/kg)	<0.0049 U	<0.0004 U	<0.00039 U	<0.00176 U	**0.00259 J**	<0.00165 U	**0.00295**	<0.000527 U
2-Methylnaphthalene	(mg/kg)	<0.07 U	<0.0057 U	<0.0056 U	**0.00233 J**	**0.00222 J**	<0.00165 U	**0.0157**	**0.00208**
1-Methylnaphthalene	(mg/kg)	--	--	--	**0.00193 J**	**0.00167 J**	<0.00165 U	--	--

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 13-3: AOC D6 PAH Soil Results

Site Name		D6	D6	D6	D6	D6	D6	D6	D6	D6
Boring, Well or Sample Location Number		D1SD003	D1SS001	D1SS002	D1SS005	D1SS006	D6-SB01	D6-SB02	D6-SB02	D6-SB04
Sample Depth (feet)		0-0	0-0	0-0	0-0	0-0	2-4	2-4	8-10	3-5
Sample Date		9/28/2001	9/28/2001	9/28/2001	9/29/2001	9/29/2001	6/12/2014	6/12/2014	6/12/2014	6/12/2014
Sample Name		01D1SD003SE	01D1SS001SO	01D1SS002SO	01D1SS005SO	01D1SS006SO	D6-SB01-2.0-4.0-0614	D6-SB02-2.0-4.0-0614	D6-SB02-8.0-10.0-0614	D6-SB04-3.0-5.0-0614
GRO	(mg/kg)	<1.15 U	<1.03 U	<0.651 U	<1.31 U	<0.997 U	**37**	**24**	**30**	**13**
DRO	(mg/kg)	<23.3 U	<19.9 U	<19.2 U	<20.5 U	<21.4 U	**2800**	**2200**	**2300**	**1600**
RRO	(mg/kg)	<25 U	<21.4 U	<20.6 U	<22 U	<22.9 U	**120**	**71**	**92**	**33 J**
Acenaphthene	(mg/kg)	<0.000777 U	<0.000766 U	<0.000595 U	<0.00082 U	<0.000751 U	**0.16**	**0.097**	**0.069**	**0.12**
Acenaphthylene	(mg/kg)	<0.000685 U	<0.000675 U	<0.000524 U	<0.000722 U	<0.000662 U	**0.063**	**0.11**	**0.092**	**0.1**
Anthracene	(mg/kg)	<0.000396 U	<0.00039 U	<0.000303 U	<0.000418 U	<0.000382 U	**0.14**	**0.086**	**0.055**	**0.05**
Benzo(a)anthracene	(mg/kg)	<0.000958 U	<0.000944 U	<0.000734 U	<0.00101 U	<0.000926 U	**0.007**	**0.0037 J**	**0.0034 J**	**0.0017 J**
Benzo(a)pyrene	(mg/kg)	<0.000922 U	<0.000909 U	<0.000706 U	**0.00199**	<0.000891 U	<0.0028 U	<0.0027 U	<0.0027 U	<0.0029 U
Benzo(b)fluoranthene	(mg/kg)	<0.000334 U	<0.00033 U	<0.000256 U	**0.00215**	<0.000323 U	**0.0027 J**	<0.0027 U	**0.0018 J**	<0.0029 U
Benzo(g,h,i)perylene	(mg/kg)	<0.000259 U	<0.000255 U	<0.000198 U	<0.000273 U	<0.00025 U	<0.0028 U	<0.0027 U	<0.0027 U	<0.0029 U
Benzo(k)fluoranthene	(mg/kg)	<0.000685 U	<0.000675 U	<0.000524 U	<0.000722 U	<0.000662 U	<0.0028 U	<0.0027 U	<0.0027 U	<0.0029 U
Chrysene	(mg/kg)	<0.000922 U	<0.000909 U	<0.000706 U	**0.00166 J**	<0.000891 U	**0.029**	**0.016**	**0.015**	**0.0072**
Dibenzo(a,h)anthracene	(mg/kg)	<0.000366 U	<0.000361 U	<0.00028 U	<0.000386 U	<0.000354 U	<0.0028 U	<0.0027 U	<0.0027 U	<0.0029 U
Fluorene	(mg/kg)	**0.00502**	<0.000723 U	<0.000562 U	**0.00298**	<0.000709 U	**0.35**	**0.7**	**0.56**	**0.74**
Fluoranthene	(mg/kg)	<0.000733 U	<0.000723 U	<0.000562 U	<0.000774 U	<0.000709 U	**0.011**	**0.011**	**0.0075**	**0.012**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.000366 U	<0.000361 U	<0.00028 U	<0.000386 U	<0.000354 U	<0.0028 U	<0.0027 U	<0.0027 U	<0.0029 U
Naphthalene	(mg/kg)	**0.00644**	<0.000724 U	**0.0012**	**0.00315**	**0.00167**	**0.036**	**0.75**	**0.43**	**0.47**
Phenanthrene	(mg/kg)	**0.0055**	<0.00033 U	**0.00168**	**0.0119**	**0.00364**	**0.48**	**1.5**	**0.77**	**0.89**
Pyrene	(mg/kg)	<0.000518 U	<0.000511 U	<0.000397 U	<0.000547 U	<0.000501 U	**0.048**	**0.035**	**0.023**	**0.018**
2-Methylnaphthalene	(mg/kg)	**0.00581**	<0.000241 U	**0.00132**	**0.00679**	**0.00228**	**0.18**	**6.7**	**2.6**	**5.7**
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	**0.36**	**3.7**	**2**	**5.1**

Table 13-3: AOC D6 PAH Soil Results

Site Name		D6	D6	D6	D6	D6	D6	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		D6-SB05	D6-SB06	D6-SB07	D6-SB3A	D6-SB3B	D6-SB3D		
Sample Depth (feet)		2-4	2-4	6-8	2-4	2-4	0.5-2		
Sample Date		6/12/2014	6/12/2014	6/12/2014	6/13/2014	6/13/2014	6/12/2014		
Sample Name		D6-SB05-2.0-4.0-0614	D6-SB06-2.0-4.0-0614	D6-SB07-6.0-8.0-0614	D6-SB3A-2.0-4.0-0614	D6-SB3B-2.0-4.0-0614	D6-SB3D-0.5-2.0-0614		
GRO	(mg/kg)	**4.1 B**	**28**	**6.5 B**	**2.4 B**	**32**	**28**	37	**260 C**
DRO	(mg/kg)	**140**	**670**	**240**	**360**	**1700**	**770**	13000	**230 C**
RRO	(mg/kg)	<27 U	**22 J**	<27 U	**37 J**	**63**	**60**	120	**230 H**
Acenaphthene	(mg/kg)	**0.0068**	**0.074**	**0.019**	<0.0027 U	**0.14**	**0.01**	0.16	**180 F**
Acenaphthylene	(mg/kg)	**0.0064**	**0.049**	**0.014**	**0.0028 J**	**0.068**	**0.02**	0.11	**180 F**
Anthracene	(mg/kg)	**0.0042 J**	**0.027**	**0.014**	**0.0051 J**	**0.068**	**0.022**	0.14	**1680 D**
Benzo(a)anthracene	(mg/kg)	**0.0021 J**	<0.0028 U	<0.0026 U	<0.0027 U	**0.0024 J**	**0.0023 J**	0.007	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0027 U	<0.0028 U	<0.0028 U	0.00199	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0027 U	**0.0017 J**	<0.0028 U	0.0027	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0027 U	<0.0028 U	<0.0028 U	0.0063	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0027 U	<0.0028 U	<0.0028 U	0.00323	**4 D**
Chrysene	(mg/kg)	**0.0026 J**	<0.0028 U	**0.0043 J**	**0.0026 J**	**0.01**	**0.0078**	0.029	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0027 U	<0.0028 U	<0.0028 U	0.0045	**0.04 D**
Fluorene	(mg/kg)	**0.039**	**0.44**	**0.14**	**0.01**	**0.69**	**0.04**	0.74	**190 D**
Fluoranthene	(mg/kg)	**0.0021 J**	**0.0087**	**0.0046 J**	<0.0027 U	**0.026**	**0.0036 J**	0.026	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0027 U	<0.0028 U	<0.0026 U	<0.0027 U	<0.0028 U	<0.0028 U	0.0062	**0.4 D**
Naphthalene	(mg/kg)	**0.0063 B**	**0.078**	**0.011 B**	**0.013 B**	**0.33**	**0.025**	0.75	**2.1 E**
Phenanthrene	(mg/kg)	**0.021**	**0.38**	**0.18**	**0.012**	**1.3**	**0.19**	1.5	**1680 D**
Pyrene	(mg/kg)	**0.0032 J**	**0.01**	**0.0058**	**0.0034 J**	**0.024**	**0.013**	0.048	**110 D**
2-Methylnaphthalene	(mg/kg)	**0.018**	**0.18**	**0.029**	**0.032**	**4.3**	**0.05**	6.7	**6.1 F**
1-Methylnaphthalene	(mg/kg)	**0.047**	**0.74**	**0.034**	**0.021**	**2.5**	**0.039**	5.1	**6.2 F**

Table 13-4a: AOC D6 Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D6	D6-SB01	2-4	6/12/2014	D6-SB01-2.0-4.0-0614	<0.01 U	<0.01 U	0.0043 J	<0.02 U	35 B	34.9757	88 B	--	<1.9 U	0.99 J,B	37	53	390
D6	D6-SB04	3-5	6/12/2014	D6-SB04-3.0-5.0-0614	<0.0073 U,ML	<0.0073 U,ML	0.0077 ML	0.0273 ML	18 B	17.965	85 B	--	<1.4 U,MN	1.2 J,B	21 MH	38 ML	310
D6	D6-SB06	2-4	6/12/2014	D6-SB06-2.0-4.0-0614	<0.0091 U	<0.0091 U	0.006 J	<0.0182 U	23 B	22.9758	97 B	--	<1.7 U	2.5 J,B	26	49	370
D6	D6-SB07	6-8	6/12/2014	D6-SB07-6.0-8.0-0614	<0.009 U	<0.009 U	<0.009 U	<0.018 U	3.5 B	3.473	1.1 B	--	<0.34 U	<0.34 U	<0.34 U	<0.34 U	4.4 J,B
D6	D6-SB3A	2-4	6/13/2014	D6-SB3A-2.0-4.0-0614	<0.0095 U	<0.0095 U	0.0069 J	<0.019 U	1.3 J,B	1.2741	0.38 J,B	--	0.19 J,B	<0.36 U	<0.36 U	<0.36 U	1.8 J,B
D6	D6-SB3B	2-4	6/13/2014	D6-SB3B-2.0-4.0-0614	<0.0082 U	<0.0082 U	0.0073 J	0.0391 J	17 B	16.9536	59 B	--	<1.5 U	2.3 J,B	21	37	270
D6	D6-SB3D	0.5-2	6/12/2014	D6-SB3D-0.5-2.0-0614	<0.011 U	0.0036 J	0.006 J	0.0152 J	--	--	--	--	--	--	--	--	--
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.009	0.008	0.007	0.022	16.300	16.270	55.080	#DIV/0!	1.172	1.282	17.617	29.617	224.37

Table 13-4b: AOC D6 Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D6	D6-SB01	2-4	6/12/2014	D6-SB01-2.0-4.0-0614	--	--	8.4 QL	100	470	74	--	74 QL	680	650 QH	100 QN	578.4	1404	1982.4
D6	D6-SB04	3-5	6/12/2014	D6-SB04-3.0-5.0-0614	--	--	33 QL	150	220	21 MH	--	100 QL	430	230 QH	23 QH	403	760	1163
D6	D6-SB06	2-4	6/12/2014	D6-SB06-2.0-4.0-0614	--	--	4.8 QL	40	110	15	--	25 QL	180	150 QH	20 QH	154.8	355	509.8
D6	D6-SB07	6-8	6/12/2014	D6-SB07-6.0-8.0-0614	--	--	0.16 QL	3.2 J	25	3.8 J	--	0.45 QL	26	49 QH	7.2 QH	28.36	75.45	103.81
D6	D6-SB3A	2-4	6/13/2014	D6-SB3A-2.0-4.0-0614	--	--	0.28 J	2.1 J	19	8.5	--	10	84	110	24	21.38	204	225.38
D6	D6-SB3B	2-4	6/13/2014	D6-SB3B-2.0-4.0-0614	--	--	8.5	53	120	18	--	65	400	370	60	181.5	835	1016.5
D6	D6-SB3D	0.5-2	6/12/2014	D6-SB3D-0.5-2.0-0614	--	--	1.3 QL	16	79	17	--	14 QL	100	130 QH	26 QH	96.3	244	340.3
average with fraction:							8.063	52.043	149.000	22.471		41.207	271.429	241.286	37.171			

Table 13-4c: AOC D6 Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.00916	0.00810	0.00674	0.02240	16.26953	8.06286	52.04286	149.00000	22.47143	1.17167	1.28167	17.61667	41.20714	271.42857	241.28571	37.17143	859
Fraction of TPH mass in A&A EC groups	1.06595E-05	9.42896E-06	7.84915E-06	0.00003	0.01894	0.00939	0.06058	0.17345	0.02616	0.00136	0.00149	0.02051	0.04797	0.31596	0.28087	0.04327	1.00
GRO, DRO & RRO A&A Groups	**GRO aromatics**					**DRO aromatics**			**RRO aromatics**	**GRO aliphatics**			**DRO aliphatics**			**RRO aliphatics**	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.018993					0.243413			0.026158	0.023363			0.644803			0.043270	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.000561	0.000496	0.000413	0.001373	0.997156	0.038559	0.248883	0.712558	1.000000	0.058379	0.063860	0.877761	0.074392	0.490013	0.435596	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	4.24%
% of TPH that is DRO=	88.82%
% of TPH that is RRO=	6.94%

GRO % aromatics	0.448413215
GRO % aliphatics	0.551586785
DRO % aromatics	0.274047544
DRO % aliphatics	0.725952456
RRO % aromatics	0.376766467
RRO % aliphatics	0.623233533

Table 13-4d: AOC D6 HRC Input

input to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.448413215
DRO: fraction aromatic	0.274047544
RRO: fraction aromatic	0.376766467

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.03855876
Aromatic C12-C16	0.248882998
Aromatic C16-C21	0.712558241

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.058379007
Aliphatic C6-C8	0.063859824
Aliphatic C8-C10	0.877761169
Aliphatic C10-C12	0.074391675
Aliphatic C12-C16	0.490012766
Aliphatic C16-C21	0.435595559

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons

GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Table 13-5: AOC D6 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
D6	AST6-3	NA	9/25/2005	05Y-DT7-09-DW	<0.028 U	<0.06 U	--	<0.00012 U	<0.00031 U	<0.00031 U	<0.00093 U
D6	AST6-3	NA	9/28/2005	05Y-DT6-09-GW	<0.028 U	<0.06 U	--	<0.00012 U	<0.00031 U	<0.00031 U	<0.00093 U
D6	AST6-3	NA	6/7/2014	AST6-3-WG01-0614	**0.023 J**	**0.082 J**	**0.08 J**	<0.0004 U	**0.00014 J**	<0.0004 U	**0.00074 J**
D6	D1SD001	NA	9/28/2001	01D1SD001WS	<0.025 U	**0.0896 JB**	--	<0.000065 U	<0.0000766 U	**0.0000978 J**	<0.0002413 U
D6	D1SD002	NA	9/28/2001	01D1SD002WS	<0.025 U	**0.0784 JB**	--	<0.000065 U	<0.0000766 U	<0.0000727 U	<0.0002413 U
D6	D1SD003	NA	9/28/2001	01D1SD003WS	<0.025 U	**0.0782 JB**	--	<0.000065 U	<0.0000766 U	<0.0000727 U	<0.0002413 U
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0.023	0.082	0.08	0.0004	0.00014	0.0004	0.00074
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:

Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
BTEX= benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
RRO = residual-range organics

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

Table 13-6: AOC D6 PAH Groundwater Results

Site Name		D6	D6	D6	D6	D6	D6	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		AST6-3	AST6-3	AST6-3	D1SD001	D1SD002	D1SD003		
Sample Depth		NA	NA	NA	NA	NA	NA		
Sample Date		9/25/2005	9/28/2005	6/7/2014	9/28/2001	9/28/2001	9/28/2001		
Sample Name		05Y-DT7-09-DW	05Y-DT6-09-GW	AST6-3-WG01-0614	01D1SD001WS	01D1SD002WS	01D1SD003WS		
GRO	(mg/L)	<0.028 U	<0.028 U	**0.023 J**	<0.025 U	<0.025 U	<0.025 U	0.023	**2.2 H**
DRO	(mg/L)	<0.06 U	<0.06 U	**0.082 J**	**0.0896 JB**	**0.0784 JB**	**0.0782 JB**	0.082	**1.5 H**
RRO	(mg/L)	--	--	**0.08 J**	--	--	--	0.08	**1.1 H**
Acenaphthene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U,QL	<0.0000015 U	<0.0000015 U	<0.0000015 U	0.000015	**0.22 H**
Acenaphthylene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U,QL	<0.0000014 U	<0.0000014 U	<0.0000015 U	0.000015	**0.22 H**
Anthracene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U	<0.0000014 U	<0.0000014 U	<0.0000015 U	0.000015	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U	<0.0000042 U	<0.0000042 U	<0.0000043 U	0.000015	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U	<0.0000045 U	<0.0000045 U	<0.0000046 U	0.000015	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U	<0.0000028 U	<0.0000028 U	<0.0000029 U	0.000015	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U	<0.0000033 U	<0.0000033 U	<0.0000034 U	0.000015	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U	<0.0000037 U	<0.0000037 U	<0.0000038 U	0.000015	**0.0012 H**
Chrysene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U	<0.0000023 U	<0.0000023 U	<0.0000024 U	0.000015	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.00001 U	<0.0000101 U	<0.000015 U	<0.0000026 U	<0.0000026 U	<0.0000026 U	0.000015	**0.000012 H**
Fluorene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U,QL	<0.0000013 U	<0.0000013 U	<0.0000013 U	0.000015	**0.15 H**
Fluoranthene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U	<0.0000018 U	<0.0000018 U	<0.0000018 U	0.000015	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U	<0.0000029 U	<0.0000029 U	<0.000003 U	0.000015	**0.00012 H**
Naphthalene	(mg/L)	<0.000031 U	<0.0000313 U	**0.000014 QL**	<0.0000021 U	<0.0000021 U	<0.0000021 U	0.000014	**0.073 H**
Phenanthrene	(mg/L)	<0.000015 U	**0.000016 J**	<0.000015 U,QL	<0.0000021 U	<0.0000021 U	<0.0000022 U	0.000015	**1.1 H**
Pyrene	(mg/L)	<0.000015 U	<0.0000152 U	<0.000015 U	<0.0000013 U	<0.0000013 U	<0.0000013 U	0.000015	**0.11 H**
2-Methylnaphthalene	(mg/L)	<0.000015 U	**0.0000177 J**	<0.000015 U,QL	<0.0000014 U	<0.0000014 U	<0.0000015 U	0.000015	**0.015 H**
1-Methylnaphthalene	(mg/L)	<0.000015 U	**0.0000169 J**	<0.000015 U,QL	--	--	--	0.000015	**0.015 H**

Notes:

Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

Table 13-7a: AOC D6 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

ProUCL Input File

GRO	d_GRO	DRO	d_DRO	RRO	d_RRO	Benzene	d_Benzene	Toluene	d_Toluene	Ethylbenzene	d_Ethylbenzene	Xylene	d_Xylene
0.2	0												
1.1	1	1700	1										
0.29	0	5600	1										
5.5	1	1400	1										
3.3	1	450	1										
37	1	2800	1	120	1	0.01	0	0.01	0	0.0043	1	0.02	0
24	1	2200	1	71	1	0.0087	0	0.0028	1	0.0088	1	0.0192	1
30	1	2300	1	92	1	0.0094	0	0.0051	1	0.0062	1	0.0254	1
13	1	1600	1	33	1	0.0073	0	0.0073	0	0.0077	1	0.0273	1
28	1	670	1	22	1	0.0091	0	0.0091	0	0.006	1	0.0182	0
6.5	1	240	1	27	0	0.009	0	0.009	0	0.009	0	0.018	0
2.4	1	360	1	37	1	0.0095	0	0.0095	0	0.0069	1	0.019	0
32	1	1700	1	63	1	0.0082	0	0.0082	0	0.0073	1	0.0391	1
28	1	770	1	60	1	0.011	0	0.0036	1	0.006	1	0.0152	1

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options				
From File	WorkSheet.wst	Benzene	0.011	maximum LOD
Full Precision	OFF	Toluene	0.0051	maximum detected conc
Confidence Coefficient	95%	Ethylbenzene	0.0088	maximum detected conc
Number of Bootstrap Operations	10000	Xylene	0.0391	maximum detected conc
		GRO	21.76	95%UCL
		DRO	2632	95%UCL
		RRO	78.56	95%UCL

GRO

General Statistics

Number of Valid Data	14	Number of Detected Data	12
Number of Distinct Detected Data	11	Number of Non-Detect Data	2
		Percent Non-Detects	14.29%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	1.1	Minimum Detected	0.0953
Maximum Detected	37	Maximum Detected	3.611
Mean of Detected	17.57	Mean of Detected	2.386
SD of Detected	13.46	SD of Detected	1.199
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	0.29	Maximum Non-Detect	-1.238
Note: Data have multiple DLs - Use of KM Method is recommend		Number treated as Non-Detect	2
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	12
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	14.29%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.87	Shapiro Wilk Test Statistic	0.872
5% Shapiro Wilk Critical Value	0.859	5% Shapiro Wilk Critical Value	0.859
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	15.07	Mean	1.742
SD	13.91	SD	1.974
95% DL/2 (t) UCL	21.66	95% H-Stat (DL/2) UCL	502.9
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	13.92	Mean in Log Scale	2.007
SD	15.14	SD in Log Scale	1.464
95% MLE (t) UCL	21.08	Mean in Original Scale	15.17
95% MLE (Tiku) UCL	21.09	SD in Original Scale	13.8
		95% t UCL	21.7
		95% Percentile Bootstrap UCL	21.01
		95% BCA Bootstrap UCL	21.43
		95% H UCL	94.51
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.94	**Data appear Normal at 5% Significance Level**	
Theta Star	18.69		
nu star	22.56		
A-D Test Statistic	0.673	**Nonparametric Statistics**	
5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753	Mean	15.21
5% K-S Critical Value	0.251	SD	13.25
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	3.699
		95% KM (t) UCL	21.76
Assuming Gamma Distribution		95% KM (z) UCL	21.3
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	21.64
Minimum	1E-06	95% KM (bootstrap t) UCL	22.41
Maximum	37	95% KM (BCA) UCL	21.61
Mean	15.06	95% KM (Percentile Bootstrap) UCL	21.29
Median	9.75	95% KM (Chebyshev) UCL	31.34
SD	13.93	97.5% KM (Chebyshev) UCL	38.31
k star	0.257	99% KM (Chebyshev) UCL	52.02
Theta star	58.63		
Nu star	7.191	**Potential UCLs to Use**	
AppChi2	2.276	95% KM (t) UCL	21.76
95% Gamma Approximate UCL	47.57	95% KM (Percentile Bootstrap) UCL	21.29
95% Adjusted Gamma UCL	56.19		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table 13-7a: AOC D6 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

DRO

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12
Raw Statistics		**Log-transformed Statistics**	
Minimum	240	Minimum of Log Data	5.481
Maximum	5600	Maximum of Log Data	8.631
Mean	1676	Mean of log Data	7.087
Geometric Mean	1197	SD of log Data	0.902
Median	1600		
SD	1430		
Std. Error of Mean	396.6		
Coefficient of Variation	0.853		
Skewness	1.797		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.829	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2383	95% H-UCL	3615
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3736
95% Adjusted-CLT UCL (Chen-1995)	2540	97.5% Chebyshev (MVUE) UCL	4606
95% Modified-t UCL (Johnson-1978)	2416	99% Chebyshev (MVUE) UCL	6315
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.305	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1284		
MLE of Mean	1676		
MLE of Standard Deviation	1467		
nu star	33.93		
Approximate Chi Square Value (.05)	21.61	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	2329
Adjusted Chi Square Value	20.22	95% Jackknife UCL	2383
		95% Standard Bootstrap UCL	2308
Anderson-Darling Test Statistic	0.266	95% Bootstrap-t UCL	2720
Anderson-Darling 5% Critical Value	0.748	95% Hall's Bootstrap UCL	5374
Kolmogorov-Smirnov Test Statistic	0.133	95% Percentile Bootstrap UCL	2355
Kolmogorov-Smirnov 5% Critical Value	0.241	95% BCA Bootstrap UCL	2497
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3405
		97.5% Chebyshev(Mean, Sd) UCL	4153
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	5622
95% Approximate Gamma UCL (Use when n >= 40)	2632		
95% Adjusted Gamma UCL (Use when n < 40)	2813		
Potential UCL to Use		Use 95% Approximate Gamma UCL	2632

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

RRO

General Statistics

Number of Valid Data	9	Number of Detected Data	8
Number of Distinct Detected Data	8	Number of Non-Detect Data	1
		Percent Non-Detects	11.11%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	22	Minimum Detected	3.091
Maximum Detected	120	Maximum Detected	4.787
Mean of Detected	62.25	Mean of Detected	4.001
SD of Detected	32.55	SD of Detected	0.563
Minimum Non-Detect	27	Minimum Non-Detect	3.296
Maximum Non-Detect	27	Maximum Non-Detect	3.296

Warning: There are only 8 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.953	Shapiro Wilk Test Statistic	0.969
5% Shapiro Wilk Critical Value	0.818	5% Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	56.83	Mean	3.846
SD	34.51	SD	0.704
95% DL/2 (t) UCL	78.22	95% H-Stat (DL/2) UCL	115.1
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	54.11	Mean in Log Scale	3.895
SD	36.94	SD in Log Scale	0.615
95% MLE (t) UCL	77	Mean in Original Scale	57.67
95% MLE (Tiku) UCL	77.78	SD in Original Scale	33.4
		95% t UCL	78.38
		95% Percentile Bootstrap UCL	75.45
		95% BCA Bootstrap UCL	77.67
		95% H UCL	101.7
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	2.583	**Data appear Normal at 5% Significance Level**	
Theta Star	24.1		
nu star	41.34		
A-D Test Statistic	0.196	**Nonparametric Statistics**	
5% A-D Critical Value	0.719	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.719	Mean	57.78
5% K-S Critical Value	0.295	SD	31.37
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	11.18
		95% KM (t) UCL	78.56
Assuming Gamma Distribution		95% KM (z) UCL	76.16
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	78.2
Minimum	5.841	95% KM (bootstrap t) UCL	82.91
Maximum	120	95% KM (BCA) UCL	78
Mean	55.98	95% KM (Percentile Bootstrap) UCL	76.89
Median	60	95% KM (Chebyshev) UCL	106.5
SD	35.78	97.5% KM (Chebyshev) UCL	127.6
k star	1.398	99% KM (Chebyshev) UCL	169
Theta star	40.05		
Nu star	25.16	**Potential UCLs to Use**	
AppChi2	14.73	95% KM (t) UCL	78.56
95% Gamma Approximate UCL	95.6	95% KM (Percentile Bootstrap) UCL	76.89
95% Adjusted Gamma UCL	107.7		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Table 13-7b: AOC D6 PAH Soil 95% UCL Concentrations

ProUCL Input File

Naphthalene	_dNaphthalene	2-Methylnaphthalene	_d2-Methylnaphthalene	1-Methylnaphthalene	_d1-Methylnaphthalene
0.0036	0	0.06	0	10.3	1
0.0068	0	1.1	1	2.07	1
17	1	56	1	21.6	1
1.1	1	3.8	1	7.2	1
0.17	1	2.5	1	3.4	1
5.39	1	14.6	1	4.8	1
0.0157	0	1.7	1	2.3	1
16.1	1	38	1	0.47	1
0.0108	1	0.018	1	0.079	1
0.00764	0	0.00255	0	0.051	1
0.00892	0	0.0229	1	0.32	1
0.00776	0	0.00259	0	1.3	1
3.3	1	12	1	3.4	1
1.1	1	6	1	0.92	1
1.6	1	5	1	1.5	1
1.6	1	2.9	1		
0.059	1	0.33	1		
0.039	1	0.17	1		
0.034	1	0.087	1		
0.24	1	0.42	1		
0.3	1	1.6	1		
0.3	1	3.5	1		
0.15	1	0.75	1		
0.0028	0	1.5	1		
0.25	1	1.4	1		

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options				
From File	WorkSheet.wst	Naphthalene	5.967	95%UCL
Full Precision	OFF	2-Methylnaphthalene	17.58	95%UCL
Confidence Coefficient	95%	1-Methylnaphthalene	7.904	95%UCL
Number of Bootstrap Operations	10000			

Naphthalene

General Statistics

Number of Valid Data	25	Number of Detected Data	18
Number of Distinct Detected Data	15	Number of Non-Detect Data	7
		Percent Non-Detects	28.00%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0108	Minimum Detected	-4.528
Maximum Detected	17	Maximum Detected	2.833
Mean of Detected	2.708	Mean of Detected	-0.736
SD of Detected	5.225	SD of Detected	2.097
Minimum Non-Detect	0.0028	Minimum Non-Detect	-5.878
Maximum Non-Detect	0.0157	Maximum Non-Detect	-4.154
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	8
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	17
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	32.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.556	Shapiro Wilk Test Statistic	0.971
5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.951	Mean	-2.128
SD	4.569	SD	2.896
95% DL/2 (t) UCL	3.514	95% H-Stat (DL/2) UCL	200.6
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.536	Mean in Log Scale	-2.093
SD	5.787	SD in Log Scale	2.837
95% MLE (t) UCL	2.516	Mean in Original Scale	1.951
95% MLE (Tiku) UCL	2.624	SD in Original Scale	4.569
		95% t UCL	3.514
		95% Percentile Bootstrap UCL	3.531
		95% BCA Bootstrap UCL	4.242
		95% H UCL	154.9
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.356	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	7.61		
nu star	12.81		
A-D Test Statistic	0.803	**Nonparametric Statistics**	
5% A-D Critical Value	0.825	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.825	Mean	1.953
5% K-S Critical Value	0.218	SD	4.475
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.921
		95% KM (t) UCL	3.528

Table 13-7b: AOC D6 PAH Soil 95% UCL Concentrations

Assuming Gamma Distribution		95% KM (z) UCL	3.468
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	3.51
Minimum	0.000001	95% KM (bootstrap t) UCL	7.159
Maximum	17	95% KM (BCA) UCL	3.636
Mean	1.95	95% KM (Percentile Bootstrap) UCL	3.532
Median	0.17	95% KM (Chebyshev) UCL	5.967
SD	4.569	97.5% KM (Chebyshev) UCL	7.705
k star	0.16	99% KM (Chebyshev) UCL	11.12
Theta star	12.19		
Nu star	7.999	**Potential UCLs to Use**	
AppChi2	2.734	95% KM (Chebyshev) UCL	5.967
95% Gamma Approximate UCL	5.703		
95% Adjusted Gamma UCL	6.168		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

2-Methylnaphthalene

General Statistics

Number of Valid Data	25	Number of Detected Data	22
Number of Distinct Detected Data	22	Number of Non-Detect Data	3
		Percent Non-Detects	12.00%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.018	Minimum Detected	-4.017
Maximum Detected	56	Maximum Detected	4.025
Mean of Detected	6.973	Mean of Detected	0.38
SD of Detected	13.77	SD of Detected	2.106
Minimum Non-Detect	0.00255	Minimum Non-Detect	-5.972
Maximum Non-Detect	0.06	Maximum Non-Detect	-2.813

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	20
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	20.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.538	Shapiro Wilk Test Statistic	0.965
5% Shapiro Wilk Critical Value	0.911	5% Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	6.137	Mean	-0.338
SD	13.09	SD	2.846
95% DL/2 (t) UCL	10.61	95% H-Stat (DL/2) UCL	933.4
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	4.039	Mean in Log Scale	-0.168
SD	14.88	SD in Log Scale	2.489
95% MLE (t) UCL	9.13	Mean in Original Scale	6.138
95% MLE (Tiku) UCL	9.017	SD in Original Scale	13.09
		95% t UCL	10.62
		95% Percentile Bootstrap UCL	10.77
		95% BCA Bootstrap UCL	12.65
		95% H UCL	213.1
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.392	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	17.81		
nu star	17.23		
A-D Test Statistic	0.578	**Nonparametric Statistics**	
5% A-D Critical Value	0.822	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.822	Mean	6.138
5% K-S Critical Value	0.198	SD	12.82
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	2.625
		95% KM (t) UCL	10.63
Assuming Gamma Distribution		95% KM (z) UCL	10.46
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	10.62
Minimum	0.000001	95% KM (bootstrap t) UCL	20.62
Maximum	56	95% KM (BCA) UCL	10.89
Mean	6.136	95% KM (Percentile Bootstrap) UCL	10.76
Median	1.5	95% KM (Chebyshev) UCL	17.58
SD	13.09	97.5% KM (Chebyshev) UCL	22.53
k star	0.229	99% KM (Chebyshev) UCL	32.25
Theta star	26.84		
Nu star	11.43	**Potential UCLs to Use**	
AppChi2	4.855	95% KM (Chebyshev) UCL	17.58
95% Gamma Approximate UCL	14.45		
95% Adjusted Gamma UCL	15.36		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table 13-7b: AOC D6 PAH Soil 95% UCL Concentrations

1-Methylnaphthalene

General Statistics			
Number of Valid Observations	15	Number of Distinct Observations	14
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.051	Minimum of Log Data	-2.976
Maximum	21.6	Maximum of Log Data	3.073
Mean	3.981	Mean of log Data	0.409
Median	2.07	SD of log Data	1.698
SD	5.655		
Std. Error of Mean	1.46		
Coefficient of Variation	1.421		
Skewness	2.493		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.689	Shapiro Wilk Test Statistic	0.958
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.552	95% H-UCL	38.74
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	16.8
95% Adjusted-CLT UCL (Chen-1995)	7.386	97.5% Chebyshev (MVUE) UCL	21.79
95% Modified-t UCL (Johnson-1978)	6.709	99% Chebyshev (MVUE) UCL	31.6
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.549	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	7.252		
MLE of Mean	3.981		
MLE of Standard Deviation	5.373		
nu star	16.47		
Approximate Chi Square Value (.05)	8.293	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	6.382
Adjusted Chi Square Value	7.588	95% Jackknife UCL	6.552
		95% Standard Bootstrap UCL	6.304
Anderson-Darling Test Statistic	0.158	95% Bootstrap-t UCL	9.679
Anderson-Darling 5% Critical Value	0.784	95% Hall's Bootstrap UCL	16.28
Kolmogorov-Smirnov Test Statistic	0.113	95% Percentile Bootstrap UCL	6.495
Kolmogorov-Smirnov 5% Critical Value	0.232	95% BCA Bootstrap UCL	7.593
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10.34
		97.5% Chebyshev(Mean, Sd) UCL	13.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	18.51
95% Approximate Gamma UCL	7.904		
95% Adjusted Gamma UCL	8.639		
Potential UCL to Use		Use 95% Approximate Gamma UCL	7.904

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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Table 13-8: AOC D6 Outlier Test Results

Outlier Tests for Selected Variables

User Selected Options

From File	WorkSheet.wst	
Full Precision	OFF	
Test for Suspected Outliers with Dixon test		1
Test for Suspected Outliers with Rosner test		1

Dixon's Outlier Test for DRO

Number of data = 13
10% critical value: 0.467
5% critical value: 0.521
1% critical value: 0.615

1. Data Value 5600 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.630

For 10% significance level, 5600 is an outlier.
For 5% significance level, 5600 is an outlier.
For 1% significance level, 5600 is an outlier.

2. Data Value 240 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.082

For 10% significance level, 240 is not an outlier.
For 5% significance level, 240 is not an outlier.
For 1% significance level, 240 is not an outlier.

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Table 13-9a: AOC D6 HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	max LOD	max LOD, ND in 2014	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	maximum detected conc	max LOD, ND in 2014	
Ethylbenzene (c & nc)	maximum detected conc	max measured conc in 2014	
Xylenes (total) (nc)	maximum detected conc	max measured conc in 2014	
GRO	95%UCL	max measured conc in 2014	
DRO	95%UCL	max measured conc in 2014	
RRO	95%UCL	max measured conc in 2014	
GRO aromatics	site specific VPH & EPH data	modeled from soils data	
DRO aromatics	site specific VPH & EPH data	modeled from soils data	
RRO aromatics	site specific VPH & EPH data	modeled from soils data	
GRO aliphatics	site specific VPH & EPH data	modeled from soils data	
DRO aliphatics	site specific VPH & EPH data	modeled from soils data	
RRO aliphatics	site specific VPH & EPH data	modeled from soils data	
Acenaphthene (nc)	max measured conc	max LOD, ND in 2014	
Acenaphthylene (nc)	max measured conc	max LOD, ND in 2014	
Anthracene (nc)	max measured conc	max LOD, ND in 2014	
Benzo(g,h,i)perylene (nc)	max DL (<2014) or LOD (2014)	max LOD, ND in 2014	
Fluoranthene (nc)	max measured conc	max LOD, ND in 2014	
Fluorene (nc)	max measured conc	max LOD, ND in 2014	
Naphthalene (c & nc)	95%UCL	max measured conc in 2014	
Phenanthrene (nc)	max measured conc	max LOD, ND in 2014	
Pyrene (nc)	max measured conc	max LOD, ND in 2014	
Benzo(a)anthracene (c)	max measured conc	modeled from soils data	
Benzo(b)fluoranthene (c)	max measured conc	modeled from soils data	
Benzo(k)fluoranthene (c)	max measured conc	modeled from soils data	
Benzo(a)pyrene (c)	max measured conc	modeled from soils data	
Chrysene (c)	max measured conc	modeled from soils data	
Dibenz(a,h)anthracene (c)	max DL (<2014) or LOD (2014)	modeled from soils data	
Indeno(1,2,3-cd)pyrene (c)	max DL (<2014) or LOD (2014)	modeled from soils data	
1-Methylnaphthalene (nc)	95%UCL	max LOD, ND in 2014	
2-Methylnaphthalene (nc)	95%UCL	max LOD, ND in 2014	

Hydrocarbon Characterization Data

Hydrocarbon Fractions	Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_5-C_6	Site specific EPH & VPH data
Aliphatic C_6-C_8	Site specific EPH & VPH data
Aliphatic C_8-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/L = milligrams per liter
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Table 13-9b: AOC D6 HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	**Input Values**			**Source of Data**
bulk density (lbs/ft^3)	125.0538462			D sites average value
specific gravity	2.824666667			D sites average value
moisture content (% by weight)	8.6625			D sites average value
foc	0.005826667			D sites average value
Soil temp (C)	5.3			D sites average value
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt			D sites average value
Hydrogeologic Conditions				
Source length (ft)	80			scaled from site maps
Average precipitation (in/yr)	143.44			NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	7.27E-06			average value of D5 and D6
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8			estimated thickness of the aquifer based on the 2014 boring logs
Infiltration rate (m/yr)	0.7286752			20% of average precipitation
Hydraulic gradient	0.0085			Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1			Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters				
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3			NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth				
depth to groundwater at seasonal low water level at downgradient end of source (ft)	66			Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	6			Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	16.5			Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	0			Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time				
Soil Direct Contact	1			Site specific conceptual site model
Outdoor Air	1			Site specific conceptual site model
Indoor Air	0			Site specific conceptual site model
Groundwater Ingestion	0			Site specific conceptual site model
Other Input:				
ADEC Hazard ID	0			ADEC CS database
Latitude	0			ADEC CS database
Longitude	0			ADEC CS database
Width of Source (ft)	60			scaled from site maps
Area of NAPL contaminated soil source (ft^2)	4800			scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.0085			Measured slope of water table
Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	125.05	125.05	125.05	D sites average value
specific gravity of solids	2.824667	2.824667	2.824667	D sites average value
moisture content (% by weight)	8.66	8.66	8.66	D sites average value
foc	0.005827	0.005827	0.005827	D sites average value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	0.1	0.1	0.1	Site Specific (depth to source minus foundation depth-- distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	6.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 13-10: AOC D6 Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	6.78541E-08	0.0068	0.0047
Outdoor air inhalation	2.96813E-09	0.0003	0.0002
Indoor air inhalation (vapor intrusion)	8.37187E-08	0.0084	0.0021
Groundwater Ingestion	1.5376E-07	0.0154	0.0024
Cumulative Risk	**3E-07**	**0.0**	**0.0**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	2.04523E-07	0.0205	0.0531
Outdoor air inhalation	1.28756E-08	0.0013	0.0006
Indoor air inhalation (vapor intrusion)	3.51619E-07	0.0352	0.0090
Groundwater Ingestion	2.58317E-07	0.0258	0.0033
Cumulative Risk	**1E-06**	**0.1**	**0.10**

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 13-11: AOC D6 Summary of Bulk Fuel Hydrocarbon Risk

	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Fraction of Risk Values				
			Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor intrusion)	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	10	0.000	<1	<1	<1	<1	<1
DRO Aromatics	721	0.000	<1	<1	<1	<1	<1
RRO Aromatics	30	0.000	<1	No RfC	No Rfc	<1	<1
GRO Aliphatics	12	0.000	<1	<1	<1	<1	<1
DRO Aliphatics	1911	0.000	<1	<1	<1	<1	<1
RRO Aliphatics	49	0.000	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	10	0.000	<1	<1	<1	<1	<1
DRO Aromatics	721	0.000	<1	<1	<1	<1	<1
RRO Aromatics	30	0.000	<1	No Rfc	No Rfc	<1	<1
GRO Aliphatics	12	0.000	<1	<1	<1	<1	<1
DRO Aliphatics	1911	0.000	<1	<1	<1	<1	<1
RRO Aliphatics	49	0.000	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
mg/L = milligram(s) per liter
No RfC = no reference concentration available; risk standard is assumed to be met due to low volatility of the fraction
RRO = residual-range organics

Table 13-12: AOC D6 Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
2-Methylnaphthalene (nc)	6.7	6.1	MTGW	10	MTGW	6.7	NA	83	MTGW
total DRO	5600[a]	230	MTGW	1200	MTGW	2632	12500	11427	Soil Direct Contact

Notes:

[a] = Historical maximum concentration (13000 mg/kg) not considered representative of current conditions as discussed in Section 13.4.1.

ACL = alternate cleanup level
(c) = carcinogen
DRO = diesel-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
MTGW = migration to groundwater
NA = not applicable
(nc) = non-carcinogen

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14.0 AOC D7 – ARMY DOCK AREA – FORMER 2000 BBL TANK – NO. 832

14.1 AREA DESCRIPTION AND BACKGROUND

AOC D7 is the site of former Tank No. 832 (AST7) within the historical Army Dock area tank farm. The tank farm served as the primary fuel off-loading and storage site for World War II military activities in Yakutat. Eight ASTs (ASTs 1–8) with tank capacities ranging from 20,000 to 80,000 gal and associated piping were used to store and transfer diesel fuel to the dock at Monti Bay. Former ASTs 5 through 8 were installed at the southern portion of the tank farm, at significantly higher elevations than ASTs 1 and 2. ASTs 6, 7 and 8 were located west of the access road, with a cleared trail extending west from AST6 to AST7. The concrete tank pad, steel tank bands and pipe stands remain at the former location of AST7.

Historical data indicate that the DRO present in soil and groundwater at the site exceed regulatory standards. Surface soil samples collected around former AST7 had DRO at a maximum concentration of 23,000 mg/kg (S&W 2006a). DRO was detected in subsurface soil at a concentration of 6,880 mg/kg at a depth of 53 feet bgs. Groundwater samples collected from monitoring well AST 7-4 had DRO concentrations up to 4.25 mg/L (S&W 2006b).

Data from previous investigations were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at AOC D7. These data, along with field screening results and visual observations, were reviewed to select appropriate sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations and the estimated NAPL source area at AOC D are shown on Figure 14-1.

14.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC D7 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Evaluate current groundwater conditions.
- Determine the vertical extent of petroleum soil contamination in the saturated zone.

14.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC D7 included advancement of soil borings, collection of soil and groundwater samples, and aquifer (slug) testing. These activities are described below by media.

