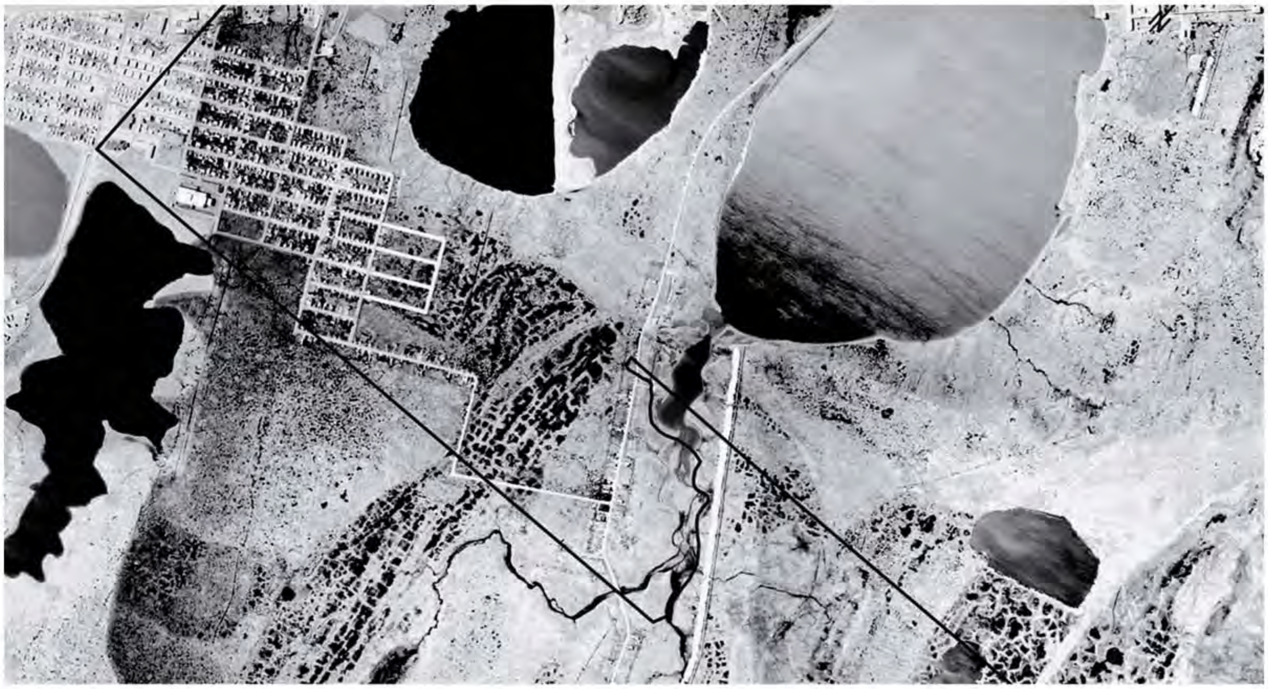
FINAL
16 April 2013

Second Five-Year Review

Airstrip (Site 5), Powerhouse (Site 12), and Bulk Fuel Tank Farm (Site 13)

Naval Arctic Research Laboratory
Barrow, Alaska

Department of the Navy
Naval Facilities Engineering Command Northwest
1101 Tautog Circle
Silverdale, WA 98315



DEDICATION TO TAMAR STEPHENS

In loving memory of Tamar Stephens, Project Manager with the Contaminated Sites Program at the Alaska Department of Environmental Conservation (ADEC), who will be remembered for her genuine love for the environment and humanity. Tamar’s involvement at ADEC has left a lasting impression of admiration in those she worked with or met throughout her journeys in Alaska.

EXECUTIVE SUMMARY

As lead agency for the environmental cleanup of the former Naval Arctic Research Laboratory (NARL), the U.S. Navy (Navy) has performed this second 5-year review for the Airstrip (Site 5), Powerhouse (Site 12), and the former Bulk Fuel Tank Farm (BFTF [Site 13]). The purpose of this 5-year review is to ensure that the cleanup actions selected in the decision documents for these three sites remain protective of human health and the environment. Five-year reviews are required in the decision documents for each of the sites because contaminants have been left in place above levels that allow for unlimited use and unrestricted exposure.

This second 5-year review was prepared in accordance with *Navy/Marine Corps Policy for Conducting Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Five-Year Reviews* (May 2011) and the U.S. Environmental Protection Agency's *Comprehensive Five-Year Review Guidance* (OSWER 9355.7-03B-P, June 2001). Although these sites are not included under CERCLA, the Navy has agreed with Alaska Department of Environmental Conservation to conduct 5-year reviews to assess protectiveness of the remedies. The triggering action for this review was the execution by the Navy of the first 5-year review on June 3, 2008. This review evaluates data collected at the site between October 2007 and September 2012. Since the first 5-year review in June 2008, ongoing monitoring of active zone water, surface water (Airstrip, Site 5 and Powerhouse, Site 12 only), and sediment (BFTF, Site 13 only) has continued. Additional soil investigations have been performed at both the Airstrip and Powerhouse (Sites 5 and 12) to provide additional information regarding residual petroleum contamination in soil that may be contributing to active zone water concentrations.

This 5-year review concludes that the cleanup actions at the three sites do not appear to be functioning as anticipated, based on the increasing concentrations of chemicals of concern (COCs) in groundwater adjacent to surface water at all three sites. Natural biodegradation is still occurring at all three sites, although possibly not optimally, as indicated by the increasing contaminant concentration trends. Diesel-range organics (DRO), gasoline-range organics (GRO), 1,2-dichloroethane, and benzene concentrations are increasing at one or more wells at the Airstrip, Sites 5, and DRO and benzene concentrations are increasing in one or more wells at the Powerhouse, Site 12. At the former BFTF, Site 13, DRO, GRO, and xylenes concentrations are increasing at one well. Protection of surface water has been maintained at all three sites, as documented by surface water sample results. Residual free product has not been measured in any site monitoring well during this data review period. However, there may be localized pockets of free product in the soil and/or permafrost that were not remediated in 2002 at the Airstrip and in 2003 at the Powerhouse that could be contributing to increasing groundwater concentrations at these sites. The additional soil investigations conducted in 2012 at the Airstrip and Powerhouse (Sites 5 and 12) concluded that there are localized areas of contamination or "hot spot" areas in soil that are contributing to the increasing groundwater concentrations at these two sites. The 2012 site investigation recommended reevaluating the soil cleanup levels, because the current cleanup levels may be too high to be protective of the groundwater quality, and assessing the feasibility of implementing additional measures to clean up the areas of highest concentrations or hot spots.

The cleanup actions at the Airstrip, Powerhouse, and former BFTF (Sites 5, 12, and 13, respectively) currently protect human health and the environment because COC concentrations in surface water are below the decision document cleanup levels, and surface water is the exposure medium for establishing that human health and the environment are protected. However, the following actions need to be taken to ensure protectiveness:

- Perform permafrost depth studies at all three sites.
- Enhance the long-term monitoring well network to better define active zone water table gradients and flow directions.
- Reevaluate the designated soil cleanup levels, given the continued exceedances of cleanup levels in groundwater wells at all three sites.
- Assess the feasibility of implementing additional cleanup actions of hot spot soils at the Airstrip and Powerhouse sites.
- Treat additional soil from the south bank area, the turnaround area, and historical sampling location “90” at the former BFTF site.

Although soil removal and treatment actions have been performed and monitoring of active zone water, surface water, and sediment is ongoing, these additional actions are needed to ensure future protectiveness because of continuing exceedances of cleanup levels and increasing concentration trends in shoreline groundwater wells at all three sites.

Five-Year Review Summary Form

SITE IDENTIFICATION

Site name: Naval Arctic Research Laboratory

EPA ID *(from WasteLAN)*: NA

Region: 10	**State:** AK	**City/County:** Barrow

SITE STATUS

NPL status: Final Deleted Other (specify) Not listed on NPL

Remediation status (choose all that apply): Under Construction Operating **X** Complete

Multiple OUs?* YES NO **X**	**Construction completion date:** September 2003

Has site been put into reuse? YES NO **X**

REVIEW STATUS

Lead agency: EPA State Tribe Other Federal Agency: Navy

Author name: Kendra Leibman

Author title: Remedial Project Manager	**Author affiliation:** Naval Facilities Engineering Command Northwest, Navy

Review period:** 10/07 to 09/12

Date(s) of site inspection: Annual inspections

Type of review:
Post-SARA Pre-SARA NPL-Removal only
[✓ Non-NPL Remedial Action Site] NPL State/Tribe-lead
Regional Discretion

Review number: 1 (first) [✓ 2 (second)] 3 (third) Other (specify)________________________

Triggering action:
Actual RA Onsite Construction at OU#____ Actual RA Start at OU ___
Construction Completion [✓ Previous Five-Year Review Report]
Other (specify):____

Triggering action date: June 2008

Due date *(five years after triggering action date)*: June 2013

*["OU" refers to operable unit.]

**[Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Five-Year Review Summary Form (Cont.)

Issues:

General

- Decision document criteria for cessation of monitoring have not yet been met.

Airstrip, Site 5

- Concentrations of chemicals of concern (COCs) in shoreline wells are increasing.
- Concentrations of diesel-range organics (DRO) in the background well (AS-WP-21B) in 2012 were approaching the cleanup level, and this well may no longer be representative of background conditions.
- Residual soil contamination is impacting active zone water.

Powerhouse, Site 12

- Concentrations of COCs in shoreline wells are increasing.
- Residual soil contamination is impacting active zone water.

Former Bulk Fuel Tank Farm, Site 13

- Concentrations of COCs in shoreline wells are increasing, but surface water concentrations continue to meet cleanup levels.
- Excavation at the south bank area left soil containing DRO at concentrations exceeding the decision document cleanup level.
- Some soil planned for excavation was not excavated, including soils in the former BFTF turnaround area and the outlying petroleum-contaminated soil area at historical sampling location 90.
- Landfarming has not been shown to have met the treatment endpoint goal.

Recommendations and Follow-up Actions:

General

- Continue monitoring at all three sites until decision document criteria for cessation of monitoring are met. Evaluate during the next 5-year review.
- Reevaluate the designated soil cleanup levels, given the continued exceedances of cleanup levels in groundwater wells at all three sites.
- Enhance the long-term monitoring well network to better define active zone water table gradients and flow directions.
- Research the availability of better statistical methods for analysis of site data.
- Include the Native Village of Barrow and Inupiat Community of the Arctic Slope on the interview list for subsequent 5-year reviews.

Five-Year Review Summary Form (Cont.)

Recommendations and Follow-up Actions (Cont.):

Airstrip, Site 5

- Perform additional investigation of changes in permafrost levels.
- Perform investigation of containment berm functionality.
- Perform engineering inspection of south depression cap to assess functionality.
- Assess the feasibility of implementing additional cleanup actions of hot spot soils.
- After next sampling event, evaluate whether well AS-WP-21B is still representative of background concentrations.
- Discontinue gasoline-range organics (GRO) monitoring at well AS-WP-02
- Perform further evaluation of the possible spill area east of the access road including researching the possible presence of a pipeline in this area or another source that may explain elevated GRO and benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations.

Powerhouse, Site 12

- Perform additional investigation of changes in permafrost levels.
- Assess the feasibility of implementing additional cleanup actions of hot spot soils.
- Monitor total aromatic hydrocarbons in wells adjacent to Imikpuk Lake and at surface water sampling locations.
- Discontinue GRO monitoring at wells PH-MW-02, PH-WP-02, and PH-WP-06.
- Discontinue residual-range organics monitoring at well PH-WP-01.
- Discontinue tetrachloroethene monitoring at all surface water locations (PH-SW-01, PH-SW-02, and PH-SW-03).

Former Bulk Fuel Tank Farm, Site 13

- Discontinue lead monitoring at wells BFTF-WP-04 through BFTF-WP-10.
- Discontinue ethylbenzene and toluene monitoring at well BFTF-WP-08.
- Discontinue benzene, toluene, ethylbenzene, and xylenes monitoring at wells BFTF-WP-09 and BFTF-WP-10.
- Discontinue GRO monitoring at well BFTF-WP-10.
- Perform additional treatment of landfarmed soils that have not met the treatment endpoint goal.
- Treat additional soil from the south bank area, the turnaround area, and around historical sampling location 90.
- Evaluate potential causes of increasing COC concentrations in groundwater, including the potential effects of residual soil contamination and changes in permafrost levels. If warranted based on additional investigation, evaluate potential additional source removal/remedial actions.

Five-Year Review Summary Form (Cont.)

Protectiveness Statement(s):

The cleanup actions at the Airstrip, Powerhouse, and former BFTF (Sites 5, 12, and 13, respectively) currently protect human health and the environment because COC concentrations in surface water are below the decision document cleanup levels, and surface water is the exposure medium for establishing that human health and the environment are protected. However, the following actions need to be taken to ensure protectiveness:

- Perform permafrost depth studies at all three sites.
- Enhance the long-term monitoring well network to better define active zone water table gradients and flow directions.
- Reevaluate the designated soil cleanup levels, given the continued exceedances of cleanup levels in groundwater wells at all three sites.
- Assess the feasibility of implementing additional cleanup actions of hot spot soils at the Airstrip and Powerhouse sites.
- Treat additional soil from the south bank area, the turnaround area, and from historical sampling location 90 at the former BFTF site.

Although soil removal and treatment actions have been performed and monitoring of active zone water, surface water, and sediment is ongoing, these additional actions are needed to ensure future protectiveness because of continuing exceedances of cleanup levels and increasing concentration trends in shoreline groundwater wells at all three sites.

Other Comments: None

Signature sheet for the former NARL second 5-year review for the Airstrip (Site 5), Powerhouse (Site 12), and former Bulk Fuel Tank Farm (Site 13).

30 April 2013

C.S. LaPlatney
Captain, CEC, U.S. Navy
Commanding Officer
Naval Facilities Engineering Command Northwest

Date

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ABBREVIATIONS AND ACRONYMS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
BFTF	Bulk Fuel Tank Farm
bgs	below ground surface
BLM	U.S. Bureau of Land Management
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAO	cleanup action objective
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
DCA	dichloroethane
DD	decision document
DoD	U.S. Department of Defense
DRO	diesel-range organics
Eco-SSL	ecological soil screening level
EPA	U.S. Environmental Protection Agency
GRO	gasoline-range organics
HAVE	hot air vapor extraction
IAS	initial assessment study
IRIS	Integrated Risk Information System
LEA	Land Exchange Agreement
m^3	cubic meter
MCL	maximum contaminant level
µg/L	microgram per liter
mg/kg	milligram per kilogram
mg/kg-day	milligram per kilogram per day
mg/L	milligram per liter
NACIP	Naval Assessment and Control of Installation Pollutants
NARL	Naval Arctic Research Laboratory
Navy	U.S. Navy
NAVFAC NW	Naval Facilities Engineering Command Northwest
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NIRIS	Naval Installation Restoration Information Solution
NSB	North Slope Borough
PAH	polycyclic aromatic hydrocarbon

ABBREVIATIONS AND ACRONYMS (Continued)

PCB	polychlorinated biphenyl
PCE	tetrachloroethene
RAB	Restoration Advisory Board
RBSL	risk-based screening level
RRO	residual-range organics
TAH	total aromatic hydrocarbons
TEL	threshold effect level
TPH	total petroleum hydrocarbons
TPHCWG	Total Petroleum Hydrocarbon Working Group
UIC	Ukpeaġvik Iñupiat Corporation
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USGS	U.S. Geological Service
UVOST	Ultraviolet Optical Screening Tool
VOC	volatile organic compound

1.0 INTRODUCTION

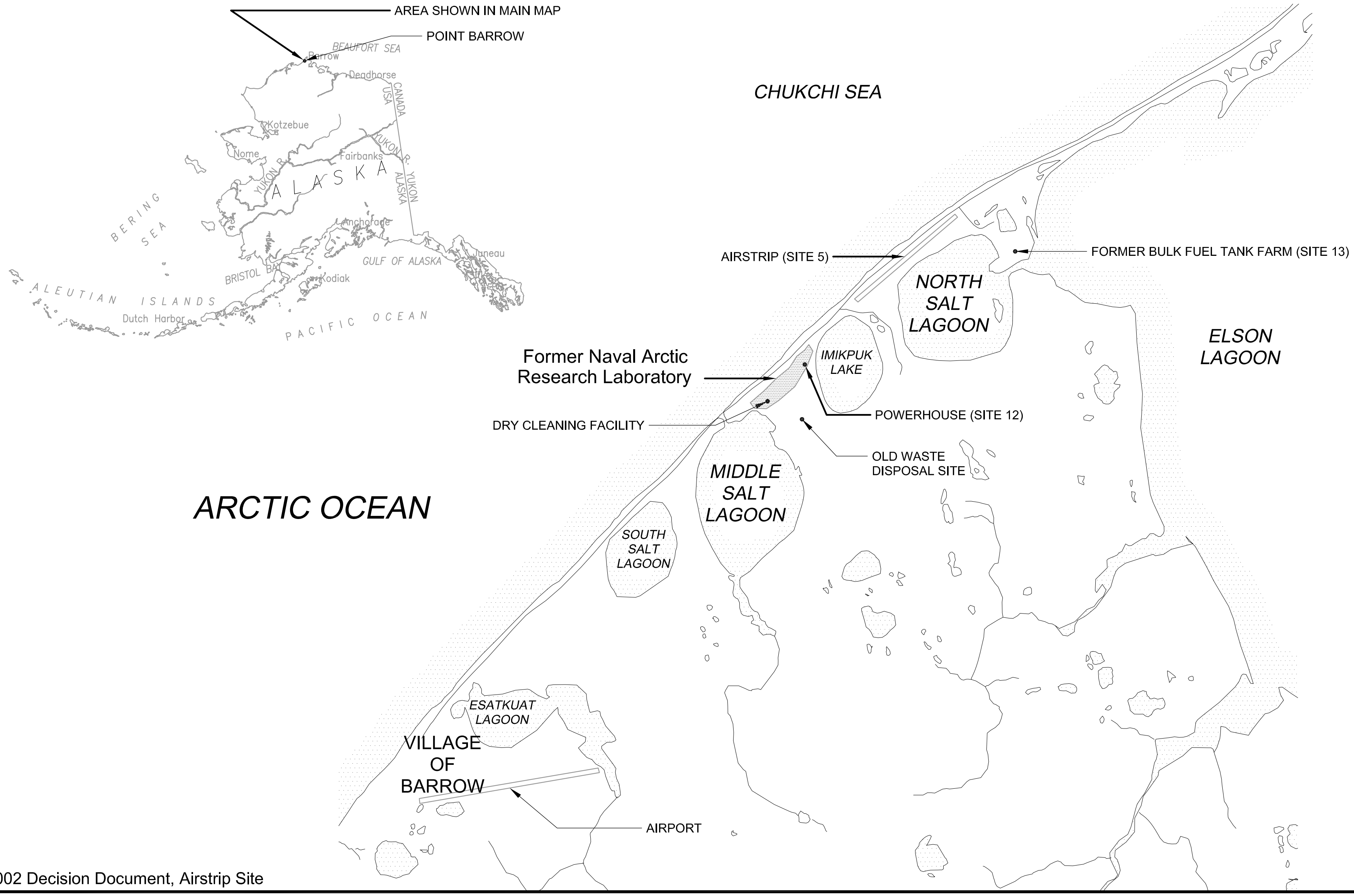
This document presents the results of the second 5-year review performed for the former Naval Arctic Research Laboratory (NARL) Airstrip (Site 5), Powerhouse (Site 12), and former Bulk Fuel Tank Farm (BFTF) (Site 13). NARL is located along the shore of the Chukchi Sea on Alaska's North Slope, approximately 4 miles northeast of the village of Barrow and 6 miles southwest of Point Barrow (Figure 1-1).

The purpose of a 5-year review is to determine whether the cleanup actions selected for implementation in the decision documents (DDs) for a site remain protective of human health and the environment. The methods, findings, and conclusions of 5-year reviews are documented in 5-year review reports, which identify any issues found during the review and recommendations to address them.

Environmental cleanup at NARL is regulated by the State of Alaska Department of Environmental Conservation (ADEC). NARL is not a Superfund site, and thus the specific requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] Part 300) are not applicable. However, the U.S. Navy (Navy) and ADEC have agreed to conduct 5-year reviews for NARL using Navy and U.S. Environmental Protection Agency (EPA) guidance (U.S. Navy 2011b and USEPA 2001 and 2012a) developed for CERCLA 5-year reviews. ADEC does not offer specific format and content guidance for 5-year reviews.

The Naval Facilities Engineering Command Northwest (NAVFAC NW) has conducted this second 5-year review. This review was conducted from May 2012 through November 2012 using analytical data generated between October 2007 and September 2012. The triggering action for this review was the execution by the Navy of the first 5-year review on June 3, 2008. Contaminants have been left at NARL above levels that allow for unlimited use and unrestricted exposure. This report documents the results of the review, issues identified, and recommended actions.

The first 5-year review covered data generated at the three sites from August 2003 to September 2007 (U.S. Navy 2008b). The triggering action for the first 5-year review was the completion of soil removal and treatment actions in October 2003.



Source: 2002 Decision Document, Airstrip Site

U.S. NAVY

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SCALE IN MILES

Figure 1-1
Vicinity of Naval Arctic Research Laboratory

Naval Arctic
Research Laboratory
Barrow, AK
SECOND 5-YEAR REVIEW

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2.0 SITE CHRONOLOGY

Table 2-1 provides a chronology of the primary events associated with site discovery, investigation, and remediation at the former NARL. The following text provides additional detail regarding site activities.

2.1 OVERALL SITE CHRONOLOGY

Early evaluations of environmental conditions at NARL were carried out under the Naval Assessment and Control of Installation Pollutants (NACIP) program. The functions of the NACIP program have since been incorporated into the broader Department of Defense-wide Installation Restoration Program.

The initial environmental investigation at NARL consisted of an initial assessment study (IAS) carried out in 1983 (U.S. Navy 1983). The IAS evaluated 11 potentially contaminated areas associated with NARL, including known disposal sites. The Navy interviewed former site employees and conducted inspections for waste disposal sites, drummed waste, and electrical transformers, as well as evidence of releases of hazardous materials, including petroleum compounds.

Where potential environmental issues were identified during the IAS, additional information was typically collected through more focused follow-up investigations for the individual sites. For each site, the investigations and resulting data were generally equivalent to a remedial investigation. However, instead of formal remedial investigation reports, the investigation results were documented in individual investigation reports.

Preliminary human health and ecological risk assessments were performed for NARL in the early 1990s (U.S. Navy 1992).

The chronology for Airstrip (Site 5), Powerhouse (Site 12), and the former BFTF (Site 13) are described below and include the site investigations, risk assessments, removal actions, and monitoring events.

2.2 AIRSTRIP, SITE 5, CHRONOLOGY

There have been numerous site investigations at the Airstrip, Site 5, since the IAS in the early 1980s. The following brief summary does not include every investigation, but focuses instead on several primary investigation events.

An extensive investigation in 1993 included sampling of soil, lake and lagoon sediments, active zone groundwater (a shallow groundwater system that is only present during thaw season), and surface water (U.S. Navy 1993). A focused site inspection of the Airstrip, Site 5, fuel spill area in 1995 had the goals of establishing the nature and extent of contaminants at the site and collecting information to guide the design of a berm and product recovery trench (U.S. Navy 1995).

A 1,500-foot-long below-ground ice wall containment berm and fuel recovery trench were constructed in 1996. The associated recovery system was in operation from 1996 until 1999. The containment berm was extended in 2000 (U.S. Navy 2000c).

Approximately 4,000 feet of underground fuel pipeline connecting the Powerhouse (Site 12) to the BFTF (Site 13) and passing through the Airstrip (Site 5) was removed in 1997 (U.S. Navy 1997).

A comprehensive site investigation was carried out in 1998 to provide data to support a baseline risk assessment for the Airstrip, Site 5 (U.S. Navy 1999a). Soil, sediments, active zone groundwater, and surface water were sampled.

A number of free-product studies were carried out at the Airstrip, Site 5, between 1996 and 2002 for the specific purposes of locating, controlling, and recovering free product from the active zone and underlying permafrost (U.S. Navy 1996, 1998, 2000c, and 2002a).

A baseline human health and ecological risk assessment for the Airstrip, Site 5, was completed in 2000 (U.S. Navy 2000d). Several reports document the results of subsequent reevaluation of some elements of the baseline risk assessment between 2000 and 2002 (U.S. Navy 2001a, 2001b 2002b, and 2002c).

An interim removal of petroleum-contaminated soil was performed at the Airstrip, Site 5, in 2000, following completion of the baseline risk assessment (U.S. Navy 2000d).

Based on the results of the site investigations and baseline risk assessment and a comparison of alternative cleanup approaches for the Airstrip, Site 5, a preferred alternative was selected and documented in a DD in July 2002 (U.S. Navy and ADEC 2002). The primary components of the selected remedy include excavation and hot air vapor extraction (HAVE) treatment of petroleum-contaminated soil, capping of a portion of the site, and long-term monitoring of active zone groundwater and Imikpuk Lake surface water.

The active measures for the Airstrip, Site 5, were carried out during 2002 and the results documented in closure reports published in April 2003 (U.S. Navy 2003c) and April 2004 (U.S. Navy 2004b) and a summary report (U.S. Navy 2004c).

2.3 POWERHOUSE, SITE 12, CHRONOLOGY

The Powerhouse, Site 12, was subject to several investigations between 1983 and 1999. Investigations following up on the IAS between 1987 and 1991 involved limited environmental sampling (USDOE 1987; U.S. Navy 1987 and 1992). In 1997, 4,000 feet of fuel pipeline connecting the Powerhouse (Site 12) to the BFTF (Site 13) were excavated and removed (U.S. Navy 1997). Groundwater and soil were sampled along the pipeline right of way.

A separate investigation in 1997 involved sampling of groundwater between the Powerhouse, Site 12, and Imikpuk Lake (UIC 1998). A focused investigation was carried out in 1998 to establish whether free product was present at the site (Hart Crowser 1998). Several wells were installed during this focused investigation to investigate for free product at the site; however, no soil or groundwater samples were collected. A separate comprehensive site characterization investigation was carried out in 1998 and 1999 to support the risk assessment and cleanup action selection process, which included sampling of soil, sediment, groundwater, and surface water (U.S. Navy 1999a).

The aboveground storage tanks (ASTs) at the Powerhouse, Site 12, were also removed in 1998.

A baseline human health and ecological risk assessment for the Powerhouse, Site 12, was completed in 2000 (U.S. Navy 2000a).

Based on the results of the site investigations, the risk assessment, and a comparison of alternative cleanup approaches, a preferred alternative for the Powerhouse, Site 12, was selected and documented in a DD executed in March 2003 (U.S. Navy, ADEC, and UIC 2003a). The primary components of the selected remedy included excavation and appropriate disposal of soils contaminated with polychlorinated biphenyls (PCBs), excavation and HAVE of petroleum-contaminated soils, and long-term monitoring.

The active measures for the Powerhouse, Site 12, were carried out during the summer of 2003 and the results documented in closure reports published in September 2003 (U.S. Navy 2003a) and April 2004 (U.S. Navy 2004b).

2.4 FORMER BULK FUEL TANK FARM, SITE 13, CHRONOLOGY

Several investigations following the IAS were carried out at the former BFTF, Site 13, between 1986 and 1997. Investigations in 1986, 1988, 1989, and 1990 included sampling of groundwater and soil and analysis for a variety of analytes, including petroleum. Soil samples collected during an investigation in 1991 were analyzed for a variety of analytes, including benzene, toluene, ethylbenzene, and xylenes (BTEX), various petroleum fractions, polycyclic aromatic hydrocarbons (PAHs), and lead. A limited program of soil sampling was carried out in June 1994 to identify soils with elevated levels of gasoline suitable for a small-scale treatability test.

An extensive site investigation was carried out at the former BFTF, Site 13, in 1997 to generate sufficient data to support a baseline risk assessment. This investigation included sampling of surface and subsurface soils, active zone water, surface water, and sediments (U.S. Navy 1999b).

The baseline human health and ecological risk assessment for the former BFTF, Site 13, was completed in 1999 (U.S. Navy 1999b). The results of reevaluation of some human health risk components were documented in a technical response letter in 2000 (U.S. Navy 2000b).

Based on the findings of the site investigations and risk assessment and a comparison of alternative cleanup approaches, a soil cleanup action was selected for the former BFTF, Site 13, and documented in a DD in March 2003 (U.S. Navy, ADEC, and UIC 2003b). The primary components of the cleanup action included HAVE, landfarming, and long-term monitoring of active zone groundwater and North Salt Lagoon sediments. The active measures for the former BFTF, Site 13, were carried out during the summer of 2003, and the results documented in closure reports published in October 2003 (U.S. Navy 2003b) and April 2004 (U.S. Navy 2004b) and a summary report (U.S. Navy 2004c).

Table 2-1
Chronology of Events

Event	Date
NARL established	1947
Navy involvement in site management and scientific research ends	1981
Initial site assessment study for NARL	1983
Powerhouse, Site 12, supplemental investigations	1983–1999
Land Exchange Agreement where portions of NARL transferred to UIC	1986
Former BFTF, Site 13, site investigations	1986–1997
Former BFTF, Site 13, ASTs and associated piping removal	1990
Initial human health and ecological risk assessments for NARL	1991–1992
Airstrip, Site 5, supplemental site characterization	1993
Airstrip, Site 5, hydrologic investigation	1993
Former BFTF, Site 13, soil removal and treatability study	1994
Airstrip, Site 5, site inspection report	1995
Airstrip, Site 5, below-ground ice wall containment berm constructed	1996
Airstrip, Site 5, free-product recovery system in operation	1996–1999
Powerhouse, Site 12, fuel pipeline excavated	Summer 1997
Powerhouse, Site 12, two ASTs removed	1998
Airstrip, Site 5, and Powerhouse, Site 12, comprehensive site investigation	1998–1999
Former BFTF, Site 13, baseline risk assessment	July 1999
Airstrip, Site 5, extension of the ice wall containment berm by 220 feet	2000
Powerhouse, Site 12, baseline risk assessment	June 2000
Airstrip, Site 5, baseline risk assessment	June 2000
Former BFTF, Site 13, supplemental risk calculations addressing fish consumption and inhalation of volatiles	June 2000
Powerhouse, Site 12, interim soil removal	September 2000
Airstrip, Site 5, interim soil removal	September 2000
Airstrip, Site 5, final decision document	July 2002
Airstrip, Site 5, soil removal and treatment	2002
Powerhouse, Site 12, final decision document	March 2003
Former BFTF, Site 13, final decision document	March 2003
Airstrip, Site 5, final environmental baseline survey report	April 2003
Airstrip, Site 5, final closure report	April 2003
Powerhouse, Site 12, soil removal	2003
Former BFTF, Site 13, landfarming	June–September 2003
Powerhouse, Site 12, final closure report, under-building removal	September 2003
Airstrip, Site 5, final environmental baseline survey	September 2003
Former BFTF, Site 13, final closure report, landfarming	October 2003
Final closure report for Powerhouse and BFTF (Sites 12 and 13)	April 2004
2003 annual water monitoring report for the Airstrip Site	May 2004
Final 2004 monitoring report for Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13)	March 2005

Table 2-1 (Continued)
Chronology of Events

Event	Date
Final 2005 monitoring report for Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13)	March 2006
Final 2006 BFTF, Site 13, landfarm confirmation sampling report	October 2006
Final 2006 monitoring report for Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13)	February 2007
Final 2007 monitoring report for Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13)	April 2008
Final first 5-year review for Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13)	June 2008
Final 2008 monitoring report for Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13)	June 2009
Former BFTF, Site 13, final 2008 landfarm confirmation sampling report	June 2009
Final 2009 monitoring report for Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13)	March 2010
Final 2010 monitoring report for Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13)	March 2011
Final 2011 monitoring report for Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13)	March 2012
Draft 2012 monitoring report for Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13)	March 2013
Airstrip, Site 5, and Powerhouse, Site 12, draft soil investigation results report	March 2013

Notes:
ASTs - aboveground storage tanks
BFTF - Bulk Fuel Tank Farm
DD - decision document
NARL - Naval Arctic Research Laboratory
UIC - Ukpeaġvik Iñupiat Corporation

3.0 BACKGROUND

The Navy established the NARL in 1947 using approximately 3,500 acres of land and facilities from the National Petroleum Reserve No. 4, which were withdrawn from the U.S. Department of the Interior by Public Land Order 82(115). NARL is located approximately 4 miles northeast of the village of Barrow and 6 miles southwest of Point Barrow on the coastal plain of Alaska’s North Slope. The original mission of NARL was to serve as a supply center for regional petroleum exploration. At the time NARL was established, structures at the site consisted of two buildings used for scientific research and other support buildings, such as residential housing (U.S. Navy 2000e).

The topography at NARL is comparatively flat, local relief generally limited to 6 to 8 feet. One exception is a natural beach ridge that was built up to serve as a roadbed. Soils at NARL remain frozen at the surface (referred to as “permafrost”) throughout most of the year. Shallow lakes are abundant in the area because of the flat topography and shallow permafrost. During the short summer, some surface thawing does occur, leading to a limited “active zone” groundwater commonly reaching a maximum depth of 6 feet by August or September.

The Navy managed the actual NARL laboratory facilities from 1947 to 1981. The other support facilities at the site were operated by a succession of agencies:

- 1947–1953: U.S. Geological Service (USGS)
- 1954–1972: U.S. Air Force (USAF)
- 1972–1981: Navy
- 1981–1984: USGS
- 1984–1986: Ukpeaġvik Iñupiat Corporation (UIC)

The Navy began phasing out NARL activities in 1978. Laboratory operations ended in 1980. The USGS took over as site caretaker in 1981, and UIC assumed caretaker responsibilities in 1984, which continued until 1986. The Land Exchange Agreement (LEA) executed between the U.S. Government and the UIC in 1986 transferred NARL lands to UIC, with the exception of the Airstrip, Site 5, and the area east of the Middle Salt Lagoon (see Figure 1-1).

The LEA documented a number of property transfer requirements associated with transfer of portions of NARL to the UIC. These requirements included actions to be taken to address environmental issues at the site. As a result, the LEA was a primary source document for planning and carrying out early environmental investigations and cleanup actions. The primary sites addressed in the LEA (U.S. Navy 2000e, Appendix A), the Airstrip (Site 5), Powerhouse (Site 12), and BFTF (Site 13), are discussed individually below.

3.1 AIRSTRIP, SITE 5

The Airstrip, Site 5, occupies the northern portion of NARL, along the shore of the Chukchi Sea (Figure 3-1). Site facilities historically included the 5,000-foot-long runway, the hangar, the apron connecting the hangar to the runway, and associated buildings. At least eight storage tanks were used to store aviation gas and motor vehicle gas supplied by pipelines from the BFTF, Site 13 (U.S. Navy 2000d and 2000e; U.S. Navy and ADEC 2002).

A total of approximately 366,000 gallons of fuel of various types was reportedly spilled during the active life of the Airstrip, Site 5. Major spill incidents were recorded in 1976 (48,000 gallons of motor vehicle gas), 1978 (24,000 gallons of aviation gas and 277,000 gallons of motor vehicle gas), and 1986 (4,000 to 15,000 gallons of aviation gas). Approximately 140,000 gallons of the motor vehicle gas spilled in 1978 was reportedly recovered and the remainder burned.

The Navy conducted a number of investigations of the Airstrip, Site 5, subsequent to the IAS. Some of the major investigations included:

- A hydrologic investigation in 1993 of the link between active zone water at the Airstrip, Site 5, and Imikpuk Lake
- A site inspection in 1995
- A pre-construction investigation in 1995 for a planned containment berm and fuel recovery trench
- Investigations of free product between 1996 and 1998

Based on the findings from these and other investigations, the Navy undertook a number of cleanup actions at the Airstrip, Site 5, prior to 1998. A 1,500-foot-long below-ground ice wall containment berm and fuel recovery trench were constructed along the eastern shoreline of Imikpuk Lake in 1996. The associated fuel recovery system operated from 1996 through 1999. Approximately 4,000 feet of underground fuel pipeline connecting the Powerhouse to the pumphouse at the Airstrip were removed in 1997.

Additional sampling was carried out in 1998 to provide data to support a baseline risk assessment. Media sampled included surface soil, subsurface soil, active zone water, surface water, and sediment. Overall, the primary chemicals determined to exceed ADEC criteria were the following:

- Gasoline-range organics (GRO), diesel-range organics (DRO), and benzo(a)pyrene in surface soil

- GRO in subsurface soil
- DRO, GRO, and benzene in active zone water
- DRO in surface water at a small pond east of the hangar

Efforts to recover free product from the Airstrip, Site 5, included the construction of a 220-foot extension to the containment berm in 2000. It is estimated that the free-product recovery measures conducted through 2000 recovered or burned 320,000 to 346,000 of the estimated 366,000 gallons of fuel released at the site. An investigation in 2002 indicated that the free product remaining at the site exists in isolated pockets within the permafrost and, as a result, is comparatively immobile.

Initial human health and ecological risk assessments were performed for sites at the former NARL complex (including the Airstrip, Site 5) in the early 1990s (U.S. Navy and ADEC 2002). Subsequent to the initial risk assessments, a methodology was developed where the Navy solicited input from community members and ADEC to address potential risks due to total petroleum hydrocarbon (TPH) fractions (GRO, DRO, and RRO) in site media. Using this new methodology, a baseline risk assessment (including both human and ecological health) was performed for the Airstrip site in 2000 (U.S. Navy 2000d), based on the work plan completed in 1999. The Airstrip human health and ecological risk assessments used historical soil and sediment data collected during 1993 and 1995 and soil, sediment, active zone water, and surface water data collected in 1998. The risk assessments were prepared by the Navy to support site closure and the potential future transfer of the property to the UIC.

In September 2000, after the baseline risk assessment was completed, the Navy excavated approximately 40 cubic yards of petroleum-contaminated soil from the Airstrip, Site 5. The soil was stockpiled for future treatment to remove petroleum (U.S. Navy and ADEC 2002).

Several aspects of the baseline risk assessment were reevaluated between 2000 and 2002, including recalculation of risks following excavation of soil, recalculation of indoor air risks, development of the dermal contact cleanup level for construction workers, and calculation of fish ingestion risks. When risks were recalculated following removal of the petroleum-contaminated soil, human health risks from exposure to soil were found to be below ADEC cancer risk management thresholds for all users. The baseline risk assessment predicted high risks to future residents from inhalation of indoor air, based on modeled indoor air concentrations (U.S. Navy and ADEC 2002). In order to confirm or refute the baseline risk assessment results, ambient air and soil gas samples were collected adjacent to the Airstrip site in July 2001. Using these results, risks were recalculated and found to be acceptable for potential future residents. A risk-based cleanup level for construction worker dermal contact with the DRO-aliphatic fraction in active zone water was developed using data from the 2001 monitoring event (U.S. Navy and

ADEC 2002). Finally, to more accurately assess risks from eating North Salt Lagoon fish, fish were caught from the lagoon and chemically analyzed for petroleum hydrocarbons. No contamination was found in the fish, and risks from fish ingestion were reevaluated as being negligible (U.S. Navy and ADEC 2002).

Based on the above interim soil cleanup activities and risk reevaluations, the only risks remaining at the site were to lower food-chain wildlife (e.g., grubs) living in south depression soil/sediment (U.S. Navy and ADEC 2002). In addition, the risk assessment process concluded that the isolated pockets of free product remaining at the site do not pose an unacceptable risk to human health or the environment (U.S. Navy and ADEC 2002).

3.2 POWERHOUSE, SITE 12

The Powerhouse, Site 12, is located at the northern end of the NARL facility, just west of Imikpuk Lake (Figure 3-2). The primary facilities at the site include the original Powerhouse (Building 342), which operated from 1950 through 1971, the new Powerhouse (Building 442) constructed in 1971, two 20,000-gallon aboveground fuel storage tanks providing fuel to the generators, and a pipeline connecting to the pumphouse located near the Airstrip hangar (U.S. Navy 2000a, 2000e, and 2003a).

Three releases of fuel at the Powerhouse, Site 12, have been recorded: a 15,000-gallon spill of aviation gasoline at the old Powerhouse in 1952, a 10,000-gallon spill of aviation gasoline at the old Powerhouse in 1958, and a release of an unknown quantity of fuel from a leaking tank valve observed in 1988.

Primary investigations carried out at the Powerhouse, Site 12, included the following:

- A series of investigations of soil, active zone water, and surface water in 1988, 1989, 1990, and 1991
- A remedial investigation in 1991
- An investigation of active zone water adjacent to Imikpuk Lake in 1997
- Free-product investigations in 1997 and 1998

As discussed for the Airstrip, Site 5, approximately 4,000 feet of underground fuel pipeline connecting the Powerhouse to the pumphouse at the Airstrip were removed in 1997. The Powerhouse, Site 12, fuel tanks were removed in 1998.

An additional comprehensive site investigation was conducted in 1998 to collect data to support a baseline risk assessment for the Powerhouse, Site 12. The media sampled were soils, active zone water, surface water, and sediment (U.S. Navy 1999a).

As a result of these investigations, the primary chemicals found to exceed ADEC cleanup criteria were the following:

- Residual-range organics (RRO), DRO, and PCBs in soil
- RRO, DRO, and GRO in active zone water

Initial human health and ecological risk assessments were performed for sites at the former NARL complex (including the Powerhouse, Site 12) in the early 1990s (U.S. Navy, ADEC, and UIC 2003a). Subsequent to the initial risk assessments, a methodology was developed where the Navy solicited input from community members and ADEC to address potential risks due to TPH fractions (GRO, DRO, and RRO) in site media. Using this new methodology, a baseline risk assessment (including both human and ecological health) was performed for the Powerhouse site in 2000 (U.S. Navy 2000a), based on the work plan completed in 1999. The risk assessments were prepared by the Navy to support site closure and transfer of the property to the UIC.

Approximately 360 cubic yards of petroleum-contaminated soil were excavated from three locations at the Powerhouse, Site 12, in 2000. These soils were stockpiled together with 40 yards of Airstrip, Site 5, soil in a hangar at the Airstrip to await future treatment to remove the petroleum. Analytical results from this removal indicated residual DRO concentrations exceeding ADEC maximum allowable concentrations (unrestricted use in an Arctic Zone) in the southern portion of the 50- by 70-foot excavation between the Powerhouse buildings (U.S. Navy, ADEC, and UIC 2003a).

Several aspects of the baseline risk assessment were reevaluated between 2000 and 2002, including recalculation of risks following excavation of soil, recalculation of indoor air risks, and development of the dermal contact cleanup level for construction workers. When risks were recalculated following removal of the petroleum-contaminated soil, human health risks from exposure to soil had decreased. As with the Airstrip, Site 5, the Powerhouse, Site 12, baseline risk assessment predicted high risks to future residents from inhalation of indoor air (U.S. Navy, ADEC, and UIC 2003a). Using the ambient air and soil gas sample results for the Airstrip site, risks were recalculated for the Powerhouse site and found to be acceptable for potential future residents (U.S. Navy, ADEC, and UIC 2003a). A risk-based cleanup level for construction worker dermal contact with the DRO-aliphatic fraction in active zone water was developed for the Powerhouse site, as was done for the Airstrip site, using data from the 2001 monitoring event (U.S. Navy, ADEC, and UIC 2003a).

Based on the above interim soil cleanup activities and risk reevaluations, the only risks remaining at the Powerhouse, Site 12, are associated with possible dermal contact with or ingestion of soil contaminated with DRO by residential children (U.S. Navy, ADEC, and UIC 2003a).

3.3 FORMER BULK FUEL TANK FARM, SITE 13

The former BFTF, Site 13, covers an area of approximately 5 acres (Figure 3-3). Facilities at the former BFTF, Site 13, consisted of six ASTs, a pumphouse, and associated piping. Five of the tanks had a capacity of 47,000 gallons and one had a capacity of 25,000 gallons. Five of the tanks rested on a constructed 5-foot-thick raised gravel pad. The sixth tank rested on a concrete slab (U.S. Navy 1999b and 2000e; U.S. Navy, ADEC, and UIC 2003b).

The only documented fuel release at the former BFTF occurred in 1970, when up to 100,000 gallons of aviation gasoline may have escaped into the gravel pad because of a broken pipeline. Evidence was also observed during removal of the tanks in 1990 that one tank had leaked. However, no estimate of the amount of the release is available. No evidence of free product was found at the former BFTF, Site 13, in an investigation carried out in 1997.

The piping at the former BFTF, Site 13, was removed in 1988. The tanks and the concrete slab were removed in 1990, and the pumphouse was removed in 1996.

Primary investigations of the former BFTF, Site 13, included the following:

- Sampling of soil, active zone water, and surface water in 1990 and 1991
- A free-product investigation in 1997

The Navy also performed sampling at the former BFTF, Site 13, in 1997 to provide data to support a baseline risk assessment. Surface soils, subsurface soils, active zone water, surface water, and sediment were sampled, and a variety of organic compounds and metals were found in each medium sampled. The primary chemicals found to exceed ADEC cleanup standards during this event were as follows:

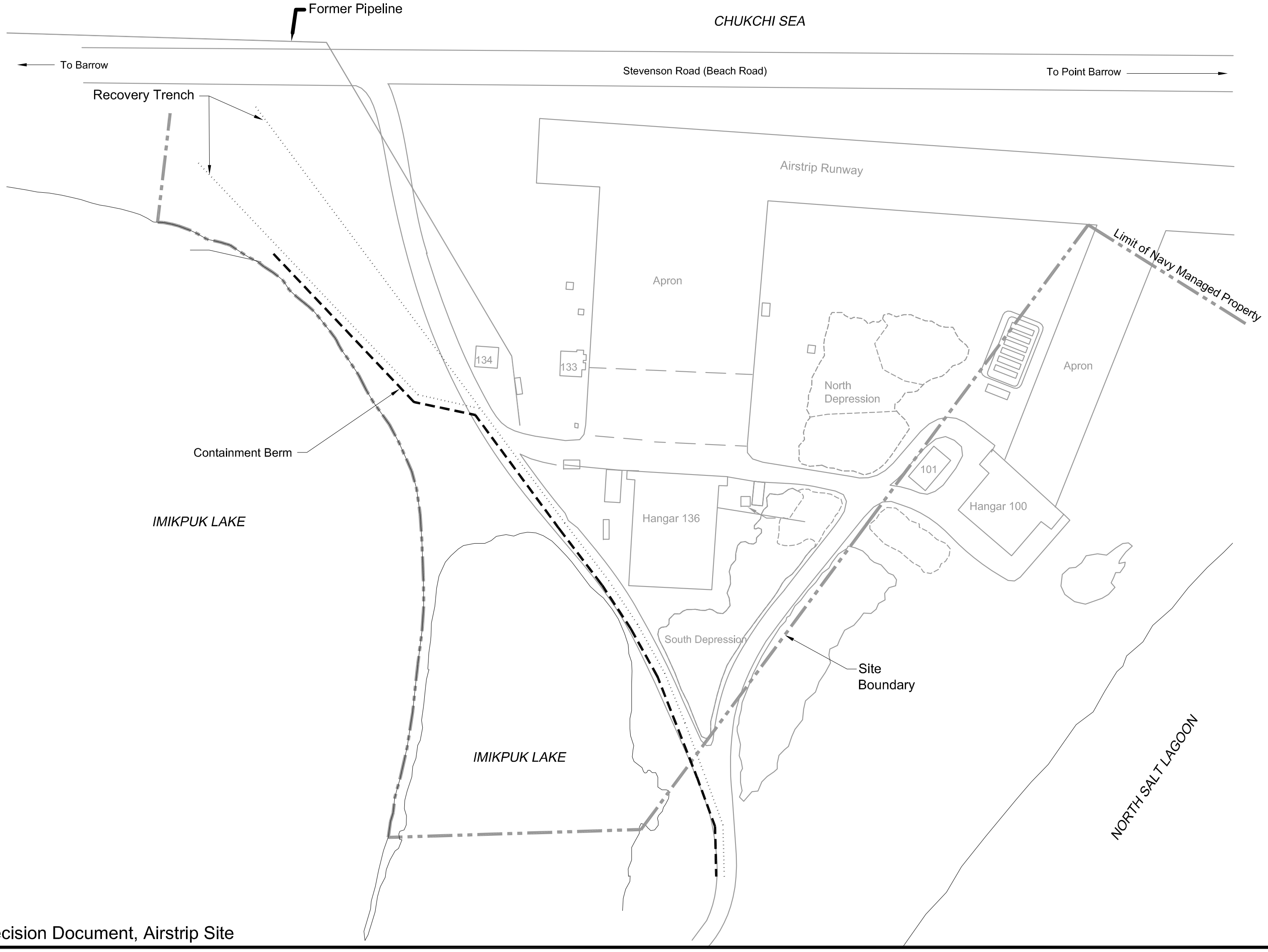
- DRO and lead in surface soil
- GRO in subsurface soil
- Benzene, vinyl chloride, pentachlorophenol, and lead in active zone water
- DRO in sediments

No chemical exceeded ADEC standards in surface water.

Initial human health and ecological risk assessments were performed for sites at the former NARL complex (including the former BFTF) in the early 1990s (U.S. Navy, ADEC, and UIC 2003b). Subsequent to the initial risk assessments, a methodology was developed where the Navy solicited input from community members and ADEC to address potential risks due to TPH fractions (GRO, DRO, and RRO) in site media. Using this new methodology, a baseline risk assessment for the former BFTF was completed in 1999 using the site investigation data (U.S. Navy 1999b). The purpose of the baseline risk assessment was to determine the potential for adverse health effects for people using the site (residents, industrial workers, construction workers, and recreational/subsistence users) and wildlife that may use the site or be exposed to chemicals in North Salt Lagoon.

Supplemental risk calculations were completed in 2000 for inhalation of volatiles from soil and groundwater both outdoors and inside buildings and for consumption of fish from North Salt Lagoon (U.S. Navy, ADEC, and UIC 2003b). The inhalation of gases from soil and active zone groundwater were assessed in a technical response letter prepared following the baseline risk assessment. Risks were modeled for residential, commercial/industrial, and construction worker exposures and shown to be below ADEC risk management thresholds (U.S. Navy, ADEC, and UIC 2003b). Risks associated with ingestion of fish were re-estimated based on revised fish ingestion rates and were found to be above ADEC risk management thresholds because of the DRO-aliphatic fraction concentration detected in surface water and sediment of North Salt Lagoon (U.S. Navy, ADEC, and UIC 2003b). To more accurately assess risks from eating North Salt Lagoon fish, another study was conducted where fish were caught from the lagoon and chemically analyzed for petroleum hydrocarbons. TPH compounds were not detected in the fish tissue, and recalculated risks from fish ingestion resulted in risks below the ADEC management thresholds (U.S. Navy, ADEC, and UIC 2003b).

Based on the risk reevaluations, the former BFTF, Site 13, poses potentially unacceptable human health site risks to future construction workers from inhalation of volatile chemicals from soil and to future recreational children from dermal contact with DRO in the melt water pond surface water (U.S. Navy, ADEC, and UIC 2003b). Furthermore, the site also poses moderate ecological risks primarily from DRO and lead in soil.