14.3.1 Soil

Boring locations at AOC D7 were selected based on review of historical data and the estimated extent of the source area as depicted on Figure 14-1. Four soil borings were advanced at locations with high DRO concentrations and ROST/LIF responses; three adjacent to the concrete tank pad (D7-SB01 through SB03) and one approximately 50 feet northwest of the tank pad (D7-SB04). A fifth boring was placed at a surface soil “hot spot” with a DRO concentration of 23,000 mg/kg (D7-SB05A), and three step-out borings advanced approximately 5 feet away to delineate surface impacts. In general, borings were advanced to depths ranging from 4 to 11 feet bgs; however, D7-SB03 was extended into the saturated zone to 72 feet bgs to define impacts vertically. Soils at the site generally consist of an organic surface layer over fine to medium sands and silty sands, which grade to fine to coarse sand and gravel with depth. Soil boring logs are included in Appendix C.

Field screening samples were collected from above and below the target depth intervals and screened for volatile organics using a PID. Soil samples collected for laboratory analysis were selected from the target depth(s) or adjusted to the most likely contaminated depth based on field observations (e.g., PID, visual, and olfactory). With the exception of D7-SB03, one sample from each boring with the highest evidence of contamination was submitted for laboratory analysis. At boring D7-SB03, the five most contaminated soil samples were selected for laboratory analysis; three from the vadose zone and two from the saturated zone. One additional saturated zone soil sample was collected from beneath the smear zone in D7-SB03 for vertical delineation. The bottom of the smear zone was determined by screening soil samples continuously until no evidence of contamination was observed (e.g. PID, visual, and olfactory). The sample from the second consecutive split-spoon showing no signs of contamination was submitted for laboratory analysis to confirm the vertical extent of impacts. All samples were analyzed for GRO, DRO, RRO, BTEX and PAHs. Samples from D7-SB02, SB03 (4 samples), SB04, and SB05A were also analyzed for VPH and EPH.

Field observations and screening results were used to refine the estimated limits of the NAPL source area shown on Figure 14-1.

BACKGROUND SOIL CONDITIONS

Soil samples collected outside the AOC D NAPL source areas were analyzed to assess the geophysical properties (e.g., grain size, bulk density, moisture content, and specific gravity) and the naturally occurring organic carbon content of soils at the site. Refer to Section 8.3.1 for a discussion on background sampling activities at AOC D.

14.3.2 Groundwater

Groundwater assessment for the site included sampling of monitoring well AST7-4. Groundwater samples were collected using a bladder pump with a dedicated bladder and analyzed for GRO, DRO, RRO, BTEX, PAHs, EPH and VPH. Low Flow Groundwater Sample Collection Records are included in Appendix D.

AQUIFER TESTING

Subsequent to sampling, slug tests were performed at monitoring well AST7-4 to obtain hydraulic conductivity values for input into the HRC. Due to the minimum amount of water in the well, a water slug was used to displace the water column instead of a solid slug. These tests were performed and evaluated following the procedures outlined in Section 3.4.5. Slug test data are included in Appendix E and results discussed in Section 14.4 below.

14.4 GROUNDWATER CONDITIONS

As discussed in Section 8.4, groundwater contours were developed for the AOC D area and show an overall groundwater flow direction to the northwest, with an apparent localized cone of depression in the vicinity of City of Yakutat water supply wells ARCO #1 and/or ARCO #2. Horizontal gradients across AOC D were averaged with a resulting gradient estimated at 0.0085 ft/ft.

Slug test data were reduced using AQTESOLV software for subsequent evaluation using the Bouwer & Rice Method (1976) for unconfined aquifers, as well as the Hvorslev Method (1951) for comparison (AQTESOLV 2014). Hydraulic conductivities calculated at AOC D7 using Bouwer & Rice are presented in Table 4-4. The average hydraulic conductivity of 0.45 ft/day was used as input in the HRC for the site.

14.5 ANALYTICAL RESULTS

14.5.1 Soil

A total of 13 soil samples were collected from eight soil borings at the site and submitted for laboratory analyses. These data were collected from: 1) the most highly contaminated soils identified in this area for input in evaluating risk, 2) from the saturated zone below the estimated depth of contamination at D7-SB03 to define the vertical extent of impacts, and 3) at step-out locations to define surface soil impacts. Results show that all 12 samples collected for the HRC had DRO concentrations above the Method Two cleanup level ranging from 280 mg/kg to 6,100 mg/kg. The PAHs 1-methylnaphthalene and 2-methylnaphthalene were also detected at concentrations above Method Two cleanup levels in one sample. No other analytes were reported at concentrations above Method Two cleanup levels. DRO impacts above cleanup levels are present in the smear zone at approximately 60 to 64 feet bgs; however, screening results indicate that hydrocarbon concentrations decrease significantly within the saturated zone below 65 feet. DRO concentrations in a sample collected to confirm delineation of impacts vertically at AOC D7 (70-72 feet bgs) were below the cleanup level. Soil analytical results for the samples collected in 2014 are presented in summary tables provided in Appendix J. Sample locations are shown on Figure 14-1 and a cross sectional view of the site showing the vertical extent of impacts is presented along A-A' as Figure 14-2.

Constituent data collected within the defined source zone were used to supplement the historical data set for characterization of the NAPL source zone. Historical and recent (2014) POL data evaluated for AOC D7 are presented in Table 14-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 14-2. The location of the historical maximum DRO concentration (04Y-DT7-02-SS), which exceeded the ADEC maximum allowable concentration at 23,000 mg/kg, was resampled in 2014. The 2014 samples had much lower DRO concentrations ranging from 1,500 to 6,100 mg/kg and are considered representative of current conditions. Consequently, the 2004 historical maximum concentration was not included in the 95% UCL calculation. Additionally, historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attention of these constituents. PAH soil data are presented in Table 14-3, and VPH/EPH results are presented in Table 14-4. These data were used as input in calculating soil ACLs and to evaluate risk at AOC D7 using the HRC.

14.5.2 Groundwater

Groundwater assessment at the site included sampling monitoring well AST7-4. Analytical results indicate that DRO was detected above the Table C groundwater cleanup level. No other constituent concentrations were reported above regulatory standards in groundwater at AOC D7. Analytical results are summarized in Appendix J.

Results for AST7-4 were used to supplement historical groundwater data for the AOC D7 area. Historical and recent (2014) groundwater results for POLs, PAHs and VPH/EPH are summarized in Table 14-5 through Table 14-7, respectively. Constituent concentrations exceeding the Table C groundwater cleanup levels at AOC D are presented in Figure 8-3**.**

14.6 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC D7; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

14.6.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet the ADEC "Cleanup Complete" criteria, the AOC D7 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion).

The AOC D7 risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at the site at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be incomplete at the present time, because there is not an occupied building within 30 feet of the AOC D7 source area. The groundwater ingestion exposure route is considered to be complete at the present time, due to the possible influence of the pumping wells on groundwater flow in this area (Figure 8-3). Water samples from these wells show all chemical results below 1/10th of the Table C drinking water standard. Significant surface soil impacts are present at the site with visual impacts observed. However, overland migration of impacts via runoff/erosion to the nearest surface water body (pond to the north) is unlikely. This is based on the topography surrounding the tank pad, location of impacted areas (impacts are primarily localized in a depression with no significant drainage path to the pond observed), and the area between the site and pond being heavily vegetated. Additionally, previous surface water samples collected from the pond at locations downgradient of AOC D7 show TAH and TAqH meet Alaska WQS criteria. PAHs were detected in sediment but at concentrations below the NOAA SQuiRT PAL and TAL criteria (ENSR 2003b).

The AOC D7 exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

14.6.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each hydrocarbon constituent (BTEX 2014 data only) and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in Table 4-2. The source area data set for toluene, ethylbenzene, and total xylenes had a limited number of relatively low concentration detections; therefore, the maximum detected values from the source area were used as exposure point concentrations. Benzene was not detected in 2014, so the maximum LOD value from the 2014 source area data set was used as the exposure point concentration. There were adequate data to calculate 95% UCLs for GRO, DRO, and RRO; therefore, ProUCL was used to calculate 95% UCLs for the HRC input. ProUCL formatted outputs are displayed in Table 14-8a.

Table 14-9 presents the ProUCL outlier test results for DRO, and as shown, the test indicated that the highest DRO concentration included in the 95% UCL calculation (8,000 mg/kg) was not a statistical outlier. A Q-Q plot and box plot of the DRO source area data are presented in Figure 14-3a and Figure 14-3b, respectively. Both the Q-Q and box plots show that the highest DRO concentration did not graph significantly above the other data, which also suggests that the highest DRO result was not a statistical outlier.

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 14-3. Naphthalene, 1-methylnaphthalene and 2-methylnaphthalene had maximum concentrations that presented a significant fraction of risk and had a sufficient number of detections to calculate 95% UCLs; therefore, the 95% UCL concentrations were calculated and used as exposure point concentrations (Table 14-8b). Benzo(k)fluoranthene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene were not detected at the site, so the maximum LOD values were used as the exposure point concentrations. The maximum detected concentrations were used as the exposure point concentrations for the remaining PAH constituents.

Six VPH and EPH source area samples were used to characterize the bulk hydrocarbon chemistry. The HRC input values calculated from the source area VPH/EPH data are shown in Table 14-4.

The source of each HRC soil exposure point input value is documented in Table 14-10a.

14.6.3 Groundwater Exposure Point Concentrations

Benzene was not detected at the site; therefore, the maximum LOD for the sample collected from the source area well was used as the exposure point concentration. Toluene, ethylbenzene, xylene, GRO, DRO and RRO were detected in groundwater at the site, so the maximum detected concentration was used as input to the HRC. In addition, the maximum GRO, DRO and RRO aromatic and aliphatic concentrations (derived from the VPH/EPH test results) were used as input to the HRC.

The PAH constituents anthracene, benzo(a)anthracene, and chrysene were not detected; therefore, the maximum LOD values were used as the exposure point concentrations. The remaining PAH constituents were detected in groundwater at the site, so the maximum detected concentrations were used as input to the HRC.

The source of each HRC groundwater exposure point input value is documented in Table 14-10a.

14.6.4 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to AOC D7 is presented in Table 14-10b.

14.6.5 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results is included as Table N-9 of Appendix N and the risk posed by the site conditions is summarized in Table 14-11 and Table 14-12. Table N-9 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for AOC D7 indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and assuming that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).
- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aromatic and aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.
- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, the site conditions are protective of human health under an unrestricted (residential) land use scenario.

14.7 ALTERNATIVE CLEANUP LEVELS

Constituents and/or hydrocarbon fractions exceeding the ADEC Method Two cleanup levels at AOC D7 include 1-methylnaphthalene, 2-methylnaphthalene and DRO. Soil ACLs have been developed for these constituents and/or hydrocarbon fractions as shown in Table 14-13.

DRO, 1-methylnaphthalene, and 2-methylnaphthalene exceed the Method Two migration to groundwater cleanup levels. However, the migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult's Law) and dilution-attenuation calculations are applied, the AOC D7 exposure point concentrations meet the migration to groundwater criteria. Under these conditions it is typically not necessary to calculate ACLs, but for this contract ACLs have been back calculated for site COPCs and are presented in Table 14-13. The exposure point concentrations at AOC D7 are less than the ACLs calculated using the HRC, documenting that the site meets the ADEC migration to groundwater criteria.

14.8 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at AOC D was evaluated and a preliminary ecological CSM developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at AOC D7 are protective of the environment:

- Overland migration of surface impacts via runoff/erosion to the nearest surface water body (pond central to AOC D) is unlikely due to the topography surrounding the tank pad and impacted areas (impacts are primarily localized in a depression with no significant drainage path to the pond observed) and the area between the site and pond is heavily vegetated. Additionally, previous surface water samples collected from the pond at locations downgradient of AOC D7 show TAH and TAqH meet Alaska WQS criteria. PAHs were detected in sediment but at concentrations below the NOAA SQuiRT PAL and TAL criteria (ENSR 2003b).
- While Monti Bay is located north of the site, groundwater results indicate petroleum hydrocarbons are not migrating to the marine environment at concentrations above Alaska WQS for TAH or TAqH.
- Petroleum hydrocarbons in surface soil at AOC D7 cover 0.2 acres, which accounts for approximately 65% of all surface soil contamination at AOC D. When AOC D7 is included, the impacted surface soil areas (0.31 acres in total) are less than the ADEC 0.5 acre *de minimis* criterion.
- Risk to the environment has been evaluated for the AOC D area (in entirety) using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation of AOC D7 is not needed and site conditions are protective of the environment.

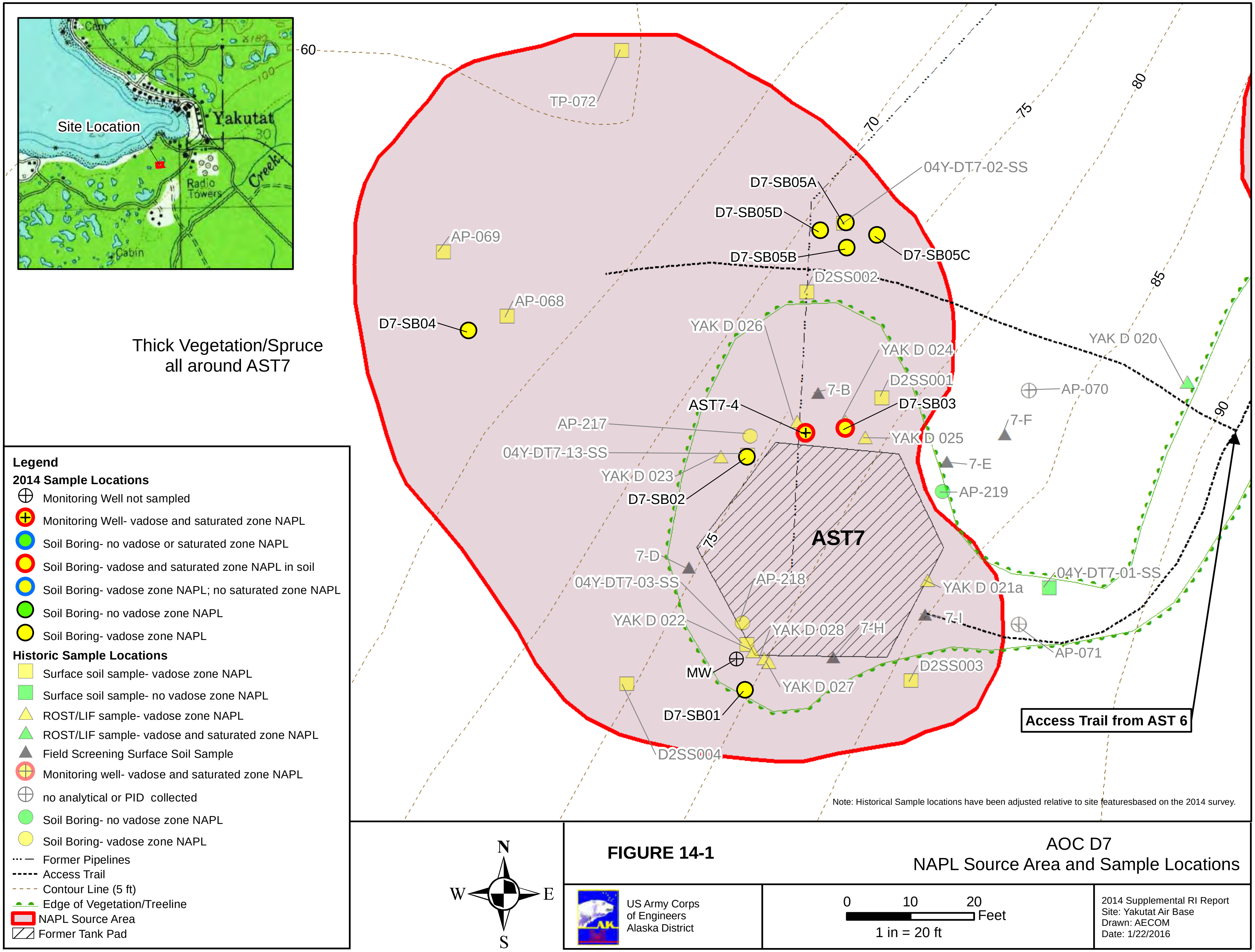

FIGURE 14-1

AOC D7
NAPL Source Area and Sample Locations

US Army Corps
of Engineers
Alaska District

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

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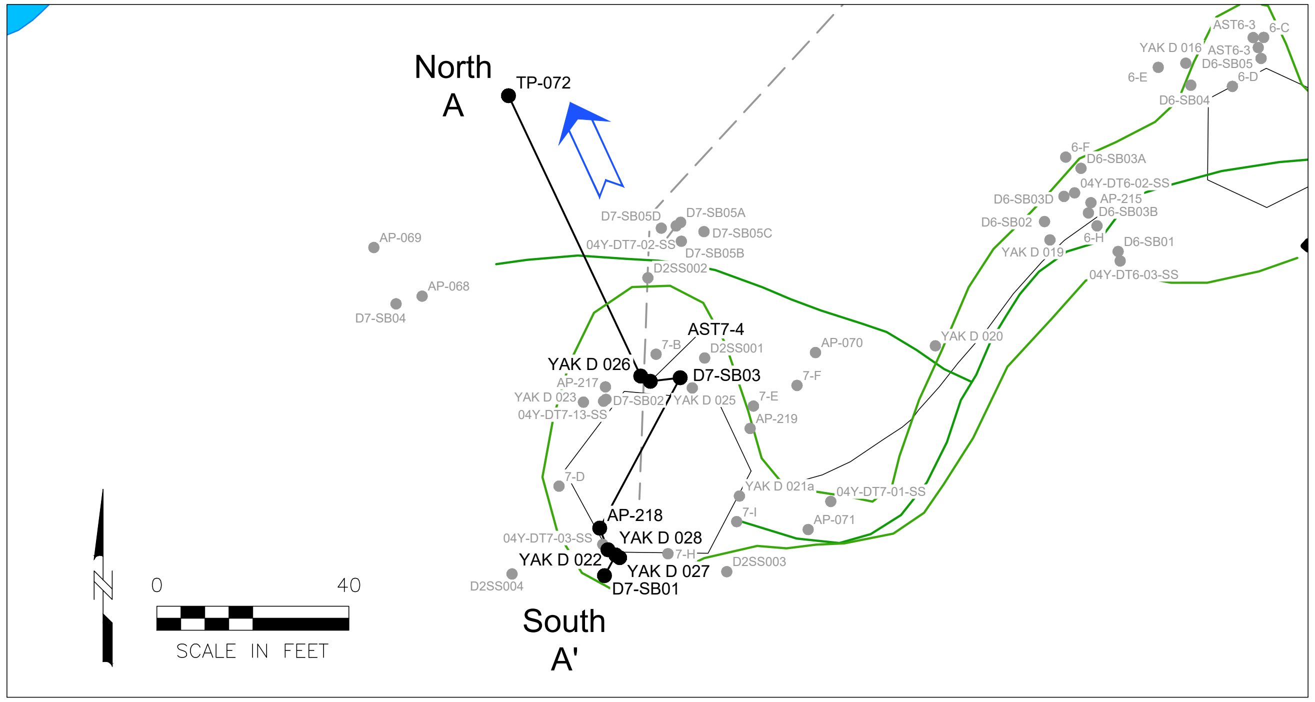
Notes
Depth = feet below ground surface
DRO = diesel range organics
DTW = depth to water below top of casing
mg/kg = milligram per kilogram
mg/L = milligram per liter
NA = not analyzed
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
ND = not detected
ROST = rapid optical screening tool
RRO = residual range organics
Yr. = year sample was collected

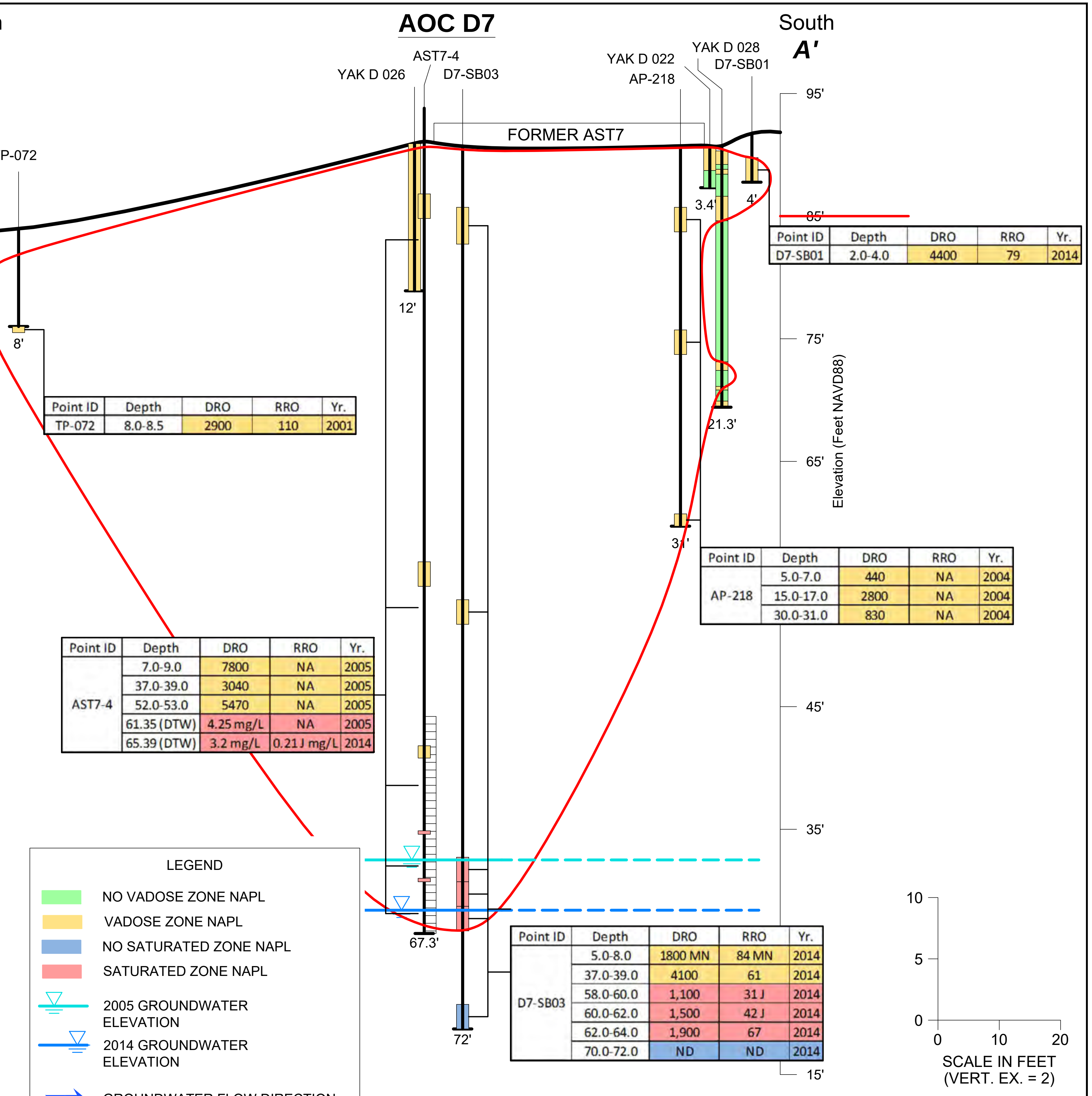
All DRO and RRO results are in mg/kg unless otherwise noted on the figure. See Appendix J for result qualifiers.

Location IDs beginning with YAK identify historical ROST borings. ROST results with percent reference emitter limits >1% are considered to be above the NAPL threshold (>230 mg/kg for DRO and RRO).

CROSS SECTION INDEX



AOC D7



Point ID	Depth	DRO	RRO	Yr.
TP-072	8.0-8.5	2900	110	2001

Point ID	Depth	DRO	RRO	Yr.
AST7-4	7.0-9.0	7800	NA	2005
	37.0-39.0	3040	NA	2005
	52.0-53.0	5470	NA	2005
	61.35 (DTW)	4.25 mg/L	NA	2005
	65.39 (DTW)	3.2 mg/L	0.21 J mg/L	2014

Point ID	Depth	DRO	RRO	Yr.
D7-SB01	2.0-4.0	4400	79	2014

Point ID	Depth	DRO	RRO	Yr.
AP-218	5.0-7.0	440	NA	2004
	15.0-17.0	2800	NA	2004
	30.0-31.0	830	NA	2004

Point ID	Depth	DRO	RRO	Yr.
D7-SB03	5.0-8.0	1800 MN	84 MN	2014
	37.0-39.0	4100	61	2014
	58.0-60.0	1,100	31 J	2014
	60.0-62.0	1,500	42 J	2014
	62.0-64.0	1,900	67	2014
	70.0-72.0	ND	ND	2014

LEGEND

🟩	NO VADOSE ZONE NAPL
🟨	VADOSE ZONE NAPL
🟦	NO SATURATED ZONE NAPL
🟥	SATURATED ZONE NAPL
▽	2005 GROUNDWATER ELEVATION
▽	2014 GROUNDWATER ELEVATION
⇨	GROUNDWATER FLOW DIRECTION
—	ESTIMATED VERTICAL EXTENT OF NAPL SOURCE ZONE
▤	SCREEN INTERVAL

Figure: 14-2

CROSS SECTION A-A'
AOC D7

U.S. Army
Corps of Engineers
Alaska District

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 01/16/15

Last saved by: SCHWARTZE(2016-03-29) Last Plotted: 2016-03-29
Filename: L:\GROUP\CAD\YAKUTAT AFB\FIGURES\YAK_FIG_14-2_ A-A' D-AST7.DWG

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Figure 14-3a: AOC D7 DRO Q-Q Plot

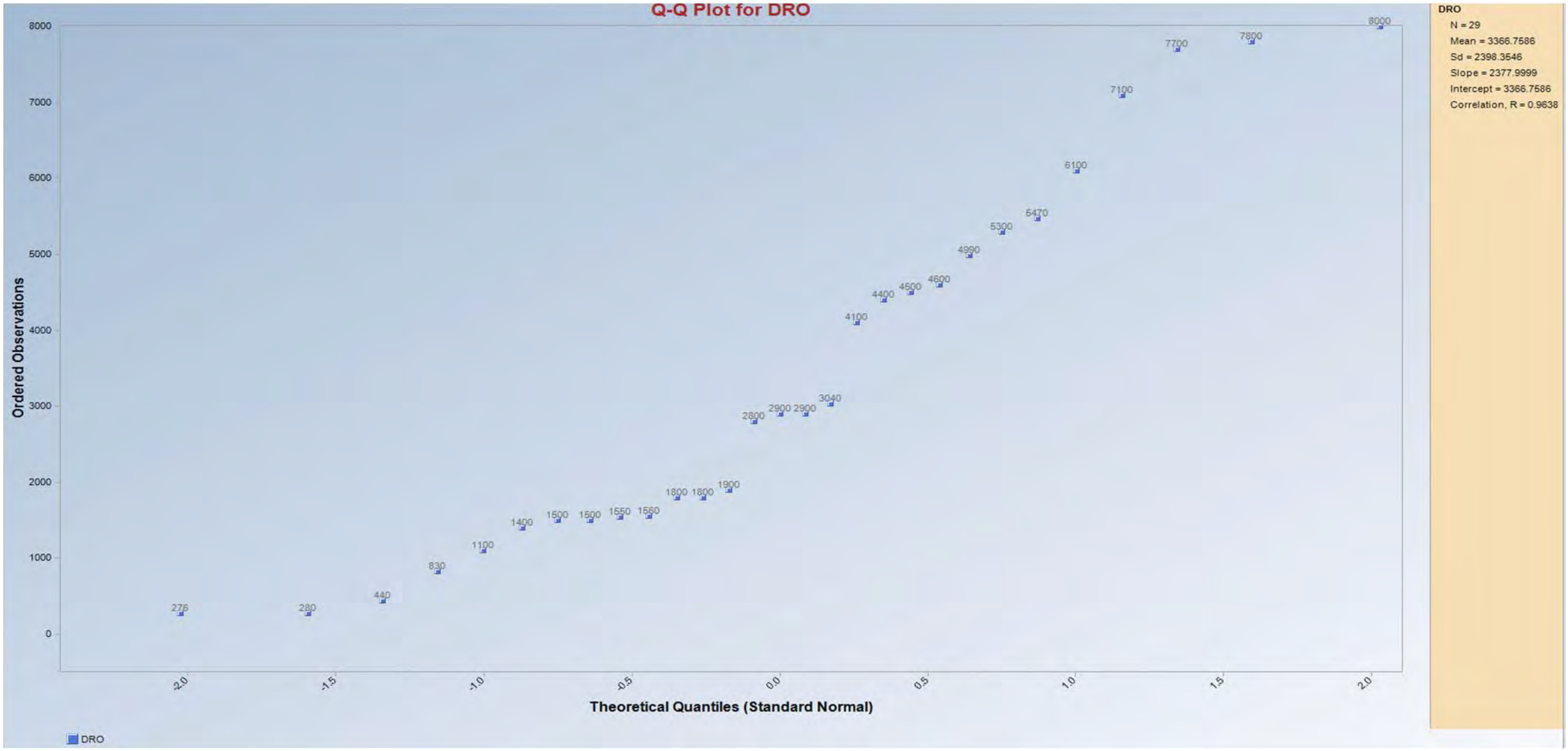

FIGURE 14-3b: AOC D7 DRO Box Plot

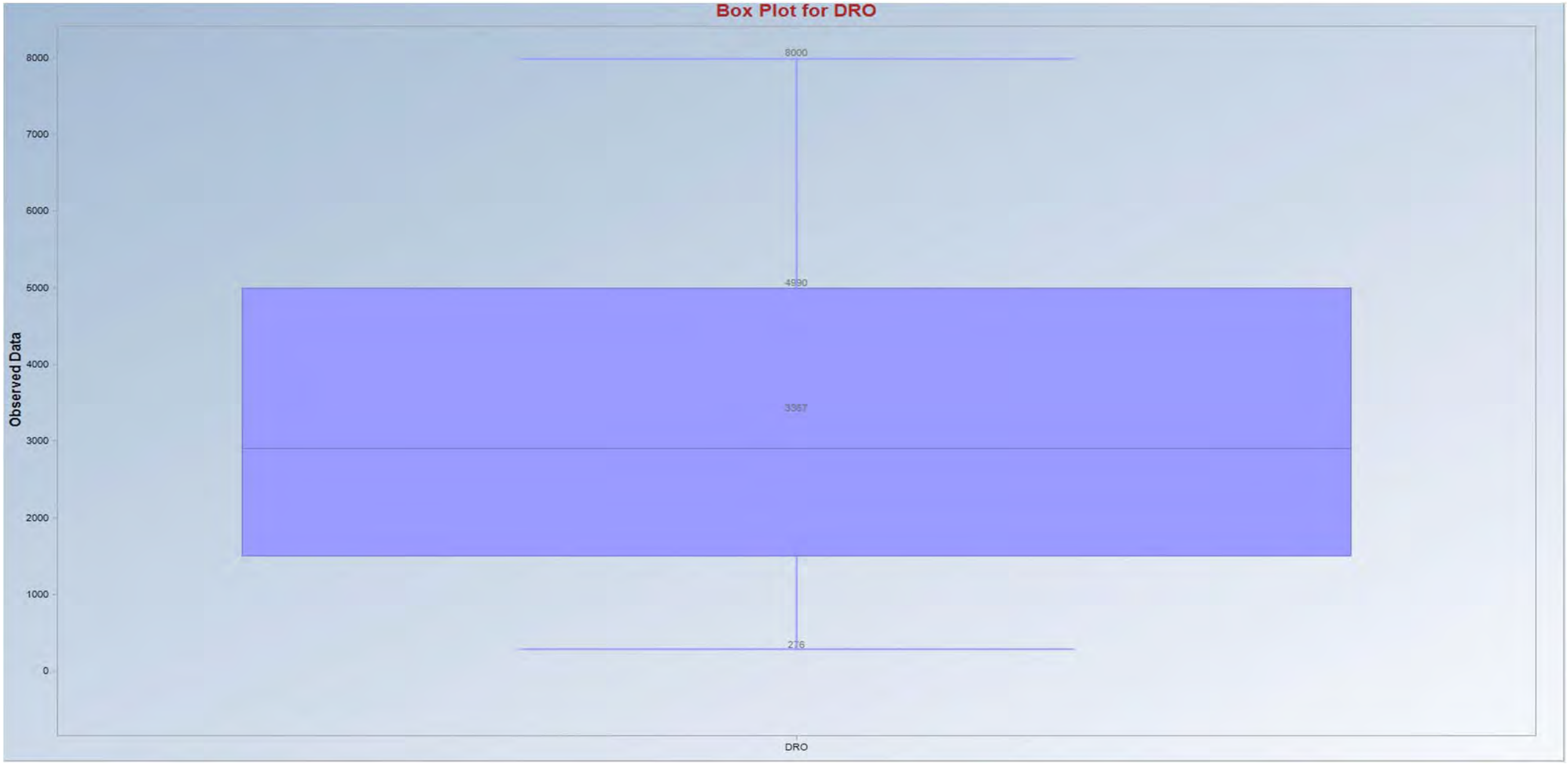

Table 14-1: AOC D7 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D7	04Y-DT7-01-SS	0-1	8/8/2004	04Y-DT7-01-SS	<0.23 U	**3.7 J**	--	<0.0008 U	**0.0008 J**	**0.004**	--
D7	04Y-DT7-02-SS	0-1	8/8/2004	04Y-DT7-02-SS	<0.29 U	**23000**	--	<0.0011 U	<0.001 U	**0.0083 J**	--
D7	04Y-DT7-03-SS	0-1	8/8/2004	04Y-DT7-03-SS	<1.6 U	**7100**	--	**0.0059 J**	**0.012 J**	**0.036**	--
D7	04Y-DT7-13-SS	0-0	8/26/2004	04Y-DT7-13-SS	**12**	**7700**	--	**0.0095 J**	<0.0037 U	**0.015 J**	--
D7	AP-069	5.5-6	8/12/2001	01D2B2002SO	**13**	**4600**	**120**	<0.0075 U	<0.0075 U	<0.0075 U	<0.0225 U
D7	AP-217	10-11	8/9/2004	04Y-DT7-04-SO	<3.6 U	**2900**	--	<0.013 U	**0.18**	**0.058 J**	--
D7	AP-217	20-22	8/9/2004	04Y-DT7-05-SO	<1.8 U	**8000**	--	<0.0063 U	**0.12**	**0.043 J**	--
D7	AP-217	25-26.5	8/9/2004	04Y-DT7-06-SO	**14**	**1800**	--	<0.0053 U	**0.017 J**	**0.018 J**	--
D7	AP-218	5-7	8/21/2004	04Y-DT7-07-SO	**35**	**440**	--	**0.0026 J**	<0.0025 U	**0.022**	--
D7	AP-218	15-17	8/21/2004	04Y-DT7-08-SO	**1.4**	**2800**	--	<0.0005 U	**0.0049**	**0.0022 J**	--
D7	AP-218	30-31	8/21/2004	04Y-DT7-09-SO	**4.5**	**830**	--	**0.0019 J**	**0.0006**	**0.011**	--
D7	AP-219	5-7	8/24/2004	04Y-DT7-10-SO	<0.34 U	<0.66 U	--	**0.003 J**	<0.0012 U	**0.0091 J**	--
D7	AP-219	10-11.5	8/24/2004	04Y-DT7-11-SO	<0.22 U	<0.65 U	--	<0.0008 U	<0.0007 U	**0.0025 J**	--
D7	AP-219	20-22	8/24/2004	04Y-DT7-12-SO	<0.25 U	**64**	--	<0.0009 U	**0.0033 J**	**0.0063 J**	--
D7	AST7-4	7-9	9/24/2005	05Y-DT7-01-SO	**35.2**	**7800**	--	<0.0138 U	**0.201 J**	**0.0647 JB**	**0.519 J**
D7	AST7-4	37-39	9/24/2005	05Y-DT7-06-SO	**73**	**3040**	--	<0.0293 U	**0.0863 J**	<0.113 U	**0.326 J**
D7	AST7-4	52-53	9/24/2005	05Y-DT7-08-SO	**70**	**5470**	--	<0.00297 U	**0.00875 J**	<0.0114 U	**0.0329 J**
D7	D2SS001	0-0	9/25/2001	01D2SS001SO	<1.64 U	**276 B**	**84.8**	<0.0136 U	<0.0136 U	<0.0136 U	<0.0407 U
D7	D2SS002	0-0	9/25/2001	01D2SS002SO	**2.82**	**1560 B**	**158**	<0.0108 U	<0.0108 U	**0.0214 J**	<0.0324 U
D7	D2SS003	0-0	9/26/2001	01D2SS003SO	<1.47 U	**1550 B**	**240**	<0.0121 U	<0.0121 U	**0.0263**	<0.0364 U
D7	D2SS004	0-0	9/26/2001	01D2SS004SO	**94.8**	**4990**	**336 B**	<0.0111 U	**0.0136 J**	<0.0111 U	**0.0448 J**
D7	D7-SB01	2-4	6/13/2014	D7-SB01-2.0-4.0-0614	**86 QH**	**4400**	**79**	<0.0098 U	**0.063**	<0.0098 U	**0.602**
D7	D7-SB02	2-4	6/13/2014	D7-SB02-2.0-4.0-0614	**60**	**1400**	**27 J**	<0.0086 U	**0.014 J**	<0.0086 U	**0.0911 , J**
D7	D7-SB03	5-8	6/23/2014	D7-SB03-5.0-8.0-0614	**100 QH**	**1800 MN**	**84 MN**	<0.0089 U,ML	**0.053 J**	<0.0089 U,ML	**0.129 J**
D7	D7-SB03	37-39	6/23/2014	D7-SB03-37.0-39.0-0614	**210 QH**	**4100**	**61**	<0.0089 U	**0.081**	<0.0089 U	**0.226**
D7	D7-SB03	58-60	6/23/2014	D7-SB03-58.0-60.0-0614	**67**	**1100**	**31 J**	<0.0066 U	<0.0066 U	<0.0066 U	<0.0132 U
D7	D7-SB03	60-62	6/24/2014	D7-SB03-60.0-62.0-0614	**120 QH**	**1500**	**42 J**	<0.0091 U	<0.0091 U	<0.0091 U	<0.0182 U
D7	D7-SB03	62-64	6/24/2014	D7-SB03-62.0-64.0-0614	**130 QH**	**1900**	**67**	<0.011 U	<0.011 U	<0.011 U	<0.022 U
D7	D7-SB03	70-72	6/24/2014	D7-SB03-70.0-72.0-0614	**15 B**	<7.5 U	<29 U	<0.0093 U	<0.0093 U	<0.0093 U	<0.0186 U
D7	D7-SB04	7-9	6/13/2014	D7-SB04-7.0-9.0-0614	**3.9**	**280**	**28 QN**	<0.0095 U	**0.011 J**	<0.0095 U	<0.019 U
D7	D7-SB5A	2-4	6/13/2014	D7-SB5A-2.0-4.0-0614	**30**	**1500**	**66 QN**	<0.0071 U	**0.0029 J**	<0.0071 U	**0.0124 J**
D7	D7-SB5B	0.5-2	6/13/2014	D7-SB5B-0.5-2.0-0614	**27**	**5300**	**200 QN**	<0.0096 U	**0.0046 J**	**0.0044 J**	**0.0226 J**
D7	D7-SB5C	0-2	6/13/2014	D7-SB5C-0.0-2.0-0614	**22**	**4500**	**170 QN**	<0.0098 U	**0.005 J**	**0.0058 J**	**0.0248 J**
D7	D7-SB5D	0-2	6/13/2014	D7-SB5D-0.0-2.0-0614	**22**	**6100**	**270 QN**	<0.01 U	**0.0036 J**	**0.0062 J**	**0.0175 J**
D7	TP-072	8-8.5	8/9/2001	01D2TP001SO	**12**	**2900**	**110**	<0.0034 U	<0.0034 U	<0.0034 U	<0.0102 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					210	23000	336	0.0095	0.201	0.0647	0.602
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:

Bold = detected analyte

Shading = result above screening criteria.

Yellow = NAPL-contaminated soil source area.

-- = not analyzed

BTEX = benzene, toluene, ethylbenzene & xylenes

DRO = diesel-range organics

GRO = gasoline-range organics

HRC = hydrocarbon risk calculator

mg/kg = milligrams per kilogram

NA = not applicable

RRO = residual-range organics

Data qualifiers:

B = analyte detected in blank

J = estimated value

JB = estimated value & analyte detected in blank

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level sources:

A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion

B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation

C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater

D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact

E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation

F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater

H = Source delineation criteria not related to ADEC regulatory levels

Table 14-2: AOC D7 Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D7	04Y-DT7-02-SS	0-1	8/8/2004	04Y-DT7-02-SS	<0.29 U	**23000**	--	--	--	--	--
D7	04Y-DT7-03-SS	0-1	8/8/2004	04Y-DT7-03-SS	<1.6 U	**7100**	--	--	--	--	--
D7	04Y-DT7-13-SS	0-0	8/26/2004	04Y-DT7-13-SS	**12**	**7700**	--	--	--	--	--
D7	AP-069	5.5-6	8/12/2001	01D2B2002SO	**13**	**4600**	**120**	--	--	--	--
D7	AP-217	10-11	8/9/2004	04Y-DT7-04-SO	<3.6 U	**2900**	--	--	--	--	--
D7	AP-217	20-22	8/9/2004	04Y-DT7-05-SO	<1.8 U	**8000**	--	--	--	--	--
D7	AP-217	25-26.5	8/9/2004	04Y-DT7-06-SO	**14**	**1800**	--	--	--	--	--
D7	AP-218	5-7	8/21/2004	04Y-DT7-07-SO	**35**	**440**	--	--	--	--	--
D7	AP-218	15-17	8/21/2004	04Y-DT7-08-SO	**1.4**	**2800**	--	--	--	--	--
D7	AP-218	30-31	8/21/2004	04Y-DT7-09-SO	**4.5**	**830**	--	--	--	--	--
D7	AST7-4	7-9	9/24/2005	05Y-DT7-01-SO	**35.2**	**7800**	--	--	--	--	--
D7	AST7-4	37-39	9/24/2005	05Y-DT7-06-SO	**73**	**3040**	--	--	--	--	--
D7	AST7-4	52-53	9/24/2005	05Y-DT7-08-SO	**70**	**5470**	--	--	--	--	--
D7	D2SS001	0-0	9/25/2001	01D2SS001SO	<1.64 U	**276 B**	**84.8**	--	--	--	--
D7	D2SS002	0-0	9/25/2001	01D2SS002SO	**2.82**	**1560 B**	**158**	--	--	--	--
D7	D2SS003	0-0	9/26/2001	01D2SS003SO	<1.47 U	**1550 B**	**240**	--	--	--	--
D7	D2SS004	0-0	9/26/2001	01D2SS004SO	**94.8**	**4990**	**336 B**	--	--	--	--
D7	D7-SB01	2-4	6/13/2014	D7-SB01-2.0-4.0-0614	**86 QH**	**4400**	**79**	<0.0098 U	**0.063**	<0.0098 U	**0.602**
D7	D7-SB02	2-4	6/13/2014	D7-SB02-2.0-4.0-0614	**60**	**1400**	**27 J**	<0.0086 U	**0.014 J**	<0.0086 U	**0.0911 , J**
D7	D7-SB03	5-8	6/23/2014	D7-SB03-5.0-8.0-0614	**100 QH**	**1800 MN**	**84 MN**	<0.0089 U,ML	**0.053 J**	<0.0089 U,ML	**0.129 J**
D7	D7-SB03	37-39	6/23/2014	D7-SB03-37.0-39.0-0614	**210 QH**	**4100**	**61**	<0.0089 U	**0.081**	<0.0089 U	**0.226**
D7	D7-SB03	58-60	6/23/2014	D7-SB03-58.0-60.0-0614	**67**	**1100**	**31 J**	<0.0066 U	<0.0066 U	<0.0066 U	<0.0132 U
D7	D7-SB03	60-62	6/24/2014	D7-SB03-60.0-62.0-0614	**120 QH**	**1500**	**42 J**	<0.0091 U	<0.0091 U	<0.0091 U	<0.0182 U
D7	D7-SB03	62-64	6/24/2014	D7-SB03-62.0-64.0-0614	**130 QH**	**1900**	**67**	<0.011 U	<0.011 U	<0.011 U	<0.022 U
D7	D7-SB04	7-9	6/13/2014	D7-SB04-7.0-9.0-0614	**3.9**	**280**	**28 QN**	<0.0095 U	**0.011 J**	<0.0095 U	<0.019 U
D7	D7-SB5A	2-4	6/13/2014	D7-SB5A-2.0-4.0-0614	**30**	**1500**	**66 QN**	<0.0071 U	**0.0029 J**	<0.0071 U	**0.0124 J**
D7	D7-SB5B	0.5-2	6/13/2014	D7-SB5B-0.5-2.0-0614	**27**	**5300**	**200 QN**	<0.0096 U	**0.0046 J**	**0.0044 J**	**0.0226 J**
D7	D7-SB5C	0-2	6/13/2014	D7-SB5C-0.0-2.0-0614	**22**	**4500**	**170 QN**	<0.0098 U	**0.005 J**	**0.0058 J**	**0.0248 J**
D7	D7-SB5D	0-2	6/13/2014	D7-SB5D-0.0-2.0-0614	**22**	**6100**	**270 QN**	<0.01 U	**0.0036 J**	**0.0062 J**	**0.0175 J**
D7	TP-072	8-8.5	8/9/2001	01D2TP001SO	**12**	**2900**	**110**	<0.0034 U	<0.0034 U	<0.0034 U	<0.0102 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					210	23000	336	0.011	0.081	0.0062	0.602
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:

Bold = detected analyte

Shading = result above screening criteria.