Source: 2002 Decision Document, Airstrip Site

U.S. NAVY

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0 150 300

SCALE IN FEET

Figure 3-1
Airstrip, Site 5

Naval Arctic
Research Laboratory
Barrow, AK
SECOND 5-YEAR REVIEW

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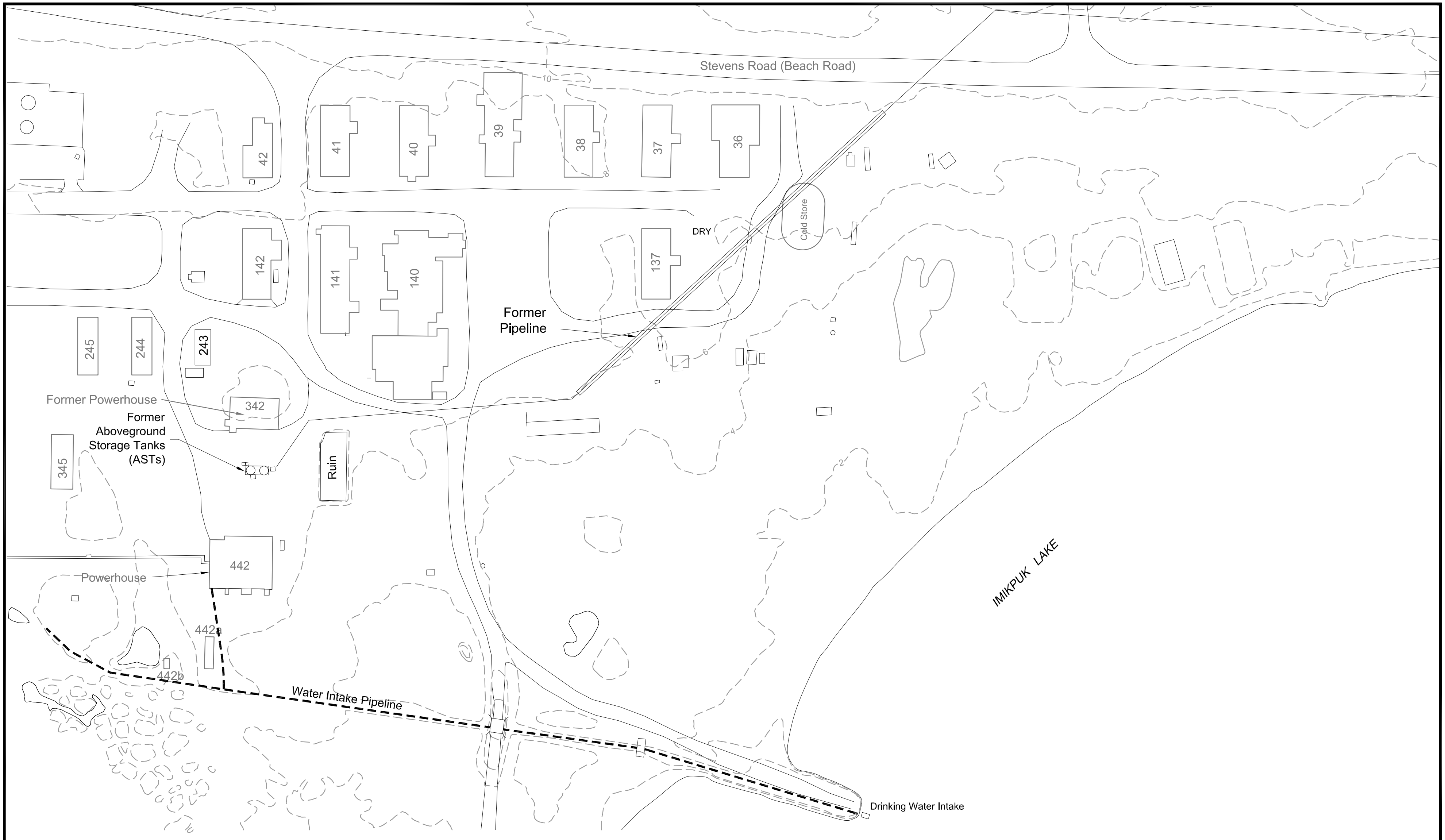

Source: 2002 Decision Document, Powerhouse Site

U.S. NAVY

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SCALE IN FEET

Figure 3-2
Powerhouse, Site 12

Naval Arctic
Research Laboratory
Barrow, AK
SECOND 5-YEAR REVIEW

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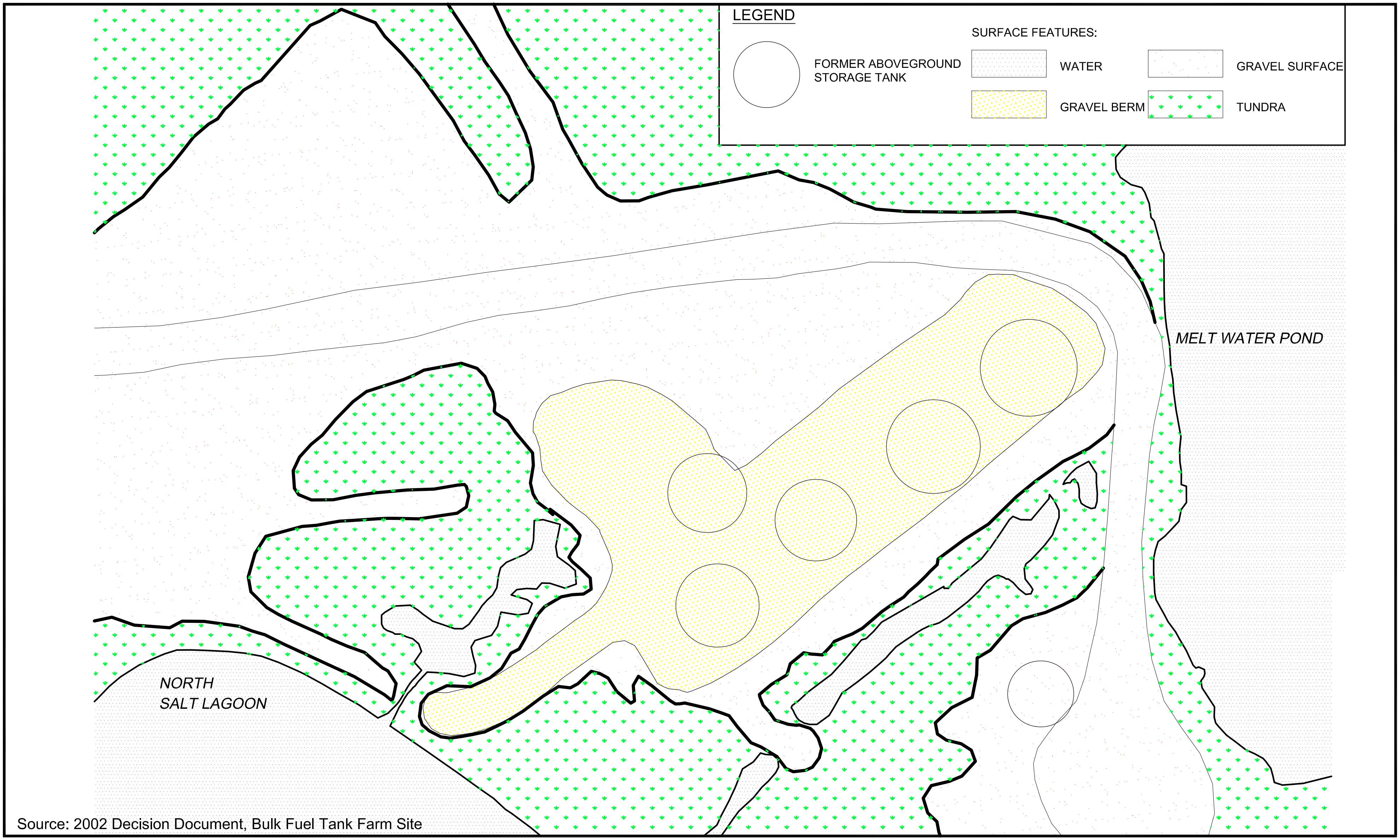

Source: 2002 Decision Document, Bulk Fuel Tank Farm Site

U.S. NAVY

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SCALE IN FEET

Figure 3-3
Former Bulk Fuel Tank Farm, Site 13

Naval Arctic
Research Laboratory
Barrow, AK
SECOND 5-YEAR REVIEW

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4.0 CLEANUP ACTIONS

This section summarizes the cleanup action objectives (CAOs), selected cleanup actions, and operation, maintenance, and monitoring requirements for each of the three sites.

The first comprehensive long-term monitoring plan for the Airstrip (Site 5), Powerhouse (Site 12), and BFTF (Site 13) sites was published in April 2004 (U.S. Navy 2004a). Starting in 2005, annual project plans were prepared for conducting the long-term monitoring at the three sites (U.S. Navy 2005a, 2006c, 2007b, 2008a, 2009a, 2010a, 2011a, 2012a, and 2012b).

4.1 AIRSTRIP, SITE 5

4.1.1 Airstrip, Site 5, Cleanup Action Objectives

Although not termed “CAOs” in the DD, the following objectives can be inferred from the risk assessment summary and cleanup level discussion in the Airstrip, Site 5, DD. Objectives are identified for soil, active zone water, and soil/sediment at the south depression (Figure 3-1):

- Protect persons who may contact site soil containing chemicals of concern (COCs) above ADEC maximum allowable concentrations for unrestricted site use in the Arctic Zone, as listed in Table B2 of 18 Alaska Administrative Code (AAC) 75.341(d).
- Protect construction workers who may contact active zone water containing DRO during soil excavation activities in the vicinity of the apron.
- Protect ecological receptors in the south depression from COC concentrations in groundwater above risk-based levels.
- Reduce the potential for soil/sediment to produce a sheen in the south depression if disturbed.
- Clean up the soil/sediment in the south depression with the intent of preventing potential contamination of intermittent surface water in the depression.
- Control potential migration of contaminants from the site to Imikpuk Lake.
- For the former NARL facility as a whole, achieve an acceptable cumulative risk, as estimated from a cumulative risk evaluation.

4.1.2 Airstrip, Site 5, Cleanup Action Selection

The selected cleanup action for the Airstrip, Site 5, includes the following:

- Excavate and treat approximately 2,400 cubic yards of petroleum-contaminated soils using HAVE.
- Place a 1-foot-thick soil cap over approximately one-third of the north end of the south depression.
- Conduct a 5-year monitoring program for monitoring natural attenuation of constituents in active zone water.
- Conduct a 5-year monitoring program for monitoring Imikpuk Lake surface water quality.
- After 5 years of operation, evaluate the need for continued monitoring.
- Evaluate the cumulative residual risk for the site after cleanup levels have been achieved at the former NARL facility.

4.1.3 Airstrip, Site 5, Cleanup Action Implementation

Excavation of soil contaminated with GRO from the area between and south of Buildings 133 and 134 (Figure 3-1) was completed in October 2002 (U.S. Navy 2003c). A total of 2,028 cubic yards of soil was excavated from this area to a depth of approximately 30 inches below ground surface (bgs) (approximately 6 inches above the groundwater surface). Four of five post-excavation soil samples collected from the walls of the excavation and submitted for laboratory analysis contained GRO and total xylenes at concentrations below the DD cleanup levels of 1,440 and 81 mg/kg, respectively. One post-excavation soil sample collected from the south wall of the excavation contained GRO at 1,660 mg/kg, which exceeded the DD cleanup level. This sample also contained total xylenes at 170.1 mg/kg, which exceeded the DD cleanup level.

Excavation of DRO-contaminated soil from the area west of the north depression was completed in November 2002. A total of 240 cubic yards of soil was excavated from this area, to a depth of approximately 18 inches bgs (approximately 6 inches above the groundwater surface). One post-excavation soil sample was collected from the sidewall of the excavation and submitted for laboratory analysis. This sample contained DRO, GRO, and total xylenes at concentrations less than the DD cleanup levels of 12,500, 1,440, and 81 mg/kg, respectively.

Soil excavated from both areas was treated at Hangar 136 concurrent with treatment of soil previously stockpiled within the hangar (approximately 435 cubic yards). The soil was treated in five treatment piles using HAVE technology. Treatment times ranged from 7 to 13 days per pile. During treatment, a post-treatment soil sample showed that a portion of treatment pile 1 did not meet the treatment endpoint criteria. Eighty-five cubic yards of soil represented by this soil sample were re-treated as part of treatment pile 3. Final post-treatment soil samples demonstrated that treatment endpoints were reached. Treated soil was used to backfill the excavations and to perform capping of the south depression in December 2002. Because of the lateness of the season and the inability to dewater the south depression, the 1-foot-thick cap at the south depression was placed over ice.

4.1.4 Airstrip, Site 5, Operation, Maintenance, and Monitoring

The first post-DD long-term monitoring event at the Airstrip site was performed in 2003, in accordance with a site-specific monitoring plan published in 2003 (U.S. Navy 2003d). Monitoring according to project plans has been conducted twice per year starting in 2003 and annually since 2009 and is documented in annual reports (U.S Navy 2004d, 2005b, 2006a, 2007a, 2008c, 2009c, 2010b, 2011c, 2012c, and 2013a).

Monitoring Required

The Airstrip, Site 5, DD required monitoring of eight wells, including four wells located along the lake shoreline. Sampling was to be conducted two times per year, with analysis for the following analytes: GRO, DRO, and VOCs (BTEX and 1,2-dichloroethane [1,2-DCA]), as well as geochemical indicators of petroleum hydrocarbon degradation. The monitoring program was established to ensure that active zone water entering Imikpuk Lake meets both the drinking water standards and surface water quality standards and to assess the effectiveness of natural attenuation at the site. In addition, active zone water associated with contaminated soil areas was to be monitored to ensure that the contamination concentrations are decreasing and that contamination is not moving toward the lake. Surface water quality was to be monitored for GRO, DRO, BTEX, and 1,2-DCA at four locations in Imikpuk Lake once per year.

The DD established specific performance criteria for natural attenuation based on the monitoring data and established contingent actions triggered by the monitoring data. The DD also required review of the monitoring program after 5 years and established decision endpoints based on the monitoring data. In addition, the DD required that if the specific wells designated for monitoring were destroyed, replacement wells must be installed in approximately the same locations. Table 4-1 summarizes the monitoring requirements as listed in the DD for the Airstrip, Site 5.

Because active zone water from monitoring wells still exceeded criteria established in the DD, the first 5-year review recommended continued monitoring at the Airstrip until the DD criteria for cessation of monitoring are met (U.S. Navy 2008b). Based on the first 5-year review recommendations (U.S. Navy 2008b), maintenance and monitoring requirements were revised as follows:

- Since 2008, the 2007 well AS-WP-101 was relocated, and more representative data have been gathered than from the 2007 well location. The location of this well in 2008 through 2011 is consistent with its location in 2005 and 2006.
- Since 2008, 1,2-DCA monitoring was discontinued at all locations, except AS-WP-10 and AS-SW-02.

Monitoring Performed

Post-DD monitoring at the Airstrip, Site 5, began in 2003, the year following completion of soil excavation and treatment (U.S. Navy 2004a). Annual monitoring plans have included the eight wells and four surface water sampling locations required by the DD. However, the arctic environment and the hydrogeology of the site have sometimes prevented sample collection from some of the required wells. For example, monitoring well AS-WP-18 replaced Well J because of unsuccessful sampling attempts during the first 5-year review period. Wells AS-WP-02, AS-WP-10, AS-WP-11, AS-WP-12, AS-WP-16, and AS-WP-21 have been consistently sampled.

During the 2008 field event, visual site inspections and sample collection were conducted during two sampling rounds once in July and once in September (U.S. Navy 2009c). Starting in 2009, only one field event per year was conducted (U.S. Navy 2010b, 2011c, 2012c, and 2013a). As documented in an ADEC (2009) letter to the Navy, annual monitoring was determined to be sufficient because there were statistically minimal differences in the results of the twice-per-year sampling, making the second sampling event redundant. However, the Navy will resume biannual sampling when the site is at or approaching the DD cleanup levels. The following items were noted in the 2008 to 2012 annual reports regarding well sampling:

- All wells were intact in 2008, and the original AS-WP-101 well was located and sampled.
- In 2009, active zone water sampling was conducted in September and no wells were reinstalled (U.S. Navy 2010b).
- In 2010, well AS-WP-02 was reinstalled deeper and renamed AS-WP-02B (U.S. Navy 2011c), and one round of active zone water sampling was conducted in August/September.

- The 2011 field activities occurred in August and no monitoring wells were replaced (U.S. Navy 2012c).

- In 2012, well AS-WP-16 was found broken off at the ground surface and was reinstalled within the same location and named AS-WP-16B (U.S. Navy 2013a).

Four surface water samples have been collected and analyzed from Imikpuk Lake at least once per year between 2005 and 2012 as required by the DD. Surface water samples were collected twice during 2004 and 2008.

Groundwater and surface water samples from each sampling event have been analyzed for GRO, DRO, and VOCs, as required by the DD, and modified by the recommendations in the first 5-year review. Analysis of geochemical indicators of petroleum hydrocarbon degradation has also been conducted during each sampling event. The natural attenuation parameters tested for have generally consisted of the following, with some variation in the analyte list as the monitoring program evolved:

- Dissolved oxygen
- Oxidation-reduction potential
- pH
- Temperature
- Conductivity
- Salinity
- Turbidity
- Nitrate
- Sulfate
- Methane
- Ferrous iron
- Alkalinity

These parameters have been analyzed variously using a field instrument, analyte-specific colorimetric field test kits, or by an off-site analytical laboratory.

During the 2010 field season, a soil investigation at the Airstrip and Powerhouse sites was conducted to assess the location and magnitude of petroleum compounds that may be contributing to the increasing trends and exceedances in the active zone water (U.S. Navy 2011c). Soil samples were collected from five borings at each site according to long-term monitoring project plan Field Procedure 6 (U.S. Navy 2010a). Soil samples consisted of grab samples from two depths out of each boring, generally from 8 to 12 inches and then 26 to

30 inches bgs. These soil samples were analyzed for GRO, DRO, RRO, and BTEX (U.S. Navy 2011c). The soil investigation results are discussed in Section 6.4.1.

In 2011, four new monitoring wells were installed by USAF (AFAS-WP-19 through AFAS-WP-22) as part of the USAF Clean Sweep Program at Barrow (U.S. Navy 2013a). These wells were installed in the vicinity of the south depression area and the eastern ponds to determine if residual contamination is migrating from the south depression toward the eastern ponds and ultimately to the North Salt Lagoon. Results are included in Section 6.4.1.

During the summer of 2012, a soil investigation at the Airstrip site was conducted to assess the location and magnitude of petroleum compounds that may be contributing to the increasing trends and exceedances in the active zone water. One hundred and five locations were screened using a direct-push drill rig to advance an Ultraviolet Optical Screening Tool (UVOST), which determines the presence or absence of fuels by measuring the fluorescence returned from a laser probe pushed into the soil. The UVOST field investigation logged DRO, GRO, and RRO levels, while BTEX logging was not performed because of the additional cost required for a 10-membrane interface probe. Soil borings were obtained from at least 10 percent of the UVOST locations (i.e., 11 soil borings), including the locations identified as containing the highest levels of contaminants. In addition, one surface soil sample was collected in the east corner of Hangar 136 below an AST where significant hydrocarbon staining was observed. Samples were analyzed for GRO, DRO, and BTEX (U.S. Navy 2012c). Section 6.4.1 discusses the 2012 soil investigation results.

4.2 POWERHOUSE, SITE 12

4.2.1 Powerhouse, Site 12, Cleanup Action Objectives

Although not termed CAOs in the DD, the following objectives can be inferred from the risk assessment summary and cleanup level discussion in the Powerhouse, Site 12, DD. Objectives are identified for soil and active zone water:

- Protect persons who may contact site soil containing COCs above ADEC maximum allowable concentrations for unrestricted site use in the Arctic Zone, as listed in Table B2 of 18 AAC 75.341(d).

- Protect construction workers who may contact active zone water containing DRO during soil excavation activities.

- Control potential migration of contaminants from the site to Imikpuk Lake.

- For the former NARL facility as a whole, achieve an acceptable cumulative risk, as estimated from a cumulative risk evaluation.

4.2.2 Powerhouse, Site 12, Cleanup Action Selection

The selected cleanup action for the Powerhouse, Site 12, includes the following:

- Sample soils beneath the former Powerhouse for PCBs, GRO, DRO, and RRO after building demolition is complete.
- Excavate soil next to Building 140 that contains PCBs above the ADEC soil cleanup level for unrestricted site use and dispose of soil off site. If PCB-contaminated soil is encountered beneath the former Powerhouse, also excavate and dispose of this soil in a permitted off-site landfill.
- Excavate petroleum-contaminated soil adjacent to the former ASTs and beneath the former Powerhouse. The intent would be to remove all soil above cleanup levels. Transport petroleum-contaminated soil to the Navy’s Airstrip, Site 5, for treatment using HAVE.
- Excavate and treat, using HAVE, an estimated 150 cubic yards of stained surface soil.
- Conduct a 5-year monitoring program for monitoring natural attenuation of constituents in active zone water.
- Conduct a 5-year monitoring program for monitoring Imikpuk Lake surface water quality.
- After 5 years of operation, evaluate the need for continued monitoring.
- Evaluate the cumulative residual risk for the site after cleanup levels have been achieved at the former NARL facility.

4.2.3 Powerhouse, Site 12, Cleanup Action Implementation

Excavation of soil beneath the former Powerhouse was completed in August 2003 (U.S. Navy 2003a). Based on soil samples collected from beneath the building in June 2003 (U.S. Navy 2003a), soil containing RRO above the DD cleanup level was hand excavated from two locations. Soil was excavated in 6-foot-square areas at each location, from the building floor to the permafrost layer (approximately 18 inches deep). Confirmation samples showed that soil containing RRO above the DD cleanup level of 22,000 mg/kg had been removed. The confirmation samples also did not contain total PCBs above 1 mg/kg. Note that PCBs, GRO, and DRO were not detected above DD cleanup levels in any of the soil samples collected in June 2003 prior to excavation activities.

Approximately 9 cubic yards of PCB-containing soil located adjacent to Building 140 was excavated and packaged for off-site disposal in August 2003 (U.S. Navy 2004b). Confirmation samples collected from the walls and floor of the excavation did not contain total PCBs at concentrations greater than the DD cleanup level of 1 mg/kg.

Also in August 2003, approximately 150 cubic yards of stained surface soil located adjacent to Building 342 (former Powerhouse) were excavated to a depth of 12 to 15 inches bgs and transported to Hangar 136 for treatment using the HAVE technology. Screening soil samples were collected during excavation and used to assess when sufficient soil had been excavated. Confirmation soil samples collected from the walls and floor of the excavation did not contain DRO or RRO at concentrations exceeding the DD cleanup levels for these petroleum fractions of 12,500 and 22,000 mg/kg, respectively (U.S. Navy 2004b).

At the former AST area, approximately 77 cubic yards of petroleum-contaminated soil were excavated to depths of 18 to 30 inches bgs. This excavation was also performed in August 2003, coincident with the other cleanup activities at the site. Confirmation soil samples collected from the walls and floor of the excavation did not contain DRO or RRO at concentrations exceeding the DD cleanup levels for these petroleum fractions of 12,500 and 22,000 mg/kg, respectively (U.S. Navy 2004b).

Petroleum-contaminated soil was treated using HAVE technology, as required by the DD. Treatment of soil from the Powerhouse, Site 12, was performed at Hangar 136 and completed by the end of August 2003. A total of 236 cubic yards of soil from the Powerhouse were treated, together with soil from other NARL sites. Samples of the treated soil demonstrated that the soil met the endpoint goals following treatment (U.S. Navy 2004b).

During demolition of the AST stand in 2001, the contractor removed associated piping, separating it from what appeared to be an abandoned unused fuel storage tank located adjacent to the north side of Building 442. Consequently, a spill of fresh diesel fuel was discovered in July 2002. UIC excavated the impacted soil, and the Navy treated it, but it is likely that additional contamination of groundwater occurred. This spill was managed through the ADEC Spill Prevention and Response Program rather than the Contaminated Sites Program (ADEC 2008b).

4.2.4 Powerhouse, Site 12, Operation, Maintenance, and Monitoring

The first post-DD long-term monitoring event at the Powerhouse was performed in 2004 (U.S. Navy 2005b). Monitoring according to project plans has been conducted twice a year starting in 2004 and annually since 2009 and is documented in annual reports (U.S Navy 2005b, 2006a, 2007a, 2008c, 2009c, 2010b, 2011c, 2012c, and 2013a).

Monitoring Required

The Powerhouse, Site 12, DD required long-term monitoring of active zone water using seven existing wells and two newly developed wells (for a total of nine wells). The monitoring program was established to ensure that active zone water entering Imikpuk Lake meets both the drinking water standards and surface water quality standards, as well as to assess the effectiveness of natural attenuation at the site. In addition, active zone water associated with contaminated soil areas was to be monitored to ensure that the contaminant concentrations are decreasing and contamination is not moving toward the lake. The DD required that if the specific wells designated for monitoring were destroyed, replacement wells must be installed in approximately the same locations.

Monitoring using the nine monitoring wells was to be performed twice per year, in early July and late September. In addition, three Imikpuk Lake surface water locations were to be monitored once per year (early July). The active zone water and surface water samples were to be analyzed for GRO, DRO, RRO, VOCs, and geochemical indicators of petroleum hydrocarbon biodegradation to support demonstration that the hydrocarbons in groundwater are attenuating naturally.

The DD established specific performance criteria for natural attenuation based on the monitoring data and established contingent actions triggered by the monitoring data. The DD also required review of the monitoring program after 5 years and established decision endpoints based on the monitoring data. Table 4-2 summarizes the monitoring and maintenance requirements as listed in the DD for the Powerhouse, Site 12.

Because active zone water from monitoring wells still exceeded criteria established in the DD, the first 5-year review recommended continued monitoring at the Powerhouse (Site 12) until the DD criteria for cessation of monitoring are met (U.S. Navy 2008b). Based on the first 5-year review recommendations (U.S. Navy 2008b), monitoring requirements were revised as follows:

- Since 2008, analysis for tetrachloroethene (PCE) was discontinued in active zone water samples.

- Since 2008, analysis for GRO was discontinued at monitoring wells PH-MW-06, PH-WP-01, and PH-WP-03.

Monitoring Performed

All nine wells selected for monitoring in the DD (except PH-MW-02 replaced PH-WP-08) were monitored during two field events in 2008 (July and September). Starting in 2009, only one field event per year was conducted, as approved by the Navy and ADEC and documented in the ADEC (2009) letter to the Navy. However, the Navy will resume biannual sampling when the site is at or approaching the DD cleanup levels. The following wells were routinely sampled: PH-MW-02, PH-MW-06, PH-MW-10, PH-MW-11, PH-WP-01, PH-WP-02, PH-WP-03, PH-WP-06, and PH-WP-09. The following items were noted in the 2008 and 2012 annual reports regarding well sampling:

- During July 2008, well PH-WP-01 was reinstalled (note that it was found out of the ground in September 2007) at approximately 44 feet to the southwest of the original location and renamed PH-WP-01B (U.S. Navy 2009c). Well PH-WP-02 was found dry during July.

- In 2009, active zone water sampling was conducted once in September. Well PH-MW-10 was reinstalled approximately 10 feet west of its previous location and renamed PH-MW-10B (U.S. Navy 2010b). Well PH-WP-02 was noted as dry during this sampling event.

- In 2010, well PH-MW-02 was found dry, and, thus, the casing was pulled out and a new casing was installed within the same boring. The well was renamed PH-MW-02B. PH-WP-01B ran dry during well stabilization; therefore, the casing was pulled out and a new casing was installed within the same boring. The well was renamed PH-WP-01C (U.S. Navy 2011c).

- In 2011, well PH-WP-03 was reinstalled 1 foot north of its previous location and renamed PH-MW-03B (U.S. Navy 2012c).

- In 2012, no monitoring wells required replacement, and sampling was conducted in August (U.S. Navy 2013a).

Groundwater samples from each sampling event have been analyzed for GRO, DRO, RRO, and VOCs, as required by the DD and modified by the recommendations in the first 5-year review. Analysis of geochemical indicators of petroleum hydrocarbon degradation has also been conducted during each sampling event. The natural attenuation parameters tested for have generally consisted of the following, with some variation in the analyte list as the monitoring program evolved:

- Dissolved oxygen
- Oxidation-reduction potential
- pH
- Temperature
- Conductivity
- Salinity
- Turbidity
- Nitrate
- Sulfate
- Methane
- Ferrous iron
- Alkalinity

These parameters have been analyzed variously using a field instrument, analyte-specific colorimetric field test kits, or an off-site analytical laboratory.

Three surface water stations were monitored once per year during this 5-year review period and samples were analyzed for GRO, DRO, RRO, and VOCs, as required by the DD. Surface water samples were not analyzed for RRO as required by the DD in 2004 and 2005, but were analyzed for RRO starting in 2006 through 2012.

Section 4.1.4 (under Monitoring Performed) provides details of the soil investigation conducted in 2010 at the Airstrip and Powerhouse sites. The additional soil investigation was performed to determine the location and magnitude of petroleum compounds that may be contributing to the increasing trends and exceedances in the active zone water (U.S. Navy 2011c). The soil investigation results are discussed in Section 6.4.2.

During the summer of 2012, a soil investigation at the Powerhouse site was conducted to address increasing trends and exceedances in the active zone water. Sixty-seven locations were screened using UVOST technology. The UVOST field investigation logged DRO, GRO, and RRO levels, while BTEX logging was not performed. Soil borings were obtained from at least 10 percent of the UVOST locations (i.e., 12 borings), including the locations identified as containing the highest levels of contaminants. However, samples were only collected from 11 of the soil borings, because the sample from one boring (PH4-B12) had no signs of contamination (no staining or odor). Samples were analyzed for GRO, DRO, and BTEX (U.S. Navy 2012c). The 2012 soil investigation results are discussed in Section 6.4.2.

4.3 FORMER BULK FUEL TANK FARM, SITE 13

4.3.1 Former Bulk Fuel Tank Farm, Site 13, Cleanup Action Objectives

CAOs for the former BFTF, Site 13, are tabulated in the DD Tables 1 and 2. Additional CAOs can be inferred from the risk assessment summary and cleanup level discussion in the former BFTF, Site 13, DD. CAOs are identified for surface and subsurface soil, active zone water, and groundwater discharging to surface water:

- Prevent exposures of wildlife to lead and DRO in surface soil.
- Prevent exposures of construction workers to VOCs in subsurface soil.
- Prevent potential exposures of aquatic organisms and wildlife to active zone water containing COCs discharging to surface water.
- Prevent exposures of construction workers during soil excavation activities to active zone water containing DRO.
- For the former NARL facility as a whole, achieve an acceptable cumulative risk, as estimated from a cumulative risk evaluation.

4.3.2 Former Bulk Fuel Tank Farm, Site 13, Cleanup Action Selection

The selected cleanup action for the former BFTF, Site 13, includes the following:

- Excavate soil with the highest contamination concentrations, located at the turnaround area and the south bank of the gravel pad. Transport this soil to the NARL Airstrip, Site 5, for thermal treatment using HAVE.
- Construct biological treatment cells at the south end of the NARL Airstrip site and/or at the gravel pad itself. Contaminated soil from the gravel pad and surrounding tundra that is not HAVE treated will be placed in the biocells and treated by landfarming.
- If soil treatment endpoints from landfarming are not reached at the end of one treatment season, transport remaining contaminated soil to the NARL Airstrip site for thermal treatment using HAVE.
- Conduct a 5-year program monitoring the natural attenuation of active zone water along the shorelines of the nearby melt water pond and North Salt Lagoon.

- Conduct a 5-year monitoring program for natural attenuation of sediments in North Salt Lagoon to verify that contaminant transport has ceased following soil cleanup.

- After 5 years of operation, evaluate the need for continued monitoring.

- Evaluate the cumulative residual risk for the site after cleanup levels have been achieved at the former NARL facility.

4.3.3 Former Bulk Fuel Tank Farm, Site 13, Cleanup Action Implementation

Soil excavation and HAVE treatment activities at the former BFTF, Site 13, were conducted in June 2003 (U.S. Navy 2004b). HAVE treatment was chosen for the areas with the highest contaminant levels, which ranged up to 24,700 mg/kg of DRO-aliphatic. A total of 3,080 cubic yards of petroleum-contaminated soil was excavated from the south bank of the gravel pad and treated using HAVE. Soils were excavated, transported to the Airstrip, Site 5, for treatment, and returned to the excavation after reaching treatment endpoint criteria (U.S. Navy 2004c).

The DD anticipated that approximately 600 cubic yards of petroleum-contaminated soil would also be excavated from the former BFTF turnaround area for HAVE treatment. However, because a substantially larger than anticipated volume of petroleum-contaminated soil was found during excavation along the south bank of the gravel pad, a field decision was made to excavate and treat (using HAVE) a larger volume of south bank soil in lieu of creating a new excavation in the middle of the turnaround area (U.S. Navy 2004c).

Landfarming was used to treat approximately 4,700 cubic yards of petroleum-contaminated soil at the gravel pad. Of the 4,700 cubic yards of this landfarmed soil, 3,800 cubic yards were from within the gravel pad itself and 900 cubic yards were from outlying areas (nearby, but not on, the gravel pad). Landfarming was one of the treatment technologies selected in the DD (U.S. Navy 2004c). Plans to excavate and landfarm soil from around outlying historical sampling location “90” (U.S. Navy 2003d) were cancelled in the field because of standing water in that area (U.S. Navy 2004c). Landfarming was performed from July 12 through September 3, 2003, and the Navy and ADEC concurred that the landfarming operation had met its endpoint goals (U.S. Navy 2006b). Landfarmed soil was left in place following completion of landfarming. No additional cap material was placed on top of the gravel pad after landfarming (U.S. Navy 2004c).

Treatment, backfilling, and final grading were completed by early October 2003. All HAVE-treated soil met the treatment endpoint criteria. All post-treatment landfarm soil samples were well below the target landfarm cleanup levels for GRO, benzene, BTEX, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene (U.S. Navy 2004c). Final DRO concentrations in landfarm-treated soil ranged from 113 to 684 mg/kg. Four of the post-treatment samples from the landfarmed soil contained DRO above the ADEC Method 1 cleanup level of 500 mg/kg, the DD cleanup level for soil left in place. All four were below the former BFTF, Site 13, risk-based cleanup level of 1,328 mg/kg, the DD goal for treatment of soil.

All four post-excavation soil samples collected in 2003 from the sidewalls of the south bank excavation exceeded the DD cleanup level for soil left in place for DRO (500 mg/kg). DRO concentrations in these samples ranged from 1,940 to 37,000 mg/kg. These samples were collected from the points where field screening indicated the highest remaining contamination. In all cases, this was immediately above the permafrost. The DRO concentrations in these samples represent remaining conditions in the subsurface soil just above the permafrost outside the limits of the excavation (U.S. Navy 2004c).

Following completion of soil removal and treatment in 2003, concerns were raised that the number of post-landfarming soil samples (10) was insufficient to verify that landfarming treatment had met the endpoint goals. Therefore, 16 additional soil samples were collected by the Navy in the landfarmed area in July 2006 at the request of ADEC and UIC. These samples were analyzed for DRO by ADEC Method AK102. DRO concentrations in the samples ranged from 27.1 to 2,530 mg/kg. DRO concentrations in soil from near permafrost and the active groundwater layer were generally higher. With the exception of one sample, all soil samples collected from within 24 inches of ground surface contained DRO at concentrations below 500 mg/kg (U.S. Navy 2006b). The overall site average and 95 percent upper confidence limit for remaining DRO in the landfarmed soil are above the landfarm cleanup goal of 500 mg/kg, but below the risk-based cleanup level of 1,328 mg/kg.

A third confirmation sampling event started in September 2007 was terminated early because of security concerns. The sampling event was completed in September 2008. The former BFTF landfarmed area was sampled using the multi-incremental sampling approach developed by ADEC. The area was divided into 4 decision units, and 30 sampling locations within each of the four decision units were randomly selected in accordance with 18 AAC 75.335(b) requirements. Sample intervals included the 0- to 18-inch and 18- to 36-inch depths. The samples were composited, sieved, and secondarily composited as described in the 2008 former BFTF confirmation sampling report (U.S. Navy 2009b). This resulted in a total of eight samples (six environmental and two quality control samples). Each sample was sent to the laboratory for DRO (Method AK102) chemical analysis. DRO results from the 0- to 18-inch-interval samples were compared to the 500 mg/kg level and the 18- to 36-inch-interval samples to the risk-based cleanup level of 1,328 mg/kg to determine whether the site had achieved the cleanup goals. Results indicated that DRO exceeded the 500 mg/kg surface soil cleanup level at one location (BFTF-CS-02a) at a reported level of 630 mg/kg. No subsurface location sample exceeded the 1,328 mg/kg cleanup level. Based on only one sample slightly exceeding the cleanup level in surface soil and the long-term monitoring program data supporting the conclusion that contaminants are not migrating off site, the Navy concluded that no further action is recommended for site soils at the former BFTF site (U.S. Navy 2009b). However, ADEC's (2010) review of the 2008 confirmation sampling report concluded that soil at the former BFTF, except for soil in decision unit 1a, would require additional in situ treatment to meet the DRO cleanup level of 500 mg/kg. Alternatively, ADEC recommended that the cleanup team members could revise, through cooperative agreement, the DRO cleanup level so that it is less conservative. Additional treatment of the soil would then not be necessary.

As identified in the first 5-year review, none of the soil samples collected during or following soil removal and treatment was analyzed for lead, although the DD established a cleanup level for lead in soil. The first 5-year review recommended including lead in the 2008 confirmatory sampling described above; however, lead analysis was inadvertently not included.

4.3.4 Former Bulk Fuel Tank Farm, Site 13, Operation, Maintenance, and Monitoring

The first post-DD long-term monitoring event at the former BFTF site was performed in 2004 (U.S. Navy 2005b). Monitoring according to project plans has been conducted twice per year starting in 2004 and annually since 2009 and is documented in annual reports (U.S Navy 2005b, 2006a, 2007a, 2008c, 2009c, 2010b, 2011c, 2012c, and 2013a).

Monitoring Required

The former BFTF, Site 13, DD required a 5-year monitoring program for the active zone water to track contaminant concentration trends in the active zone water near the interface with surface waters at the melt water pond and North Salt Lagoon. Monitoring was to be performed to determine whether the remediation of soils had prevented further contamination of the surface water bodies and to demonstrate the natural attenuation of active zone water. Three sentinel wells were to be installed along the road to the east of the raised gravel pad to monitor for possible migration of the impacted active zone water toward the melt water pond. Similarly, three sentinel wells were to be installed along the southwest shoreline to monitor for possible migration of the impacted active zone water toward the North Salt Lagoon. One sample was to be collected from active zone water from each of the sentinel wells in July and September of each year. These groundwater samples were to be analyzed for benzene, xylenes, GRO, DRO, and RRO using EPA Method SW8260 and ADEC Methods AK101, AK102, and/or AK103 as appropriate. Note that monitoring for lead was not required, although cleanup levels for lead in surface soil and active zone water were established in the DD. The DD required that if the specific wells designated for monitoring were destroyed during the monitoring program, replacement wells must be installed in approximately the same locations.

The BFTF, Site 13, DD also required a monitoring program for sediments to monitor trends in sediment concentrations in North Salt Lagoon to determine whether COCs in the sediments were naturally attenuating. Three samples were to be collected in September of each year from the same locations sampled in 1997 from North Salt Lagoon. These sediment samples were to be analyzed for GRO and DRO using ADEC Methods AK101 and AK102, respectively. Table 4-3 summarizes the monitoring requirements as listed in the DD for the BFTF, Site 13.

Because active zone water from monitoring wells still exceeded criteria established in the DD, the first 5-year review recommended continued monitoring at the BFTF (Site 13) until the DD criteria for cessation of monitoring are met (U.S. Navy 2008b). Based on the first 5-year review recommendations (U.S. Navy 2008b), monitoring requirements were revised as follows:

- Since 2008, total lead was added to the analyte list for sediment locations in North Salt Lagoon.
- Since 2008, dissolved lead was added to the analyte list for active zone water samples.
- Since 2008, analysis of GRO and BTEX was discontinued at monitoring wells BFTF-WP-04, BFTF-WP-05, and BFTF-WP-06.

Monitoring Performed

The six sentinel wells required by the DD and one background well were monitored during two field events in 2008 (July and September). Starting in 2009, only one field event per year was conducted as approved by the Navy and ADEC and documented in the ADEC (2009) letter to the Navy. However, the Navy will resume biannual sampling when the site is at or approaching the DD cleanup levels. The following wells were routinely sampled: BFTF-WP-04, BFTF-WP-05, BFTF-WP-06, BFTF-WP-07, BFTF-WP-08, BFTF-WP-09, and BFTF-WP-10. The following items were noted in the 2008 to 2012 annual reports regarding well sampling:

- During 2008, no well was replaced during the two sampling events (U.S. Navy 2009c).
- In 2009, active zone water sampling was conducted in September and wells BFTF-WP-07 and BFTF-WP-08 were reinstalled (although not stated in the annual report, it is assumed in their original locations) and renamed BFTF-WP-07B and BFTF-WP-08B (U.S. Navy 2010b).
- In 2010, wells BFTF-WP-5, BFTF-WP-06, and BFTF-WP-08B were reinstalled and renamed BFTF-WP-5B (south of its original location), BFTF-WP-06B (in its original location), and BFTF-WP-08C (in its original location), respectively, and one round of sampling was conducted in August (U.S. Navy 2011c).

- The 2011 field activities occurred in August and no monitoring wells were replaced (U.S. Navy 2012c).

- In 2012, BFTF-WP-08C and BFTF-WP-09 were found missing. BFTF-WP-08C was reinstalled 2 feet north of its original location and named BFTF-WP-08D. BFTF-WP-09 was reinstalled 4 feet south of its original location and named BFTF-WP-09B.

Active zone water samples from each sampling event have been analyzed for GRO, DRO, and the VOCs required by the DD. Samples have not been analyzed for RRO, as required by the DD. However, the DD did not establish a cleanup level for RRO in active zone water. As recommended in the first 5-year review, dissolved lead was added to the active zone water analyte list in 2008. Analysis of geochemical indicators of petroleum hydrocarbon degradation has also been conducted during each sampling event. The natural attenuation parameters tested for have generally consisted of the following, with some variation in the analyte list as the monitoring program evolved:

- Dissolved oxygen
- Oxidation-reduction potential
- pH
- Temperature
- Conductivity
- Salinity
- Turbidity
- Nitrate
- Sulfate
- Methane
- Ferrous iron
- Alkalinity

These parameters have been analyzed variously using a field instrument, analyte-specific colorimetric field test kits, or an off-site analytical laboratory.

Sediment samples have been collected from three locations in the North Salt Lagoon annually and analyzed for GRO and DRO, as required by the DD. Lead sampling in soil was recommended as part of the first 5-year review. Although the lead sampling recommendation was intended for the HAVE-treated soil confirmation sampling, starting in 2008, sediment samples have been analyzed for lead in addition to GRO and DRO.

A small shoreline seep was identified near location BFTF-SED-54 during the 2010 field event (U.S. Navy 2011c). The seep was not flowing into the North Salt Lagoon, but was contained within a small puddle that exhibited a sheen and a petroleum odor. No sample was collected at that time, and no seep was located during the 2011 field season (U.S. Navy 2012c).

Table 4-1
Summary of Airstrip, Site 5, Decision Document Monitoring and Maintenance Requirements

Activity/Medium/Location	Frequency	Analysis
Monitor active zone water at eight wells: • Shoreline: AS-WP-02, AS-WP-10, AS-WP-12, and AS-WP-16 • Other wells: AS-WP-11 (north depression), AS-WP-21 (crossgradient), AS-WP-101 (downgradient of soil excavation), and Well J (upgradient of containment berm)	Two times per year	• GRO, DRO, BTEX, TAH, and 1,2-dichloroethane • Geochemical indicators of petroleum hydrocarbon degradation
Monitor surface water at four locations in Imikpuk Lake: AS-SW-1 through AS-SW-4	Once per year	GRO, DRO, BTEX, TAH, and 1,2-dichloroethane
Conduct a review of site conditions.	After 5 years	Not applicable
Maintenance: Replace monitoring wells if destroyed during monitoring program.	As needed	Not applicable

Notes:
BTEX - benzene, toluene, ethylbenzene, and xylenes
DRO - diesel-range organics
GRO - gasoline-range organics
TAH - total aromatic hydrocarbons

Table 4-2
Summary of Powerhouse, Site 12, Decision Document Monitoring and Maintenance Requirements

Activity/Medium/Location	Frequency	Analysis
Monitor active zone water at nine wells: • Shoreline: PH-WP-01, PH-WP-02, and PH-WP-03 • Other wells: PH-WP-06 (downgradient of former pipeline), PH-WP-08 (downgradient of former pipeline), PH-WP-09 (downgradient of former ASTs), PH-MW-06 (downgradient of former pipeline), and two new wells (upgradient)	Twice per year in early July and late September	• GRO, DRO, RRO, and VOCs (BTEX and tetrachloroethene) • Geochemical indicators of petroleum hydrocarbon degradation
Monitor surface water at three locations in Imikpuk Lake: PH-SW-01 through PH-SW-03	Once per year in early July	GRO, DRO, RRO, and VOCs (BTEX and tetrachloroethene)
Conduct a review of site conditions.	After 5 years	Not applicable
Maintenance: Replace monitoring wells if destroyed during monitoring program.	As needed	Not applicable

Notes:
BTEX - benzene, toluene, ethylbenzene, and xylenes
DRO - diesel-range organics
GRO - gasoline-range organics
RRO - residential-range organics
VOCs - volatile organic compounds

Table 4-3
Summary of Former BFTF, Site 13, Decision Document Monitoring and Maintenance Requirements

Activity/Medium/Location	Frequency	Analysis
Monitor active zone water at six sentinel wells and one background well: • Melt Water Pond shoreline, BFTF-WP-04, BFTF-WP-05, and BFTF-WP-06 • Background well BFTF-WP-07 • North Salt Lagoon shoreline: BFTF-WP-08, BFTF-WP-09, and BFTF-WP-10	Twice per year in July and September	GRO, DRO, RRO, benzene, and xylene
Monitor sediment in North Salt Lagoon at three locations (53, 54, and 55) established in 1997.	Once per year in September	GRO and DRO
Conduct a review of site conditions.	After 5 years	Not applicable
Maintenance: Replace monitoring wells if destroyed during monitoring program.	As needed	Not applicable

Notes:
DRO - diesel-range organics
GRO - gasoline-range organics
RRO - residential-range organics

5.0 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The Navy performed the soil removal and treatment components of the cleanup actions at all three sites, as modified through concurrence with ADEC. Since the first 5-year review, the Navy has performed monitoring as required by the DDs and as modified through concurrence with ADEC. From 2003 through 2008, monitoring at all three sites occurred twice a year (July and September), as established in the DDs. Beginning in 2009, the Navy and ADEC agreed that monitoring once a year was sufficient.

The Navy has completed or made significant progress on all of the actions recommended by the first 5-year review. The recommended actions and notes regarding their completion are summarized in Table 5-1. All the monitoring recommendations presented in the first 5-year review report for the Airstrip, Powerhouse, and former BFTF have been completed, except soil samples collected in 2008 at the former BFTF were not analyzed for lead. Some of the recommendations (e.g., items 4, 6, 12, 13, and 15) include ongoing activities or studies to be completed before a resolution can be determined or decision made. These are carried forward in this 5-year review as recommendations and follow-up actions.

Table 5-1
Summary of Progress Since Last 5-Year Review

Item No.	Recommendation/ Follow-Up Action	Completion Date	Progress	Reference
General				
1	Establish safety procedures that protect field personnel and allow annual monitoring to be completed as planned.	2008	SES-TECH provided one security professional to support the field teams during the sampling events, who was present on site during sampling activities only.	U.S. Navy 2008a
2	Continue monitoring at all three sites until decision document criteria for cessation of monitoring are met. Evaluate during the next 5-year review.	Ongoing	Monitoring of groundwater, surface water, and sediment was continued throughout this 5-year review period because decision document criteria have not been met for many of the COCs.	U.S. Navy 2013a
Airstrip, Site 5				
3	Reinstall well AS-WP-101 closer to its 2006 location to obtain more representative trend data.	2008	Location AS-WP-101 was reviewed during mobilization activities for 2008 and the original sampled well was located and sampled. The 2007 results were reported for a reinstalled well located slightly downgradient of the existing ice wall. Therefore, the 2008 through 2012 data more correctly reflect actual concentrations on the upgradient side of the wall. Concentrations for DRO and toluene showed no trends, but were reported as stable, and GRO, benzene, ethylbenzene, and xylene concentrations were reported as decreasing.	U.S. Navy 2009c and 2012c
4	Perform engineering inspection of south depression cap to assess functionality.	Ongoing	The visual assessment performed in 2010 showed no evidence of contaminant impacts (no stressed vegetation or sheen). However, the Navy recommended in 2011 that an additional assessment be performed to assess the impact that south depression capped soils may have on the surrounding area.	U.S. Navy 2011c, 2012c, and 2013a

Table 5-1 (Continued)
Summary of Progress Since Last 5-Year Review

Item No.	Recommendation/ Follow-Up Action	Completion Date	Progress	Reference
			In 2011, four new monitoring wells were installed by USAF (AFAS-WP-19 thru AFAS-WP-22) as part of the USAF Clean Sweep Program at Barrow. These wells were installed in the vicinity of the south depression area and the eastern ponds to determine if residual contamination is migrating from the south depression toward the eastern ponds and ultimately to the North Salt Lagoon.	
5	Discontinue 1,2-DCA monitoring at all locations except AS-WP-10 and AS-SW-02.	2008	Monitoring of 1,2-DCA was discontinued at locations AS-WP-02, -11, -12, -16, -18, -21, and -101 and AS-SW-01, -03, and -04.	U.S. Navy 2009c
Powerhouse, Site 12				
6	Meet with Ukpeaġvik Iñupiat Corporation (UIC) and Bureau of Land Management to resolve concerns.	Ongoing	The 2011 long-term monitoring report recommended that a written agreement be obtained from ADEC and UIC stating that no further action is necessary for cleanup beneath the Powerhouse site, based upon polychlorinated biphenyl and RRO data provided by the Navy that were below cleanup levels. ADEC determined cleanup underneath the former Powerhouse building (Building 342) complete in 2003. The 2012 soil investigation focused on the Powerhouse site areas of concern that may be contributing to increasing trends. This may give a better understanding of residual contamination that is contributing to the exceedances of groundwater criteria. At this time, the Navy is not in the position to request a determination of no further action from ADEC for RRO.	U.S. Navy 2012c and ADEC 2003

Table 5-1 (Continued)
Summary of Progress Since Last 5-Year Review

Item No.	Recommendation/ Follow-Up Action	Completion Date	Progress	Reference
7	Discontinue analysis for tetrachloroethene in active zone water samples.	2008	Based on prior minimal detections, monitoring for tetrachloroethene in active zone water samples was discontinued.	U.S. Navy 2009c
8	Discontinue GRO monitoring at wells PH-MW-01, PH-WP-03, and PH-WP-06.	2008	GRO monitoring at wells PH-MW-01B, PH-WP-03, and PH-WP-06 was discontinued.	U.S. Navy 2009c
Former Bulk Fuel Tank Farm, Site 13				
9	During planned soil sampling in 2008, add lead to the analyte list.	2008	Although total and dissolved lead by EPA Method 6020 was added to the analyte list in the 2008 sampling for sediment and water, it was not added for soil (see Section 6.4.3).	U.S. Navy 2009c
10	Add dissolved lead to the analyte list for active zone water samples.	2008	Total and dissolved lead by EPA Method 6020 was added to the analyte list in the 2008 water and sediment sampling.	U.S. Navy 2009c
11	Discontinue GRO and BTEX monitoring at wells BFTF-WP-04, BFTF-WP-05, and BFTF-WP-06.	2008	GRO and BTEX monitoring at wells BFTF-WP-04, BFTF-WP-05, and BFTF-WP-06 was discontinued.	U.S. Navy 2009c
12	Assess the feasibility of removing and treating additional soil from the south bank area and from around historical sampling location “90.”	Ongoing	Some soil planned for excavation was not excavated, and soil with elevated levels of DRO may remain on site. Since the last 5-year review, no soil has been removed. Because the soil at the south bank could still act as an additional source area for continued contamination of the active zone water, ADEC concurred with the first 5-year review’s recommendation in the letter for approval of the final 2008 former BFTF confirmation sampling report.	ADEC 2010

Table 5-1 (Continued)
Summary of Progress Since Last 5-Year Review

Item No.	Recommendation/ Follow-Up Action	Completion Date	Progress	Reference
13	Collect, analyze, and evaluate additional samples from the landfarmed soil to assess adequacy of treatment against decision document criteria.	Ongoing	Confirmation sampling was performed in 2008 to assess the adequacy of the treatment of the landfarmed soils. The confirmation sampling report finalized in 2009 recommended no further action for site soils at the former BFTF because only one surface soil location exceeded cleanup levels, based on a DRO cleanup level of 500 mg/kg for surface soil and 1,328 mg/kg for subsurface soil. However, ADEC did not agree with the conclusions of the report in regard to the site cleanup levels presented in the decision document. The heavily contaminated soil was excavated and treated by hot air vapor extraction technology as intended by the remedy. However, the remaining soil was treated with in situ landfarming, as opposed to the planned ex situ landfarming. The 1,328 mg/kg cleanup level applies to the treatment of surface soil for the protection of wildlife as left in place, and a cleanup level of 500 mg/kg is applied to treated soil. As all the soil was treated in place and all the soil (both surface and subsurface) was mixed during tilling, ADEC stated that the 500 mg/kg cleanup level should be applied to all soil within the landfarmed area. Therefore, the 500-mg/kg cleanup level was applied to the soils at the former BFTF. All surface and subsurface soils, except for surface soils in Decision Unit 1a, exceeded the DRO cleanup level for treated soil.	U.S. Navy 2009b and ADEC 2010

Table 5-1 (Continued)
Summary of Progress Since Last 5-Year Review

Item No.	Recommendation/ Follow-Up Action	Completion Date	Progress	Reference
14	Assess the active zone water flow direction change following 2008 data collection and evaluate potential impacts to the monitoring plan.	2008	In general, groundwater is shown to flow southwest across the site from the melt water pond towards the North Salt Lagoon. However, prior sampling years reported groundwater flowing in the opposite direction. The reversal of groundwater flow occurred as a result of interchanging the coordinates between wells BFTF-WP-06 and BFTF-WP-07. This error was identified during the September 2008 sampling event when Global Positioning System was used to confirm the location of wells. The coordinates have been corrected in the Navy's Naval Installation Restoration Information Solutions database, and the southwest direction of groundwater stands true.	U.S. Navy 2009c
15	If the data available at the time of the next 5-year review indicate that any COC concentrations in sentinel wells are increasing, or that COCs in North Salt Lagoon sediments are not naturally attenuating, evaluate potential additional source removal actions.	Ongoing	North Salt Lagoon sentinel well BFTF-WP-08 has shown increasing trends for GRO, DRO, and total xylenes. However, natural attenuation factors such as ferrous iron, methane, and alkalinity consistently imply that biodegradation or natural attenuation is occurring.	U.S. Navy 2013a

Notes:
ADEC - Alaska Department of Environmental Conservation
BFTF - Bulk Fuel Tank Farm
BTEX - benzene, toluene, ethylbenzene, and xylenes
COC - chemical of concern
DCA – dichloroethane
DRO - diesel-range organics
GRO - gasoline-range organics
mg/kg - milligram per kilogram
RRO - residual-range organics
USAF - U.S. Air Force

6.0 FIVE-YEAR REVIEW PROCESS

6.1 FIVE-YEAR REVIEW TEAM

The Navy is the lead agency for this second 5-year review, represented by personnel from NAVFAC NW. Project managers and other staff from ADEC and UIC have also participated in the review process. Both ADEC and UIC are cosignatories of the DDs for NARL, except the Airstrip site DD was not signed by UIC because the property is still owned by the Navy. All team members had the opportunity to provide input to this report.

6.2 COMMUNITY INVOLVEMENT

6.2.1 History of Community Involvement

The Navy has been involved in the Barrow RAB since its inception in 1995 and has a representative assigned as the Navy Co-Chair. The Barrow RAB has been active in restoration projects at the former NARL facility, meeting at a minimum of twice per year since 1995. Meeting agendas in the last 5 years have consisted of site updates, which have included summaries of sampling and monitoring results. The risk assessment process for the former NARL sites was developed using input from the community of Barrow from public meetings in 1996. Presentations and public participation also occurred during the initial planning and implementation phases of the risk assessments.

The NARL Cleanup Team Partnership was formalized in 1999. The partnership consisted of representatives from the Navy, UIC (as landowner of the Powerhouse, Site 12, and former BFTF, Site 13), and ADEC. More specifically, it consisted initially of the Navy project manager at that time, the ADEC project manager, and a representative designated by the UIC Board of Directors. UIC was also regularly represented by an employee from the UIC real estate division. At various times, other people from these three agencies, or consultants for UIC or the Navy, would attend the meetings. Representatives from the Native Village of Barrow would occasionally sit in on the meetings for informational purposes. Until March 9, 2006, the partnership met at least three times per year and more frequently, as necessary, to review primary documents and plan activities. Although partnership meetings have not been held since March 9, 2006, direct meetings between UIC and the Navy have been held subsequently, as needed. ADEC strongly recommends that these team meetings resume, specifically in regards to cleanup levels for the former BFTF site (ADEC 2010).

6.2.2 Community Involvement During the Five-Year Review

Since the last 5-year review, RAB meetings have occurred at least twice a year. The Navy contacted members of the RAB during this 5-year review and offered the opportunity to participate through the interview process. Results of interviews are presented in Section 6.2.3. The draft second 5-year review report was made available at the public repository, Tuzzy Consortium Library, in Barrow, Alaska. The Navy published a notification in the *Arctic Sounder* when the draft 5-year review report was available for public review.

6.2.3 Results of Interviews

As part of the 5-year review, interviews were conducted with persons familiar with the cleanup actions at NARL. Interview candidates were identified from the Navy (specifically NAVFAC NW), ADEC, UIC, North Slope Borough (NSB) of Land Management, U.S. Bureau of Land Management (BLM), USAF, USACE, and residents of Barrow. Members of the RAB included the representatives of ADEC, NAVFAC NW, NSB, USAF, USACE, and Barrow residents. A set of interview questions and instructions was sent by e-mail to interview candidates. All interview participants chose to reply by e-mail. Not all of those invited to participate chose to do so.

The interview responses are included in Appendix B. Highlights of the interviews are summarized below.

U.S. Department of Defense Personnel, Including the U.S. Air Force, U.S. Navy, and U.S. Army Corps of Engineers

The U.S. Department of Defense (DoD) respondents included the USAF, Navy, and USACE. All were in agreement that the cleanup actions and monitoring implemented had met the intent of the DDs and continue to be effective. A USAF respondent noted that there have been discussions in the RAB meetings regarding loss of permafrost and wildlife migratory habits. NAVFAC NW personnel noted that the increasing temperatures in soil caused by increasing air temperatures may result in deeper active zone depths (i.e., deeper thaw of the permafrost), which may result in the release of petroleum hydrocarbons that hover above the permafrost during summer months. The Navy also commented that soil investigations planned for 2012 should illustrate the vertical and horizontal extent of residual petroleum contamination to better assess the contaminant migration and result in revised monitoring recommendations. DoD personnel were not aware of any changes in land use, public access, or other site conditions that could impact the protectiveness of the cleanup actions. USACE personnel commented that there was a lack of information to answer questions regarding monitoring of the sites.

Agency Personnel

ADEC personnel were not aware of any changes in land use, public access, or other site conditions that could impact the protectiveness of the cleanup actions nor of any community concerns. The respondent from ADEC gave a response regarding new scientific findings that could call into question the protectiveness of the cleanup actions. Specifically, the respondent commented on the investigation of a tundra pond on the adjacent USAF property that was identified as an area of fuel contamination. The source of the pond's contamination is most likely from the migration of contaminants through the active zone water at the Airstrip site. The respondent stated that the USAF and Navy are coordinating to expand the monitoring program for the Airstrip site. The ADEC respondent also supports the Navy's 2012 soil investigations to further characterize soil at the Powerhouse and Airstrip sites.

Landowner Personnel

A landowner response was received from BLM. The BLM respondent gave comments and recommendations regarding the implementation and monitoring of the remedies for the Airstrip site. The BLM respondent stated that the current and past focus of monitoring has been assuming the subsurface flow is to the south towards Imikpuk Lake. However, sheen observed on surface water to the east suggests flow is also to the east. It was recommended that monitoring wells should also be placed to the east of the Airstrip site. It was also recommended by the BLM respondent to place signage and summer season usage of sorbents/booming in the shallow surface water where sheening is occurring. The respondent also commented that many of the monitoring wells were in unusable condition and should be properly plugged or abandoned.

Community

The NSB Land Management respondent felt well informed of the progress and monitoring the Navy has implemented at the site and was satisfied with the information provided to the RAB by the Navy. With regard to community concerns, the NSB respondent noted the concern of community members that have summer cabins in close proximity to the former BFTF area. It was stated that the community members no longer use the cabins because of the odor. Also, the NSB respondent stated that some community members are concerned that the community's health has been affected by petroleum at the site. It was further commented that the community feels that natural attenuation of the former BFTF area is not effective because of the fuel odor that still exists. It was also recommended by the NSB respondent that the Airstrip site be revisited to investigate if any additional fuel that was not located has migrated to the test boreholes and if the ice wall is still effective, or has failed because of climate change. Other recommendations included sending more interview questionnaires to other organizations, such as the Native Village of Barrow and Inupiat Community of Arctic Slope, and having the Navy present the site's information from precleanup to present status before any close-out of the sites. The Native Village of Barrow and Inupiat Community of Arctic Slope were contacted during this review. However, no response to the interview questionnaires was received.

In contrast to the NSB respondent, the UIC respondent felt uninformed about the progress of environmental cleanup activities at the Powerhouse and former BFTF sites. The respondent felt the cleanup process was too slow and has held up progress for use of land to lease as staging areas. In regards to the effects on the community, the UIC respondent stated that the delay has had a negative impact on the economy of the community because of the loss of revenue associated with the staging areas. It was recommended by the UIC respondent that the site land be transferred for surface use only if other cleanup is still pending.

6.3 DOCUMENT REVIEW

Documents reviewed during this 5-year review were primarily those describing the inspections, sampling, and monitoring of the selected cleanup actions during the time period October 2007 to September 2012. Earlier documents were reviewed as needed to establish a complete summary of the site history. The primary documents that were reviewed are as follows:

- The signed DDs (U.S. Navy and ADEC 2002 and U.S. Navy, ADEC, and UIC 2003a and 2003b)
- Project Plans (U.S. Navy 2007b, 2008a, 2009a, 2010a, 2011a, 2012a, and 2012b)
- Annual monitoring reports prepared during this 5-year review period (U.S. Navy 2008c, 2009c, 2010b, 2011c, 2012c, and 2013a)
- Former BFTF confirmation sampling report (U.S. Navy 2009b)

6.4 DATA REVIEW

This section summarizes trends in chemical data collected through the various monitoring programs at NARL from October 2007 through September 2012. The monitoring programs are described in Section 4, and the implications of the data regarding the functionality and protectiveness of the cleanup actions are discussed in Section 7. Site inspections are discussed separately in Section 6.5. The long-term and recent data trends are discussed by site in the sections that follow.

Trend analysis was performed as part of long-term monitoring reporting using the Mann-Kendall test to determine whether the concentrations of petroleum hydrocarbons at each monitoring location are decreasing, increasing, or remaining stable. The Mann-Kendall test is a nonparametric test for analyzing data that do not follow a normal distribution. This statistical test is ideal for datasets with irregular sampling intervals and missing data and data with both detect and nondetect results. It was, therefore, appropriately used for the trend analysis at all three sites. Trend analysis was only performed for chemicals with concentrations that have exceeded cleanup levels during the last 5 years of sampling. For data that do not have a trend identified at the 80 percent confidence interval, the coefficient of variation was used to assess the stability of the data (U.S. Navy 2013a). Summary tables of the Mann-Kendall results are presented by site on Tables 6-1 through 6-3. Note that although the 80 percent confidence level is considered acceptable for establishing a trend, the 90 percent confidence level is also presented in the discussion below as further lines of evidence that increases the certainty of the trend observed.

6.4.1 Airstrip, Site 5, Monitoring Data

Figure 6-1 shows the location of the wells and surface water sampling locations used for long-term monitoring for the Airstrip, Site 5. The long-term monitoring program has included annual evaluation of COC concentrations in groundwater relative to DD cleanup levels, trends in COC concentrations in groundwater, evidence of natural degradation, and potential impacts to surface water in Imikpuk Lake. The 2012 monitoring report (U.S. Navy 2013a) evaluates data available prior to the signing of the DD through 2012. The data for each sampling location are summarized in tabular and graphical format in Appendix A on summary sheets excerpted and updated from the most recent monitoring report.

Active zone water is consistently found to flow from north to south towards Imikpuk Lake. However, a 1993 U.S. Geological study found that active zone water flow may also exist to the east toward North Salt Lagoon, although the flow rate is expected to be very low (U.S. Navy 2012c).

COCs at the Airstrip that have historically exceeded active zone water cleanup levels for the protection of Imikpuk Lake are DRO, GRO, total aromatic hydrocarbons (TAH), 1,2-DCA, and BTEX. Based on prior minimal detections, chlorinated solvent sampling has been terminated at all wells at the Airstrip site, with the exception of 1,2-DCA at well AS-WP-10 and surface water location AS-SW-02, as recommended in the first 5-year review (U.S. Navy 2008b). Table 6-1 presents the Mann-Kendall results for the 2012 COC trend evaluations at the Airstrip site. In 2012, four new monitoring wells were installed by USAF (AFAS-WP-19 through AFAS-WP-22) to the east of the south depression area to determine if residual contamination is migrating from the south depression toward eastern ponds and ultimately to the North Salt Lagoon. The COCs monitored at these new wells were GRO, DRO, and BTEX. Details of the data and trend evaluations are presented below.

COC Concentrations in Shoreline Wells

Monitoring at four Imikpuk Lake shoreline wells (AS-WP-02, AS-WP-10, AS-WP-12, and AS-WP-16) is intended to document COC concentrations at the points of compliance for protection of surface water in Imikpuk Lake (U.S. Navy and ADEC 2002). Appendix A Tables A-1, A-2, A-4, and A-5 present the analytical results and trend graphs for the COCs of each shoreline well. COC concentrations in samples from the shoreline wells are generally lower in comparison to concentrations prior to implementation of the cleanup action in 2002. At most of these shoreline wells, one or more COCs continue to be detected at concentrations above DD cleanup levels in each monitoring year. Although concentrations of some individual COCs at some wells exhibited decreasing trends, for most COCs at most shoreline wells no statistically significant trend was discerned prior to 2008 (U.S. Navy 2008c). Increasing trends were reported in 2012 for 1,2-DCA, GRO, DRO, and benzene in one or more shoreline wells. However, the 2012 concentrations appear to be lower than the 2011 concentrations for most of these same COCs. As recommended in the first 5-year review, 1,2-DCA monitoring was discontinued at all shoreline well locations except AS-WP-10.

COC concentrations in well AS-WP-02 have decreased substantially since 1998 (prior to implementation of the 2002 cleanup actions) when benzene, TAH, GRO, and DRO all exceeded the cleanup levels at concentrations of 24, 1,052, 4,100, and 3,440 µg/L, respectively. Post-cleanup-action COC concentrations are consistently lowest at shoreline well AS-WP-02. TAH has been detected in this well above the cleanup level in 6 of the last 14 sampling events. However, TAH concentrations appear to be decreasing in the last few years (September 2008 to August 2012), and the most recent concentrations (2012) were detected below laboratory reporting limits. Other than TAH, only benzene and DRO have been detected above the cleanup level in this well since the last 5-year review. A Mann-Kendall trend evaluation was not performed for well AS-WP-02B, because benzene and DRO concentrations have not consistently exceeded cleanup criteria during the last four sampling events. (Note that well AS-WP-02 was renamed AS-WP-02B in 2010 after well repair.) The graphed data presented in Appendix A Table A-1 shows a generally decreasing trend for BTEX, DRO, and GRO.

COC concentrations in samples from shoreline well AS-WP-10 have increased since 2002, but are still approximately an order of magnitude lower than initial sampling in 1998 (see Appendix A Table A-2). COC concentrations at AS-WP-10 have been the highest of the shoreline wells during the first and second 5-year review periods, with benzene, GRO, DRO, and TAH consistently exceeding cleanup levels. The 1,2-DCA concentration did not exceed the DD cleanup level for this compound in July 2008. However, 1,2-DCA concentrations have consistently exceeded the cleanup level in samples collected from AS-WP-10 since that monitoring event. In 2010, TAH data and graphing suggested an increasing trend. However, the more recent 2011 and 2012 data show concentrations decreasing. The driver for TAH is benzene. The Mann-Kendall trend analysis reported in 2012 for 1,2-DCA, GRO, DRO, and benzene indicated increasing trends at the 80 percent confidence level. At the 90 percent confidence level, increasing trends were indicated for 1,2-DCA and benzene, but no trend was indicated for DRO and GRO. The 2012 concentrations of benzene, total BTEX (TAH), DRO, and GRO are lower than previous 2011 concentrations.

At well AS-WP-12, COC concentrations have declined approximately one order of magnitude since 1998, with the exception of DRO, which has recently increased (see Appendix A Table A-4). No trend is apparent for GRO and TAH, and increasing concentration trends are apparent for DRO. The 2012 long-term monitoring reported an increasing trend for DRO at the 80 percent confidence level, and no trend at the 90 percent confidence level, which in the last 5-year review was reported as decreasing. In 2007, all COCs in this well were below their respective cleanup levels. However, between September 2009 and August 2012, TAH and DRO concentrations were above their respective cleanup levels. DRO concentrations have been above respective cleanup levels in 14 of 19 sampling events. The graph presented in Appendix A Table A-4 for DRO concentrations shows an inflection point between 2008 and 2009, followed by a dramatic incline in the years following. However, the 2012 DRO concentration decreased, compared to the 2011 concentrations. DRO concentrations decreased from 21,000 µg/L (2011) to 10,000 µg/L (2012).

At well AS-WP-16, 2007 COC concentrations were approximately one-third of 1998 COC concentrations and approximately one-half of the September 2001 concentrations (just prior to implementation of the DD cleanup action) (see Appendix A Table A-5). However, COC concentrations from July 2008 until August 2011 steadily increased to concentrations approximately two-thirds the 1998 concentrations, except the DRO concentration, which is higher than the 1998 concentration. Benzene, TAH, and DRO concentrations remain above the DD cleanup levels in this well. However, the 2012 concentrations are lower than the 2011 concentrations. Trend analysis performed in 2012 show increasing trends for benzene and DRO at both the 80 and 90 percent confidence levels. The TAH concentrations from 2009 through 2012 suggest a decreasing trend.

COC Concentrations at Site Wells

Monitoring at upland wells AS-WP-11, AS-WP-18 (replacement for Well J), and AS-WP-101 is intended to provide COC trend data of site wells following the DD cleanup action (U.S. Navy and ADEC 2002). These site wells are located upgradient of the containment berm, where some of the highest concentrations of the active zone water were historically detected. Appendix A Tables A-3, A-6, and A-8 present the analytical results and trend graphs for the COCs of each site well. Concentrations of many COCs in these site wells are somewhat lower than those measured in 1998 (AS-WP-11 and AS-WP-18) or 2001 (AS-WP-101). However, some COC concentrations have increased since 1998 (specifically DRO in well AS-WP-11, TAH in well AS-WP-18, and benzene in well AS-WP-101). Beginning in 2002, the Navy conducted studies at the Airstrip site to monitor the migration of petroleum through the permafrost that indicated the potential presence of free product in discontinuous pockets of permafrost at the site (U.S. Navy 2012c). Although free product was observed in Well J during September 2004 (U.S. Navy 2005b), no measurable product has been found in site wells during this second 5-year review period. Note that Well J is no longer sampled because it was consistently dry and well AS-WP-18 has replaced it as a monitoring location. As recommended in the first 5-year review, 1,2-DCA monitoring was discontinued at all site well locations.

In August 2012 at well AS-WP-11, benzene, TAH, and DRO were above the DD cleanup levels at concentrations of 63, 384.5, and 51,000 µg/L, respectively (see Appendix A Table A-3). The Mann-Kendall statistical test completed in 2012 (U.S. Navy 2013a) reported an increasing trend in DRO data at both the 80 and 90 percent confidence levels. Graphed data on Appendix A Table A-3 also show recent DRO concentrations increasing. The benzene concentrations exhibit decreasing trends at the 80 and 90 percent confidence levels, and GRO concentrations exhibit decreasing trends at the 80 percent level as well (no trend shown at the 90 percent confidence level). Furthermore, 2012 concentrations for both GRO and BTEX are lower than 2011 concentrations. Therefore, the data for well AS-WP-11 strongly supports the trend that GRO and BTEX concentrations at this location are slowly declining, while DRO is exhibiting a consistently increasing trend.

At well AS-WP-18 (see Appendix A Table A-6), the highest recent concentrations reported for benzene, GRO, and DRO were during 2007 and 2008, with a benzene concentration of 670 µg/L (fall 2007), GRO of 6,200 µg/L (fall 2008), and DRO of 8,300 µg/L (fall 2008). The highest recent concentration for TAH was reported in 2012 (2,260 µg/L). From 2003 to 2012, benzene, TAH, and GRO concentrations remained above DD cleanup levels. DRO only exceeded DD cleanup levels twice during this same time period. Benzene concentrations showed a decreasing trend in the 2012 trends analysis, as opposed to the increasing trend reported in the 2007 trend analysis. No concentration trend was apparent at this well for any of the other COCs. In particular, GRO and DRO appeared to be stable with no trend (U.S. Navy 2013a). Recent 2012 concentrations for all COCs have increased compared to 2011. These increasing trends are exhibited for GRO, DRO, and BTEX on Appendix A Table A-6 trends graphs.

A smaller data set is available for well AS-WP-101 as compared to other site wells, because of the repeated difficulty obtaining an active zone water sample from this location. Data are available from 2001, 2006, and 2007 through 2012 (see Appendix A Table A-8). Well AS-WP-101 could not be located during the 2003 sampling activities (U.S. Navy 2004d) and was not reinstalled until the 2004 field season (U.S. Navy 2005b). The well did not have enough recoverable water to allow sampling in either 2004 or 2005. In 2005, the well was reinstalled at a new location, 21 feet south and 94 feet east of the original location (still north of the road), in an attempt to achieve recoverable water (U.S. Navy 2006a). However, sampling was still not possible in 2005. In 2006, the well was found intact and was sampled in both July and September (U.S. Navy 2007a). In 2007, the well was reported as having been "removed during previous activities at the site" (U.S. Navy 2008c). The well was reinstalled "northeast of and mid-way between AS-WP-10 and the edge of the roadway" (U.S. Navy 2008c). This new location was approximately 150 to 200 feet southwest (approximately downgradient) of the location sampled in 2006. Because of this change in location, the apparent substantial reduction in many COC concentrations between 2006 and 2007 is more representative of the spatial distribution of COCs at the site than temporal trends in COCs. Location AS-WP-101 was reviewed during mobilization activities for 2008, and the original well was located and sampled. The 2007 data results were reported for a reinstalled well slightly downgradient of the existing ice wall. Therefore, the 2008 through 2012 data are a better representation of actual concentrations on the upgradient side of the containment berm.

In 2006, COC concentrations from well AS-WP-101 were similar to those reported in 2001. Since 2008, benzene, toluene, TAH, GRO, and DRO in this well have all exceeded their respective DD cleanup levels. Ethylbenzene exceeded cleanup levels in 2008 only. Trend analysis in 2012 concluded that GRO, benzene, ethylbenzene, and xylene concentrations are decreasing at the 80 percent confidence level, and both DRO and toluene concentrations are stable, with no trend at the 80 percent confidence level. No trend was indicated for any of these chemicals at the 90 percent confidence level, with the exception of benzene, which had a decreasing trend. 2012 concentrations for all COCs have decreased, with the exception of ethylbenzene, compared to the 2011 concentrations. Trends graphs for COCs at well AS-WP-101 are presented in Appendix A Table A-8.

U.S. Air Force Wells

In 2011, four new monitoring wells were installed by USAF (AFAS-WP-19 through AFAS-WP-22) as part of the USAF Clean Sweep Program at Barrow (U.S. Navy 2013a). These wells were sampled to determine if residual contamination on the Navy's property is migrating via the active zone water to the USAF property and the North Salt Lagoon. The 2012 study found that three of the four new wells have GRO exceedances above cleanup levels, and all four wells have exceedances of TAH concentrations. Total BTEX (TAH) and GRO concentrations exceeded their respective cleanup levels at well locations AFAS-WP-19, AFAS-WP-20, and AFAS-WP-22. Well AFAS-WP-21, the well located closest to the North Salt Lagoon and farthest from the south depression cap, did not have GRO exceedances, but TAH concentrations exceeded DD cleanup levels. Benzene concentrations exceeded cleanup levels at wells AFAS-WP-20 and AFAS-WP-22, and toluene concentrations exceeded cleanup levels at well AFAS-WP-22. The highest concentrations were found at well AFAS-WP-20, which is located northwest of the south depression cap area and outside the Navy's property line. Appendix A Table A-9 presents the analytical results for the COCs of each USAF well.

Background Well Results

Some COCs have been occasionally detected in active zone water samples collected from the background well, AS-WP-21, including benzene, toluene, TAH, GRO, and DRO. However, detected COC concentrations in water samples from this well have consistently been below the DD cleanup levels. The recent measured concentrations of indicator contaminants at background well AS-WP-21B were reported below laboratory reporting limits (See Appendix A Table A-7), except for DRO. The DRO concentration measured in 2012 in this well was approaching the cleanup level. Therefore, this well may no longer be representative of background conditions. Data from well AS-WP-21 have also been used for comparing biodegradation parameter values to equivalent parameter values from site wells and shoreline wells.

Natural Biodegradation Results

The measured values of natural biodegradation parameters in active zone water at the site have consistently been indicative of microbial activity and biodegradation of petroleum compounds. Depressed dissolved oxygen levels and low oxygen-reduction potential values are generally observed in wells with higher petroleum concentrations, as compared to the background well. Depleted oxygen and low oxygen-reduction potential levels indicate that anaerobic conditions currently dominate at the Airstrip site. Some ferric iron reduction may still be taking place at the site, as indicated by detections of ferrous iron above background (0.0 mg/L in 2012), which represent the strongest iron reduction conditions at the site since 2006. No nitrate has been detected at the site since 2008 (with the exception of one reading in 2009 at well AS-WP-101), which suggests that nitrate has been depleted. Nitrate is typically the second electron acceptor to be used in the biodegradation of an organic compound. Sulfate concentrations were lower than the background concentration at ten wells in 2012, which is an indication that sulfate reduction is occurring and depleting the sulfate available at the site. Ten wells had higher methane concentrations than background in 2012, indicating biodegradation by methanogenesis is occurring. Taken together, these results suggest that natural attenuation via biodegradation is actively occurring at the Airstrip site (U.S. Navy 2013a).

Surface Water Results

Surface water locations AS-SW-01 through AS-SW-04 were sampled to evaluate potential contaminant impacts to Imikpuk Lake (see Appendix A Table A-10). Although the COCs are consistently detected in Imikpuk Lake surface water, concentrations have been below the DD cleanup levels for data from years 2007 to 2012 (U.S. Navy 2013a). During the previous 5-year review period, DRO was detected at 1,600 µg/L (estimated), which exceeded the DD cleanup level of 1,500 µg/L during one sampling event. This exceedance was not repeated during this 5-year review period. Based on prior minimal detections, chlorinated solvent sampling has been terminated at all surface water sampling locations, with the exception of 1,2-DCA at AS-SW-02, as recommended in the first 5-year review (U.S. Navy 2008b).

Soil Results

During 2010, a soil investigation was conducted to determine the location and magnitude of petroleum compounds that may be contributing to the increasing trends and exceedances in the active zone water. The soil investigation was conducted at the former spill areas, some of which were excavated (U.S. Navy 1993 and 2001a), in relation to selected wells that have shown increasing petroleum compounds and associated VOC trends. No soil study was conducted during 2011.

None of the COC concentrations in the samples from the five soil borings sampled in 2010 exceeded the soil cleanup levels set forth in the Airstrip, Site 5 DD (see Appendix A Table A-11). The highest contaminant concentrations were at borings AS-B3 and AS-B4. AS-B3 was located within the capped soils in the south depression, and AS-B4 was located near a former excavated area west of the north depression (see Figure 6-1). The highest detection of GRO in the soil borings was 540 mg/kg at boring AS-B3 (at 28 to 30 inches bgs). The highest detection of DRO was 3,400 mg/kg at boring AS-B4 (at 30 inches bgs). RRO was only detected in two borings, AS-B1 and AS-B3, but at very low levels. Benzene was detected in one sample only at AS-B1, but below the laboratory reporting limit. Of toluene, ethylbenzene, and xylenes detections, only one sample had a detection of toluene and xylenes above the laboratory reporting limit, which was boring AS-B4 at 30 inches bgs (U.S. Navy 2011c).

The lack of significant detections in soil at the tested locations in 2010 provided part of the impetus for the 2012 soil investigations to further investigate why there are increasing concentration trends in the active zone water at the Airstrip site. The 2012 soil investigation expanded the areas investigated in 2010 and included a UVOST investigation and soil sampling. Soil samples were obtained from 11 soil borings (selected based on 10 percent of the UVOST locations), including the locations identified as containing the highest levels of contaminants. Samples were analyzed for GRO, DRO, and BTEX (U.S. Navy 2012c). One hundred and five UVOST probes were performed throughout the site. The UVOST profiles and soil samples were used to determine the extent of residual petroleum contamination and whether isolated pockets of hydrocarbon contamination or widespread low-level contamination exists at the Airstrip site. Figure 6-2 presents the sampling locations of the soil borings and UVOST probes.

The UVOST results were used to determine the probable areas of the highest hydrocarbon concentrations or hot spots. Borings were located in the determined hot-spot areas and soil samples taken in these locations. The sample results of the 2012 soil investigation are presented in Appendix A Table A-11. At the Airstrip site, only one GRO concentration exceeded the cleanup level of 1,400 µg/L, and it was at location AS4-B2, which is located west of Hangar 136 and north of Imikpuk Lake. An area of GRO contamination in the range of 100 to 1,700 mg/kg was centered on this location. The analytical data also indicated a large area of DRO in the range of 1,000 to 5,000 mg/kg occurring north of the Hangar 136 and east of the apron. Two smaller areas of DRO were found to occur west of the apron near Building 134 and at the east corner of the hangar. The UVOST data suggest that these areas are isolated pockets of elevated DRO concentrations. However, there may be one continuous area of elevated DRO concentrations between the north and south depression areas. The locations of the elevated DRO and GRO concentrations in soil are upgradient of the monitoring wells (AS-WP-10, AS-WP-12, and AS-WP-16) that have increasing DRO and GRO concentrations. Furthermore, the boring with the highest concentration of GRO in soil (location AS4-B2) is located near well AS-WP-101, which exhibited the highest GRO concentration in groundwater (U.S. Navy 2013b).

One surface soil sample was collected from the interior of Hangar 136 where ASTs are located. The soil sample AS-AST-1 was collected from the stained area below the AST to determine if it represented a potential source of the elevated concentrations at boring AS3-B1. However, the hydrocarbon results for the surface soil sample were all low or nondetect (see Appendix A Table A-11) (U.S. Navy 2013b).

Future Monitoring Recommendations

Monitoring equivalent to that performed in 2012 should continue at the Airstrip, Site 5, except the GRO monitoring at well AS-WP-02 should be discontinued. Table 6-4 summarizes the rationale for the recommended change to monitoring at the Airstrip site. Although 1,2-DCA concentrations at surface water location AS-SW-02 are consistently at concentrations below the detection limit, it is located downgradient to well AS-WP-10, and, therefore, 1,2-DCA monitoring should be continued at this location.

6.4.2 Powerhouse, Site 12, Monitoring Data

Figure 6-3 shows the location of the wells and surface water sampling locations used for long-term monitoring for the Powerhouse, Site 12. The long-term monitoring program has included annual evaluation of COC concentrations in groundwater relative to DD cleanup levels, trends in COC concentrations in groundwater, evidence of natural degradation, and potential impacts to surface water in Imikpuk Lake. The most recent monitoring report from 2012 (U.S. Navy 2013a) evaluates data available prior to signing of the DD through 2012. The data for each sampling location are summarized in tabular and graphical format in Appendix A on summary sheets excerpted and updated from the most recent monitoring report.

Active zone water beneath the Powerhouse, Site 12, is consistently found to flow from west to east (from the area of the Powerhouse towards Imikpuk Lake).

COCs at the Powerhouse site that have historically exceeded active zone water cleanup levels for the protection of Imikpuk Lake are DRO, GRO, RRO, and benzene. Table 6-2 presents the Mann-Kendall results for the COC trend evaluations at the Powerhouse. Details of the data and trend evaluations are presented below.

COC Concentrations in Shoreline Wells

Monitoring at three Imikpuk Lake shoreline wells (PH-WP-01, PH-WP-02, and PH-WP-03) is intended to document COC concentrations at the points of compliance for protection of surface water in Imikpuk Lake and if source controls remain effective at the site (U.S. Navy, ADEC, and UIC 2003a). Appendix A Tables A-16 through A-18 present the analytical results and trend graphs for the COCs of each shoreline well. Overall, COC concentrations in samples from the shoreline wells are similar to concentrations immediately following implementation of the cleanup action in 2003. At most of these shoreline wells, one or more COCs continue to be detected at concentrations above DD cleanup levels in each monitoring year (mostly typically DRO, with some RRO and benzene exceedances). Overall the data implies an increasing DRO concentration trend at two of the three shoreline wells. For the other COCs, no statistically significant upward or downward trend can be discerned (U.S. Navy 2013a). PCE was not detected in samples from these wells at concentrations greater than the laboratory reporting limit and was, therefore, discontinued from the active zone monitoring plan for all shoreline wells, as recommended in the first 5-year review (U.S. Navy 2008b).

At well PH-WP-01, COC concentrations are generally lower than in 1998 and September 2003, immediately following implementation of the soil removal and treatment component of the DD cleanup action (Appendix A Table A-16). BTEX compounds have not been detected above the DD cleanup levels and are often not detected above the laboratory reporting limits. DRO and RRO were sporadically detected above the DD cleanup levels prior to summer 2008. However, DRO concentrations measured between fall 2008 and 2012 have consistently been above the cleanup level. RRO concentrations have consistently been below the cleanup level from 2008 to 2012. As recommended in the first 5-year review (U.S. Navy 2008b), GRO monitoring was discontinued at this well because GRO concentrations were consistently reported below DD cleanup level. Trend analysis performed in 2012 showed DRO concentrations were stable, with no trend at the 80 percent confidence level (U.S. Navy 2013a). DRO concentrations from 2008 to 2012 suggest a possible declining trend (see trends graph presented in Appendix A Table A-16).

At well PH-WP-02, the 2012 benzene, toluene, GRO, and DRO concentrations are lower than those measured in 1998. In contrast, 2012 ethylbenzene, total xylenes, and RRO concentrations are slightly higher than in 1998 (Appendix A Table A-17). Benzene is inconsistently detected above the DD cleanup level in this well, whereas DRO is consistently detected above the DD cleanup level. Benzene was detected above the cleanup level during the second 5-year review period in July and September 2008, September 2009, and August 2012. RRO was detected above the cleanup level in the July and September 2006 samples, but detected below the DD cleanup level in 2007 through 2009 sampling and at the cleanup level in 2010 and 2011. The DRO concentration in 2012 was below the cleanup level. All other COCs have been consistently detected below the DD cleanup levels. Trend analysis performed in 2012 showed an increasing trend for DRO concentrations at both the 80 and 90 percent confidence levels, and benzene concentrations exhibiting no trend with stable values.

At well PH-WP-03, 2012 concentrations of RRO, DRO, and total xylenes are lower than those measured in 1998. In contrast, 2012 concentrations of benzene, ethylbenzene, and toluene are slightly higher than in 1998 (Appendix A Table A-18). RRO was occasionally detected above the DD cleanup level from 1998 to 2009. From 2010 to 2012, RRO concentrations have consistently exceeded cleanup levels. Since 2006, DRO concentrations were consistently detected above the DD cleanup level (see Appendix A Table A-18). The 2012 benzene concentration of 9.7 µg/L is the only benzene concentration detected above the cleanup level since 1998. All other COCs have consistently been either not detected above the laboratory reporting limit, or detected at concentrations below their respective cleanup levels (although detected concentrations of these COCs are greater than in 1998). As recommended in the first 5-year review (U.S. Navy 2008b), GRO monitoring was discontinued at this well because GRO concentrations were consistently below the DD cleanup level. Trend analysis performed in 2012 showed an increasing trend for DRO (at both confidence levels) and no trend and stable concentrations for RRO (U.S. Navy 2013a). However, 2012 concentrations for DRO and RRO have decreased, compared to 2010 and 2011 concentrations. Although no trend analysis was performed for BTEX, recent data imply that there is an increasing trend for benzene (U.S. Navy 2013a).

COC Concentrations at Site Wells

Wells PH-MW-02, PH-MW-06, PH-MW-10, PH-MW-11, PH-WP-06, and PH-WP-09 associated with contaminated soil areas, are monitored to document COC concentration trends following the DD cleanup action and the progress of natural attenuation (U.S. Navy, ADEC, and UIC 2003a). Appendix A Tables A-12 through A-15, A-19, and A-20 present the analytical results and trend graphs for the COCs of each site well. With some exceptions, COC concentrations in the site wells are still similar to those measured in 1998 and in July 2004 following implementation of the soil removal and treatment cleanup action. For half of the site wells, one or more COCs remain at concentrations above the DD cleanup levels. COC concentration trend calculations from the 2012 monitoring report most frequently demonstrate stable or no statistically significant upward or downward trend for most COCs at most wells (U.S. Navy 2013a). However, increasing trends were shown for benzene at well PH-MW-02. A decreasing trend was shown for DRO at well PH-MW-02 and for benzene and RRO at well PH-WP-09. Although a sheen or petroleum odor was frequently reported at wells PH-MW-02 and PH-MW-09, no free-phase petroleum hydrocarbons have been reported during the last two 5-year review periods. PCE was not detected in samples from the site wells at concentrations greater than the laboratory reporting limit (except at well PH-MW-06 in July and September of 2006, where it was detected at 1.14 µg/L and 0.65 µg/L, respectively) and was, therefore, removed from the active zone monitoring plan analyte list for all site wells as recommended in the first 5-year review (U.S. Navy 2008b).

At well PH-MW-02, except for RRO, the August 2012 COC concentrations were lower than those measured in 1998 and similar to those measured in July 2004, following implementation of the cleanup action (see Appendix A Table A-12). This well was dry from September 2006 through September 2009. As of August 2012, benzene and DRO remain above the DD cleanup levels. Until 2011, RRO concentrations were above cleanup levels. However, in 2012, RRO concentrations equaled the cleanup level of 1,100 µg/L. GRO has been below the cleanup level for the three latest monitoring events (August 2010, 2011, and 2012). Toluene, ethylbenzene, and total xylenes have consistently been below the DD cleanup levels since the inception of monitoring. As recommended in the first 5-year review (U.S. Navy 2008b), PCE monitoring was discontinued at this well because PCE was consistently not detected in this well. The 2012 trend analysis reported that benzene concentrations exhibited an increasing trend (80 percent confidence level only), DRO concentrations exhibited a decreasing trend, and RRO concentrations exhibited no trend with stable values at well PH-MW-02 (U.S. Navy 2013a).

At well PH-MW-06, concentrations of COCs other than DRO, RRO, and benzene measured in August 2012 were lower than those measured in 1998 and July 2004, following implementation of the cleanup action (see Appendix A Table A-13). RRO concentrations in 2012 were still higher than those measured in 1998 and July 2004. However RRO has only been detected above the DD cleanup level once since the last 5 year review, in August 2010. DRO is consistently detected above the DD cleanup level. Benzene had not been detected at a concentration higher than the DD cleanup level since September 2006; however, the 2012 concentration exceeded the cleanup level. Toluene, ethylbenzene, and total xylenes are consistently detected below the laboratory reporting limit or at concentrations below the DD cleanup levels. As recommended in the first 5-year review (U.S. Navy 2008b), GRO and PCE monitoring was discontinued at this well because concentrations were consistently below DD cleanup levels. The 2012 trend analysis reported that benzene and DRO concentrations exhibited no trend, with stable values (U.S. Navy 2013a).

Well PH-MW-10 was installed in July 2004 as part of the DD monitoring requirements. In September 2006, July 2007, and September 2008, the well was dry and could not be sampled. Since 2007, only one benzene concentration (reported in the sample from September 2009) and two RRO concentrations (reported in the environmental and field duplicate samples from August 2011) have exceeded DD cleanup levels (see Appendix A Table A-14). Ethylbenzene, toluene, total xylenes, GRO, and DRO have consistently been detected at concentrations below the DD cleanup levels. As recommended in the first 5-year review (U.S. Navy 2008b), PCE monitoring was discontinued at this well because the concentrations were consistently below DD cleanup levels. No increasing or decreasing COC concentration trend was apparent in the long-term monitoring report for this well since the last 5-year review (U.S. Navy 2013a). No Mann-Kendall trend analysis was performed for this well.

Well PH-MW-11 was installed in July 2004 as part of the DD monitoring requirements. RRO has been detected at a concentration exceeding the DD cleanup level in only one sample collected (September 2006) since monitoring began in 2004 (see Appendix A Table A-15). GRO, DRO, and BTEX compounds have consistently been detected at concentrations below the DD cleanup levels. Therefore, none of the detected COC concentrations has exceeded the DD cleanup levels since the September 2006 RRO exceedance. As recommended in the first 5-year review (U.S. Navy 2008b), PCE monitoring was discontinued at this well because concentrations were consistently below the DD cleanup level. No increasing or decreasing COC concentration trend was reported in the long-term monitoring reports for this well since the last 5-year review (U.S. Navy 2013a). No Mann-Kendall trend analysis was performed for this well.

At well PH-WP-06, COC concentrations are still somewhat higher than in 1998. Except for RRO, COCs are similar to or slightly lower than concentrations measured in July 2004, following implementation of the soil removal and treatment cleanup action in 2003. Starting in July 2005, RRO concentrations have been consistently higher than those in July 2004 (see Appendix A Table A-19). Since the last 5-year review, DRO and RRO are occasionally detected above the DD cleanup levels. BTEX compounds have been detected at concentrations below the DD cleanup levels. As recommended in the first 5-year review (U.S. Navy 2008b), PCE monitoring was discontinued at this well because PCE was consistently not detected at this well. No statistically significant increasing or decreasing concentration trend is apparent for the data from 1998 through 2012. The 2012 trend analysis reported that RRO concentrations had no trend with stable values (U.S. Navy 2013a).

At well PH-WP-09, recent COC concentrations are similar to those measured in 1998 or, those measured in July 2004, following implementation of the soil removal and treatment cleanup action. DRO and benzene have most consistently been detected at concentrations exceeding the DD cleanup levels (see Appendix A Table A-20). RRO is inconsistently detected above the cleanup level. GRO concentrations exceeded the cleanup level twice before 2008 (in September 2001 and July 2007). However, GRO concentrations exceeded the DD cleanup level from 2008 through 2009 and equaled the DD cleanup level in 2010 and 2011. The most recent 2012 concentration of GRO was detected below the cleanup level. Toluene, ethylbenzene, and total xylenes are consistently detected at concentrations below the DD cleanup levels. As recommended in the first 5-year review (U.S. Navy 2008b), PCE monitoring was discontinued at this well because PCE was consistently not detected at this well. The 2012 trend analysis reported DRO and GRO concentrations as stable with no trend and decreasing trends for both benzene and RRO concentrations.

Natural Biodegradation Results

The measured values of natural biodegradation parameters in active zone water at the site have consistently been indicative of microbial activity and biodegradation of petroleum compounds. Depressed dissolved oxygen levels and low oxygen-reduction potential values indicate that anaerobic conditions currently dominate at the Powerhouse site. Methane and alkalinity concentrations have been indicative of anaerobic respiration. A site wide increase in alkalinity concentrations over time and the presence of methane at higher concentrations than background indicate that methanogenesis is occurring. Ferric iron reduction may still be occurring at the site, as indicated by detections of ferrous iron above the background concentration. No nitrate has been detected at the site in recent sampling, which indicates that the chemical process denitrification has occurred, or that it has never been a prominent process at the site. Sulfate concentrations less than the background concentration in some of the wells also indicate that sulfate reduction is likely occurring at some of the wells.

Surface Water Results

As reported in the last 5-year review, no sheen or free product has been observed on the surface water of Imikpuk Lake during this review period. In the first 5-year review, GRO and RRO had occasionally been detected at the surface water monitoring stations, but at concentrations below the DD cleanup level. Recent sampling has shown many more detections for all chemicals, including PCE, BTEX, GRO, DRO, and RRO. However, all detections are significantly below the DD cleanup levels, and the new detections are most likely because of improved analytical instruments, which are capable of attaining lower detection limits (see Appendix A Table A-21).

Soil Results

In 2010, a soil investigation was conducted to determine the location and magnitude of petroleum compounds that may be contributing to the increasing trends and cleanup level exceedances in the active zone water. Five soil borings (PH-B1 through PH-B5) were drilled at locations in proximity to selected wells that have shown consistent or increasing trends in petroleum compounds and related VOCs.

None of the COC concentrations in the samples from soil borings sampled in 2010 exceeded the DD soil cleanup levels, which are the maximum allowable concentrations for Arctic Zone soils (identified in Table B-2 of 18 AAC 75.341) that apply to unrestricted site use and soils left in place. The two highest GRO concentrations were in borings PH-B4 and PH-B5 at 26 to 30 inches bgs (estimated at 97 and 95 mg/kg, respectively). The highest detection of DRO was at 0 to 12 inches bgs for boring PH-B5 (7,500 mg/kg). The highest detection of RRO was in boring PH-B2 at 28 to 30 inches bgs (estimated at 12,000 mg/kg). Benzene was not detected in the five borings, but toluene, ethylbenzene, and/or xylene were detected in borings PH-B2, PH-B3, PH-B4, and PH-B5 (see Appendix A Table A-22; note data qualifiers). The concentrations of COCs in the 2010 soil samples were below the applicable site soil cleanup levels, yet groundwater concentrations continue to show increasing trends and to exceed groundwater criteria. Therefore, the 2012 soil investigation focused on the areas of concern that may be contributing to increasing trends, such as areas of historical petroleum spills and previously excavated areas of the site.

The 2012 soil investigation included a UVOST investigation and soil sampling. Sixty-seven UVOST probes were performed throughout the site. Soil samples were obtained from 11 soil borings (selected based on 10 percent of the UVOST locations), including the locations identified as containing the highest levels of contaminants. Samples were analyzed for GRO, DRO, and BTEX (U.S. Navy 2012c). The UVOST profiles and soil samples were used to determine the extent of residual petroleum contamination and whether isolated pockets of hydrocarbon contamination or widespread low-level contamination exists at the Powerhouse site. Figure 6-4 presents the sampling locations of the soil borings and UVOST probes.

The UVOST results were used to determine the probable areas of the highest hydrocarbon concentrations or hot spots. Borings were located in the determined hot-spot areas and soil samples taken in these locations. The 2012 analytical results (presented in Appendix A Table A-22) showed no exceedance of cleanup levels for any of the chemicals. Analytical soil data indicated a large area of DRO in the range of 1,000 to 6,300 mg/kg occurring between and east of the two powerhouse buildings. Elevated DRO in the range of 1,000 to 2,000 mg/kg was also found extending northward from the powerhouses along the former pipeline corridor in the vicinity of Building 137. The highest DRO soil concentration of 6,300 mg/kg at boring location PH4-B8 is located adjacent to the highest DRO groundwater concentration at monitoring well location PH-WP-09B. Only low concentrations of GRO, generally less than 100 mg/kg, were found at the site (U.S. Navy 2013b).

Future Monitoring Recommendations

Monitoring that is equivalent to that performed in 2012 should continue, with the following exceptions. GRO monitoring should be discontinued for wells PH-MW-02, PH-WP-02, and PH-WP-06, and RRO monitoring should be discontinued at well PH-WP-01. Monitoring of PCE in surface water should also be discontinued at all locations. The monitoring recommendations, as well as the rationale for these recommendations, are summarized in Table 6-4.

The BTEX compounds were not recommended for removal from the Powerhouse site monitoring program because of potential requirements to monitor for TAH. While total BTEX (TAH) has not been tracked for Powerhouse site wells, this appears to have been an oversight, as the DD (U.S. Navy, ADEC, and UIC 2003a) references 18 AAC 70 for the protection of surface water, which includes surface water quality criteria for TAH. The Airstrip site tracks TAH in its monitoring program based on protecting the same water body (Imikpuk Lake) as the Powerhouse site. Consequently, TAH should be tracked in the Powerhouse shoreline wells adjacent to Imikpuk Lake and at the surface water sampling locations in the same manner as it is tracked at the Airstrip site to comply with ADEC surface water quality criteria.

6.4.3 Former Bulk Fuel Tank Farm, Site 13 Monitoring Data

Figure 6-5 shows the location of the wells used for long-term monitoring for the former BFTF, Site 13. The long-term monitoring program has included annual evaluation of COC concentrations in groundwater relative to DD cleanup levels, trends in COC concentrations in groundwater, evidence of natural degradation, and potential impacts to sediment in the melt water pond and North Salt Lagoon. The most recent monitoring report (U.S. Navy 2013a) evaluates data available prior to signing of the DD through 2012. The data for each well are summarized in tabular and graphical format in Appendix A on summary sheets excerpted and updated from the most recent monitoring report. In general, active zone water is shown to flow southwest across the site from the melt water pond toward the North Salt Lagoon.

COCs at the former BFTF site that have historically exceeded active zone water cleanup levels for the protection of North Salt Lagoon are DRO, GRO, benzene, xylene, and lead. Table 6-3 presents the Mann-Kendall results for the COC trend evaluations at the former BFTF for both the active zone water and sediment sampling wells. Details of the data and trend evaluations are presented below.

COC Concentrations in Melt Water Pond Sentinel Wells

Wells BFTF-WP-04, BFTF-WP-05, and BFTF-WP-06 were installed in July 2004 as sentinel wells for the melt water pond in accordance with the BFTF, Site 13, DD. These wells were installed in approximately the same locations as previous monitoring wells with the same well names. Results of samples collected in 2001 from these locations are therefore included in COC trend analyses. Appendix A Tables A-23, A-24, and A-25 present the analytical results and trend graphs for the COCs of each melt water pond sentinel well. From September 2001 to September 2007, GRO and BTEX compounds were consistently detected below the laboratory reporting limits, or at concentrations below the DD cleanup levels at the melt water pond wells, except xylene was detected once in 2004 at BFTF-WP-05 at a concentration greater than the DD cleanup level. Therefore, as recommended in the first 5-year review, GRO and BTEX monitoring was discontinued at these wells. DRO was only occasionally detected at concentrations above the DD cleanup level in all three wells prior to 2007 sampling. However, no DRO concentration from the 2007 to 2012 sampling events exceeded the DD cleanup level. DRO concentrations in all three wells appear to be stable.

As recommended in the first 5-year review, dissolved lead was added to the monitoring analyte list for active zone water monitoring in July 2008. Lead concentrations were below the cleanup level of 3.2 µg/L at wells BFTF-WP-04 and BFTF-WP-06 from July 2008 to August 2012, where results were either below detection limits or at very low detected concentrations. Lead concentrations were below the cleanup level in well BFTF-WP-05, with the exception of the 5.09 µg/L result from September 2009, which slightly exceeded the cleanup level.

COC Concentrations at North Salt Lagoon Sentinel Wells

Wells BFTF-WP-08, -09, and -10 were installed in July 2004 as sentinel wells for the North Salt Lagoon, in accordance with the BFTF, Site 13, DD. These wells were installed in approximately the same locations as previous monitoring wells with the same well names. Results of samples collected in 2001 from these locations are therefore included in COC trend analyses. Appendix A Tables A-27, A-28, and A-29 present the analytical results and trend graphs for the COCs of each North Salt Lagoon sentinel well. From 2001 to 2012, GRO, DRO, benzene, and total xylenes have been detected at concentrations above the DD cleanup levels at well BFTF-WP-08. At the other two North Salt Lagoon wells, only DRO and GRO (at BFTF-WP-09 only) have been detected at concentrations above the DD cleanup level. As recommended in the first 5-year review, lead was added to the monitoring analyte list for active zone water monitoring in July 2008.

At well BFTF-WP-08, GRO and total xylenes have consistently been detected at concentrations above the DD cleanup levels (see Appendix A Table A-27). DRO and benzene decreased to concentrations below their respective cleanup levels in 2006. However, benzene concentrations were above the cleanup level in 2007, 2008, and 2011, and DRO concentrations were above the cleanup level in 2008, 2010, and 2011. Toluene and ethylbenzene have consistently been detected below their respective cleanup levels. Lead concentrations have consistently been below the cleanup level. The highest concentrations of lead at the North Salt Lagoon were reported in July and September of 2008 at concentrations of 2.49 and 2.46 µg/L, respectively. The 2012 trend analysis reported benzene concentrations as stable with no trend. GRO, DRO, and total xylenes concentrations have increasing trends at the 80 percent confidence level. GRO and total xylenes concentrations also show increasing trends at the 90 percent confidence level. However, DRO has no trend at the 90 percent confidence level (U.S. Navy 2013a). Lead concentrations from 2008 to 2012 appear to be decreasing over time, but no trend analysis was performed. The 2012 concentrations for all COCs at well BFTF-WP-08 decreased compared to 2011 concentrations. Trend graphs presented in Appendix A Table A-27 clearly show a sharp drop from 2011 to 2012 for GRO, DRO, and BTEX compounds, which may suggest a declining trend.

At well BFTF-WP-09, BTEX compounds have consistently been detected below the laboratory reporting limits, or at concentrations below the DD cleanup levels (see Appendix A Table A-28). DRO was typically detected at concentrations above the DD cleanup level from 2001 to 2007, except for the July 2001 and July 2005 sampling events. However, from 2008 to 2011 no concentration of DRO exceeded the DD cleanup level. In 2012, both DRO and GRO concentrations exceeded their respective cleanups levels. It appeared from the graphed data from years 2007 to 2011 (presented in Appendix A Table A-28) that DRO concentrations are decreasing over time. Graphed data from years 2011 to 2012 suggest that DRO concentrations may be increasing again. However, no trend analysis was performed for well BFTF-WP-09 (U.S. Navy 2013a). All lead concentrations have consistently been the below cleanup level as well.

At well BFTF-WP-10, GRO and BTEX compounds have consistently been detected below the laboratory reporting limits or at concentrations below the DD cleanup levels (see Appendix A Table A-29). All lead concentrations have also consistently been below the cleanup level. DRO increased from a low concentration of 150 µg/L in 2001 to a maximum concentration in September 2005 of 6,640 µg/L (above the DD cleanup level). Since September 2005, DRO concentrations have remained above the DD cleanup level, except in July 2007, September 2009, and most recently in 2012, where concentrations dropped significantly to 610, 450, and 110 µg/L, respectively. The recent 2012 trend analysis reported DRO concentrations as stable with no trend. However, it should be noted that DRO has exceeded the DRO cleanup level in 7 of the 10 last sampling events. There appeared to be an increasing trend for DRO concentrations from 2009 to 2011. However, recent 2012 DRO concentrations suggest a possible decreasing trend, as presented in the graph of Appendix A Table A-29.

North Sentinel Well

Although well BFTF-WP-07 was installed as a background well, this well is no longer used as a background well for former BFTF, Site 13, because the groundwater sampling results from this well are indicative of organic contamination and biodegradation. This well is now considered a sentinel well. Beginning in 2010, AS-WP-21 was used as a background well for this site. Monitoring results for AS-WP-21 are included in Section 6.4.1, and are not repeated here.

In well BFTF-WP-07, GRO, DRO, and BTEX compounds have consistently been detected below the laboratory reporting limits, or at concentrations below the DD cleanup levels since analysis for these compounds began in July 2005, except for the benzene concentration in 2012 that exceeded the cleanup level (see Appendix A Table A-26). Additionally, lead concentrations have consistently been below the cleanup level at well BFTF-WP-07.

Natural Biodegradation Results

Ferrous iron, methane, alkalinity, and other geochemical indicator data consistently imply that biodegradation of hydrocarbons is occurring in active zone water. Oxygen-reduction potential, ferrous iron, methane, and alkalinity concentrations all suggest that anaerobic respiration is occurring. The low dissolved oxygen levels and oxygen-reduction potential values are consistent with a reducing environment. Ferrous iron was detected in all wells, indicating that anaerobic degradation is occurring at the site. Increasing alkalinity concentrations over time are indicative that microbial activity (such as carbon dioxide production) is occurring at the former BFTF site. The higher-than-background methane concentrations also indicate that biodegradation by means of methanogenesis may be occurring at these locations. Sulfate levels are above background at the wells along the North Salt Lagoon, which suggests that sulfate reduction is not complete at the site. However, high tide levels may have influenced the sulfate concentrations. Overall, the reported data suggest natural attenuation via biodegradation is still occurring at the former BFTF site (U.S. Navy 2013a).