Yellow = NAPL-contaminated soil source area.

-- = not analyzed

BTEX = benzene, toluene, ethylbenzene & xylenes

DRO = diesel-range organics

GRO = gasoline-range organics

HRC = hydrocarbon risk calculator

mg/kg = milligrams per kilogram

NA = not applicable

RRO = residual-range organics

Data qualifiers:

B = analyte detected in blank

J = estimated value

JB = estimated value & analyte detected in blank

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level sources:

A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion

B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation

C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater

D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact

E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation

F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater

H = Source delineation criteria not related to ADEC regulatory levels

Table 14-3: AOC D7 PAH Soils Results

Site Name		D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7
Boring, Well or Sample Location Number		04Y-DT7-03-SS	AP-069	AP-217	AP-218	AP-218	AP-219	AST7-4	AST7-4	AST7-4	D2SS001	D2SS002
Sample Depth (feet)		0-1	5.5-6	20-22	5-7	15-17	5-7	7-9	37-39	52-53	0-0	0-0
Sample Date		8/8/2004	8/12/2001	8/9/2004	8/21/2004	8/21/2004	8/24/2004	9/24/2005	9/24/2005	9/24/2005	9/25/2001	9/25/2001
Sample Name		04Y-DT7-03-SS	01D2B2002SO	04Y-DT7-05-SO	04Y-DT7-07-SO	04Y-DT7-08-SO	04Y-DT7-10-SO	05Y-DT7-01-SO	05Y-DT7-06-SO	05Y-DT7-08-SO	01D2SS001SO	01D2SS002SO
GRO	(mg/kg)	<1.6 U	**13**	<1.8 U	**35**	**1.4**	<0.34 U	**35.2**	**73**	**70**	<1.64 U	**2.82**
DRO	(mg/kg)	**7100**	**4600**	**8000**	**440**	**2800**	<0.66 U	**7800**	**3040**	**5470**	**276 B**	**1560 B**
RRO	(mg/kg)	--	**120**	--	--	--	--	--	--	--	**84.8**	**158**
Acenaphthene	(mg/kg)	<0.0023 U	<0.0072 U	<0.0021 U	<0.0022 U	<0.0048 U	<0.00021 U	**0.59**	**0.317**	**0.267**	<0.000971 U	<0.00808 U
Acenaphthylene	(mg/kg)	<0.0071 U	<0.0063 U	<0.0063 U	**0.037**	<0.014 U	<0.00064 U	**0.397**	<0.0157 U	<0.0157 U	<0.000855 U	<0.00711 U
Anthracene	(mg/kg)	<0.003 U	<0.0037 U	<0.0027 U	<0.0029 U	<0.0061 U	<0.00027 U	**0.00506**	<0.0157 U	<0.0157 U	<0.000494 U	<0.00411 U
Benzo(a)anthracene	(mg/kg)	<0.0061 U	<0.0089 U	<0.0055 U	<0.0058 U	<0.012 U	<0.00055 U	**0.00395 J**	<0.0157 U	<0.0157 U	<0.0012 U	<0.00995 U
Benzo(a)pyrene	(mg/kg)	<0.01 U	<0.0085 U	<0.0094 U	<0.01 U	<0.021 U	<0.00095 U	<0.000735 U	<0.0157 U	<0.0157 U	<0.00115 U	<0.00958 U
Benzo(b)fluoranthene	(mg/kg)	<0.004 U	<0.0031 U	<0.0036 U	<0.0038 U	<0.0081 U	<0.00036 U	<0.00142 U	<0.0157 U	<0.0157 U	<0.000418 U	<0.00348 U
Benzo(g,h,i)perylene	(mg/kg)	<0.0054 U	<0.0024 U	<0.0049 U	<0.0052 U	<0.011 U	<0.0005 U	<0.00166 U	<0.0157 U	<0.0157 U	<0.000324 U	<0.00269 U
Benzo(k)fluoranthene	(mg/kg)	<0.0025 U	<0.0063 U	<0.0022 U	<0.0024 U	<0.0051 U	<0.00023 U	<0.000491 U	<0.0157 U	<0.0157 U	<0.000855 U	<0.00711 U
Chrysene	(mg/kg)	<0.003 U	<0.0085 U	<0.0027 U	<0.0028 U	<0.0061 U	<0.00027 U	**0.0204**	<0.0157 U	**0.0212 J**	<0.00115 U	<0.00958 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.0039 U	<0.0034 U	<0.0035 U	<0.0037 U	<0.0079 U	<0.00035 U	<0.00145 U	<0.0157 U	<0.0157 U	<0.000457 U	<0.0038 U
Fluorene	(mg/kg)	<0.0029 U	<0.0068 U	**3.6**	**0.27**	**1**	<0.00026 U	**2.54**	**1.58**	**1.31**	<0.000916 U	<0.00762 U
Fluoranthene	(mg/kg)	<0.007 U	<0.0068 U	<0.0063 U	<0.0067 U	<0.014 U	<0.00063 U	**0.041 J**	**0.0218 J**	**0.0549**	<0.000916 U	<0.00762 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0054 U	<0.0034 U	<0.0048 U	<0.0051 U	<0.011 U	<0.00049 U	<0.00147 U	<0.0157 U	<0.0157 U	<0.000457 U	<0.0038 U
Naphthalene	(mg/kg)	<0.0036 U	<0.0068 U	**17**	**0.17**	**1.1**	**0.0096**	**16.1**	**5.39**	<0.0157 U	**0.0108**	<0.00764 U
Phenanthrene	(mg/kg)	<0.0034 U	**0.25**	**1.7**	**0.21**	**0.67**	**0.0021**	**1.88**	**0.713**	**0.552**	<0.000418 U	<0.00348 U
Pyrene	(mg/kg)	<0.0042 U	**0.044**	**0.046**	<0.004 U	<0.0086 U	<0.00038 U	**0.0386**	**0.0213 J**	**0.0554**	<0.000647 U	<0.00538 U
2-Methylnaphthalene	(mg/kg)	<0.06 U	**1.1**	**56**	**2.5**	**3.8**	<0.0055 U	**38**	**14.6**	**1.7**	**0.018**	<0.00255 U
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	--	**21.6**	**10.3**	**2.07**	--	--

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 14-3: AOC D7 PAH Soil Results

Site Name		D7	D7	D7	D7	D7	D7	D7	D7	D7
Boring, Well or Sample Location Number		D2SS003	D2SS004	D7-SB01	D7-SB02	D7-SB03	D7-SB03	D7-SB03	D7-SB03	D7-SB03
Sample Depth (feet)		0-0	0-0	2-4	2-4	5-8	37-39	58-60	60-62	62-64
Sample Date		9/26/2001	9/26/2001	6/13/2014	6/13/2014	6/23/2014	6/23/2014	6/23/2014	6/24/2014	6/24/2014
Sample Name		01D2SS003SO	01D2SS004SO	D7-SB01-2.0-4.0-0614	D7-SB02-2.0-4.0-0614	D7-SB03-5.0-8.0-0614	D7-SB03-37.0-39.0-0614	D7-SB03-58.0-60.0-0614	D7-SB03-60.0-62.0-0614	D7-SB03-62.0-64.0-0614
GRO	(mg/kg)	<1.47 U	**94.8**	**86 QH**	**60**	**100 QH**	**210 QH**	**67**	**120 QH**	**130 QH**
DRO	(mg/kg)	**1550 B**	**4990**	**4400**	**1400**	**1800 MN**	**4100**	**1100**	**1500**	**1900**
RRO	(mg/kg)	**240**	**336 B**	**79**	**27 J**	**84 MN**	**61**	**31 J**	**42 J**	**67**
Acenaphthene	(mg/kg)	<0.00943 U	<0.0082 U	**0.1**	**0.085**	**0.13 MN**	**0.24**	**0.03**	<0.0025 U	<0.0026 U
Acenaphthylene	(mg/kg)	<0.00831 U	<0.00723 U	**0.1**	**0.059**	**0.066**	**0.12**	**0.041**	**0.044**	**0.022**
Anthracene	(mg/kg)	<0.0048 U	<0.00418 U	**0.028**	**0.026**	**0.041**	**0.087**	**0.051**	<0.0025 U	<0.0026 U
Benzo(a)anthracene	(mg/kg)	<0.0116 U	<0.0101 U	<0.0028 U	<0.0028 U	**0.0025 J**	**0.0032 J**	**0.0016 J**	**0.0021 J**	**0.0015 J**
Benzo(a)pyrene	(mg/kg)	<0.0112 U	<0.00973 U	<0.0028 U	<0.0028 U	<0.0025 U	<0.0025 U	<0.0025 U	<0.0025 U	<0.0026 U
Benzo(b)fluoranthene	(mg/kg)	<0.00406 U	<0.00353 U	<0.0028 U	<0.0028 U	**0.0024 J**	**0.0017 J**	**0.0017 J**	**0.0021 J**	**0.0017 J**
Benzo(g,h,i)perylene	(mg/kg)	<0.00314 U	<0.00273 U	<0.0028 U	<0.0028 U	<0.0025 U	<0.0025 U	<0.0025 U	<0.0025 U	<0.0026 U
Benzo(k)fluoranthene	(mg/kg)	<0.00831 U	<0.00723 U	<0.0028 U	<0.0028 U	<0.0025 U	<0.0025 U	<0.0025 U	<0.0025 U	<0.0026 U
Chrysene	(mg/kg)	<0.0112 U	<0.00973 U	**0.0042 J**	**0.0055**	**0.012**	**0.017**	**0.0083**	**0.011**	**0.0076**
Dibenzo(a,h)anthracene	(mg/kg)	<0.00444 U	<0.00386 U	<0.0028 U	<0.0028 U	<0.0025 U	<0.0025 U	<0.0025 U	<0.0025 U	<0.0026 U
Fluorene	(mg/kg)	<0.0089 U	<0.00774 U	**0.54**	**0.43**	**0.31 H**	**0.59**	**0.13**	<0.0025 U	<0.0026 U
Fluoranthene	(mg/kg)	<0.0089 U	<0.00774 U	**0.0063**	**0.008**	**0.0081**	**0.0083**	**0.0036 J**	**0.0084**	<0.0026 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.00444 U	<0.00386 U	<0.0028 U	<0.0028 U	<0.0025 U	<0.0025 U	<0.0025 U	<0.0025 U	<0.0026 U
Naphthalene	(mg/kg)	<0.00892 U	<0.00776 U	**3.3**	**1.1**	**1.6**	**1.6**	**0.059**	**0.039**	**0.034**
Phenanthrene	(mg/kg)	<0.00406 U	<0.00353 U	**0.52**	**0.44**	**0.3**	**0.76**	**0.084**	**0.081**	<0.0026 U
Pyrene	(mg/kg)	<0.00629 U	<0.00547 U	**0.0082**	**0.0094**	**0.019**	**0.028**	**0.017**	**0.021**	**0.014**
2-Methylnaphthalene	(mg/kg)	**0.0229**	<0.00259 U	**12**	**6**	**2.9**	**5**	**0.33**	**0.17**	**0.087**
1-Methylnaphthalene	(mg/kg)	**--**	**--**	**7.2**	**3.4**	**2.3**	**4.8**	**0.47**	**0.079**	**0.051**

Table 14-3: AOC D7 PAH Soil Results

Site Name		D7	D7	D7	D7	D7	D7	D7	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		D7-SB03	D7-SB04	D7-SB5A	D7-SB5B	D7-SB5C	D7-SB5D	TP-072		
Sample Depth (feet)		70-72	7-9	2-4	0.5-2	0-2	0-2	8-8.5		
Sample Date		6/24/2014	6/13/2014	6/13/2014	6/13/2014	6/13/2014	6/13/2014	8/9/2001		
Sample Name		D7-SB03-70.0-72.0-0614	D7-SB04-7.0-9.0-0614	D7-SB5A-2.0-4.0-0614	D7-SB5B-0.5-2.0-0614	D7-SB5C-0.0-2.0-0614	D7-SB5D-0.0-2.0-0614	01D2TP001SO		
GRO	(mg/kg)	**15 B**	**3.9**	**30**	**27**	**22**	**22**	**12**	210	**260 C**
DRO	(mg/kg)	<7.5 U	**280**	**1500**	**5300**	**4500**	**6100**	**2900**	8000	**230 C**
RRO	(mg/kg)	<29 U	**28 QN**	**66 QN**	**200 QN**	**170 QN**	**270 QN**	**110**	336	**230 H**
Acenaphthene	(mg/kg)	<0.0029 U	**0.035**	**0.16**	**0.21**	**0.087**	<0.0028 U	**0.13**	0.59	**180 F**
Acenaphthylene	(mg/kg)	<0.0029 U	**0.014**	**0.075**	**0.11**	**0.052**	<0.0028 U	<0.0067 U	0.397	**180 F**
Anthracene	(mg/kg)	<0.0029 U	**0.0073**	**0.062**	**0.1**	**0.056**	<0.0028 U	<0.0039 U	0.1	**1680 D**
Benzo(a)anthracene	(mg/kg)	<0.0029 U	**0.0013 J**	**0.0031 J**	**0.0034 J**	<0.0028 U	<0.0028 U	<0.0093 U	0.00395	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.0029 U	**0.0015 J**	<0.0027 U	<0.0028 U	<0.0028 U	<0.0028 U	<0.009 U	0.0015	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	<0.0029 U	**0.0026 J**	<0.0027 U	**0.0038 J**	**0.0023 J**	**0.0036 J**	<0.0033 U	0.0038	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.0029 U	**0.0012**	<0.0027 U	<0.0028 U	<0.0028 U	<0.0028 U	<0.0025 U	0.0012	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.0029 U	<0.00078 U	<0.0027 U	<0.0028 U	<0.0028 U	<0.0028 U	<0.0067 U	0.0157	**4 D**
Chrysene	(mg/kg)	<0.0029 U	**0.0039 J**	**0.011**	**0.026**	**0.017**	**0.036**	<0.009 U	0.036	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.0029 U	<0.00078 U	<0.0027 U	<0.0028 U	<0.0028 U	<0.0028 U	<0.0036 U	0.0157	**0.04 D**
Fluorene	(mg/kg)	**0.0026 J**	**0.16 J**	**0.72**	**0.72**	**0.27**	**0.74 ML**	**0.65**	3.6	**190 D**
Fluoranthene	(mg/kg)	<0.0029 U	**0.0032 J**	**0.027**	**0.054**	**0.028**	<0.0028 U	<0.0072 U	0.0549	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0029 U	<0.00078 U	<0.0027 U	<0.0028 U	<0.0028 U	<0.0028 U	<0.0036 U	0.0157	**0.4 D**
Naphthalene	(mg/kg)	<0.0029 U	**0.24 J**	**0.3**	**0.3**	**0.15**	<0.0028 U	**0.25**	17	**2.1 E**
Phenanthrene	(mg/kg)	<0.0029 U	**0.11**	**1**	**1.2**	**0.32**	**0.69**	**0.58**	1.88	**1680 D**
Pyrene	(mg/kg)	<0.0029 U	**0.0028 J**	**0.027**	**0.059**	**0.043**	**0.074**	<0.0051 U	0.074	**110 D**
2-Methylnaphthalene	(mg/kg)	<0.0029 U	**0.42**	**1.6**	**3.5**	**0.75**	**1.5 MH**	**1.4**	56	**6.1 F**
1-Methylnaphthalene	(mg/kg)	<0.0029 U	**0.32**	**1.3**	**3.4**	**0.92**	**1.5**	**--**	21.6	**6.2 F**

Table 14-4a: AOC D7 Non-Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D7	D7-SB03	70-72	6/24/2014	D7-SB03-70.0-72.0-0614	<0.0093 U	<0.0093 U	<0.0093 U	<0.0186 U	3.1 J,QL	3.0721	7.1 J,QL	--	<1.8 U,QL	2.8 J,QL	<1.8 U,QL	6.3 J,QL	38 J,QL

Table 14-4b: AOC D7 Non-Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D7	D7-SB03	70-72	6/24/2014	D7-SB03-70.0-72.0-0614	--	--	0.21 J	<2.4 U	<2.4 U	<2.4 U	--	0.76 J	<2.4 U	<2.4 U	<2.4 U	5.01	5.56	10.57

Table 14-4c: AOC D7 Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D7	D7-SB02	2-4	6/13/2014	D7-SB02-2.0-4.0-0614	<0.0086 U	<0.0086 U	0.014 J	0.0911 , J	37 QH	36.8949	130 QH	--	<1.6 U	2.4 J,QH	43 QH	36 QH	460 QH
D7	D7-SB03	5-8	6/23/2014	D7-SB03-5.0-8.0-0614	<0.0089 U,ML	<0.0089 U,ML	0.053 J	0.129 J	42 QH	41.818	110 QH	--	<1.67 U	10 J,B	24 QH	44 B	400 QH
D7	D7-SB03	60-62	6/24/2014	D7-SB03-60.0-62.0-0614	<0.0091 U	<0.0091 U	<0.0091 U	<0.0182 U	32 B	31.9727	85 B	--	<1.8 U,QL	<1.8 U	17	54 B	350
D7	D7-SB03	62-64	6/24/2014	D7-SB03-62.0-64.0-0614	<0.011 U	<0.011 U	<0.011 U	<0.022 U	50 B	49.967	150 B	--	<2 U,QL	2.2 J,B	53	58 B	550
D7	D7-SB04	7-9	6/13/2014	D7-SB04-7.0-9.0-0614	<0.0095 U	<0.0095 U	0.011 J	<0.019 U	0.86 J,B	0.83	2.4 J,B	--	0.25 J,B	<0.36 U	0.36 U,J	1.2 J,B	12 J,B
D7	D7-SB5A	2-4	6/13/2014	D7-SB5A-2.0-4.0-0614	<0.0071 U	<0.0071 U	0.0029 J	0.0124 J	20 B	19.9847	71 B	--	<1.3 U	2.3 J,B	22	34	300
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.009	0.009	0.017	0.049	30.310	30.245	91.400	#DIV/0!	1.437	3.177	26.560	37.867	345.33

Table 14-4d: AOC D7 Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D7	D7-SB02	2-4	6/13/2014	D7-SB02-2.0-4.0-0614	--	--	13	47	63	8.8	--	170	570	290	36	123	1030	1153
D7	D7-SB03	5-8	6/23/2014	D7-SB03-5.0-8.0-0614	--	--	38	120	300	56	--	160	710	520	81	458	1390	1848
D7	D7-SB03	60-62	6/24/2014	D7-SB03-60.0-62.0-0614	--	--	13	98	220	28	--	150	570	370	50	331	1090	1421
D7	D7-SB03	62-64	6/24/2014	D7-SB03-62.0-64.0-0614	--	--	7.1	92	310	50	--	160	810	530	78	409.1	1500	1909.1
D7	D7-SB04	7-9	6/13/2014	D7-SB04-7.0-9.0-0614	--	--	4 J	14	22	4.2 J	--	20 J	69 J	43	7.5	40	132	172
D7	D7-SB5A	2-4	6/13/2014	D7-SB5A-2.0-4.0-0614	--	--	8.8	45	120	20	--	120	560	450	70	173.8	1130	1303.8
average with fraction:							13.983	69.333	172.500	27.833		130.000	548.167	367.167	53.750			

Table 14-4e: AOC D7 Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.00903	0.00903	0.01683	0.04862	30.24455	13.98333	69.33333	172.50000	27.83333	1.43667	3.17667	26.56000	130.00000	548.16667	367.16667	53.75000	1444
Fraction of TPH mass in A&A EC groups	6.25475E-06	6.25475E-06	1.16555E-05	0.00003	0.02094	0.00968	0.04801	0.11944	0.01927	0.00099	0.00220	0.01839	0.09001	0.37956	0.25423	0.03722	1.00
GRO, DRO & RRO A&A Groups	GRO aromatics					DRO aromatics			RRO aromatics	GRO aliphatics			DRO aliphatics			RRO aliphatics	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.020999					0.177130			0.019272	0.021585			0.723797			0.037217	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.000298	0.000298	0.000555	0.001603	0.997246	0.054662	0.271027	0.674311	1.000000	0.046086	0.101903	0.852010	0.124362	0.524394	0.351244	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	4.26%
% of TPH that is DRO=	90.09%
% of TPH that is RRO=	5.65%

GRO % aromatics	0.49312807
GRO % aliphatics	0.50687193
DRO % aromatics	0.196608129
DRO % aliphatics	0.803391871
RRO % aromatics	0.341164454
RRO % aliphatics	0.658835546

Table 14-4f: AOC D7 HRC Input

input to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.49312807
DRO: fraction aromatic	0.196608129
RRO: fraction aromatic	0.341164454

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.054661541
Aromatic C12-C16	0.271027428
Aromatic C16-C21	0.67431103

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.046086399
Aliphatic C6-C8	0.101903336
Aliphatic C8-C10	0.852010265
Aliphatic C10-C12	0.124362245
Aliphatic C12-C16	0.524394133
Aliphatic C16-C21	0.351243622

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Table 14-5: AOC D7 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
D7	AST7-4	NA	10/1/2005	05Y-DT7-10-GW	**0.109 B**	**4.25**	--	**0.0000507 J**	**0.000477 J**	**0.000154 J**	**0.002138 JB**
D7	AST7-4	NA	6/8/2014	AST7-4-WG01-0614	**0.06 J**	**3.2**	**0.21 J**	<0.0004 U	**0.00017 QH**	**0.00016 QH**	**0.00076 QH**
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0	0	0	0	0	0	0
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:

Bold = The analyte was detected.

Shading = The result is above the screening criteria.

-- = not analyzed

BTEX= benzene, toluene, ethylbenzene & xylenes

DRO = diesel-range organics

GRO = gasoline-range organics

mg/L = milligrams per liter

NA = not applicable

RRO = residual-range organics

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)

J = estimated value

JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level source:

H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

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Table 14-6: AOC D7 PAH Groundwater Results

Site Name		D7	D7	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		AST7-4	AST7-4		
Sample Depth		NA	NA		
Sample Date		10/1/2005	6/8/2014		
Sample Name		05Y-DT7-10-GW	AST7-4-WG01-0614		
GRO	(mg/L)	**0.109 B**	**0.06 J**	0.06	**2.2 H**
DRO	(mg/L)	**4.25**	**3.2**	3.2	**1.5 H**
RRO	(mg/L)	**--**	**0.21 J**	0.21	**1.1 H**
Acenaphthene	(mg/L)	**0.000957**	**0.00042 QL**	0.00042	**0.22 H**
Acenaphthylene	(mg/L)	**0.000207**	**0.00017 QL**	0.00017	**0.22 H**
Anthracene	(mg/L)	<0.000011 U	<0.000015 U	0.000015	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.000011 U	<0.000015 U	0.000015	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.0000082 U	**0.0000076 J**	0.0000076	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.0000082 U	**0.000009 J**	0.000009	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	**0.0000044 JB**	**0.0000074 J**	0.0000074	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.0000057 U	**0.0000071 J**	0.0000071	**0.0012 H**
Chrysene	(mg/L)	<0.0000089 U	<0.000015 U	0.000015	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	**0.0000083 JB**	**0.0000063 J**	0.0000063	**0.000012 H**
Fluorene	(mg/L)	**0.0048**	**0.0015**	0.0015	**0.15 H**
Fluoranthene	(mg/L)	**0.0000393 J**	**0.00003**	0.00003	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	**0.0000091 JB**	**0.0000075 J**	0.0000075	**0.00012 H**
Naphthalene	(mg/L)	**0.00627**	**0.00023 QL**	0.00023	**0.073 H**
Phenanthrene	(mg/L)	**0.000887**	**0.00071**	0.00071	**1.1 H**
Pyrene	(mg/L)	**0.0000296 J**	**0.000031 J**	0.000031	**0.11 H**
2-Methylnaphthalene	(mg/L)	**0.0105**	**0.00099 QL**	0.00099	**0.015 H**
1-Methylnaphthalene	(mg/L)	**0.0171**	**0.0013 QL**	0.0013	**0.015 H**

Notes:

Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for PAHs

Table 14-7: AOC D7 All VPH & EPH Groundwater Results

Site Name		D7	maximum value
Boring or Well Number		AST7-4	
Sample Depth		NA	
Sample Date		6/8/2014	
Sample Name		AST7-4-WG01-0614	
C8-C10 Aromatics V	(mg/L)	**0.0092 J**	
C10-C12 Aromatics V	(mg/L)	**0.069 J**	
C12-C13 Aromatics V	(mg/L)	**--**	
C5-C6 Aliphatics V	(mg/L)	<0.006 U	
C6-C8 Aliphatics V	(mg/L)	<0.006 U	
C8-C10 Aliphatics V	(mg/L)	**0.0073 J**	
C10-C12 Aliphatics V	(mg/L)	**0.052**	
Total VPH V	(mg/L)	**0.3 J**	
C8-C10 Aromatics	(mg/L)	**--**	
C10-C12 Aromatics	(mg/L)	**0.095 J**	
C12-C16 Aromatics	(mg/L)	**0.25**	
C16-C21 Aromatics	(mg/L)	**0.54 J**	
C21-C34 Aromatics	(mg/L)	**0.13 J**	
C8-C10 Aliphatics	(mg/L)	**--**	
C10-C12 Aliphatics	(mg/L)	**0.22 J**	
C12-C16 Aliphatics	(mg/L)	**1 J**	
C16-C21 Aliphatics	(mg/L)	**0.94 J**	
C21-C34 Aliphatics	(mg/L)	**0.16**	
GRO Aromatics (C5 to C10 aro)	(mg/L)	0.0092	0.0092
GRO Aliphatics (C5 to C10 ali)	(mg/L)	0.0193	0.0193
DRO Aromatics (C10 to C21)	(mg/L)	0.885	0.885
DRO Aliphatics (C10 to C21)	(mg/L)	2.16	2.16
RRO Aromatics (C21 to C34 aro)	(mg/L)	0.13	0.13
RRO Aliphatics (C21 to C34 ali)	(mg/L)	0.16	0.16
GRO (sum of C5 to C10 A&A)	(mg/L)	0.0285	0.0285
DRO (sum of C10 to C21 A&A)	(mg/L)	3.045	3.045
RRO (sum of C21 to C35 A&A)	(mg/L)	0.29	0.29
GRO (AK101)	(mg/L)	**0.06**	
DRO (AK102)	(mg/L)	**3.2**	
RRO (AK103)	(mg/L)	**0.21**	

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/L = milligrams per liter
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
V = defines VPH results versus EPH results
Result = detected results for VPH, EPH, GRO, DRO and RRO bolded

Table 14-8a: AOC D7 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

ProUCL Input File

GRO	d_GRO	DRO	d_DRO	RRO	d_RRO	Benzene	d_Benzene	Toluene	d_Toluene	Ethylbenzene	d_Ethylbenzene	Xylene	d_Xylene
0.29	0												
1.6	0	7100	1										
12	1	7700	1										
13	1	4600	1	120	1								
3.6	0	2900	1										
1.8	0	8000	1										
14	1	1800	1										
1.4	1	2800	1										
4.5	1	830	1										
35	1	440	1										
73	1	3040	1										
70	1	5470	1										
35.2	1	7800	1										
1.64	0	276	1	84.8	1								
2.82	1	1560	1	158	1								
1.47	0	1550	1	240	1								
94.8	1	4990	1	336	1								
86	1	4400	1	79	1	0.0098	0	0.0098	0	0.063	1	0.602	1
60	1	1400	1	27	1	0.0086	0	0.0086	0	0.014	1	0.0911	1
210	1	4100	1	61	1	0.0089	0	0.0089	0	0.081	1	0.226	1
100	1	1800	1	84	1	0.0089	0	0.0089	0	0.053	1	0.129	1
67	1	1100	1	31	1	0.0066	0	0.0066	0	0.0066	0	0.0132	0
120	1	1500	1	42	1	0.0091	0	0.0091	0	0.0091	0	0.0182	0
130	1	1900	1	67	1	0.011	0	0.011	0	0.011	0	0.022	0
3.9	1	280	1	28	1	0.0095	0	0.0095	0	0.011	1	0.019	0
30	1	1500	1	66	1	0.0071	0	0.0071	0	0.0029	1	0.0124	1
27	1	5300	1	200	1	0.0096	0	0.0044	1	0.0046	1	0.0226	1
22	1	4500	1	170	1	0.0098	0	0.0058	1	0.005	1	0.0248	1
22	1	6100	1	270	1	0.01	0	0.0062	1	0.0036	1	0.0175	1
12	1	2900	1	110	1	0.0034	0	0.0034	0	0.0034	0	0.0102	0

ProUCL Output File

```
                                General UCL Statistics for Data Sets with Non-Detects
              User Selected Options                          Benzene     0.011    maximum LOD
                          From File  WorkSheet.wst           Toluene     0.0062   maximum detected conc
                     Full Precision  OFF                Ethylbenzene     0.081    maximum detected conc
             Confidence Coefficient  95%                      Xylene     0.183     95%UCL
   Number of Bootstrap Operations    10000                       GRO     82.03     95%UCL
                                                                 DRO     4408      95%UCL
                                                                 RRO     167.1     95%UCL
GRO
                                                 General Statistics
                     Number of Valid Data     30                        Number of Detected Data        24
          Number of Distinct Detected Data    22                        Number of Non-Detect Data       6
                                                                           Percent Non-Detects     20.00%
                    Raw Statistics                              Log-transformed Statistics
                        Minimum Detected     1.4                               Minimum Detected     0.336
                        Maximum Detected     210                               Maximum Detected     5.347
                        Mean of Detected     51.9                              Mean of Detected     3.327
                          SD of Detected     51.59                               SD of Detected     1.322
                      Minimum Non-Detect     0.29                            Minimum Non-Detect    -1.238
                      Maximum Non-Detect     3.6                             Maximum Non-Detect     1.281
Note: Data have multiple DLs - Use of KM Method is recommended           Number treated as Non-Detect   8
For all methods (except KM, DL/2, and ROS Methods),                        Number treated as Detected  22
Observations < Largest ND are treated as NDs                       Single DL Non-Detect Percentage  26.67%
                                                   UCL Statistics
     Normal Distribution Test with Detected Values Only       Lognormal Distribution Test with Detected Values Only
                  Shapiro Wilk Test Statistic   0.851                    Shapiro Wilk Test Statistic    0.948
              5% Shapiro Wilk Critical Value    0.916                 5% Shapiro Wilk Critical Value    0.916
          Data not Normal at 5% Significance Level           Data appear Lognormal at 5% Significance Level
              Assuming Normal Distribution                           Assuming Lognormal Distribution
                  DL/2 Substitution Method                                  DL/2 Substitution Method
                                      Mean   41.69                                              Mean    2.589
                                        SD   50.42                                                SD    1.939
                         95% DL/2 (t) UCL    57.33                             95%  H-Stat (DL/2) UCL   347.9
       Maximum Likelihood Estimate(MLE) Method                                            Log ROS Method
                                      Mean   31.5                                  Mean in Log Scale    2.777
                                        SD   62.07                                   SD in Log Scale    1.629
                           95% MLE (t) UCL   50.76                            Mean in Original Scale    41.89
                        95% MLE (Tiku) UCL   51.43                              SD in Original Scale    50.26
                                                                                       95% t UCL    57.48
                                                                       95% Percentile Bootstrap UCL    57.54
                                                                             95% BCA Bootstrap UCL    59.72
                                                                                       95% H UCL    167.5
     Gamma Distribution Test with Detected Values Only              Data Distribution Test with Detected Values Only
                    k star (bias corrected)   0.846          Data appear Gamma Distributed at 5% Significance Level
                                Theta Star   61.32
                                   nu star   40.63

                          A-D Test Statistic   0.235                          Nonparametric Statistics
                        5% A-D Critical Value  0.775                           Kaplan-Meier (KM) Method
                          K-S Test Statistic   0.775                                              Mean    41.81
                        5% K-S Critical Value  0.184                                                SD    49.48
   Data appear Gamma Distributed at 5% Significance Level                                    SE of Mean    9.227
                                                                                         95% KM (t) UCL    57.49
               Assuming Gamma Distribution                                               95% KM (z) UCL    56.99
        Gamma ROS Statistics using Extrapolated Data                               95% KM (jackknife) UCL    57.22
                                  Minimum  0.000001                               95% KM (bootstrap t) UCL    61.81
                                  Maximum    210                                       95% KM (BCA) UCL    58.69
                                     Mean    41.52                      95% KM (Percentile Bootstrap) UCL    57.45
                                   Median     22                                 95% KM (Chebyshev) UCL    82.03
                                       SD    50.56                             97.5% KM (Chebyshev) UCL    99.43
                                   k star    0.196                               99% KM (Chebyshev) UCL    133.6
                               Theta star    211.6
                                  Nu star    11.77                              Potential UCLs to Use
                                  AppChi2    5.077                               95% KM (Chebyshev) UCL    82.03
               95% Gamma Approximate UCL     96.27
                95% Adjusted Gamma UCL       101.3
                                   Note: DL/2 is not a recommended method.
     Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
       These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
                               For additional insight, the user may want to consult a statistician.
```

Table 14-8a: AOC D7 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

DRO

	General Statistics		
Number of Valid Observations	29	Number of Distinct Observations	26
Raw Statistics		**Log-transformed Statistics**	
Minimum	276	Minimum of Log Data	5.62
Maximum	8000	Maximum of Log Data	8.987
Mean	3367	Mean of log Data	7.787
Geometric Mean	2408	SD of log Data	0.944
Median	2900		
SD	2398		
Std. Error of Mean	445.4		
Coefficient of Variation	0.712		
Skewness	0.585		
	Relevant UCL Statistics		
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.911	Shapiro Wilk Test Statistic	0.915
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4124	95% H-UCL	5767
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6868
95% Adjusted-CLT UCL (Chen-1995)	4151	97.5% Chebyshev (MVUE) UCL	8248
95% Modified-t UCL (Johnson-1978)	4132	99% Chebyshev (MVUE) UCL	10958
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.492	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	2256		
MLE of Mean	3367		
MLE of Standard Deviation	2756		
nu star	86.56		
Approximate Chi Square Value (.05)	66.11	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0407	95% CLT UCL	4099
Adjusted Chi Square Value	65.04	95% Jackknife UCL	4124
		95% Standard Bootstrap UCL	4103
Anderson-Darling Test Statistic	0.406	95% Bootstrap-t UCL	4177
Anderson-Darling 5% Critical Value	0.761	95% Hall's Bootstrap UCL	4164
Kolmogorov-Smirnov Test Statistic	0.112	95% Percentile Bootstrap UCL	4130
Kolmogorov-Smirnov 5% Critical Value	0.165	95% BCA Bootstrap UCL	4121
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5308
		97.5% Chebyshev(Mean, Sd) UCL	6148
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	7798
95% Approximate Gamma UCL (Use when n >= 40)	4408		
95% Adjusted Gamma UCL (Use when n < 40)	4480		
Potential UCL to Use		Use 95% Approximate Gamma UCL	4408

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

RRO

	General Statistics		
Number of Valid Observations	18	Number of Distinct Observations	18
Raw Statistics		**Log-transformed Statistics**	
Minimum	27	Minimum of Log Data	3.296
Maximum	336	Maximum of Log Data	5.817
Mean	120.8	Mean of log Data	4.524
Median	84.4	SD of log Data	0.777
SD	90.27		
Std. Error of Mean	21.28		
Coefficient of Variation	0.747		
Skewness	1.09		
	Relevant UCL Statistics		
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.881	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	157.8	95% H-UCL	193.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	226.8
95% Adjusted-CLT UCL (Chen-1995)	161.6	97.5% Chebyshev (MVUE) UCL	272.1
95% Modified-t UCL (Johnson-1978)	158.7	99% Chebyshev (MVUE) UCL	361.1
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.705	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	70.84		
MLE of Mean	120.8		
MLE of Standard Deviation	92.49		
nu star	61.37		
Approximate Chi Square Value (.05)	44.35	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0357	95% CLT UCL	155.8
Adjusted Chi Square Value	42.97	95% Jackknife UCL	157.8
		95% Standard Bootstrap UCL	154.6
Anderson-Darling Test Statistic	0.286	95% Bootstrap-t UCL	167.8
Anderson-Darling 5% Critical Value	0.753	95% Hall's Bootstrap UCL	162.3
Kolmogorov-Smirnov Test Statistic	0.146	95% Percentile Bootstrap UCL	156.5
Kolmogorov-Smirnov 5% Critical Value	0.206	95% BCA Bootstrap UCL	162.2
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	213.5
		97.5% Chebyshev(Mean, Sd) UCL	253.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	332.5
95% Approximate Gamma UCL	167.1		
95% Adjusted Gamma UCL	172.5		
Potential UCL to Use		Use 95% Approximate Gamma UCL	167.1

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

Table 14-8a: AOC D7 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

Xylene

General Statistics			
Number of Valid Data	13	Number of Detected Data	8
Number of Distinct Detected Data	8	Number of Non-Detect Data	5
		Percent Non-Detects	38.46%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0124	Minimum Detected	-4.39
Maximum Detected	0.602	Maximum Detected	-0.507
Mean of Detected	0.141	Mean of Detected	-2.795
SD of Detected	0.201	SD of Detected	1.392
Minimum Non-Detect	0.0102	Minimum Non-Detect	-4.585
Maximum Non-Detect	0.022	Maximum Non-Detect	-3.817
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	7
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	6
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	53.85%

Warning: There are only 8 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.703	Shapiro Wilk Test Statistic	0.921
5% Shapiro Wilk Critical Value	0.818	5% Shapiro Wilk Critical Value	0.818
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0897	Mean	-3.579
SD	0.167	SD	1.493
95% DL/2 (t) UCL	0.172	95% H-Stat (DL/2) UCL	0.431
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.836
		SD in Log Scale	1.768
		Mean in Original Scale	0.0883
		SD in Original Scale	0.168
		95% t UCL	0.171
		95% Percentile Bootstrap UCL	0.172
		95% BCA Bootstrap UCL	0.215
		95% H-UCL	0.908
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.534	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.263		
nu star	8.551		
A-D Test Statistic	0.47	**Nonparametric Statistics**	
5% A-D Critical Value	0.747	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.747	Mean	0.0916
5% K-S Critical Value	0.305	SD	0.16
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0474
		95% KM (t) UCL	0.176
Assuming Gamma Distribution		95% KM (z) UCL	0.17
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.173
Minimum	0.000001	95% KM (bootstrap t) UCL	0.366
Maximum	0.602	95% KM (BCA) UCL	0.183
Mean	0.0866	95% KM (Percentile Bootstrap) UCL	0.175
Median	0.0175	95% KM (Chebyshev) UCL	0.298
SD	0.169	97.5% KM (Chebyshev) UCL	0.387
k star	0.178	99% KM (Chebyshev) UCL	0.563
Theta star	0.485		
Nu star	4.637	**Potential UCLs to Use**	
AppChi2	0.988	95% KM (BCA) UCL	0.183
95% Gamma Approximate UCL	0.406		
95% Adjusted Gamma UCL	0.518		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table 14-8b: AOC D7 PAH Soil 95% UCL Concentrations

ProUCL Input File

Naphthalene	_dNaphthalene	2-Methylnaphthalene	_d2-Methylnaphthalene	1-Methylnaphthalene	_d1-Methylnaphthalene
0.0036	0	0.06	0	10.3	1
0.0068	0	1.1	1	2.07	1
17	1	56	1	21.6	1
1.1	1	3.8	1	7.2	1
0.17	1	2.5	1	3.4	1
5.39	1	14.6	1	4.8	1
0.0157	0	1.7	1	2.3	1
16.1	1	38	1	0.47	1
0.0108	1	0.018	1	0.079	1
0.00764	0	0.00255	0	0.051	1
0.00892	0	0.0229	1	0.32	1
0.00776	0	0.00259	0	1.3	1
3.3	1	12	1	3.4	1
1.1	1	6	1	0.92	1
1.6	1	5	1	1.5	1
1.6	1	2.9	1		
0.059	1	0.33	1		
0.039	1	0.17	1		
0.034	1	0.087	1		
0.24	1	0.42	1		
0.3	1	1.6	1		
0.3	1	3.5	1		
0.15	1	0.75	1		
0.0028	0	1.5	1		
0.25	1	1.4	1		

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options				
From File	WorkSheet.wst	Naphthalene	5.967	95%UCL
Full Precision	OFF	2-Methylnaphthalene	17.58	95%UCL
Confidence Coefficient	95%	1-Methylnaphthalene	7.904	95%UCL
Number of Bootstrap Operations	10000			

Naphthalene

General Statistics

Number of Valid Data	25	Number of Detected Data	18
Number of Distinct Detected Data	15	Number of Non-Detect Data	7
		Percent Non-Detects	28.00%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0108	Minimum Detected	-4.528
Maximum Detected	17	Maximum Detected	2.833
Mean of Detected	2.708	Mean of Detected	-0.736
SD of Detected	5.225	SD of Detected	2.097
Minimum Non-Detect	0.0028	Minimum Non-Detect	-5.878
Maximum Non-Detect	0.0157	Maximum Non-Detect	-4.154
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	8
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	17
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	32.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.556	Shapiro Wilk Test Statistic	0.971
5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.951	Mean	-2.128
SD	4.569	SD	2.896
95% DL/2 (t) UCL	3.514	95% H-Stat (DL/2) UCL	200.6
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.536	Mean in Log Scale	-2.093
SD	5.787	SD in Log Scale	2.837
95% MLE (t) UCL	2.516	Mean in Original Scale	1.951
95% MLE (Tiku) UCL	2.624	SD in Original Scale	4.569
		95% t UCL	3.514
		95% Percentile Bootstrap UCL	3.531
		95% BCA Bootstrap UCL	4.242
		95% H UCL	154.9
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.356	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	7.61		
nu star	12.81		
A-D Test Statistic	0.803	**Nonparametric Statistics**	
5% A-D Critical Value	0.825	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.825	Mean	1.953
5% K-S Critical Value	0.218	SD	4.475
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.921
		95% KM (t) UCL	3.528
Assuming Gamma Distribution		95% KM (z) UCL	3.468
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	3.51
Minimum	0.000001	95% KM (bootstrap t) UCL	7.159
Maximum	17	95% KM (BCA) UCL	3.636
Mean	1.95	95% KM (Percentile Bootstrap) UCL	3.532
Median	0.17	95% KM (Chebyshev) UCL	5.967
SD	4.569	97.5% KM (Chebyshev) UCL	7.705
k star	0.16	99% KM (Chebyshev) UCL	11.12
Theta star	12.19		
Nu star	7.999	**Potential UCLs to Use**	
AppChi2	2.734	95% KM (Chebyshev) UCL	5.967
95% Gamma Approximate UCL	5.703		
95% Adjusted Gamma UCL	6.168		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table 14-8b: AOC D7 PAH Soil 95% UCL Concentrations