Sediment Sampling Results

Data for three sediment sampling locations in the North Salt Lagoon are available for 1997 and 2004 through 2012. DRO is consistently detected in sediment from all three locations, while GRO has only been detected once in the last 5 years, in sample BFTF-SED-53 in September 2009 (see Appendix A Table A-30). In the most recent trend analysis which included data from 2004 thru 2012 , trends for DRO concentrations at locations BFTF-SED-53, BFTF-SED-54, and BFTF-SED-55 were reported as decreasing at both the 80 and 90 percent confidence levels (U.S. Navy 2013a). It should also be noted at location BFTF-SED-53 that the highest concentration of DRO of 110 mg/kg was reported with a ZL qualifier, which suggests that the detection of DRO may not be representative of a petroleum product (see Appendix A Table A-32 for qualifier definitions). As recommended in the first 5-year review, lead was added to the monitoring analyte list for sediment. Lead concentrations at all three sediment locations appear to be stable with no trend (U.S. Navy 2013a) (see Appendix A Table A-30).

During the 2010 site assessment, a small shoreline seep was observed to have a sheen and petroleum odor. The seep was near location BFTF-SED-53, but did not flow into the North Salt Lagoon and was contained in a small puddle. No seep was identified during the 2011 and 2012 site assessments.

Future Monitoring Recommendations

Monitoring equivalent to that performed in 2012 should continue for the former BFTF site with the following exceptions. Analysis of lead in groundwater samples from wells BFTF-WP-04 through BFTF-WP-10 can be discontinued because lead has either not been detected, or has been consistently detected at concentrations well below the cleanup level, except for a one time exceedance at BFTF-WP-05 in September 2009. Using the same rationale, ethylbenzene and toluene analysis should also be discontinued at monitoring well BFTF-WP-08, BTEX analysis at monitoring wells BFTF-WP-09 and BFTF-WP-10, and GRO analysis at monitoring well BFTF-WP-10. The monitoring recommendations, as well as the rationale for these recommendations, are summarized in Table 6-4.

The last 5-year review recommended that lead be added to the soil sampling and active zone water monitoring analyte list. During this review period, lead was analyzed for in active zone water monitoring and in sediment sampling of the North Salt Lagoon. However, lead was not added to the soil sampling analyte list. The recommendation for lead to be added to soil sampling is no longer necessary, as all but one lead concentration measured in water was below the cleanup level of 3.2 µg/L. The single exceedance was at well BFTF-WP-05 at a concentration of 5.09 µg/L during September 2009 sampling. The post-2009 lead concentrations in water were 0.039 µg/L in 2010 and not detected in 2011 and 2012. Although lead was detected in all sediment locations, the Mann-Kendall trend analysis reported lead concentrations as stable.

6.5 RESULTS OF SITE INSPECTIONS

Site inspections from 2008 through 2012 were conducted concurrently with monitoring events at each of the three sites. During the site inspections, the conditions of the monitoring wells were assessed and monitoring wells were reinstalled or redeveloped as needed. Visual site inspections also included inspections of surface water for any signs of petroleum sheen, observances of site surface soils for signs of discoloration or odor, and noting of any stressed vegetation. These visual inspections are summarized by site below.

Navy personnel visit the site at least twice a year and review the site for any changes in land use or site conditions that could affect the protectiveness of the cleanup actions. ADEC personnel also reported that they visit the site at least once annually.

6.5.1 Airstrip, Site 5

In accordance with the recommendations of the first 5-year review, the capped area in the south depression of the Airstrip site was visually inspected on August 24, 2010 to assess its functionality. Most of the south depression area was under water during the inspection. During the inspection, it was also noted that one culvert discharged into the south depression from the north depression, while two other culverts connect the south depression to low-lying areas off site to the east. No water was seen flowing through the culverts during the inspection, and the direction of flow appeared to be to the east. No sheen was observed either in the larger ponded area south of the cap, or on puddles that were observed on top of the cap. The visual assessment concluded that there was no evidence of contaminant impacts (no stressed vegetation or sheen). However, the Navy recommended in 2011 that an additional assessment be performed to understand the impact the south depression capped soils may have on the surrounding area. This additional assessment was conducted in 2012 and included a UVOST investigation and sampling of four new wells east of the south depression cap.

During visual site inspections from 2008 to 2012 for the Airstrip, no free-phase petroleum product was observed in any of the monitoring wells, and no soil staining and/or stressed vegetation was observed near any of the monitoring wells. During water sample collection of 2008, a surface sheen that appeared to be bubbling to the surface of Imikpuk Lake was observed at location AS-SW-01. Although a slight sheen was present in standing water around well AS-WP-10 in 2008, no sheen was observed on nearby standing water in inspections thereafter. Purge water from wells AS-WP-10 and AS-WP-11 was also slightly discolored in 2008. Fuel odor was detected consistently in wells AS-WP-10, AS-WP -11, and AS-WP-101 from 2008 to 2012. Fuel odor was also detected in wells AS-WP -12 and AS-WP-18 during the 2010, 2011, and 2012 inspections. During the 2012 inspection, a light fuel odor was also noted at well AS-WP-02B and new wells AFAS-WP-19, AFAS-WP-19-20, and AFAS-WP-22. In the vicinity of new wells AFAS-WP-19 and AFAS-WP-20, areas of staining and slight sheen were observed during sampling in the wet soils and standing water.

6.5.2 Powerhouse, Site 12

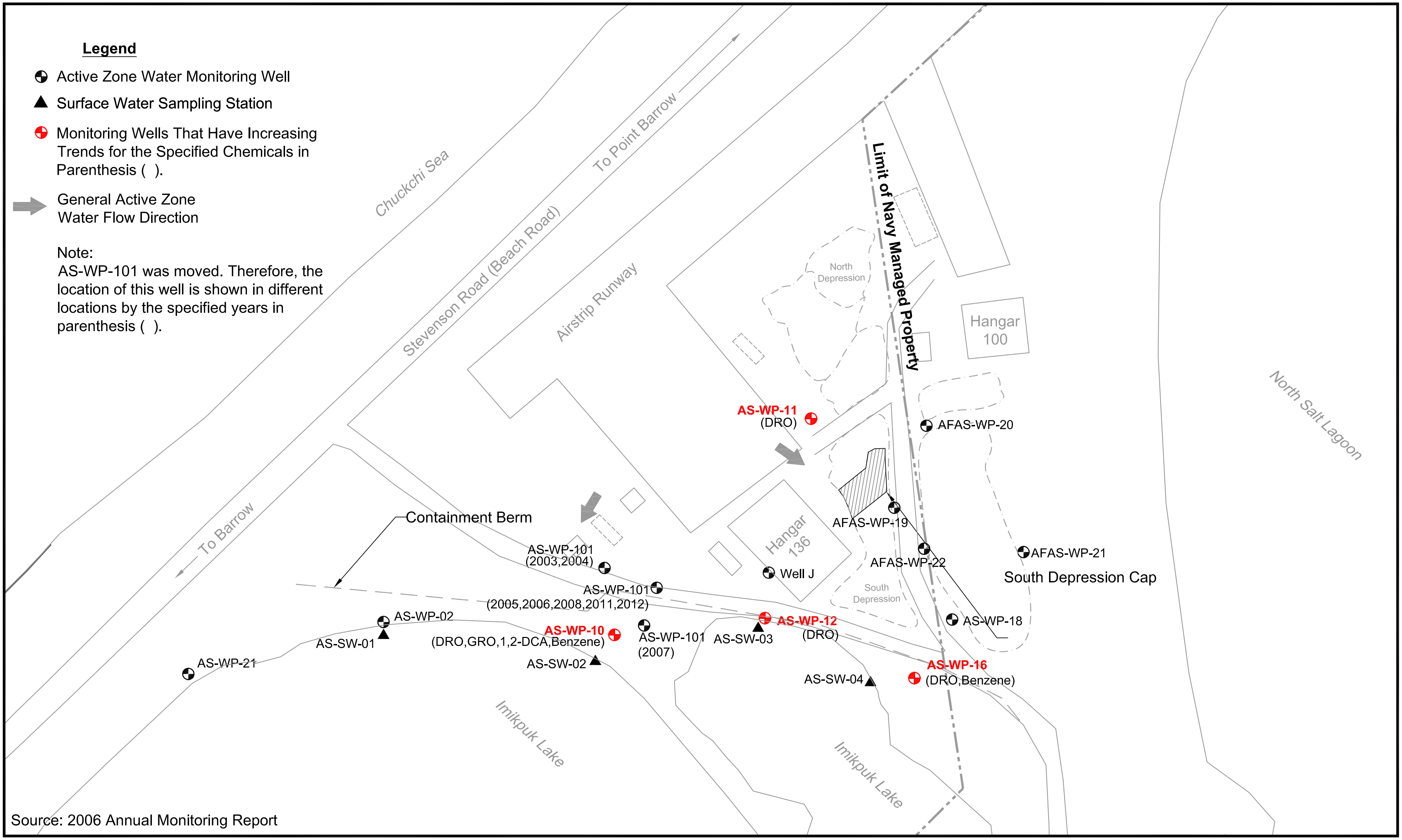
During visual site inspections from 2008 to 2012 for the Powerhouse site, no free-phase petroleum product was observed in any of monitoring wells. In both 2008 and 2009, inspections of the laydown yard at the powerhouse, where most of the wells are located, had a number of pools of discolored standing water. It was also reported in 2009 that there were numerous areas of stained soil, and petroleum sheen was present in this same area. There were other observations of sheen, discolorations, odors, and stains that were noted during visual inspections of the Powerhouse site that are described below.

During the 2008 inspection, a slight sheen was observed on the purge water from well PH-WP-09, and it was reported that the purge water from this well had a fuel odor and discoloration. In 2009, no sheen was observed on the purge water from any of the Powerhouse site monitoring wells. However, purge water from well PH-WP-09B was brown in color. No odors were noted during the 2009 sampling, but windy conditions may have influenced the conditions of the air current. No sheen was observed nor odors detected during the 2009 surface water sampling. In 2010, an additional area of ponded water located 12 feet downgradient from PH-WP-09B had a dense sheen visible on the surface when the sediment was stirred up, but no other staining was observed in the soil near this well. A light sheen was also observed on the purge water from well PH-WP-02. Unlike in 2010, no water was ponded near PH-WP-09B, and no evidence of sheen or staining was noted in 2011 or 2012. No sheen or odor was detected during the last three surface water sampling events from 2010 to 2012.

During the last three site inspections of 2010, 2011, and 2012, surficial soil staining and stressed vegetation were observed in a 40- by 10-foot area surrounding well PH-WP-02, which is the same location where a light sheen was also noted in 2010. Soil staining that appeared surficial was observed along the inland side of the beach between wells PH-WP-02 and PH-WP-01C. Some smaller areas of staining and stressed vegetation were also noted in a lower ponded and vegetated back beach area between the two wells. Staining was only noticeable when the surrounding unstained gravel was dry. A small area of stained soil was also noted near the base of well PH-WP-06 during the 2010 and 2011 inspections, though it was not observed during 2012 inspection.

6.5.3 Former Bulk Fuel Tank Farm, Site 13

No free-phase petroleum product was observed in any of the monitoring wells, nor was soil staining and/or stressed vegetation observed near any of the monitoring wells during visual inspections conducted from 2008 to 2012. No sheen was observed on any of the surface water locations during 2008 and 2009 visual site inspections. However, purge water from well BFTF-WP-08 was slightly discolored in July 2008 and strongly discolored and foamy in September 2008. In 2010, a small 1- by 2-foot area of sheen was observed approximately 10 feet east of location BFTF-SED-54 along a seep at the beach front. The sheen had a light petroleum odor, but was not entering the North Salt Lagoon (a small beach sediment deposit was preventing its movement). In 2011 and 2012, no seep was located during the visual site inspection anywhere between wells BFTF-WP-08C and BFTF-WP-09 (location BFTF-SED-54 is located between these two wells). It appeared that sand and sediment had formed a substantial shoreline beach deposit. The beach deposit acts as a berm along the lagoon shoreline and prevents drainage of the back beached ponded areas. No sheen was noted in the ponded areas during the 2012 inspection.



Source: 2006 Annual Monitoring Report

U.S. NAVY

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Figure 6-1
Airstrip, Site 5, Monitoring Locations

Naval Arctic
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Barrow, AK
SECOND 5-YEAR REVIEW

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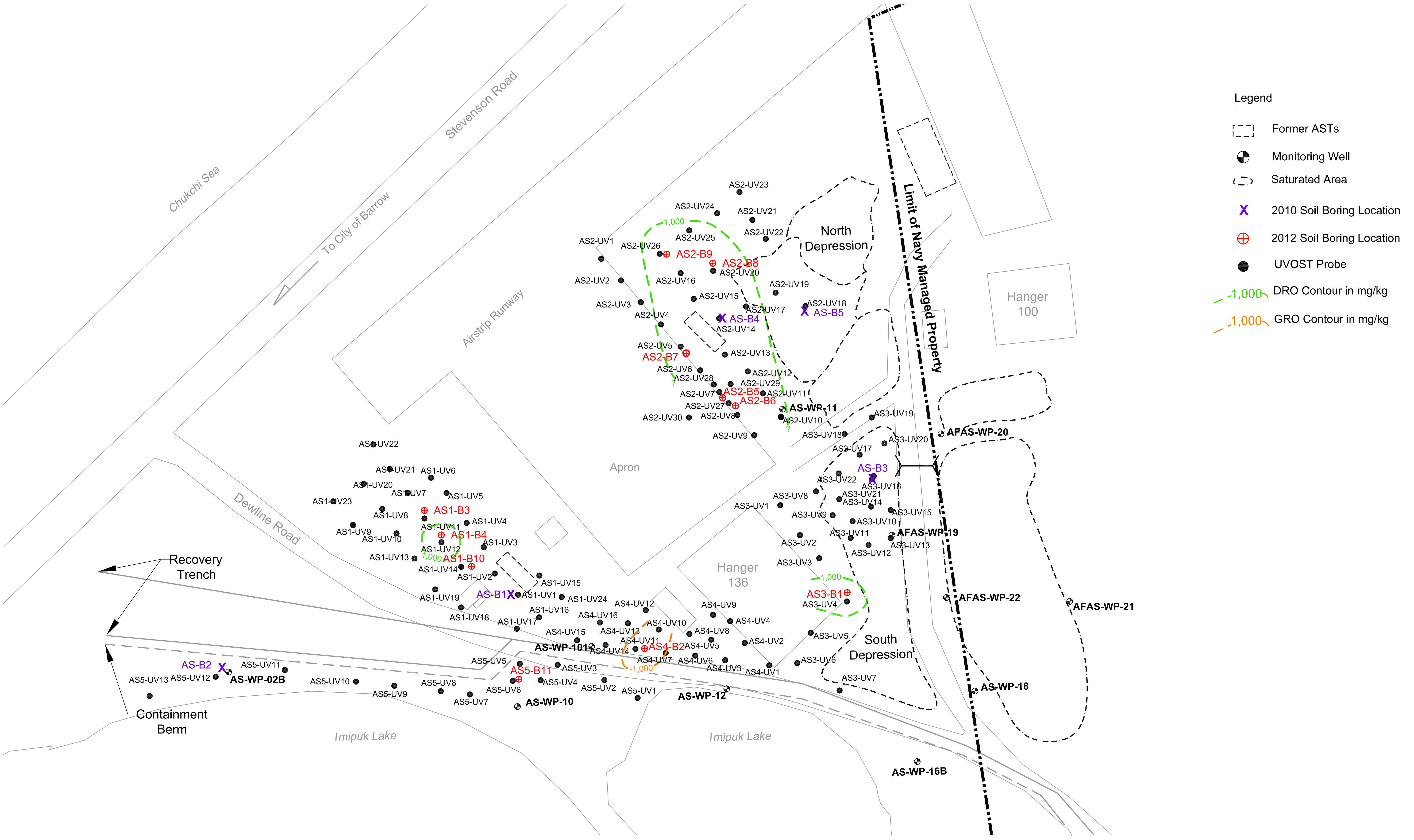

U.S. NAVY

Naval Artic
Research Laboratory
Barrow, AK
SECOND 5-YEAR
REVIEW

Figure 6-2
NARL Airstrip Boring Locations

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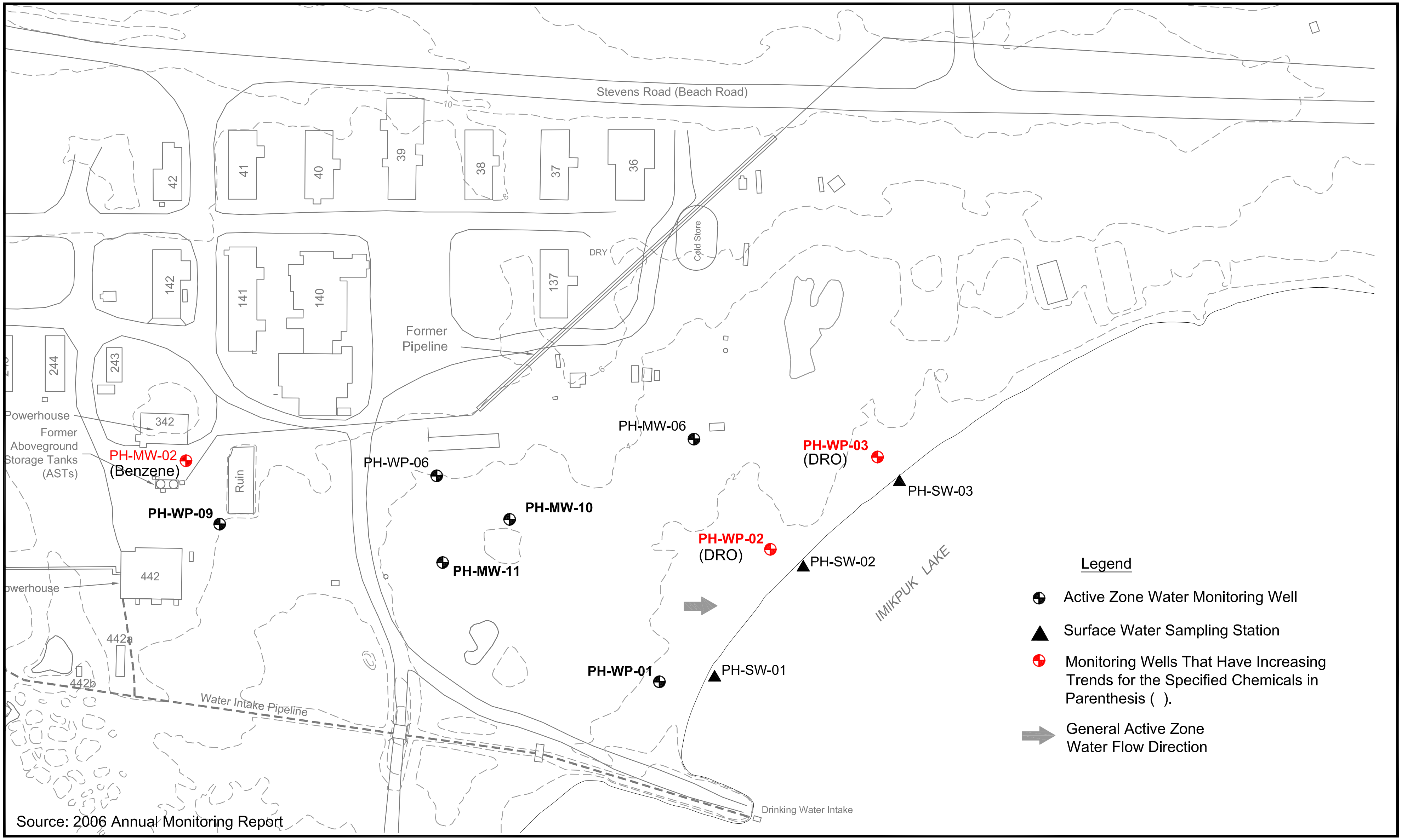

Source: 2006 Annual Monitoring Report

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Figure 6-3
Powerhouse, Site 12, Monitoring Locations

Naval Arctic
Research Laboratory
Barrow, AK
SECOND 5-YEAR REVIEW

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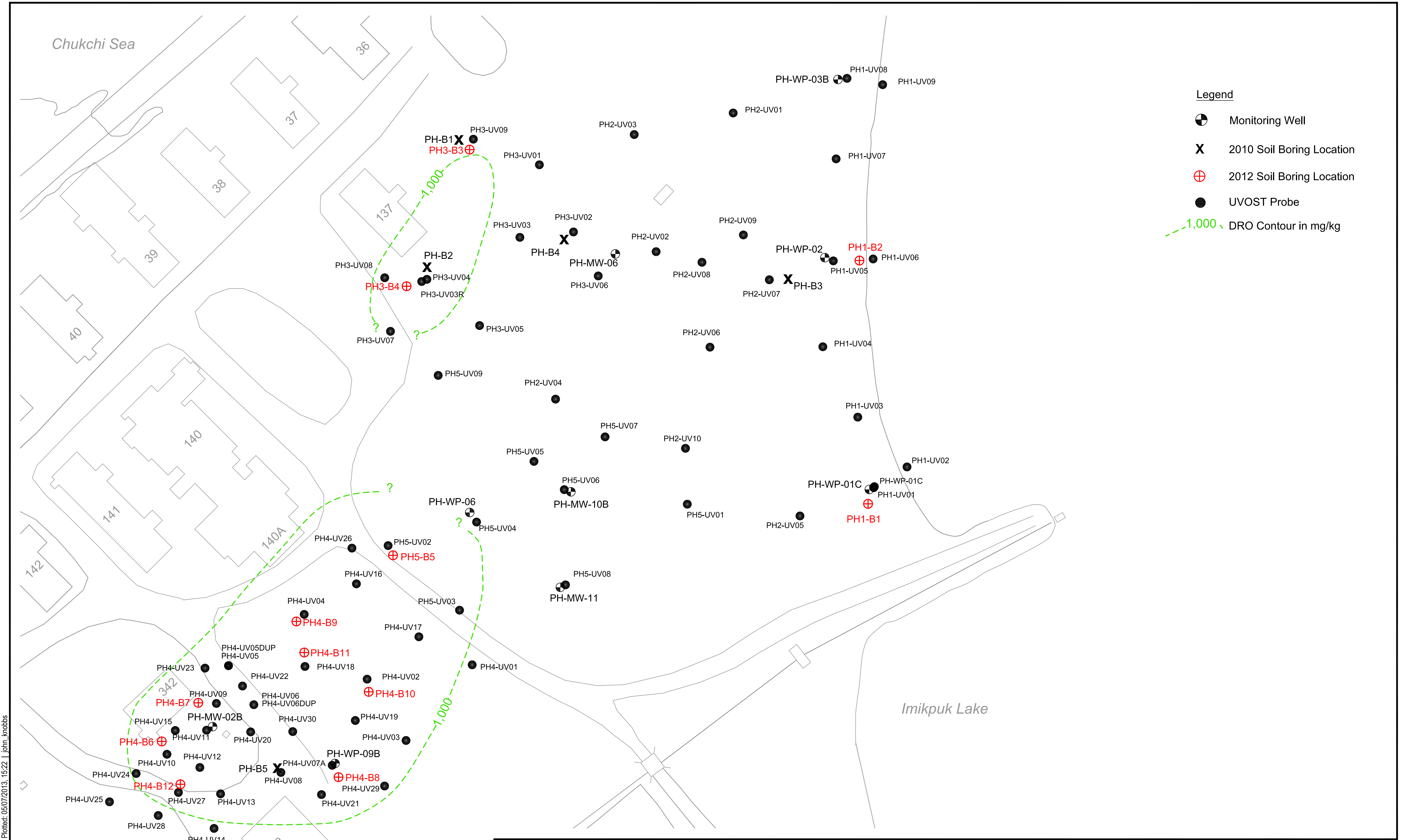

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Barrow, AK
SECOND 5-YEAR
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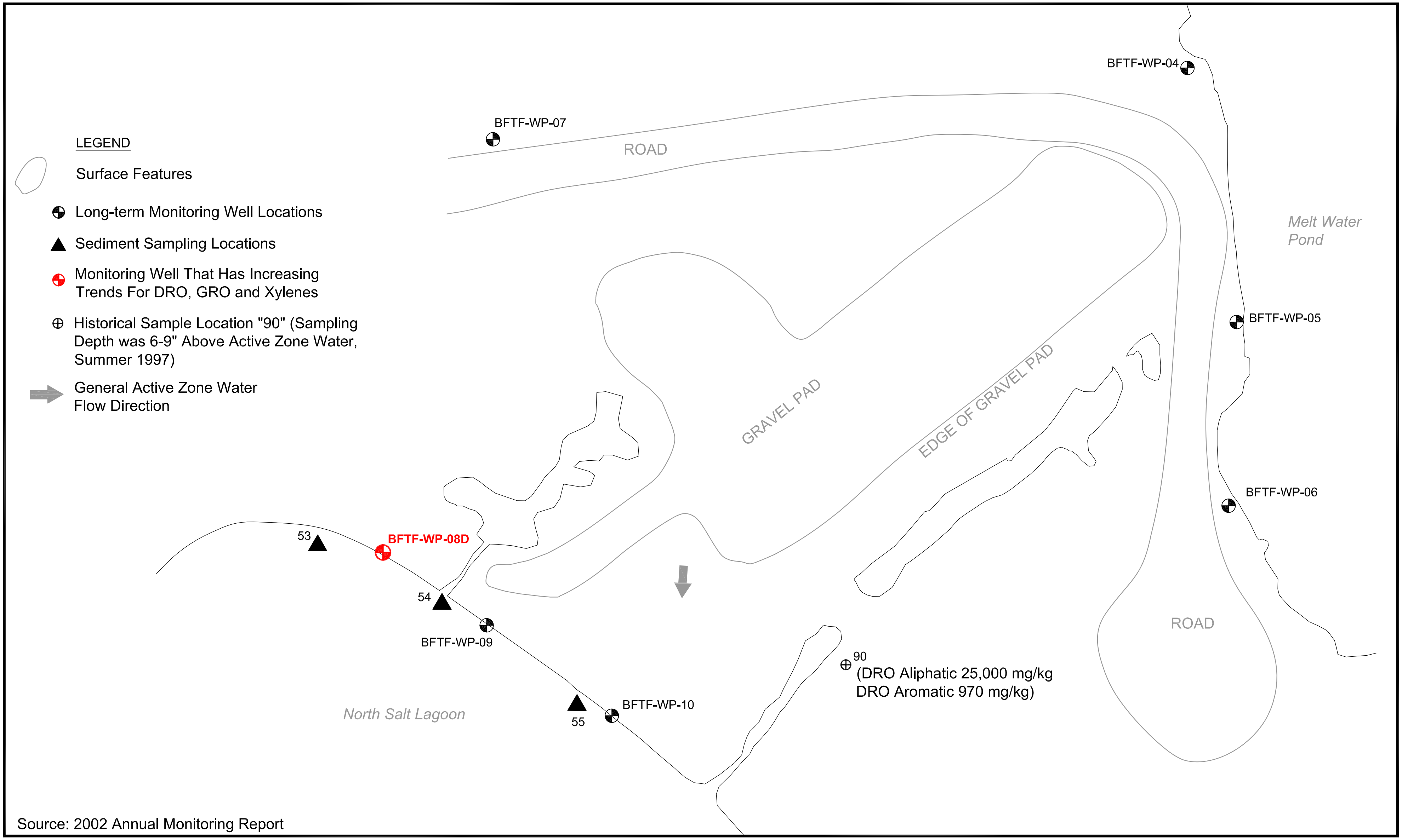
Figure 6-4
NARL Powerhouse Boring Locations



Source: 2002 Annual Monitoring Report

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Figure 6-5
Former BFTF, Site 13, Monitoring Locations

Naval Arctic
Research Laboratory
Barrow, AK
SECOND 5-YEAR REVIEW

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Table 6-1
Concentration Trend Evaluation for the Airstrip, Site 5

Sample Location	Chemical[a]	No. of Sampling Periods	Mann-Kendall Trend at 80% CL	Mann-Kendall Trend at 90% CL	Stability Test If No Trend Exists at 80% CL	Trend Observed in Graphed Data[b]
AS-WP-10	**1,2-DCA**	9	Increasing	Increasing	NA	NA
	GRO	10	Increasing	None	NA	None
	DRO	10	Increasing	None	NA	None
	Benzene	10	Increasing	Increasing	NA	None
AS-WP-11	GRO	10	Decreasing	None	NA	Decreasing
	DRO	10	Increasing	Increasing	NA	Increasing
	Benzene	10	Decreasing	Decreasing	NA	Decreasing
AS-WP-12	**DRO**	10	Increasing	None	NA	Increasing
AS-WP-16B	**Benzene**	10	Increasing	Increasing	NA	Increasing
	DRO	10	Increasing	Increasing	NA	Increasing
AS-WP-18	**GRO**	10	None	None	Stable	None
	DRO	10	None	None	Stable	None
	Benzene	10	Decreasing	None	NA	Decreasing
AS-WP-101	**GRO**	10	Decreasing	None	NA	Decreasing
	DRO	10	None	None	Stable	Stable
	Benzene	10	Decreasing	Decreasing	NA	Stable
	Toluene	10	None	None	Stable	None
	Ethylbenzene	10	Decreasing	None	NA	Decreasing
	Xylenes	10	Decreasing	None	NA	None

[a] Bolded chemicals exceed cleanup level in 2012.
[b] See Appendix A for visual graph.

Notes:
CL - confidence level
DCA - dichloroethane
DRO - diesel-range organics
GRO - gasoline-range organics
NA - not applicable

Table 6-2
Concentration Trend Evaluation for the Powerhouse, Site 12

Sample Location	Chemical[a]	No. of Sampling Periods	Mann-Kendall Trend at 80% CL	Mann-Kendall Trend at 90% CL	Stability Test If No Trend Exists at 80% CL	Trend Observed in Graphed Data[b]
PH-MW-02B	**Benzene**	9	Increasing	None	NA	None
	DRO	9	Decreasing	None	NA	Decreasing
	RRO	9	None	None	Stable	Decreasing
PH-MW-06	**Benzene**	10	None	None	Stable	None
	DRO	10	None	None	Stable	None
PH-WP-01C	**DRO**	10	None	None	Stable	Stable
PH-WP-02	**Benzene**	10	None	None	Stable	Stable
	DRO	10	Increasing	Increasing	NA	Increasing
PH-WP-03B	**DRO**	10	Increasing	Increasing	NA	Increasing
	RRO	10	None	None	Stable	None
PH-WP-06	RRO	10	None	None	Stable	None
PH-WP-09B	**Benzene**	10	Decreasing	Decreasing	NA	Decreasing
	GRO	10	None	None	Stable	Stable
	DRO	10	None	None	Stable	None
	RRO	10	Decreasing	None	NA	Stable

[a] Bolded chemicals exceed cleanup level in 2012.
[b] See Appendix A for visual graph.

Notes:
CL - confidence level
DRO - diesel-range organics
GRO - gasoline-range organics
NA - not applicable
RRO - residual-range organics

Table 6-3
Concentration Trend Evaluation for the Former BFTF, Site 13

Sample Location	Chemical[a]	No. of Sampling Periods	Mann-Kendall Trend at 80% CL	Mann-Kendall Trend at 90% CL	Stability Test If No Trend Exists at 80% CL	Trend Observed in Graphed Data[b]
Active Zone Water						
BFTF-WP-08D	Benzene	10	None	None	Stable	Stable
	Xylenes	10	Increasing	Increasing	NA	Increasing
	GRO	10	Increasing	Increasing	NA	Increasing
	DRO	10	Increasing	None	NA	Increasing
BFTF-WP-10	DRO	10	None	None	Stable	None
Sediment						
BFTF-SED-53	DRO	7	Decreasing	Decreasing	Unstable	None
	Lead	6	None	None	Stable	Stable
BFTF-SED-54	DRO	7	Decreasing	Decreasing	NA	Decreasing
	Lead	6	None	None	Stable	Stable
BFTF-SED-55	DRO	7	Decreasing	Decreasing	NA	Decreasing
	Lead	6	None	None	Stable	Stable

[a] Bolded chemicals exceed cleanup level in 2012.
[b] See Appendix A for visual graph.

Notes:
CL - confidence level
DRO - diesel-range organics
GRO - gasoline-range organics
NA - not applicable

Table 6-4
Future Monitoring Recommendations

Monitoring Recommendation	Rationale for Recommendation
Airstrip, Site 5	
Discontinue GRO monitoring at well AS-WP-02.	GRO concentrations had a decreasing trend from 2010 to 2012. In 2012, GRO concentrations significantly dropped from 500 µg/L (in 2011) to 86 µg/L. Furthermore, no GRO concentration has exceeded the cleanup level of 1,300 µg/L since 1998.
Powerhouse, Site 12	
Discontinue GRO monitoring at well PH-MW-02.	Although GRO concentrations showed visually increasing trends on trend graph from 2010 and 2011, and concentrations were approaching the cleanup level, the 2012 GRO concentrations are approximately half of what they were in 2011 (decreasing from 1,100 to 560 µg/L).
Discontinue GRO monitoring at well PH-WP-02.	GRO concentrations had a visually decreasing trend on trend graph from 2008 to 2012. No GRO concentration has exceeded the cleanup level of 1,300 µg/L since 1998.
Discontinue GRO monitoring at well PH-WP-06.	GRO concentrations had a decreasing trend from 2010 to 2012. No GRO concentration has exceeded the cleanup level of 1,300 µg/L since 2004. The most recent 2012 GRO concentration of 94 µg/L is less than half of the 2011 concentration of 220 µg/L.
Discontinue RRO monitoring at well PH-WP-01.	RRO concentrations had a visually decreasing trend on trend graph from 2010 to 2012. No concentration has exceeded the cleanup level of 1,000 µg/L in the last 5 years. Well PH-WP-01 is located downgradient of well PH-MW-11. Although PH-MW-11 had a visually increasing trend for RRO concentrations from 2009 to 2011, the most recent 2012 concentration of 740 µg/L was substantially lower than the 2011 concentration of 1,100 µg/L.
Discontinue PCE monitoring at well PH-SW-01.	PCE has not been detected since monitoring began in 2007. No PCE has been detected in nearby shoreline well PH-WP-01C, and, therefore, PCE monitoring ceased in 2008 at this well (with the exception of one accidental analyses of PCE in September 2009, which was not detected as well).
Discontinue PCE monitoring at well PH-SW-02.	There has only been one very low detection of PCE since monitoring began in 2007. No detection of PCE was identified in nearby shoreline well PH-WP-02. Therefore, PCE monitoring ceased in 2008 at PH-WP-02.
Discontinue PCE monitoring at well PH-SW-03.	PCE has not been detected since monitoring began in 2007. No PCE has been detected in nearby shoreline well PH-WP-03. Therefore, PCE monitoring ceased in 2008 at this well.
Former Bulk Fuel Tank Farm, Site 13	
Discontinue lead monitoring at well BFTF-WP-04.	Lead concentrations have not been consistently detected since monitoring began in 2008. All detections have been below the cleanup level of 3.2 µg/L.
Discontinue lead monitoring at well BFTF-WP-05.	Lead concentrations have not been consistently detected at well BFTF-WP-05 since monitoring began in 2008. Only one of the five samples detected was above the cleanup level of 3.2 µg/L. The most recent 2012 sample at well BFTF-WP-05 was not detected for lead.
Discontinue lead monitoring at well BFTF-WP-06.	Lead concentrations have not been consistently detected since monitoring began in 2008. All detections have been below the cleanup level of 3.2 µg/L.

Table 6-4 (Continued)
Future Monitoring Recommendations

Monitoring Recommendation	Rationale for Recommendation
Former Bulk Fuel Tank Farm, Site 13 (Continued)	
Discontinue lead monitoring at well BFTF-WP-07.	Lead concentrations have not been consistently detected since monitoring began in 2008. All detections have been below the cleanup level of 3.2 µg/L.
Discontinue lead, ethylbenzene, and toluene monitoring at well BFTF-WP-08.	Lead concentrations have been detected at concentrations below the cleanup level of 3.2 µg/L since monitoring began in 2008.
	Ethylbenzene concentrations have been detected at concentrations below the cleanup level of 700 µg/L since monitoring began in 2001.
	Toluene concentrations have been detected at concentrations below the cleanup level of 1,000 µg/L since monitoring began in 2001.
Discontinue lead and BTEX monitoring at well BFTF-WP-09.	Lead concentrations have either been detected at concentrations below the cleanup level of 3.2 µg/L, or not detected (in last two sampling events of 2011 and 2012).
	There has been either no detection or detections at low concentrations (below cleanup levels) for BTEX since monitoring began in 2001.
Discontinue lead, BTEX, and GRO monitoring at well BFTF-WP-10.	Lead concentrations have not been consistently detected since monitoring began in 2008, and all detections have been below the cleanup level of 3.2 µg/L.
	There has been either no detection or detections at low concentrations (below cleanup levels) for BTEX since monitoring began in 2001.
	There has been either no detection or detections at low concentrations (below cleanup levels) for GRO since monitoring began in 2001.

Notes:
BTEX - benzene, toluene, ethylbenzene, and xylenes
GRO - gasoline-range organics
PCE - tetrachloroethene
RRO - residual-range organics
µg/L - microgram per liter

7.0 TECHNICAL ASSESSMENT

7.1 FUNCTIONALITY OF CLEANUP ACTION

This section answers the question "Is the cleanup action functioning as intended by the decision documents?" The functionality of the remedy components applicable to each site are summarized in the sections that follow.

7.1.1 Functionality of Cleanup Action for the Airstrip, Site 5

Is the remedy functioning as intended by the DD? No, the remedy at Airstrip, Site 5, is not currently functioning as intended by the DD, because concentrations of COCs in three of the four shoreline wells are above cleanup levels, and concentrations of DRO, GRO, 1,2-DCA, and benzene are increasing in one or more of these wells. While these increasing concentrations are a concern, warranting further investigation and possible further actions, concentrations are not currently adversely impacting Imikpuk Lake (the water body to be protected), as concentrations of COCs in the surface water samples are less than the cleanup levels.

The Navy has completed extensive additional investigations in 2010 and 2012 to develop a better understanding of the residual soil contamination that is contributing to exceedances in shoreline and site wells. The results of the 2010 soil investigation did not find any significant residual petroleum concentrations in soils that could easily explain the increasing concentrations in groundwater. The 2012 soil investigation concluded that there are localized areas of DRO and GRO contamination at the Airstrip site, and these areas of elevated DRO and GRO concentrations, although not exceeding soil cleanup levels, are likely the source of the elevated groundwater DRO and GRO concentrations. The study also suggested that the increasing DRO and GRO trends in the monitoring wells adjacent to Imikpuk Lake were possibly because of the containment berm not optimally blocking groundwater movement.

Landowners and the community have raised concerns regarding whether contamination from the site is impacting areas east of the site, not just south, and regarding the continued effectiveness of the ice wall with the rising temperatures due to climate change. The 2012 long-term monitoring report concluded that the contaminants detected in the new wells (AFAS-19 through AFAS-22) located east of the site were most likely from a previously unidentified source centered in the vicinity of well AFAS-WP-20 and not the result of contaminant migration from the Airstrip site. Regarding community concerns related to the effectiveness of the ice wall, increasing concentrations observed in the wells immediately downgradient of the wall suggest that the effectiveness of the ice wall may be compromised (Figure 6-1).

The south depression cap was visually inspected on August 24, 2010. During the visual inspection, the cap appeared to be continuous and to prevent sheen from forming on the surrounding surface water. While the results of the inspection are encouraging in terms of the functionality of the cap, the first five-year review recommended a full engineering evaluation of the cap, and a more in depth evaluation than that performed in 2010 may be warranted.

Although COCs have been detected in surface water samples from Imikpuk Lake, they were all below cleanup levels during this 5-year review period, indicating that there are no current impacts to the lake. Concentrations of COCs in three of the four shoreline wells (the points of compliance for protection of surface water in Imikpuk Lake) continue to exceed cleanup levels. Furthermore, concentrations of selected COCs are increasing in these three shoreline wells, as described below:

- DRO concentrations in AS-WP-10, AS-WP-12, and AS-WP-16B
- 1,2-DCA, GRO, and benzene concentrations in AS-WP-10
- Benzene concentrations in AS-WP-16B

Concentrations of COCs in all three site wells, which are located upgradient of the containment berm, continue to exceed cleanup levels. However, decreasing or stable COC concentration trends are reported in these three site wells, except for DRO in well AS-WP-11, which exhibited increasing trends. The measured values of natural biodegradation parameters in active zone water from both shoreline and site wells have consistently been indicative of microbial activity and biodegradation of petroleum compounds. Recommendations for optimizing the monitoring program given current site conditions are provided in Section 6.4.1.

Because of increasing petroleum compound concentration trends in shoreline wells and exceedances of cleanup levels in most shoreline and site wells, additional soil investigations were conducted in 2010 that consisted of advancing five soil borings to a depth of 30 inches. Two of the borings had petroleum odor, sheen, and elevated photoionization detector readings. No soil boring sampled in 2010 exceeded the soil cleanup levels established in the DD, and the results did not explain the increasing concentration trends. However, soil cleanup levels at the Airstrip site were not based on concentrations protective of water and may need to be reevaluated (see discussion in Section 7.2.1). Because the 2010 investigation did not explain the increasing concentration trends, the more extensive 2012 soil investigation was conducted (as described below).

Based on the recommendations from the soil investigation in the 2010 annual monitoring report, 105 locations were screened in 2012 at the Airstrip site using a direct read screening tool, UVOST, which quickly determines the presence or absence of fuels by measuring the fluorescence returned from a laser probe pushed into the soil. Soil borings were obtained from approximately 10 percent of the UVOST locations (i.e., 11 soil borings), including the locations identified as containing the highest levels of contaminants based on the UVOST results, and sampled for GRO, DRO, and BTEX. The 2012 soil investigation identified three areas with the highest concentration of DRO at the Airstrip site, one primary area and two smaller subareas in soil. These are located north of Hangar 136 and east of the apron, at the east corner of the Hangar 136, and west of the apron. The area with the highest GRO concentrations was located close to Imikpuk Lake and west of Hangar 136. The areas of elevated DRO and GRO concentrations, although not exceeding soil cleanup levels, are likely the source of the elevated groundwater DRO and GRO concentrations. Furthermore, the increasing groundwater concentration trends in the monitoring wells adjacent to Imikpuk Lake suggest that the containment berm is not optimally blocking groundwater movement. The 2012 site investigation recommended reevaluating the soil cleanup levels, because the current cleanup levels may be too high to be protective of the groundwater quality, and assessing the feasibility of implementing additional measures to clean up the areas of highest concentrations or hot spots.

The 2010 annual report recommended that the surface water in the south depression area be sampled, and the culvert flow direction from the south depression area be assessed in 2011. These activities were not included in the tasks for the 2011 or 2012 field season. However, these recommendations should be addressed in future field work. Assessing the culvert flow direction will assist in determining if water can migrate from the south depression area to the east. Furthermore, it was recommended that a borehole be installed in the roadway to the east of the south depression area to measure the depth to permafrost to determine if the permafrost is acting as an ice dam (natural barrier) between the low areas. Additional research on the current permafrost depth at the site may prove beneficial for understanding how changes to the permafrost depth may affect the mobility of remaining petroleum at the site.

7.1.2 Functionality of Cleanup Action for the Powerhouse, Site 12

Is the remedy functioning as intended by the DD? No, the remedy at Powerhouse, Site 12, is not currently functioning as intended by the DD, because concentrations of COCs in all three of the shoreline wells are above cleanup levels, and concentrations of DRO are increasing in one or more of these wells. Similar to the Airstrip site, concentrations are not currently adversely impacting Imikpuk Lake (the water body to be protected), as concentrations of COCs in the surface water samples are less than the cleanup levels. Visual site inspections from 2008 to 2012 reported that no free-phase petroleum product was encountered in any of the monitoring wells, indicating that residual free product does not explain concentration increases. Stained soil was found during the 2012 visual inspection in the same areas since 2010. The areas include an area surrounding well PH-WP-02 and along the inland side of the beach area between wells PH-WP-02 and PH-WP-01C. The staining is apparent only in dry conditions. No sheens or odors were detected during the surface water sampling. The Navy has completed extensive additional investigations in 2012 to develop a better understanding of the residual soil contamination that is contributing to exceedances in shoreline and site wells. The 2012 investigation concluded that there are localized areas of DRO contamination at the Powerhouse, and these areas of elevated DRO concentrations, although not exceeding soil cleanup levels, are likely the source of the elevated groundwater DRO concentrations.

Although COCs have been detected in surface water samples from Imikpuk Lake, they were all below cleanup levels during this 5-year review period, indicating that there are no current impacts to the lake. Concentrations of COCs in all three shoreline wells (the points of compliance for protection of surface water in Imikpuk Lake) continue to exceed cleanup levels. Furthermore, DRO concentrations are increasing in two of the three shoreline wells (PH-WP-02 and PH-WP-03B). During this 5-year review period, concentrations of COCs in five of the six site wells (located in areas associated with contaminated soil) continued to exceed cleanup levels. However, decreasing or stable COC concentration trends are reported in these wells, except for benzene concentrations in one well (PH-MW-02B). The measured values of natural biodegradation parameters in active zone water from both shoreline and site wells have consistently been indicative of microbial activity and biodegradation of petroleum compounds. Recommendations for optimizing the monitoring program, given current site conditions, are provided in Section 6.4.2.

Because of increasing petroleum compound concentration trends in shoreline wells and exceedances of cleanup levels in most shoreline and site wells, additional soil investigations occurred in 2010 that consisted of advancing five borings to a depth of 30 inches. All borings had a petroleum odor or sheen except PH-B4, which had an organic layer at approximately 26 inches bgs and a methane and decomposing odor. No soil boring sampled in 2010 exceeded the soil cleanup levels established in the DD, and, as with the 2010 soil investigations at the Airstrip site, the results did not explain increasing concentration trends. However, soil cleanup levels at the Powerhouse site were not based on concentrations protective of water and may need to be reevaluated (see discussion in Section 7.2.1). Because the 2010 investigation did not explain the increasing concentration trends, the more extensive 2012 soil investigation was conducted (as described below).

Based on the recommendations from the soil investigation in the 2010 annual monitoring report, 67 locations were screened at the Powerhouse site in 2012 using a direct-read screening tool, UVOST, which quickly determines the presence or absence of fuels by measuring the fluorescence returned from a laser probe pushed into the soil. Soil borings were obtained from approximately 10 percent of the UVOST locations (i.e., 11 soil borings), including the locations identified as containing the highest levels of contaminants, and sampled for GRO, DRO, and BTEX. The 2012 soil investigation identified two areas with the highest concentration of DRO contamination at the Powerhouse site, one primary area and one smaller subarea. These are located between and east of the two powerhouse buildings and in the vicinity of Building 137. The areas of elevated DRO concentrations are also likely the source of elevated groundwater DRO concentrations exhibited in site monitoring wells. The 2012 site investigation recommended reevaluating the soil cleanup levels, because the current cleanup levels may be too high to be protective of the groundwater quality, and assessing the feasibility of implementing additional measures to clean up the areas of highest concentrations or hot spots.

7.1.3 Functionality of Cleanup Action for the Former BFTF, Site 13

Is the remedy functioning as intended by the DD? No, the remedy at the former BFTF, Site 13, is not currently functioning as intended by the DD, as indicated by COC concentrations remaining above cleanup levels in the three North Salt Lagoon sentinel wells, and concentrations of DRO, GRO, and xylenes increasing in one of these wells. However, concentrations are not currently adversely impacting North Salt Lagoon (the water body to be protected). Although no sediment cleanup levels have been established, concentrations are likely not a health concern for either human or ecological receptors. With the exception of GRO in one sample, sediment concentrations of COCs are below soil cleanup concentrations protective of human health (for human health, soil cleanup levels are protective of sediment exposures) and are below ecological risk-based levels for sediment based on the analysis presented in Section 7.2.3. Based on the natural biodegradation results presented in Section 6.4.3, biodegradation is still occurring at the site.

Soils may be contributing to the increases in concentration because concentrations exceeding the DD endpoint criteria were left in place in the south bank excavation area. Also, soils in the former BFTF turnaround area and the outlying petroleum-contaminated soil area at historical sampling location 90 were not excavated or treated as required by the DD. Furthermore, the landfarming portion of the remedy did not achieve the treated soil cleanup level of 500 mg/kg for DRO in most of the treated soils. In a letter dated January 11, 2010, based on their review of the 2008 former BFTF confirmation sampling report, ADEC recommended that the Navy perform additional in situ landfarming to attain the 500-mg/kg cleanup level, and further evaluate all soils previously planned for excavation/treatment where such activities have not occurred.

Based on the 2008 to 2012 visual inspections, no free-phase petroleum product was encountered in any of the monitoring wells, and no soil staining and/or stressed vegetation was observed near any of the monitoring wells. Therefore, free product does not appear to be present and potentially contributing to increasing active zone concentrations. During 2008 monitoring activities, purge water from well BFTF-WP-08 was slightly discolored in July and strongly discolored and foamy in September. In 2010, a small area of sheen was observed approximately 10 feet east of location BFTF-SED-54 along a seep at the beach front. The sheen had a light petroleum odor, but was not entering the North Salt Lagoon (a small beach sediment deposit was preventing its movement). In addition, community members indicated that the cabins close to the site are no longer being used because of the petroleum odor.

COC concentrations in samples from the melt water pond sentinel wells have not exceeded the DD cleanup levels since 2006, except for lead in the September 2009 sample from well BFTF-WP-05, which only slightly exceeded the cleanup level. Concentrations of COCs in the three North Salt Lagoon sentinel wells continue to exceed cleanup levels. Furthermore, the DRO, GRO, and xylenes concentrations are increasing in one of the three wells (BFTF-WP-08D). Stable COC concentrations are reported in one of the other wells with cleanup level exceedances, and no trend analysis was performed at the third well with an exceedance. The measured values of natural biodegradation parameters in active zone water from both the melt water pond and the North Salt Lagoon wells have consistently been indicative of microbial activity and biodegradation of petroleum compounds.

DRO is consistently detected in sediment from all three locations, while GRO has only been detected twice in the last 5 years from location BFTF-SED-53 in 2009 (190 mg/kg) and 2012 (2.4 mg/kg). Although no GRO or DRO cleanup levels were established in the DD for sediment, soil cleanup levels are protective of human health sediment exposures. All DRO concentrations were below the soil cleanup level of 500 mg/kg. However, one out of the two detections of GRO was above the treated soil cleanup level of 100 mg/kg, as specified in the DD.

Although sampling results from July 2007 through August 2012 have low detections of lead, no concentration exceeded the soil cleanup level of 40.5 mg/kg, and concentrations are stable. While no lead cleanup level was established in the DD for sediment, the soil cleanup level is protective of human health sediment exposures. It should be noted that the first 5-year review recommended that potential additional source removal actions be evaluated if any COC concentration in sentinel wells is increasing, or if COCs in North Salt Lagoon sediments are not naturally attenuating. Recommendations for optimizing the monitoring program, given current site conditions, are provided in Section 6.4.3.

7.2 CONTINUED VALIDITY OF DECISION DOCUMENT ASSUMPTIONS

This section answers the question “Are the exposure assumptions, toxicity data, cleanup levels, and CAOs used at the time of cleanup action selection still valid?” Therefore, this section evaluates the protectiveness of the cleanup action by reviewing any change to cleanup levels that were proposed in the DDs and risk assessment assumptions (exposure and toxicity) provided in the signed Airstrip (Site 5), Powerhouse (Site 12), and former BFTF (Site 13) DDs and supporting risk assessments.

Overall, no change to cleanup levels or exposure and toxicity assumptions that has occurred since the DDs were signed affects the protectiveness of the cleanup actions at the Airstrip, Powerhouse, and former BFTF (Sites 5, 12, and 13, respectively). For the cleanup levels that are risk-based and were calculated in supporting documents to the DDs (as opposed to published cleanup values), most would be higher if calculated today.

7.2.1 Review of Applicable or Relevant and Appropriate Requirements

Five-year review guidance (USEPA 2001) indicates that the question of interest in developing the 5-year review is not whether a standard, in this case a cleanup level, in the DD has changed in the intervening period, but whether such a change to a standard calls into question the protectiveness of the cleanup action. If the change in the standard would be more stringent, the next stage is to evaluate and compare the old and the new standards and their associated risk. This comparison is done to assess whether the currently calculated risk associated with the standard identified in the DD is still below ADEC's acceptable excess cancer risk of 10^{-5}, or below a hazard index of 1 for noncancer effects. If the old standard is not considered protective, a new cleanup standard may need to be adopted as a follow-up to the 5-year review.

As part of this second 5-year review, the applicable or relevant and appropriate requirements (ARARs) used as the basis for all of the cleanup levels identified in the DDs were reviewed for changes that could affect the protectiveness of the cleanup actions. The standards that were reviewed are the following:

- Alaska 18 AAC 75 soil and groundwater cleanup levels
- Alaska 18 AAC 70 water quality standards
- Alaska 18 AAC 80 drinking water standards

Sometimes changes in ARARs result in lowering the numeric cleanup level. In these instances, the new, lower cleanup level must be evaluated to determine whether there is a negative effect on the protectiveness of the cleanup action. This evaluation, where necessary, is discussed below by site. In other instances, the cleanup level remains unchanged or has increased. The Airstrip, Site 5, and Powerhouse, Site 12, cleanup levels are based on ADEC published values, except DRO's cleanup level for active zone water (interior monitoring wells only) which is a site-specific risk level protective of construction workers. Former BFTF, Site 13, cleanup levels are based on site-specific risk-based levels for ecological receptors and construction workers. For these three sites, no ARAR change was found that would call into question the protectiveness of the cleanup levels or cleanup actions.

Airstrip, Site 5

Cleanup levels were established in the Airstrip, Site 5, DD for soil, active zone water protection of Imikpuk Lake, and direct contact with active zone water (U.S. Navy and ADEC 2002, Table 1). The soil cleanup levels for the petroleum compounds were based on ADEC's maximum allowable concentrations for unrestricted land use in the Arctic Zone, as listed in

Table B2 of 18 AAC 75.341(d). Maximum allowable concentrations were selected as appropriate soil cleanup levels because the human health risk assessment found no unacceptable health risks from direct contact exposure to soil concentrations of GRO, DRO, or RRO (U.S. Navy and ADEC 2002). For xylenes, the cleanup level was the ADEC Method 2 soil cleanup level for the inhalation pathway under unrestricted land use in the Arctic Zone, as listed in Table B1 of 18 AAC 75.341(c), and is based on the soil saturation level of xylene. Table 7-1 summarizes the soil cleanup levels established in the Airstrip site DD and the current soil cleanup levels.

No change has been made to the ADEC Method 2 soil cleanup levels for DRO, GRO, and RRO since the DD. However, the Method 2 xylene soil cleanup level has decreased from 81 mg/kg (based on the ADEC maximum allowable concentration at the time of the DD) to 63 mg/kg because of ADEC adding the inhalation cleanup level based on a new Integrated Risk Information System (IRIS) inhalation reference concentration for this chemical. As discussed in Section 4.1.3, the site soil cleanup was implemented in October and November 2002 for the two contaminated areas, and soil was treated using HAVE technology until endpoints were reached for GRO, DRO, and total xylenes (U.S. Navy 2003c). Because the contaminated site soil has been removed prior to the lowering of the xylene soil cleanup level, there is a potential for residual contamination to remain on site between 63 and 81 mg/kg. However, the value change is small and would not likely affect the protectiveness of the cleanup action. Also, soil sampling conducted at the Airstrip site in 2010 showed xylene results were either not detected or less than 1 mg/kg in 10 samples from 5 soil boring locations (U.S. Navy 2011c). Furthermore, in the 12 soil samples (11 borings and one surface soil sample) collected in 2012, xylene results were all less than 63 mg/kg.

The active zone water cleanup levels are for the protection of Imikpuk Lake as a drinking water source. DRO, GRO, and RRO cleanup levels were based on ADEC's groundwater cleanup levels for drinking water as listed in Table C of 18 AAC 75.345. The cleanup level for TAH was based on ADEC water quality standards, and the cleanup levels for 1,2-DCA and BTEX were based on ADEC's maximum contaminant levels (MCLs) for drinking water (18 AAC 80.300). Table 7-2 summarizes the active zone water cleanup levels presented in the Airstrip, Site 5, DD (U.S. Navy and ADEC 2002, Table 1) for the protection of Imikpuk Lake. Out of the list of chemicals in Table 7-2, only the GRO Table C groundwater cleanup level changed from 1,300 µg/L to 2,200 µg/L. However, because the GRO cleanup level increased, this change would not affect the protectiveness of the cleanup action. The Navy is pursuing an Explanation of Significant Differences from ADEC to increase the GRO cleanup level from 1,300 to 2,200 µg/L. No change has been made to the water quality standards or the drinking water MCLs since the DD.

A risk-based cleanup level of 8,200 µg/L for DRO-aliphatic was calculated for the protection of direct contact with active zone water by construction workers. A potential change to this risk-based cleanup level is addressed in Section 7.2.2 under "Toxicity Criteria." There was no finding that would affect the protectiveness of the cleanup action concerning this direct contact cleanup level.

Powerhouse, Site 12

Cleanup levels were established in the Powerhouse, Site 12, DD for soil, active zone water for the protection of Imikpuk Lake, and direct contact with active zone water (U.S. Navy, ADEC, and UIC 2003a, Table 1). The soil cleanup levels for the petroleum compounds were based on the ADEC maximum allowable concentrations for unrestricted land use in the Arctic Zone, as listed in Table B2 of 18 AAC 75.341(d). The risk assessment had identified some marginal health risks above target health goals for children, primarily from inhalation of volatile compounds in soil. However, after further evaluation of the inhalation pathway and an interim soil removal, the DD concluded that ADEC maximum allowable concentrations did not constitute a health risk. Therefore, maximum allowable concentrations were health-protective cleanup levels. For PCBs, the ADEC default soil cleanup level is 1 mg/kg, unless ADEC determines that a different cleanup level is necessary. Table 7-3 summarizes the soil cleanup levels presented in the Powerhouse, Site 12, DD. After evaluating the revised Alaska Method 2 soil cleanup levels, no value change has been made for these chemicals since the DD and the first 5-year review. Therefore, no change was found that would affect the protectiveness of the cleanup action.

The active zone water cleanup levels for DRO, GRO, and RRO for the protection of Imikpuk Lake were based on ADEC groundwater cleanup levels for drinking water as listed in Table C of 18 AAC 75.345. The active zone water cleanup level for BTEX and PCE were based on ADEC MCLs for drinking water (18 AAC 80.300). Table 7-4 summarizes the active zone water cleanup levels presented in the Powerhouse, Site 12, DD for the protection of Imikpuk Lake (U.S. Navy, ADEC, and UIC 2003a, Table 1). Out of the list of chemicals in Table 7-4, only the GRO Table C groundwater cleanup level changed from 1,300 to 2,200 µg/L. However, because the GRO cleanup level increased, this change would not affect the protectiveness of the cleanup action. The Navy is pursuing an Explanation of Significant Differences from ADEC to increase the GRO cleanup level from 1,300 to 2,200 µg/L. No change has been made to the drinking water MCLs since the DD.

A risk-based cleanup level of 8,200 µg/L for DRO-aliphatic was calculated for the protection of direct contact with active zone water by construction workers. A potential change to this risk-based cleanup level is addressed in Section 7.2.2 under "Toxicity Criteria." There was no finding that would affect the protectiveness of the cleanup action concerning this direct-contact cleanup level.

Former Bulk Fuel Tank Farm, Site 13

The risk assessment for the former BFTF, Site 13, identified health risks above target health risks for construction workers and ecological receptors (soil) and children (surface water). Cleanup levels were established for soil and active zone water at the former BFTF site. Soil cleanup levels for GRO, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene were based on protection of human health and were calculated to be protective of construction worker exposures to subsurface soil. Site-specific risk assessment methodology was used to establish cleanup levels. For DRO and lead, soil cleanup levels were based on protection of ecological health and were calculated to be protective of wildlife exposures to surface soil. The active zone water cleanup levels for DRO-aromatic, GRO-aliphatic, lead, benzene, and xylenes are based on protection of aquatic organisms.

The closure report regarding soil remediation conducted in 2003, 2006, and 2008 (which consisted of HAVE and landfarming) (U.S. Navy 2004e, 2006b, and 2009b) and the annual monitoring reports (U.S. Navy 2005b, 2006a, 2007a, 2008c, 2009c, 2010b, 2011c, 2012c, and 2013a) used a modification to the DD approach for establishing soil cleanup levels for DRO and GRO. These alternative cleanup levels were considered in this evaluation, together with the DD cleanup levels. ADEC approved the alternative cleanup level interpretation through their review and approval of the annual monitoring reports. Table 7-5 lists the soil cleanup levels used for determining landfarm confirmation sampling compliance.

Cleanup Levels Based on Protection of Human Health. Table 7-5 summarizes the soil cleanup levels presented in the BFTF, Site 13, DD (U.S. Navy, ADEC, and UIC 2003b, Table 1). Risk-based cleanup levels protective of construction workers using site-specific calculations and risk assumptions are further evaluated in Section 7.2.2 and would likely be different (higher) if calculated today. Therefore, there is no change that affects the protectiveness of the cleanup action.

As presented in Table 7-5, the risk-based cleanup levels listed in the DD for GRO-aliphatic, GRO-aromatic, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene of 5.8, 79, 1.9, and 0.61 mg/kg, respectively, are well below the current ADEC Method 2 soil cleanup levels for unrestricted land use in the Arctic Zone.

Cleanup Levels Based on Protection of Ecological Health. Table 7-5 summarizes the soil cleanup levels presented in the BFTF, Site 13, DD (U.S. Navy, ADEC, and UIC 2003b, Table 1). The soil cleanup levels listed in the DD for DRO-aliphatic, DRO-aromatic, and lead (1,328, 300, and 40.5 mg/kg, respectively) would be equal to or higher than the risk-based cleanup levels if they were calculated today based on current scientific literature. Therefore, there is no change to soil cleanup levels that affects the protectiveness of the cleanup action. A more detailed explanation of the soil cleanup levels evaluation and a discussion of the protectiveness of the cleanup action are included in Section 7.2.3.

Table 7-6 summarizes the active zone water cleanup levels for DRO-aromatic, GRO-aliphatic, and lead of 240, 160, and 3.2 µg/L, respectively, where DRO-aromatic and GRO-aliphatic are based on risk-based levels protective of freshwater aquatic organisms and lead is based on National Recommended Water Quality Criteria. There would be no changes to the risk-based cleanup levels based on review of current scientific literature and therefore no impact on protectiveness of the cleanup action. The current lead cleanup level is 5.8 µg/L, based on EPA’s revised national recommended water quality criteria (USEPA 2012b) and site-specific hardness data. Because the DD cleanup level of 3.2 µg/L is lower, it is still protective of the cleanup action. A more detailed explanation of the active zone water cleanup levels evaluation and a discussion of the protectiveness of the cleanup action are included in Section 7.2.3.

Soil Cleanup Levels Based on Protection of Groundwater

The soil cleanup levels for all three sites were based on the protection of human and ecological health via direct contact, as discussed above, not on protection of active zone water (and ultimately surface water) concentrations via leaching. ADEC does not provide soil cleanup levels based on the protection of groundwater for the Arctic Zone, likely because of the issues surrounding active zone water and the lack of true groundwater in the Arctic Zone. Therefore, soil concentrations that prevent increases in water above cleanup levels are not available in ADEC’s published cleanup level tables for the Arctic Zone. However, ADEC does have soil cleanup levels protective of groundwater for areas of Alaska outside the Arctic Zone. The cleanup levels for the migration-to-groundwater pathway for Alaska sites outside the Arctic Zone for the under 40-inch zones is 250 mg/kg for DRO, 300 mg/kg for GRO, and 11,000 mg/kg for RRO. Concentrations of DRO, GRO, and/or RRO above these cleanup levels remain in soil at all three sites.

Additional site-specific analysis would need to be done to assess what soil concentrations might be protective of active zone and surface water for this arctic site. Also, Method One, Petroleum Hydrocarbon Soil Cleanup levels in the Arctic Zone (18 AAC 75.341), are available as possible cleanup levels that may be more protective of active zone water. These cleanup levels are currently used at the former BFTF for treated soils. Current increasing groundwater trends need to be addressed regardless of the concentrations remaining in soil. However, as part of a feasibility study, it may be useful to calculate soil concentrations protective of surface water to fully address additional soil removal actions, if warranted.

7.2.2 Review of Risk Assessment Assumptions for Human Health

Human health risk assessment assumptions were also reviewed as part of the requirement to assess protectiveness of the cleanup actions. For human health, potentially changes could have occurred in two areas since the signing of the Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13, respectively) DDs: toxicity values for select chemicals and exposure assumptions. How these changes to toxicity and exposure parameters might affect the protectiveness of the cleanup action is discussed below.

Toxicity Criteria

Changes to toxicity criteria may raise or lower the current cleanup level if it was a risk-based value. As noted in the first 5-year review, EPA's IRIS reported changes in toxicity criteria since the signing of the DDs for toluene (revised in 2005) and xylene (revised in 2003) (USEPA 2012c). In addition, PCE's toxicity criteria were revised in 2012 (USEPA 2012c). The Method 2 soil cleanup level for xylene has been revised from 81 to 63 mg/kg (see Table 7-1 for Site 5), based on the inclusion of an oral reference dose of 0.2 mg/kg-day. Previously ADEC did not list an oral reference dose (ADEC 2004), and 81 mg/kg was based on the ADEC Method 2 Arctic Zone soil maximum allowable concentrations (18 AAC 75.341 Table B2) at the time of the DD. The active zone water cleanup levels at the Airstrip (Site 5) for toluene and xylene and at the Powerhouse (Site 12) for toluene, xylene, and PCE are based on ADEC MCLs for drinking water (18 AAC 80.300). Therefore, the toxicity criteria changes do not impact these values.

Diesel and gasoline fuels are complex mixtures of aliphatic and aromatic hydrocarbons. All petroleum fuels, including DRO and GRO, must be divided into these two major subcategories: aromatic (benzene-ring compounds) and aliphatic (straight carbon-chain compounds) in health evaluations. The more toxic aromatic portion of GRO is usually evaluated separately as the BTEX compounds. DRO fuels typically contain 80 to 90 percent aliphatic hydrocarbons and 10 to 20 percent aromatic hydrocarbons (ATSDR 1999). ADEC defines diesel as containing carbon chain length C10 to C25 (ADEC 2000). The ADEC DRO carbon-chain-length range does not exactly match the carbon-chain-length fraction upon which the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) toxicity criteria for human health risk assessments are based (TPHCWG 1999). The DRO aliphatic fraction was evaluated for construction worker exposure to active zone water at the Airstrip (Site 5) and Powerhouse (Site 12).

As listed in Table 7-2 for the Airstrip (Site 5) and Table 7-4 for the Powerhouse (Site 12), an active zone water cleanup level of 8,200 µg/L was calculated for the protection of construction workers through dermal contact with the aliphatic fraction of DRO. The dermal reference dose used to calculate the active zone water cleanup level of 8,200 µg/L in the DD was 5 x 10^{-2} mg/kg-day, or 50 percent of the current oral reference dose 1 x 10^{-1} mg/kg-day (ADEC 2008a). Based on current dermal guidance, the EPA (2004) recommends assuming 100 percent gastrointestinal absorption for organic compounds (other than those specifically listed on Exhibit 4-1 in USEPA 2004). Therefore, there should be no adjustment to the oral reference dose for DRO aliphatic to obtain a dermal reference dose. The ADEC risk assessment procedures manual (ADEC 2011b) follows EPA guidance (2004) for calculating dermal references doses. If this cleanup level was calculated today and all assumptions except the reference dose were the same as in the original risk assessments (U.S. Navy 1999b and 2000a), the cleanup level would be 16,400 µg/L. This is because risk equations are linear, such that doubling the reference dose doubles the cleanup level. However, the lower cleanup level of 8,200 µg/L listed in the Airstrip (Site 5) and Powerhouse (Site 12) DDs is still protective of human health, and the higher current cleanup level of 16,400 µg/L does not affect the protectiveness of the cleanup action. Recent DRO concentrations in active zone water in some wells at the Airstrip (Site 5) and Powerhouse (Site 12) exceed 16,400 µg/L.

As described in the Airstrip (Site 5) DD (U.S. Navy and ADEC 2002), the active zone water cleanup level of 8,200 µg/L for direct contact exceeds the solubility of DRO-aliphatic in water. Therefore, DRO concentrations would only approach the cleanup level where free product is present. Free product has historically been present in active zone water at the Airstrip, Site 5. In September 2004, 0.04 foot of free product was measured in Well J (U.S. Navy 2005b). An odor and sheen have been reported in this well during other monitoring events. Well J was not sampled during the first 5-year review period because of a lack of recoverable water. Therefore, because Well J was a nonproductive well, it was excluded from the monitoring program. Well AS-WP-18 was included in the monitoring program to replace Well J, and free product has not been recorded in this or other site wells. Free product was not observed while sampling active zone water at Powerhouse, Site 12, wells during the first or second 5-year review periods (U.S. Navy 2005b, 2006a, 2007a, 2008b, 2008c, 2009c, 2010b, 2011c, 2012c, and 2013a).

Exposure Parameters

No human health route of exposure or receptors has changed or been newly identified at any of the sites since the signing of the three DDs. The expected land use stated in the DDs has not changed on or near the Airstrip, Powerhouse, and BFTF (Sites 5, 12, and 13, respectively). Physical site conditions have not changed at any of the three sites. Therefore, the exposure assumptions upon which the cleanup action was based have not changed for any of the sites. The following paragraphs are an evaluation of the exposure parameters used to calculate cleanup levels at the BFTF, Site 13, based on revisions to relevant guidance documents.

Table 7-5 identifies the risk-based soil cleanup levels presented in the BFTF, Site 13, DD (U.S. Navy, ADEC, and UIC 2003b, Table 1) for GRO-aliphatic (5.8 mg/kg), GRO-aromatic (79 mg/kg), 1,2,4-trimethylbenzene (1.9 mg/kg), and 1,3,5-trimethylbenzene (0.61 mg/kg). The soil cleanup levels were calculated based on protection of the inhalation, ingestion, and dermal pathways for construction worker exposure to soil. According to ADEC (2008a) cleanup level guidance, standardized default exposure parameters developed by the EPA were used in developing soil cleanup levels, except for exposure frequency. As identified in the first 5-year review and still applicable during this 5-year review, the following exposure parameters used to calculate risk-based cleanup levels in the DD could be calculated differently, based on EPA's revised soil screening guidance and dermal guidance (USEPA 2002 and 2004):

- The soil ingestion rate could be changed from 100 mg/day (outdoor worker) to 330 mg/day (construction worker).
- The dermal pathway would not be included, because soil COCs are volatile and EPA dermal guidance does not recommend evaluating them (USEPA 2004).
- The inhalation rate could be changed from 15 m^3/day (1.5 m^3/hour x 10 hours/day from EPA's *Exposure Factor Handbook* [USEPA 2011]) to 20 m^3/day.

Since ADEC (2011b) does not specify exposure factors for construction workers (only outdoor commercial/industrial workers), these alternative exposure parameters could be used in calculating risk-based cleanup levels today. This would result in higher cleanup levels than listed in the DD, assuming all other parameters used in the original risk assessment (U.S. Navy 1999b) remained the same. The cleanup levels appear to be considerably conservative, such that they are certainly health protective of construction worker exposures. In fact, as shown on Table 7-5, the cleanup levels proposed in the DD are also below the ADEC Method 2 soil cleanup levels for unrestricted land use, which include much longer exposure durations to COCs in soil. Therefore, no change was found that would affect the protectiveness of the cleanup action.

7.2.3 Review of Risk Assessment Assumptions for Ecological Health

Ecological health risk assessment assumptions were also reviewed as part of the requirement to assess protectiveness of the cleanup actions. As described in Section 7.2.1, only the BFTF, Site 13, had cleanup levels based on ecological risk. The focus of ecological health is on toxicity and species selected, rather than exposure assumptions as with human health. Therefore, the ecological health discussion is divided into soil and water and describes current toxicological information and its effect on the protectiveness of the cleanup action. It should be noted that an April 2011 technical memorandum issued by ADEC indicates that a risk assessment cannot be used to develop groundwater or surface water cleanup levels less stringent than either the Table C values under 18 AAC 75 or the water quality standards under 18 AAC 70. This new guidance was considered as part of this 5-year review of the Arctic Zone water cleanup levels (ADEC 2011a). None of the revisions to water quality standards under 18 AAC 70 affected any COC in this 5-year review.

Soil

Table 7-5 summarizes the soil cleanup levels and Table 7-6 summarizes the active zone water cleanup levels presented in the former BFTF, Site 13, DD (U.S. Navy, ADEC, and UIC 2003b, Table 1). Soil cleanup levels were calculated for DRO-aliphatic, DRO-aromatic, and lead and are discussed below. As mentioned in Section 7.2.2, diesel fuels are a complex mixture of aliphatic and aromatic hydrocarbons. It is not known whether these differences in carbon-chain-length fractions impact toxic responses in ecological receptors. DRO is generally divided into two major subcategories in health evaluations: aromatic (benzene ring) and aliphatic (straight carbon chain).

DRO-Aliphatic. In the original risk assessment (U.S. Navy 1999b), a single mouse oral median lethal dose value for tridecene was used to derive risk-based screening levels (RBSLs) for DRO-aliphatic for three mammalian species. The shrew was found to be the most sensitive, with a cleanup level of 1,328 mg/kg. The TPHCWG (1999) oral reference dose recommended for the aliphatic portion of the C9–C16 fraction is 0.1 mg/kg-day and is derived from several rodent studies of petroleum mixtures containing branched, straight, and cyclic alkanes and jet petroleum No. 8 within the carbon range of C7–C18. Most of these studies were unpublished. No toxicity data for plants, soil invertebrates, or birds was located, and no soil RBSL was developed for these receptors in the original risk assessment report (U.S. Navy 1999b).

A review of the literature did not reveal any additional DRO mammalian studies since the DD and the completion of this second 5-year review. In the first 5-year review (U.S. Navy 2008b), the crude oil RBSLs for livestock developed by the American Petroleum Institute (2006) were evaluated, but the RBSLs were found to be consistent with the mammal RBSLs used in the DD. Recent studies of petroleum have focused on biofuels and inhalation of diesel fumes. No update to the mid-distillate-range petroleum toxicity profiles (e.g., jet fuels, fuel oils, or TPH) has been released since 2008. Therefore, no change to the mammalian DRO-aliphatic number was found that would affect the protectiveness of the cleanup action.

DRO-Aromatic. For human health risk assessments, the TPHGWC recommends using 0.04 mg/kg-day as a reference dose for this general carbon fraction range (C9–C16), which is representative of the EPA’s reference dose for fluorene and fluoranthene (TPHCWG 1999). For ecological receptors, the final cleanup level in the DD for DRO-aromatics was based on using fluorene as a surrogate. The cleanup level for DRO-aromatic was based on an earthworm screening criteria of 30 mg/kg, the Tier 1 ecological benchmark (U.S. Navy 1999b). A 10-fold uncertainty factor was applied to derive a final cleanup level of 300 mg/kg in the DD.

No update to the mid-distillate-range petroleum toxicity profiles (e.g., jet fuels, fuel oils, or total petroleum hydrocarbons) or to the PAH ecological soil screening level (Eco-SSL) has been released since 2008. No toxicity data specific to DRO for plants, soil invertebrates, or birds was located during this review, and no soil RBSL was developed for these receptors in the original risk assessment report (U.S. Navy 1999b). No significant change to the DRO cleanup levels based on mammalian receptors is needed. Therefore, the DRO-aromatic cleanup level is still protective of the environment.

In 2001, ADEC issued guidance discouraging the use of aliphatic/aromatic analytical testing because of limitations in repeatability, accuracy, and precision in the analytical methods (ADEC 2001). While the April 18, 2012, version of 18 AAC 75 does establish soil cleanup goals for carbon fractions of TPH based on human health, degradation or remediation of the aromatic components of DRO happens more readily than the aliphatic portion of DRO. Thus, the HAVE-treated soils are more likely to have retained the aliphatic chains. Given the degree of uncertainty in the DRO-aromatic cleanup level for ecological receptors and the environmental fate of aromatic DRO, the existing DRO-aliphatic RBSL for the shrew, the most sensitive species, of 1,328 mg/kg is expected to be protective of ecological receptors if applied as the cleanup level for total DRO.

Lead. The DD (U.S. Navy, ADEC, and UIC 2003b) established a cleanup level for lead as 40.5 mg/kg. The basis of this value was not presented, but is likely a screening level wildlife preliminary remediation goal based on the American woodcock (Efroymson et al. 1997). It is unclear why this value was preferentially selected as a cleanup level, given that woodcock are not a species known to occur in Alaska. In addition, the area-wide 95 percent upper confidence lead concentration of 70 mg/kg did not exceed the refined RBSL of 124 mg/kg for the Lapland longspur, which was the most sensitive indicator species in the site-specific risk assessment (U.S. Navy 1999b). Because woodcock are not a species known to occur in Alaska and the wildlife preliminary remediation goals are intended to be used as generic screening criteria, rather than as cleanup goals, it would appear the 40.5 mg/kg cleanup criterion, while still protective of the environment, may be overly conservative for bird and mammal species that may occur at the BFTF, Site 13. The risk-based cleanup level for lead of 124 mg/kg based on the Lapland longspur, as calculated in the risk assessment, appears to be more appropriate as a lead cleanup level than the cleanup level chosen in the DD. Therefore, the Navy is pursuing an Explanation of Significant Differences from ADEC to increase the lead cleanup level from 40.5 to 124 mg/kg.

To evaluate whether the site-specific lead refined RBSL of 124 mg/kg would also be protective of other ecological receptors, current toxicity benchmarks for plants and invertebrates were reviewed. In 2005, the collaborative effort of a multi-stakeholder work group consisting of federal, state, consulting, industry, and academic participants led by the EPA Office of Emergency and Remedial Response established Eco-SSLs. Although Eco-SSLs are soil screening numbers and, as such, are not appropriate for use as cleanup levels, screening ecotoxicity values are derived to avoid underestimating risk. The lead Eco-SSL for plants is 120 mg/kg and for invertebrates 1,700 mg/kg (USEPA 2005a). No update to the 2005 Eco-SSL document for lead was located as part of this 5-year review, and no new lead data for soils has been collected. Although a historical maximum detected concentration of lead of 970 mg/kg exceeded the plant benchmark, the environmental relevance is difficult to predict, given that remediation has occurred on this site since the soil concentration was measured. In addition, the Eco-SSL document states that requiring a cleanup level based solely on Eco-SSL values would not be technically defensible.

The cleanup level for lead of 40.5 mg/kg is conservatively protective. No post-cleanup lead sample has been collected. However, the area-wide lead concentrations described above (precleanup) do not exceed the refined RBSL of 124 mg/kg. Therefore, the cleanup action appears to remain protective, despite the lack of soil data showing post-cleanup concentrations below the cleanup level.

Active Zone Water

Table 7-6 summarizes the active zone water cleanup levels presented in the BFTF, Site 13, DD (U.S. Navy, ADEC, and UIC 2003b, Table 1). Water cleanup levels were calculated for DRO-aromatic, GRO-aliphatic, lead, and xylene and are discussed below.

DRO-Aromatic. For DRO-aromatic, the active zone water cleanup level of 240 µg/L was based on a surrogate chemical, toluene. EPA has not established a national recommended water quality criterion for toluene based on the current on-line version of the table on EPA’s website (USEPA 2012b). The Table C groundwater cleanup levels (18 AAC 75, April 18, 2012) for toluene is 1,000 is µg/L and for DRO is 1,500 µg/L. A 1997 study for the Presidio of San Francisco (IT Corporation 1997) identified a point-of-compliance concentration for toluene of 1,000 µg/L, which is consistent with the Table C groundwater cleanup value for toluene. Because of DRO analysis changes required by ADEC, the 2006 annual monitoring report (U.S. Navy 2007a) provided a methodology of extrapolating a total DRO cleanup level using aromatic/aliphatic fractions. Thus, this modified total DRO cleanup level of 923 µg/L (U.S. Navy 2007a) and the cleanup level of 240 µg/L for DRO-aromatic from the DD were evaluated for protectiveness.

The 1997 IT Corporation study that focused on deriving chronic TPH criteria for surface water overlying future freshwater/estuarine wetlands identified 2,200 µg/L for fuel oil (IT Corporation 1997). The cleanup level from the DD of 240 µg/L and the modified cleanup level for total DRO of 923 µg/L are more conservative than the fuel oil and toluene values reported and alternatively adhere to the toluene surrogate approach, where a 1,000 µg/L toluene value was identified as a point-of-compliance criterion. The cleanup level for DRO-aromatic and the modified cleanup level for total DRO are considered protective of the environment, because they are lower than the values found during the scientific literature search.

GRO-Aliphatic. The existing cleanup level of 160 µg/L from the DD (U.S. Navy, ADEC, and UIC 2003b) is based on the surrogate chemical, octane. A national recommended water quality criterion has not been established for octane or any other gasoline aliphatic hydrocarbons, based on the current on-line version of the table on EPA's website (USEPA 2012b). The Table C groundwater cleanup level (18 AAC 75, April 18, 2012) for GRO is 2,200 µg/L, which is protective of human health. Because of GRO analysis changes required by ADEC, the 2006 annual monitoring report (U.S. Navy 2007a) provided a methodology of extrapolating a total GRO cleanup level using aromatic/aliphatic fractions. Thus, this modified total GRO cleanup level of 267 µg/L (U.S. Navy 2007a) and the cleanup level of 160 µg/L for GRO-aliphatic from the DD were evaluated for protectiveness.

The IT Corporation study focused on deriving chronic TPH criteria for surface water overlying future wetlands and recommended 1,200 µg/L for gasoline (IT Corporation 1997). A summary table of aquatic toxicity data for freshwater aquatic species in this 1997 study reported a range of chronic toxicity values of 120 µg/L for daphnids to greater than 1,334 µg/L for fish. While the 120-µg/L chronic gasoline value for daphnids and a 170 µg/L chronic value for algae from another study (Rausina, Sword, and White 1997) were lower than the modified total GRO cleanup value for Barrow, these values were based on gasoline-blending streams. Alternative chronic values for gasoline reported in the IT Corporation report (457 µg/L for algae and 443 µg/L for daphnids) are considered more representative of weathered gasoline at Barrow. These values are greater than the cleanup level of 160 µg/L, or the modified total GRO cleanup level of 267 µg/L. Therefore, the cleanup action is still protective of the environment.

Lead. Table C of the April 18, 2012, version of 18 AAC 75 establishes a groundwater cleanup goal for lead of 15 µg/L. The lead cleanup level established in the DD (U.S. Navy, ADEC, and UIC 2003b) of 3.2 µg/L is lower than this value and was based on an EPA national ambient water quality freshwater chronic criterion (USEPA 2012b) for lead of 2.5 µg/L and site-specific hardness data. The national water quality criterion has not changed since the first 5-year review. This value is based on a default hardness of 100 mg/L calcium carbonate. In general, the higher the hardness, the greater the freshwater national water quality criterion for lead and, therefore, the greater the acceptable cleanup level.

A site-specific lead cleanup level of 3.2 µg/L was calculated based on available hardness data in the DD. During this second 5-year review, the hardness data from July 2004 to August 2012 were evaluated to provide a current site-specific hardness value. As summarized in Table 7-7, the average hardness data range from 167 to 289 mg/L calcium carbonate. The average hardness value of 217 mg/L was calculated using alkalinity data from the seven wells at former BFTF site, which equates to a lead cleanup level of 5.8 µg/L. Thus, the lead cleanup level of 3.2 µg/L listed in the DD (U.S. Navy, ADEC, and UIC 2003b) remains protective of the environment.

During the first 5-year review, active zone water samples were not analyzed for lead, making comparison to the cleanup level impossible. Since July 2008, six rounds of lead samples have been collected. One exceedance (5.09 µg/L) of the 3.2 µg/L cleanup level was noted at well BFTF-WP-05 on September 2, 2009. However, this value did not exceed the 5.8 µg/L lead level, which is considered more representative of a cleanup level that would be currently established. In addition, the lead concentrations for this well in 2010, 2011, and 2012 (0.039 µg/L, less than 0.6 µg/L, and less than 0.122 µg/L, respectively) were well below the lead cleanup level of 3.2 µg/L listed in the DD.

Xylenes. The cleanup level for xylenes of 18 µg/L was derived using a screening benchmark of 1.8 µg/L for m-xylene as the basis. This value remains the most conservative screening value for m-xylenes listed in the Oak Ridge Risk Assessment Information System. The EPA has not established a national recommended water quality criterion for xylenes as of 2012 (USEPA 2012b). However, the EPA provided multiple aquatic toxicity studies as part of their evaluation of the reregistration eligibility decision for xylenes (USEPA 2005b). The acute toxicity values listed in this document ranged from 1,000 to 3,200 µg/L. Chronic toxicity was not listed as an environmental concern in surface water because of the rapid volatilization of xylenes. However, the IT Corporation study that focused on deriving chronic TPH criteria for surface water overlying future wetlands established a surface water criterion of 130 µg/L for xylenes (IT Corporation 1997). Given these findings, the 18 µg/L cleanup level for active zone water for xylenes is still protective of the environment and is much lower than the ADEC Table C groundwater cleanup value for xylenes of 10,000 µg/L in 18 AAC 75.

Sediment

The BFTF DD established monitoring of sediment at three locations (BFTF-SED-53, -54 and -55) along the shoreline of the North Salt Lagoon to verify that contaminant transport has ceased following soil cleanup. The initial analytes were TPH as gasoline (GRO) and as diesel (DRO). Starting in July 2008, lead was added to the sediment sampling program. No sediment cleanup level was established for the site in the BFTF DD. In the “ecoscoping” guidance for sediment (ADEC 2012), ADEC recommends the use of the threshold effect level (TEL) sediment quality guidelines, as published in the National Oceanic and Atmospheric Administration Screening Quick Reference Tables (NOAA 2008) and as applicable to lead. For GRO and DRO, other references were reviewed including sediment benchmarks from Massachusetts Department of Environmental Protection (MADEP).

Lead. None of the lead concentrations in sediment collected between July 2008 and August 2012 (maximum of 16.9 mg/kg) has exceeded the lead TEL of 30.2 mg/kg.

GRO. There is no TEL value or other established sediment screening value for GRO. A 1997 IT Corporation study that focused on deriving TPH criteria for sediments of a future freshwater/estuarine wetland identified LC25 values (lethal concentration affecting 25 percent of tested organisms) of 11.6 mg/kg for amphipods, 76 mg/kg for mysids, and 209 mg/kg for bivalves exposed to gasoline (IT Corporation 1997). However, the criteria were highly uncertain, since the sediment sample tested contained both gasoline and fuel oil. MADEP (2007) derived sediment benchmarks based on carbon fractionation. Because gasoline is composed largely of C7 to C12 and the aromatic fraction is not likely to persist in weathered hydrocarbons (particularly once released to the sediment), the C9 to C12 aliphatic chain benchmark of 27.2 mg/kg at 1 percent organic carbon was assumed to be most comparable to the Barrow GRO hydrocarbons.

Upon review of sediment data between July 2007 and August 2012, with the exception of one Y flagged concentration of 190 mg/kg at location BFTF-SED-53 in 2009 and one 2012 detection of 2.4 mg/kg, there have been no detectable concentrations of gasoline in the sediment samples. The Y flag indicates that the chromatogram resembles a petroleum product, but the elution does not match the calibration standard. Detection limits have exceeded 27.2 mg/kg at all three sampling locations between 2009 and 2011.

DRO. There is no TEL value or other established sediment screening value for DRO. A 1997 IT Corporation study that focused on deriving TPH criteria for sediments of a future freshwater/estuarine wetland identified an amphipod-based LC25 value (lethal concentration affecting 25 percent of tested organisms) of 144 mg/kg for diesel/fuel oil (IT Corporation 1997).

Upon review of sediment data between July 2007 and August 2012, DRO has been detected at all three sediment locations, with the exception of BFTF-SED-55 during September 2009. Detected concentrations ranged from 2 to 110 mg/kg and none of the samples have exceeded the 144 mg/kg benchmark.

7.3 NEW INFORMATION

This section is in response to the question “Has any other information come to light that could call into question the protectiveness of the cleanup actions?”

While climate change is not “new,” there is increasing evidence of permafrost warming in Barrow since the DDs were written in the early 2000s. The climate research station in Barrow is recording consistent temperature increases in shallow permafrost in the coastal area, even when other areas of the Arctic do not show upward temperature trends every year (NOAA 2012 and Romanovsky et al. 2002). Figure 7-1 shows NOAA’s permafrost temperature information for Barrow for 2003 through 2009. Permafrost warming results in thawing and areas of discontinuous permafrost. To the extent that warming is occurring at the NARL site, it could impact the remedy by decreasing functionality of the ice wall at the Airstrip site and be contributing to additional remobilization of residual petroleum in deeper soils at all three sites. Therefore, any additional investigation to assess the feasibility of additional remedial actions at Barrow should take climate change into account. The most recent long-term monitoring reports for the sites have recommended investigations of the current depth of the permafrost and depth changes be conducted at all three sites, but most particularly at the Airstrip site (U.S. Navy 2011c and 2012c).

No other information reviewed during this 5-year review, apart from what is included previously in this document, affects the protectiveness of the cleanup actions.

7.4 TECHNICAL ASSESSMENT SUMMARY

Overall, the cleanup actions at the three sites do not appear to be functioning as anticipated, based on the increasing concentrations in groundwater adjacent to surface water at all three sites. Natural biodegradation is still occurring, although not optimally at all three sites. Protection of surface water has been maintained at all three sites, as documented by surface water sample results. No free-phase petroleum product has been measured in any site monitoring wells during this data review period. However, there may be localized pockets of free product in the soil and/or permafrost that were not remediated in 2002 at the Airstrip site and in 2003 at the Powerhouse site that could be contributing to increasing groundwater concentrations at these sites. The soil investigation in 2012 concluded that there are localized areas of contamination or hot spot areas in soil that are contributing to the increasing groundwater concentrations. The 2012 site investigation recommended reevaluating the soil cleanup levels, because the current cleanup levels may be too high to be protective of the groundwater quality, and assessing the feasibility of implementing additional measures to clean up the areas of highest concentrations or hot spots.

At the Airstrip, Site 5, the inspection of the cap indicates that the cap is likely functioning as intended, but a full engineering evaluation has not been conducted. Soils surrounding the cap were further investigated in 2012. The 2012 soil investigation determined that a small area of GRO and DRO contamination exists between Hangar 136 and the south depression cap. However, based on the UVOST screening, further soil sampling within the south depression cap was not warranted.

Because of the increasing concentrations at Airstrip, Site 5, in active zone wells immediately downgradient of the ice wall, the ice wall containment berm does not appear to be functioning as intended. The latest long-term monitoring reports recommend that investigations of the current permafrost depths be performed. Monitoring of active zone water and surface water should continue until DD endpoint criteria are met, with evaluation during the next 5-year review. Soils surrounding the wall were further investigated in 2012. The investigation concluded that the hot spots were most likely the source for the increasing groundwater trends in the wells adjacent to Imikpuk Lake, suggesting that the containment berm is not optimally blocking groundwater movement to the lake.

At the Powerhouse, Site 12, active zone water samples from shoreline wells are consistently exceeding cleanup levels. Therefore, monitoring of active zone water and surface water should continue until DD endpoint criteria are met, with evaluation during the next 5-year review. The latest long-term monitoring reports recommend that investigations of the current permafrost depths be performed. The additional 2012 soil investigations at the Powerhouse, Site 12, imply that the hot spots in soil are the source of increasing DRO concentrations in monitoring wells. Therefore, the feasibility of implementing further soil cleanup measures at these hot spot locations should be assessed.

For the former BFTF, Site 13, residual petroleum concentrations in landfarmed soil and the possibility that impacted soils still remain in the vicinity of sampling location 90 and turnaround area may be contributing to the increasing groundwater concentrations and the remedy not functioning as intended. Based on the increasing concentrations in one shoreline well and the results of the 2008 soil sampling, the incomplete remediation identified in the last 5-year review may warrant more active follow-up:

- Excavation at the south bank area left soil containing DRO at concentrations exceeding the DD cleanup level, and some soils planned for excavation in the former BFTF turnaround area and the outlying petroleum-contaminated soil area (at historical sampling location 90) were not excavated.

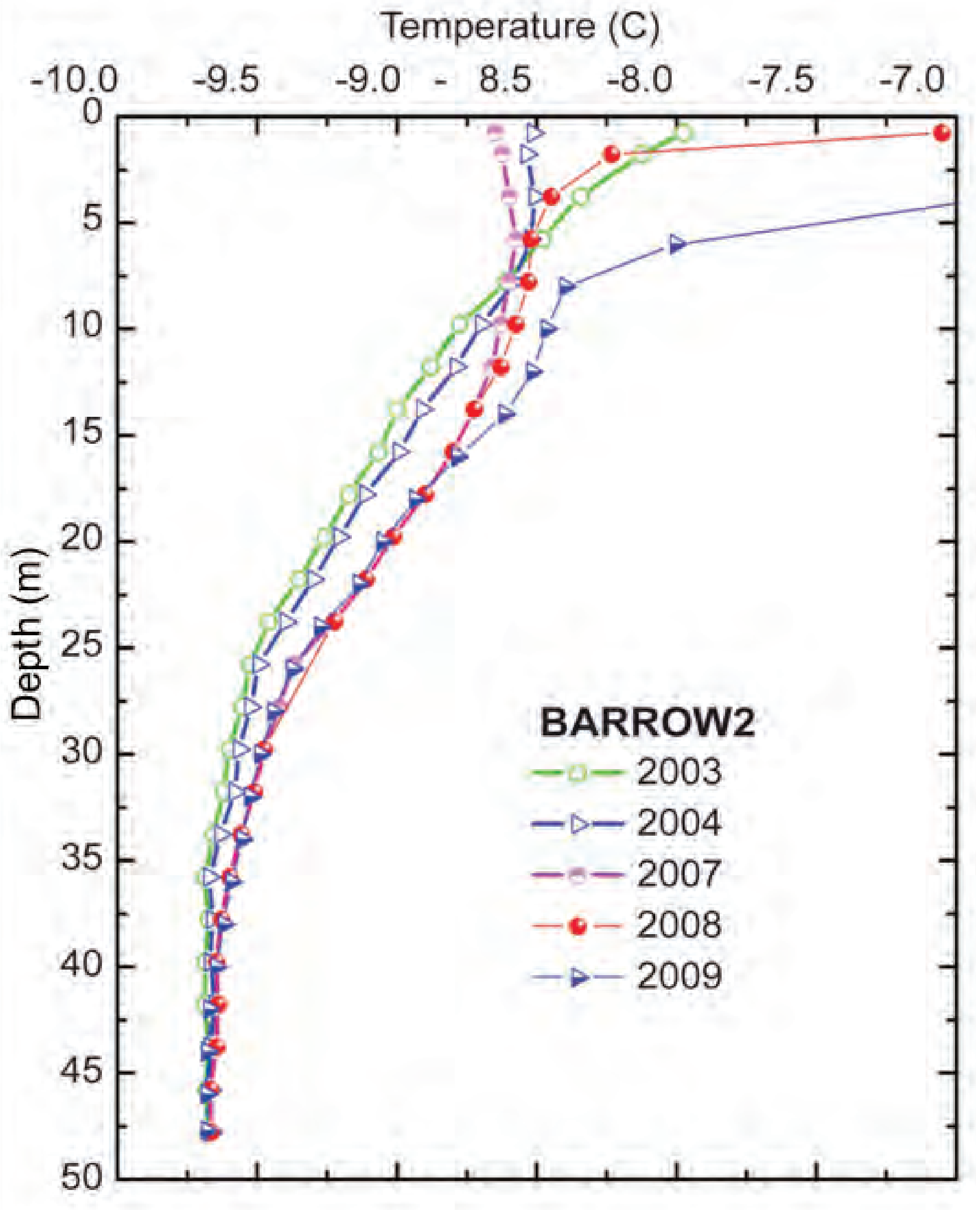
- Landfarming has not been shown to have met the treatment endpoint goal.

These issues for the former BFTF should be addressed prior to the next 5-year review to demonstrate the functionality of the cleanup action. Monitoring should continue, because the purposes for monitoring stated in the DD are still relevant and necessary.

Overall, there has been no change to cleanup levels and exposure and toxicity assumptions since the DDs were signed that affect the protectiveness of the cleanup actions at the Airstrip, Powerhouse, and BFTF (Sites 5, 12 and 13, respectively). Most of the cleanup levels that are risk based and were calculated in supporting documents to the DDs (as opposed to published cleanup values) would be higher if calculated today. Similar to the first 5-year review, the cleanup level for lead should be revised from 40.5 to 124 mg/kg, with concurrence by project team members. However, soil cleanup levels were not based on the protection of the leaching-to-active-zone-water pathway, but on the direct-soil-contact pathway for humans and ecological receptors. Therefore, soil concentrations protective of active zone water, and ultimately surface water, may need to be developed.

7.5 ISSUES

Table 7-8 lists the issues identified as a result of this 5-year review that appear to have the potential to affect the protectiveness of the cleanup actions at NARL.



Source: NOAA 2012

U.S. NAVY

Figure 7-1
2003–2009 Permafrost Temperature
Barrow, Alaska

Naval Arctic
Research Laboratory
Barrow, AK
SECOND 5-YEAR REVIEW

Table 7-1
Soil Cleanup Levels for the Airstrip, Site 5

Chemical	Decision Document Cleanup Level[a] (mg/kg)	Current Cleanup Level (mg/kg)	Cleanup Level Basis
Total Petroleum Hydrocarbons			
Diesel-range organics	12,500	12,500	ADEC Method 2, maximum allowable concentrations, Arctic Zone (Alaska 18 AAC 75.341)
Gasoline-range organics	1,400	1,400	
Residual-range organics	22,000	22,000	
Volatile Organic Compound			
Xylenes	81	**63**	ADEC Method 2, Arctic Zone, inhalation (saturation limit) (Alaska 18 AAC 75.341)

[a] These values were obtained from Table 1 of the decision document for the Airstrip, Site 5 (U.S. Navy and ADEC 2002).

Notes:
Bold indicates a cleanup level change.
AAC - Alaska Administrative Code
ADEC - Alaska Department of Environmental Conservation
mg/kg - milligram per kilogram

Table 7-2
Active Zone Water Cleanup Levels for the Protection of Imikpuk Lake at the Airstrip, Site 5

Chemical	Decision Document Cleanup Level[a] (µg/L)	Current Cleanup Level (µg/L)	Cleanup Level Basis
Total Petroleum Hydrocarbons			
Diesel-range organics	1,500/8,200[b]	1,500/8,200[b]	ADEC groundwater cleanup levels (18 AAC 75)
Gasoline-range organics	1,300	**2,200**	
Residual-range organics	1,100	1,100	
Volatile Organic Compounds			
TAH	10	10	ADEC water quality standards (18 AAC 70)
1,2-Dichloroethane	5	5	ADEC maximum contaminant levels for drinking water (18 AAC 80.300)
Benzene	5	5	
Ethylbenzene	700	700	
Toluene	1,000	1,000	
Xylenes	10,000	10,000	

[a] These values were obtained from Table 1 of the decision document for the Airstrip, Site 5 (U.S. Navy and ADEC 2002).

[b] DRO cleanup level of 1,500 µg/L applies to sentinel wells for Imikpuk Lake and is the ADEC groundwater cleanup level. DRO cleanup level of 8,200 µg/L applies to the aliphatic fraction at interior wells for protection of construction workers.

Notes:
Bold indicates a cleanup level change.
AAC - Alaska Administrative Code
ADEC - Alaska Department of Environmental Conservation
µg/L - microgram per liter
TAH - total aromatic hydrocarbons

Table 7-3
Soil Cleanup Levels for the Powerhouse, Site 12

Chemical	Decision Document Cleanup Level[a] (mg/kg)	Cleanup Level Basis
Total Petroleum Hydrocarbons		
Diesel-range organics	12,500	ADEC Method 2, maximum allowable concentrations, Arctic Zone (Alaska 18 AAC 75)
Gasoline-range organics	1,400	
Residual-range organics	22,000	
Polychlorinated Biphenyls		
PCBs	1	ADEC Method 2, Arctic Zone (Alaska 18 AAC 75)

[a] These values were obtained from Table 1 of the decision document for the Powerhouse, Site 12 (U.S. Navy, ADEC, and UIC 2003a). During this second 5-year review, no change has been made to the ADEC Method 2 cleanup levels since the decision document and the first 5-year review. Therefore, these values are equivalent to those of 18 AAC 75.

Notes:
AAC - Alaska Administrative Code
ADEC - Alaska Department of Environmental Conservation
mg/kg - milligram per kilogram
PCBs - polychlorinated biphenyls

Table 7-4
Active Zone Water Cleanup Levels for the Protection of Imikpuk Lake at the Powerhouse, Site 12

Chemical	Decision Document Cleanup Level[a] (µg/L)	Current Cleanup Level (µg/L)	Cleanup Level Basis
Total Petroleum Hydrocarbons			
Diesel-range organics	1,500/8,200[b]	1,500/8,200[b]	ADEC groundwater cleanup levels (Alaska 18 AAC 75)
Gasoline-range organics	1,300	**2,200**	
Residual-range organics	1,100	1,100	
Volatile Organic Compounds			
Benzene	5	5	ADEC maximum contaminant levels for drinking water (18 AAC 80.300)
Ethylbenzene	700	700	
Tetrachloroethene	5	5	
Toluene	1,000	1,000	
Xylenes	10,000	10,000	

[a] These values were obtained from Table 1 of the decision document for the Powerhouse, Site 12 (U.S. Navy, ADEC, and UIC 2003a).

[b] DRO cleanup level of 1,500 µg/L applies to sentinel wells for Imikpuk Lake and is the ADEC groundwater cleanup level. DRO cleanup level of 8,200 µg/L applies to the aliphatic fraction at interior wells for protection of construction workers.

Notes:
Bold indicates a cleanup level change.
ADEC - Alaska Department of Environmental Conservation
µg/L - microgram per liter

Table 7-5
Soil Cleanup Levels for the Former Bulk Fuel Tank Farm, Site 13

Chemical	Cleanup Level in the DD[a] (mg/kg)	Cleanup Level Basis From DD	Current Cleanup Level (mg/kg)	Current Cleanup Level Basis
Protection of Ecological Health – Surface Soil				
DRO-aliphatic	1,328	Risk-based levels protective of wildlife exposures to surface soil	1,328	No change, based on current literature review
DRO-aromatic	300	Risk-based levels protective of earthworms in surface soil	300	No change, based on current literature review
DRO (total)	1,328	DRO-aliphatic cleanup level is expected to be protective of ecological receptors if applied as the cleanup level for total DRO (see Section 7.2.3 for further discussion).	1,328	No change, based on current literature review. This value applies only to "bottom of the hole" soil confirmation, based on recent communication between the Navy and ADEC (2010).
DRO (total) – treated soils	500	Target cleanup level for treated soil is based on Method 1, Arctic Zone, only if BTEX is less than 15 mg/kg and benzene is less than 0.5 mg/kg. If benzene and BTEX levels are not tested for or not met, the DRO target endpoint is 200 mg/kg.	500	Same basis as DD. However, the 500 mg/kg applies to all depths (surface and subsurface) of treated soil (in situ or ex situ) based on recent communication between the Navy and ADEC (2010).
Lead	40.5	Wildlife preliminary remediation goal is based on the American woodcock (Efroymson et al. 1997) exposure to surface soil.	124	Risk-based level protective of Lapland longspur's (U.S. Navy 1999b) exposure to surface soil, a more appropriate cleanup level, has not been adopted at this time. However, the Navy is pursuing an Explanation of Significant Differences (see Section 7.2.3).

Table 7-5 (Continued)
Soil Cleanup Levels for the Former Bulk Fuel Tank Farm, Site 13

Chemical	Cleanup Level in the DD[a] (mg/kg)	Cleanup Level Basis From DD	Current Cleanup Level (mg/kg)	Current Cleanup Level Basis
Protection of Human Health – Subsurface Soil				
GRO-aliphatic	5.8	Risk-based levels protective of construction worker exposure to subsurface soil	Not recalculated	Based on current information, the risk-based cleanup level protective of a construction worker would likely be higher.
GRO-aromatic	79	Risk-based levels protective of construction worker exposure to subsurface soil	Not recalculated	Based on current information, the risk-based cleanup level protective of a construction worker would likely be higher.
GRO (total) – treated soils	100	Target cleanup level for treated soil is based on Method 1, Arctic Zone.	100	Same basis as DD
1,2,4-Trimethylbenzene	1.9	Risk-based levels protective of construction worker exposure to subsurface soil	Not recalculated	Based on current information the risk-based cleanup level protective of a construction worker would likely be higher. Current Method 2 direct contact (inhalation) value is 49 mg/kg. Current Method 2 migration to groundwater value is 23 mg/kg.
1,3,5-Trimethylbenzene	0.61	Risk-based levels protective of construction worker exposure to subsurface soil	Not recalculated	Based on current information, the risk-based cleanup level protective of a construction worker would likely be higher. Current Method 2 direct contact (inhalation) value is 42 mg/kg. Current Method 2 migration to groundwater value is 23 mg/kg.

Table 7-5 (Continued)
Soil Cleanup Levels for the Former Bulk Fuel Tank Farm, Site 13

[a] These values were obtained from Table 1 of the DD for the former Bulk Fuel Tank Farm, Site 13 (U.S. Navy, ADEC, and UIC 2003b) and apply to soils left in place unless noted otherwise.