2-Methylnaphthalene

General Statistics			
Number of Valid Data	25	Number of Detected Data	22
Number of Distinct Detected Data	22	Number of Non-Detect Data	3
		Percent Non-Detects	12.00%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.018	Minimum Detected	-4.017
Maximum Detected	56	Maximum Detected	4.025
Mean of Detected	6.973	Mean of Detected	0.38
SD of Detected	13.77	SD of Detected	2.106
Minimum Non-Detect	0.00255	Minimum Non-Detect	-5.972
Maximum Non-Detect	0.06	Maximum Non-Detect	-2.813
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	20
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	20.00%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.538	Shapiro Wilk Test Statistic	0.965
5% Shapiro Wilk Critical Value	0.911	5% Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	6.137	Mean	-0.338
SD	13.09	SD	2.846
95% DL/2 (t) UCL	10.61	95% H-Stat (DL/2) UCL	933.4
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	4.039	Mean in Log Scale	-0.168
SD	14.88	SD in Log Scale	2.489
95% MLE (t) UCL	9.13	Mean in Original Scale	6.138
95% MLE (Tiku) UCL	9.017	SD in Original Scale	13.09
		95% t UCL	10.62
		95% Percentile Bootstrap UCL	10.77
		95% BCA Bootstrap UCL	12.65
		95% H UCL	213.1
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.392	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	17.81		
nu star	17.23		
A-D Test Statistic	0.578	**Nonparametric Statistics**	
5% A-D Critical Value	0.822	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.822	Mean	6.138
5% K-S Critical Value	0.198	SD	12.82
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	2.625
		95% KM (t) UCL	10.63
Assuming Gamma Distribution		95% KM (z) UCL	10.46
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	10.62
Minimum	0.000001	95% KM (bootstrap t) UCL	20.62
Maximum	56	95% KM (BCA) UCL	10.89
Mean	6.136	95% KM (Percentile Bootstrap) UCL	10.76
Median	1.5	95% KM (Chebyshev) UCL	17.58
SD	13.09	97.5% KM (Chebyshev) UCL	22.53
k star	0.229	99% KM (Chebyshev) UCL	32.25
Theta star	26.84		
Nu star	11.43	**Potential UCLs to Use**	
AppChi2	4.855	95% KM (Chebyshev) UCL	17.58
95% Gamma Approximate UCL	14.45		
95% Adjusted Gamma UCL	15.36		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

1-Methylnaphthalene

General Statistics			
Number of Valid Observations	15	Number of Distinct Observations	14
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.051	Minimum of Log Data	-2.976
Maximum	21.6	Maximum of Log Data	3.073
Mean	3.981	Mean of log Data	0.409
Median	2.07	SD of log Data	1.698
SD	5.655		
Std. Error of Mean	1.46		
Coefficient of Variation	1.421		
Skewness	2.493		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.689	Shapiro Wilk Test Statistic	0.958
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.552	95% H-UCL	38.74
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	16.8
95% Adjusted-CLT UCL (Chen-1995)	7.386	97.5% Chebyshev (MVUE) UCL	21.79
95% Modified-t UCL (Johnson-1978)	6.709	99% Chebyshev (MVUE) UCL	31.6
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.549	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	7.252		
MLE of Mean	3.981		
MLE of Standard Deviation	5.373		
nu star	16.47		
Approximate Chi Square Value (.05)	8.293	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	6.382
Adjusted Chi Square Value	7.588	95% Jackknife UCL	6.552
		95% Standard Bootstrap UCL	6.304
Anderson-Darling Test Statistic	0.158	95% Bootstrap-t UCL	9.679
Anderson-Darling 5% Critical Value	0.784	95% Hall's Bootstrap UCL	16.28
Kolmogorov-Smirnov Test Statistic	0.113	95% Percentile Bootstrap UCL	6.495
Kolmogorov-Smirnov 5% Critical Value	0.232	95% BCA Bootstrap UCL	7.593
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10.34
		97.5% Chebyshev(Mean, Sd) UCL	13.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	18.51
95% Approximate Gamma UCL	7.904		
95% Adjusted Gamma UCL	8.639		
Potential UCL to Use		Use 95% Approximate Gamma UCL	7.904

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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Table 14-9: AOC D7 Outlier Test Results

Outlier Tests for Selected Variables

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers with Rosner test	1

Rosner's Outlier Test for DRO

Mean	**3367**
Standard Deviation	**2398**
Number of data	**29**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	3367	2357	8000	5	1.966	2.89	3.22

For 5% Significance Level, there is no Potential Outlier

For 1% Significance Level, there is no Potential Outlier

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Table 14-10a: AOC D7 HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	max LOD, ND in 2014	max LOD, ND in 2014	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	maximum detected conc	max measured conc in 2014	
Ethylbenzene (c & nc)	maximum detected conc	max measured conc in 2014	
Xylenes (total) (nc)	maximum detected conc	max measured conc in 2014	
GRO	95%UCL	max LOD, ND in 2014	
DRO	95%UCL	max measured conc in 2014	
RRO	95%UCL	max measured conc in 2014	
GRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
DRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
RRO aromatics	site specific VPH & EPH data	site specific VPH & EPH data	
GRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
DRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
RRO aliphatics	site specific VPH & EPH data	site specific VPH & EPH data	
Acenaphthene (nc)	max measured conc	max measured conc in 2014	
Acenaphthylene (nc)	max measured conc	max measured conc in 2014	
Anthracene (nc)	max measured conc	max LOD, ND in 2014	
Benzo(g,h,i)perylene (nc)	max measured conc	max measured conc in 2014	
Fluoranthene (nc)	max measured conc	max measured conc in 2014	
Fluorene (nc)	max measured conc	max measured conc in 2014	
Naphthalene (c & nc)	95%UCL	max measured conc in 2014	
Phenanthrene (nc)	max measured conc	max measured conc in 2014	
Pyrene (nc)	max measured conc	max measured conc in 2014	
Benzo(a)anthracene (c)	max measured conc	max LOD, ND in 2014	
Benzo(b)fluoranthene (c)	max measured conc	max measured conc in 2014	
Benzo(k)fluoranthene (c)	max DL (<2014) or LOD (2014)	max measured conc in 2014	
Benzo(a)pyrene (c)	max measured conc	max measured conc in 2014	
Chrysene (c)	max measured conc	max LOD, ND in 2014	
Dibenz(a,h)anthracene (c)	max DL (<2014) or LOD (2014)	max measured conc in 2014	
Indeno(1,2,3-cd)pyrene (c)	max DL (<2014) or LOD (2014)	max measured conc in 2014	
1-Methylnaphthalene (nc)	95%UCL	max measured conc in 2014	
2-Methylnaphthalene (nc)	95%UCL	max measured conc in 2014	

Hydrocarbon Characterization Data	
Hydrocarbon Fractions	Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_5-C_6	Site specific EPH & VPH data
Aliphatic C_6-C_8	Site specific EPH & VPH data
Aliphatic C_8-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:

BTEX = benzene, toluene, ethylbenzene, xylene
(c) = carcinogen
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
(nc) = non-carcinogen
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Table 14-10b: AOC D7 HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	**Input Values**			**Source of Data**
bulk density (lbs/ft^3)	125.0538462			D sites average value
specific gravity	2.824666667			D sites average value
moisture content (% by weight)	8.6625			D sites average value
foc	0.005826667			D sites average value
Soil temp (C)	5.3			D sites average value
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt			D sites average value
Hydrogeologic Conditions				
Source length (ft)	108			scaled from site maps
Average precipitation (in/yr)	143.44			NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	1.59E-04			D7 value
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8			estimated thickness of the aquifer based on the 2014 boring logs
Infiltration rate (m/yr)	0.7286752			20% of average precipitation
Hydraulic gradient	0.0085			Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1			Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters				
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3			NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth				
depth to groundwater at seasonal low water level at downgradient end of source (ft)	64			Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	6			Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	64			Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	0			Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time				
Soil Direct Contact	1			Site specific conceptual site model
Outdoor Air	1			Site specific conceptual site model
Indoor Air	0			Site specific conceptual site model
Groundwater Ingestion	0			Site specific conceptual site model
Other Input				
ADEC Hazard ID	0			ADEC CS database
Latitude	0			ADEC CS database
Longitude	0			ADEC CS database
Width of Source (ft)	90			scaled from site maps
Area of NAPL contaminated soil source (ft^2)	9720			scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.0085			Measured slope of water table
Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	125.05	125.05	125.05	D sites average value
specific gravity of solids	2.8246667	2.8246667	2.824667	D sites average value
moisture content (% by weight)	8.66	8.66	8.66	D sites average value
foc	0.0058267	0.0058267	0.005827	D sites average value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	0.1	0.1	0.1	Site Specific (depth to source minus foundation depth--distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	6.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 14-11: AOC D7 Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	1.64357E-07	0.0164	0.0105
Outdoor air inhalation	3.94703E-10	0.0000	0.0000
Indoor air inhalation (vapor intrusion)	3.28001E-09	0.0003	0.0001
Groundwater Ingestion	1.02805E-06	0.1028	0.0145
Cumulative Risk	**1E-06**	**0.1**	**0.0**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	4.94579E-07	0.0495	0.1196
Outdoor air inhalation	1.71221E-09	0.0002	0.0000
Indoor air inhalation (vapor intrusion)	1.3776E-08	0.0014	0.0003
Groundwater Ingestion	1.72712E-06	0.1727	0.0204
Cumulative Risk	**2E-06**	**0.2**	**0.10**

Notes:
Fraction of Risk values equal to or less than one meet the ADEC risk standard
Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 14-12: AOC D7 Summary of Bulk Fuel Hydrocarbon Risk

	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Fraction of Risk Values				
			Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor intrusion)	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	40	0.009	<1	<1	<1	<1	<1
DRO Aromatics	867	0.885	<1	<1	<1	<1	<1
RRO Aromatics	57	0.130	<1	No RfC	No Rfc	<1	<1
GRO Aliphatics	42	0.019	<1	<1	<1	<1	<1
DRO Aliphatics	3541	2.160	<1	<1	<1	<1	<1
RRO Aliphatics	110	0.160	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	40	0.009	<1	<1	<1	<1	<1
DRO Aromatics	867	0.885	<1	<1	<1	<1	<1
RRO Aromatics	57	0.130	<1	No Rfc	No Rfc	<1	<1
GRO Aliphatics	42	0.019	<1	<1	<1	<1	<1
DRO Aliphatics	3541	2.160	<1	<1	<1	<1	<1
RRO Aliphatics	110	0.160	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
mg/L = milligram(s) per liter
No RfC = no reference concentration available; risk standard is assumed to be met due to low volatility of the fraction
RRO = residual-range organics

Table 14-13: AOC D7 Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
1-Methylnaphthalene (nc)	22.9	6.2	MTGW	11	MTGW	7.9	NA	64	MTGW
2-Methylnaphthalene (nc)	56	6.1	MTGW	11	MTGW	17.58	NA	53	MTGW
total DRO	8000[a]	230	MTGW	1200	MTGW	4408	12500	10326	Soil Direct Contact

Notes:

[a] = Historical maximum concentration (23000 mg/kg) not considered representative of current conditions as discussed in Section 14.5.1.

ACL = alternate cleanup level

(c) = carcinogen

DRO = diesel-range organics

HRC = hydrocarbon risk calculator

mg/kg = milligrams per kilogram

MTGW = migration to groundwater

NA = not applicable

(nc) = non-carcinogen

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15.0 AOC D8 – ARMY DOCK AREA – FORMER 2000 BBL TANK – NO. 829

15.1 AREA DESCRIPTION AND BACKGROUND

AOC D8 is the site of former Tank No. 829 (AST8) within the historical Army Dock area tank farm. The tank farm served as the primary fuel off-loading and storage site for World War II military activities in Yakutat. Eight ASTs (ASTs 1–8) with tank capacities ranging from 20,000 to 80,000 gal and associated piping were used to store and transfer diesel fuel to the dock at Monti Bay. Former ASTs 5 through 8 were installed at the southern portion of the tank farm, at significantly higher elevations than ASTs 1 and 2. A wood stave water tank is presently located on the tank pad that formerly supported AST8, located immediately behind the pump house for the Yakutat public water system west of the access road. Two public water supply wells (ARCO #1 and ARCO #2) and associated well houses are located adjacent to the water tank and pump house. According to the City of Yakutat Department of Public Works, drinking water wells ARCO #1 and ARCO #2 extend to 174 and 125 feet bgs, respectively. Static water level was measured at approximately 70 feet bgs and 69 feet bgs, respectively, and drinking water is pumped from approximately 96 feet bgs.

Vadose zone soil samples previously collected at the AOC D8 source area had DRO concentrations of 2,000 mg/kg at 10 to 12 feet bgs and 8,500 mg/kg at 25 to 26 feet bgs (S&W 2006a). A maximum ROST/LIF response of 122.3 %RE was detected at 19 feet bgs (USACE 2006). GRO, DRO, RRO, BTEX and PAHs were not detected in drinking water samples collected from water supply wells ARCO #1 and ARCO #2 in 2004 (S&W 2006a). These water supply wells are located within the AOC D8 source area footprint, but are screened below the water table and below the NAPL contaminated soils.

Data from previous investigations were compiled and used to define the nature and extent of the hydrocarbon contaminated soil source area at AOC D8. These data, along with field screening results and visual observations, were reviewed to select appropriate sampling locations, target depths, and the necessary number of lab samples required to implement the HRC. Historical sample locations and the estimated NAPL source area at AOC D8 are shown in conjunction with the AOC D5 and AOC D6 areas on Figure 12-1.

15.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC D8 included:

- Collect supplemental soil and groundwater data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Evaluate current groundwater conditions.

15.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC D8 included advancement of soil borings, collection of soil samples and sampling drinking water from two City of Yakutat public water supply wells. These activities are described below by media.

15.3.1 Soil

Based on the available data, DRO is present in vadose zone soils northwest, south, and east of the existing tank pad (current location of a City of Yakutat water tank), extending to a minimum depth of 26 feet bgs south of the tank pad. Supplemental RI activities included advancing five soil borings to depths ranging from 14 to 38 feet bgs to collect data for the HRC; two east of the water tank (D8-SB01 and SB02), two inside the fenced area south-southeast of the tank (D8-SB03 and SB04), and one outside the fence behind the pump house and northwest of the tank (D8-SB05). Soils at the site consist of fine to medium sands and fine to coarse sands with gravel, with abundant boulders and occasional thin silty sand layers. Soil boring logs are included in Appendix C.

Field screening samples were collected from above and below the target depth intervals and screened for volatile organics using a PID. Soil samples collected for laboratory analysis were selected from the target depth(s) or adjusted to the most likely contaminated depth based on field observations (e.g., PID, visual, and olfactory). Three soil samples were collected from D8-SB04, two soil samples from D8-SB01, SB03 and SB05, and one sample from D8-SB02 for laboratory analysis. Samples were analyzed for GRO, DRO, RRO, BTEX, PAHs, VPH and EPH, except for the sample from the deepest interval at D8-SB04, which was not analyzed for VPH/EPH. Field observations and screening results were used to refine the estimated limits of the NAPL source area shown on Figure 12-1.

BACKGROUND SOIL CONDITIONS

Soil samples collected outside the AOC D NAPL source areas were analyzed to assess the geophysical properties (e.g., grain size, bulk density, moisture content, and specific gravity) and the naturally occurring organic carbon content of soils at the site. Refer to Section 8.3.1 for a discussion on background sampling activities at AOC D.

15.3.2 Groundwater

Groundwater assessment for the site included sampling the City of Yakutat water supply wells ARCO #1 and ARCO #2. Groundwater samples were collected directly from the piping in the well houses and analyzed for GRO, DRO, RRO, BTEX, and PAHs. Locations for these wells are shown on Figure 12-1 and Groundwater Sample Collection Records are included in Appendix D.

15.4 GROUNDWATER CONDITIONS

As discussed in Section 8.4, groundwater contours were developed for the AOC D area and show an overall groundwater flow direction to the northwest, with an apparent localized cone of depression in the vicinity of City of Yakutat water supply wells ARCO #1 and/or ARCO #2. Horizontal gradients across AOC D were averaged with a resulting gradient estimated at 0.0085 ft/ft.

There are no monitoring wells associated with AOC D8 at this time; therefore, the average hydraulic conductivity value of 0.021 ft/day, calculated for wells adjacent to the site (AST5-4 and AST6-3), was used for input into the HRC. The calculated hydraulic conductivity values are presented in Table 4-4.

15.5 ANALYTICAL RESULTS

15.5.1 Soil

A total of ten soil samples were collected from five soil borings at the site and submitted for laboratory analyses. These data were collected from the most highly contaminated soils to supplement historical data for input in evaluating risk at this site. Results show that six of the ten samples had DRO concentrations above the Method Two cleanup level, ranging from 350 mg/kg to 8,000 mg/kg. The PAHs 1-methylnaphthalene and 2-methylnaphthalene were also detected at concentrations above Method Two cleanup levels in two samples from one soil boring. No other analytes were reported at concentrations above Method Two cleanup levels at AOC D8. Soil analytical results for the samples collected in 2014 are presented in summary tables provided in Appendix J. Sample locations are shown on Figure 12-1 and cross sectional views of the site showing the vertical extent of impacts are presented along B-B’ as Figure 12-3 and C-C’ as Figure 12-4. As shown on the cross sections, the depth of the source area has not been determined, but extends to at least 38 feet bgs. To be conservative, the risk evaluation assumes that the NAPL source area extends through the zone of seasonal water table fluctuation.

Constituent data collected within the defined source zone were used to supplement the historical data set for characterization of the NAPL source zone. Historical and recent (2014) POL data evaluated for the AOC D8 area are presented in Table 15-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 15-2. Historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attenuation of these constituents. PAH soil data are presented in Table 15-3, and VPH/EPH results are presented in Table 15-4. These data were used as input in calculating soil ACLs and to evaluate risk at AOC D8 using the HRC.

15.5.2 Groundwater

Groundwater assessment at the site included sampling water supply wells ARCO #1 and ARCO #2. Analytical results indicate that DRO, RRO and all PAH constituents were detected; however, detected concentrations did not exceed the Table C groundwater cleanup levels or the EPA MCLs. Due to the presence of numerous trace level detections and concern about potential contamination to the drinking water source, further evaluation of results was performed. As discussed in Section 3.6.3, the DRO and RRO concentrations detected were similar to those reported in the MB samples, and the PAH detections are interpreted to be false positive results caused by the analysis of spiked LCSs immediately prior to analyzing the production well samples. Additionally, the groundwater concentrations measured in the wells are low and represent only a small fraction of the allowable risk. Analytical results are summarized in Appendix J.

Results for the water supply wells were used to supplement historical groundwater data for AOC D8. Historical and recent (2014) groundwater results for POLs and PAHs are summarized in Table 15-5 and Table 15-6, respectively.

15.6 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC D8; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

15.6.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet the ADEC "Cleanup Complete" criteria, the AOC D8 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion).

The AOC D8 risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be complete for a site worker scenario at the present time, because there is an occupied building within 30 feet of the AOC D8 source area. The building is a pump house for the Public Works Department and is only entered for periodic maintenance, which constitutes a lower exposure level than the residential and/or industrial scenarios. The groundwater ingestion exposure route is considered to be complete at the present time due to the presence of the water supply wells within or near the source area footprint (Figure 12-1) and possible influence of the water supply pumping wells on groundwater flow in this area. Water samples from these wells show all chemical results below 1/10th of the Table C drinking water standard. Surface water and sediment pathways are considered incomplete based on the unlikely potential for surface runoff or sediment transport to nearby surface water bodies.

The AOC D8 exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

15.6.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each hydrocarbon constituent (BTEX 2014 data only) and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in

Table 15-2. The source area data set for toluene, ethylbenzene, and total xylenes had a limited number of relatively low concentration detections; therefore, the maximum detected values from the source area were used as exposure point concentrations. Benzene was not detected; therefore, the maximum LOD value was used as the exposure point concentration. There were adequate data to calculate 95% UCLs for GRO, DRO, and RRO, so ProUCL was used to calculate 95% UCLs for the HRC input. ProUCL formatted outputs are displayed in Table 15-7a.

Table 15-8 presents the ProUCL outlier test results for DRO, and as shown, the test indicated that the highest DRO concentration measured at the site (8,500 mg/kg) is not a statistical outlier. A Q-Q plot and box plot of the DRO source area data are presented in Figure 15-1a and Figure 15-1b. Both the Q-Q and box plots show that the highest DRO concentration graphed significantly above the other data, which could suggest that the highest DRO result was a statistical outlier if the contaminated soil concentrations were normally distributed (the 95% UCL calculations indicate that DRO concentrations from the source area are not normally distributed).

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 15-3. At AOC D8, naphthalene and 2-methylnaphthalene had maximum concentrations that presented a significant fraction of risk and had a sufficient number of detections to calculate 95% UCLs. Therefore, the 95% UCL concentrations were calculated and used as exposure point concentrations for these constituents (Table 15-7b). The maximum detected concentrations were used as the exposure point concentrations for the remaining PAH constituents at AOC D8.

Six VPH and EPH source area samples were used to characterize the bulk hydrocarbon chemistry. The HRC input values calculated from the source area VPH/EPH data are shown in Table 15-4.

The source of each HRC soil exposure point input value is documented in Table 15-9a.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

To be conservative, the risk evaluation for the site assumes that the NAPL source area extends through the zone of seasonal water table fluctuation. In addition, there is not a monitoring well with a shallow screened interval at AOC D8, so the BTEX, GRO, DRO, RRO and PAH exposure point concentrations used as input to the risk evaluation are the higher of (1) the result measured in the production wells for detected constituents; or (2) the groundwater concentrations predicted or modeled by the HRC based on the soil concentration data from the NAPL soil source area. This approach is interpreted to yield conservative results, especially considering that the detections are interpreted to be associated with MBs or false positives (Section 15.5.2).

The source of each HRC groundwater exposure point input value is documented in Table 15-9a.

15.6.3 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to AOC D8 is presented in Table 15-9b.

15.6.4 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results for AOC D8 is included as Table N-10 of Appendix N and the risk posed by the site conditions is summarized in Table 15-10 and Table 15-11. Table N-10 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for AOC D8 indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and assuming that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).
- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aromatic and aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.
- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, the site conditions are protective of human health under an unrestricted (residential) land use scenario.

15.7 ALTERNATIVE CLEANUP LEVELS

Constituents and/or hydrocarbon fractions exceeding the ADEC Method Two cleanup levels at AOC D8 include 1-methylnaphthalene, 2-methylnaphthalene and DRO. Soil ACLs have been developed for these constituents and/or hydrocarbon fractions as shown in Table 15-12.

DRO, 1-Methylnaphthalene, and 2-methylnaphthalene exceed the Method Two migration to groundwater cleanup levels. However, the migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult’s Law) and dilution-attenuation calculations are applied, the AOC D8 exposure point concentrations meet the migration to groundwater criteria. Under these conditions it is typically not necessary to calculate ACLs, but for this contract ACLs have been back calculated for site COPCs and are presented in Table 15-12. The exposure point concentrations at AOC D8 are less than the ACLs calculated using the HRC, documenting that the site meets the ADEC migration to groundwater criteria.

15.8 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at AOC D was evaluated and a preliminary ecological CSM developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at AOC D8 are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.
- There is not significant surface water runoff or sediment transport from the site to surface water bodies (e.g. nearby pond) based on topography, vegetative cover, and lack of surface soil contamination.
- While Monti Bay is located north of the site, groundwater results indicate that petroleum hydrocarbons are not migrating to the marine environment at concentrations above Alaska WQS for TAH or TAqH.
- Petroleum hydrocarbons in surface soil at AOC D (D1 – D8) cover 0.31 acre. The impacted surface soil areas are less than the ADEC 0.5 acre *de minimis* criterion. Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.

- Risk to the environment has been evaluated for the AOC D area (in entirety) using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation of AOC D8 is not needed and site conditions are protective of the environment.

FIGURE 15-1a: AOC D8 DRO Q-Q Plot

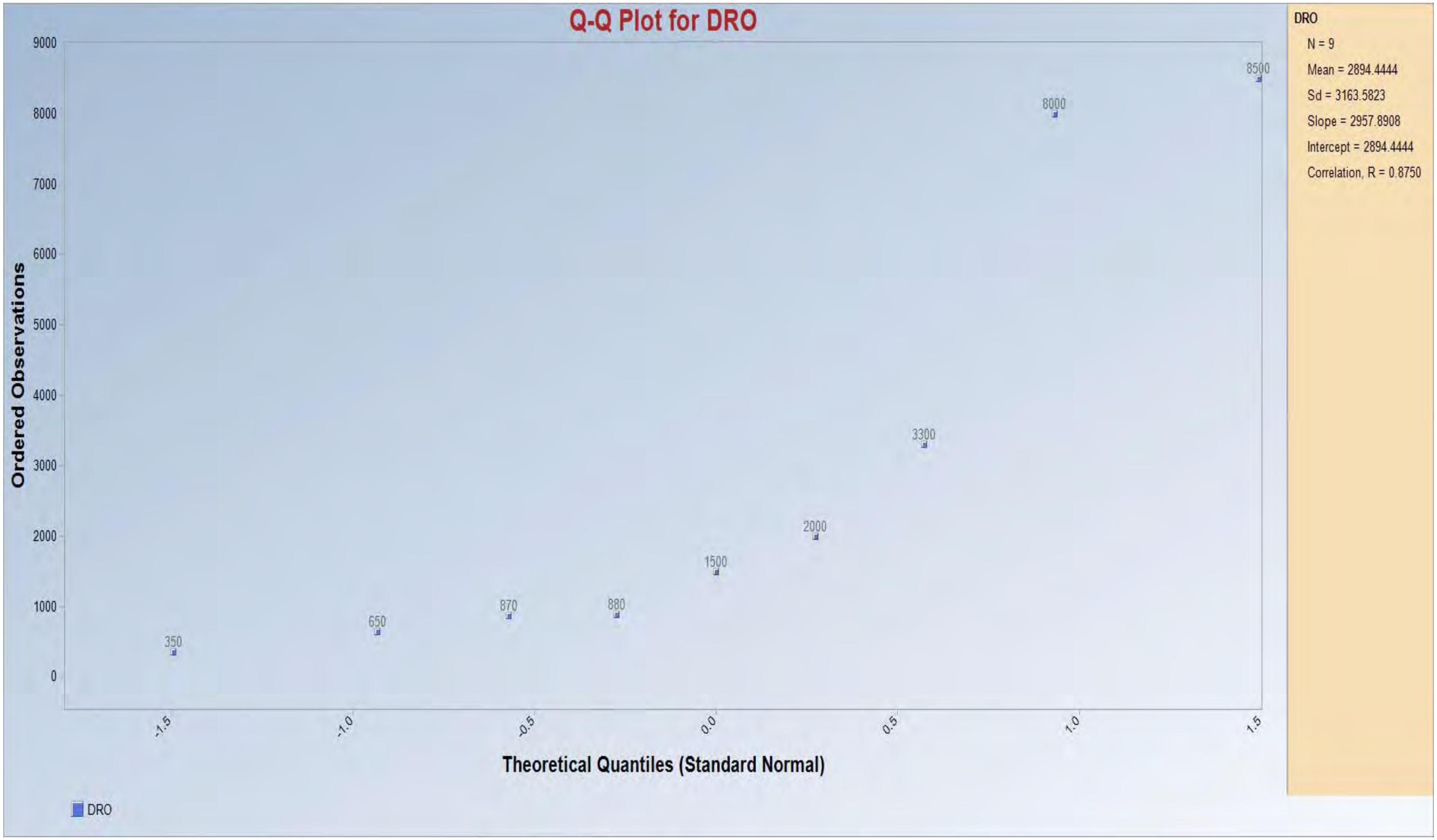

FIGURE 15-1b: AOC D8 DRO Box Plot

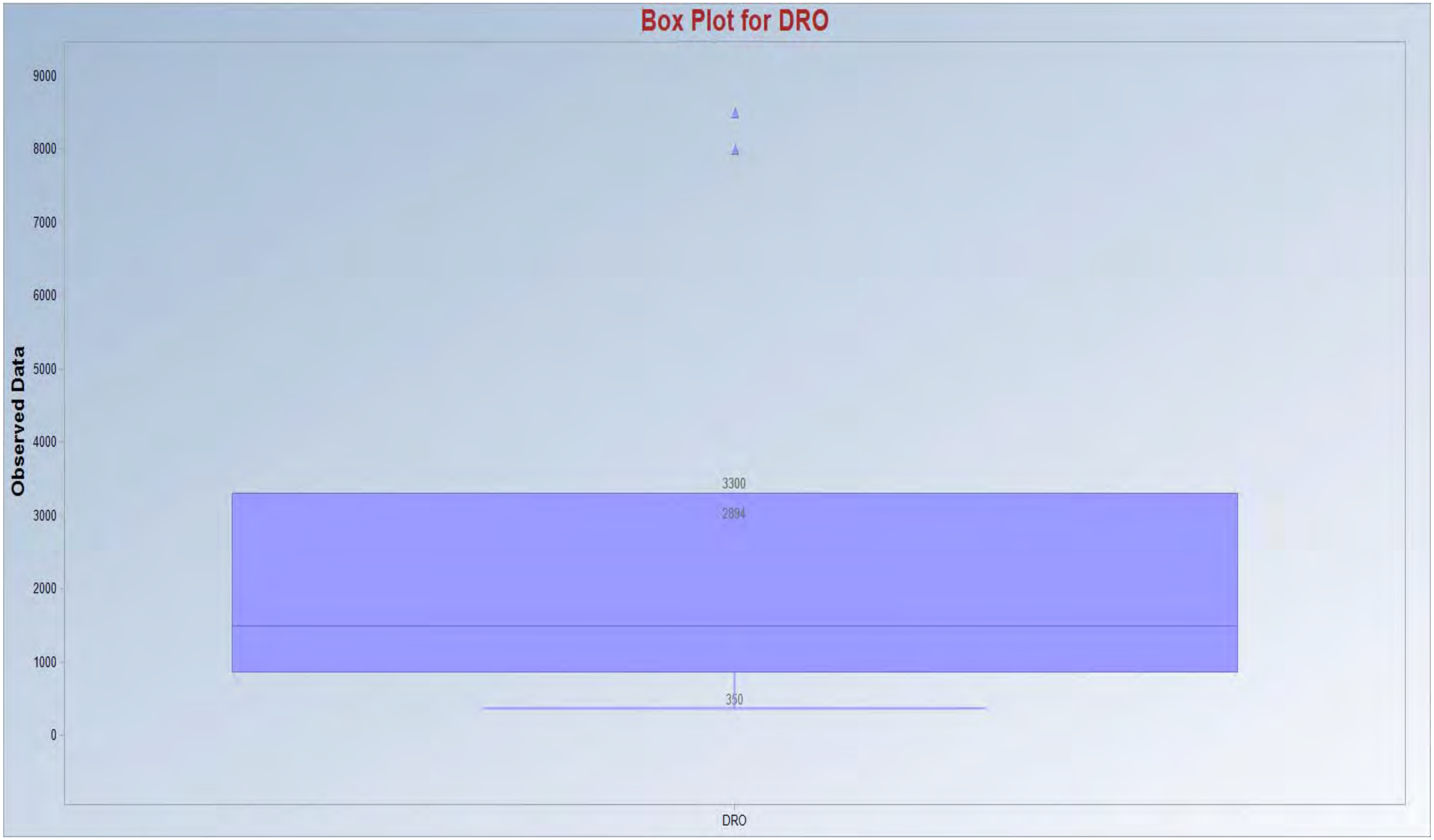

Table 15-1: AOC D8 All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D8	04Y-DT8-01-SS	0-0	8/7/2004	04Y-DT8-01-SS	<0.15 U	**11**	--	<0.0005 U	<0.0005 U	**0.0024 J**	--
D8	04Y-DT8-02-SS	0-0	8/7/2004	04Y-DT8-02-SS	<0.15 U	**5.6**	--	<0.0005 U	<0.0005 U	**0.0076**	--
D8	04Y-DT8-06-SS	0-0	8/12/2004	04Y-DT8-06-SS	<0.23 U	**200**	--	<0.0008 U	**0.0027 J**	**0.0054 J**	--
D8	AP-220	20-22	8/8/2004	04Y-DT8-03-SO	**0.23 J**	**2.7 J**	--	<0.0008 U	**0.0008 J**	**0.0032**	--
D8	AP-220	45-47	8/8/2004	04Y-DT8-04-SO	<0.24 U	**2.1 J**	--	<0.0009 U	**0.0008 J**	**0.0031**	--
D8	AP-220	65-67	8/8/2004	04Y-DT8-05-SO	<0.21 U	**2.2 J**	--	**0.0018 J**	**0.0024 J**	**0.0041 J**	--
D8	AP-221	10-12	8/13/2004	04Y-DT8-07-SO	**0.18**	**2000**	--	**0.0006 J**	**0.0062**	**0.009**	--
D8	AP-221	25-26	8/13/2004	04Y-DT8-10-SO	<3.9 U	**8500**	--	<0.014 U	**0.52**	**0.017**	--
D8	AP-221	35-36.5	8/13/2004	04Y-DT8-11-SO	<0.21 U	**25**	--	**0.0008 J**	**0.03**	**0.0031 J**	--
D8	AP-222	5-7	8/13/2004	04Y-DT8-12-SO	<0.59 U	**51**	--	**0.0054 J**	**0.0048 J**	**0.022**	--
D8	AP-222	10-12	8/13/2004	04Y-DT8-13-SO	--	**880**	--	--	--	--	--
D8	AP-222	15-16	8/21/2004	04Y-DT8-13-SO	<0.19 U	<0.64 U	--	**0.0026 J**	**0.0032 J**	**0.0051 J**	--
D8	AP-222	20-21	8/14/2004	04Y-DT8-14-SO	**0.56 J**	**38**	--	**0.0089**	**0.003 J**	**0.028**	--
D8	D8-BG01	12-14	6/20/2014	D8-BG01-12.0-14.0-0614	**51**	**16 J**	<28 U	--	--	--	--
D8	D8-BG01	16.5-17	6/20/2014	D8-BG01-16.5-17.0-0614	**3.1 B**	**3.1 J**	<28 U	--	--	--	--
D8	D8-BG07	4-6	6/24/2014	D8-BG07-4.0-6.0-0614	**1.9 B**	**4.3 J**	<29 U	--	--	--	--
D8	D8-BG07	10-12	6/24/2014	D8-BG07-10.0-12.0-0614	**5.6 B**	<6.7 U	<26 U	--	--	--	--
D8	D8-BG07	20-22	6/24/2014	D8-BG07-20.0-22.0-0614	**2.4 B**	<6.8 U	<26 U	--	--	--	--
D8	D8-SB01	8-10	6/8/2014	D8-SB01-8.0-10.0-0614	**6.5 B**	**130**	<27 U	<0.0067 U	<0.0067 U	<0.0067 U	<0.0134 U
D8	D8-SB01	12-14	6/8/2014	D8-SB01-12.0-14.0-0614	<1.5 U	**4.3 J**	<26 U	<0.006 U	<0.006 U	<0.006 U	<0.012 U
D8	D8-SB02	8-10	6/8/2014	D8-SB02-12.0-14.0-0614	**100**	**650**	**26 J**	<0.0053 U	**0.0052 J**	<0.0053 U	**1.136 J**
D8	D8-SB03	16-18	6/9/2014	D8-SB03-16.0-18.0-0614	**38 B,QH**	**870**	**30 J**	<0.0096 U	**0.008 J**	<0.0096 U	<0.0192 U
D8	D8-SB03	20-22	6/9/2014	D8-SB03-20.0-22.0-0614	**20 B,QH**	**350**	<26 U	<0.0084 U	**0.013 J**	<0.0084 U	<0.0168 U
D8	D8-SB04	12-14	6/9/2014	D8-SB04-12.0-14.0-0614	**34 B,QH**	**1500**	**59**	<0.0088 U	<0.0088 U	<0.0088 U	<0.0176 U
D8	D8-SB04	25-27	6/9/2014	D8-SB04-25.0-27.0-0614	**190 QH**	**8000 QH**	**200**	<0.0083 U,MN	**0.42 MN**	**0.0056 MN**	**0.7296 MN**
D8	D8-SB04	36-38	6/9/2014	D8-SB04-36.0-38.0-0614	**200 QH**	**3300**	**95**	<0.0057 U	**0.8**	<0.0057 U	**1.2057**
D8	D8-SB05	12-14	6/8/2014	D8-SB05-12.0-14.0-0614	<2 U	**28**	<26 U	<0.0079 U	**0.0049 J**	<0.0079 U	**0.0125 J**
D8	D8-SB05	15-17	6/8/2014	D8-SB05-15.0-17.0-0614	<2.7 U	**13 J**	<27 U	<0.011 U	**0.014 J**	**0.0069 J**	**0.029 J**
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					200	8500	200	0.0089	0.8	0.028	1.2057
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:

Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:

B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:

A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 15-2: AOC D8 Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
D8	AP-221	10-12	8/13/2004	04Y-DT8-07-SO	**0.18**	**2000**	--	--	--	--	--
D8	AP-221	25-26	8/13/2004	04Y-DT8-10-SO	<3.9 U	**8500**	--	--	--	--	--
D8	AP-222	10-12	8/13/2004	04Y-DT8-13-SO	--	**880**	--	--	--	--	--
D8	D8-SB02	8-10	6/8/2014	D8-SB02-12.0-14.0-0614	**100**	**650**	**26 J**	<0.0053 U	**0.0052 J**	<0.0053 U	**1.136 J**
D8	D8-SB03	16-18	6/9/2014	D8-SB03-16.0-18.0-0614	**38 B,QH**	**870**	**30 J**	<0.0096 U	**0.008 J**	<0.0096 U	<0.0192 U
D8	D8-SB03	20-22	6/9/2014	D8-SB03-20.0-22.0-0614	**20 B,QH**	**350**	<26 U	<0.0084 U	**0.013 J**	<0.0084 U	<0.0168 U
D8	D8-SB04	12-14	6/9/2014	D8-SB04-12.0-14.0-0614	**34 B,QH**	**1500**	**59**	<0.0088 U	<0.0088 U	<0.0088 U	<0.0176 U
D8	D8-SB04	25-27	6/9/2014	D8-SB04-25.0-27.0-0614	**190 QH**	**8000 QH**	**200**	<0.0083 U,MN	**0.42 MN**	**0.0056 MN**	**0.7296 MN**
D8	D8-SB04	36-38	6/9/2014	D8-SB04-36.0-38.0-0614	**200 QH**	**3300**	**95**	<0.0057 U	**0.8**	<0.0057 U	**1.2057**
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					200	8500	200	0.0096	0.8	0.0056	1.2057
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
BTEX = benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 15-3: AOC D8 PAH Soils Results

Site Name		D8	D8	D8	D8	D8	D8	D8	D8
Boring, Well or Sample Location Number		04Y-DT8-01-SS	AP-220	AP-221	AP-222	D8-SB01	D8-SB01	D8-SB02	D8-SB03
Sample Depth (feet)		0-0	45-47	10-12	5-7	8-10	12-14	8-10	16-18
Sample Date		8/7/2004	8/8/2004	8/13/2004	8/13/2004	6/8/2014	6/8/2014	6/8/2014	6/9/2014
Sample Name		04Y-DT8-01-SS	04Y-DT8-04-SO	04Y-DT8-07-SO	04Y-DT8-12-SO	D8-SB01-8.0-10.0-0614	D8-SB01-12.0-14.0-0614	D8-SB02-12.0-14.0-0614	D8-SB03-16.0-18.0-0614
GRO	(mg/kg)	<0.15 U	<0.24 U	**0.18**	<0.59 U	**6.5 B**	<1.5 U	**100**	**38 B,QH**
DRO	(mg/kg)	**11**	**2.1 J**	**2000**	**51**	**130**	**4.3 J**	**650**	**870**
RRO	(mg/kg)	--	--	--	--	<27 U	<26 U	**26 J**	**30 J**
Acenaphthene	(mg/kg)	<0.00032 U	<0.00021 U	<0.00022 U	<0.00031 U	**0.016**	**0.003 J**	**0.071**	**0.07**
Acenaphthylene	(mg/kg)	<0.00096 U	<0.00064 U	<0.00065 U	<0.00093 U	**0.0043 J**	<0.0027 U	**0.035**	**0.039**
Anthracene	(mg/kg)	<0.00041 U	<0.00027 U	<0.00028 U	<0.00039 U	**0.0037 J**	<0.0027 U	**0.012 J**	**0.015**
Benzo(a)anthracene	(mg/kg)	<0.00083 U	<0.00055 U	<0.00056 U	<0.0008 U	<0.0027 U	<0.0027 U	**0.0027 J**	<0.0025 U
Benzo(a)pyrene	(mg/kg)	<0.0014 U	<0.00094 U	<0.00096 U	<0.0014 U	<0.0027 U	<0.0027 U	**0.0018 J**	<0.0025 U
Benzo(b)fluoranthene	(mg/kg)	<0.00054 U	<0.00036 U	<0.00036 U	<0.00052 U	<0.0027 U	<0.0027 U	**0.0022 J**	<0.0025 U
Benzo(g,h,i)perylene	(mg/kg)	<0.00075 U	<0.00049 U	<0.0005 U	<0.00072 U	<0.0027 U	<0.0027 U	**0.0017 J**	<0.0025 U
Benzo(k)fluoranthene	(mg/kg)	<0.00034 U	<0.00022 U	<0.00023 U	<0.00033 U	<0.0027 U	<0.0027 U	**0.0017 J**	<0.0025 U
Chrysene	(mg/kg)	<0.00041 U	<0.00027 U	<0.00027 U	<0.00039 U	<0.0027 U	<0.0027 U	**0.0029 J**	**0.0036 J**
Dibenzo(a,h)anthracene	(mg/kg)	<0.00053 U	<0.00035 U	<0.00036 U	<0.00051 U	<0.0027 U	<0.0027 U	**0.0016 J**	<0.0025 U
Fluorene	(mg/kg)	<0.00039 U	<0.00026 U	<0.00026 U	<0.00038 U	**0.06**	**0.011**	**0.23**	**0.14**
Fluoranthene	(mg/kg)	<0.00095 U	<0.00063 U	<0.00064 U	<0.00091 U	**0.0021 J**	<0.0027 U	**0.0046 J**	**0.0075**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.00073 U	<0.00048 U	<0.00049 U	<0.0007 U	<0.0027 U	<0.0027 U	**0.0021 J**	<0.0025 U
Naphthalene	(mg/kg)	<0.00049 U	<0.00032 U	<0.00033 U	<0.00047 U	**0.071**	**0.025**	**0.11**	**0.027**
Phenanthrene	(mg/kg)	<0.00046 U	**0.0021**	<0.00031 U	**0.0031**	**0.054**	**0.0044 J**	**0.12**	**0.29**
Pyrene	(mg/kg)	<0.00058 U	<0.00038 U	<0.00039 U	<0.00055 U	**0.002 J**	<0.0027 U	**0.0031 J**	**0.0068**
2-Methylnaphthalene	(mg/kg)	<0.0083 U	<0.0054 U	<0.0056 U	<0.0079 U	**0.085**	**0.012**	**0.88**	**0.73**
1-Methylnaphthalene	(mg/kg)	--	--	--	--	**0.024**	**0.0026 J**	**0.67**	**0.39**

Notes:

Bold = detected analyte

Shading = result above screening criteria.

Yellow = NAPL-contaminated soil source area.

-- = not analyzed

DRO = diesel-range organics

GRO = gasoline-range organics

HRC = hydrocarbon risk calculator

mg/kg = milligrams per kilogram

NA = not applicable

PAH = polycyclic aromatic hydrocarbons

RRO = residual-range organics

Data qualifiers:

B = analyte detected in blank

J = estimated value

JB = estimated value & analyte detected in blank

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level sources:

A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion

B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation

C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater

D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact

E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation

F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater

H = Source delineation criteria not related to ADEC regulatory levels

Table 15-3: AOC D8 PAH Soils Results

Site Name		D8	D8	D8	D8	D8	D8	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		D8-SB03	D8-SB04	D8-SB04	D8-SB04	D8-SB05	D8-SB05		
Sample Depth (feet)		20-22	12-14	25-27	36-38	12-14	15-17		
Sample Date		6/9/2014	6/9/2014	6/9/2014	6/9/2014	6/8/2014	6/8/2014		
Sample Name		D8-SB03-20.0-22.0-0614	D8-SB04-12.0-14.0-0614	D8-SB04-25.0-27.0-0614	D8-SB04-36.0-38.0-0614	D8-SB05-12.0-14.0-0614	D8-SB05-15.0-17.0-0614		
GRO	(mg/kg)	**20 B,QH**	**34 B,QH**	**190 QH**	**200 QH**	<2 U	<2.7 U	200	**260 C**
DRO	(mg/kg)	**350**	**1500**	**8000 QH**	**3300**	**28**	**13 J**	8000	**230 C**
RRO	(mg/kg)	<26 U	**59**	**200**	**95**	<26 U	<27 U	200	**230 H**
Acenaphthene	(mg/kg)	**0.037**	**0.081**	**1.2**	**0.54**	**0.0037 J**	**0.0039 J**	1.2	**180 F**
Acenaphthylene	(mg/kg)	**0.021**	**0.042**	**0.34**	**0.21**	<0.0026 U	**0.0022 J**	0.34	**180 F**
Anthracene	(mg/kg)	**0.0061**	**0.033**	<0.027 U	<0.026 U	<0.0026 U	**0.0026 J**	0.033	**1680 D**
Benzo(a)anthracene	(mg/kg)	<0.0026 U	<0.0026 U	<0.027 U	**0.041 J**	<0.0026 U	**0.0021 J**	0.041	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.0026 U	<0.0026 U	<0.027 U	<0.026 U	<0.0026 U	<0.0028 U	0.0018	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	<0.0026 U	**0.0017 J**	<0.027 U	<0.026 U	<0.0026 U	<0.0028 U	0.0022	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.0026 U	<0.0026 U	<0.027 U	<0.026 U	<0.0026 U	<0.0028 U	0.0017	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.0026 U	<0.0026 U	<0.027 U	<0.026 U	<0.0026 U	<0.0028 U	0.0017	**4 D**
Chrysene	(mg/kg)	**0.0025 J**	**0.0091**	**0.04 J**	**0.032 J**	<0.0026 U	**0.002 J**	0.04	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.0026 U	<0.0026 U	<0.027 U	<0.026 U	<0.0026 U	<0.0028 U	0.0016	**0.04 D**
Fluorene	(mg/kg)	**0.086**	**0.25**	**2.2**	**1.4**	**0.01**	**0.011**	2.2	**190 D**
Fluoranthene	(mg/kg)	**0.0031 J**	**0.019**	**0.12**	**0.049 J**	<0.0026 U	**0.0024 J**	0.12	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0026 U	<0.0026 U	<0.027 U	<0.026 U	<0.0026 U	**0.0017 J**	0.0021	**0.4 D**
Naphthalene	(mg/kg)	**0.033**	**0.026**	**12**	**3.8**	**0.0099 B**	**0.035**	12	**2.1 E**
Phenanthrene	(mg/kg)	**0.13**	**0.41**	**5.7**	**2**	**0.0078**	**0.012**	5.7	**1680 D**
Pyrene	(mg/kg)	**0.0025 J**	**0.02**	**0.087**	**0.038 J**	<0.0026 U	**0.0021 J**	0.087	**110 D**
2-Methylnaphthalene	(mg/kg)	**0.53**	**0.12**	**40**	**11**	**0.019**	**0.045**	40	**6.1 F**
1-Methylnaphthalene	(mg/kg)	**0.32**	**0.14**	**20**	**6.3**	**0.011**	**0.018**	20	**6.2 F**

Table 15-4a: AOC D8 Non-Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D8	D8-SB01	12-14	6/8/2014	D8-SB01-12.0-14.0-0614	<0.006 U	<0.006 U	<0.006 U	<0.012 U	1.3 J,B	1.282	1.9 J,B	--	1.6 J	3.6 J,QN	1.3 J	<2.4 U	5 J,B
D8	D8-SB01	8-10	6/8/2014	D8-SB01-8.0-10.0-0614	<0.0067 U	<0.0067 U	<0.0067 U	<0.0134 U	5.1 J,B	5.0799	8.5 J,B	--	9.8 J	1.4 J,QN	6.3 J	<2.7 U	58 J,B
D8	D8-SB05	12-14	6/8/2014	D8-SB05-12.0-14.0-0614	<0.0079 U	<0.0079 U	0.0049 J	0.0125 J	3.8 J,B	3.7826	5.2 J,B	--	<3.2 U	<3.2 U,QN	1.7 J	<3.2 U	22 J,B
D8	D8-SB05	15-17	6/8/2014	D8-SB05-15.0-17.0-0614	<0.011 U	0.0069 J	0.014 J	0.029 J	3.9 J,B	3.857	5.4 J,B	--	<4.3 U	<4.3 U,QN	2.5 J	<4.3 U	2.5 J,B

Table 15-4b: AOC D8 Non-Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D8	D8-SB01	12-14	6/8/2014	D8-SB01-12.0-14.0-0614	--	--	0.31 J	<2.2 U	<2.2 U	<2.2 U	--	1 J	1.1 J	<2.2 U	<2.2 U	4.71	4.3	9.01
D8	D8-SB01	8-10	6/8/2014	D8-SB01-8.0-10.0-0614	--	--	0.43 J	4.2 J	14	2.8 J	--	2.6 J	26	25	4.9 J	18.63	53.6	72.23
D8	D8-SB05	12-14	6/8/2014	D8-SB05-12.0-14.0-0614	--	--	0.19 J	<2.1 U	2.9 J	1.1 J	--	0.48 J	4.6 J	5.5	3.6 J	5.19	10.58	15.77
D8	D8-SB05	15-17	6/8/2014	D8-SB05-15.0-17.0-0614	--	--	0.28 J	<2.2 U	2.3 J	<2.2 U	--	0.62 J	2.8 J	2.8 J	2.4 J	4.78	6.22	11

Table 15-4c: AOC D8 Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
D8	D8-SB01	8-10	6/8/2014	D8-SB01-8.0-10.0-0614	<0.0067 U	<0.0067 U	<0.0067 U	<0.0134 U	5.1 J,B	5.0799	8.5 J,B	--	9.8 J	1.4 J,QN	6.3 J	<2.7 U	58 J,B
D8	D8-SB02	8-10	6/8/2014	D8-SB02-12.0-14.0-0614	<0.0053 U	<0.0053 U	0.0052 J	1.136 J	66	64.8588	61 B	--	3.3 J	3.9 J,QN	86.4	47	320
D8	D8-SB03	16-18	6/9/2014	D8-SB03-16.0-18.0-0614	<0.0096 U	<0.0096 U	0.008 J	<0.0192 U	17 J,B	16.9728	36 J,B	--	<3.9 U	<3.9 U,QN	5.5 J	25 J	190
D8	D8-SB03	20-22	6/9/2014	D8-SB03-20.0-22.0-0614	<0.0084 U	<0.0084 U	0.013 J	<0.0168 U	14 J,B	13.9702	25 J,B	--	<3.4 U	6.9 J,QN	<3.4 U	22 J	150 J
D8	D8-SB04	12-14	6/9/2014	D8-SB04-12.0-14.0-0614	<0.0088 U	<0.0088 U	<0.0088 U	<0.0176 U	32 B	31.9736	89 B	--	<3.6 U	<3.6 U,QN	20 J	74	460
D8	D8-SB04	25-27	6/9/2014	D8-SB04-25.0-27.0-0614	<0.0083 U,MN	0.0056 MN	0.42 MN	0.7296 MN	97 QH	95.8504	210 QH	--	<3.4 U	11 J,QH	110 QH	62 QH	940 QH
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.008	0.007	0.077	0.322	38.517	38.118	71.583	#DIV/0!	4.567	5.117	38.600	38.783	353.00

Table 15-4d: AOC D8 Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
D8	D8-SB01	8-10	6/8/2014	D8-SB01-8.0-10.0-0614	--	--	0.43 J	4.2 J	14	2.8 J	--	2.6 J	26	25	4.9 J	18.63	53.6	72.23
D8	D8-SB02	8-10	6/8/2014	D8-SB02-12.0-14.0-0614	--	--	11	40	56	5.1 J	--	45	190	82	7.8	107	317	424
D8	D8-SB03	16-18	6/9/2014	D8-SB03-16.0-18.0-0614	--	--	9.8	51	100	16	--	45	240	170	26	160.8	455	615.8
D8	D8-SB03	20-22	6/9/2014	D8-SB03-20.0-22.0-0614	--	--	4 J	21	39	5.4	--	20	100	58	8.8	64	178	242
D8	D8-SB04	12-14	6/9/2014	D8-SB04-12.0-14.0-0614	--	--	12	83	220	34	--	84	480	360	56	315	924	1239
D8	D8-SB04	25-27	6/9/2014	D8-SB04-25.0-27.0-0614	--	--	160	800	1200	150	--	940	3700	2300	330	2160	6940	9100
average with fraction:							32.872	166.533	271.500	35.550		189.433	789.333	499.167	72.250			

Table 15-4e: AOC D8 Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.00785	0.00740	0.07695	0.32210	38.11762	32.87167	166.53333	271.50000	35.55000	4.56667	5.11667	38.60000	189.43333	789.33333	499.16667	72.25000	2143
Fraction of TPH mass in A&A EC groups	3.6623E-06	3.45237E-06	3.59E-05	0.00015	0.01778	0.01534	0.07769	0.12666	0.01659	0.00213	0.00239	0.01801	0.08838	0.36825	0.23288	0.03371	1.00
GRO, DRO & RRO A&A Groups	**GRO aromatics**					**DRO aromatics**			**RRO aromatics**	**GRO aliphatics**			**DRO aliphatics**			**RRO aliphatics**	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.017977					0.219695			0.016585	0.022526			0.689510			0.033707	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.000204	0.000192	0.001997	0.008359	0.989248	0.069805	0.353645	0.576549	1.000000	0.094581	0.105972	0.799448	0.128174	0.534079	0.337746	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	4.05%
% of TPH that is DRO=	90.92%
% of TPH that is RRO=	5.03%

GRO % aromatics	0.443838112
GRO % aliphatics	0.556161888
DRO % aromatics	0.241633691
DRO % aliphatics	0.758366309
RRO % aromatics	0.329777365
RRO % aliphatics	0.670222635

Table 15-4f: AOC D8 HRC Input

nput to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.443838112
DRO: fraction aromatic	0.241633691
RRO: fraction aromatic	0.329777365

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.069805304
Aromatic C12-C16	0.353645286
Aromatic C16-C21	0.57654941

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.094580601
Aliphatic C6-C8	0.105971695
Aliphatic C8-C10	0.799447705
Aliphatic C10-C12	0.128174478
Aliphatic C12-C16	0.534079119
Aliphatic C16-C21	0.337746403

Notes:

-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons

GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Table 15-5: AOC D8 All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
D8	ARCO Well#1	NA	8/30/2004	04Y-DA1-01-GW	<0.003 U	<0.023 U	**--**	<0.00015 U	<0.00018 U	<0.00024 U	**--**
D8	ARCO Well#1	NA	7/1/2014	DA1-WG01-0714	<0.044 U	**0.027 J**	**0.023 J**	<0.0004 U	<0.0004 U	<0.0004 U	<0.0008 U
D6	ARCO Well#2	NA	8/30/2004	04Y-DA2-01-GW	<0.003 U	<0.022 U	**--**	<0.00015 U	<0.00018 U	<0.00024 U	**--**
D6	ARCO Well#2	NA	6/28/2014	DA2-WG01-0614	**0.016 J**	<0.05 U	<0.05 U,QL	<0.0004 U	<0.0004 U	<0.0004 U	<0.0008 U
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0.016	0.027	0.023	0.0004	0.0004	0.0004	0.0008
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:

Bold = The analyte was detected.

Shading = The result is above the screening criteria.

-- = not analyzed

BTEX= benzene, toluene, ethylbenzene & xylenes

DRO = diesel-range organics

GRO = gasoline-range organics

mg/L = milligrams per liter

NA = not applicable

RRO = residual-range organics

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)

J = estimated value

JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level source:

H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

Table 15-6: AOC D8 PAH Groundwater Results

Site Name		D8	D8	D6	D6	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		ARCO Well#1	ARCO Well#1	ARCO Well#2	ARCO Well#2		
Sample Depth		NA	NA	NA	NA		
Sample Date		8/30/2004	7/1/2014	8/30/2004	6/28/2014		
Sample Name		04Y-DA1-01-GW	DA1-WG01-0714	04Y-DA2-01-GW	DA2-WG01-0614		
GRO	(mg/L)	<0.003 U	<0.044 U	<0.003 U	**0.016 J**	0.016	**2.2 H**
DRO	(mg/L)	<0.023 U	**0.027 J**	<0.022 U	<0.05 U	0.027	**1.5 H**
RRO	(mg/L)	--	**0.023 J**	--	<0.05 U,QL	0.023	**1.1 H**
Acenaphthene	(mg/L)	<0.000011 U	**0.0000066 MN**	<0.000011 U	**0.0000091 J**	0.0000091	**0.22 H**
Acenaphthylene	(mg/L)	<0.0000098 U	**0.0000062 MN**	<0.00001 U	**0.0000084 J**	0.0000084	**0.22 H**
Anthracene	(mg/L)	<0.000011 U	<0.000015 U	<0.000011 U	**0.0000073 J**	0.0000073	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.00002 U	<0.000015 U	<0.000021 U	**0.0000079 J**	0.0000079	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.000011 U	<0.000015 U	<0.000011 U	**0.0000062 J**	0.0000062	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.000026 U	<0.000015 U	<0.000026 U	**0.0000072 J**	0.0000072	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.000013 U	<0.000015 U	<0.000014 U	**0.000007 J**	0.000007	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.000016 U	<0.000015 U	<0.000016 U	**0.0000069 J**	0.0000069	**0.0012 H**
Chrysene	(mg/L)	**0.000011 J**	<0.000015 U	**0.000011 J**	**0.000008 J**	0.000008	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.000017 U	<0.000015 U	<0.000017 U	**0.0000063 J**	0.0000063	**0.000012 H**
Fluorene	(mg/L)	<0.000012 U	**0.0000074 J**	<0.000013 U	**0.000011 J**	0.000011	**0.15 H**
Fluoranthene	(mg/L)	<0.000024 U	**0.0000066 J**	<0.000025 U	**0.00001 J**	0.00001	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.000013 U	<0.000015 U	<0.000014 U	**0.000009 J**	0.000009	**0.00012 H**
Naphthalene	(mg/L)	<0.000031 U	**0.000024 B**	<0.000032 U	**0.000029 B**	0.000029	**0.073 H**
Phenanthrene	(mg/L)	<0.000031 U	**0.00001 B**	<0.000032 U	**0.000015 B**	0.000015	**1.1 H**
Pyrene	(mg/L)	<0.000028 U	<0.000015 U	<0.000029 U	**0.0000073 J**	0.0000073	**0.11 H**
2-Methylnaphthalene	(mg/L)	<0.000012 U	**0.000011 B**	<0.000013 U	**0.000013 B**	0.000013	**0.015 H**
1-Methylnaphthalene	(mg/L)	--	**0.0000087 B**	--	**0.0000082 B**	0.0000087	**0.015 H**

Notes:

Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
PAH = polycyclic aromatic hydrocarbon
RRO = residual-range organics

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for PAHs

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Table 15-7a: AOC D8 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

ProUCL Input File

GRO	d_GRO	DRO	d_DRO	RRO	d_RRO	Benzene	d_Benzene	Toluene	d_Toluene	Ethylbenzene	d_Ethylbenzene	Xylene	d_Xylene
0.18	1	2000	1										
3.9	0	8500	1										
		880	1										
100	1	650	1	26	1	0.0053	0	0.0053	0	0.0052	1	1.136	1
38	1	870	1	30	1	0.0096	0	0.0096	0	0.008	1	0.0192	0
20	1	350	1	26	0	0.0084	0	0.0084	0	0.013	1	0.0168	0
34	1	1500	1	59	1	0.0088	0	0.0088	0	0.0088	0	0.0176	0
190	1	8000	1	200	1	0.0083	0	0.0056	1	0.42	1	0.7296	1
200	1	3300	1	95	1	0.0057	0	0.0057	0	0.8	1	1.2057	1

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options				
From File	WorkSheet.wst	Benzene	0.0096	maximum LOD
Full Precision	OFF	Toluene	0.0056	maximum detected conc
Confidence Coefficient	95%	Ethylbenzene	0.8	maximum detected conc
Number of Bootstrap Operations	10000	Xylene	1.2057	maximum detected conc
		GRO	128.1	95%UCL
		DRO	6124	95%UCL
		RRO	129.7	95%UCL

GRO

General Statistics

Number of Valid Data	8	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	1
		Percent Non-Detects	12.50%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.18	Minimum Detected	-1.715
Maximum Detected	200	Maximum Detected	5.298
Mean of Detected	83.17	Mean of Detected	3.371
SD of Detected	82.34	SD of Detected	2.41
Minimum Non-Detect	3.9	Minimum Non-Detect	1.361
Maximum Non-Detect	3.9	Maximum Non-Detect	1.361

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.844	Shapiro Wilk Test Statistic	0.777
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	73.02	Mean	3.033
SD	81.46	SD	2.428
95% DL/2 (t) UCL	127.6	95% H-Stat (DL/2) UCL	336784
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	59.05	Mean in Log Scale	2.912
SD	94.73	SD in Log Scale	2.582
95% MLE (t) UCL	122.5	Mean in Original Scale	72.87
95% MLE (Tiku) UCL	124.8	SD in Original Scale	81.61
		95% t UCL	127.5
		95% Percentile Bootstrap UCL	119.3
		95% BCA Bootstrap UCL	127.4
		95% H UCL	1038052
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.432	**Data appear Normal at 5% Significance Level**	
Theta Star	192.4		
nu star	6.052		
A-D Test Statistic	0.389	**Nonparametric Statistics**	
5% A-D Critical Value	0.746	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.746	Mean	72.8
5% K-S Critical Value	0.326	SD	76.41
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	29.18
		95% KM (t) UCL	128.1
Assuming Gamma Distribution		95% KM (z) UCL	120.8
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	126.9
Minimum	0.000001	95% KM (bootstrap t) UCL	178.9
Maximum	200	95% KM (BCA) UCL	125.5
Mean	72.77	95% KM (Percentile Bootstrap) UCL	121.5
Median	36	95% KM (Chebyshev) UCL	200
SD	81.71	97.5% KM (Chebyshev) UCL	255
k star	0.23	99% KM (Chebyshev) UCL	363.1
Theta star	316.8		
Nu star	3.675	**Potential UCLs to Use**	
AppChi2	0.598	95% KM (t) UCL	128.1
95% Gamma Approximate UCL	447.4	95% KM (Percentile Bootstrap) UCL	121.5
95% Adjusted Gamma UCL	748.4		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table 15-7a: AOC D8 BTEX, GRO, DRO RRO Soil 95% UCL Concentrations

DRO

General Statistics

Number of Valid Observations	9	Number of Distinct Observations	9
Raw Statistics		**Log-transformed Statistics**	
Minimum	350	Minimum of Log Data	5.858
Maximum	8500	Maximum of Log Data	9.048
Mean	2894	Mean of log Data	7.437
Median	1500	SD of log Data	1.105
SD	3164		
Std. Error of Mean	1055		
Coefficient of Variation	1.093		
Skewness	1.328		

Warning: There are only 9 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.754	Shapiro Wilk Test Statistic	0.941
Shapiro Wilk Critical Value	0.829	Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4855	95% H-UCL	12177
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	7592
95% Adjusted-CLT UCL (Chen-1995)	5128	97.5% Chebyshev (MVUE) UCL	9645
95% Modified-t UCL (Johnson-1978)	4933	99% Chebyshev (MVUE) UCL	13678
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.79	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	3666		
MLE of Mean	2894		
MLE of Standard Deviation	3257		
nu star	14.21		
Approximate Chi Square Value (.05)	6.718	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0231	95% CLT UCL	4629
Adjusted Chi Square Value	5.667	95% Jackknife UCL	4855
		95% Standard Bootstrap UCL	4524
Anderson-Darling Test Statistic	0.478	95% Bootstrap-t UCL	8214
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	13446
Kolmogorov-Smirnov Test Statistic	0.198	95% Percentile Bootstrap UCL	4634
Kolmogorov-Smirnov 5% Critical Value	0.286	95% BCA Bootstrap UCL	5089
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	7491
		97.5% Chebyshev(Mean, Sd) UCL	9480
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	13387
95% Approximate Gamma UCL	6124		
95% Adjusted Gamma UCL	7259		
Potential UCL to Use		Use 95% Approximate Gamma UCL	6124

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

RRO

General Statistics

Number of Valid Data	6	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	1
		Percent Non-Detects	16.67%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	26	Minimum Detected	3.258
Maximum Detected	200	Maximum Detected	5.298
Mean of Detected	82	Mean of Detected	4.118
SD of Detected	71.52	SD of Detected	0.842
Minimum Non-Detect	26	Minimum Non-Detect	3.258
Maximum Non-Detect	26	Maximum Non-Detect	3.258

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.843	Shapiro Wilk Test Statistic	0.941
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	70.5	Mean	3.859
SD	69.9	SD	0.985
95% DL/2 (t) UCL	128	95% H-Stat (DL/2) UCL	461.7
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	65.26	Mean in Log Scale	3.753
SD	70.92	SD in Log Scale	1.168
95% MLE (t) UCL	123.6	Mean in Original Scale	69.48
95% MLE (Tiku) UCL	122.5	SD in Original Scale	70.94
		95% t UCL	127.8
		95% Percentile Bootstrap UCL	118.1
		95% BCA Bootstrap UCL	130
		95% H UCL	988.7
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.885	**Data appear Normal at 5% Significance Level**	
Theta Star	92.61		
nu star	8.854		
A-D Test Statistic	0.303	**Nonparametric Statistics**	
5% A-D Critical Value	0.685	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.685	Mean	72.67
5% K-S Critical Value	0.361	SD	62.02
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	28.31
		95% KM (t) UCL	129.7
Assuming Gamma Distribution		95% KM (z) UCL	119.2
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	128.4
Minimum	0.000001	95% KM (bootstrap t) UCL	217.5
Maximum	200	95% KM (BCA) UCL	119.8
Mean	68.33	95% KM (Percentile Bootstrap) UCL	119.8
Median	44.5	95% KM (Chebyshev) UCL	196
SD	72.2	97.5% KM (Chebyshev) UCL	249.4
k star	0.227	99% KM (Chebyshev) UCL	354.3
Theta star	300.7		
Nu star	2.727	**Potential UCLs to Use**	
AppChi2	0.296	95% KM (t) UCL	129.7
95% Gamma Approximate UCL	628.9	95% KM (Percentile Bootstrap) UCL	119.8
95% Adjusted Gamma UCL	1389		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table 15-7b: AOC D8 PAH Soil 95% UCL Concentrations

ProUCL Input File

Naphthalene	d_Naphthalene	2-Methylnaphthalene	d_2-Methylnaphthalene	1-Methylnaphthalene	d_1-Methylnaphthalene
0.00033	0	0.0056	0	0.67	1
0.11	1	0.88	1	0.39	1
0.027	1	0.73	1	0.32	1
0.033	1	0.53	1	0.14	1
0.026	1	0.12	1	20	1
12	1	40	1	6.3	1
3.8	1	11	1		

ProUCL Output File

General UCL Statistics for Data Sets with Non-Detects

User Selected Options				
From File	WorkSheet.wst	Naphthalene	9.817	95%UCL
Full Precision	OFF	2-Methylnaphthalene	32.37	95%UCL
Confidence Coefficient	95%	1-Methylnaphthalene	20	max detected
Number of Bootstrap Operations	10000			

Naphthalene

General Statistics

Number of Valid Data	7	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	1
		Percent Non-Detects	14.29%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.026	Minimum Detected	-3.65
Maximum Detected	12	Maximum Detected	2.485
Mean of Detected	2.666	Mean of Detected	-1.51
SD of Detected	4.813	SD of Detected	2.726
Minimum Non-Detect	0.00033	Minimum Non-Detect	-8.016
Maximum Non-Detect	0.00033	Maximum Non-Detect	-8.016

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.664	Shapiro Wilk Test Statistic	0.796
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.285	Mean	-2.539
SD	4.507	SD	3.687
95% DL/2 (t) UCL	5.596	95% H-Stat (DL/2) UCL	6367000000
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1.842	Mean in Log Scale	-2.441
SD	4.637	SD in Log Scale	3.501
95% MLE (t) UCL	5.247	Mean in Original Scale	2.285
95% MLE (Tiku) UCL	5.088	SD in Original Scale	4.507
		95% t UCL	5.596
		95% Percentile Bootstrap UCL	5.166
		95% BCA Bootstrap UCL	6.866
		95% H UCL	600900000
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.251	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	10.62		
nu star	3.013		
A-D Test Statistic	0.744	**Nonparametric Statistics**	
5% A-D Critical Value	0.774	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.774	Mean	2.289
5% K-S Critical Value	0.358	SD	4.171
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	1.727
		95% KM (t) UCL	5.645
Assuming Gamma Distribution		95% KM (z) UCL	5.129
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	5.598
Minimum	0.000001	95% KM (bootstrap t) UCL	316.4
Maximum	12	95% KM (BCA) UCL	5.16
Mean	2.285	95% KM (Percentile Bootstrap) UCL	5.17
Median	0.033	95% KM (Chebyshev) UCL	9.817
SD	4.507	97.5% KM (Chebyshev) UCL	13.07
k star	0.199	99% KM (Chebyshev) UCL	19.47
Theta star	11.46		
Nu star	2.792	**Potential UCLs to Use**	
AppChi2	0.314	95% KM (Chebyshev) UCL	9.817
95% Gamma Approximate UCL	20.35		
95% Adjusted Gamma UCL	39.48		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table 15-7b: AOC D8 PAH Soil 95% UCL Concentrations

2-Methylnaphthalene

General Statistics

Number of Valid Data	7	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	1
		Percent Non-Detects	14.29%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.12	Minimum Detected	-2.12
Maximum Detected	40	Maximum Detected	3.689
Mean of Detected	8.877	Mean of Detected	0.482
SD of Detected	15.81	SD of Detected	2.144
Minimum Non-Detect	0.0056	Minimum Non-Detect	-5.185
Maximum Non-Detect	0.0056	Maximum Non-Detect	-5.185

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.654	Shapiro Wilk Test Statistic	0.922
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	7.609	Mean	-0.427
SD	14.82	SD	3.1
95% DL/2 (t) UCL	18.49	95% H-Stat (DL/2) UCL	34908306
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	6.155	Mean in Log Scale	-0.281
SD	15.25	SD in Log Scale	2.812
95% MLE (t) UCL	17.35	Mean in Original Scale	7.61
95% MLE (Tiku) UCL	16.83	SD in Original Scale	14.82
		95% t UCL	18.49
		95% Percentile Bootstrap UCL	17.41
		95% BCA Bootstrap UCL	22.86
		95% H UCL	1776100
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.305	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	29.07		
nu star	3.664		
A-D Test Statistic	0.557	**Nonparametric Statistics**	
5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753	Mean	7.626
5% K-S Critical Value	0.353	SD	13.71
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	5.676
		95% KM (t) UCL	18.66
Assuming Gamma Distribution		95% KM (z) UCL	16.96
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	18.47
Minimum	0.000001	95% KM (bootstrap t) UCL	346.6
Maximum	40	95% KM (BCA) UCL	18.87
Mean	7.609	95% KM (Percentile Bootstrap) UCL	17.45
Median	0.73	95% KM (Chebyshev) UCL	32.37
SD	14.82	97.5% KM (Chebyshev) UCL	43.07
k star	0.212	99% KM (Chebyshev) UCL	64.1
Theta star	35.89		
Nu star	2.968	**Potential UCLs to Use**	
AppChi2	0.363	95% KM (Chebyshev) UCL	32.37
95% Gamma Approximate UCL	62.22		
95% Adjusted Gamma UCL	121		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table 15-8: AOC D8 Outlier Test Results

```
                                  Outlier Tests for Selected Variables
                                User Selected Options
                                            From File    WorkSheet.wst
                                       Full Precision    OFF
         Test for Suspected Outliers with Dixon test                        1
       Test for Suspected Outliers with Rosner test                         2


                        Dixon's Outlier Test for DRO

Number of data = 9
10% critical value: 0.441
5% critical value: 0.512
1% critical value: 0.635

1.  Data Value 8500 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.064

For 10% significance level, 8500 is not an outlier.
For 5% significance level, 8500 is not an outlier.
For 1% significance level, 8500 is not an outlier.

2. Data Value 350 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.039

For 10% significance level, 350 is not an outlier.
For 5% significance level, 350 is not an outlier.
For 1% significance level, 350 is not an outlier.
```

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Table 15-9a: AOC D8 HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	max LOD	modeled from soils data	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	maximum detected conc	modeled from soils data	
Ethylbenzene (c & nc)	maximum detected conc	modeled from soils data	
Xylenes (total) (nc)	maximum detected conc	modeled from soils data	
GRO	95%UCL	modeled from soils data	
DRO	95%UCL	modeled from soils data	
RRO	95%UCL	modeled from soils data	
GRO aromatics	site specific VPH & EPH data	modeled from soils data	
DRO aromatics	site specific VPH & EPH data	modeled from soils data	
RRO aromatics	site specific VPH & EPH data	modeled from soils data	
GRO aliphatics	site specific VPH & EPH data	modeled from soils data	
DRO aliphatics	site specific VPH & EPH data	modeled from soils data	
RRO aliphatics	site specific VPH & EPH data	modeled from soils data	
Acenaphthene (nc)	max measured conc	modeled from soils data	
Acenaphthylene (nc)	max measured conc	modeled from soils data	
Anthracene (nc)	max measured conc	maximum detected conc in 2014	
Benzo(g,h,i)perylene (nc)	max measured conc	maximum detected conc in 2014	
Fluoranthene (nc)	max measured conc	maximum detected conc in 2014	
Fluorene (nc)	max measured conc	modeled from soils data	
Naphthalene (c & nc)	95%UCL	modeled from soils data	
Phenanthrene (nc)	max measured conc	modeled from soils data	
Pyrene (nc)	max measured conc	maximum detected conc in 2014	
Benzo(a)anthracene (c)	max measured conc	maximum detected conc in 2014	
Benzo(b)fluoranthene (c)	max measured conc	maximum detected conc in 2014	
Benzo(k)fluoranthene (c)	max measured conc	maximum detected conc in 2014	
Benzo(a)pyrene (c)	max measured conc	maximum detected conc in 2014	
Chrysene (c)	max measured conc	maximum detected conc in 2014	
Dibenz(a,h)anthracene (c)	max measured conc	maximum detected conc in 2014	
Indeno(1,2,3-cd)pyrene (c)	max measured conc	maximum detected conc in 2014	
1-Methylnaphthalene (nc)	max measured conc	modeled from soils data	
2-Methylnaphthalene (nc)	95%UCL	modeled from soils data	

Hydrocarbon Characterization Data

Hydrocarbon Fractions	Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_{5}-C_{6}	Site specific EPH & VPH data
Aliphatic C_{6}-C_{8}	Site specific EPH & VPH data
Aliphatic C_{8}-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:
BTEX = benzene, toluene, ethylbenzene, xylene
(c) = carcinogen
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
(nc) = non-carcinogen
RRO = residual-range organics

Table 15-9b: AOC D8 HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	**Input Values**			**Source of Data**
bulk density (lbs/ft^3)	125.0538462			D sites average value
specific gravity	2.824666667			D sites average value
moisture content (% by weight)	8.6625			D sites average value
foc	0.005826667			D sites average value
Soil temp (C)	5.3			D sites average value
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt			D sites average value
Hydrogeologic Conditions				
Source length (ft)	90			scaled from site maps
Average precipitation (in/yr)	143.44			NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	7.27E-06			average value of D5 and D6
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8			estimated thickness of the aquifer based on the 2014 boring logs
Infiltration rate (m/yr)	0.7286752			20% of average precipitation
Hydraulic gradient	0.0085			Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1			Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters				
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3			NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth				
depth to groundwater at seasonal low water level at downgradient end of source (ft)	65			Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	6			Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	65			Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	8			Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time				
Soil Direct Contact	1			Site specific conceptual site model
Outdoor Air	1			Site specific conceptual site model
Indoor Air	0			Site specific conceptual site model
Groundwater Ingestion	1			Site specific conceptual site model
Other Input				
ADEC Hazard ID	0			ADEC CS database
Latitude	0			ADEC CS database
Longitude	0			ADEC CS database
Width of Source (ft)	40			scaled from site maps
Area of NAPL contaminated soil source (ft^2)	3600			scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.0085			Measured slope of water table
Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	125.05	125.05	125.05	D sites average value
specific gravity of solids	2.824667	2.824667	2.824667	D sites average value
moisture content (% by weight)	8.66	8.66	8.66	D sites average value
foc	0.005827	0.005827	0.005827	D sites average value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	6.6	0.1	0.1	Site Specific (depth to source minus foundation depth--distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	6.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 15-10: AOC D8 Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	6.65566E-08	0.0067	0.0212
Outdoor air inhalation	8.53327E-09	0.0009	0.0003
Indoor air inhalation (vapor intrusion)	1.2709E-07	0.0127	0.0034
Groundwater Ingestion	1.22577E-06	0.1226	0.5738
Cumulative Risk	**1E-06**	**0.1**	**0.6**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	2.0055E-07	0.0201	0.2408
Outdoor air inhalation	3.7017E-08	0.0037	0.0010
Indoor air inhalation (vapor intrusion)	5.33779E-07	0.0534	0.0141
Groundwater Ingestion	2.0593E-06	0.2059	0.8033
Cumulative Risk	**3E-06**	**0.3**	**1.00**

Notes:
Fraction of Risk values equal to or less than one meet the ADEC risk standard
Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 15-11: AOC D8 Summary of Bulk Fuel Hydrocarbon Risk

	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Fraction of Risk Values				
			Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor intrusion)	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	55	0.197	<1	<1	<1	<1	<1
DRO Aromatics	1480	0.418	<1	<1	<1	<1	5.106
RRO Aromatics	43	0.000	<1	No RfC	No Rfc	<1	<1
GRO Aliphatics	71	0.025	<1	<1	<1	<1	<1
DRO Aliphatics	4644	0.001	<1	<1	<1	<1	<1
RRO Aliphatics	87	0.000	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	55	0.197	<1	<1	<1	<1	<1
DRO Aromatics	1480	0.418	<1	<1	<1	<1	7.148
RRO Aromatics	43	0.000	<1	No Rfc	No Rfc	<1	<1
GRO Aliphatics	71	0.025	<1	<1	<1	<1	<1
DRO Aliphatics	4644	0.001	<1	<1	<1	<1	<1
RRO Aliphatics	87	0.000	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics

GRO = gasoline-range organics

mg/kg = milligrams per kilogram

Table 15-12: AOC D8 Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
1-Methylnaphthalene (nc)	20	6.2	MTGW	10	MTGW	20	NA	87	MTGW
2-Methylnaphthalene (nc)	40	6.1	MTGW	10	MTGW	32	NA	72	MTGW
total DRO	8500	230	MTGW	1200	MTGW	6124	12500	10939	Soil Direct Contact

Notes:
ACL = alternate cleanup level
(c) = carcinogen
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
MTGW = migration to groundwater
NA = not applicable
(nc) = non-carcinogen

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16.0 AOC M3 – AIR CORPS INCREASE GROUP NO. 1 – 50 KW POWERHOUSE – NO. 520

16.1 AREA DESCRIPTION AND BACKGROUND

AOC M3, referred to as the Air Corps Increase Group No. 1 Powerhouse – No. 520, is located in a heavily wooded area northwest of Cannon Beach Road. The site was accessed from the north via a cleared road/path at the end of State Camp Road. According to the USACE Yakutat Landing Field Alaska Utilities Layout A.C. Expansion Area engineering design drawing (28 June 1943), AOC M3 was the location of a 50 kW Powerhouse, identified as Building No. 520. A metal Quonset hut is located in a small clearing at the end of the access road and is the only building structure currently at the site. Two former ASTs were depicted south of the powerhouse on engineering design plans. These ASTs have been removed and only the concrete tank saddles and a few lengths of steel pipe remain. The exact removal date of the ASTs is unknown.

During a Supplemental RI conducted at the site in 2010, surface and subsurface soil samples were collected at the perimeter of the existing Quonset hut. Benzo(a)pyrene was detected in one surface soil sample above the ADEC Method Two cleanup level (0.4 mg/kg) at a concentration of 0.84 mg/kg. Constituents detected in groundwater samples did not exceed the ADEC Table C cleanup criteria (S&W 2012).

Data from previous investigations, along with field screening results and visual observations, were reviewed to select appropriate sampling locations and target depths to evaluate potential soil impacts at AOC M3. Historical sample locations are shown on Figure 16-1.

16.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC M3 included:

- Evaluate the vertical and horizontal extent of PAHs in soil above the ADEC Method Two cleanup levels at the 50 kW Powerhouse and perform a visual inspection to determine a potential PAH contamination source.
- Determine whether POL-contaminated soil is associated with the concrete saddles at the 50 kW Powerhouse and evaluate the nature and extent of contamination, if present.

16.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at AOC M3 included advancement of soil borings and collection of soil samples. These activities are described below.

16.3.1 Soil

Data collected at the 50 kW Powerhouse during previous RIs indicate that benzo(a)pyrene was detected at concentrations exceeding the ADEC Method Two cleanup level in surface soil (M3SS01) near the entrance to the existing Quonset hut. A visual inspection of the area was conducted to identify potential PAH sources, including fire rings, wood piles, ash piles, charcoal, or other evidence of recreational activities. There was no evidence of non-FUDS related activity or potential sources of PAHs identified. Five soil borings were advanced at and around the historical benzo(a)pyrene soil exceedance to delineate the single PAH hit: two samples from M3-SB01 and SB04 to delineate the impacts laterally and vertically, and one each from M3-SB02, SB03 and SB05 to define the lateral extent of impacts. Each sample was submitted for laboratory analysis of PAHs.

POL investigation activities included advancing ten soil borings (M3-SB06 through SB15) around the concrete tank saddles adjacent to the southeast side of the Quonset hut. Sampling locations were selected in the field based on field observations and are shown on Figure 16-1. Based on field screening results for volatile organics, three additional borings (M3-SB16 through SB18) were advanced for lateral delineation of potential impacts. Soil samples collected for laboratory analysis were selected from the two intervals with the highest screening values (M3-SB06 and SB10) to characterize soil impacts, and a second sample was collected deeper from M3-SB06 for vertical delineation of potential impacts. Soil samples retained for laboratory analysis were analyzed for GRO, BTEX, DRO, RRO and PAHs.

16.4 ANALYTICAL RESULTS

At the southern end of the 50 kW Powerhouse Quonset hut, surface soil samples were collected from five locations to resample/confirm a benzo(a)pyrene soil exceedance at historical location M3SS01 and determine the extent of the soil impacts, if currently present. Benzo(a)pyrene was detected at four of the five sample locations and all PAH concentrations detected in the samples, including benzo(a)pyrene, were below the ADEC Method Two cleanup levels. Benzo(a)pyrene concentrations range from 0.005 to 0.31 mg/kg, and the highest concentration was at the resampled historical exceedance. Results indicate that the previous benzo(a)pyrene concentration above the Method Two cleanup level was an isolated occurrence.

Field screening samples were collected from 13 soil borings around the former AST tank saddles to determine the potential presence and extent of POLs in soil. Analytical results (Appendix J) show that DRO was detected in soil above the Method Two cleanup level at concentrations up to 3,300 mg/kg, and RRO exceeded the Method Two cleanup level in a duplicate sample at a concentration of 9,300 mg/kg. No other constituent concentrations exceeded Method Two cleanup levels at AOC M3. Results of samples submitted for delineation of POL impacts were below cleanup levels, defining the extent of these impacts. Historical and current (2014) DRO concentrations in soil and PID field screening results at AOC M3 are presented on Figure 16-1.

16.5 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at AOC M3. A site-specific risk assessment was not conducted for this AOC based on limited availability of site-specific input parameters. However, human health cumulative risk was evaluated using the Online Calculator (ADEC 2008b) and environmental risk was considered through the ADEC ecological scoping process (ADEC 2014). Additionally, 95% UCLs were calculated for DRO and RRO and compared to Method Two cleanup levels to evaluate representative site-wide human health exposure scenarios.

16.5.1 Potential Exposure Pathways and Pathways Complete at the Present Time

The AOC M3 exposure human health pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

To meet the ADEC “Cleanup Complete” criteria, the AOC M3 risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include, direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion). However, the groundwater pathway is considered insignificant based on all currently available chemical data showing concentrations below 1/10th Table C groundwater cleanup levels (ADEC 2010b). Insignificant pathways are not carried forward in the evaluation of risk. Likewise, the migration to groundwater contaminant transport mechanism is considered minimal and not evaluated further.

Pathways complete at the present time include direct contact or ingestion of contaminants in soil and outdoor air inhalation, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered incomplete at the present time, based on the absence of occupied buildings within 30 feet of the AOC M3 source area. Surface water and sediment pathways are considered incomplete since there are no surface water bodies in the vicinity of the site that could be impacted from migration of contaminants.

16.5.2 Cumulative Risk Evaluation

Cumulative risk was calculated at AOC M3 using the Online Calculator. The evaluation was conducted following the ADEC *Cumulative Risk Guidance* (ADEC 2008b). Cumulative risk was calculated using all site data with the exception of arsenic, which is considered naturally occurring in background based on lack of a known anthropogenic source at this site (ADEC 2009a). Petroleum hydrocarbons (GRO, DRO, RRO) were also excluded from cumulative risk and evaluated separately per the ADEC guidance (ADEC 2008b, see Section 16.5.3). In addition, PAH data from historical sample M3SS01 were excluded since this area was resampled in 2014. Per the ADEC guidance, the maximum concentrations of each COPC were applied as exposure point concentrations for the cumulative risk calculation. Results show a cumulative HI an order of magnitude below the ADEC risk benchmark and the cumulative cancer risk meets the ADEC risk standard of 1×10^{-5}. The cumulative risk calculation results are also within the allowable risk range (1×10^{-4} to 1×10^{-6}) provided in the EPA *National Oil and Hazardous Substances Pollution Contingency Plan* (40 CFR §300.430(e)(2)). The Online Calculator input and output sheet is available in Appendix M.

16.5.3 Petroleum Hydrocarbon Evaluation

Petroleum hydrocarbon indicator compounds incorporated into the cumulative risk calculation, discussed above, show acceptable risk. However, risk associated with petroleum hydrocarbon fractions was evaluated separately. To evaluate risk associated with DRO and RRO at AOC M3, calculations of 95% UCLs were performed to generate statistically derived exposure point concentrations and compared to default risk-based concentrations identified in Method Two.

Detections for DRO and RRO soil analytical results were compiled in ProUCL and run to calculate 95% UCLs. The 95% UCL of the population mean for analytical detections can be used as the representative concentration for receptor (e.g. human) exposure to contamination remaining at the site (see Section 4.1.2). DRO and RRO were analyzed for all distributions, based on 12 samples with detections for DRO and 13 samples with detections for RRO; the output can be found in Table 16-1. Based on a nonparametric distribution at the 5% significance level, the 95% UCL recommended by ProUCL for DRO was at a concentration of 4,397 mg/kg. Since this value is higher than the maximum site concentration encountered at AOC M3, the maximum DRO concentration was used to evaluate exposure. The RRO analytical results also showed a nonparametric distribution, which provided a ProUCL recommended 95% UCL of 7,902 mg/kg. This concentration was used to evaluate exposure to RRO.