Notes:
BTEX - benzene, toluene, ethylbenzene, and xylenes
DD - decision document
ADEC - Alaska Department of Environmental Conservation
DRO - diesel-range organics
GRO - gasoline-range organics
mg/kg - milligram per kilogram

Table 7-6
Active Zone Water Cleanup Levels for the Former Bulk Fuel Tank Farm, Site 13

Chemical	Cleanup Level in the DD[a] (µg/L)	Cleanup Level Basis From DD	Current Cleanup Level (µg/L)	Current Cleanup Level Basis
Protection of Ecological Health				
DRO-aromatic	240	Ecological risk-based levels in active zone water, based on freshwater aquatic organisms	240	No change, based on current literature review
GRO-aliphatic	160		160	
DRO (total)	--	--	923	Extrapolated value from the 2006 annual monitoring report (U.S. Navy 2007a)
GRO (total)	--	--	267	
Lead	3.2	NAWQC chronic	5.8	NAWQC chronic (ADEC 2008c; USEPA 2012b) and site-specific hardness data.
Xylenes	18	Ecological risk-based levels in active zone water, based on freshwater aquatic organisms	18	No change, based on current literature review
Protection of Human Health				
Benzene	5	ADEC groundwater cleanup level	5	ADEC Table C groundwater cleanup level (18 AAC 75)
DRO (total)	--	--	1,500	ADEC Table C groundwater cleanup level (18 AAC 75)
GRO (total)	--	--	2,200	ADEC Table C groundwater cleanup level (18 AAC 75)
Lead	--	--	15	ADEC Table C groundwater cleanup level (18 AAC 75)
Xylenes	--	--	10,000	ADEC Table C groundwater cleanup level (18 AAC 75)

[a] As reported in Table 1 of the DD for the former Bulk Fuel Tank Farm, Site 13 (U.S. Navy, ADEC, and UIC 2003b)

Table 7-6 (Continued)
Active Zone Water Cleanup Levels for the Former Bulk Fuel Tank Farm, Site 13

Notes:
AAC - Alaska Administrative Code
ADEC - Alaska Department of Environmental Conservation
DRO - diesel-range organics
GRO - gasoline-range organics
µg/L - microgram per liter
NAWQC - national ambient water quality criteria (40 Code of Federal Regulations Part 131)

Table 7-7
Summary of Water Hardness (Total Alkalinity) as Calcium Carbonate

Sampling Date[a] (Month/Year)	Location						
	BFTF-WP-4 (mg/L)	BFTF-WP-5 (mg/L)	BFTF-WP-6 (mg/L)	BFTF-WP-7 (mg/L)	BFTF-WP-8 (mg/L)	BFTF-WP-9 (mg/L)	BFTF-WP-10 (mg/L)
7/2004	145	313	319	128	180	196	227
9/2004	195	236	245	163	193	214	449
7/2005	NM	210	217	89	40	122	217
9/2005	199	224	353	140	183	252	137
7/2006	175	170	220	120	67	220	144
9/2006	165	120	187	118	80	252	136
7/2007	240	220	200	180	160	220	280
9/2007	210	190	NM	110	NM	NM	NM
7/2008	240	220	300	140	180	NM	220
9/2008	260	260	320	240	400	220	180
9/2009	260	240	320	200	NM	210	140
9/2010	360	200	380	240	300	220	220
9/2011	280	200	400	220	320	200	240
8/2012	300	240	300	250	160	180	180
Average Hardness	233	217	289	167	189	209	213
Site Average: 217							

[a] Data from 2001 from BFTF-WP-5 and BFTF-WP-7 through BFTF-WP-10 were not considered because these hardness data were collected prior to remediation.

Notes:
mg/L - milligram per liter
NM - not measured

Table 7-8
Issues

Item No.	Issue	Affects Protectiveness	
		Current	Future
General			
1	Decision document criteria for cessation of monitoring have not yet been met.	No	Yes
Airstrip, Site 5			
2	Concentrations of COCs in shoreline wells are increasing.	No	Yes
3	Concentrations of DRO in the background well (AS-WP-21B) in 2012 were approaching the cleanup level, and this well may no longer be representative of background conditions.	No	No
4	Residual soil contamination is impacting active zone water.	No	Yes
Powerhouse, Site 12			
5	Concentrations of COCs in shoreline wells are increasing.	No	Yes
6	Residual soil contamination is impacting active zone water.	No	Yes
Former Bulk Fuel Tank Farm, Site 13			
7	Concentrations of COCs in shoreline wells are increasing, but surface water concentrations continue to meet cleanup levels.	No	Yes
8	Excavation at the south bank area left soil containing DRO at concentrations exceeding the decision document cleanup level.	No	Yes
9	Some soil planned for excavation was not excavated, including soils in the former BFTF turnaround area and the outlying petroleum-contaminated soil area at historical sampling location 90.	No	Yes
10	Landfarming has not been shown to have met the treatment endpoint goal.	No	Yes

Notes:
COCs - chemicals of concern
DRO - diesel-range organics

8.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

This section presents the recommendations and follow-up actions identified as a result of the 5-year review process. Table 8-1 summarizes the recommendations.

Table 8-1
Recommendations and Follow-Up Actions

Item No.	Recommendation/ Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Action: Affects Protectiveness	
					Current	Future
General						
1	Continue monitoring at all three sites until decision document criteria for cessation of monitoring are met. Evaluate during the next 5-year review.	Navy	ADEC	April 2018	No	Yes
2	Reevaluate the designated soil cleanup levels, given the continued exceedances of cleanup levels in groundwater wells at all three sites.	Navy	ADEC	April 2018	No	Yes
3	Enhance the long-term monitoring well network to better define active zone water table gradients and flow directions.	Navy	ADEC	April 2018	No	Yes
4	Research the availability of better statistical methods for analysis of site data.	Navy	ADEC	April 2018	No	No
5	Include the Native Village of Barrow and Inupiat Community of the Arctic Slope on the interview list for subsequent 5-year reviews.	Navy	ADEC	April 2018	No	No
Airstrip, Site 5						
6	Perform additional investigation of changes in permafrost levels.	Navy	ADEC	April 2018	No	Yes
7	Perform investigation of containment berm functionality.	Navy	ADEC	April 2018	No	Yes
8	Perform engineering inspection of south depression cap to assess functionality.	Navy	ADEC	April 2018	No	Yes
9	Assess the feasibility of implementing additional cleanup actions of hot spot soils.	Navy	ADEC	April 2018	No	Yes
10	After next sampling event, evaluate whether well AS-WP-21B is still representative of background conditions.	Navy	ADEC	Summer 2014	No	No
11	Discontinue GRO monitoring at well AS-WP-02.	Navy	ADEC	Summer 2014	No	No

Table 8-1 (Continued)
Recommendations and Follow-Up Actions

Item No.	Recommendation/ Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Action: Affects Protectiveness	
					Current	Future
12	Perform further evaluation of the possible spill area east of the access road including researching the possible presence of a pipeline in this area or another source that may explain elevated GRO and BTEX concentrations.	Navy	ADEC	April 2018	No	Yes
Powerhouse, Site 12						
12	Perform additional investigation of changes in permafrost levels.	Navy	ADEC	April 2018	No	Yes
13	Assess the feasibility of implementing additional cleanup actions of hot spot soils.	Navy	ADEC	April 2018	No	Yes
14	Monitor total aromatic hydrocarbons in wells adjacent to Imikpuk Lake and at surface water sampling locations.	Navy	ADEC	Summer 2014	No	No
15	Discontinue GRO monitoring at wells PH-MW-02, PH-WP-02, and PH-WP-06.	Navy	ADEC	Summer 2014	No	No
16	Discontinue residual-range organics monitoring at well PH-WP-01.	Navy	ADEC	Summer 2014	No	No
17	Discontinue tetrachloroethene monitoring at all surface water locations (PH-SW-01, PH-SW-02, and PH-SW-03).	Navy	ADEC	Summer 2014	No	No
Former Bulk Fuel Tank Farm, Site 13						
18	Discontinue lead monitoring at wells BFTF-WP-04 through BFTF-WP-10.	Navy	ADEC	Summer 2014	No	No
19	Discontinue ethylbenzene and toluene monitoring at well BFTF-WP-08.	Navy	ADEC	Summer 2014	No	No
20	Discontinue BTEX monitoring at wells BFTF-WP-09 and BFTF-WP-10.	Navy	ADEC	Summer 2014	No	No
21	Discontinue GRO monitoring at well BFTF-WP-10.	Navy	ADEC	Summer 2014	No	No
22	Perform additional treatment of landfarmed soils that have not met the treatment endpoint goal.	Navy	ADEC	April 2018	No	Yes

Table 8-1 (Continued)
Recommendations and Follow-Up Actions

Item No.	Recommendation/ Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Action: Affects Protectiveness	
					Current	Future
23	Treat additional soil from the south bank area, the turnaround area, and around historical sampling location 90.	Navy	ADEC	April 2018	No	Yes
24	Evaluate potential causes of increasing COC concentrations in groundwater, including the potential effects of residual soil contamination and changes in permafrost levels. If warranted based on additional investigation, evaluate potential additional source removal/remedial actions.	Navy	ADEC	April 2018	No	Yes

Notes:
ADEC - Alaska Department of Environmental Conservation
BTEX - benzene, toluene, ethylbenzene, and xylenes
COC - chemical of concern
GRO - gasoline-range organics

9.0 CERTIFICATION OF PROTECTIVENESS

The cleanup actions at the Airstrip, Powerhouse, and former BFTF (Sites 5, 12, and 13, respectively) currently protect human health and the environment because COC concentrations in surface water are below the DD cleanup levels, and surface water is the exposure medium for establishing that human health and the environment are protected. However, the following actions need to be taken to ensure protectiveness:

- Perform permafrost depth studies at all three sites.
- Enhance the long-term monitoring well network to better define active zone water table gradients and flow directions.
- Reevaluate the designated soil cleanup levels, given the continued exceedances of cleanup levels in groundwater wells at all three sites.
- Assess the feasibility of implementing additional cleanup actions of hot spot soils at the Airstrip and Powerhouse sites.
- Treat additional soil from the south bank area, the turnaround area, and from historical sampling location 90 at the former BFTF site.

Although soil removal and treatment actions have been performed and monitoring of active zone water, surface water, and sediment is ongoing, these additional actions are needed to ensure future protectiveness because of continuing exceedances of cleanup levels and increasing concentration trends in shoreline groundwater wells at all three sites.

10.0 NEXT REVIEW

The next 5-year review is scheduled for April 2018.

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APPENDIX A

Monitoring Data Summaries

(Source: U.S. Navy 2013a)

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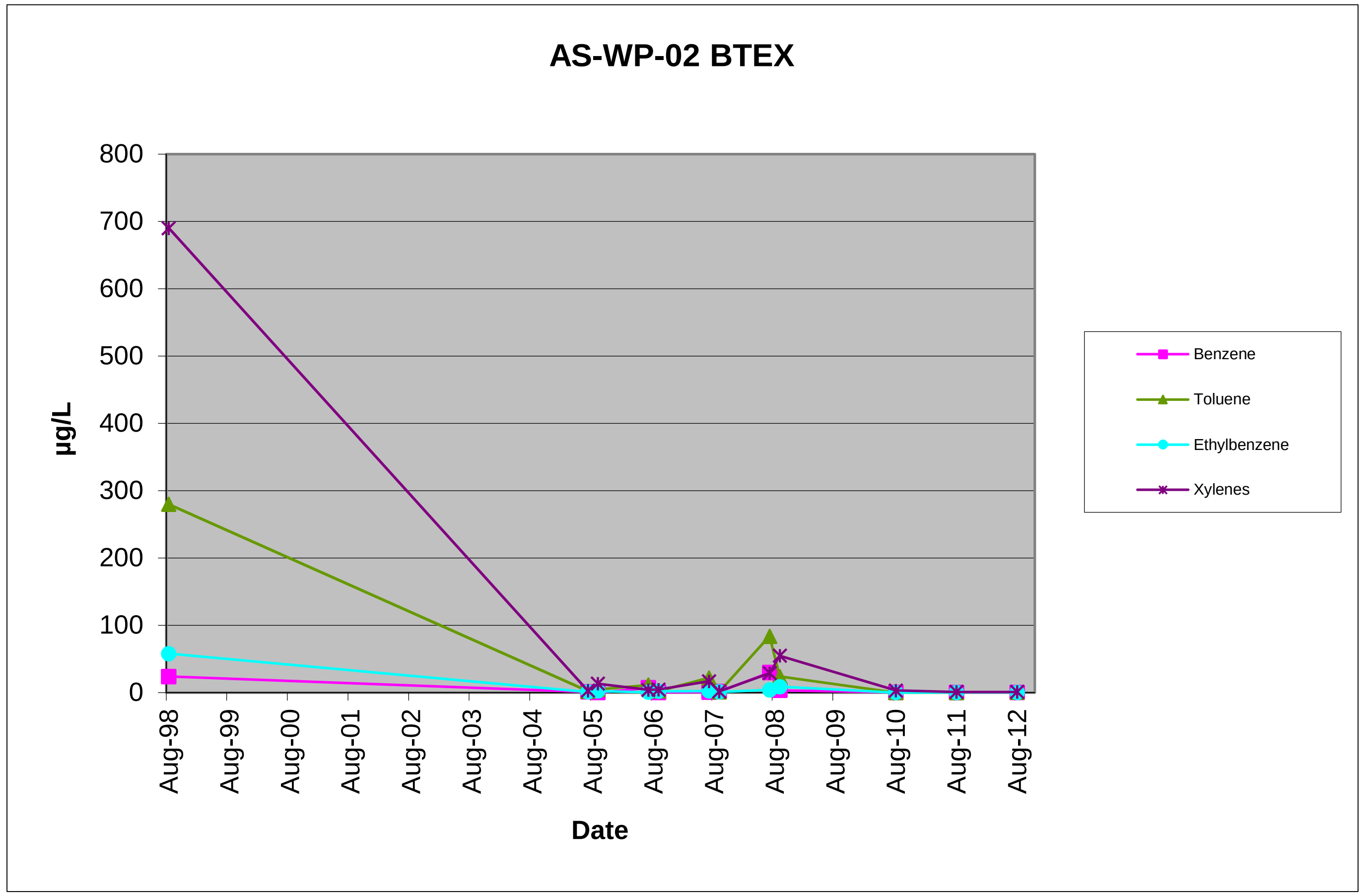
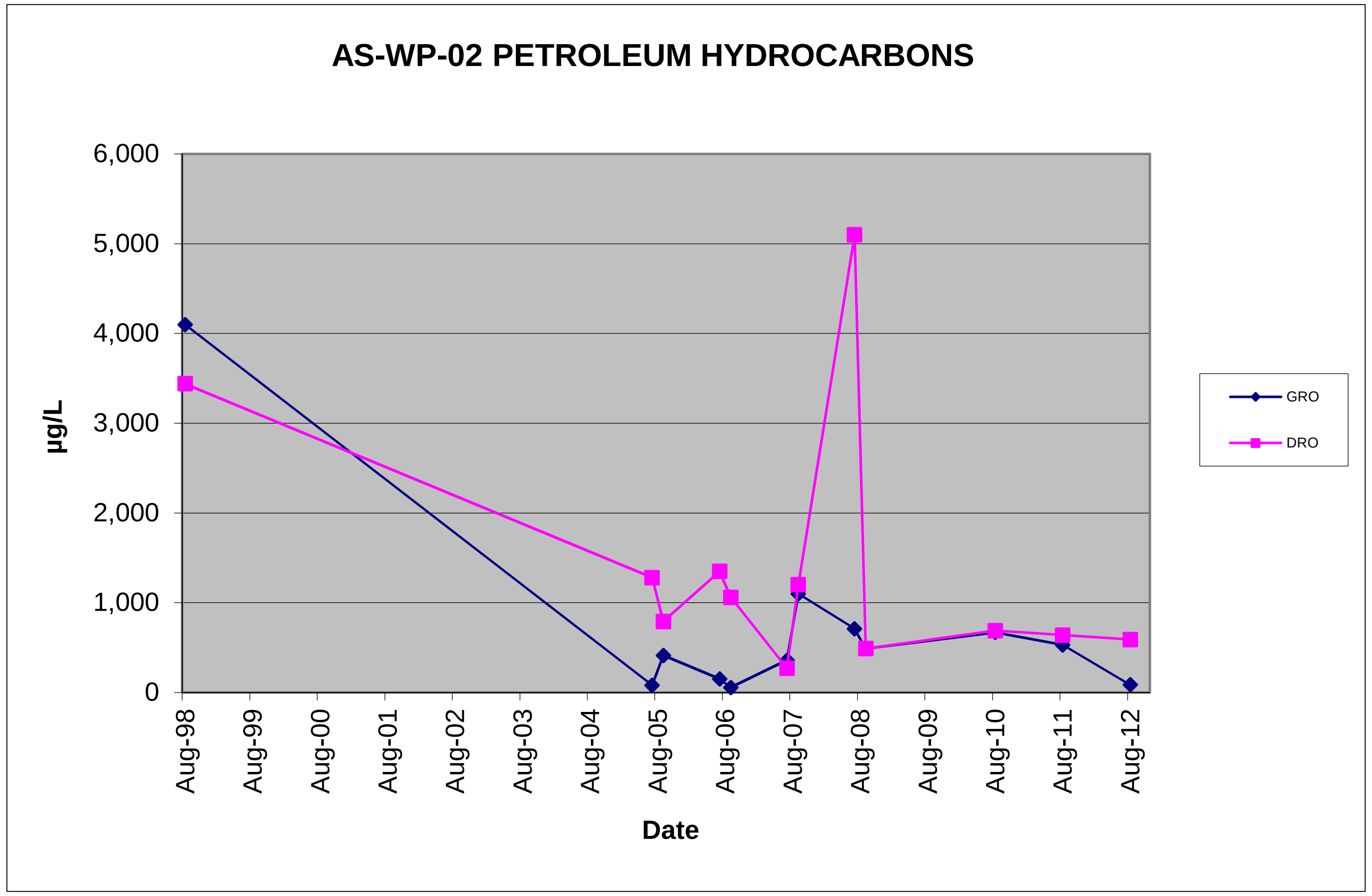
Airstrip Site

Table A-1. AS-WP-02

		VOCs (µg/L)						Petroleum Hydrocarbons (µg/L)		Geochemical Parameters				
Well ID	**Collection Date**	**1,2-DCA**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**Total BTEX (TAH)**	**GRO (AK 101)**	**DRO (AK 102)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**10**	**1,300**	**1,500** 1/	--	--	--	--	--
AS-WP-02	8/7/1998	N/A	**24**	280	58	690	**1,052**	**4,100**	**3,440**	N/A	N/A	N/A	N/A	N/A
AS-WP-02	7/10/2005	1.0 U	1.0 U	2.34	1.0 U	3.0 U	7.34 J	80 U	1,280	159	0.25	17	0.2	1.2 U
AS-WP-02	9/9/2005	1.0 U	0.19 J	5.0	2.41	13.4	**21 J**	414	792	137	0.31	17	0.06	1.08 J
AS-WP-02	7/21/2006	0.50 U	**7.33**	11.4	0.62 J	4.26	**23.61 J**	151	1,350	120	0.047 J	2.0	0.05	90.1
AS-WP-02*	9/14/2006	0.50 UK	0.491 J	2.51	2 U	4.57	9.571 J	55.9 J	1,060	151	0.09 J	12	0.02	1.0 U
AS-WP-02	7/30/2007	1.0 U	0.78 J	22	2.5	17	**42.28 J**	360	270	80	0.0	7.2	2.0	0.67 J
AS-WP-02	9/12/2007	1.0 U	1.50	1.0 U	1.0 U	1.9	5.4 J	1,100	1,200	240	0.80	40	2.0	17
AS-WP-02	7/22/2008	N/A	**30**	84 D	4.2	29	**147.2 D**	710 Y	**5,100 Y**	220	0	15.2	0.2	220
AS-WP-02	9/6/2008	N/A	3.5	24	8.9	55	**91.4**	490 Y	490 J	200	0	26.7	0.2	0.5 U
AS-WP-02	9/6/2009	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
AS-WP-02B	8/31/2010	NS	0.5 U	0.28 J	0.28 J	3.3	4.36 J	670 Y	690 J	180	0	22	0	0.38 J
AS-WP-02B	8/21/2011	N/A	0.5 U	0.5 U	0.5 U	1 U	2.5 U	530 Y	640 J	200	0	22.2	0.3	1.3
AS-WP-02B (DUP)	8/21/2011	N/A	0.50 U	0.50 U	0.50 U	1.00 U	2.5 U	500 Y	580 J	180	0	22.5	0.3	0.34 J
AS-WP-02B	8/15/2012	N/A	0.5 U	0.65 UJ	0.5 U	1 U	2.65 U	86 J	590 J	160	0	34.2	0.0	1.3 U

For all notes see the acronyms and abbreviations presented at the end of Appendix A



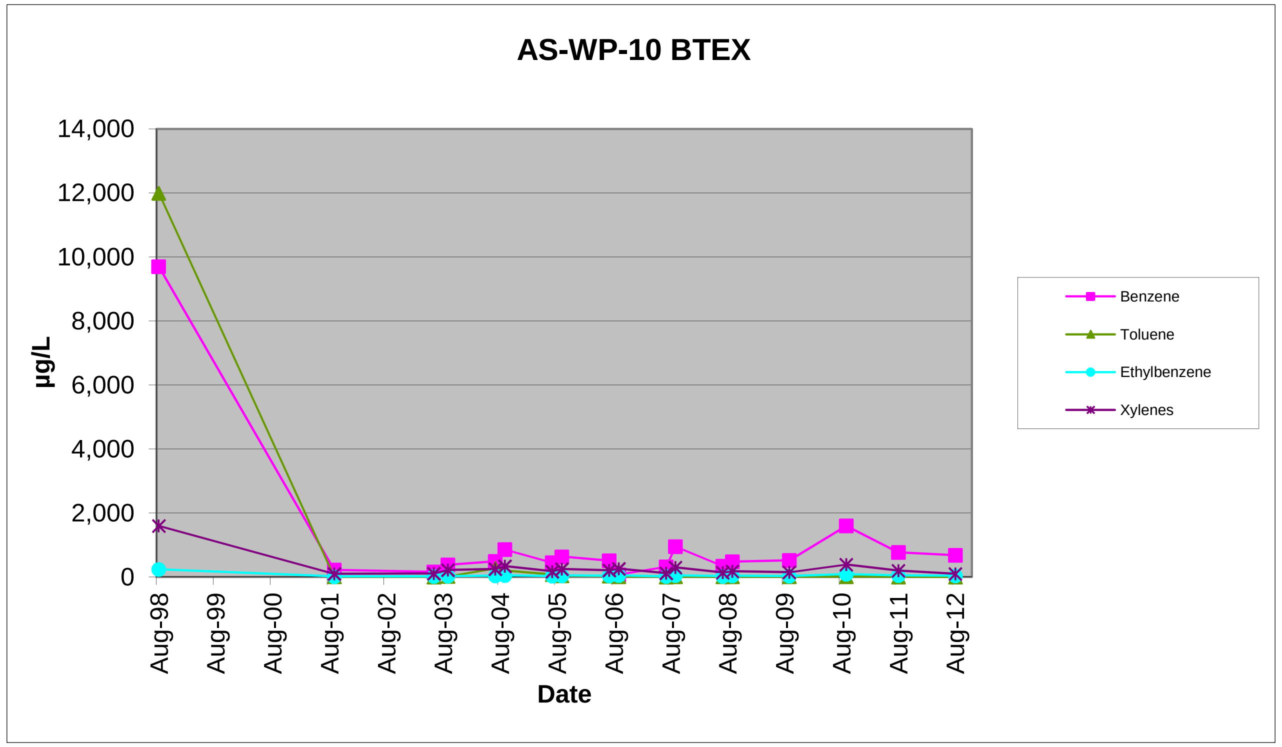


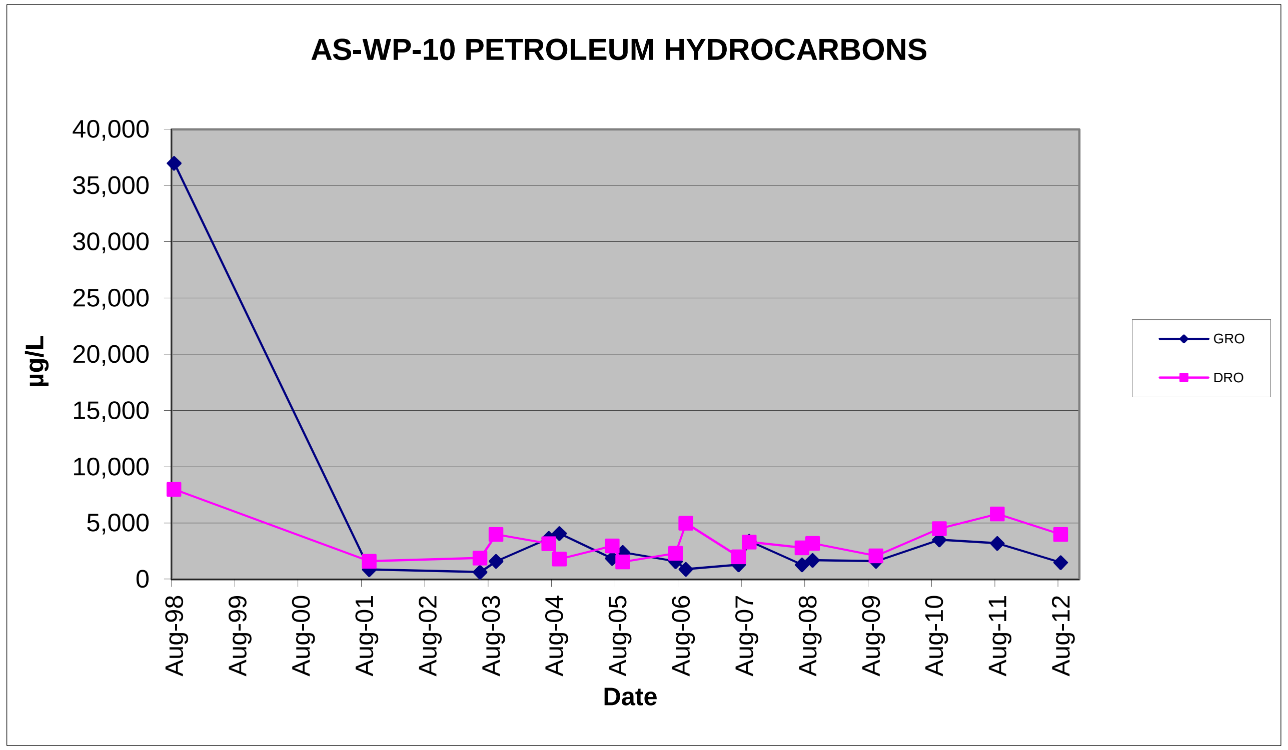
Airstrip Site

Table A-2. AS-WP-10

		VOCs (µg/L)						Petroleum Hydrocarbons (µg/L)			Geochemical Parameters				
Well ID	**Collection Date**	**1,2-DCA**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**Total BTEX (TAH)**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater															
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**10**	**1,300**	**1,500** [1/]	**1,100**	--	--	--	--	--
AS-WP-10	8/7/1998	N/A	**9,700**	**12,000**	240 J	1,600	**23,540 J**	**37,000**	**8,000 JY**	906	N/A	N/A	N/A	N/A	N/A
	9/26/2001	N/A	**220**	5.0	14	95	**334**	860 Z	**1,600**	320 Z	314	0.20	1.0	124	N/A
	6/19/2003	2.0 U	**160**	4.4	17	108	**289.4**	650	**1,900**	870	274	0	0.0	2.75	N/A
	9/3/2003	2 U	**380**	15	33	219	**647**	**1,600**	**4,000**	N/A	344	0	0.0	2.76	N/A
	7/25/2004	**5.85**	**492**	267	39.1	249.6	**1,047.70**	**3,640**	**3,170 X**	N/A	553	0.10 U	0.0	32.3	15,800 W
	9/22/2004	**10**	**856**	194	53.3	336	**1,439.30**	**4,090**	**1,810 X**	N/A	480	0.10 U	0.0	58.2	17,300 W
	7/10/2005	**5.55**	**453**	82.8	27.5	173.8	**737.1**	**1,870**	**2,960**	N/A	431	0.10 U	0.0	55.6	8,170 W
	9/9/2005	**7.15**	**634**	41.8	44.6	249	**969.4**	**2,400**	**1,550**	N/A	266	0.10 U	0.0	42.5	4,510 W
	7/21/2006	**5.3**	**513**	25.7	36.4	212	**787.1**	**1,590**	**2,320**	N/A	320	0.037 J	0.0	0	7,720
*	9/14/2006	**2,000 JK**	**74.6**	13.4	46.7	259	**393.7**	888	**4,990**	N/A	398	0.093 J	0.0	55	7,300
AS-WP-10-1C	7/30/2007	3.7	**320**	4.4	21	120	**465.4**	1,300	**2,000**	N/A	0.52	0	1.0 U	1.0	2,300
AS-WP-10-2	9/11/2007	1.0 U	**910 E**	10	50	300	**1,310 E**	**3,400**	**3,300**	N/A	460	0	3.3	3.2	2,400
AS-WP-10-2DL	9/11/2007	**10 U**	**950**	6.0 J	45	260	**1,261.9 J**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,800
AS-WP-10-1	7/23/2008	5.0 D	**340 D**	11 D	24 D	136 D	**511 D**	**1,300 DY**	**2,800 Y**	N/A	620	0	1.5	2.0	3,800
AS-WP-10-2	9/6/2008	**5.9 D**	**480 D**	8.1 D	36 D	180 D	**704.1 D**	**1,700 Y**	**3,200 Y**	N/A	660	0	4.1	1.6	3,600
AS-WP-10	9/5/2009	**5.7 J**	**520 JD**	6.1 J	29	150	**705.1 JD**	**1,600 Y**	**2,100 Y**	N/A	620	0	904	1.2	2,300
AS-WP-10	9/2/2010	**14 D**	**1,600 D**	9.3 D	87 D	390 D	**2,086.3 D**	**3,500 Y**	**4,500 Y**	N/A	350	0	5.24	1	3,000
AS-WP-10	8/21/2011	**8.4 D**	**770 D**	3.5 D	53 D	198 D	**971.50 D**	**3,200 Z**	**5,800 Y**	N/A	160	0	34.3	1.0	790
AS-WP-10	8/17/2012	**29 D**	**680 D**	2.2 D	42 D	97 D	**821.2 D**	**1,500 Y**	**4,000 YJ**	N/A	320	0	30.8	2.4	970
AS-WP-10 (DUP)	8/17/2012	**29 D**	**680 D**	2.4 D	42 D	99 D	**823.4 D**	**1,500 Y**	**3,900 YJ**	N/A	340	0	29.2	3.2	970

For all notes see the acronyms and abbreviations presented at the end of Appendix A



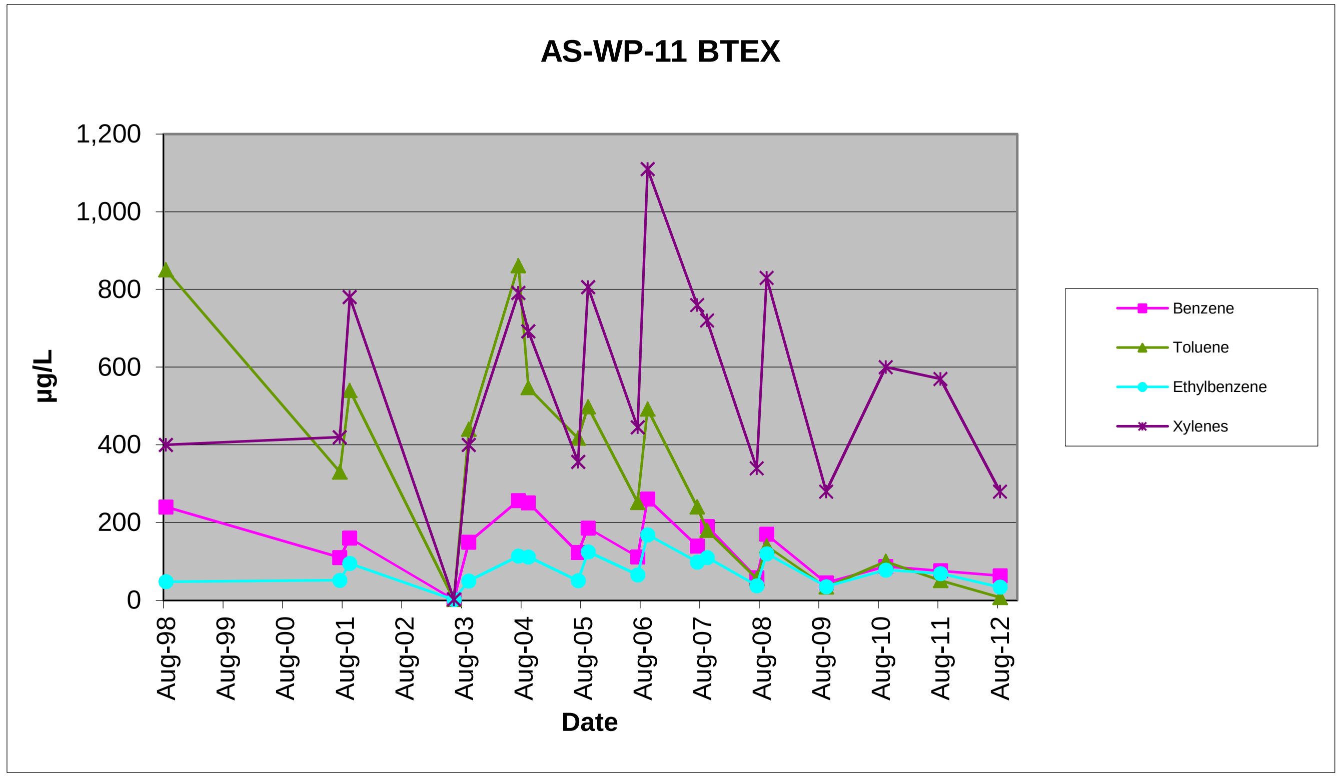


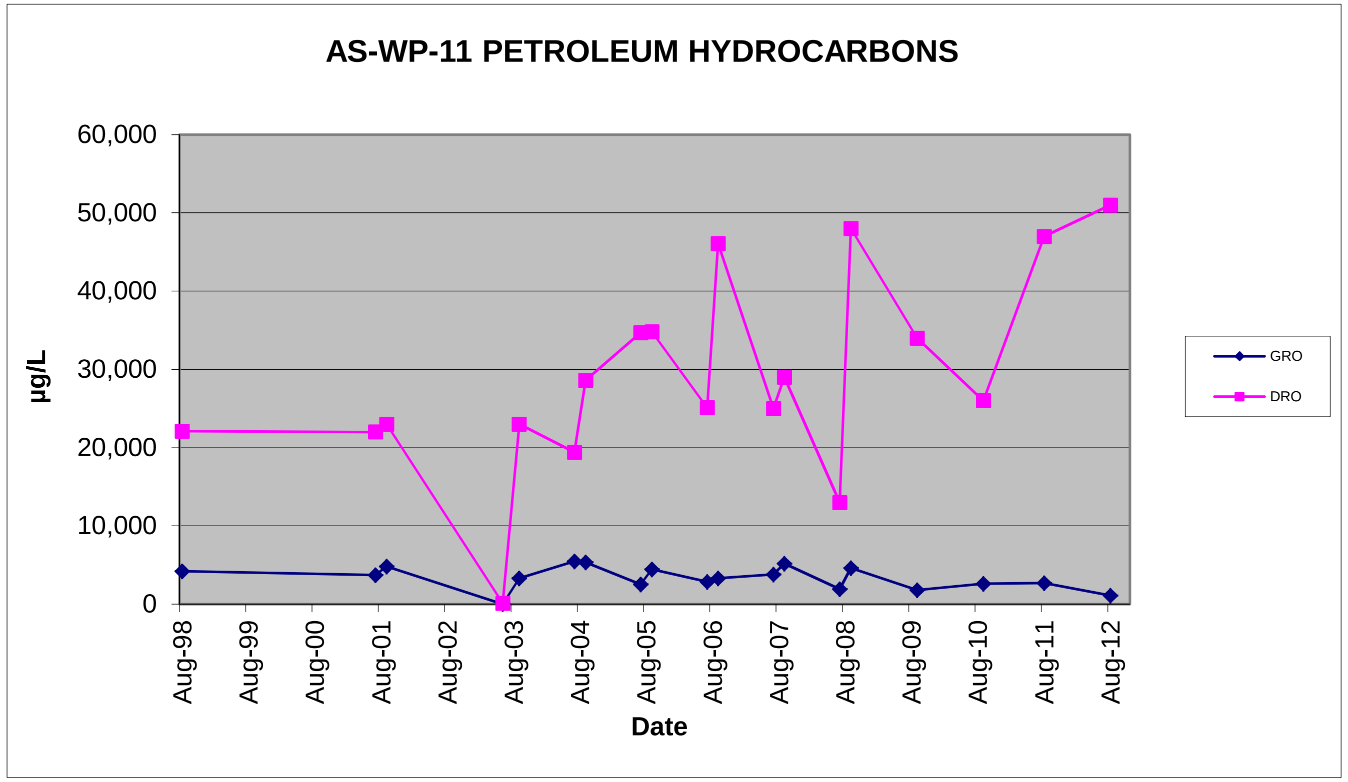
Airstrip Site

Table A-3. AS-WP-11

		VOCs (µg/L)						Petroleum Hydrocarbons (µg/L)		Geochemical Parameters				
Well ID	**Collection Date**	**1,2-DCA**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**Total BTEX (TAH)**	**GRO (AK 101)**	**DRO (AK 102)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**10**	**1,300**	**8,200** [1/]	--	--	--	--	--
AS-WP-11	8/7/1998	N/A	**240**	850	48	400	**1,538**	**4,200**	**22,100 Y**	N/A	N/A	N/A	N/A	N/A
AS-WP-11	7/26/2001	N/A	**110**	330	52	420	**912**	**3,700**	**22,000**	286	0.20	0.30	22.9	N/A
AS-WP-11	9/26/2001	N/A	**160**	540	95	780	**1,575**	**4,800 H**	**23,000 YJ**	300	0.20	0.30	38.6	N/A
AS-WP-11	6/19/2003	2.0 U	2.0 U	2.0 U	2.0 U	2.28 UJ	8.28 UJ	16 J	120	174.4	0	46	0	N/A
AS-WP-11	9/3/2003	2.0 U	**150**	440	50	400	**1,040**	**3,300**	**23,000**	276	0	0	2.74	N/A
AS-WP-11	7/25/2004	5.0 U	**257**	861	114	791	**2,023**	**5,480**	**19,400 X**	362	0.10 U	0	2.17	7,260 W
AS-WP-11	9/22/2004	5.0 U	**251**	547	112	692	**1,602**	**5,360**	**28,600 X**	410	0.10 U	0	10.8	2,080 W
AS-WP-11	7/10/2005	5.0 U	**123**	417	50.5	356	**946.5**	**2,540**	**34,700**	353	0.10 U	0	24.9	2,290 W
AS-WP-11	9/9/2005	5.0 U	**186**	498	125	806	**1,615**	**4,450**	**34,800**	256	0.10 U	0	7.75	2,380 W
AS-WP-11	7/21/2006	5.0 U	**112**	252	65.7	445	**874.7**	**2,870**	**25,100**	280	0.192	0	10.2	3,080
AS-WP-11*	9/14/2006	0.50 UK	**261**	492	169	1,110	**2,032**	**3,320**	**46,100**	352	0.031	0	17	8,000
AS-WP-11	7/27/2007	1.0 U	**140**	240	99	760	**1,249**	**3,800**	**25,000**	360	0	1.0 U	0	1,400 J
AS-WP-11	9/12/2007	1.0 U	**190**	180	110	720	**1,220**	**5,200**	**29,000 J**	460	0.20	1.0	2.0	960
AS-WP-11	7/12/2008	N/A	**58**	56	38	340 D	**492 D**	**1,900 DY**	**13,000 Y**	340	0	14.7	1.0	2,300
AS-WP-11	9/6/2008	N/A	**170 D**	140 D	120 D	830 D	**1,260 D**	**4,600 Y**	**48,000 Y**	440	0	1.9	2.0	5,700
AS-WP-11	9/5/2009	N/A	**45**	34	35	280 D	**394 D**	**1,800 Y**	**34,000 Y**	340	0	3.23	1.0	5,200
AS-WP-11	9/2/2010	N/A	**87 D**	100 D	78 D	600 D	**865 D**	**2,600 Y**	**26,000 Y**	350	0	1.6	1.0	4,300
AS-WP-11	8/23/2011	N/A	**76 D**	51	69	570 D	**697 D**	**2,700 Y**	**47,000 Y**	300	0	0.66	0.8	3,700
AS-WP-11	8/17/2012	N/A	**63 D**	7.5 D	34 D	280 D	**384.5 D**	1,100 Y	**51,000 YJ**	380	0	6.5	2.2	4,400

For all notes see the acronyms and abbreviations presented at the end of Appendix A



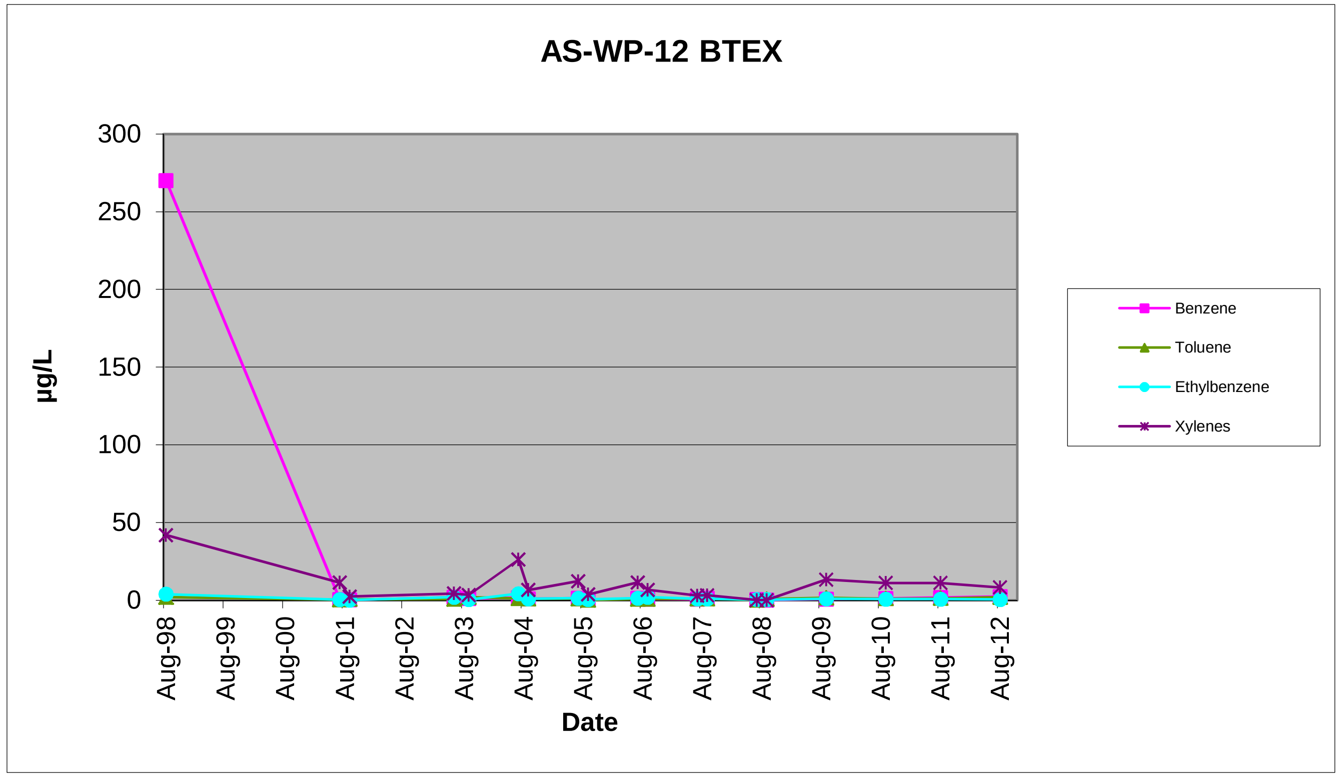


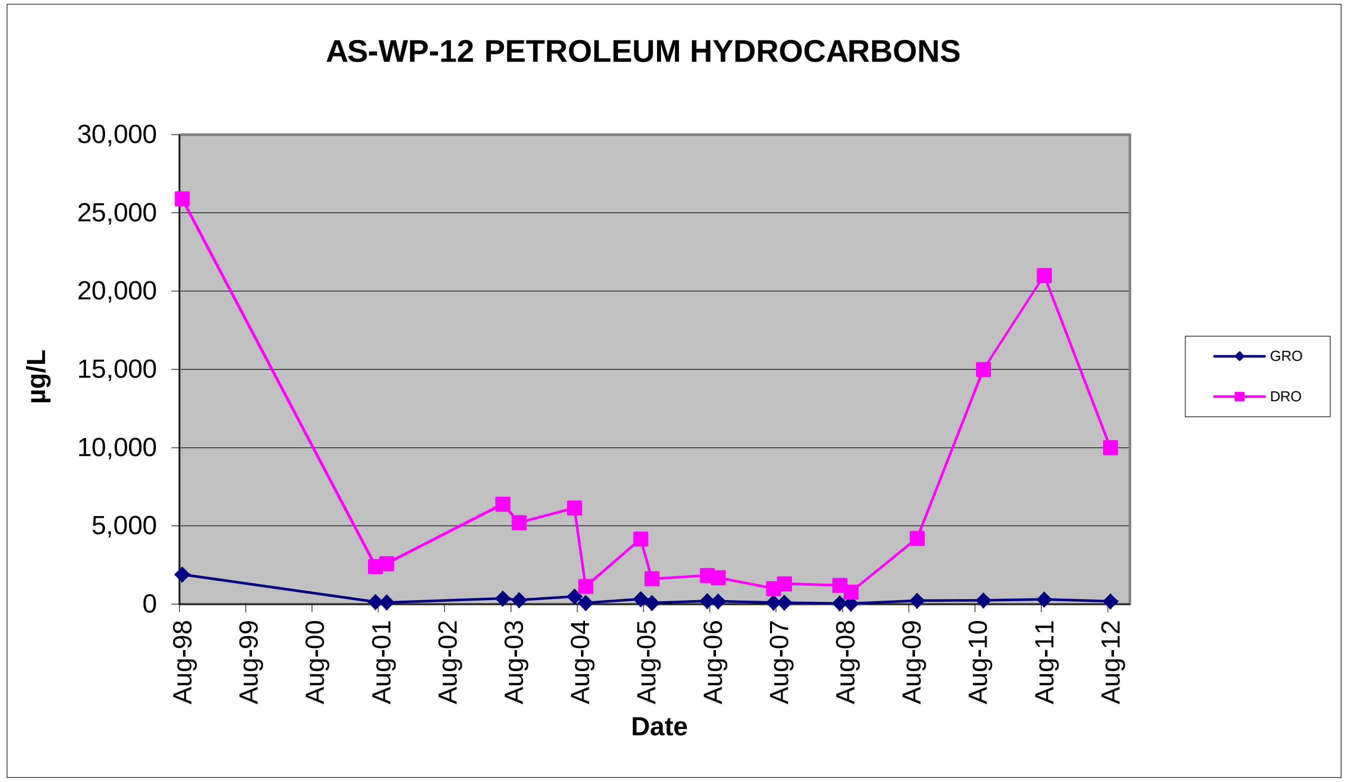
Airstrip Site

Table A-4. AS-WP-12

		VOCs (µg/L)						Petroleum Hydrocarbons (µg/L)		Geochemical Parameters				
Well ID	**Collection Date**	**1,2-DCA**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**Total BTEX (TAH)**	**GRO (AK 101)**	**DRO (AK 102)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**10**	**1,300**	**1,500**[1/]	--	--	--	--	--
AS-WP-12	8/7/1998	N/A	**270**	2.0 J	4.0 J	42	**312 J**	**1,900**	**25,900**	N/A	N/A	N/A	N/A	N/A
	7/26/2001	N/A	0.50 U	0.40 J	0.50	11.4	**12.8 J**	140 H	**2,400 JL**	55	0.20	5.9	0.35	N/A
	9/26/2001	N/A	0.29 J	0.70	0.14 J	2.5	3.63 J	110 H	**2,600 Y**	148	0.10	4.6	2.86	N/A
	6/21/2003	2.0 U	2.0 U	0.78 J	2.0 U	4.4	9.18 J	360	**6,400**	100.8	0	0	0.1	N/A
	9/3/2003	2.0 U	1.1 J	2 U	0.5 J	3.5 UJ	7.1 UJ	270	**5,200**	180	0	0	0.030	N/A
	7/25/2004	1.0 U	1.79	1.29	4.29	26.23	**33.6**	489	**6,150 X**	92	0.10 U	0	2.94	207 W
	9/22/2004	1.0 U	1.0 U	1.0 U	1.08	6.68	9.76 J	80 U	1,130 X	92	0.10 U	1.0	0	35.1
	7/10/2005	1.0 U	1.41	1.0 U	1.47	12.32	**16.2 J**	329	**4,170**	101	0.10 U	0	0.10	133
	9/9/2005	1.0 U	0.33 J	0.20 J	0.53 J	3.78	4.84 J	72.3 J	**1,620**	190	0.10 U	0	1.15	26.2
	7/21/2006	0.50 U	1.3	0.77 J	1.39	11.5	**14.96 J**	200	**1,830**	80	0.10 U	0	0.030	31.1
	* 9/14/2006	0.50 UK	0.766	0.717 J	2 U	6.78	**10.26 J**	179	**1,690**	78	0.10 U	0	0.020	36
AS-WP-12-1C	7/30/2007	1.0 U	0.68 J	1.0 U	1.0 U	3.0	5.68 J	100 U	990	80	2	4.2	1.0	34
AS-WP-12B-2	9/11/2007	1.0 U	1.5	1.0 U	1.0 U	3.3	6.8 J	100	1,300	140	0.20	1 U	2.0	5,100
AS-WP-12-1	7/22/2008	N/A	0.50 U	0.12 J	0.50 U	0.22 J	1.34 J	48 J	1,200 Y	80	0	5.0	0	4.3
AS-WP-12-2	9/5/2008	N/A	0.21 J	0.72 U	0.50 U	0.26 J	1.69 J	37 J	780 Y	120	0	2.8	1.6	35
AS-WP-12	9/5/2009	N/A	0.87	1.6	1.0	13.4	**16.87**	230 H	**4,200 Y**	80	0	20.1	0	26
AS-WP-12	9/1/2010	N/A	1.2	1.1	0.8	11.2	**14.31**	250 H	**15,000 Y**	280	0	8.25	0.6	200
AS-WP-12	8/22/2011	N/A	1.9	1.3	0.79	11.2	**14.4**	310 H	**21,000 Y**	260	0	4.6	1.2	340
AS-WP-12	8/17/2012	N/A	2.4	2	0.6	8.3	**13.3**	180 Y	**10,000 YJ**	260	0	1.29	2.7	500

For all notes see the acronyms and abbreviations presented at the end of Appendix A