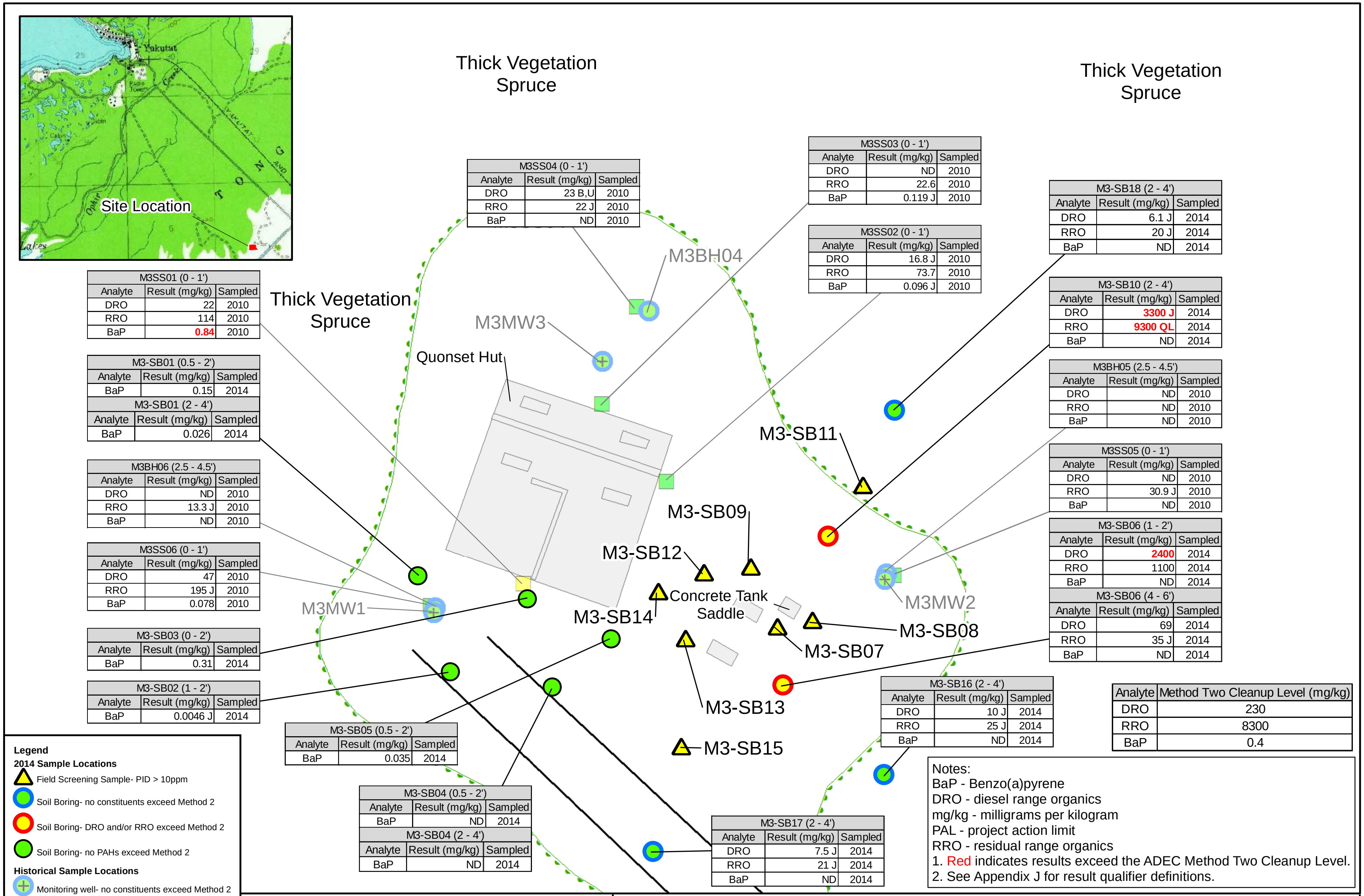
As noted above in Section 16.5.1, exposure pathways considered complete for evaluation of risk include direct contact / ingestion and inhalation of contaminants in soil across the site; this was defined as an approximately 6,000 square feet area encompassing detected DRO and RRO in soil and reworked ground conditions. The ADEC risk-based Method Two cleanup levels protective of the complete and significant pathways were compared to the site DRO and RRO soil exposure point concentrations. The maximum detected concentration of DRO in soil was 3,300 mg/kg, less than the applicable Method Two cleanup level of 8,250 mg/kg. The RRO 95% UCL was calculated to be 7,902 mg/kg, representative of site-wide exposure, and less than the applicable Method Two cleanup level of 8,300 mg/kg. This indicates that the representative concentrations for contamination at AOC M3 do not pose unacceptable risk for direct contact / ingestion or inhalation, since they are lower than the risk-based levels. Therefore, although exposure pathways are complete, they are either insignificant (groundwater) or do not pose unacceptable risk to potential current or future receptors at AOC M3.

16.6 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at AOC M3 was evaluated and a preliminary ecological CSM developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. Detected constituents (metals and PCBs) are included in the ecoscoping discussion below; however, since these compounds were not detected above the ADEC Method Two soil cleanup levels, they were not discussed in previous sections. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at AOC M3 are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.
- There are no surface water bodies in the vicinity that could be impacted from migration of contaminants.
- Hydrocarbon (DRO) and PAH contamination is localized in surface and shallow subsurface soil. Although moose and/or bears and other wildlife may traverse the area, the overall footprint of the area is small (< 3,600 ft^2 or 0.08 acre) relative to the foraging ranges of these and even smaller prey animals (e.g., mice). Therefore, potential ecological exposure, while possibly complete in the AOC M3 area, is expected to be insignificant.
- Low levels of several bioaccumulative metals have been detected in surface soil (S&W 2012). However, these metals are likely attributed to natural conditions and, therefore, are not considered further in the evaluation.
- For PCBs, detections are localized to few sample locations (S&W 2012) and significant exposure is not anticipated in these areas; therefore, an off-ramp is proposed. Although the potential for exposure exists in this area, sensitive receptors are unlikely to be present or obtain resources from these areas alone. Based on a preliminary estimate of soil concentrations protective of ecological receptors using the ecological risk equation per the EPA guidance (2005) (re-arranged to calculate a protective soil concentrations) for the short-tailed shrew (a maximally exposed receptor for bioaccumulative chemicals), a protective concentration of 0.7 mg/kg in soil is estimated. This assumes that there are no observed adverse effect level toxicity data (0.137 mg/kg-day per Toxicological Benchmarks for Wildlife [Sample et al. 1996]), which is typically applied for screening while considering typical diet (invertebrates, plants and small animals) and home range (0.39 hectares), as reported in the Wildlife Exposure Factors Handbook (EPA 1993). When considering the lowest observed adverse effect level (0.685 mg/kg-day per Sample et al., 1996), with all else held constant, the resulting protective soil level is 3.3 mg/kg. While preliminary, these estimates demonstrate that exposure to PCBs by wildlife at AOC M3 is not likely significant as reported PCB concentrations are comparable to or below these protective, site-specific levels.
- Risk to the environment has been evaluated using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation is not needed and AOC M3 site conditions are protective of the environment.



M3SS01 (0 - 1')		
Analyte	Result (mg/kg)	Sampled
DRO	22	2010
RRO	114	2010
BaP	**0.84**	2010

M3-SB01 (0.5 - 2')		
Analyte	Result (mg/kg)	Sampled
BaP	0.15	2014

M3-SB01 (2 - 4')		
Analyte	Result (mg/kg)	Sampled
BaP	0.026	2014

M3BH06 (2.5 - 4.5')		
Analyte	Result (mg/kg)	Sampled
DRO	ND	2010
RRO	13.3 J	2010
BaP	ND	2010

M3SS06 (0 - 1')		
Analyte	Result (mg/kg)	Sampled
DRO	47	2010
RRO	195 J	2010
BaP	0.078	2010

M3-SB03 (0 - 2')		
Analyte	Result (mg/kg)	Sampled
BaP	0.31	2014

M3-SB02 (1 - 2')		
Analyte	Result (mg/kg)	Sampled
BaP	0.0046 J	2014

M3SS04 (0 - 1')		
Analyte	Result (mg/kg)	Sampled
DRO	23 B,U	2010
RRO	22 J	2010
BaP	ND	2010

M3SS03 (0 - 1')		
Analyte	Result (mg/kg)	Sampled
DRO	ND	2010
RRO	22.6	2010
BaP	0.119 J	2010

M3SS02 (0 - 1')		
Analyte	Result (mg/kg)	Sampled
DRO	16.8 J	2010
RRO	73.7	2010
BaP	0.096 J	2010

M3-SB18 (2 - 4')		
Analyte	Result (mg/kg)	Sampled
DRO	6.1 J	2014
RRO	20 J	2014
BaP	ND	2014

M3-SB10 (2 - 4')		
Analyte	Result (mg/kg)	Sampled
DRO	**3300 J**	2014
RRO	**9300 QL**	2014
BaP	ND	2014

M3BH05 (2.5 - 4.5')		
Analyte	Result (mg/kg)	Sampled
DRO	ND	2010
RRO	ND	2010
BaP	ND	2010

M3SS05 (0 - 1')		
Analyte	Result (mg/kg)	Sampled
DRO	ND	2010
RRO	30.9 J	2010
BaP	ND	2010

M3-SB06 (1 - 2')		
Analyte	Result (mg/kg)	Sampled
DRO	**2400**	2014
RRO	1100	2014
BaP	ND	2014

M3-SB06 (4 - 6')		
Analyte	Result (mg/kg)	Sampled
DRO	69	2014
RRO	35 J	2014
BaP	ND	2014

M3-SB05 (0.5 - 2')		
Analyte	Result (mg/kg)	Sampled
BaP	0.035	2014

M3-SB04 (0.5 - 2')		
Analyte	Result (mg/kg)	Sampled
BaP	ND	2014

M3-SB04 (2 - 4')		
Analyte	Result (mg/kg)	Sampled
BaP	ND	2014

M3-SB16 (2 - 4')		
Analyte	Result (mg/kg)	Sampled
DRO	10 J	2014
RRO	25 J	2014
BaP	ND	2014

M3-SB17 (2 - 4')		
Analyte	Result (mg/kg)	Sampled
DRO	7.5 J	2014
RRO	21 J	2014
BaP	ND	2014

Analyte	Method Two Cleanup Level (mg/kg)
DRO	230
RRO	8300
BaP	0.4

Legend

2014 Sample Locations

- ▲ Field Screening Sample- PID > 10ppm
- ● Soil Boring- no constituents exceed Method 2
- ● Soil Boring- DRO and/or RRO exceed Method 2
- ● Soil Boring- no PAHs exceed Method 2

Historical Sample Locations

- ⊕ Monitoring well- no constituents exceed Method 2
- ● Soil Boring- no constituents exceed Method 2
- 🟨 Surface Soil Sample - PAHs exceed Method 2
- 🟩 Surface soil sample- no PAHs exceed Method 2
- 🟥 Estimated NAPL Source Area
- ▭ Former 50 kW Powerhouse - No. 520
- — Former Road
- ⁀ Edge of Vegetation

Notes:
BaP - Benzo(a)pyrene
DRO - diesel range organics
mg/kg - milligrams per kilogram
PAL - project action limit
RRO - residual range organics
1. Red indicates results exceed the ADEC Method Two Cleanup Level.
2. See Appendix J for result qualifier definitions.

N
W
E
S

FIGURE 16-1

AOC M3
Soil Analytical Results

US Army Corps
of Engineers
Alaska District

0 10 20
Feet
1 in = 20 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 3/29/2016

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Table 16-1: AOC M3 DRO RRO Soil 95% UCL Concetrations

ProUCL Input File

DRO	RRO
6.1	20
7.5	21
10	25
16.8	73.7
22	114
23	22
47	195
69	35
2400	1100
3300	9300
	0.119
	30.9
	13.3

ProUCL Output File

General UCL Statistics for Full Data Sets

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

DRO

General Statistics

Number of Valid Observations	10	Number of Distinct Observations	10

Raw Statistics		**Log-transformed Statistics**	
Minimum	6.1	Minimum of Log Data	1.808
Maximum	3300	Maximum of Log Data	8.102
Mean	590.1	Mean of log Data	3.914
Geometric Mean	50.11	SD of log Data	2.254
Median	22.5		
SD	1210		
Std. Error of Mean	382.6		
Coefficient of Variation	2.05		
Skewness	1.912		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.551	Shapiro Wilk Test Statistic	0.801
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1292	95% H-UCL	58337
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1454
95% Adjusted-CLT UCL (Chen-1995)	1467	97.5% Chebyshev (MVUE) UCL	1930
95% Modified-t UCL (Johnson-1978)	1330	99% Chebyshev (MVUE) UCL	2865

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.264	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	2232		
MLE of Mean	590.1		
MLE of Standard Deviation	1148		
nu star	5.287		
Approximate Chi Square Value (.05)	1.287	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0267	95% CLT UCL	1219
Adjusted Chi Square Value	0.979	95% Jackknife UCL	1292
		95% Standard Bootstrap UCL	1186
Anderson-Darling Test Statistic	1.531	95% Bootstrap-t UCL	34168
Anderson-Darling 5% Critical Value	0.821	95% Hall's Bootstrap UCL	24701
Kolmogorov-Smirnov Test Statistic	0.379	95% Percentile Bootstrap UCL	1243
Kolmogorov-Smirnov 5% Critical Value	0.289	95% BCA Bootstrap UCL	1387
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2258
		97.5% Chebyshev(Mean, Sd) UCL	2980
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	4397
95% Approximate Gamma UCL (Use when n >= 40)	2424		
95% Adjusted Gamma UCL (Use when n < 40)	3188		

Potential UCL to Use	Use 99% Chebyshev (Mean, Sd) UCL	4397

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Table 16-1: AOC M3 DRO RRO Soil 95% UCL Concetrations

RRO

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.119	Minimum of Log Data	-2.129
Maximum	9300	Maximum of Log Data	9.138
Mean	842.3	Mean of log Data	3.865
Geometric Mean	47.7	SD of log Data	2.596
Median	30.9		
SD	2558		
Std. Error of Mean	709.5		
Coefficient of Variation	3.037		
Skewness	3.526		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.373	Shapiro Wilk Test Statistic	0.892
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2107	95% H-UCL	131198
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2878
95% Adjusted-CLT UCL (Chen-1995)	2751	97.5% Chebyshev (MVUE) UCL	3835
95% Modified-t UCL (Johnson-1978)	2223	99% Chebyshev (MVUE) UCL	5714
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.242	**Data appear Lognormal at 5% Significance Level**	
Theta Star	3483		
MLE of Mean	842.3		
MLE of Standard Deviation	1713		
nu star	6.288		
Approximate Chi Square Value (.05)	1.789	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	2009
Adjusted Chi Square Value	1.469	95% Jackknife UCL	2107
		95% Standard Bootstrap UCL	1974
Anderson-Darling Test Statistic	1.636	95% Bootstrap-t UCL	40656
Anderson-Darling 5% Critical Value	0.85	95% Hall's Bootstrap UCL	26896
Kolmogorov-Smirnov Test Statistic	0.309	95% Percentile Bootstrap UCL	2250
Kolmogorov-Smirnov 5% Critical Value	0.259	95% BCA Bootstrap UCL	2977
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3935
		97.5% Chebyshev(Mean, Sd) UCL	5273
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	7902
95% Approximate Gamma UCL (Use when n >= 40)	2961		
95% Adjusted Gamma UCL (Use when n < 40)	3605		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	7902

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

17.0 AIR CORPS INCREASE GROUP NO. 1 - 400 KW POST POWERHOUSE – NO. 564

17.1 AREA DESCRIPTION AND BACKGROUND

A second powerhouse (400 kW Post Powerhouse – No. 564) was identified on the Yakutat Army Air Base Alaska Utilities Layout Air Corps Expansion asbuilt (27 July 1942). The remains of this powerhouse were identified approximately 900 feet north of the former 50 kW Powerhouse (AOC M3) as shown on Figure 17-1. At the request of the USFS, the powerhouse was not removed during the 1984 USACE restoration activities.

17.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for AOC M3 included determining the location of a former 400 kW Post Powerhouse reportedly located approximately 900 feet north of AOC M3, and performing a visual inspection of the powerhouse to identify potential sources and/or evidence of contamination.

17.3 SUMMARY OF FIELD WORK

The MLA survey crew was utilized to locate the 400 kW Post Powerhouse, approximately 900 feet north of the AOC M3 50 kW Powerhouse (Figure 17-1). Building remnants and various debris were identified at the presumed location. A visual inspection was performed to identify remaining features, potential POL sources, and any visible evidence of contamination. A foundation approximately 75 feet x 51 feet appeared to be the primary feature of a collapsed building. The building foundation and debris were moss covered, and the surrounding area was heavily vegetated. Downed trees made visual inspection difficult. The primary features observed are shown on Figure 17-1 and included:

- An approximate 75 feet x 51 feet block foundation
- Collapsed wood debris throughout the majority of the northern and western half of the foundation
- A possible heat exchanger and associated piping at the northwest corner of the building
- Two partially collapsed chimneys along the western wall of the foundation
- A single doorway entrance on the north side of the foundation
- A larger opening within the block foundation on the south side of the foundation
- Two pipes exiting the southwest corner of the foundation and a possible drain pipe
- A large diameter corrugated pipe/hole outside the west foundation wall
- A ‘spark arrester’ (identified by name plate) on the ground outside to the northeast
- Four empty, partial or intact drums (one northeast and three south-southwest of the foundation)
- Various metal debris approximately 25 feet south of the foundation opening
- Various metal debris approximately 35 feet southwest of the southwest foundation corner

No visual evidence of soil contamination was observed; however, as previously stated, the area is heavily vegetated and moss covers a large portion of the ground and debris. Features of the former 400 kW Post Powerhouse and the surrounding area were photo documented (Appendix A). Based on the building’s historical use as a powerhouse and the features identified during the visual inspection, it is recommended that further investigation be conducted at this site.

The remnants of two collapsed Quonset huts (possibly former living quarters) were noted to the west-southwest of the former 400 kW Post Powerhouse. A small concrete pad was located near the Quonset huts; however, the purpose for the pad (tank or other) could not be determined.

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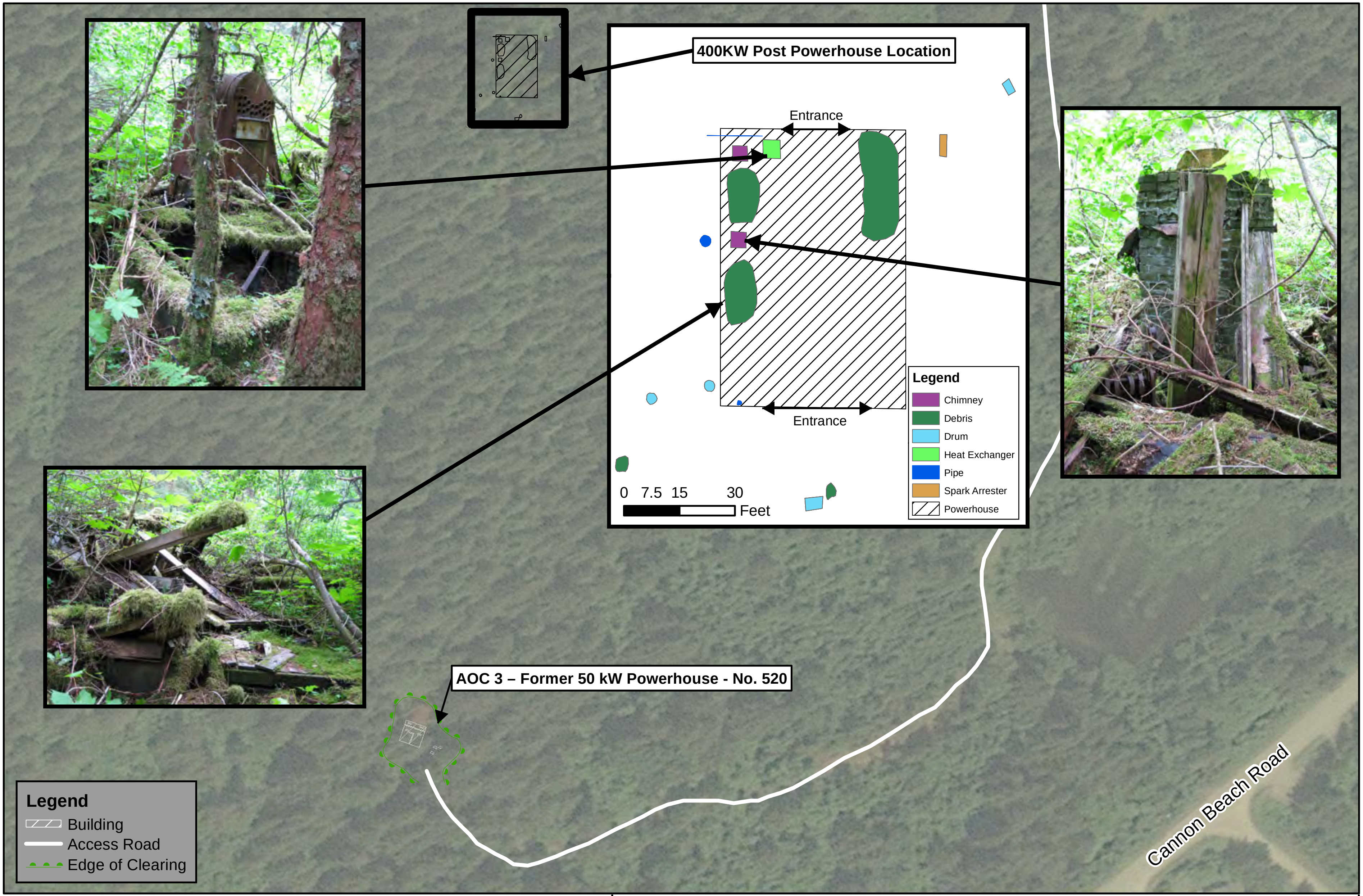

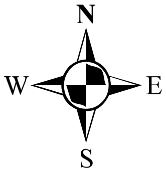

FIGURE 17-1

400 KW Post Powerhouse Site Location Map

US Army Corps
of Engineers
Alaska District

0 50 100
Feet
1 in = 167 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 3/30/2016

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18.0 AOC O1 – AIR CORPS WAREHOUSE GROUP NO. 2 – SUSPECTED DRUM DUMP

18.1 AREA DESCRIPTION AND BACKGROUND

AOC O1 is the location of a suspected drum dump at the former Air Corps Warehouse Group No. 2. The four structures that originally made up the Warehouse Group were moved from Yakutat to Whittier after the air base was declared surplus in 1945. Three empty, rusted 55-gal drums are located on, or near, the foundation, which is located adjacent to a small stream/drainage ditch. The banks of the adjacent stream are generally steep and heavily wooded. A small side tributary enters the stream from the southwest approximately 200 feet from the site (concrete foundation).

A previous investigation conducted at the site in 2001 detected arsenic in surface and subsurface soils above the ADEC Method Two soil cleanup level at concentrations ranging from 1.96 mg/kg to 15 mg/kg; however, only two surface samples had concentrations exceeding the background level (11.6 mg/kg) for the region (ENSR 2003b). No other analytes exceeded the ADEC Method Two soil cleanup levels. Lead was detected in groundwater at concentrations up to 0.0452 mg/L, which is above the ADEC Table C groundwater cleanup level of 0.015 mg/L. The elevated lead levels were likely caused by suspended solids associated with turbidity in the sample, resulting from purging and sampling using a bailer (ENSR 2003b). Subsequent groundwater samples collected from wells AP-100 and AP-099 in 2004 show that lead was not detected in groundwater at either location (S&W 2006a).

Two surface water samples collected from the stream/drainage ditch adjacent to the site had lead concentrations of 0.0127 mg/L and 0.0128 mg/L, which exceed the NOAA SQuiRT Freshwater Chronic value of 0.0025 mg/L. One sample was collected less than 50 feet downstream (south) of the concrete foundation and the second sample was collected approximately 200 feet downstream (southwest) of the concrete foundation, at the confluence of a side stream that reportedly drains the AOC O1 drum dump area (ENSR 2003b). Historical surface water sample locations for AOC O1 are shown on Figure 18-1.

18.2 DATA COLLECTION OBJECTIVES

Data collection objectives for AOC O1 included determining the current surface water concentrations of total and dissolved lead and hardness upstream and downstream of the site, and identifying possible contaminant sources.

18.3 SUMMARY OF FIELD WORK

Two surface water samples collected from a stream/drainage ditch adjacent to AOC O1 were found to have lead concentrations that exceeded the NOAA SQuiRT most stringent screening value. Supplemental RI activities included the collection of five surface water samples the length of the stream in the vicinity of AOC O1: two samples downstream of the site at locations with previous lead exceedances (O1-WS01 and WS02), one sample (O1-WS03) further downstream approximately 200 feet southwest of the confluence with the side channel, and two samples upstream to the northeast of the concrete foundation (O1-WS04 and WS05). Surface water sampling locations are shown on Figure 18-1. Surface water samples were collected using a peristaltic pump with dedicated tubing.

18.4 ANALYTICAL RESULTS

Surface water samples collected at AOC O1 were analyzed for total lead, dissolved lead, and hardness. Dissolved lead data were compared to a hardness-dependent Alaska WQS value calculated at 0.00293 mg/L based on average hardness for the studied water body. Total lead data were compared to the Table C groundwater cleanup level of 0.015 mg/L. Total and dissolved lead were not detected at any of the five surface water sample locations. The corresponding LODs are below the calculated Alaska WQS criterion. Analytical results indicate that lead is currently not present above risk-based standards in the stream/drainage ditch adjacent to AOC O1. Surface water lead results are presented in a summary table in Appendix J and shown on Figure 18-1.

18.5 HUMAN HEALTH RISK EVALUATION

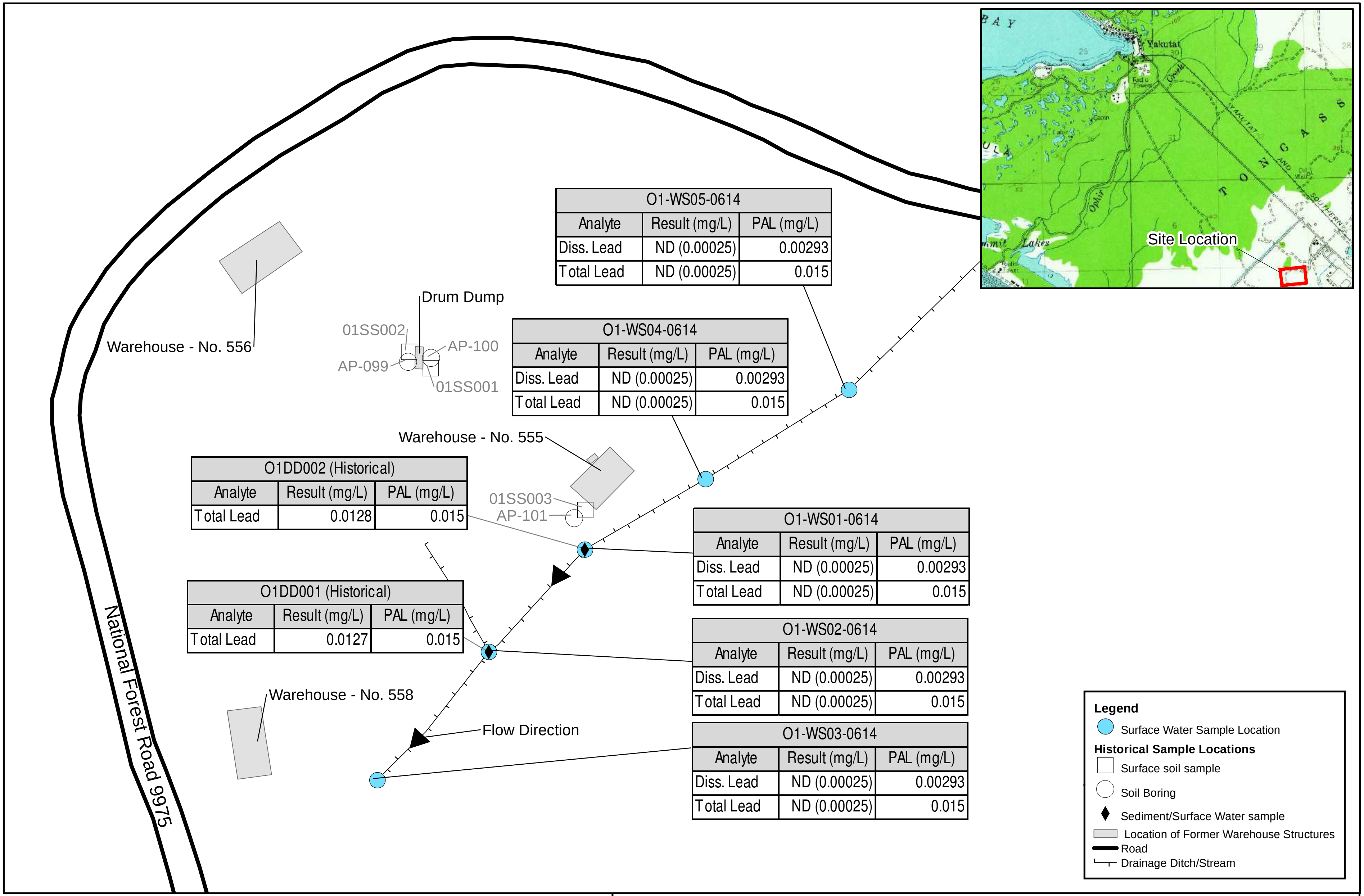
Concerns of previous lead detections in groundwater and surface water were re-evaluated in 2004 and 2014, respectively. Sample results show that lead was not detected in groundwater or surface water at AOC O1 during these sampling events. Further evaluation of risk to human health was not required and a CSM was not developed for this site.

18.6 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at AOC O1 was evaluated and a preliminary ecological CSM developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. Detected constituents (petroleum hydrocarbons, metals, PCBs and 4,4-DDT) are included in the ecoscoping discussion below; however, since these compounds were not detected above the ADEC Method Two soil cleanup levels, they were not discussed in previous sections. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at AOC O1 are protective of the environment:

- No visible surface soil staining or distressed vegetation or other signs of direct impacts have been observed at the site.
- Petroleum hydrocarbons in surface soil cover a 30 x 40 feet area, which is less than the ADEC 0.5 acre *de minimis* criterion. Review of soil data indicates that chemical impacts (for petroleum related and non-petroleum related compounds) are localized and predominately detected at one sample location (ENSR 2003a). Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.
- Low levels of several bioaccumulative metals have been detected in surface soil (ENSR 2003a). However, these metals are likely attributed to natural conditions and, therefore, are not considered further in the evaluation.
- Surface soil samples collected in 2001 showed low-level detections of PCBs and 4,4’-DDT (ENSR 2003a). However, PCBs and DDT were detected at one sample location O1SS003 and were J-flagged and detected only marginally above the laboratory detection limit (but below the method reporting limit), and consequently their detected levels may be an artifact of analytical imprecision. Further, the detected concentrations (and non-detected concentrations here and at other locations) were well below applicable screening levels: PCBs= 0.020 mg/kg, per the EPA Region IV Soil Screening Values and DDT= 0.0035 mg/kg per the EPA Region V Ecological Screening Levels. No other detections were noted.
- Although drainage ditches associated with the site are intermittent, surface water in the main ditch was evaluated to determine if the surface water originating near the site (via groundwater seepage) could serve as a potential source to stream/ditch water and ultimately confluent systems downstream. Analytical results indicate that lead is currently not present above ecological risk-based standards in the stream/drainage ditch adjacent to AOC O1 and that pathways to aquatic receptors are incomplete.
- Risk to the environment has been evaluated using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation is not needed and AOC O1 site conditions are protective of the environment.



O1-WS05-0614		
Analyte	Result (mg/L)	PAL (mg/L)
Diss. Lead	ND (0.00025)	0.00293
Total Lead	ND (0.00025)	0.015

O1-WS04-0614		
Analyte	Result (mg/L)	PAL (mg/L)
Diss. Lead	ND (0.00025)	0.00293
Total Lead	ND (0.00025)	0.015

O1DD002 (Historical)		
Analyte	Result (mg/L)	PAL (mg/L)
Total Lead	0.0128	0.015

O1-WS01-0614		
Analyte	Result (mg/L)	PAL (mg/L)
Diss. Lead	ND (0.00025)	0.00293
Total Lead	ND (0.00025)	0.015

O1DD001 (Historical)		
Analyte	Result (mg/L)	PAL (mg/L)
Total Lead	0.0127	0.015

O1-WS02-0614		
Analyte	Result (mg/L)	PAL (mg/L)
Diss. Lead	ND (0.00025)	0.00293
Total Lead	ND (0.00025)	0.015

O1-WS03-0614		
Analyte	Result (mg/L)	PAL (mg/L)
Diss. Lead	ND (0.00025)	0.00293
Total Lead	ND (0.00025)	0.015

Notes:
mg/L – milligrams per liter
ND – analyte not detected above the detection limit shown in ( )
PAL – Project Action Limit
1. Surface water PAL derived from ADEC Table C drinking water standard for total lead and hardness-dependant Alaska Water Quality Standard (chronic) for dissolved lead.
2. Historical samples O1DD001 and O1DD002 collected in October 2001.

N
W E
S

FIGURE 18-1

AOC O1
Surface Water Analytical Results

US Army Corps
of Engineers
Alaska District

0 50 100
Feet
1 in = 150 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 3/17/2016

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19.0 AACS – ARMY AIRWAYS COMMUNICATIONS SYSTEM RECEIVER STATION POWERHOUSE – NO. 1202

19.1 AREA DESCRIPTION AND BACKGROUND

The AACS site was the location of the Remote Receiver Station Powerhouse - No. 1202, which a 1944 Engineer Narrative Report described as “a 24’ x 60’ Quonset, occupied jointly by the AACS, ACS, and CAA.” This site has been labeled AACS “Transmitter” on some maps, and was referred to as the “AACS Transmitter Station” in the 2010 Supplemental RI. According to the 1984 Environmental Restoration Defense Account Debris Cleanup and Site Restoration Design, buildings in the AACS area were demolished, buried in excavation pits, and covered with soil (USACE 1984). Currently, the only evidence of structures at the AACS are two concrete tank saddles at the center of the site and two rusted drums located in standing water at the northern edge of the site in a low-lying marsh area. This appears to be the northern extent of the surface water leading to an overflow ditch that parallels the west side of the access trail to the site. There is little to no flow in this ditch near the site. Another stream flowing north to south parallels the east side of the access trail but continues north away from the site near the entrance to the AACS.

During a previous RI, surface soil, sediment, surface water, and groundwater samples were collected at the AACS. One surface soil sample had DRO above the ADEC Method Two cleanup level (230 mg/kg) at a concentration of 706 mg/kg. Barium was detected in surface water at a concentration of 0.021 mg/L, which exceeded the 0.0039 mg/L NOAA SQuiRT screening level. Constituent concentrations detected in groundwater were below the applicable cleanup levels (S&W 2012). Historical sample locations are shown on Figure 19-1.

19.2 DATA COLLECTION OBJECTIVES

Specific data collection objectives for the AACS included:

- Evaluate the extent of POL-contaminated soil found near the concrete saddle identified in the 2010 RI.
- Collect supplemental soil data to further characterize the contaminant source zone and determine the soil risk-based ACLs using the Online Calculator and the HRC (18 AAC Section 75.340).
- Identify the possible source of elevated barium concentrations previously identified in surface water, evaluate current surface water conditions, and determine the upgradient and downgradient barium concentrations in surface water.

19.3 SUMMARY OF FIELD WORK

Supplemental RI activities performed at the AACS included advancement of soil borings and collection of soil and surface water samples. These activities are described below by media.

19.3.1 Soil

Supplemental RI activities proposed advancing up to 16 soil borings in the vicinity of two existing concrete saddles and a former building to delineate impacts, laterally and vertically, and obtain data for the HRC. With the exception of the two concrete saddles, no evidence of a building structure was observed during the investigation. Subsurface soils at the site consist of a surficial layer (approximately 3 inches) of peat over fine to coarse sand with gravel, with fine to medium sand from 0.3 to 2 feet in some borings. Soil boring logs are included in Appendix C.

Field screening samples were collected from each boring and screened for volatile organics using a PID. These results indicated that impacted soils are limited to a small isolated area at the end of the westernmost tank saddle. Since no other soils appeared to be impacted based on field screening and there was no evidence of former operations in other areas at the site, only twelve borings were advanced to delineate potential impacts (Figure 19-1). Soil samples collected for laboratory analysis were selected from the single boring with elevated PID readings (AA-SB05) and surrounding borings for delineation. Boring AA-SB09 was also advanced at the location with historical surface soil impacts. Two samples were collected from borings AA-SB05 and SB09, and one sample each was collected from five additional boring locations. A sample from 4 to 6 feet bgs was attempted at AA-SB05 for vertical delineation; however, continual collapse of the borehole within the water table prevented collection of representative soils at this interval.

Soil samples collected at the site were analyzed for GRO, DRO, RRO, BTEX, and PAHs. Since only soil at AA-SB05 had any evidence of contamination, only the two samples from this boring were submitted for VPH and EPH analyses to be applied toward the HRC.

BACKGROUND SOIL CONDITIONS

Soil borings were also advanced at the perimeter of the site to collect background soil data (i.e., chemical, TOC and physical parameters) for input into the HRC. Background boring locations were selected in the field based on proximity to localized impacts and field screening results. Since field screening samples from perimeter borings AA-SB01 and SB12 did not show any evidence of impacts, these two locations were incorporated into the background investigation as AA-BG01 (SB01) and AA-BG03 (SB12). Soil samples were collected from the 0 to 2-feet and 2 to 4-feet intervals representative of the impacted soils at the site. Samples were analyzed for GRO, DRO/RRO, DRO/RRO with SGC, TOC, and physical parameters (grain size, bulk density, moisture content, and specific gravity). Results of the background chemical analyses are presented in the Appendix J summary tables. Geotechnical data are summarized in Table 4-2 and TOC results are summarized in Table 4-3 (Section 4.2).

19.3.2 Surface Water

During the Supplemental RI, a surface water sample (AA-WS01) was collected at the location of the previous barium NOAA SQuiRT exceedance (former sample location AASW01) to evaluate current site conditions. A ridge or berm surrounds the majority of the site preventing any hydraulic connection to upgradient water bodies; therefore, a stream that parallels the east side of the access trail, continuing north-northeast of the AACS area was selected for collection of upgradient surface water samples (AA-WS02, WS03 and WS04). This stream is shallow, flowing north to south toward Cannon Beach Road. A downgradient surface water sample (AA-WS05) was collected from an overflow ditch south of the site. There was no visible flow in this ditch in the site vicinity; however, the ditch parallels the west side of the access trail and flow was observed further south toward Cannon Beach Road. Surface water sampling locations are shown on Figure 19-2.

Surface water samples were collected using a peristaltic pump with dedicated tubing. The surface water samples were analyzed for total barium, dissolved barium, and hardness for comparison to the Alaska WQS (18 AAC 70) drinking water standard and NOAA SQuiRT ecological screening values.

19.4 ANALYTICAL RESULTS

19.4.1 Soil

Field screening results for the site indicated that impacted soils are limited to a small isolated area at the end of the westernmost tank saddle. Soil samples collected for laboratory analysis were selected from a single boring (AA-SB05), at the location with historical surface soil impacts (AA-SB09), and from five surrounding borings for delineation. Analytical results show that DRO concentrations exceed the Method Two cleanup level at one boring location (AA-SB05) and only in the deeper sample, indicating that these impacts are very isolated and located within the smear zone. No other constituent concentrations exceeded Method Two cleanup levels for soil. Soil analytical results are presented in the Appendix J summary tables and the estimated hydrocarbon (NAPL) soil source area is shown on Figure 19-1.

Constituent data collected within the defined source zone were used to supplement the historical data set for characterization of the hydrocarbon soil source area. Historical and recent (2014) POL data evaluated for the AACS are presented in Table 19-1. Soil data representative of the NAPL contaminated soil source zone are presented in Table 19-2. Historical BTEX source area soil data were not carried forward for input into the HRC due to the high natural attention of these constituents. PAH soil data are presented in Table 19-3, and VPH/EPH results are presented in Table 19-4. These data were used as input in calculating soil ACLs and to evaluate risk at the AACS using the HRC.

19.4.2 Surface Water

Surface water samples were collected at locations onsite (AA-WS01), upgradient (AA-WS02, AA-WS03, and AA-WS04), and downgradient (AA-WS05) of the site. All barium results were at concentrations below the Alaska WQS human health criterion for drinking water of 2.0 mg/L. Values protective of freshwater aquatic life have not been promulgated through the WQS. Assessment of potential ecological risk for barium in surface water at this site has previously been evaluated using NOAA SQuiRT screening criteria. All five sample locations show concentrations above the NOAA SQuiRT chronic value of 0.0039 mg/L, but below the acute value of 0.110 mg/L.

Results for total and dissolved barium indicate that barium at this site is in the dissolved phase and not present as suspended particulates. Barium concentrations in the on-site sample (0.017 mg/L) are similar, but slightly lower than those detected upgradient (0.026 to 0.030 mg/L) and downgradient (0.019 to 024 mg/L). While the concentrations are fairly consistent, the highest are located upgradient indicating the FUDS is not a contributing source of barium and concentrations likely reflect natural conditions. Laboratory analytical results are presented in a summary table in Appendix J and are shown on Figure 19-2.

19.5 HUMAN HEALTH RISK EVALUATION

Fuel hydrocarbon concentrations above the 18 AAC 75 Method Two cleanup levels are present at the AACS; therefore, a risk evaluation was conducted using the HRC. The site-specific exposure pathways, soil and groundwater exposure point concentrations, and non-contaminant parameters used as input to the HRC are discussed below, along with the human health risk evaluation results.

19.5.1 Potential Exposure Pathways and Pathways Complete at the Present Time

To meet the ADEC “Cleanup Complete” criteria, the AACS risk evaluation calculated human health risks, assuming that all primary exposure pathways were complete under a future residential land use scenario. The primary future exposure pathways include direct contact or ingestion of contaminants in soil and groundwater, outdoor air inhalation, and indoor air inhalation (vapor intrusion).

The AACS risk evaluation also calculated risk for the pathways complete at the present time. Soil ingestion and outdoor air exposure routes were assumed to be complete at the AACS at the current time, because there is fuel hydrocarbon-contaminated soil present within 15 feet of the ground surface. The indoor air exposure route is considered to be incomplete at the present time, because there is not an occupied building within 30 feet of the AACS source area. There is currently no exposure to groundwater at the present time, because there are no known drinking water wells within the radius of influence at the site and groundwater at the site meets Table C cleanup levels. Overland flow of surface contamination at the site is unlikely based on the relatively flat topography, bermed areas, and heavy vegetative ground cover. Additionally, background data indicate that barium in surface water likely represents natural conditions.

The AACS exposure pathways that are complete at the present time and that might reasonably exist in the future were evaluated in accordance with the ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b). An evaluation of site conditions, exposure pathways, and potential receptors is presented in the Human Health CSM graphic form in Appendix L.

19.5.2 Exposure Point Concentrations

SOIL EXPOSURE POINT CONCENTRATIONS

Soil exposure point concentrations were developed for each hydrocarbon constituent and for GRO, DRO, and RRO using the NAPL-contaminated soil source area data shown in Table 19-2. Note that although 27 soil samples were collected and analyzed from the site, only two samples had DRO concentrations above the most stringent ADEC Method Two cleanup levels and no samples detected GRO or RRO above the most stringent ADEC Method Two cleanup levels (although two RRO results suggested the presence of RRO at concentrations that could affect the phase partitioning of other constituents). As shown in Table 19-2, only the BTEX data from the 2014 investigation were used in the calculation of the exposure point concentrations for the BTEX constituents (historical BTEX data did not have detections and had low DLs, but were not used to be consistent with the approach used at the other AOCs). The source area data set for toluene, total xylenes and GRO was limited to detections in one sample; therefore, the maximum detected values from the source area were used as exposure point concentrations for these constituents. Benzene and ethylbenzene were not detected, so the LOD was used as the exposure point concentration for these constituents. There were not adequate data to calculate 95% UCLs for DRO and RRO; therefore, the maximum detected concentration was used as the exposure point concentration for these fractions. Due to the limited number of detections, 95% UCLs, outlier tests and data plots were not produced for the AACS.

Soil exposure point concentrations were developed for each PAH constituent using the data shown in Table 19-3. All of the PAH constituents were detected in at least one soil sample, so the maximum detected concentrations were used as exposure point concentrations.

One VPH and EPH source area sample was used to characterize the bulk hydrocarbon chemistry. The HRC input values calculated from the source area VPH/EPH data are shown in Table 19-4.

The source of each HRC soil exposure point input value is documented in Table 19-7a.

GROUNDWATER EXPOSURE POINT CONCENTRATIONS

Groundwater samples were not collected at the AACS in 2014; therefore, the BTEX, GRO, DRO and RRO groundwater exposure point concentrations used as input to the HRC were derived from the 2010 sampling effort (Table 19-5). BTEX constituents and GRO were not detected, so the maximum LOD for the samples collected from the site wells were used as the exposure point concentrations. RRO and DRO were detected at the site, so the maximum detected concentrations were used as input to the HRC. The GRO, DRO and RRO aromatic and aliphatic concentrations used as input to the HRC were modeled using the VPH and EPH soil test results (the total GRO, DRO and RRO test results met the ADEC Table C criteria, so the use of the aromatic and aliphatic data were primarily to corroborate the measured groundwater results).