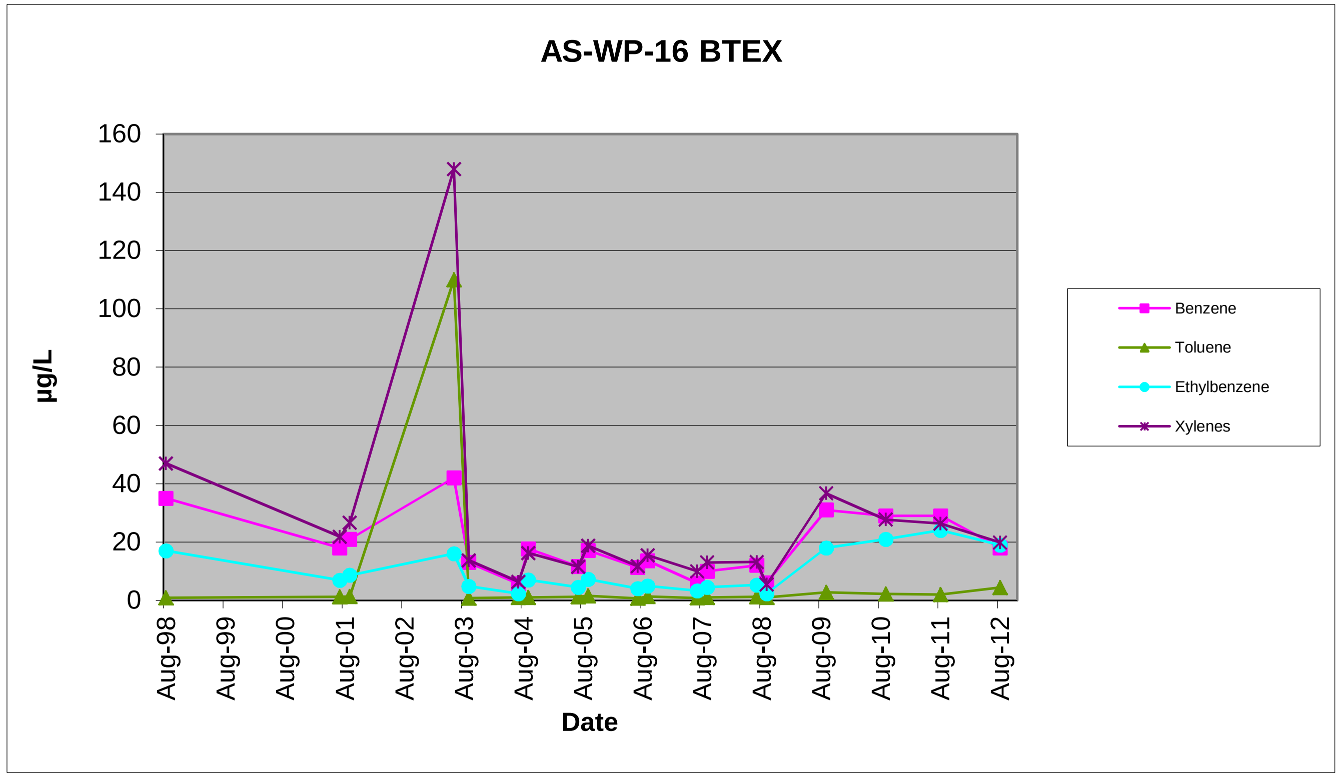


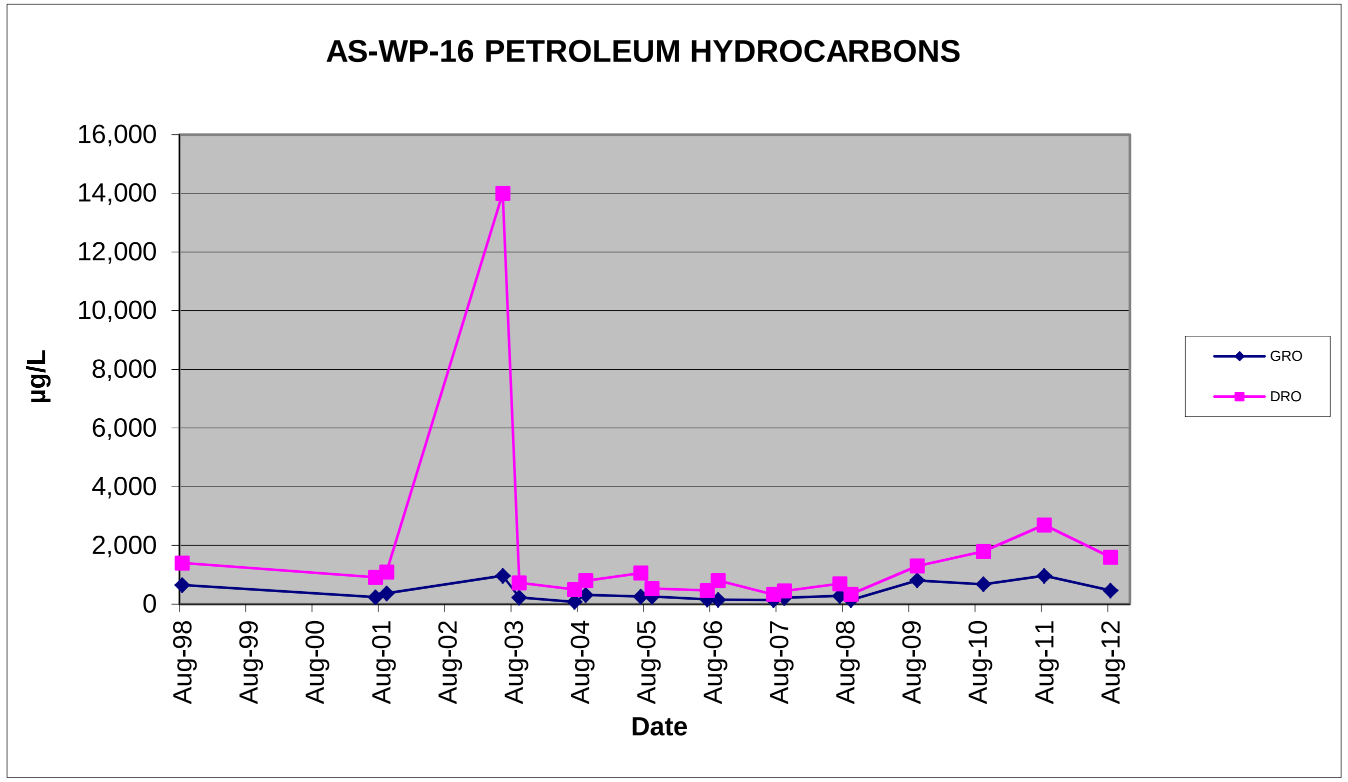
Airstrip Site

Table A-5. AS-WP-16

		VOCs (µg/L)						Petroleum Hydrocarbons (µg/L)		Geochemical Parameters				
Well ID	**Collection Date**	**1,2-DCA**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**Total BTEX (TAH)**	**GRO (AK 101)**	**DRO (AK 102)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**10**	**1,300**	**1,500** [1/]	--	--	--	--	--
AS-WP-16	8/7/1998	N/A	**35**	0.90	17	47	**99.9**	650	1,400	N/A	N/A	N/A	N/A	N/A
	7/26/2001	N/A	**18**	1.2	6.9	21.8	**47.9**	240 Y	910 JL	194	0.20	9.1	9.17	N/A
	9/26/2001	N/A	**21**	1.3 U	8.6	26.6	**57.5 J**	370 H	1,100 Y	272	0.20	12.7	14.2	N/A
	6/19/2003	2.0 U	**42**	110	16	148	**316**	970	**14,000**	N/A	0.040	7.0	0.50	N/A
	9/3/2003	2.0 U	**13**	0.73 J	4.8	13.68 J	**17.8**	230	730	237	0	0	1.14	N/A
	7/25/2004	1.0 U	**5.73**	1.0 U	2.29	6.36	**15.38 J**	80 U	500 U	116	0.10 U	0	2.19	934 W
	9/22/2004	1.0 U	**17.7**	1.0 U	6.97	16.24	**41.91 J**	317	800 X	255	0.10 U	3.0	0.070	1,910 W
	7/10/2005	1.0 U	**11.6**	1.15	4.47	11.5	**28.72**	256	1,060	302	0.10 U	0	6.25	1,850 W
	9/9/2005	0.86 J	**17.1**	1.51	7.21	18.79	**44.61**	259	536 U	80	0.10 U	0	3.75	590 W
	7/21/2006	0.54	**11.3**	0.71 J	4.09	11.7	**27.8 J**	163	468	230	0.0985 J	0	0.040	1,010
	* 9/14/2006	0.50 UK	**13.6**	1.28 J	4.89	15.46	**35.23 J**	147	804	261	0.10 U	1.0	0.050	2,200
AS-WP-16-1C	7/30/2007	1.0 U	**5.9**	0.81 J	3.3	10	**20.01 J**	140	330	N/A	N/A	1.0 U	0.8	200
AS-WP-16B-2	9/11/2007	1.0 U	**10**	0.94 J	4.5	13	**28.44 J**	220	450	240	0.20	1.3	2.8	500
AS-WP-16-1	7/22/2008	N/A	**12**	1.2	5.3	13.2	**31.7**	280	700 J	260	0	3.2	1.6	780
AS-WP-16-2	9/6/2008	N/A	**6.0**	0.99 U	2.3	5.43	**14.72 J**	140 Y	340 J	220	0	5.4	1.6	590
AS-WP-16	9/5/2009	N/A	**31**	2.7	18	36.7	**88.4**	810 Y	1,300 Y	260	0	1.84	1.6	1,900
AS-WP-16	9/1/2010	N/A	**29 J**	2.2	21	27.7	**79.9 J**	680 Y	**1,800 Y**	300	0	11.6	1.0	1,600
AS-WP-16	8/22/2011	N/A	**29**	2.0	24	26.3	**57.3**	970 Y	**2,700 Y**	300	0	64.9	1.3	920
AS-WP-16	8/17/2012	N/A	**18**	4.4	19	19.9	**61.3**	470 Y	**1,600 YJ**	260	0	97	3.7	490

For all notes see the acronyms and abbreviations presented at the end of Appendix A



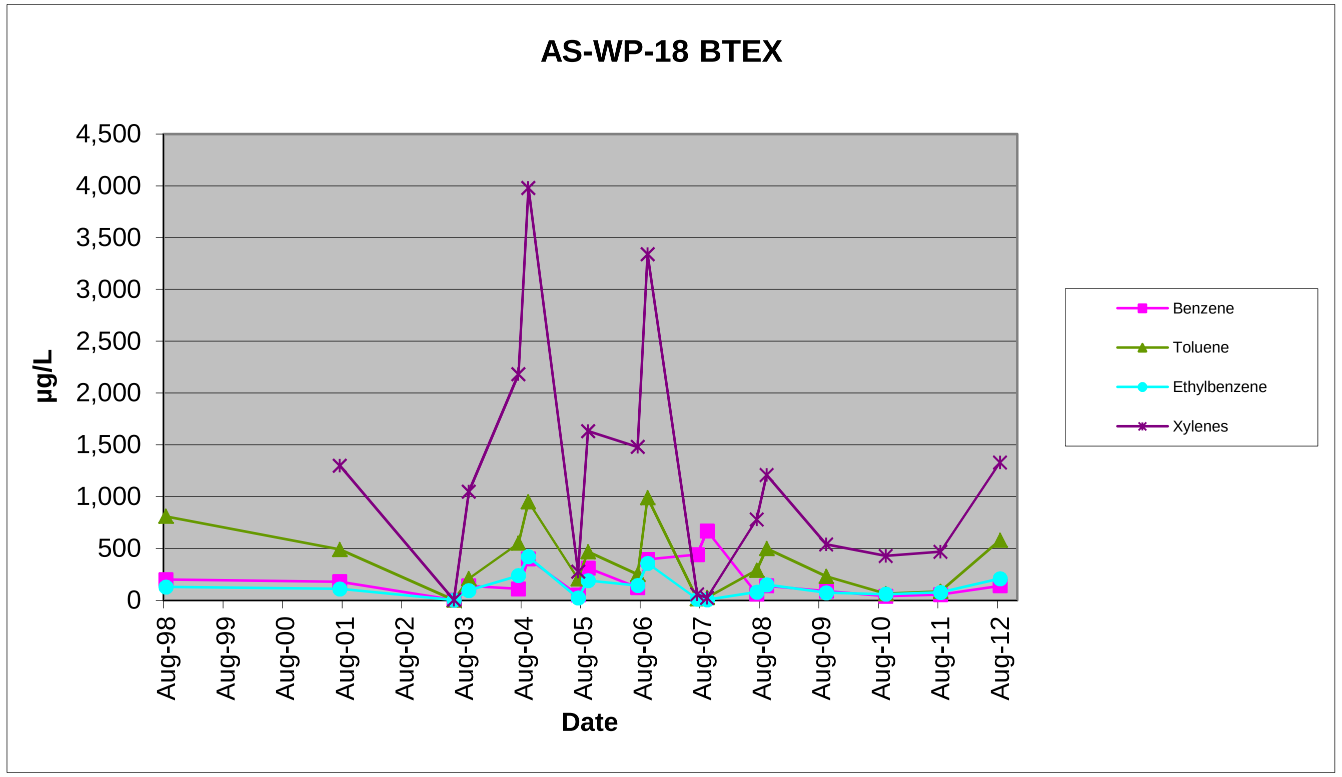


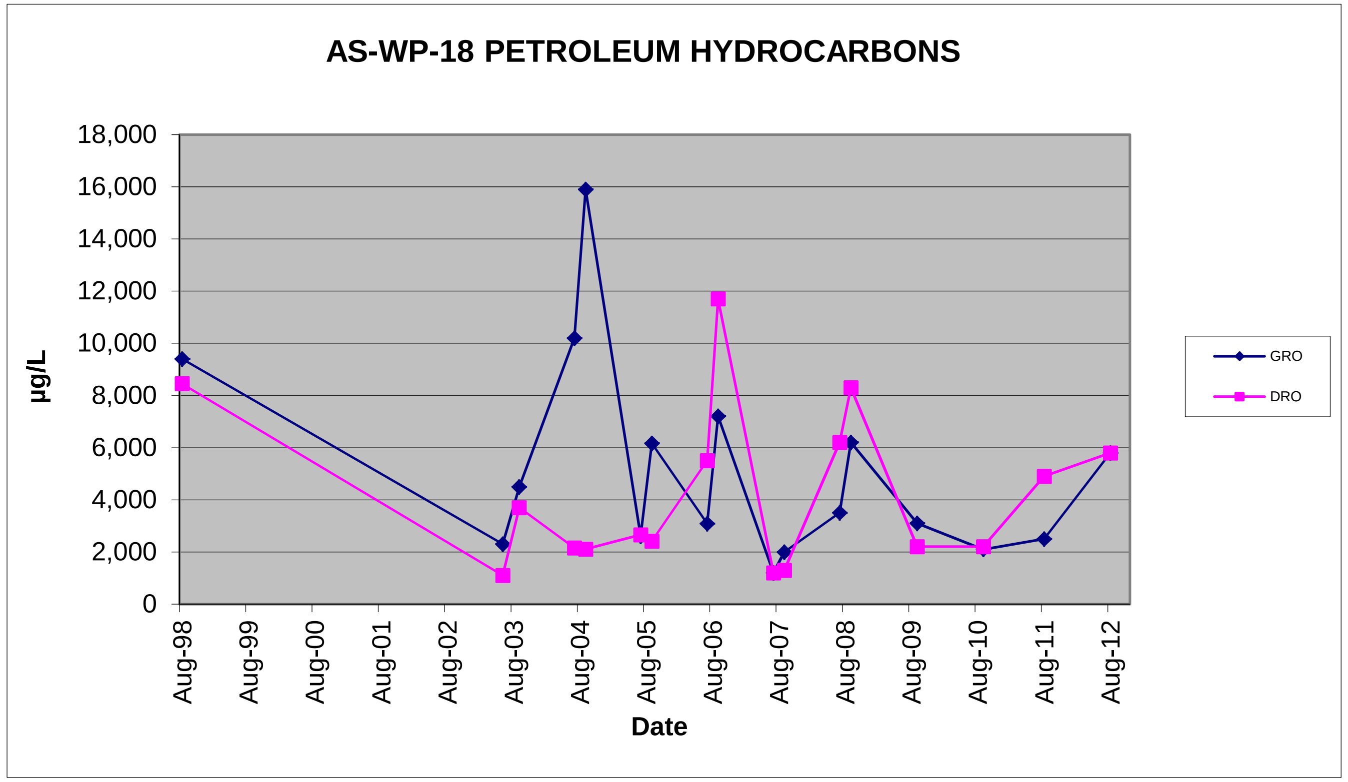
Airstrip Site

Table A-6. AS-WP-18

		VOCs (µg/L)						Petroleum Hydrocarbons (µg/L)		Geochemical Parameters				
Well ID	**Collection Date**	**1,2-DCA**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**Total BTEX (TAH)**	**GRO (AK 101)**	**DRO (AK 102)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**10**	**1,300**	**8,200** [1/]	--	--	--	--	--
AS-WP-18	8/7/1998	*50 U*	**200**	810	130	#N/A	**1,140**	**9,400**	**8,450**	N/A	N/A	N/A	N/A	N/A
	7/26/2001	N/A	**180**	490	110	1,300	**2,080**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AS-WP-18	6/19/2003	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	90.4	0.0	0.0	0.25	N/A
	6/21/2003	2.0 U	2.0 U	2.0 U	2.0 U	4.0 U	10 U	**2,300**	1,100	N/A	N/A	N/A	N/A	N/A
	9/3/2003	*10 U*	**140**	210	95	1,050	**1,495**	**4,500**	3,700	240	0.0	28	0.20	N/A
	7/25/2004	5.0 U	**110**	551	239	2,183	**3,083**	**10,200**	2,160 X	184	0.150	0.0	1.32	5,100 W
	9/22/2004	*10 U*	**400**	951	421	3,980	**5,752**	**15,900**	2,110 X	248	0.10 U	0.0	0.27	6,190 W
	7/10/2005	5.0 U	**52.8**	206	23	277	**558.8**	**2,610**	2,660 J	229	0.10 U	0.0	0.44	4,960 W
	9/9/2005	3.7 J	**312**	468	190	1,633	**2,603**	**6,160**	2,410	76	0.38	11	0.24	3,900 W
	7/21/2006	*50 U*	**123**	251	143	1,480	**1,997**	**3,090**	5,500	200	0.651	0.0	0.33	1,200
*	9/14/2006	*50 UK*	**395**	991	359	3,340	**5,085**	**7,210**	**11,700**	269	0.057	0.0	0.47	6,200
AS-WP-18B-1	7/27/2007	1.0 U	**440**	15	13	57	**525**	1,200	1,200	440	0.0	1.0 U	1.8	1,800 J
AS-WP-18B-2	9/11/2007	1.0 U	**670**	26	5.6	25	**726.6**	**2,000**	1,300 J	360	0.0	N/A	3	8,000
AS-WP-18-1	7/23/2008	N/A	**62 D**	290 D	81 D	780 D	**1,213 D**	**3,500 DY**	6,200 Y	180	0.0	8.1	0.60	1,400
AS-WP-18-2	9/6/2008	N/A	**140 D**	500 D	150 D	1,210 D	**2,000 D**	**6,200 Y**	**8,300 Y**	220	0.0	4.6	1.4	4,300
AS-WP-18	9/6/2009	N/A	**90 D**	230 D	73 D	540 D	**933 D**	**3,100 Y**	2,200 Y	180	0.0	9.61	0.0	1,700
AS-WP-18	9/1/2010	N/A	**41**	64 D	60 D	430 D	**595 D**	**2,100 Y**	2,200 Y	200	0.0	3.53	0.80	920
AS-WP-18	8/22/2011	N/A	**55**	86 D	77	470 D	**611 D**	**2,500 Y**	4,900 Y	280	0	5.4	1.1	740
AS-WP-18	8/16/2012	N/A	**140 D**	580 D	210 D	1,330 D	**2,260 D**	**5,800 Y**	5,800 YJ	260	0	8.6	2.4	3,200

For all notes see the acronyms and abbreviations presented at the end of Appendix A



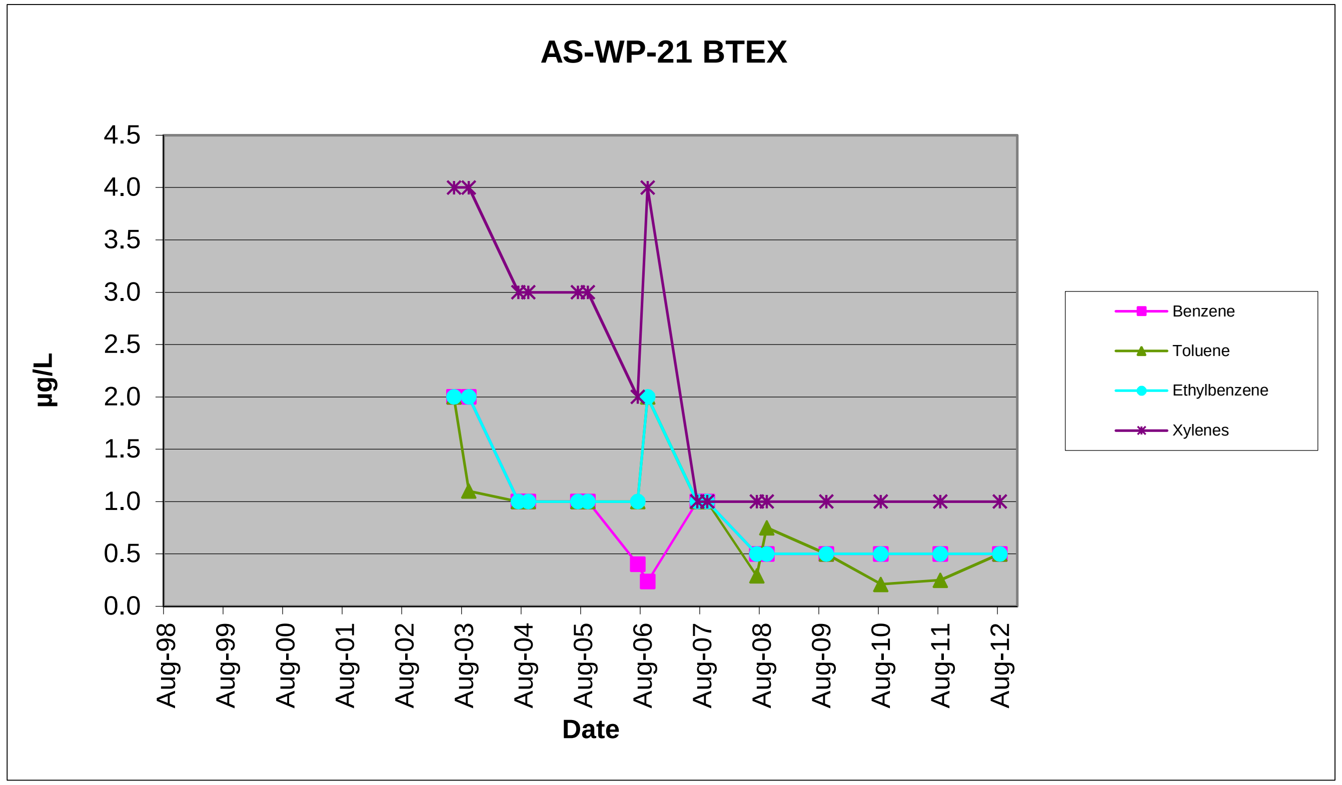


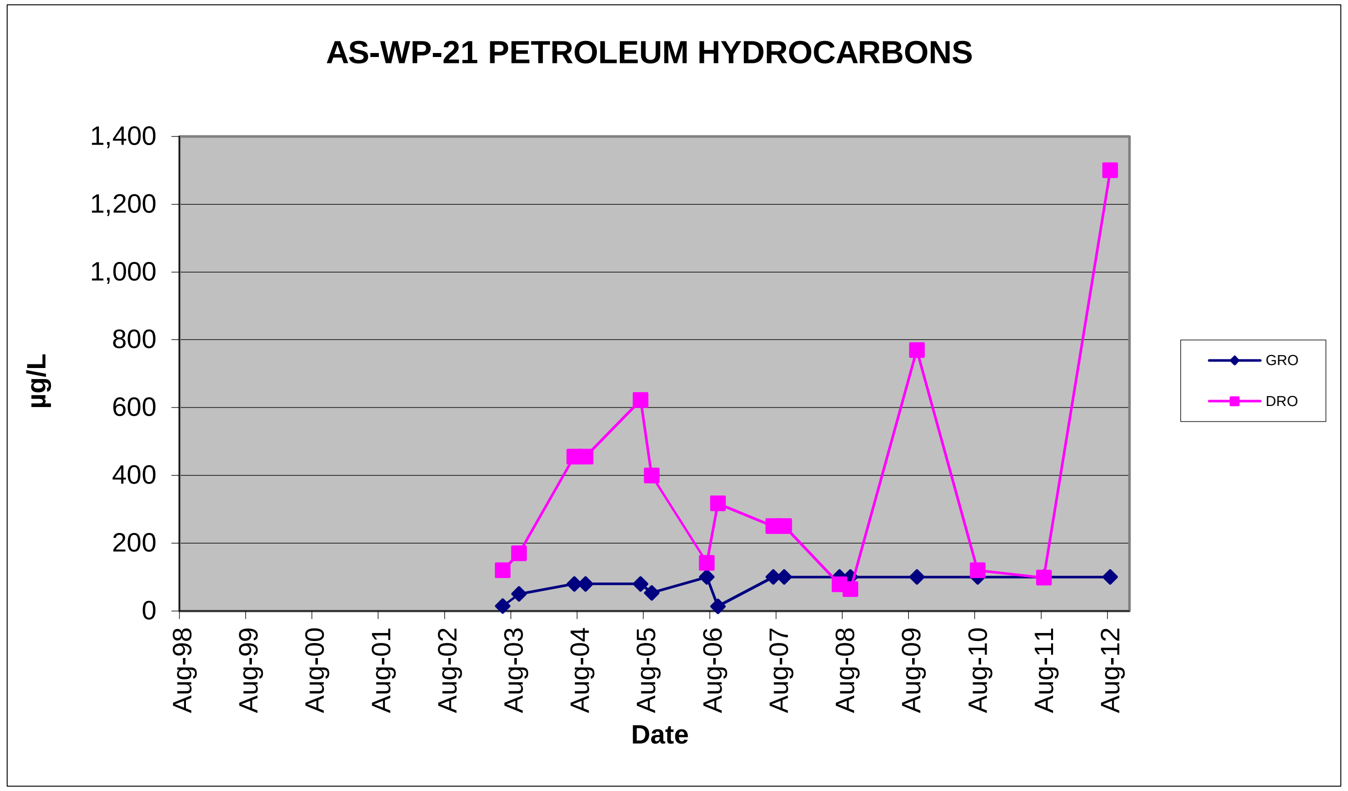
Airstrip Site

Table A-7. AS-WP-21

		VOCs (µg/L)						Petroleum Hydrocarbons (µg/L)		Geochemical Parameters				
Well ID	**Collection Date**	**1,2-DCA**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**Total BTEX (TAH)**	**GRO (AK 101)**	**DRO (AK 102)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**10**	**1,300**	**1,500** $^{1/}$	--	--	--	--	--
AS-WP-21	7/26/2001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	48	0.6	7.3	0.01	N/A
	6/19/2003	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	54	0.0	0.0	0.04	N/A
	6/21/2003	2.0 U	2.0 U	2.0 U	2.0 U	4.0 U	10 U	14 J	120	N/A	N/A	N/A	N/A	N/A
	9/3/2003	2.0 U	2.0 U	1.1 J	2.0 U	4.0 U	9.1 J	50 U	170	49	0.04	1.0	0.04	N/A
	7/25/2004	1.0 U	1.0 U	1.0 U	1.0 U	3.0 U	6.0 U	80 U	455 U	32	0.250	0.0	0.22	62.4
	9/22/2004	1.0 U	1.0 U	1.0 U	1.0 U	3.0 U	6.0 U	80 U	455 U	40	0.44	0.0	0.06	3.49
	7/10/2005	1.0 U	1.0 U	1.0 U	1.0 U	3.0 U	6.0 U	80 U	622	51	1.55	0.0	0.2	1.2 U
	9/9/2005	1.0 U	1.0 U	1.0 U	1.0 U	3.0 U	6.0 U	53.5 J	400 U	76	0.15	60	0.0	6.46
	7/21/2006	0.50 UK	0.40 U	1.0 U	1.0 U	2.0 U	4.4 U	100 U	142 J	40	0.14	0.0	0.0	5 U
	* 9/14/2006	0.50 UK	0.235 J	2.0 U	2.0 U	4.0 U	8.235 J	13.6 J	317 J	151	0.22	0.0	0.010	10 U
AS-WP-21B	7/31/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	4 U	100 U	250 U	60	0.0	4.4	0.0	0.87 U
AS-WP-21B	9/12/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	4 U	100 U	250 U	80	5.0	5.0	0.80	2.0
AS-WP-21B	7/22/2008	N/A	0.50 U	0.29 J	0.50 U	1.0 U	2.29 J	100 U	79 J	80	0.0	3.8	0	0.50 U
AS-WP-21B	9/5/2008	N/A	0.50 U	0.75 U	0.50 U	1.0 U	2.75 U	100 U	64 J	80	0.0	4.8	0.20	0.50 U
AS-WP-21B	9/4/2009	N/A	0.50 U	0.50 U	0.50 U	1.0 U	2.5 U	100 U	770 U	80	0.0	12.9	0.0	0.47 J
AS-WP-21B	8/31/2010	N/A	0.50 U	0.21 J	0.50 U	1.0 U	0.21 J	100 U	120 J	140	0.0	19.4	0.20	0.34 J
AS-WP-21B	8/22/2011	N/A	0.50 U	0.25 J	0.50 U	1.0 U	2.25 J	100 U	98 J	120	0	16.2	2.0	1.3 U
AS-WP-21B	8/15/2012	N/A	0.5 U	0.5 U	0.5 U	1.0 U	2.5 U	100 U	1,300 YJ	220	0	37	0.0	1.3 U

For all notes see the acronyms and abbreviations presented at the end of Appendix A



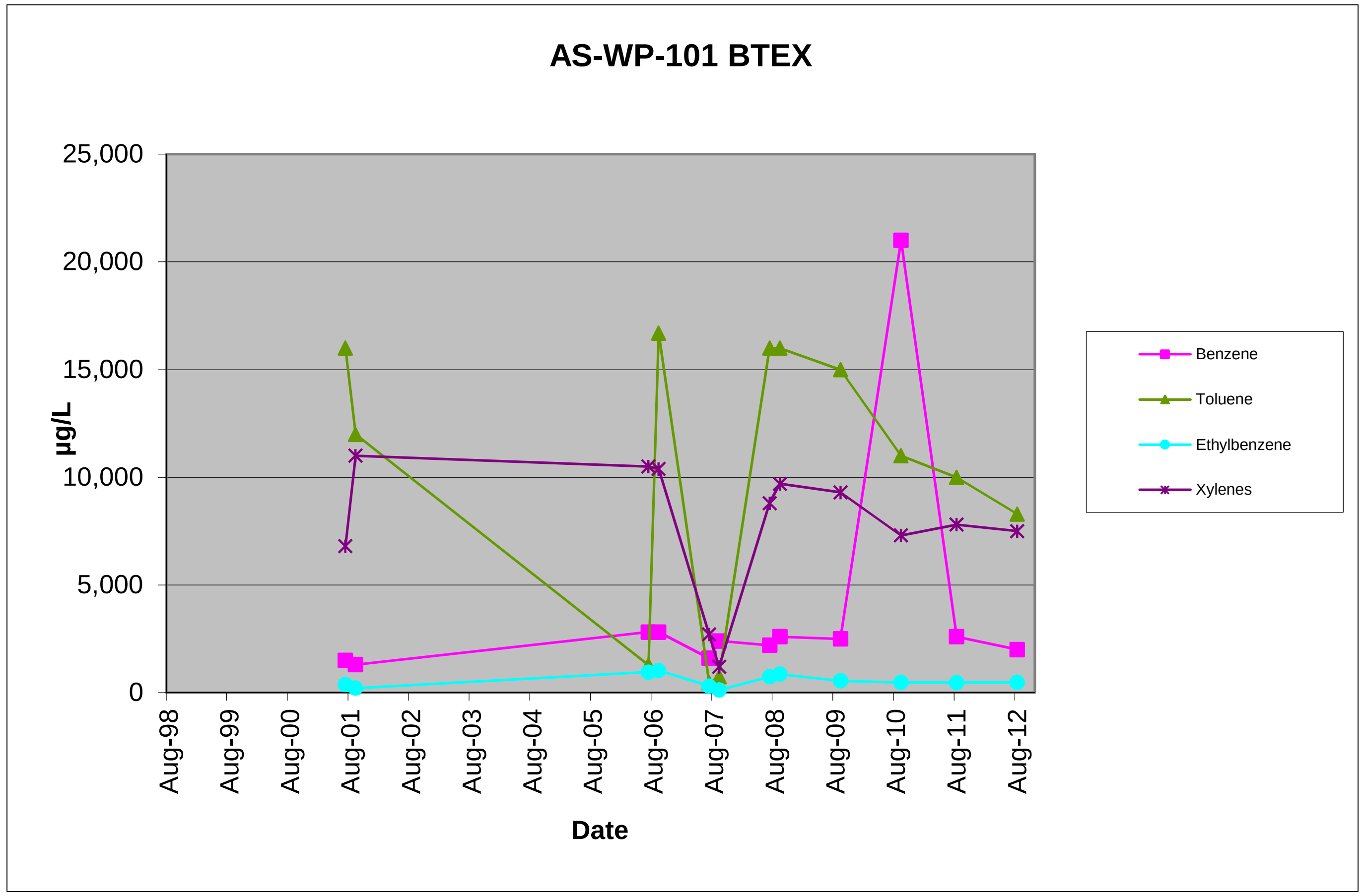


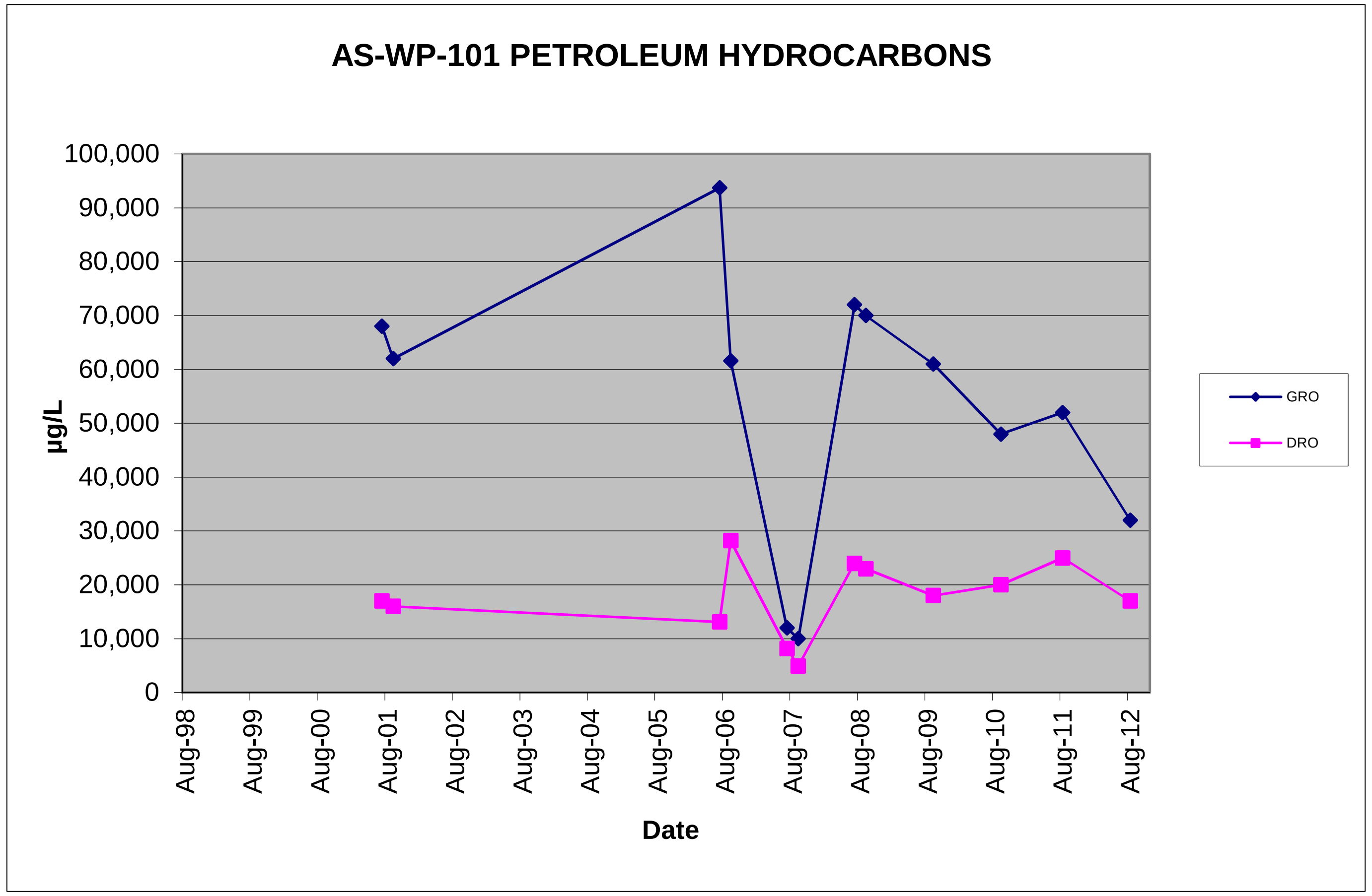
Airstrip Site

Table A-8. AS-WP-101

		VOCs (µg/L)						Petroleum Hydrocarbons (µg/L)		Geochemical Parameters				
Well ID	**Collection Date**	**1,2-DCA**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**Total BTEX (TAH)**	**GRO (AK 101)**	**DRO (AK 102)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**10**	**1,300**	**8,200** $^{1/}$	--	--	--	--	--
AS-WP-101	7/26/2001	N/A	**1,500**	**16,000**	380	6,800	**24,680**	**68,000**	**17,000**	N/A	N/A	N/A	N/A	N/A
AS-WP-101	9/26/2001	N/A	**1,300**	**12,000**	210	**11,000**	**24,510**	**62,000**	**16,000**	N/A	N/A	N/A	N/A	N/A
AS-WP-101	7/21/2006	*50 U*	**2,810**	**1,280**	**958**	**10,500**	**15,548**	**93,700**	**13,100**	350	0.10 U	130	5.3	342
*	9/14/2006	*50 UK*	**2,810**	**16,700**	**1,030**	**10,390**	**30,930**	**61,600**	**28,200**	440	0.10 U	0.0	4.1	490
AS-WP-101B	7/31/2007	1.0 U	**1,600**	N/A	N/A	N/A	N/A	**12,000**	8,200	380	0.20	4.5	1	50
AS-WP-101B	7/31/2007	N/A	N/A	460	310	2,700	**5,070**	**12,000**	N/A	380	N/A	N/A	N/A	N/A
AS-WP-101B	9/12/2007	1.0 U	N/A	N/A	N/A	N/A	N/A	**10,000**	4,900 J	480	0.0	4.5	1.4	1,400
AS-WP-101B	9/12/2007	N/A	**2,400**	750	120	1,200	**4,470**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AS-WP-101	7/23/2008	N/A	**2,200 D**	**16,000 D**	**740 D**	8,800 D	**27,740 D**	**72,000 DY**	**24,000 Y**	440	0.0	35.9	1.2	390
AS-WP-101	9/6/2008	N/A	**2,600 D**	**16,000 D**	**860 D**	9,700 D	**29,160 D**	**70,000 DY**	**23,000 Z**	480	0.0	30.4	1.8	600
AS-WP-101	9/4/2009	N/A	**2,500 D**	**15,000 D**	550 D	9,300 D	**27,350 D**	**61,000 DY**	**18,000 Y**	440	1.2	15	0.0	740
AS-WP-101	9/2/2010	N/A	**21,000 D**	**11,000 D**	480 D	7,300 D	**20,880 D**	**48,000 DY**	**20,000 L**	425	0.0	18.4	0.6	350
AS-WP-101	8/21/2011	N/A	**2,600 D**	**10,000 D**	470 D	7,800 D	**20,400 D**	**52,000 DZ**	**25,000 Y**	160	0	23.2	1.0	120
AS-WP-101	8/21/2012	N/A	**2,000 D**	**8,300 D**	480 D	7,500 D	**18,280 D**	**32,000 D**	**17,000 YJ**	400	0	12.7	2.1	380

For all notes see the acronyms and abbreviations presented at the end of Appendix A





Airstrip Site

Table A-9. AFAS-WP-19, 20, 21, 22

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)		Geochemical Parameters				
Well ID	**Collection Date**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**Total BTEX (TAH)**	**GRO (AK 101)**	**DRO (AK 102)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater													
Cleanup Level		**5**	**1,000**	**700**	**10,000**	**10**	**1,300**	**8,200** $^{1/}$	--	--	--	--	--
AFAS-WP-19	8/17/2012	2	2.1	6.4	64	**74.5**	**2,400 Y**	2,100 YJ	220	0	3.55	2.7	930
AFAS-WP-20	8/16/2012	**120 D**	310 D	470 D	6,500 D	**7,400 D**	**12,000 DY**	3,100 YJ	200	0	0.44	2.5	2,700
AFAS-WP-21	8/16/2012	4.5	1.7	1.2	52	**59.4**	150 Y	550 YJ	160	0	0.69	2.0	890
AFAS-WP-22	8/16/2012	**910 D**	**1,200 D**	330 D	2,600 D	**5,040 D**	**9,500 Y**	5,200 YJ	320	0	7.5	1.8	9,000

For all notes see the acronyms and abbreviations presented at the end of Appendix A

Airstrip Site

Table A-10. Airstrip Surface Water

		VOCs (µg/L)						Petroleum Hydrocarbons (µg/L)		
Location ID	Collection Date	1,2-DCA	Benzene	Toluene	Ethylbenzene	Xylenes	Total BTEX (TAH)	GRO (AK 101)	DRO (AK 102)	RRO (AK 103)
Surface Water										
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**10**	**1,300**	**1,500**	**1,100**
AS-SW-01	7/12/1998	N/A	0.5 U	0.5 U	0.5 U	0.5 U	1.0 U	50 U	100 U	60 J
AS-SW-01	9/28/2001	N/A	0.5 U	0.5 U	0.5 U	1 U	1.3 U	50 U	100 U	26 U
AS-SW-01	9/3/2003	2 U	2 U	2 U	2 U	4 U	10 U	50 U	94 J	N/A
AS-SW-01	7/25/2004	1 U	1 U	1 U	1 U	3 U	6 U	80 U	455 U	N/A
AS-SW-01	9/22/2004	1 U	1 U	1 U	1 U	3 U	6 U	80 U	417 U	N/A
AS-SW-01	9/9/2005	1 U	1 U	1 U	1 U	3 U	6 U	80 U	400 U	N/A
AS-SW-01	9/14/2006	0.5 U	0.384 J	2 U	2 U	2.836 UJ	7.22 UJ	13.9 J	412 J	N/A
AS-SW-01-1	7/27/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	4.0 U	100 U	250 U	N/A
AS-SW-01-1	7/23/2008	N/A	0.2 J	0.81	0.50 U	0.38 J	1.89	100 U	140 J	N/A
AS-SW-01-2	9/7/2008	N/A	0.07 J	0.50 U	0.50 U	1.0 U	2.07	100 U	770 U	N/A
AS-SW-01	9/4/2009	N/A	1	3.2	0.16 J	5.4 J	9.76 J	27 J	780 U	N/A
AS-SW-01	8/20/2010	N/A	0.17 J	0.62	0.09 J	0.41 J	1.29 J	100 U	800 U	N/A
AS-SW-01	8/19/2011	N/A	0.18 J	0.24 J	0.080 J	0.34 J	0.84 J	100 U	150 J	N/A
AS-SW-01	8/20/2012	N/A	0.5 U	0.5 U	0.5 U	1.0 U	2.5 U	100 U	110 YJ	N/A
AS-SW-02	7/12/1998	N/A	0.5 U	0.5 U	0.5 U	0.5 U	1.0 U	50 U	100 U	50 J
AS-SW-02	9/28/2001	N/A	0.5 U	0.5 U	0.5 U	1 U	1.3 U	50 U	100 U	65 U
AS-SW-02	9/4/2003	2 U	2 U	2 U	2 U	4 U	10 U	8.4 J	100	N/A
AS-SW-02	7/25/2004	1 U	1 U	1 U	1 U	3 U	6 U	80 U	500 U	N/A
AS-SW-02	9/22/2004	1 U	1 U	1 U	1 U	3 U	6 U	80 U	417 U	N/A
AS-SW-02	9/9/2005	1 U	1 U	1 U	1 U	3 U	6 U	33.4 J	400 U	N/A
AS-SW-02	9/14/2006	0.5 U	0.4 U	1 U	1 U	2 U	4.4 U	12.2 J	236 J	N/A
AS-SW-02-1	7/27/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	4.0 U	100 U	250 U	N/A
AS-SW-02-1	7/23/2008	0.50 U	0.50 U	0.26 J	0.50 U	0.12 J	1.38	100 U	100 J	N/A
AS-SW-02-1A	7/23/2008	0.50 U	0.50 U	0.20 J	0.50 U	1.0 U	2.2	100 U	100 J	N/A
AS-SW-02-2	9/7/2008	0.50 U	0.50 U	0.71 U	0.50 U	1.0 U	2.71 U	100 U	110 J	N/A
AS-SW-02-2A	9/7/2008	0.50 U	0.50 U	0.50 U	0.50 U	1.0 U	2.5 U	100 U	770 U	N/A
AS-SW-02	9/5/2009	0.50 U	0.24 J	0.50 U	0.10 J	0.49 J	1.33 J	100 U	780 U	N/A
AS-SW-02 (DUP)	9/5/2009	0.50 UJ	0.19 J	0.50 U	0.080 J	0.41 J	1.18 J	14 J	770 U	N/A
AS-SW-02	8/20/2010	0.50 U	0.5 U	0.14 J	0.500 U	1 U	0.14 J	100 U	800 U	N/A
AS-SW-02	8/19/2011	0.50 U	0.5 U	0.50 U	0.500 U	1 U	2.5 U	100 U	130 J	N/A
AS-SW-02 (DUP)	8/19/2011	0.50 U	0.50 U	0.50 U	0.50 U	1.0 U	2.5 U	100 U	170 J	N/A
AS-SW-02	8/20/2012	0.5 U	0.39 J	1.1 UJ	0.17 J	0.75 J	2.41 J	14 J	120 YJ	N/A
AS-SW-02 (DUP)	8/20/2012	0.5 U	0.4 J	1.4 UJ	0.2 J	0.91 J	2.91 J	15 J	150 YJ	N/A
AS-SW-03	7/12/1998	N/A	0.5 U	0.5 U	0.5 U	0.5 U	1.0 U	50 U	100 U	60 J
AS-SW-03	9/28/2001	N/A	0.5 U	0.5 U	0.5 U	1 U	1.3 U	50 U	100 U	38 U
AS-SW-03	9/4/2003	2 U	2 U	2 U	2 U	4 U	10 U	13 J	90 J	N/A
AS-SW-03	7/25/2004	1 U	1 U	1 U	1 U	3 U	6 U	80 U	500 U	N/A
AS-SW-03	9/22/2004	1 U	1 U	1 U	1 U	3 U	6 U	80 U	400 U	N/A
AS-SW-03	9/9/2005	1 U	0.17 J	0.2 J	1 U	3 U	6 U	21.2 J	59.3 J	N/A
AS-SW-03	9/14/2006	0.5 U	0.4 J	1 J	1 U	2 U	4.4 U	56.1 J	216 J	N/A
AS-SW-03-1	7/27/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	4.0 U	100 U	250 U	N/A
AS-SW-03-1A	7/27/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	4.0 U	100 U	250 U	N/A
AS-SW-03-1	7/24/2008	N/A	0.50 U	0.080 J	0.50 U	1.0 U	2.08	100 U	89 J	N/A
AS-SW-03-2	9/7/2008	N/A	0.50 U	0.79 U	0.50 U	1.0 U	2.79 U	100 U	770 U	N/A
AS-SW-03	9/5/2009	N/A	0.86	1.3	0.11	0.74 J	3.01 J	18 J	770 U	N/A
AS-SW-03	8/20/2010	N/A	0.15 J	0.42 J	0.5 U	0.1 J	0.67 J	100 U	800 U	N/A
AS-SW-03	8/19/2011	N/A	0.27 J	0.61	0.50 U	0.40 J	1.78 J	100 U	170 J	N/A
AS-SW-03	8/20/2012	N/A	1.2	4 J	0.16 J	2.38	7.74 J	100 U	160 YJ	N/A
AS-SW-04	7/12/1998	N/A	0.5 U	0.5 U	0.5 U	0.5 U	1.0 U	50 U	100 U	80 J
AS-SW-04	9/28/2001	N/A	0.5 U	0.5 U	0.5 U	1 U	1.3 U	50 U	100 U	34 U
AS-SW-04	9/4/2003	2 U	2 U	2 U	2 U	4 U	10 U	6.4 J	**1,600 J**	N/A
AS-SW-04	7/25/2004	1 U	1 U	1 U	1 U	3 U	6 U	80 U	500 U	N/A
AS-SW-04	9/22/2004	1 U	1 U	1 U	1 U	3 U	6 U	80 U	435 U	N/A
AS-SW-04	9/9/2005	1 U	1 U	0.19 J	1 U	3 U	6 U	18.3 J	400 U	N/A
AS-SW-04	9/14/2006	0.5 U	0.4 U	1 U	1 U	2 U	4.4 U	22.8 J	207 J	N/A
AS-SW-04-1	7/27/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	4.0 U	100 U	250 U	N/A
AS-SW-04-1	7/23/2008	N/A	0.50 U	0.12 J	0.50 U	1.0 U	2.12	100 U	91 J	N/A
AS-SW-04-2	9/7/2008	N/A	0.50 U	0.61 U	0.50 U	1.0 U	2.61 U	100 U	770 U	N/A
AS-SW-04	9/4/2009	N/A	0.21 J	0.50 U	0.50 U	0.32 J	1.53 J	100 U	360 J	N/A
AS-SW-04	8/20/2010	N/A	0.15 J	0.43 J	0.50 U	1.00 U	2.08 J	100 U	790 U	N/A
AS-SW-04	8/19/2011	N/A	0.27 J	0.61	0.50 U	0.39 J	1.77 J	100 U	200 J	N/A
AS-SW-04	8/20/2012	N/A	0.51	1.5 UJ	0.08 J	0.90 J	2.99 J	13 J	160 YJ	N/A

For all notes see the acronyms and abbreviations presented at the end of Appendix A

Table A-11. Airstrip Soil

			VOCs (mg/kg)				Petroleum Hydrocarbons (mg/kg)		
Boring ID	Depth Range feet bgs (inches)	Collection Date	Benzene	Toluene	Ethylbenzene	Xylenes	GRO (AK 101)	DRO (AK 102)	RRO (AK 103)
Soil									
Cleanup Level			**--**	**--**	**--**	**81**	**1,400**	**12,500**	**--**
AS-B1	0.8-1 (10-12)	8/18/2010	0.094 U	0.094 U	0.094 U	0.015 J	22 U	22 Y	74 J
	2.3-2.5 (28-30)	8/18/2010	0.014 J	0.023 J	0.090 U	0.078 J	8.0 J	15 J	53 J
AS-B2	0.8-1 (10-12)	8/18/2010	0.066 U	0.018 J	0.066 U	0.132 U	24 U	11 J	110 U
	2.3-2.5 (28-30)	8/18/2010	0.052 U	0.042 J	0.0062 J	0.041 J	2.9 J	52 Y	110 U
AS-B3	0-1 (0-12)	8/18/2010	0.050 U	0.015 J	0.050 U	0.063 J	2.8 J	540 Y	76 J
	2.3-2.5 (28-30)	8/18/2010	0.25 U	0.25 U	0.25 U	0.50 U	540 Y	37 JL	120 UJ
AS-B4	0-1 (0-12)	8/18/2010	0.079 U	0.014 J	0.079 U	0.158 U	34 H	2,600 Y	110 U
	2.5 (30)	8/18/2010	0.038 U	0.076	0.038 U	0.274	56 H	3,400 Y	110 UJ
AS-B5	0-1 (0-12)	8/18/2010	0.032 U	0.032 U	0.032 U	0.064 U	13 U	31 JY	110 UJ
	30	8/18/2010	0.031 U	0.031 U	0.031 U	0.062 U	20 U	7.4 J	110 U
AS3-B1	5.4-6.0	8/4/2012	2	17	5	37.6	380 Y	1,100 Y	N/A
AS4-B2	5.0-6.0	8/4/2012	0.24 J	0.28 J	2.2 J	56 J	1,400 Y	480 Y	N/A
AS4-B2 (DUP)	5.0-6.0	8/4/2012	0.31 Ui	4.3 J	2.7 J	47 J	**1,700 Y**	730 Y	N/A
AS1-B3	3.0-3.8	8/4/2012	0.035 U	0.035 U	0.035 U	0.044 J	5.2 J	300 Y	N/A
AS1-B4	2.5-3.5	8/4/2012	0.03 U	0.03 U	0.03 U	0.031 J	24 Y	1,900 Y	N/A
AS2-B5	3.5-4.0	8/4/2012	0.059 Ui	0.059 U	0.059 U	0.428 J	190 Y	4,700 Y	N/A
AS2-B6	3.5-4.5	8/5/2012	0.044 Ui	0.069 UJ	0.044 UJ	1.68 J	490 Y	5,000 Y	N/A
AS2-B7	3.0-4.0	8/5/2012	0.028 U	0.028 U	0.021 J	1.41	45 Y	1,700 Y	N/A
AS2-B8	1.0-2.0	8/5/2012	0.046 Ui	0.046 U	0.0055 J	0.25	80 JY	2,200 Y	N/A
AS2-B9	2.5-3.5	8/5/2012	0.024 U	0.024 U	0.024 U	0.024 U	35 Y	1,300 Y	N/A
AS1-B10	3.3-4.3	8/5/2012	0.031 U	0.069 UJ	0.015 J	0.44	17 Y	670 Y	N/A
AS5-B11	6.5-8.0	8/5/2012	0.37 U	0.37 U	0.37 U	0.37 U	130 U	110 Z	N/A
AS-AST-1	0.0-0.2	8/11/2012	0.028 U	0.028 U	0.028 U	0.0232 J	10 U	55	N/A

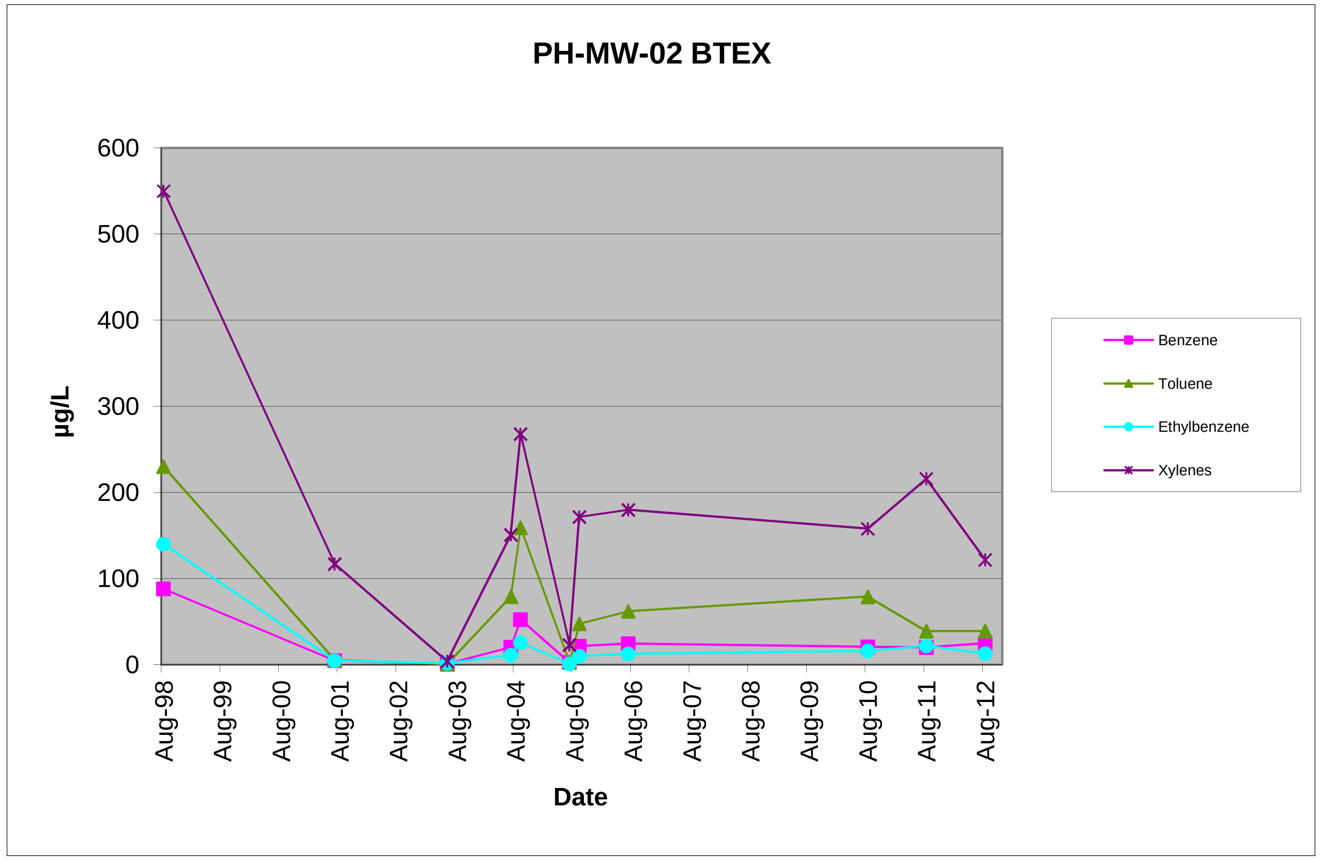
For all notes see the acronyms and abbreviations presented at the end of Appendix A