The only PAH constituent detected in groundwater at the site in 2010 was phenanthrene, so the detected value was used as the exposure point concentration (Table 19-6). For the carcinogenic PAH constituents, the maximum LOD concentrations suggested unacceptable risk, so the dissolved phase concentrations used as input to the HRC were modeled using the soils data. For the non-carcinogenic PAH constituents, the maximum LOD concentrations showed acceptable risk, but suggested that the TAqH criteria may be exceeded in the source area; therefore, the dissolved phase concentrations used as input to the HRC were modeled using the soils data.

The source of each HRC groundwater exposure point input value is documented in Table 19-7a.

19.5.3 Non-Contaminant HRC Input Parameters

As discussed in Section 4.2.2, the non-contaminant input parameters used for risk evaluation include: site-specific soil conditions; hydrogeologic conditions and climate data; source area length and vertical extent; building size and foundation type for vapor intrusion modeling; and exposure routes complete at the present time (discussed above). A summary of non-contaminant HRC input parameters specific to the AACS is presented in Table 19-7b.

19.5.4 Site-Specific Risk Evaluation Results

The HRC standard printout that summarizes input parameters and output results for the AACS is included as Table N-11 of Appendix N and the risk posed by the site conditions is summarized in Table 19-8 and 19-9. Table N-11 is a standard twelve-page printout summary from the HRC. The last page of the printout presents conclusions regarding the human health risk and eligibility of the site for closeout.

Based on site-specific exposure point concentrations and non-contaminant parameters, and assuming that all exposure pathways are complete at the present time, the HRC results for the AACS indicate that site conditions meet the ADEC human health risk standard established in 18 AAC 75.325. That is:

- The carcinogenic cumulative risk and non-carcinogenic cumulative risk posed by the individual indicator constituents meet the risk standard, assuming a residential land use scenario and that all exposure pathways are complete (soil direct contact, outdoor air vapor inhalation, indoor air vapor inhalation, and groundwater ingestion).
- The risk posed by the GRO aromatic and aliphatic, DRO aromatic and aliphatic, and RRO aromatic and aliphatic fractions meets the risk standard for each exposure pathway, assuming a residential land use scenario.
- Existing site conditions meet risk-based migration to groundwater criteria (i.e., the remaining contamination in soil is not likely to cause the groundwater to exceed risk-based concentrations).

In summary, the site conditions are protective of human health under an unrestricted (residential) land use scenario.

19.6 ALTERNATIVE CLEANUP LEVELS

DRO concentrations measured at the AACS exceed the ADEC Method Two soil cleanup level. An ACL has been developed for DRO as shown in Table 19-10.

DRO concentrations exceed the Method Two migration to groundwater cleanup level. However, the migration to groundwater calculations performed by the HRC show that when the proper phase partitioning calculations (four-phase partitioning with Raoult's Law) and dilution-attenuation calculations are applied, the AACS exposure point concentrations meet the migration to groundwater criteria. Under these conditions it is typically not necessary to calculate an ACL, but for this contract an ACL has been back calculated for DRO as shown in Table 19-10. The exposure point concentration at the AACS is less than the ACL calculated using the HRC, documenting that the site meets the ADEC migration to groundwater criteria.

19.7 ENVIRONMENTAL / ECOLOGICAL RISK EVALUATION

Ecological risk at the AACS was evaluated and a preliminary ecological CSM developed using the ADEC *Ecoscoping Guidance* (ADEC 2014). The CSM provides a general overview of the potential exposure pathways and ecological receptors at the site. Detected metals are included in the ecoscoping discussion below; however, since metals were not detected above the ADEC Method Two soil cleanup levels, they were not discussed in previous sections. A completed Ecoscoping Form and Ecological CSM documenting the results are presented in Appendix L.

The following factors support the determination that conditions at the AACS are protective of the environment:

- No visible surface soil staining or distressed vegetation were observed.

- Petroleum hydrocarbons in surface soil cover less than a 50 square feet area (0.001 acre); much less than the ADEC 0.5 acre *de minimis* criterion. Further evaluation of terrestrial pathways is not needed based on the limited quantity of surface soil contamination.
- Low levels of several bioaccumulative metals have been detected in surface soil (S&W 2012). However, these metals are likely attributed to natural conditions and, therefore, are not considered further in the evaluation.
- Overland flow of surface contamination is unlikely based on the relatively flat topography, bermed areas, and heavy vegetative ground cover. Any possible contaminant migration to surface water (drainage ditches) would most likely occur from interaction with shallow groundwater.
- While historical LODs at the primary laboratory for non-detected results indicate that groundwater in the well installed in the NAPL-contaminated soil source area and downgradient surface water did not meet TAH and TAqH ambient water quality criteria, LODs from a quality assurance groundwater sample (analyzed at a third party laboratory) from the source area well meets these criteria. Additionally, calculated values based on soil concentrations meet these criteria (Section 19.5.2). In addition, the groundwater from the site discharges to the surface water downgradient of the source, so the groundwater is unlikely to result in a surface water sheen (a surface water sheen can only be created when the NAPL contaminated soil source area extends to the groundwater discharge location).
- While barium concentrations in surface water exceed the NOAA SQuiRT chronic criterion, the source of barium is not associated with the AACS FUDS and likely represents natural conditions.
- Risk to the environment has been evaluated using the ecological scoping process described in the ADEC *Ecoscoping Guidance* (ADEC 2014). The Ecoscoping Form and CSM indicate that a more in-depth risk evaluation is not needed and AACS site conditions are protective of the environment.

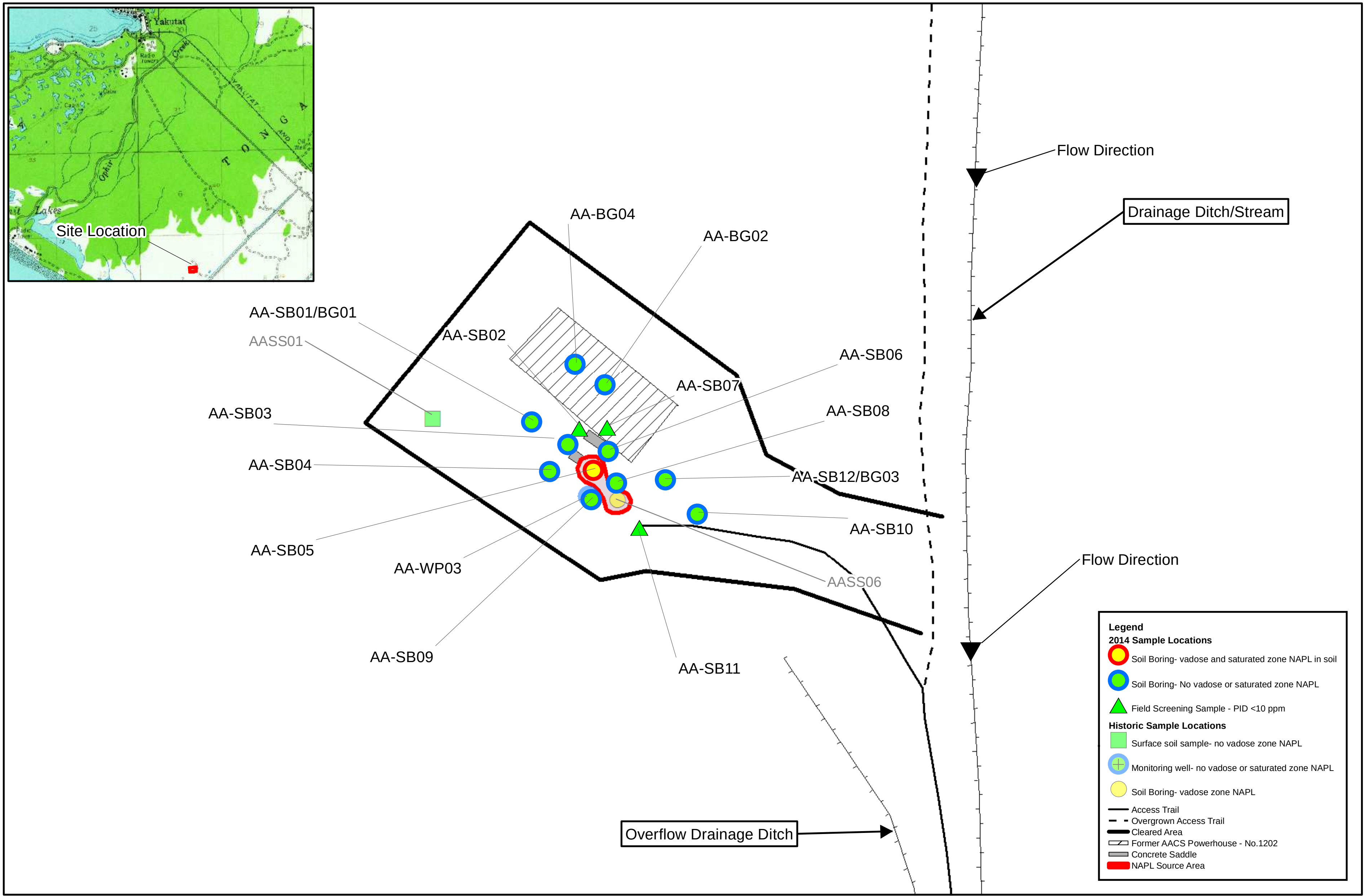

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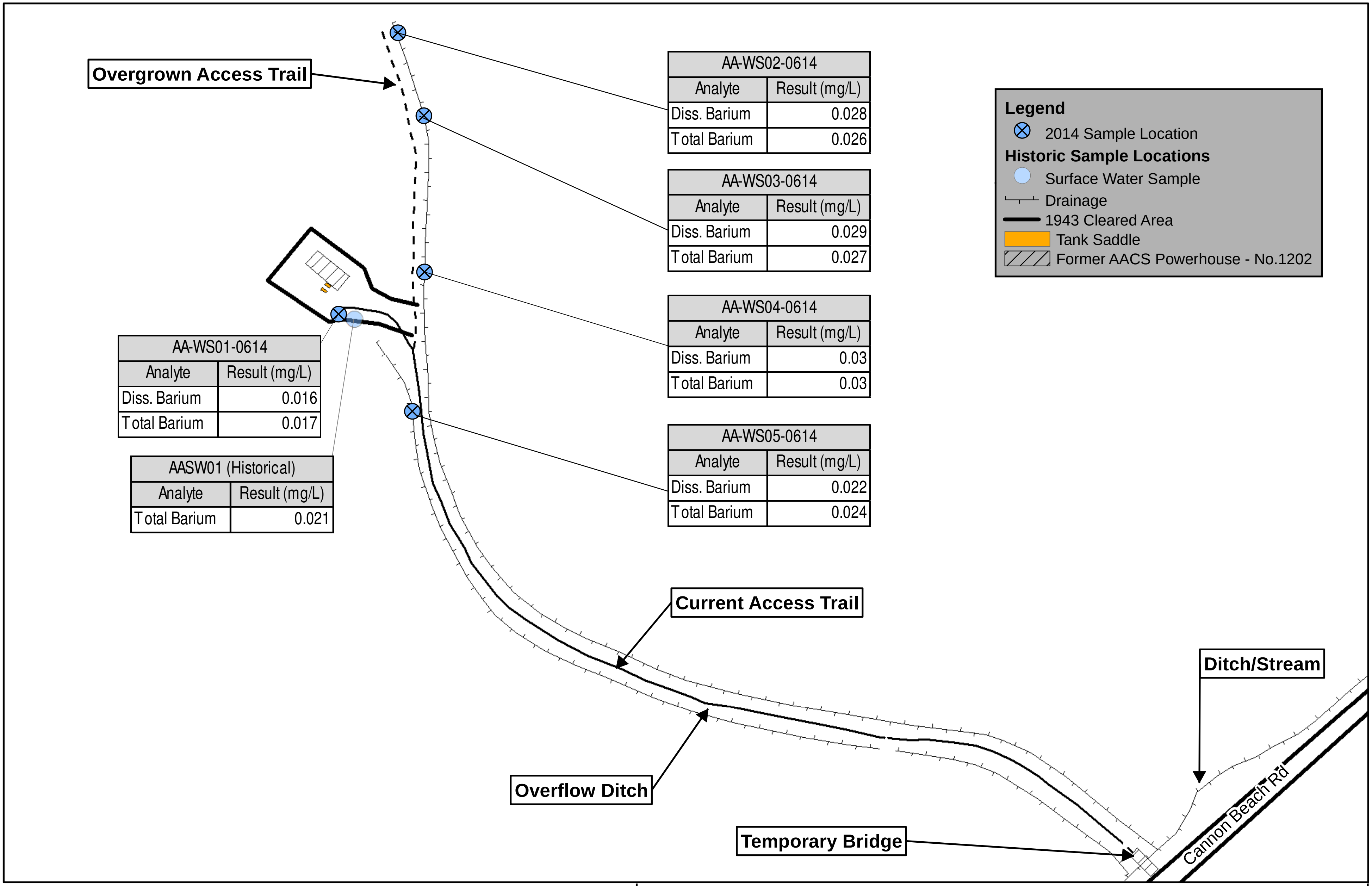
FIGURE 19-1

AACS
NAPL Source Area and Sample Locations

US Army Corps
of Engineers
Alaska District

0 20 40 Feet
1 in = 40 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016



AA-WS01-0614	
Analyte	Result (mg/L)
Diss. Barium	0.016
Total Barium	0.017

AASW01 (Historical)	
Analyte	Result (mg/L)
Total Barium	0.021

AA-WS02-0614	
Analyte	Result (mg/L)
Diss. Barium	0.028
Total Barium	0.026

AA-WS03-0614	
Analyte	Result (mg/L)
Diss. Barium	0.029
Total Barium	0.027

AA-WS04-0614	
Analyte	Result (mg/L)
Diss. Barium	0.03
Total Barium	0.03

AA-WS05-0614	
Analyte	Result (mg/L)
Diss. Barium	0.022
Total Barium	0.024

Notes:
mg/L – milligrams per liter
PAL – Project Action Limit
1. All surface water barium results below the Alaska Water Quality Standard for drinking water (2.0 mg/L) and NOAA SQUIRT acute criterion (0.110 mg/L).
2. All surface water barium results above the NOAA SQUIRT chronic criterion (0.0039 mg/L).
3. Historical sample AASW01 collected in September 2010.

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FIGURE 19-2

AACS
Surface Water Analytical Results

US Army Corps
of Engineers
Alaska District

0 50 100
Feet
1 in = 150 ft

2014 Supplemental RI Report
Site: Yakutat Air Base
Drawn: AECOM
Date: 1/22/2016

Table 19-1: AACS All BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
AACS	AA-BG01	0-2	7/3/2014	AA-BG01-0.0-2.0-0714	**73**	**5.1 QN**	<29 U,QN	--	--	--	--
AACS	AA-BG01	2-4	7/3/2014	AA-BG01-2.0-4.0-0714	**2.6 B**	**3.9 QN**	<29 U,QN	--	--	--	--
AACS	AA-BG02	0-2	7/3/2014	AA-BG02-0.0-2.0-0714	<3.2 U	**4.2 QN**	<31 U,QN	--	--	--	--
AACS	AA-BG02	2-4	7/3/2014	AA-BG02-2.0-4.0-0714	<2.3 U	**3.3 QN**	<27 U,QN	--	--	--	--
AACS	AA-BG03	0-2	7/3/2014	AA-BG03-0.0-2.0-0714	<2.9 U,MN	**29 QN**	**260 QN**	--	--	--	--
AACS	AA-BG03	2-4	7/3/2014	AA-BG03-2.0-4.0-0714	**1.6 B**	**3.1 QN**	<27 U,QN	--	--	--	--
AACS	AA-BG04	0-2	7/4/2014	AA-BG04-0.0-2.0-0714	<3.4 U	**6 QN**	<31 U,QN	--	--	--	--
AACS	AA-BG04	2-4	7/4/2014	AA-BG04-2.0-4.0-0714	**7.2 B**	**4.3 QN**	**9**	--	--	--	--
AACS	AA-SB03	2-4	7/3/2014	AA-SB03-2.0-4.0-0714	**4.3 B**	**6.6 J**	**15 J**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
AACS	AA-SB04	2-4	7/3/2014	AA-SB04-2.0-4.0-0714	**3.4 B**	**6.8 J**	**15 J**	<0.012 U	<0.012 U	<0.012 U	<0.024 U
AACS	AA-SB05	0-2	7/3/2014	AA-SB05-0.0-2.0-0714	**4.3 B**	**34**	**27 J**	<0.012 U	<0.012 U	<0.012 U	<0.024 U
AACS	AA-SB05	2-4	7/3/2014	AA-SB05-2.0-4.0-0714	**27 B**	**850 MN**	**64**	<0.0091 U	<0.0091 U	**0.0031 J**	**0.0186 J**
AACS	AA-SB06	0-2	7/3/2014	AA-SB06-0.0-2.0-0714	**3.2 B**	**13 J**	**25 J**	<0.011 U	<0.011 U	<0.011 U	<0.022 U
AACS	AA-SB08	0-2	7/3/2014	AA-SB08-0.0-2.0-0714	**6.7 B**	**11 J**	**68**	<0.011 U	<0.011 U	<0.011 U	**0.0196 J**
AACS	AA-SB09	0-2	7/3/2014	AA-SB09-0.0-2.0-0714	**7.1 B**	**12 J**	**35 J**	<0.011 U	<0.011 U	<0.011 U	<0.022 U
AACS	AA-SB09	2-4	7/3/2014	AA-SB09-2.0-4.0-0714	**23**	**9.4 J**	**17 J**	<0.01 U	<0.01 U	<0.01 U	**0.0152 J**
AACS	AA-SB10	0-2	7/3/2014	AA-SB10-0.0-2.0-0714	**2.1 B**	**13 J**	**28 J**	<0.01 U	<0.01 U	<0.01 U	<0.02 U
AACS	AASD01	0-	9/7/2010	10Y-AA-16-SD	<2.59 U	**77.2**	**533**	<0.0135 U	<0.027 U	<0.0519 U	<0.1038 U
AACS	AASS01	0-1	8/8/2010	10Y-AA-01-SS	<0.827 U	<7.3 U	**9.94 J**	<0.0043 U	<0.0086 U	<0.0086 U	<0.0251 U
AACS	AASS02	0-1	8/14/2010	10Y-AA-02-SS	**1.22 J**	**9.06 J**	**56.1**	<0.0053 U	<0.0107 U	<0.0107 U	<0.0313 U
AACS	AASS03	0-1	8/14/2010	10Y-AA-03-SS	**1.6 J**	**16.4 J**	**102**	<0.0059 U	<0.0118 U	<0.0118 U	<0.0345 U
AACS	AASS04	0-0	8/16/2010	10Y-AA-04-SS	**2.7 J**	**27.4**	**135**	<0.0064 U	<0.0127 U	<0.0127 U	<0.0372 U
AACS	AASS04	0-1	8/16/2010	10Y-AA-05-SS	<0.953 U	<7.06 U	**15 J**	<0.005 U	<0.0099 U	<0.0099 U	<0.029 U
AACS	AASS05	0-1	8/16/2010	10Y-AA-06-SS	**1.95 J**	**9.17 J**	**49.9**	<0.0093 U	<0.0185 U	<0.0185 U	<0.0542 U
AACS	AASS05	0-2	8/16/2010	10Y-AA-07-SS	<1.08 U	<7.25 U	<7.25 U	<0.0056 U	<0.0112 U	<0.0112 U	<0.0328 U
AACS	AASS06	0-1	8/16/2010	10Y-AA-08-SS	<1.69 U	**42**	**236**	<0.0088 U	<0.0176 U	<0.0176 U	<0.0514 U
AACS	AASS06	0-2	8/16/2010	10Y-AA-09-SS	<0.654 U	**706**	**91.2**	<0.0034 U	<0.0068 U	<0.0068 U	<0.0199 U
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					73	850	533	0.0135	0.027	0.0031	0.0196
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:

Bold = detected analyte

Shading = result above screening criteria.

Yellow = NAPL-contaminated soil source area.

-- = not analyzed

BTEX = benzene, toluene, ethylbenzene & xylenes

DRO = diesel-range organics

GRO = gasoline-range organics

HRC = hydrocarbon risk calculator

mg/kg = milligrams per kilogram

NA = not applicable

RRO = residual-range organics

Data qualifiers:

B = analyte detected in blank

J = estimated value

JB = estimated value & analyte detected in blank

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level sources:

A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion

B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation

C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater

D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact

E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation

F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater

H = Source delineation criteria not related to ADEC regulatory levels

Table 19-2: AACS Source Area BTEX, GRO, DRO & RRO Soils Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/kg)	DRO (mg/kg)	RRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
AACS	AA-BG03	0-2	7/3/2014	AA-BG03-0.0-2.0-0714	<2.9 U,MN	**29 QN**	**260 QN**	--	--	--	--
AACS	AA-SB05	2-4	7/3/2014	AA-SB05-2.0-4.0-0714	**27 B**	**850 MN**	**64**	<0.0091 U	<0.0091 U	**0.0031 J**	**0.0186 J**
AACS	AASD01	0-	9/7/2010	10Y-AA-16-SD	<2.59 U	**77.2**	**533**	--	--	--	--
AACS	AASS06	0-1	8/16/2010	10Y-AA-08-SS	<1.69 U	**42**	**236**	--	--	--	--
AACS	AASS06	0-2	8/16/2010	10Y-AA-09-SS	<0.654 U	**706**	**91.2**	--	--	--	--
Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					27	850	533	0.0091	0.0091	0.0031	0.0186
Screening Levels & Source					**260 C**	**230 C**	**230 H**	**0.025 F**	**6.9 F**	**6.5 F**	**6.3 F**

Notes:

Bold = detected analyte

Shading = result above screening criteria.

Yellow = NAPL-contaminated soil source area.

-- = not analyzed

BTEX = benzene, toluene, ethylbenzene & xylenes

DRO = diesel-range organics

GRO = gasoline-range organics

HRC = hydrocarbon risk calculator

mg/kg = milligrams per kilogram

NA = not applicable

RRO = residual-range organics

Data qualifiers:

B = analyte detected in blank

J = estimated value

JB = estimated value & analyte detected in blank

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level sources:

A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion

B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation

C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater

D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact

E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation

F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater

H = Source delineation criteria not related to ADEC regulatory levels

Table 19-3: AACS PAH Soils Results

Site Name		AACS	AACS	AACS	AACS	AACS	AACS	AACS
Boring, Well or Sample Location Number		AA-SB03	AA-SB04	AA-SB05	AA-SB05	AA-SB06	AA-SB08	AA-SB09
Sample Depth (feet)		2-4	2-4	0-2	2-4	0-2	0-2	0-2
Sample Date		7/3/2014	7/3/2014	7/3/2014	7/3/2014	7/3/2014	7/3/2014	7/3/2014
Sample Name		AA-SB03-2.0-4.0-0714	AA-SB04-2.0-4.0-0714	AA-SB05-0.0-2.0-0714	AA-SB05-2.0-4.0-0714	AA-SB06-0.0-2.0-0714	AA-SB08-0.0-2.0-0714	AA-SB09-0.0-2.0-0714
GRO	(mg/kg)	**4.3 B**	**3.4 B**	**4.3 B**	**27 B**	**3.2 B**	**6.7 B**	**7.1 B**
DRO	(mg/kg)	**6.6 J**	**6.8 J**	**34**	**850 MN**	**13 J**	**11 J**	**12 J**
RRO	(mg/kg)	**15 J**	**15 J**	**27 J**	**64**	**25 J**	**68**	**35 J**
Acenaphthene	(mg/kg)	<0.0027 U	<0.0029 U	<0.0031 U	<0.0028 U	<0.0031 U	<0.003 U	<0.0029 U
Acenaphthylene	(mg/kg)	<0.0027 U	<0.0029 U	<0.0031 U	**0.0095**	<0.0031 U	<0.003 U	<0.0029 U
Anthracene	(mg/kg)	<0.0027 U	**0.0022 J**	<0.0031 U	<0.0028 U	<0.0031 U	<0.003 U	<0.0029 U
Benzo(a)anthracene	(mg/kg)	<0.0027 U	**0.013**	<0.0031 U	**0.0025 J**	<0.0031 U	<0.003 U	<0.0029 U
Benzo(a)pyrene	(mg/kg)	<0.0027 U	**0.011**	<0.0031 U	<0.0028 U	<0.0031 U	<0.003 U	<0.0029 U
Benzo(b)fluoranthene	(mg/kg)	**0.0017 J**	**0.013**	<0.0031 U	<0.0028 U	<0.0031 U	<0.003 U	<0.0029 U
Benzo(g,h,i)perylene	(mg/kg)	<0.0027 U	**0.012**	<0.0031 U	<0.0028 U	<0.0031 U	<0.003 U	<0.0029 U
Benzo(k)fluoranthene	(mg/kg)	<0.0027 U	**0.014**	<0.0031 U	<0.0028 U	<0.0031 U	<0.003 U	<0.0029 U
Chrysene	(mg/kg)	**0.0017 J**	**0.014**	<0.0031 U	**0.0063**	<0.0031 U	<0.003 U	<0.0029 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.0027 U	**0.01**	<0.0031 U	<0.0028 U	<0.0031 U	<0.003 U	<0.0029 U
Fluorene	(mg/kg)	<0.0027 U	<0.0029 U	<0.0031 U	<0.0028 U	<0.0031 U	<0.003 U	<0.0029 U
Fluoranthene	(mg/kg)	<0.0027 U	**0.0076**	<0.0031 U	<0.0028 U	<0.0031 U	<0.003 U	<0.0029 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.0027 U	**0.013**	<0.0031 U	<0.0028 U	<0.0031 U	<0.003 U	<0.0029 U
Naphthalene	(mg/kg)	<0.0027 U	<0.0029 U	**0.0029 J**	**0.022**	<0.0031 U	<0.003 U	<0.0029 U
Phenanthrene	(mg/kg)	**0.0037 J**	**0.0029 J**	**0.0021 J**	**0.09 J**	**0.0022 J**	**0.0022 J**	**0.0028 J**
Pyrene	(mg/kg)	<0.0027 U	**0.0084**	<0.0031 U	**0.0079**	<0.0031 U	<0.003 U	<0.0029 U
2-Methylnaphthalene	(mg/kg)	<0.0027 U	<0.0029 U	**0.0078**	**0.13**	<0.0031 U	<0.003 U	<0.0029 U
1-Methylnaphthalene	(mg/kg)	<0.0027 U	<0.0029 U	**0.0024 J**	**0.061**	<0.0031 U	<0.003 U	<0.0029 U

Notes:
Bold = detected analyte
Shading = result above screening criteria.
Yellow = NAPL-contaminated soil source area.
-- = not analyzed
DRO = diesel-range organics
GRO = gasoline-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics

Data qualifiers:
B = analyte detected in blank
J = estimated value
JB = estimated value & analyte detected in blank
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level sources:
A = ADEC Table B2 Soil Cleanup Level (>40-in.) – Ingestion
B = ADEC Table B2 Soil Cleanup Level (>40-in.) – Inhalation
C = ADEC Table B2 Soil Cleanup Level – Migration to Groundwater
D = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Direct Contact
E = 1/10th ADEC Table B1 Soil Cleanup Level (>40-in.) – Outdoor Inhalation
F = ADEC Table B1 Soil Cleanup Level – Migration to Groundwater
H = Source delineation criteria not related to ADEC regulatory levels

Table 19-3: AACS PAH Soils Results

Site Name		AACS	AACS	AACS	AACS	AACS	AACS	AACS
Boring, Well or Sample Location Number		AA-SB09	AA-SB10	AASD01	AASS01	AASS02	AASS03	AASS04
Sample Depth (feet)		2-4	0-2	0-	0-1	0-1	0-1	0-0
Sample Date		7/3/2014	7/3/2014	9/7/2010	8/8/2010	8/14/2010	8/14/2010	8/16/2010
Sample Name		AA-SB09-2.0-4.0-0714	AA-SB10-0.0-2.0-0714	10Y-AA-16-SD	10Y-AA-01-SS	10Y-AA-02-SS	10Y-AA-03-SS	10Y-AA-04-SS
GRO	(mg/kg)	**23**	**2.1 B**	<2.59 U	<0.827 U	**1.22 J**	**1.6 J**	**2.7 J**
DRO	(mg/kg)	**9.4 J**	**13 J**	**77.2**	<7.3 U	**9.06 J**	**16.4 J**	**27.4**
RRO	(mg/kg)	**17 J**	**28 J**	**533**	**9.94 J**	**56.1**	**102**	**135**
Acenaphthene	(mg/kg)	**0.002 J**	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Acenaphthylene	(mg/kg)	<0.003 U	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Anthracene	(mg/kg)	<0.003 U	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Benzo(a)anthracene	(mg/kg)	<0.003 U	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Benzo(a)pyrene	(mg/kg)	<0.003 U	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Benzo(b)fluoranthene	(mg/kg)	**0.0018 J**	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Benzo(g,h,i)perylene	(mg/kg)	<0.003 U	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Benzo(k)fluoranthene	(mg/kg)	<0.003 U	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Chrysene	(mg/kg)	**0.002 J**	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Dibenzo(a,h)anthracene	(mg/kg)	<0.003 U	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Fluorene	(mg/kg)	**0.0057 J**	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Fluoranthene	(mg/kg)	<0.003 U	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.003 U	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Naphthalene	(mg/kg)	**0.014**	<0.003 U	<0.0519 U	<0.0165 U	<0.0206 U	<0.0227 U	<0.0245 U
Phenanthrene	(mg/kg)	**0.009**	**0.002 J**	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
Pyrene	(mg/kg)	<0.003 U	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
2-Methylnaphthalene	(mg/kg)	**0.038**	<0.003 U	<0.142 U	<0.0905 U	<0.0926 U	<0.094 U	<0.156 U
1-Methylnaphthalene	(mg/kg)	**0.011**	<0.003 U	**--**	**--**	**--**	**--**	**--**

Table 19-3: AACS PAH Soils Results

Site Name		AACS	AACS	AACS	AACS	AACS	Maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
Boring, Well or Sample Location Number		AASS04	AASS05	AASS05	AASS06	AASS06		
Sample Depth (feet)		0-1	0-1	0-2	0-1	0-2		
Sample Date		8/16/2010	8/16/2010	8/16/2010	8/16/2010	8/16/2010		
Sample Name		10Y-AA-05-SS	10Y-AA-06-SS	10Y-AA-07-SS	10Y-AA-08-SS	10Y-AA-09-SS		
GRO	(mg/kg)	<0.953 U	**1.95 J**	<1.08 U	<1.69 U	<0.654 U	27	**260 C**
DRO	(mg/kg)	<7.06 U	**9.17 J**	<7.25 U	**42**	**706**	850	**230 C**
RRO	(mg/kg)	**15 J**	**49.9**	<7.25 U	**236**	**91.2**	533	**230 H**
Acenaphthene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.002	**180 F**
Acenaphthylene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.0095	**180 F**
Anthracene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.0022	**1680 D**
Benzo(a)anthracene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.013	**0.4 D**
Benzo(a)pyrene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.011	**0.04 D**
Benzo(b)fluoranthene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.013	**0.4 D**
Benzo(g,h,i)perylene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.012	**110 D**
Benzo(k)fluoranthene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.014	**4 D**
Chrysene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.014	**40 D**
Dibenzo(a,h)anthracene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.01	**0.04 D**
Fluorene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.0057	**190 D**
Fluoranthene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.0076	**150 D**
Indeno(1,2,3-cd)pyrene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.013	**0.4 D**
Naphthalene	(mg/kg)	<0.0191 U	<0.0357 U	<0.0216 U	<0.0338 U	<0.0131 U	0.022	**2.1 E**
Phenanthrene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.09	**1680 D**
Pyrene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.0084	**110 D**
2-Methylnaphthalene	(mg/kg)	<0.131 U	<0.153 U	<0.131 U	<0.117 U	<0.132 U	0.13	**6.1 F**
1-Methylnaphthalene	(mg/kg)	--	--	--	--	--	0.061	**6.2 F**

Table 19-4a: AACS Non-Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
AACS	AA-SB05	0-2	7/3/2014	AA-SB05-0.0-2.0-0714	<0.012 U	<0.012 U	<0.012 U	<0.024 U	5.3 QL	5.264	3.2 QL	--	0.22 J,QH	<0.45 U,QN	0.51 J	4.5 B	8.8 J,QL

Table 19-4b: AACS Non-Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
AACS	AA-SB05	0-2	7/3/2014	AA-SB05-0.0-2.0-0714	--	--	0.24 J	<2.5 U	2.3 J	2 J	--	1.1 J	6 J	10	5.3 J	5.04	17.1	22.14

Table 19-4c: AACS Source Area BTEX and VPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	Benzene	Toluene	Ethylbenzene	Xylene (total)	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C13 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	Total VPH
					Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	
AACS	AA-SB05	2-4	7/3/2014	AA-SB05-2.0-4.0-0714	<0.0091 U	0.0031 J	<0.0091 U	0.0186 J	26.9	26.8723	17 QL	--	0.44 J,QH	0.33 J,QN	2.3 J	18 B,J	90 QL
					--	--	--	--	--	--	--	--	--	--	--	--	--
average with fraction:					0.009	0.003	0.009	0.019	26.900	26.872	17.000	#DIV/0!	0.440	0.330	2.300	18.000	90.00

Table 19-4d: AACS Source Area EPH Soils Results

Site Name	Boring or Well Number	Sample Depth (feet)	Sample Date	Sample Name	C8-C10 Aromatics	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	DRO Aromatics C10 to C21 (mg/kg)	DRO Aliphatics C10 to C21 (mg/kg)	DRO (Sum of C10 to C21 A&A) (mg/kg)
					Result (mg/kg)	Calculated Value (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)	Result (mg/kg)			
AACS	AA-SB05	2-4	7/3/2014	AA-SB05-2.0-4.0-0714	--	--	4.1 ML	38 ML	110 ML	20 ML	--	66 J	330 J	270 J	52 ML	152.1	666	818.1
average with fraction:							4.100	38.000	110.000	20.000		66.000	330.000	270.000	52.000			

Table 19-4e: AACS Source Area Hydrocarbon Characterization

Compounds and A&A EC Fractions	B	T	E	X	C9-C10 Aromatics	C10-C12 Aromatics	C12-C16 Aromatics	C16-C21 Aromatics	C21-C34 Aromatics	C5-C6 Aliphatics	C6-C8 Aliphatics	C8-C10 Aliphatics	C10-C12 Aliphatics	C12-C16 Aliphatics	C16-C21 Aliphatics	C21-C34 Aliphatics	TPH
Source of data used as input to the characterization where overlap exists (enter: max, VPH or EPH)					VPH	EPH						VPH	EPH				
Average concentration in A&A EC groups (mg/kg)	0.00910	0.00310	0.00910	0.01860	26.87230	4.10000	38.00000	110.00000	20.00000	0.44000	0.33000	2.30000	66.00000	330.00000	270.00000	52.00000	920
Fraction of TPH mass in A&A EC groups	9.8904E-06	3.36926E-06	9.89042E-06	0.00002	0.02921	0.00446	0.04130	0.11955	0.02174	0.00048	0.00036	0.00250	0.07173	0.35866	0.29345	0.05652	1.00
GRO, DRO & RRO A&A Groups	**GRO aromatics**					**DRO aromatics**			**RRO aromatics**	**GRO aliphatics**			**DRO aliphatics**			**RRO aliphatics**	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	0.029250					0.165311			0.021737	0.003337			0.723848			0.056517	1.00
Mass fraction of A&A EC Groups within GRO, DRO & RRO A&A Groups	0.000338	0.000115	0.000338	0.000691	0.998517	0.026956	0.249836	0.723208	1.000000	0.143322	0.107492	0.749186	0.099099	0.495495	0.405405	1.00	
Sum of A&A EC mass fractions within GRO, DRO & RRO A&A Groups	1.00					1.00			1.00	1.00			1.00			1.00	

% of TPH that is GRO=	3.26%
% of TPH that is DRO=	88.92%
% of TPH that is RRO=	7.83%

GRO % aromatics	0.897605913
GRO % aliphatics	0.102394087
DRO % aromatics	0.185918592
DRO % aliphatics	0.814081408
RRO % aromatics	0.277777778
RRO % aliphatics	0.722222222

Table 19-4f: AACS HRC Input

input to cells C14 to C16 (4-phase, cumulative risk calcs)	
GRO: fraction aromatic	0.897605913
DRO: fraction aromatic	0.185918592
RRO: fraction aromatic	0.277777778

input to cells D75 to D77 (4-phase, cumulative risk calcs)	
Aromatic C10-C12	0.02695595
Aromatic C12-C16	0.249835634
Aromatic C16-C21	0.723208416

input to cells D79 to D84 (4-phase, cumulative risk calcs)	
Aliphatic C5-C6	0.143322476
Aliphatic C6-C8	0.107491857
Aliphatic C8-C10	0.749185668
Aliphatic C10-C12	0.099099099
Aliphatic C12-C16	0.495495495
Aliphatic C16-C21	0.405405405

Notes:
-- = not analyzed
A&A = aliphatic and aromatic
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
EC = equivalent carbon
EPH = extractable petroleum hydrocarbons

GRO = gasoline-range organics
HRC = Hydrocarbon Risk Calculator
mg/kg = milligrams per kilogram
NA = not applicable
RRO = residual-range organics
TPH = total petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Table 19-5: AACS All BTEX, GRO, DRO & RRO Groundwater Results

Site Name	Boring, Well or Sample Location Number	Sample Depth (feet)	Sample Date	Sample Name	GRO (mg/L)	DRO (mg/L)	RRO (mg/L)	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)
AACS	AADW01	NA	9/7/2010	10Y-AA-17-DW	<0.031 U	<0.259 U	<0.155 U	<0.00012 U	<0.00031 U	<0.00031 U	<0.00093 U
AACS	AAGW01	NA	9/2/2010	10Y-AA-10-GW	<0.031 U	<0.254 U	<0.152 U	<0.00012 U	<0.00031 U	<0.00031 U	<0.00093 U
AACS	AAGW02	NA	9/2/2010	10Y-AA-11-GW	<0.031 U	<0.266 U	<0.16 U	<0.00012 U	<0.00031 U	<0.00031 U	<0.00093 U
AACS	AAGW03	NA	9/7/2010	10Y-AA-12-GW	<0.031 U	**0.25**	**0.18**	<0.00012 U	<0.00031 U	<0.00031 U	<0.00093 U
AACS	AASW01	NA	9/7/2010	10Y-AA-15-SW	<0.031 U	<0.255 U	<0.153 U	<0.00012 U	<0.00031 U	<0.00031 U	<0.00093 U
Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)					0.031	0.25	0.18	0.00012	0.00031	0.00031	0.00093
Screening Levels & Source					**2.2 H**	**1.5 H**	**1.1 H**	**0.0005 H**	**0.07 H**	**0.1 H**	**1 H**

Notes:
Bold = The analyte was detected.
Shading = The result is above the screening criteria.
-- = not analyzed
BTEX= benzene, toluene, ethylbenzene & xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
mg/L = milligrams per liter
NA = not applicable
RRO = residual-range organics

Data qualifiers:
B = analyte detected in the method blank (when used as a flag in a sample result)
J = estimated value
JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)
U = not detected
UJ = not detected, detection limit estimated
Additional flags are defined in Appendix J

Screening level source:
H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for BTEX

Table 19-6: AACS PAH Groundwater Results

	Site Name	AACS	AACS	AACS	AACS	AACS	Recent maximum detected concentration or maximum detection limit if all results are non-detect (potentially used as input to the HRC)	Screening Levels & Source
	Boring, Well or Sample Location Number	AADW01	AAGW01	AAGW02	AAGW03	AASW01		
	Sample Depth	NA	NA	NA	NA	NA		
	Sample Date	9/7/2010	9/2/2010	9/2/2010	9/7/2010	9/7/2010		
	Sample Name	10Y-AA-17-DW	10Y-AA-10-GW	10Y-AA-11-GW	10Y-AA-12-GW	10Y-AA-15-SW		
GRO	(mg/L)	<0.031 U	<0.031 U	<0.031 U	<0.031 U	<0.031 U	0.031	**2.2 H**
DRO	(mg/L)	<0.259 U	<0.254 U	<0.266 U	**0.25**	<0.255 U	0.25	**1.5 H**
RRO	(mg/L)	<0.155 U	<0.152 U	<0.16 U	**0.18**	<0.153 U	0.18	**1.1 H**
Acenaphthene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.22 H**
Acenaphthylene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.22 H**
Anthracene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**1.1 H**
Benzo(a)anthracene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.00012 H**
Benzo(a)pyrene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.00002 H**
Benzo(b)fluoranthene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.00012 H**
Benzo(g,h,i)perylene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.11 H**
Benzo(k)fluoranthene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.0012 H**
Chrysene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.012 H**
Dibenzo(a,h)anthracene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.000012 H**
Fluorene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.15 H**
Fluoranthene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.15 H**
Indeno(1,2,3-cd)pyrene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.00012 H**
Naphthalene	(mg/L)	<0.00062 U	<0.00062 U	<0.00062 U	<0.000094 U	<0.00062 U	0.00062	**0.073 H**
Phenanthrene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	**0.000063 J**	<0.00333 U	0.000063	**1.1 H**
Pyrene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.11 H**
2-Methylnaphthalene	(mg/L)	<0.0032 U	<0.00323 U	<0.0032 U	<0.000094 U	<0.00333 U	0.00333	**0.015 H**
1-Methylnaphthalene	(mg/L)	--	--	--	<0.00038 U	--	0.00038	**0.015 H**

Notes:

Bold = The analyte was detected.

Shading = The result is above the screening criteria.

-- = not analyzed

DRO = diesel-range organics

GRO = gasoline-range organics

mg/L = milligrams per liter

NA = not applicable

PAH = polycyclic aromatic hydrocarbon

RRO = residual-range organics

Data qualifiers:

B = analyte detected in the method blank (when used as a flag in a sample result)

J = estimated value

JB = estimated value and analyte detected in the method blank (when used as a flag in a sample result)

U = not detected

UJ = not detected, detection limit estimated

Additional flags are defined in Appendix J

Screening level source:

H = Table C for GRO, DRO & RRO and 1/10th ADEC Table C for PAHs

Table 19-7a: AACS HRC Input Values & Data Sources, Exposure Point Concentrations

Compound	Soil Concentration Data	Groundwater Concentration Data	Dissolved Phase Half Life (days)
Benzene (c & nc)	maximum LOD	maximum DL from 2010	literature value for BTEX compounds and conservative order of magnitude values for all other compounds
Toluene (nc)	maximum detected conc	maximum DL from 2010	
Ethylbenzene (c & nc)	maximum LOD	maximum DL from 2010	
Xylenes (total) (nc)	maximum detected conc	maximum DL from 2010	
GRO	maximum detected conc	maximum DL from 2010	
DRO	maximum detected conc	maximum detected conc from 2010	
RRO	maximum detected conc	maximum detected conc from 2010	
GRO aromatics	site specific VPH & EPH data	modeled from soils data	
DRO aromatics	site specific VPH & EPH data	modeled from soils data	
RRO aromatics	site specific VPH & EPH data	modeled from soils data	
GRO aliphatics	site specific VPH & EPH data	modeled from soils data	
DRO aliphatics	site specific VPH & EPH data	modeled from soils data	
RRO aliphatics	site specific VPH & EPH data	modeled from soils data	
Acenaphthene (nc)	max measured conc	modeled from soils data	
Acenaphthylene (nc)	max measured conc	modeled from soils data	
Anthracene (nc)	max measured conc	modeled from soils data	
Benzo(g,h,i)perylene (nc)	max measured conc	modeled from soils data	
Fluoranthene (nc)	max measured conc	modeled from soils data	
Fluorene (nc)	max measured conc	modeled from soils data	
Naphthalene (c & nc)	max measured conc	modeled from soils data	
Phenanthrene (nc)	max measured conc	max measured conc	
Pyrene (nc)	max measured conc	modeled from soils data	
Benzo(a)anthracene (c)	max measured conc	modeled from soils data	
Benzo(b)fluoranthene (c)	max measured conc	modeled from soils data	
Benzo(k)fluoranthene (c)	max measured conc	modeled from soils data	
Benzo(a)pyrene (c)	max measured conc	modeled from soils data	
Chrysene (c)	max measured conc	modeled from soils data	
Dibenz(a,h)anthracene (c)	max measured conc	modeled from soils data	
Indeno(1,2,3-cd)pyrene (c)	max measured conc	modeled from soils data	
1-Methylnaphthalene (nc)	max measured conc	maximum DL from 2010	
2-Methylnaphthalene (nc)	max measured conc	maximum DL from 2010	

Hydrocarbon Characterization Data	
Hydrocarbon Fractions	Distribution of DRO & GRO into Aromatic & Aliphatic Equivalent Carbon Ranges (varies by fuel type)
GRO Aromatics Fraction	Site specific EPH & VPH data
DRO Aromatics Fraction	Site specific EPH & VPH data
RRO Aromatics Fraction	Site specific EPH & VPH data
Aromatic C_{10}-C_{12}	Site specific EPH & VPH data
Aromatic C_{12}-C_{16}	Site specific EPH & VPH data
Aromatic C_{16}-C_{21}	Site specific EPH & VPH data
Aliphatic C_{5}-C_{6}	Site specific EPH & VPH data
Aliphatic C_{6}-C_{8}	Site specific EPH & VPH data
Aliphatic C_{8}-C_{10}	Site specific EPH & VPH data
Aliphatic C_{10}-C_{12}	Site specific EPH & VPH data
Aliphatic C_{12}-C_{16}	Site specific EPH & VPH data
Aliphatic C_{16}-C_{21}	Site specific EPH & VPH data

Notes:
BTEX = benzene, toluene, ethylbenzene, xylene
(c) = carcinogen
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbons
GRO = gasoline-range organics
mg/kg = milligrams per kilogram
(nc) = non-carcinogen
RRO = residual-range organics
VPH = volatile petroleum hydrocarbons

Table 19-7b: AACS HRC Input Values & Data Sources, Non-Contaminant Parameters

Source Area Soil Conditions	**Input Values**			**Source of Data**
bulk density (lbs/ft^3)	120.225			measured site value
specific gravity	2.685			measured site value
moisture content (% by weight)	11.8			measured site value
foc	0.002225			measured site value
Soil temp (C)	5.3			measured site value
Soil Grain Size Description (USCS or other; used to label CSM)	Gravelly Sand with Silt			measured site value
Hydrogeologic Conditions				
Source length (ft)	5			scaled from site maps
Average precipitation (in/yr)	143.44			NOAA Climate Data
Aquifer hydraulic conductivity (cm/sec)	3.53E-02			based on grain size and textbook values (Freeze and Cherry 1979)
Aquifer thickness (ft; below low water at downgradient edge of source)	32.8			estimated thickness of the aquifer based on the 2014 boring logs
Infiltration rate (m/yr)	0.7286752			20% of average precipitation
Hydraulic gradient	0.0038			Site specific, calculated from groundwater contours at the site
Potable or Non-potable Aquifer?	1			Potable (unless proven otherwise)
Climate Related Outdoor Air Inhalation and Soil Direct Contact Exposure Parameters				
Climate Zone of site (enter "1" for an arctic site; "2" for the <40" precip zone; and "3" for the >40" precip zone)	3			NOAA Climate Data
Groundwater Depth & Fluctuation and Soil Source Depth				
depth to groundwater at seasonal low water level at downgradient end of source (ft)	1			Depth of bottom of smear zone as indicated by borings
seasonal water table fluctuation (ft)	1			Thickness of smear zone as indicated by borings
depth to bottom of source zone at downgradient edge of source (ft)	4			Depth of bottom of smear zone as indicated by borings
depth to top of area wide source zone at downgradient edge of source (ft)	0			Depth of top of source area as indicated by borings & excavation records
Exposure Routes Complete at Present Time				
Soil Direct Contact	1			Site specific conceptual site model
Outdoor Air	1			Site specific conceptual site model
Indoor Air	0			Site specific conceptual site model
Groundwater Ingestion	0			Site specific conceptual site model
Other Input				
ADEC Hazard ID	0			ADEC CS database
Latitude	0			ADEC CS database
Longitude	0			ADEC CS database
Width of Source (ft)	90			scaled from site maps
Area of NAPL contaminated soil source (ft^2)	450			scaled from site maps
Ground surface slope (ft/ft, assumed to be in direction of groundwater flow)	0.0038			Measured slope of water table
Johnson & Ettinger Vapor Intrusion Model Parameters				
Soil Properties	Upper Layer	Middle Layer	Bottom Layer	
bulk density (lbs/ft^3)	120.23	120.23	120.23	measured site value
specific gravity of solids	2.685	2.685	2.685	measured site value
moisture content (% by weight)	11.80	11.80	11.80	measured site value
foc	0.002225	0.002225	0.002225	measured site value
Thickness of uncontaminated soil layers above source at building location (ft; upper most layer must extend below the depth of foundation; used to define the source-building separation distance)	0.1	0.1	0.1	Site Specific (depth to source minus foundation depth--distributed among 3 layers)
Building Properties				
Lb = length of building (cm)	1000			EPA default input value
Wb = width of building (cm)	1000			EPA default input value
Hb = height of building (cm)	366			EPA default input value
ER = air exchange rate (1/hr)	0.25			EPA default input value
Lf = depth below grade of bottom of floor slab or basement (ft)	6.5			EPA default input value for basement - deep GW
Lcrack = enclosed space foundation thickness or slab thickness (cm)	10			EPA default input value
delta P = pressure differential between building and soil (g/cm-s^2)	40			EPA default input value
Wcrack = floor-wall seam crack width (cm)	0.1			EPA default input value

Table 19-8: AACS Summary of Cumulative Risk Estimates

Commercial/Industrial Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	2.08576E-07	0.0209	0.0001
Outdoor air inhalation	2.19823E-11	0.0000	0.0000
Indoor air inhalation (vapor intrusion)	1.57657E-09	0.0002	0.0001
Groundwater Ingestion	6.06897E-08	0.0061	0.0194
Cumulative Risk	**3E-07**	**0.0**	**0.0**
Residential Scenario			
Exposure Route	Carcinogenic Risk (fraction of risk multiplied by 10^-5)	Carcinogenic Fraction of Risk	Non-Carcinogenic Fraction of Risk
Direct Contact	6.27388E-07	0.0627	0.0009
Outdoor air inhalation	9.53585E-11	0.0000	0.0000
Indoor air inhalation (vapor intrusion)	6.62157E-09	0.0007	0.0002
Groundwater Ingestion	1.01959E-07	0.0102	0.0272
Cumulative Risk	**1E-06**	**0.1**	**0.03**

Notes:
Fraction of Risk values equal to or less than one meet the ADEC risk standard
Carcinogenic risk values equal to or less than 10^-5 meet the ADEC risk standard

Table 19-9: AACS Summary of Bulk Fuel Hydrocarbon Risks

	Soil concentration (mg/kg):[a]	Groundwater concentration (mg/L):[a]	Fraction of Risk Values				
			Direct Contact	Outdoor air inhalation	Indoor air inhalation (vapor intrusion)	Groundwater Ingestion	Migration to groundwater
Commercial / Industrial Scenario							
GRO Aromatics	24	0.350	<1	<1	<1	<1	<1
DRO Aromatics	158	0.132	<1	<1	<1	<1	<1
RRO Aromatics	148	0.001	<1	No RfC	No Rfc	<1	<1
GRO Aliphatics	3	0.006	<1	<1	<1	<1	<1
DRO Aliphatics	692	0.001	<1	<1	<1	<1	<1
RRO Aliphatics	385	0.000	<1	No RfC	No Rfc	<1	<1
Residential Scenario							
GRO Aromatics	24	0.350	<1	<1	<1	<1	<1
DRO Aromatics	158	0.132	<1	<1	<1	<1	<1
RRO Aromatics	148	0.001	<1	No Rfc	No Rfc	<1	<1
GRO Aliphatics	3	0.006	<1	<1	<1	<1	<1
DRO Aliphatics	692	0.001	<1	<1	<1	<1	<1
RRO Aliphatics	385	0.000	<1	No Rfc	No Rfc	<1	<1

Notes:

Fraction of Risk values equal to or less than one meet the ADEC risk standard

[a] Appendix C, Table C-1 (pages 4 and 8)

DRO = diesel-range organics

GRO = gasoline-range organics

Table 19-10: AOC AACS Soil Alternative Cleanup Levels (for compounds exceeding Method Two)

Analyte or Hydrocarbon Fraction	Maximum Concentration at the Site (mg/kg)	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	ACL (mg/kg; calculated using the ADEC online calculator)	Limiting Exposure Route (ADEC online calculator)	Soil Exposure Point Concentration (mg/kg)	Method Two Maximum Allowable Conentration (mg/kg)	ACL (mg/kg; estimated using the HRC)	HRC Limiting Exposure Route
total DRO	850	230	MTGW	800	MTGW	850	12500	10190	Soil Direct Contact

Notes:
ACL = alternate cleanup level
(c) = carcinogen
DRO = diesel-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
MTGW = migration to groundwater
(nc) = non-carcinogen

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20.0 CONCLUSIONS

20.1 RI OBJECTIVES

Contaminant sources investigated during the Former Yakutat Air Base FUDS Supplemental RI were derived primarily from powerhouse operations and fueling activities (i.e., releases from spills, tank or pipeline leaks, and/or direct discharge during fueling). Key overall Supplemental RI objectives include collecting sufficient data to characterize both human health and the environment (ecological) risk at each study area under Method Three (18 AAC Section 75.340), and developing site-specific ACLs. These overall objectives were met as detailed in Sections 5.0 through 19.0 of this report and are summarized in Sections 20.2 and 20.3 below.

The following site-specific investigation objectives proposed to address data gaps and achieve the above key overall objectives were also met:

- Subsurface anomaly sources (debris) at AOCs C2/C4 were identified and associated soil and groundwater contamination was characterized.
- Background conditions for lead in surface water and sediment were established for AOCs C2/C4 and current lead and PCB concentrations in these media were evaluated.
- Current groundwater quality and conditions were assessed at AOCs C2/C4, C6 and D.
- The tidal influence of the Ankau Slough on groundwater quality and net flow at AOC C6 was evaluated and a groundwater use determination was performed under 18 AAC 75.350.
- The vertical extent of petroleum soil contamination at AOC D7 was defined.
- The nature and extent of soil contamination at AOC M3 (PAHs and POL) were characterized and delineated.
- An initial inspection of the former 400 kW Post Powerhouse, located to the north of AOC M3, was performed and documented.
- Lead concentrations in surface water from a stream/drainage ditch adjacent to AOC O1 were determined.
- The nature and extent of POL contaminated soil were determined at the AACS.
- Background conditions for barium in surface water, as well as downgradient and current onsite concentrations, were established at the AACS.

20.2 HUMAN HEALTH AND ECOLOGICAL RISK EVALUATION

Human health risk evaluations were conducted based on the CSMs developed for each AOC. AOCs with Method Two cleanup level exceedances were evaluated using the HRC and following the 18 AAC 75 Method Three guidance to assess compliance with the ADEC risk standard. Risk evaluation was based on site-specific exposure pathways, soil and groundwater exposure point concentrations, soil geotechnical properties and hydrogeologic conditions. Ecological risk was evaluated for each AOC following the ADEC *Ecoscoping Guidance* (ADEC 2014).

Overall, each AOC investigated as part of this Supplemental RI has been adequately characterized regarding risk to human health and the environment in accordance with applicable regulatory requirements. Conclusions and recommendations for the evaluated AOCs are presented below.

20.2.1 AOC C2 Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AOC C2 site conditions exceed the ADEC human health risk standard established in 18 AAC 75.325(g) and (h). The HRC results show that the risk posed by the RRO aromatic fraction exceeds the risk standards for the soil ingestion pathway and the groundwater ingestion pathway, assuming a residential (unrestricted) land use scenario. The risk was also evaluated for a site visitor scenario (e.g. a recreational user) that is representative of the current land use, and the HRC results indicate that site conditions at AOC C2 meet the ADEC human health risk standard established in 18 AAC 75.325. AOC C2 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set contains three exceedances of the ADEC maximum allowable concentration criteria; one for DRO and two for RRO in the upper 15 feet of soil. Groundwater data show RRO detected at a concentration above the Table C criterion in one temporary well. The DRO and RRO aromatic and aliphatic concentrations in groundwater are interpreted to indicate the presence of NAPL in the water sample. This is consistent with observed droplets of NAPL in water at the base of investigation test pits.

Recommendations: Site closure is recommended. AOC C2 is eligible for a "Cleanup Complete with ICs" designation, if the landowner agrees to establish ICs. The ICs should limit residential land use of the site based on the calculated unacceptable risk under a residential scenario. Alternatively, possible remedial actions include 1) removing buried used oil filters, 2) removing contaminated soil to the calculated ACLs to meet the RRO soil risk criterion, and 3) monitored natural attenuation or other groundwater remedial alternatives.

20.2.2 AOC C4 Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AOC C4 site meets the ADEC risk criteria and migration to groundwater criteria. The AOC C4 site conditions are protective of human health under a residential land use scenario assuming that the primary human health exposure pathways (soil direct contact, groundwater ingestion, outdoor air inhalation, and indoor air inhalation) are complete. The AOC C4 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set does not contain any exceedances of the ADEC maximum allowable concentration criteria in soil. The total DRO concentration in one well exceeds the Table C value; however, the measured DRO aromatic and aliphatic concentrations in the well document that the DRO aromatic and aliphatic risk based concentration criteria are met. The total DRO concentration likely indicates the presence of polar organic acids and alcohols derived from hydrocarbon biodegradation. Currently, there is not an accepted toxicity value for the polar fraction, so the risk associated with the polar fraction is not known.

Recommendations: Site closure is recommended. AOC C4 is eligible for a "Cleanup Complete with ICs" designation. The ADEC would require an IC on the site documenting the residual petroleum impacts to groundwater and informing people that the water may not be suitable as a drinking water source due to residual petroleum in the groundwater, uncertainties over risk associated with the polar compounds, and aesthetic impacts that may make the water unsuitable for drinking. Alternatively, monitored natural attenuation could be implemented to determine when the site is suitable for a “Cleanup Complete” determination.

20.2.3 AOC C6 Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AOC C6 site meets the ADEC risk criteria and migration to groundwater criteria. The AOC C6 site conditions are protective of human health under a residential land use scenario assuming that the ADEC primary exposure pathways (soil direct contact, groundwater ingestion, outdoor air inhalation, and indoor air inhalation) are complete. The AOC C6 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set does not contain any exceedances of the ADEC maximum allowable concentration criteria in soil. The total DRO concentration in one well exceeds the Table C total DRO value; however, measured DRO aromatic and aliphatic concentrations in the well document that the DRO aromatic and aliphatic risk based concentration criteria are met. The total DRO concentration likely indicates the presence of polar organic acids and alcohols derived from hydrocarbon biodegradation. Currently, there is not an accepted toxicity value for the polar fraction, so the risk associated with the polar fraction is not known.

Recommendations: Site closure is recommended. AOC C6 is eligible for a "Cleanup Complete with ICs" designation. The ADEC would require an IC on the site documenting the residual petroleum impacts to groundwater and informing people that the water may not be suitable as a drinking water source due to residual petroleum in the groundwater, uncertainties over risk associated with the polar compounds and aesthetic impacts that may make the water unsuitable for drinking. Alternatively, monitored natural attenuation could be implemented to determine when the site is suitable for a “Cleanup Complete” determination.

20.2.4 AOC D1 Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AOC D1 site meets the ADEC risk criteria and migration to groundwater criteria. The AOC D1 site conditions are protective of human health under a residential land use scenario assuming that the primary human health exposure pathways (soil direct contact, groundwater ingestion, outdoor air inhalation, and indoor air inhalation) are complete. The AOC D1 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set does not contain any exceedances of the ADEC maximum allowable concentration criteria in the upper 15 feet of soil (the data set contains one DRO maximum allowable exceedance at the 20 foot depth). Analysis of groundwater samples from monitoring wells installed in the NAPL contaminated source area footprint meet the Table C criteria.

Recommendations: Site closure is recommended. AOC D1 should receive a "Cleanup Complete" designation without ICs.

20.2.5 AOC D2 Conclusions and Recommendations

Conclusions: The AOC D2 investigation indicates that this area does not currently contain contaminant concentrations above regulatory standards; therefore, a risk evaluation was not required at this AOC.

Recommendations: Site closure is recommended. AOC D2 should receive a "Cleanup Complete" designation without ICs.

20.2.6 AOC D3 Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AOC D3 site meets the ADEC risk criteria and migration to groundwater criteria. The AOC D3 site conditions are protective of human health under a residential land use scenario assuming that the primary human health exposure pathways (soil direct contact, groundwater ingestion, outdoor air inhalation, and indoor air inhalation) are complete. The AOC D3 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set does not contain any exceedances of the ADEC maximum allowable concentration criteria in soil. Analysis of groundwater samples from monitoring wells installed in the NAPL contaminated source area footprint meet the Table C criteria.

Recommendations: Site closure is recommended. AOC D3 should receive a "Cleanup Complete" designation without ICs.

20.2.7 AOC D4 Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AOC D4 site meets the ADEC risk criteria and migration to groundwater criteria. The AOC D4 site conditions are protective of human health under a residential land use scenario assuming that the primary human health exposure pathways (soil direct contact, groundwater ingestion, outdoor air inhalation, and indoor air inhalation) are complete. The AOC D4 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set does not contain any exceedances of the ADEC maximum allowable concentration criteria in soil. Analysis of groundwater samples from monitoring wells installed in the NAPL contaminated source area footprint meet the Table C criteria.

Recommendations: Site closure is recommended. AOC D4 should receive a "Cleanup Complete" designation without ICs.

20.2.8 AOC D5 Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AOC D5 site meets the ADEC risk criteria and migration to groundwater criteria. The AOC D5 site conditions are protective of human health under a residential land use scenario assuming that the primary human health exposure pathways (soil direct contact, groundwater ingestion, outdoor air inhalation, and indoor air inhalation) are complete. The AOC D5 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set representative of current conditions does not contain any exceedances of the ADEC maximum allowable concentration criteria in soil. Analysis of groundwater samples from monitoring wells installed in the NAPL contaminated source area footprint meet the Table C criteria.

Recommendations: Site closure is recommended. AOC D5 should receive a "Cleanup Complete" designation without ICs.

20.2.9 AOC D6 Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AOC D6 site meets the ADEC risk criteria and migration to groundwater criteria. The AOC D6 site conditions are protective of human health under a residential land use scenario assuming that the primary human health exposure pathways (soil direct contact, groundwater ingestion, outdoor air inhalation, and indoor air inhalation) are complete. The AOC D6 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set representative of current conditions does not contain any exceedances of the ADEC maximum allowable concentration criteria in soil. Analysis of groundwater samples from monitoring wells installed in the NAPL contaminated source area footprint meet the Table C criteria.

Recommendations: Site closure is recommended. AOC D6 should receive a "Cleanup Complete" designation without ICs.

20.2.10 AOC D7 Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AOC D7 site meets the ADEC risk criteria and migration to groundwater criteria. The AOC D7 site conditions are protective of human health under a residential land use scenario assuming that the primary human health exposure pathways (soil direct contact, groundwater ingestion, outdoor air inhalation, and indoor air inhalation) are complete. The AOC D7 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set representative of current conditions does not contain any exceedances of the ADEC maximum allowable concentration criteria in soil. The total DRO concentration in one well exceeds the Table C total DRO value; however, measured DRO aromatic and aliphatic concentrations in the well document that the DRO aromatic and aliphatic risk based concentration criteria are met. The total DRO concentration likely indicates the presence of polar organic acids and alcohols derived from hydrocarbon biodegradation or the incorporation of NAPL into the water sample. Currently, there is not an accepted toxicity value for the polar fraction, so the risk associated with the polar fraction is not known.

Recommendations: Site closure is recommended. AOC D7 is eligible for a "Cleanup Complete with ICs" designation. The ADEC would require an IC on the site documenting the residual petroleum impacts to groundwater and informing people that the water may not be suitable as a drinking water source due to residual petroleum in the groundwater, uncertainties over risk associated with the polar compounds and aesthetic impacts that may make the water unsuitable for drinking. Alternatively, monitored natural attenuation could be implemented to determine when the site is suitable for a “Cleanup Complete” determination.

20.2.11 AOC D8 Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AOC D8 site meets the ADEC risk criteria and migration to groundwater criteria. The AOC D8 site conditions are protective of human health under a residential land use scenario assuming that the primary human health exposure pathways (soil direct contact, groundwater ingestion, outdoor air inhalation, and indoor air inhalation) are complete. The AOC D8 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set does not contain any exceedances of the ADEC maximum allowable concentration criteria in soil. Site characterization data at D8 did not confirm whether NAPL reached the water table. If NAPL did not reach the water table, then the site should be eligible for a “Cleanup Complete” without ICs determination. If NAPL did reach the water table, then groundwater samples would provide data to assess if an IC was needed. Given that groundwater samples were not collected at D8, groundwater conditions at site AOC D8 were modeled using soil data and assuming that the NAPL was smeared through the zone of seasonal water table fluctuation in the HRC evaluation. While the HRC results indicate acceptable aromatic and aliphatic risk for the groundwater ingestion pathway, it is not known if odor or taste criteria would be met or if a polar fraction is present. Currently, there is not an accepted toxicity value for the polar fraction, so the associated risk, if there is a polar fraction present, is not known.

Trace levels of GRO, DRO, RRO and PAH constituents were detected in the water samples from on-site water supply wells (ARCO #1 and ARCO #2) at concentrations below the Table C criteria and drinking water MCLs. Evaluation of these data show that DRO and RRO concentrations were similar to those reported in the laboratory method blank samples, indicating that the results are associated with laboratory interferences. The majority of PAH detections are interpreted to be false positive results caused by the analysis of spiked LCSs immediately prior to the PAH analysis. However, some uncertainty still remains regarding the source of some PAH and GRO trace detections.

Recommendations: Site closure is recommended. AOC D8 is eligible for a "Cleanup Complete with ICs" designation. The ADEC would require an IC on the site documenting the residual petroleum contaminated soil and potential impacts to groundwater and informing people that the water may not be suitable as a drinking water source due to the residual petroleum, uncertainties over risk associated with the polar compounds and aesthetic impacts that may make it unsuitable for drinking. Alternatively, to more fully determine the need for an IC at D8, additional site characterization work would be needed (i.e. install a well and collect groundwater samples in the D8 source area).

20.2.12 AOC M3 Conclusions and Recommendations

Conclusions: At AOC M3, human health cumulative risk was evaluated using the Online Calculator (ADEC 2008b) and environmental risk evaluated using the ADEC ecological scoping process. Results show a cumulative HI an order of magnitude below the ADEC risk benchmark and the cumulative cancer risk meets the ADEC risk standard of 1×10^{-5}. Additionally, AOC M3 site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

DRO in two samples exceeded the Method Two migration to groundwater cleanup levels and one soil sample contained RRO above the Method Two ingestion level. Bulk petroleum hydrocarbons are not included in human health cumulative risk calculations and were evaluated separately. The exposure pathways considered complete for the risk evaluation included direct contact / ingestion and inhalation of contaminants in soil. The groundwater pathway was considered insignificant based on all currently available groundwater data, showing concentrations below 1/10th Table C groundwater cleanup levels (ADEC 2010b). Therefore, contaminant migration to groundwater was also not evaluated further. The maximum detected DRO concentration in soil was 3,300 mg/kg, less than the Method Two risk based ingestion cleanup level of 8,250 mg/kg. Calculations of 95% UCLs were performed for RRO results to generate a statistically derived exposure point concentration. The ProUCL recommended output was compared to default risk-based concentrations identified in Method Two. The recommended RRO 95% UCL calculation was 7,902 mg/kg, representative of site-wide exposure, and less than the Method Two ingestion cleanup level of 8,300 mg/kg. Based on this evaluation, it was concluded that although exposure pathways are complete, they are either insignificant (groundwater) or do not pose unacceptable risk to potential current or future receptors at AOC M3.

Recommendations: Site closure is recommended. AOC M3 should receive a "Cleanup Complete" designation without ICs.

20.2.13 AOC O1 Conclusions and Recommendations

Conclusions: The AOC O1 investigation indicates that this area does not currently contain contaminant concentrations above regulatory standards; therefore, a risk evaluation was not required at this AOC.

Recommendations: Site closure is recommended. AOC O1 should receive a "Cleanup Complete" designation without ICs.

20.2.14 AACS Conclusions and Recommendations

Conclusions: The HRC risk calculations document that the AACS site meets the ADEC risk criteria and migration to groundwater criteria. The AACS site conditions are protective of human health under a residential land use scenario assuming that the ADEC primary exposure pathways (soil direct contact, groundwater ingestion, outdoor air inhalation, and indoor air inhalation) are complete. The AACS site conditions do not pose a threat to the environment as documented on the completed ADEC Eco Scoping forms.

The site data set does not contain any exceedances of the ADEC maximum allowable concentration criteria in soil. Analysis of groundwater samples from monitoring wells installed in the NAPL contaminated source area footprint meet the Table C criteria.

Recommendations: Site closure is recommended. AOC AACS should receive a "Cleanup Complete" designation without ICs.

20.3 POTENTIAL ECOLOGICAL RISKS

Ecological risk was evaluated for each AOC and, with the exception of AOC D2 where constituents in soil and groundwater were below cleanup levels, a preliminary ecological CSM was developed using the ADEC *Ecoscoping Guidance* (ADEC 2014) and presented in Appendix L. “Off-ramps” were established through the ecoscoping process for all AOCs. This indicates that a more in-depth risk evaluation of these sites is not needed and site conditions are protective of the environment.

20.4 400 KW POST POWERHOUSE CONCLUSIONS AND RECOMMENDATIONS

Conclusions: The visual inspection identified potential contaminant sources, including four partial or intact drums and various piping associated with the former powerhouse.

Recommendations: Based on the building’s historical use as a powerhouse and features identified during the visual inspection (drums and piping), it is recommended that further investigation be conducted at this site.

20.5 ALTERNATIVE CLEANUP LEVELS AND COPCS

Constituents in soil exceeding human health regulatory standards (Method Two cleanup levels) at each AOC were established as COPC and are presented in Table 20-1 by study area. COPCs in soil and the affected study areas include:

- DRO: AOCs C2, C4, D1, D3 – D8, M3, AACS
- RRO: AOC C2
- Benzene: AOCs C2, D1, D3
- 1-Methylnaphthalene: AOCs C2, D1, D4, D5, D7, D8
- 2-Methylnaphthalene: AOCs C2, D1, D3 – D8
- Benzo(a)pyrene*:* AOC C4

Soil ACLs considered protective of human health were calculated for COPCs at each study area using the HRC and are summarized in Table 20-1. A comparison of the soil exposure point concentrations to the calculated ACLs shows that acceptable risk was met for all sites except AOC C2. RRO in soil at AOC C2 exceeds the corresponding ACL based on the direct contact pathway. RRO concentrations in soil exceed the calculated ACL (10,033 mg/kg) at three AOC C2 locations: C2-TP07, C2-TP08 and C2-TP10 at concentrations ranging from 12,000 to 86,000 mg/kg (Table 5-14). The aerial extent (footprint) and volume of RRO contaminated soil exceeding the ACL is estimated at 3,500 ft^2 and 480 cubic yards, respectively, as shown on Figure 5-7.

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Table 20-1: Soil Alternative Cleanup Levels

Analyte or Hydrocarbon Fraction	Method Two Soil Cleanup Level (mg/kg)	Method Two Limiting Exposure Route	Soil Exposure Point Concentration (mg/kg)	ACL calculated using the HRC (mg/kg)	Limiting Exposure Route
AOC C2					
Benzene (c & nc)	0.025	MTGW	0.035	0.136	MTGW
1-Methylnaphthalene (nc)	6.2	MTGW	12	228	Soil Direct Contact
2-Methylnaphthalene (nc)	6.1	MTGW	14	204	Soil Direct Contact
total DRO	230	MTGW	6992	10779	Soil Direct Contact
total RRO	8300	Direct Contact	32933[a]	10033	Soil Direct Contact
AOC C4					
Benzo(a)pyrene (c)	0.4	Direct Contact	0.19	0.261	Soil Direct Contact
total DRO	230	MTGW	3056	10525	Soil Direct Contact
AOC C6					
total DRO	230	MTGW	2946	10628	Soil Direct Contact
AOC D1					
Benzene (c & nc)	0.025	MTGW	0.01	0.049	MTGW
1-Methylnaphthalene (nc)	6.2	MTGW	13	116	MTGW
2-Methylnaphthalene (nc)	6.1	MTGW	22	96	MTGW
total DRO	230	MTGW	8306	11513	Soil Direct Contact
AOC D3					
Benzene (c & nc)	0.025	MTGW	0.015	0.11	MTGW
2-Methylnaphthalene (nc)	6.1	MTGW	12	118	MTGW
total DRO	230	MTGW	3922	10370	Soil Direct Contact
AOC D4					
1-Methylnaphthalene (nc)	6.2	MTGW	8.3	104	MTGW
2-Methylnaphthalene (nc)	6.1	MTGW	15	87	MTGW
total DRO	230	MTGW	2703	10486	Soil Direct Contact
AOC D5					
1-Methylnaphthalene (nc)	6.2	MTGW	9.8	116	MTGW
2-Methylnaphthalene (nc)	6.1	MTGW	17	96	MTGW
total DRO	230	MTGW	2986	10284	Soil Direct Contact
AOC D6					
2-Methylnaphthalene (nc)	6.1	MTGW	6.7	83	MTGW
total DRO	230	MTGW	2632	11427	Soil Direct Contact
AOC D7					
1-Methylnaphthalene (nc)	6.2	MTGW	7.9	64	MTGW
2-Methylnaphthalene (nc)	6.1	MTGW	17.58	53	MTGW
total DRO	230	MTGW	5432	10326	Soil Direct Contact
AOC D8					
1-Methylnaphthalene (nc)	6.2	MTGW	20	87	MTGW
2-Methylnaphthalene (nc)	6.1	MTGW	32	72	MTGW
total DRO	230	MTGW	6124	10939	Soil Direct Contact
AOC M3					
total DRO	230	MTGW	NA	NA	NA
AOC AACS					
total DRO	230	MTGW	850	10190	Soil Direct Contact

Notes:

[a] = Exceeds the ADEC maximum allowable concentration under Method Two, Table B2.

ACL = alternate cleanup level
(c) = carcinogen
DRO = diesel-range organics
HRC = hydrocarbon risk calculator
mg/kg = milligrams per kilogram
MTGW = migration to groundwater
NA = not applicable
(nc) = non-carcinogen
RRO = residual-range organics

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21.0 REFERENCES

40 Code of Federal Regulations (CFR) 146. *Underground Injection Control Program: Criteria and Standards*. Part 146. Volume 24. July.

40 Code of Federal Regulations (CFR) 300. *National Oil and Hazardous Substances Pollution Contingency Plan*. Available: http://ecfr.gpoaccess.gov.

Alaska Administrative Code (AAC) 75. *Oil and Other Hazardous Substances Pollution Control*. April.

Acomb, Lawrence. 2011. *Hydrocarbon Risk Calculator User Manual*. A report prepared under contract to CH2M HILL, for the Federal Aviation Administration. Anchorage, AK. January.

Alaska Department of Environmental Conservation (ADEC). 2003. *Use of the Bootstrap Method in Calculating the Concentration Term for Estimating Risks at Contaminated Sites*. Technical Memorandum 01-004. January.

Alaska Department of Environmental Conservation (ADEC). 2006. *Biogenic Interference and Silica Gel Cleanup*. Technical Memorandum 06-001. Alaska Department of Environmental Conservation, Division of Spill Prevention and Response. May.

Alaska Department of Environmental Conservation (ADEC). 2008a. *Cleanup Levels Guidance.* Alaska Department of Environmental Conservation, Division of Spill Prevention and Response, Contaminated Sites Program. 9 June.

Alaska Department of Environmental Conservation (ADEC). 2008b. *Cumulative Risk Guidance*. Division of Spill Prevention and Response, Contaminated Sites Program. 9 June.

Alaska Department of Environmental Conservation (ADEC). 2008c. *Guidelines for Total Organic Carbon (TOC) Sample Collection and Data Reduction for Method Three and Method Four.* Technical Memorandum 08-002. Division of Spill Prevention and Response, Contaminated Sites Program. 30 September.

Alaska Department of Environmental Conservation (ADEC). 2009a. *Arsenic in Soil*. Technical Memorandum. Division of Spill Prevention and Response, Contaminated Sites Program. March.

Alaska Department of Environmental Conservation (ADEC). 2009b. *Environmental Laboratory Data and Quality Assurance Requirements*. Technical Memorandum. Division of Spill Prevention and Response, Contaminated Sites Program. March.

Alaska Department of Environmental Conservation (ADEC). 2010a. *Draft Field Sampling Guidance*. Division of Spill Prevention and Response, Contaminated Sites Program. May.

Alaska Department of Environmental Conservation (ADEC). 2010b. *Policy Guidance on Developing Conceptual Site Models*. Juneau, AK. October.

Alaska Department of Environmental Conservation (ADEC). 2011a. *Hydrocarbon Risk Calculator User Manual*. Prepared by Lawrence Acomb, Geosphere, Inc. under contract to CH2M HILL. Juneau, AK. January.

Alaska Department of Environmental Conservation (ADEC). 2011b. *Implementing Guidance for the Method Three Hydrocarbon Risk Calculator*. Division of Spill Prevention and Response, Contaminated Sites Division. February.

Alaska Department of Environmental Conservation (ADEC). 2011c. *Risk Assessment Procedures Manual*. Division of Spill Prevention and Response, Contaminated Sites Division. November.

Alaska Department of Environmental Conservation (ADEC). 2012a. *Guidelines for Data Reporting, Data Averaging, and Treatment of Non-Detect Values*. Technical Memorandum. Division of Spill Prevention and Response, Contaminated Sites Program. June.

Alaska Department of Environmental Conservation (ADEC). 2012b. *Vapor Intrusion Guidance for Contaminated Sites.* October.

Alaska Department of Environmental Conservation (ADEC). 2014. *Ecoscoping Guidance, A Tool for Developing an Ecological Conceptual Site Model*. Division of Spill Prevention and Response, Contaminated Sites Program. March.

AECOM Technical Services, Inc. (AECOM). 2014. *Final Supplemental Remedial Investigation Work Plan/QAPP, Former Yakutat Air Force Base, Formerly Used Defense Site (F10AK060602), Yakutat, Alaska*. Prepared for USACE. May. F10AK060602_03.04_0023_a.

AGRA Earth & Environmental, Inc. (AGRA). 1997. *Summary Investigation of DoD Activities on Yakutat Tribal Lands*. ANA Grant No. 90NM0024/01, Yakutat, Alaska, Volume 1, Anchorage, AK. Prepared for Yakutat Tlingit Tribe, Yakutat Native Association. March. F10AK060601_01.05_0001_p.

AQTESOLV. 2014. *Representative Values of Hydraulic Properties*. HydroSOLVE, Inc. Available at: http://www.aqtesolv.com/aquifer-tests/aquifer_properties.htm.

Atekwana, E.A., et. al., 2004. In-Situ Apparent Conductivity Measurements and Microbial Population Distribution at a Hydrocarbon Contaminated Site. *Geophysics* 69, No. 1. Pg. 56–63. Atekwana, E.A., Werkema, D.D., Duris, J.W., Rossbach, S., Atekwana, E.A., Sauck, W.A., Cassidy, D.P., Means, J., Legall, F.D., 2004.

BC Contractors-Jacobs Joint Venture (BCC-J). 2007. *Former Yakutat Air Force Base Remedial Investigation Report*, Yakutat, Alaska, Final. Prepared for USACE. March.

Bedient, P.B., H.S. Rifai and C.J. Newell, Ground Water Contamination, Transport and Remediation, Prentice Hall, Upper Saddle River New Jersey, 1999.

Bouwer, H., and R. C. Rice. 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells. *Water Resources Research.* Volume 12:423-28.

Buchman, M. F. 2008. *NOAA Screening Quick Reference Tables*. NOAA OR&R Report 08-1. Office of Response and Restoration Division. Seattle: NOAA. Available at: http://response.restoration.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf

Driscoll, Fletcher G. 1986. *Groundwater and Wells*. 2nd Ed. Johnson Filtration Systems. St. Paul, MN: H. M. Smyth Co. Table 7.1.

Ecology and Environment (E&E). 1994. *Field Investigation Report, Former Yakutat Air Base, Formerly Used Defense Site, Yakutat, Alaska, Site No. F10AK060600*. August.

Ecology and Environment (E&E). 1997. *Draft Yakutat Air Base/Ocean Cape Radio Relay Site Investigation Report, Yakutat, Alaska, Site No. F10AK060600.* Anchorage, Alaska. Prepared for Environmental Protection Agency. December. F10AK0606--_01.09_0501_a.

ENSR Consulting and Engineering (ENSR). 2003a. *2000 Remedial Investigation Report Final, Remedial Investigation/Feasibility Study, Yakutat Area, Alaska*. Document No. 09000-216-310. February. F10AK060602_03.10_0006_a.

ENSR Consulting and Engineering (ENSR). 2003b. *2001 Remedial Investigation Report Final, Remedial Investigation/Feasibility Study, Yakutat Area, Alaska*. Document No. 09000-216-334. April. F10AK060602_03.10_0005_a.

ENSR Consulting and Engineering (ENSR). 2005. *Final Feasibility Study, Yakutat Area RI/FS*. January. F10AK060602_04.09_0500_a.

Environmental Protection Agency, United States (EPA). 1993. *Wildlife Exposure Factors Handbook*. Office of Research and Development. Washington, D.C. EPA/600/R-93/187a. December.

Environmental Protection Agency, United States (EPA). 1996. *Soil Screening Guidance: Technical Background Document.* 2nd ed. EPA/540/R-95/128. Publication 9355.4-17A. Office of Solid Waste and Emergency Response. May.

Environmental Protection Agency, United States (EPA). 2002. *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*. OSWER 9285.6-10. Office of Emergency and Remedial Response. December.

Environmental Protection Agency, United States (EPA). 2005. *Guidance for Developing Ecological Soil Screening Levels*. Office of Emergency and Remedial Response. Washington D.C. November 2003, Revised February.

Environmental Protection Agency, United States (EPA). 2012. *An Overview of the Sole Source Aquifer Protection Program in EPA Region 10*. Region 10: the Pacific Northwest. Available at: http://yosemite.epa.gov/r10/water.nsf/Sole+Source+Aquifers/Overview.

Environmental Protection Agency, United States (EPA). 2013. *Designated Sole Source Aquifers in EPA Region 10: Idaho, Oregon, Washington (None in Alaska).* EPA Northwest Region 10 Map. Available at: http://www.epa.gov/region10/pdf/water/ssa/maps/ssa_all_2013.pdf.

Fetter, C. W. 1994. *Applied Hydrogeology*. 3rd ed. Upper Saddle River, NJ: Prentice-Hall.

Freeze, R. A., and J. A. Cherry. 1979. *Groundwater*. Englewood Cliffs, NJ: Prentice-Hall., p. 604.

Hem, J.D., 1985. *Study and Interpretation of the Chemical Characteristics of Natural Water*. 3rd ed. U.S. Geological Survey Water-Supply Paper, vol. 2254. Washington, DC.

Hvorslev, M.J. 1951. *Time Lag and Soil Permeability in Ground Water Observations*. Waterways Experiment Station. U.S. Army Corps of Engineers, Bulletin No. 36. April. Lloyd, J.W., Heathcote, J.A., 1985. *Natural Inorganic Hydrochemistry in Relation to Groundwater: An Introduction*. Clarendon Press, Oxford, England.

Interstate Technology & Regulatory Council (ITRC). 2009. Phytotechnology Technical and Regulatory Guidance and Decision Trees, Revised. PHYTO-3. Washington, DC: Interstate Technology& Regulatory Council, Phytotechnologies Team, Tech Reg Update. (Page iv).

Mace, R.E., R.S. Fisher, D.M. Welch, and S.P. Para, Extent, Mass, and Duration of Hydrocarbon Plumes from Leaking Petroleum Tank Sites in Texas, Bureau of Economic Geology, University of Texas at Austin, Geologic Circular, 97-1, 1997.

Marquis, S.A., and Smith, E.A. 1993. Assessment of Ground-Water Flow and Chemical Transport in a Tidally Influenced Aquifer Using Geostatistical Filtering and Hydrocarbon Fingerprinting. *Ground Water*, Vol. 32, No. 2. pp 190 – 199. March.

National Oceanic and Atmospheric Administration (NOAA). 2014. *Station Name: AK YAKUTAT STATE AP*. Retrieved January 30, 2014. Available at: http://www.ncdc.noaa.gov/cdo-web/datasets/ANNUAL/stations/COOP:509941/detail.

Newell, C.J. and J.A. Conner, Characteristics of Dissolved Hydrocarbon Plumes: Results of Four Studies, Washington D.C., American Petroleum Institute, 1998.

Rice, D.W., R.D. Grose, J.C. Michaelson, B.P. Dooher, D.H. MacQueen, J.S. Cullen, W.E. Kastenberg, L.G. Evert, and M.A. Marino, California Leaking Underground Fuel Tank (LUFT) Historical Case Analysis, Environmental Protection Dept., Nov. 16, 1995.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision*. ES/ER/TM-86/R3. Oak Ridge, Tennessee: Oak Ridge National Laboratory.

Serfes, Michael E. 1991. Determining the Mean Hydraulic Gradient of Groundwater Affected by Tidal Fluctuations. *Groundwater* 29:4 (July–August).

Shannon & Wilson, Inc. (S&W). 2006a. *Final Report, Focused Remedial Investigation, Former Yakutat AFB, Yakutat, Alaska.* April. F10AK060602_03.10_0001_a.

Shannon & Wilson, Inc. (S&W). 2006b. *Final Report, 2005 Focused Remedial Investigation, Former Yakutat Air Force Base, Yakutat, Alaska.* August. F10AK060602_03.10_0002_a.

Shannon & Wilson, Inc. (S&W). 2010*. Final Report, Feasibility Study, Former Yakutat Air Force Base, Yakutat, Alaska*. July. F10AK060602_04.09_0503_a.

Shannon & Wilson, Inc. (S&W). 2012. *Final Report, 2010 Supplemental Remedial Investigation, Former Yakutat Air Force Base, Yakutat, Alaska.* February. F10AK060602_03.10_0008_a.

Suarez, Monica, P. and Hanadi Rafai. 1999. Biodegradation Rates for Fuel Hydrocarbons and Chlorinated Solvents in Groundwater. *Bioremediation Journal.* Vol. 3, Issue 4, Pages 337-362. Available at: http://www.eosremediation.com/download/MNA/Biodegradation%20Rates%20for%20Fuel%20Hydrocarbons%20and%20Chlorinated%20Solventsin%20GW.pdf.

United States Army Corps of Engineers (USACE). 1984. *Environmental Restoration Defense Account Debris Cleanup and Site Restoration Design, Yakutat, Alaska, by Frank Moolin & Associates, Inc. for USACE.* 27 July. F10AK060601_01.04_0500_p.

United States Army Corp of Engineers (USACE). 2006. *Final Rapid Optical Screening Tool (ROST)/Laser-Induced Fluorescence (LIF) Focused Remedial Investigation, Former Yakutat Air Force Base, Yakutat, Alaska.* September. F10AK060602_03.10_0007_a.

United States Army Corp of Engineers (USACE). 2008. *Final Military Munitions Response Program CERCLA Preliminary Assessment for the Yakutat Air Base, Yakutat, Alaska.* 16 May. F10AK0606--_01.09_0505_a.

United States Army Corp of Engineers (USACE). 2011. *Manual for Electronic Deliverables, Requirements for Submittals of Documents, Laboratory Data, and Other Items*. October.

United States Geologic Survey (USGS). 1979. *Professional Paper 1017: Reconnaissance Engineering Geology of the Yakutat Area, Alaska, With Emphasis on Evaluation of Earthquakes and Other Geologic Hazards*. Prepared by L.A. Yehle. Washington, DC: U.S. Government Printing Office.

United States Geologic Survey (USGS). 1995. *Overview of Environmental and Hydrogeologic Conditions at Yakutat, Alaska*. Prepared by W.F. Holmes and J.M. Dorava. Open-File Report No. 94-713.

United States Geologic Survey (USGS). 1998. *Open-File Report 98-199: Hydrologic Investigation of the Ophir Creek Watershed near Yakutat, Alaska*. Prepared by E.G. Neal. Prepared in cooperation with ADF&G, Anchorage, AK.

Wood, W.W., 1976. *Guidelines for Collection and Field Analyses Of Groundwater Samples for Selected Unstable Constituents*. Techniques of Water-Resources Investigations of the United States Geological Survey, Book 1, Chapter D2. U.S. Geological Survey, Washington, DC.