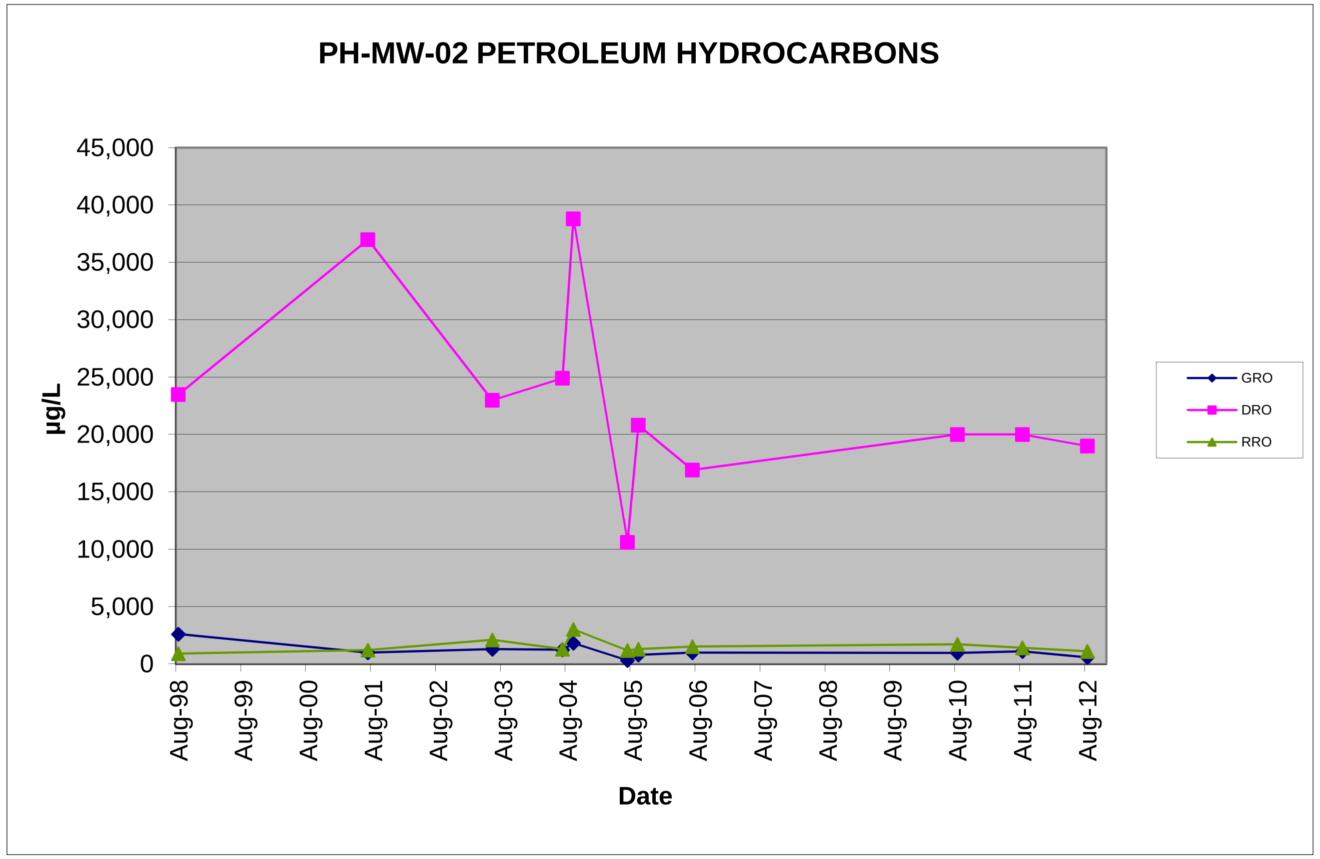
Powerhouse Site

Table A-12. PH-MW-02

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)			Geochemical Parameters				
Well ID	**Collection Date**	**PCE**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**1,300**	**8,200** [1/]	**1,100**	--	--	--	--	--
PH-MW-02	8/6/1998	N/A	**88**	230	140	550	**2,600**	**23,500**	909	N/A	N/A	N/A	N/A	N/A
PH-MW-02	7/27/2001	N/A	5.0	5.5	5.0 U	117	990 H	**37,000 Y**	**1,200 L**	234	0.10 U	61.5	15.7	N/A
PH-MW-02	6/19/2003	2.0 U	0.96 J	0.87 J	2.0 U	4.06	1,300	**23,000**	**2,100**	64	0.0	45	0.4	N/A
PH-MW-02	7/26/2004	1.0 U	**20.6**	79.2	11.1	150.8	1,230	**24,900 X**	**1,300 X**	260	0.10 U	0	12	2,040 X
PH-MW-02	9/24/2004	1.0 U	**52.4**	159	25.8	268	**1,810**	**38,800**	**3,030**	340	0.10 U	0	16.6	4,590 X
PH-MW-02	7/12/2005	1.0 U	2.55	2.56	1.0 U	23.27	319	**10,600**	**1,190**	91	0.10 U	10	2.45	206
PH-MW-02	9/7/2005	1.0 U	**21.6**	47.6	10	171.6	793	**20,800**	**1,300**	326	0.10 U	0	21.4	651 X
PH-MW-02	7/19/2006	1.0 U	**24.5**	62	12.7	180	988	**16,900**	**1,510**	254	0.10 U	0	23.8	1,690
PH-MW-02	9/12/2006	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PH-MW-02	7/28/2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PH-MW-02	7/26/2008	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PH-MW-02	9/8/2008	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PH-MW-02	9/6/2009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PH-MW-02B	8/29/2010	N/A	**21**	79 D	16	158 D	950 Y	**20,000 J**	**1,700 L**	360	0	20 U	1.2	5,600
PH-MW-02B	8/28/2011	N/A	**20**	39	22	216 D	1,100 H	**20,000 Y**	**1,400 L**	410	0	0.18 J	1.8	5,400
PH-MW-02B	8/23/2012	N/A	**25**	39	13	122 D	560 Y	**19,000 Y**	1,100 L	350	0	0.5 Ui	4.2	3,400

For all notes see the acronyms and abbreviations presented at the end of Appendix A



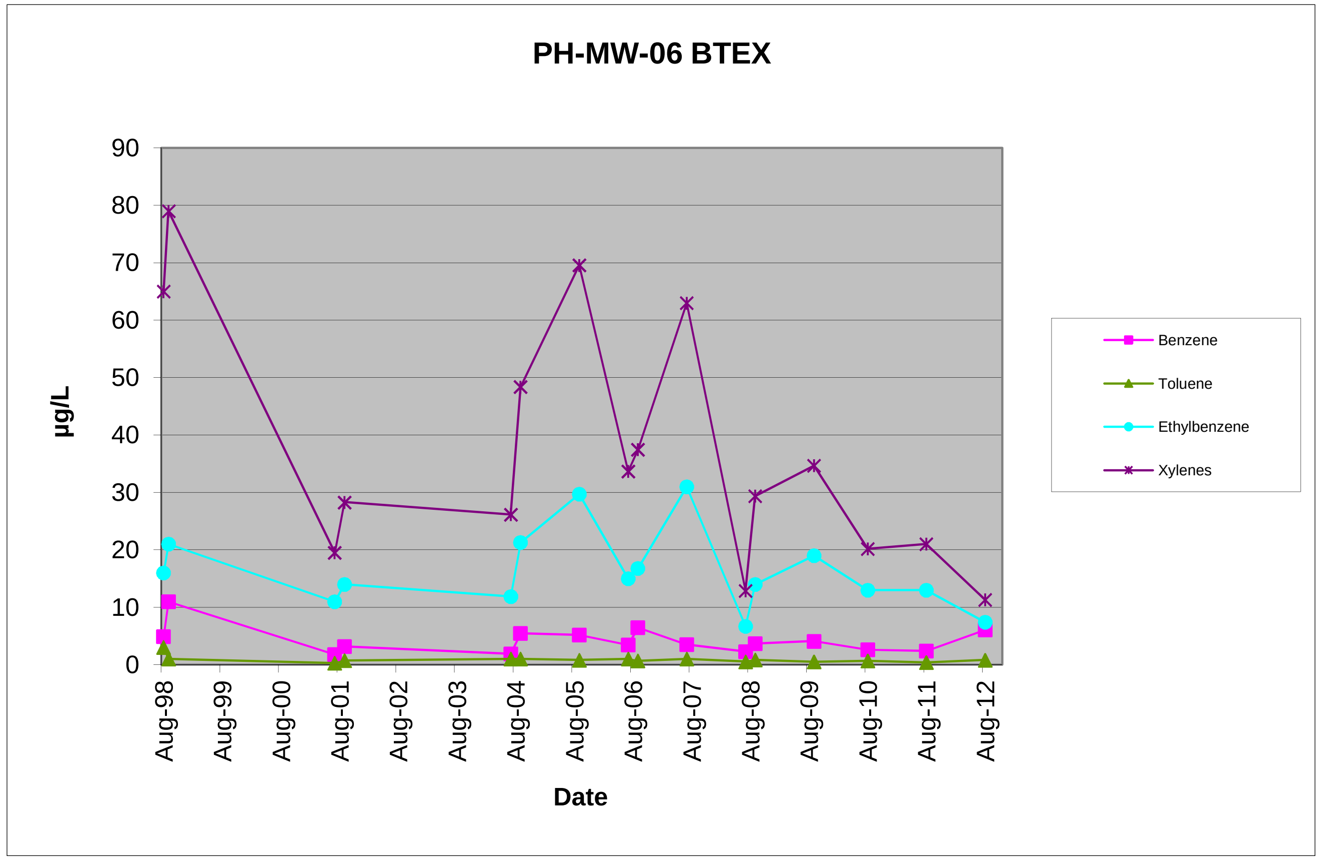


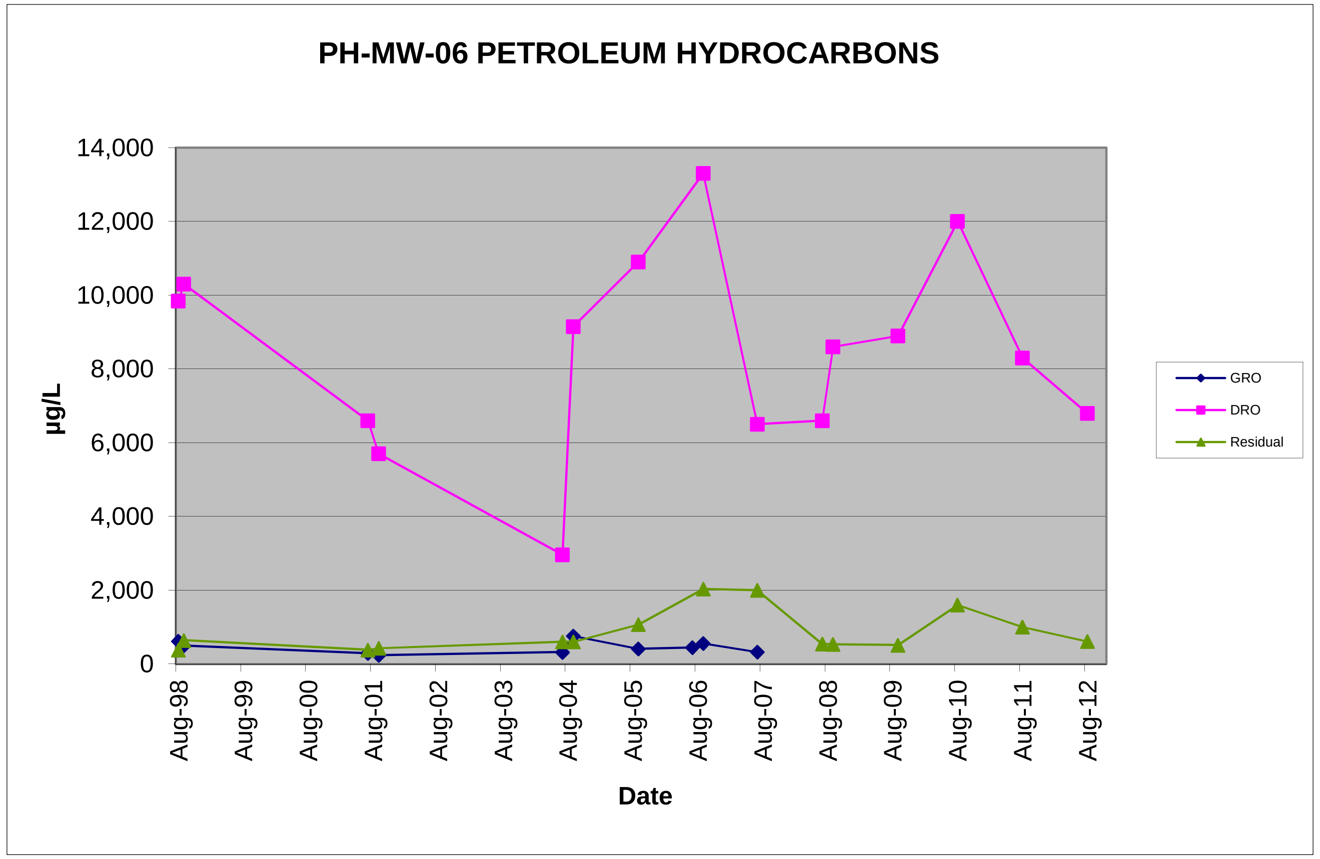
Powerhouse Site

Table A-13. PH-MW-06

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)			Geochemical Parameters				
Well ID	**Collection Date**	**PCE**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**Residual (AK 103)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**1,300**	**1,500** [1/]	**1,100**	--	--	--	--	--
PH-MW-06	8/6/1998	N/A	4.9	3.0	16	65	620	**9,840**	379	N/A	N/A	N/A	N/A	N/A
	9/22/1998	N/A	**11**	1.0	21	79	500	**10,300**	640	N/A	N/A	N/A	N/A	N/A
	7/27/2001	N/A	1.8	0.29 J	11	19.5	290 H	**6,600 Y**	380 L	33	0.50 U	120	71.5	N/A
	9/27/2001	N/A	3.2	0.73 U	14	28.3	240 H	**5,700 Y**	430 L	264	0.20 UJ	7.7	27.3	N/A
	7/26/2004	1.0 U	1.92	1.0 U	11.9	26.13	319	**2,960 X**	600 U	250	0.10 U	1.0	7.3	1,300 X
	9/24/2004	1.0 U	**5.48**	1.0 U	21.3	48.4	760	**9,150**	600 U	261	0.12	3.0	13.1	6,010 X
	9/7/2005	1.0 U	**5.21**	0.81 J	29.7	69.6	412	**10,900**	1,070	254	0.10 U	0	15	2,690 X
	7/19/2006	1.14	3.48	1.0 U	15	33.7	447	#N/A	#N/A	229	0.10 U	0	19.9	5,050
	9/12/2006	0.65 J	**6.45**	0.67 J	16.8	37.5	556	**13,300**	**2,030**	196	0.10 U	0	15.2	6,500
PH-MW-06-1	7/28/2007	1.0 U	3.5	1.0 U	31	63	320	**6,500**	*2,000 U*	300	0.20	6.8	2.0	1,400
PH-MW-06-1	7/27/2008	N/A	2.3	0.53	6.7	12.9	N/A	**6,600 YJ**	540 LJ	200	0.0	56	1.0	1,900 J
PH-MW-06-2	9/8/2008	N/A	3.7	0.85 U	14	29.4	N/A	**8,600 Y**	530 L	240	0.0	72.1	1.4	1,400
PH-MW-06	9/8/2009	N/A	4.1	0.50 U	19	34.7	N/A	**8,900 Y**	510 L	280	2.8	32.6	2.8	1,600
PH-MW-06	8/29/2010	N/A	2.6	0.69	13	20.2	N/A	**12,000 J**	**1,600 L**	280	0	10.8	1	1,000
PH-MW-06	8/25/2011	N/A	2.4	0.41 J	13	21.0	N/A	**8,300 Y**	1,000 L	280	0	30.4	1.0	1,000
PH-MW-06	8/23/2012	N/A	**6.1**	0.81 UJ	7.4	11.3	N/A	**6,800 Y**	610 L	240	0	52.2	3.7	760

For all notes see the acronyms and abbreviations presented at the end of Appendix A



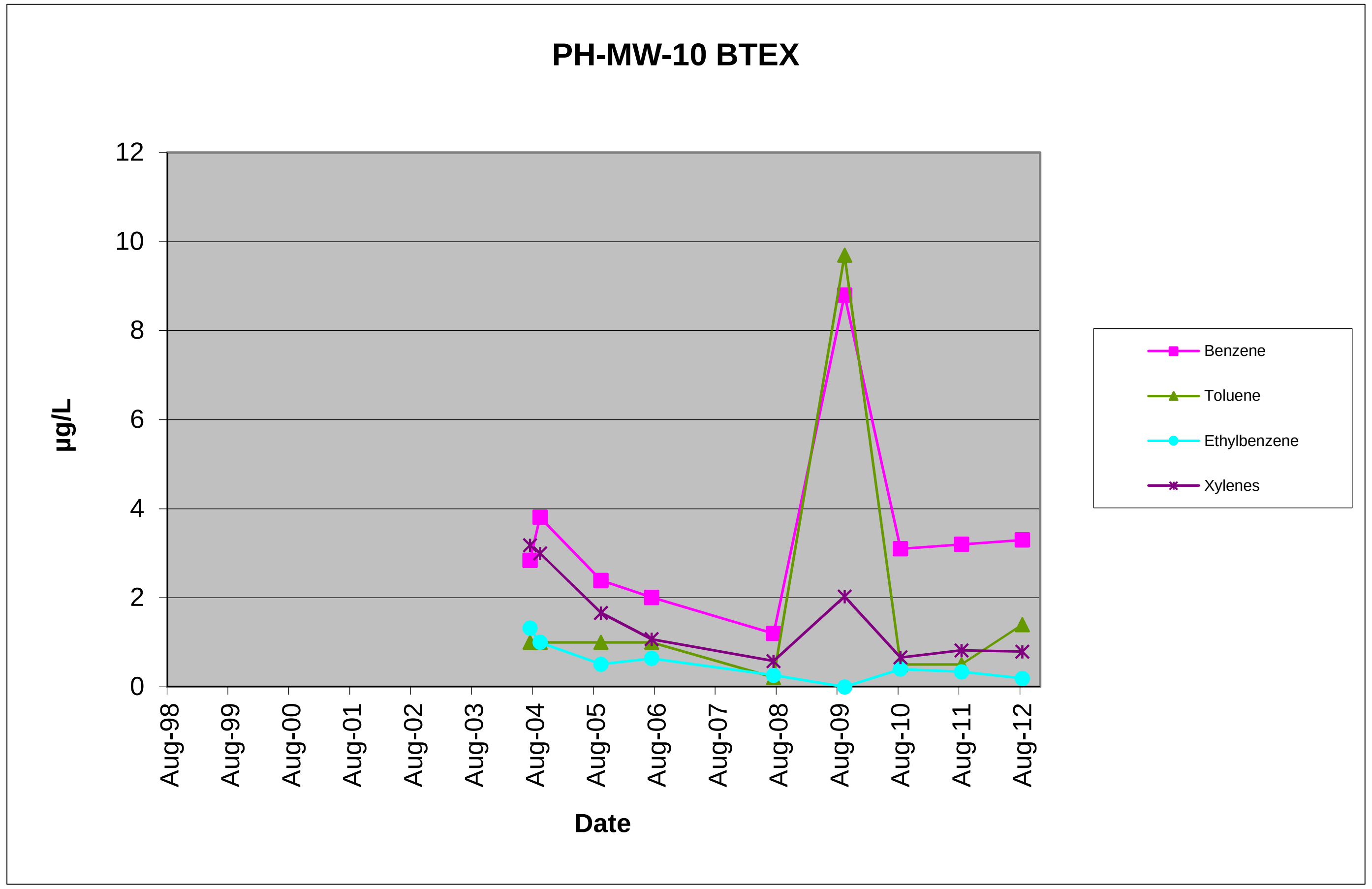


Powerhouse Site

Table A-14. PH-MW-10

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)			Geochemical Parameters				
Well ID	**Collection Date**	**PCE**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**1,300**	**8,200** [1/]	**1,100**	--	--	--	--	--
PH-MW-10	7/26/2004	1.0 U	2.84	1.0 U	1.32	3.18	80 U	2,380 X	**1,350**	219	0.1 U	8.0	2.0	450
	9/24/2004	1.0 U	3.81	1.0 U	1.0	3.0 U	80 U	2,400	600 U	405	2.19	0	0.040	2,360
	9/7/2005	1.0 U	2.39	1.0 U	0.51 J	1.66	80 U	1,900	666	263	0.15	5.0	0.80	809
	7/19/2006	1.0 U	2.01	1.0 U	0.64 J	1.07 J	65.8 J	2,180	**1,280**	170	0.0435 J	0	0.12	1,260
	9/12/2006	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7/28/2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PH-MW-10-1	7/27/2008	N/A	1.2	0.21 J	0.26 J	0.58 J	15 J	2,400 YJ	720 LJ	240	0	38.9	0.60	570 J
PH-MW-10-2	9/9/2008	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PH-MW-10B	9/9/2009	N/A	**8.8**	9.7	0.76	2.03 J	130 Z	1,600 Y	460 J	260	0	18.7	2.8	1,800
PH-MW-10B	8/29/2010	N/A	3.1	0.5 U	0.4 J	0.66 J	61 J	3,300 Y	760 L	320	0	11.5	0.6	1,800
PH-MW-10B	8/26/2011	N/A	3.2	0.5 U	0.34 J	0.55 J	35 J	5,100 Y	**1,300 L**	400	0	14.9	2.0	2,200
PH-MW-10B (DUP)	8/26/2011	N/A	2.5	0.50 U	0.23 J	0.82 J	28 J	5,200 Y	**1,300 L**	400	0	15.0	2.2	2,000
PH-MW-10B	8/23/2012	N/A	3.3	1.4 UJ	0.19 J	0.79 J	19 J	2,800 Y	770 L	380	0	15.6	2.4	2,200

For all notes see the acronyms and abbreviations presented at the end of Appendix A



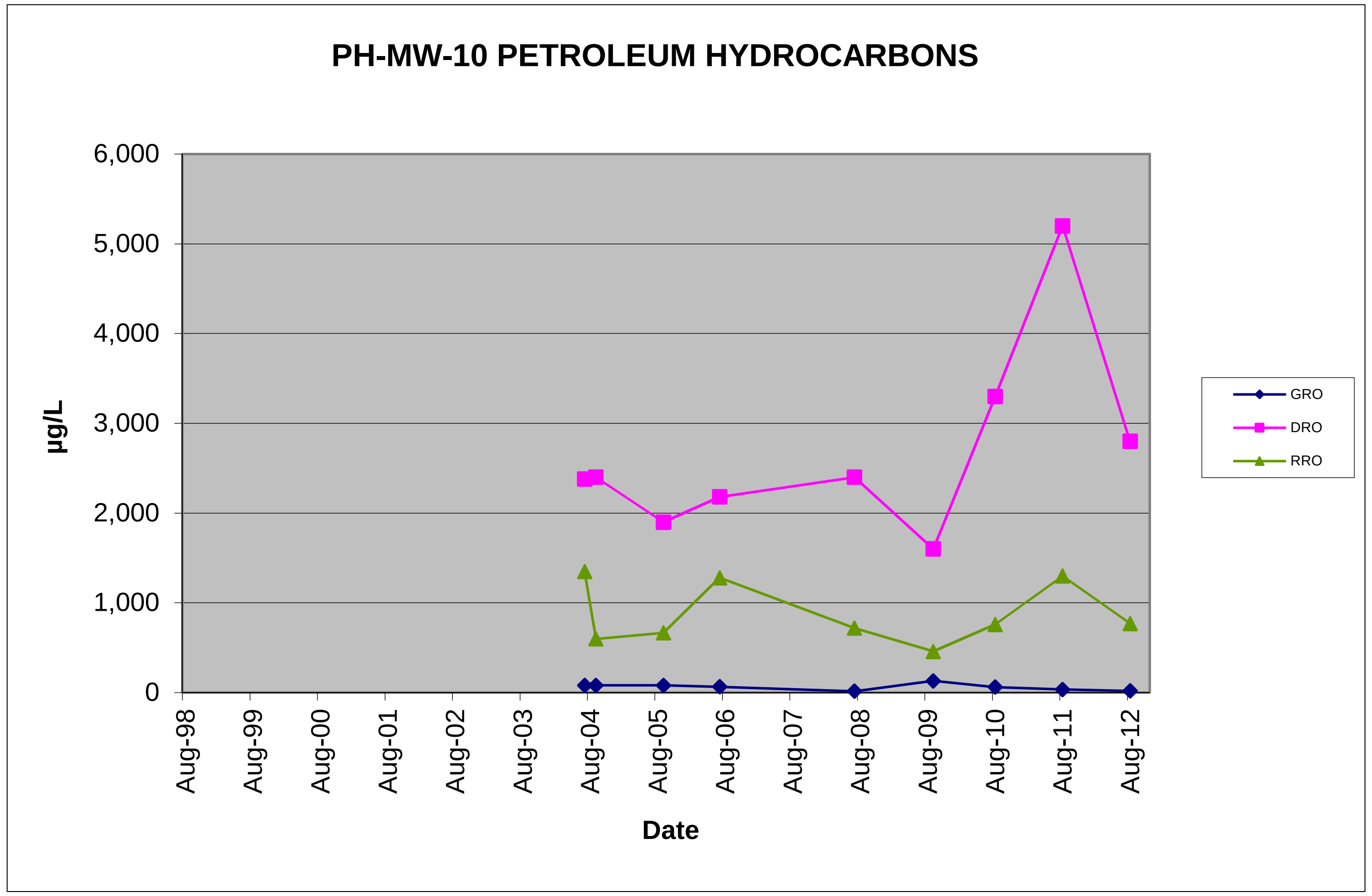


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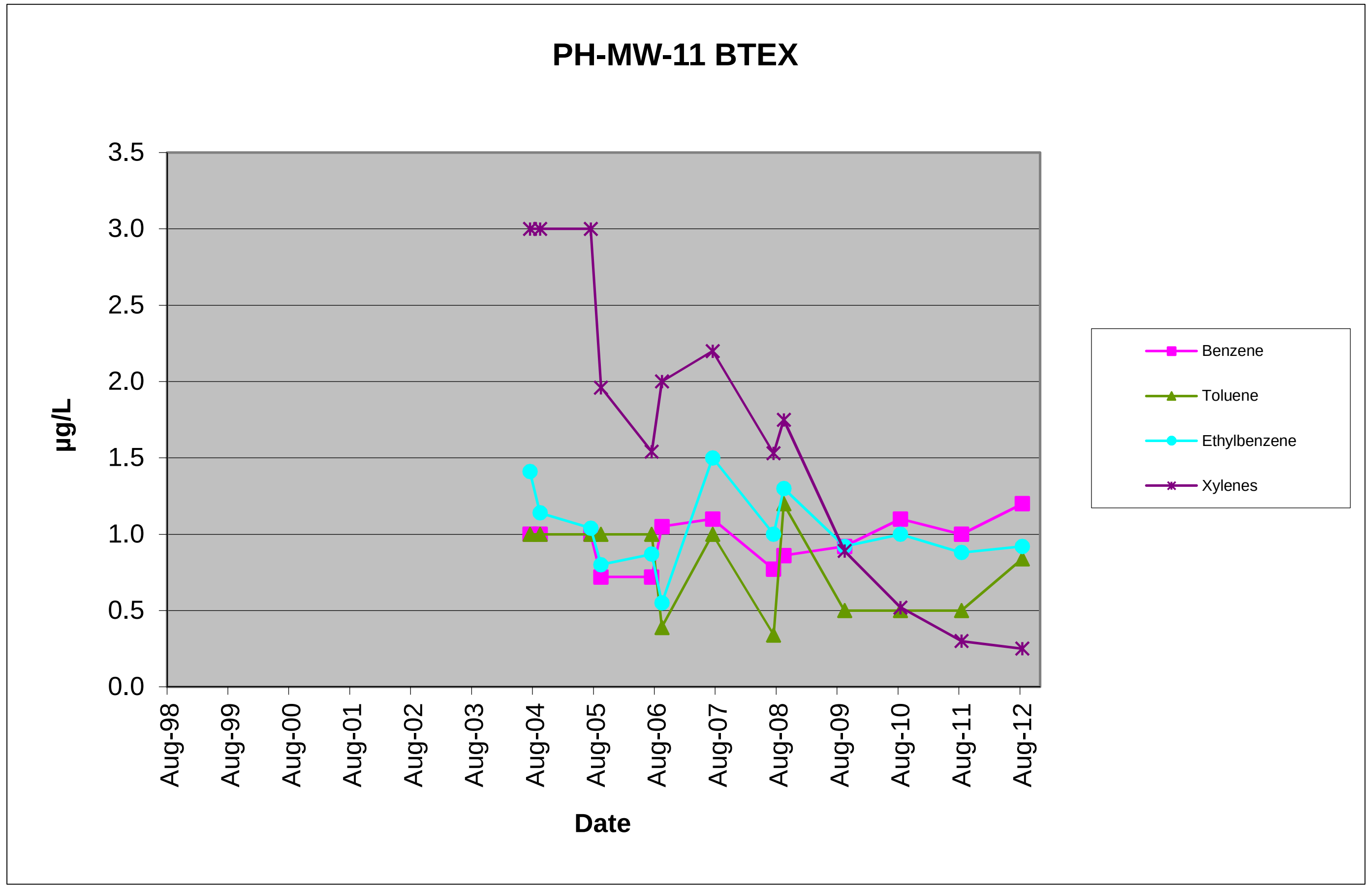
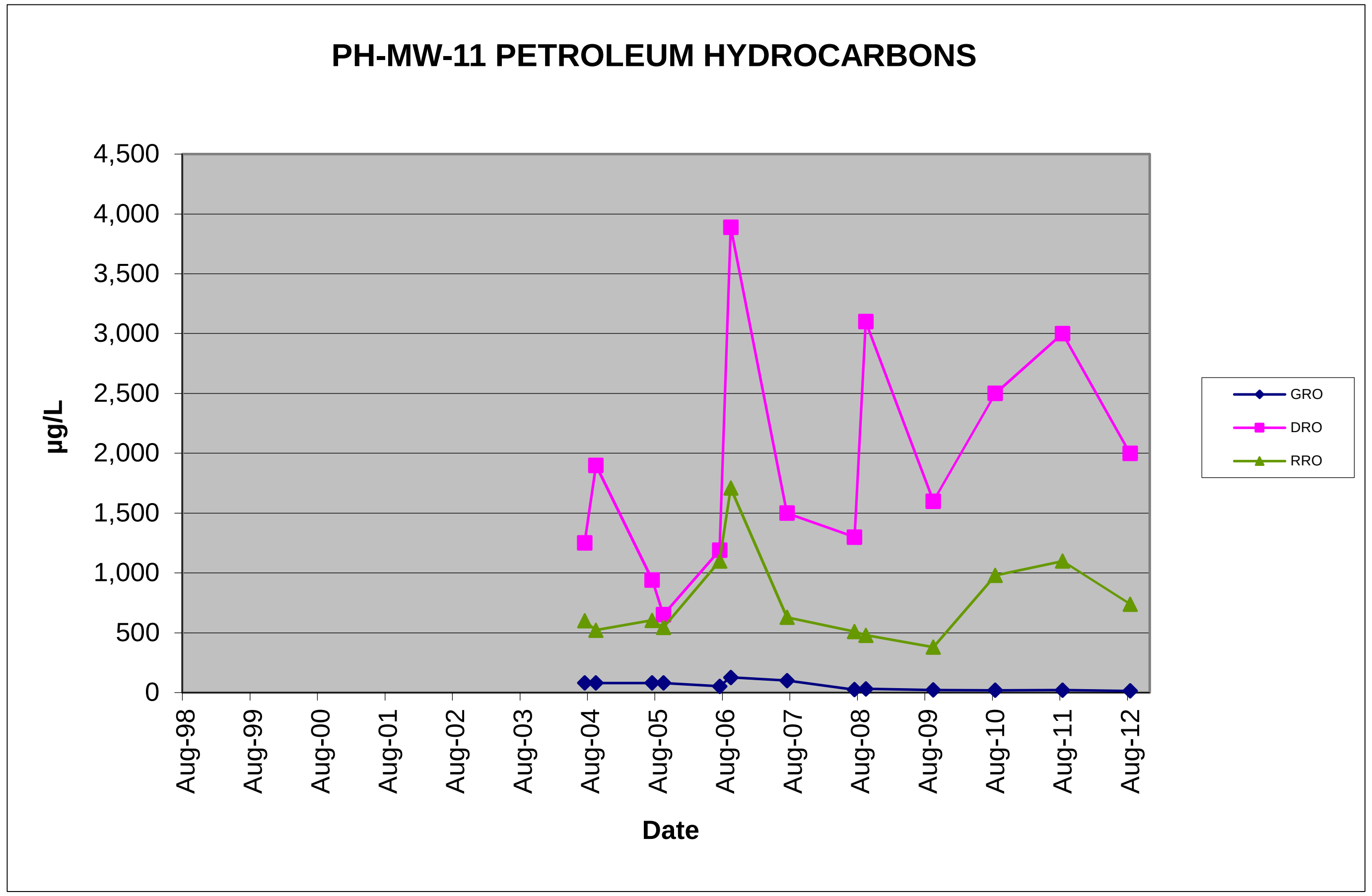
Table A-15. PH-MW-11

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)			Geochemical Parameters				
Well ID	**Collection Date**	**PCE**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**1,300**	**8,200**[1/]	**1,100**	--	--	--	--	--
PH-MW-11	7/26/2004	1.0 U	1.0 U	1.0 U	1.41	3.0 U	80 U	1,250 X	600 U	212	0.10 U	0	1.18	2,020 X
PH-MW-11	9/24/2004	1.0 U	1.0 U	1.0 U	1.14	3.0 U	80 U	1,900	522 U	303	0.33	0	11.4	6,550 X
PH-MW-11	7/12/2005	1.0 U	1.0 U	1.0 U	1.04	3.0 U	80 U	942	605	142	0.10 U	0	3.23	4,650 X
PH-MW-11	9/7/2005	1.0 U	0.72 J	1.0 U	0.80 J	1.96	80 U	651	545 U	356	0.40 J	0	9.0	1,800 X
PH-MW-11	7/19/2006	1.0 U	0.72	1.0 U	0.87 J	1.54 J	53.1 J	1,190	1,100	200	0.10 U	2	1.98	1,840
PH-MW-11	9/12/2006	1.0 U	1.05	0.39 J	0.55 J	2.0 U	127 J	3,890	**1,710**	218	0.10 U	0	3.21	8,900
PH-MW-11	7/28/2007	1.0 U	1.1	1.0 U	1.5	2.2	100 U	1,500	630	300	0.20	21	2.0	1,500
PH-MW-11	7/27/2008	N/A	0.77 J	0.34 J	1.0 J	1.53 J	25 J	1,300 YJ	510 LJ	260	0	53	2.0	4,300 J
PH-MW-11	9/8/2008	N/A	0.86	1.2 U	1.3	1.75 J	31 J	3,100 Y	480 L	300	0	58.1	2.0	7,800
PH-MW-11	9/6/2009	N/A	0.92	0.50 U	0.92	0.89 J	22 J	1,600 Y	380 J	320	0	55.3	2.6	3,000
PH-MW-11	8/29/2010	N/A	1.1	0.50 U	1	0.52 J	19 J	2,500 Y	980 L	320	0	80.8	1.0	3,900
PH-MW-11	8/26/2011	N/A	1.0	0.50 U	0.88	0.30 J	21 J	3,000 Y	1,100 L	400	0	78.5	1.9	2,100
PH-MW-11	8/23/2012	N/A	1.2	0.84 UJ	0.92	0.25 J	14 J	2,000 Y	740 L	380	0	50.6	3.0	2,600

For all notes see the acronyms and abbreviations presented at the end of Appendix A



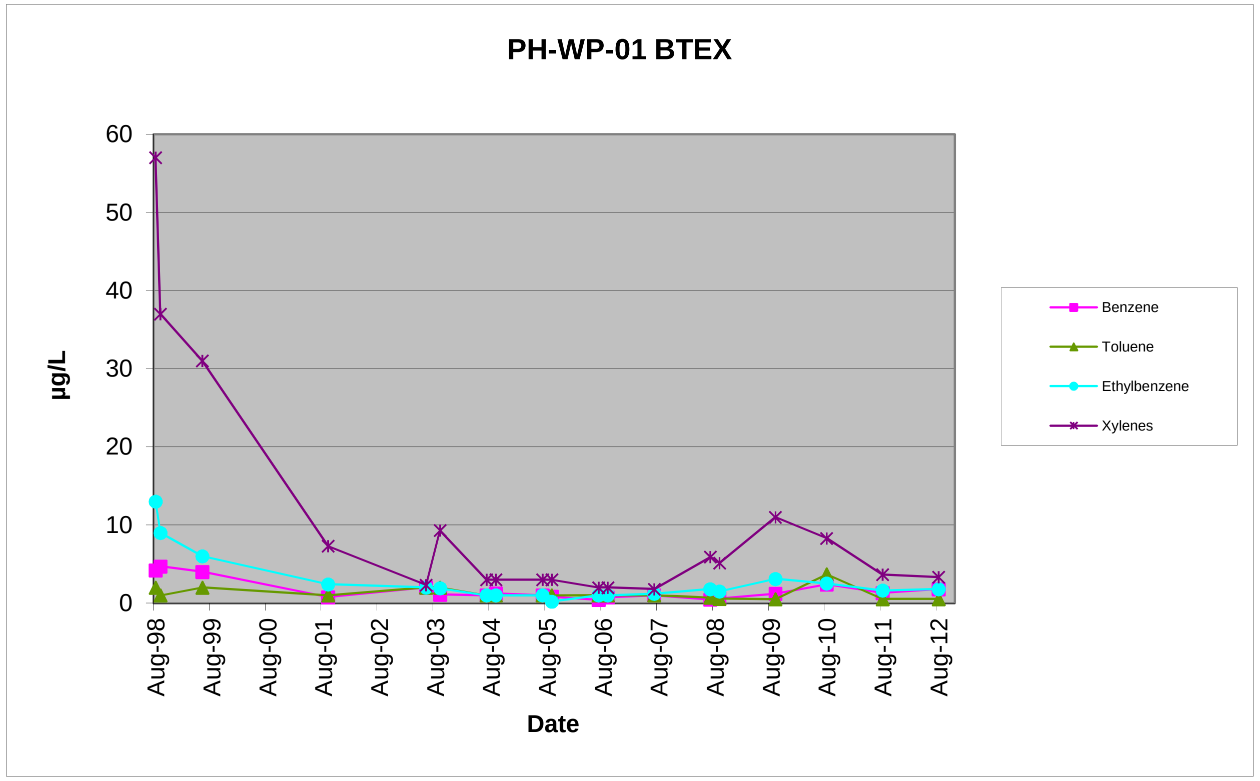


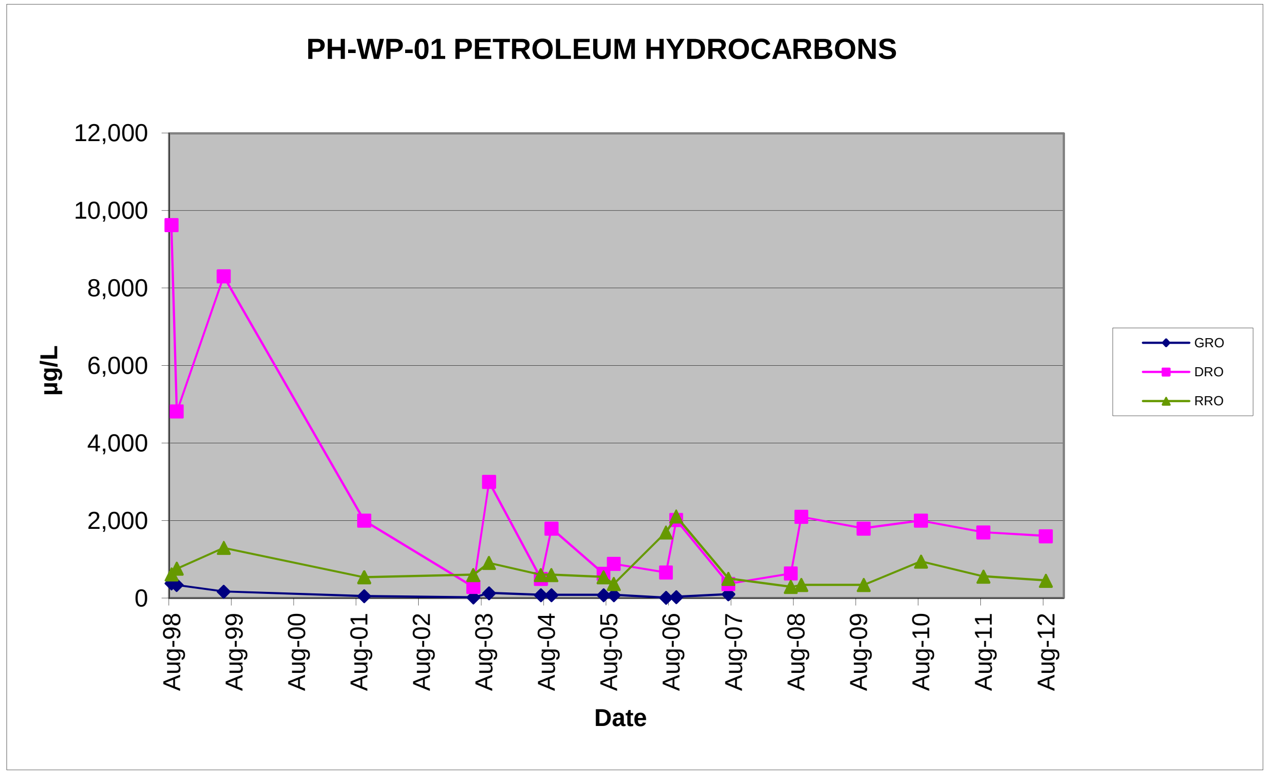
Powerhouse Site

Table A-16. PH-WP-01

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)			Geochemical Parameters				
Well ID	**Collection Date**	**PCE**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**1,300**	**1,500 1/**	**1,100**	--	--	--	--	--
PH-WP-01	8/6/1998	N/A	4.2	2	13	57	380	**9,630**	619	N/A	N/A	N/A	N/A	N/A
PH-WP-01	9/22/1998	N/A	4.7	1	9	37	340	**4,820**	760	N/A	N/A	N/A	N/A	N/A
PH-WP-01	6/30/1999	N/A	4	2	6	31	170	**8,310**	**1,300**	N/A	N/A	N/A	N/A	N/A
PH-WP-01	9/27/2001	N/A	0.78	1 U	2.4	7.3	53 H	**2,000 Y**	540 L	126	1.3 J	2.8	8.03	N/A
PH-WP-01	6/17/2003	2 U	2 U	2 U	2 U	2.32	18 J	290	600	54	0.09	0.0	0.020	N/A
PH-WP-01	9/3/2003	N/A	1.1 J	2 U	1.9 J	9.3	130	**3,000**	910	138	0.0	1.0	2.56	N/A
PH-WP-01	7/26/2004	1 U	1 U	1 U	1 U	3.0 U	80 U	500 U	600 U	212	0.13	1.0	0	11.6
PH-WP-01	9/24/2004	1 U	1.24	1 U	1 U	3.0 U	80 U	**1,800**	600 U	134	1.13	1.0	2.08	657
PH-WP-01	7/11/2005	1 U	1 U	1 U	1 U	3.0 U	80 U	635	545 U	25	0.10 U	0.0	0.080	6.72
PH-WP-01	9/7/2005	1 U	0.83 J	1 U	0.20 J	3.0 U	80 U	884	366 J	142	0.42	0.0	3.02	489
PH-WP-01	7/19/2006	1 U	0.40 U	1 U	1 U	2.0 U	11.65 J	664	**1,700**	113	0.101	1.0	0.050	38.4
PH-WP-01	9/12/2006	1 U	0.73	1 U	1 U	2.0 U	31.8 J	**2,020**	**2,110**	108	0.673	0.0	2.28	800
PH-WP-01	7/28/2007	1 U	1 U	1 U	1.2	1.8	100 U	370	500 U	100	0.0	2.3	2.0	38 J
PH-WP-01B	7/28/2008	N/A	0.45 J	0.71	1.8	5.91	N/A	640 J	290 J	N/A	N/A	3.8	N/A	350
PH-WP-01B	9/8/2008	N/A	0.63	0.57	1.5	5.16	N/A	**2,100 Y**	340 J	180	0.0	0.60	1.4	2,100
PH-WP-01B	9/8/2009	0.5 U	1.2	0.50 U	3.1	11	N/A	**1,800 Y**	340 J	220	0.0	13.1	2.0	1,000
PH-WP-01C	8/31/2010	N/A	2.4	3.70	2.5	8.3	N/A	**2,000 Y**	950 L	220	0.0	22.8	1.0	560
PH-WP-01C	8/25/2011	N/A	1.3	0.52	1.6	3.66 J	N/A	**1,700 Y**	560 L	240	0	19.5	1.6	2,000
PH-WP-01C	8/22/2012	N/A	1.8	0.53 UJ	1.8	3.32 J	N/A	**1,600 Y**	450 L	240	0	21.5	2.4	1,800

For all notes see the acronyms and abbreviations presented at the end of Appendix A



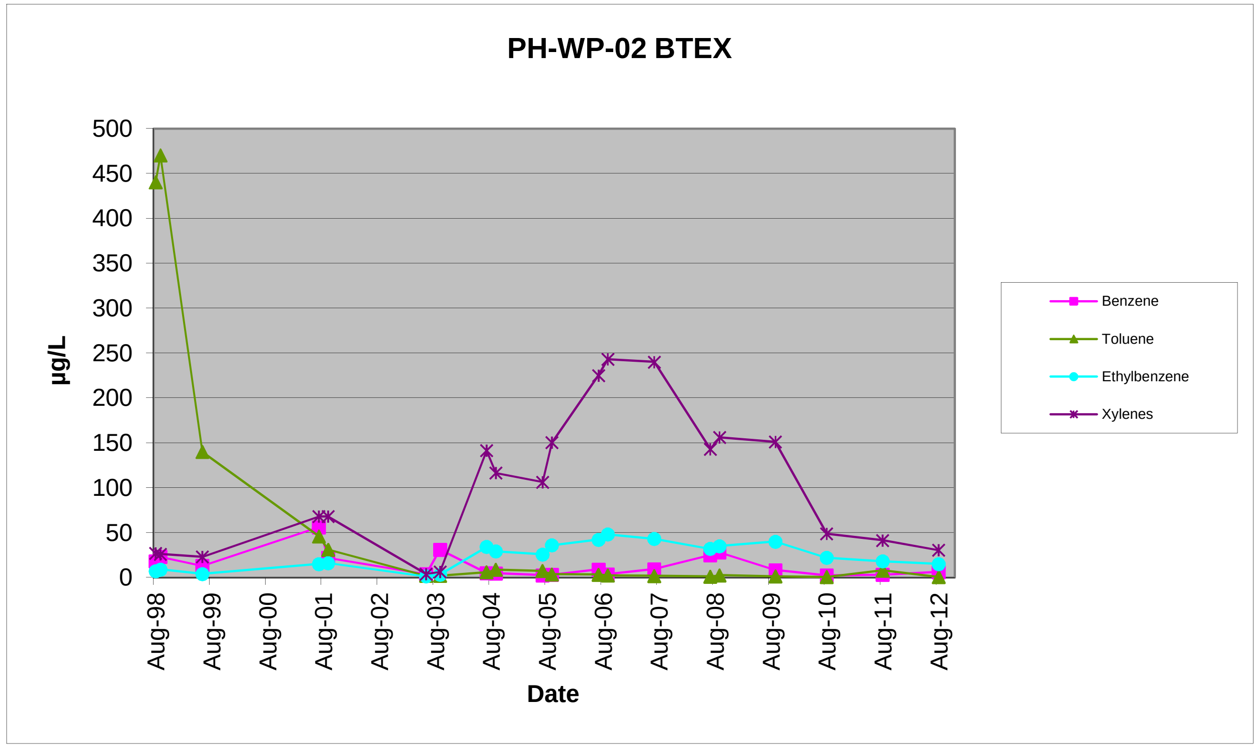


Powerhouse Site

Table A-17. PH-WP-02

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)			Geochemical Parameters				
Well ID	**Collection Date**	**PCE**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**1,300**	**1,500** [1/]	**1,100**	--	--	--	--	--
PH-WP-02	8/6/1998	N/A	**18**	440	7.0	27	**1,800**	**16,700**	490	N/A	N/A	N/A	N/A	N/A
PH-WP-02	9/22/1998	N/A	**23**	470	9.0	26	**1,900**	**19,000**	840	N/A	N/A	N/A	N/A	N/A
PH-WP-02	6/30/1999	N/A	**13**	140	4.0	23	540	**5,710**	1,000	N/A	N/A	N/A	N/A	N/A
PH-WP-02	7/27/2001	N/A	**56**	46	15	68	1,300 H	**5,400 Y**	250 L	78	6.6	6.6	24.3	N/A
PH-WP-02	9/27/2001	N/A	**22**	31	16	68	810	**5,900 Y**	350 L	102	0.50 UJ	0.20	29.2	N/A
PH-WP-02	6/17/2003	2.0 U	3.7	2.0 U	1.3 J	3.9	120	690	650	30	0.0	0.0	2.24	N/A
PH-WP-02	9/3/2003	N/A	**31**	2.0 U	3.2	6.2	350	**3,200**	750	136	0.0	0.0	1.78	N/A
PH-WP-02	7/26/2004	1.0 U	**5.08**	5.88	34	141.4	1,050	**5,650 X D-1**	600 U	132	0.10 U	0.0	3.6	562
PH-WP-02	9/24/2004	1.0 U	4.68	8.77	29.1	116.5	1,030	**6,450**	600 U	171	0.10 U	0.0	1.0	1,150
PH-WP-02	7/11/2005	1.0 U	2.45	7.38	25.6	106.3	856	**6,080**	886	54	0.10 U	0.0	4.3	714
PH-WP-02	9/7/2005	1.0 U	3.01	3.63	35.9	150.4	491	**4,640**	275 U	143	0.10 U	0.0	8.1	1,470
PH-WP-02	7/19/2006	1.0 U	**8.95**	3.19	42	225	1,030	**3,470**	**2,070**	88	0.10 U	0.0	0.70	430
PH-WP-02	9/12/2006	1.0 U	3.53	2.27	48	243	897	**5,410**	**1,260**	132	0.10 U	0.0	6.8	2,200
PH-WP-02	7/28/2007	1.0 U	**9.3**	1.9	43	240	910	**4,500**	500 U	140	0.20	1.0 U	1.4	450 J
PH-WP-02	7/27/2008	N/A	**25 J**	1.0 J	32 J	143 J	950 YJ	**11,000 YJ**	620 LJ	160	0.0	5.7	2.4	850 J
PH-WP-02	9/8/2008	N/A	**28 D**	2.5 U	35 D	156 D	1,100 Y	**9,900 Y**	510 L	220	0.0	0.20 U	1.6	1,900
PH-WP-02	9/7/2009	N/A	**8.3**	1.2	40	151 D	1,000 Y	**11,000 Y**	430 J	220	0.0	21.6	1.8	470
PH-WP-02	8/30/2010	N/A	2.3	0.5 U	22	48.7	680 Y	**10,000 Y**	1,100 L	220	0.0	16.2	1	540
PH-WP-02	8/25/2011	N/A	3.1	7.80	18	41.3	870 Y	**14,000 Y**	1,100 L	240	0	27.5	1.6	390
PH-WP-02	8/22/2012	N/A	**6.1**	0.50 U	15	30.53	720 Y	**10,000 Y**	670 L	260	0	33.1	4.0	420

For all notes see the acronyms and abbreviations presented at the end of Appendix A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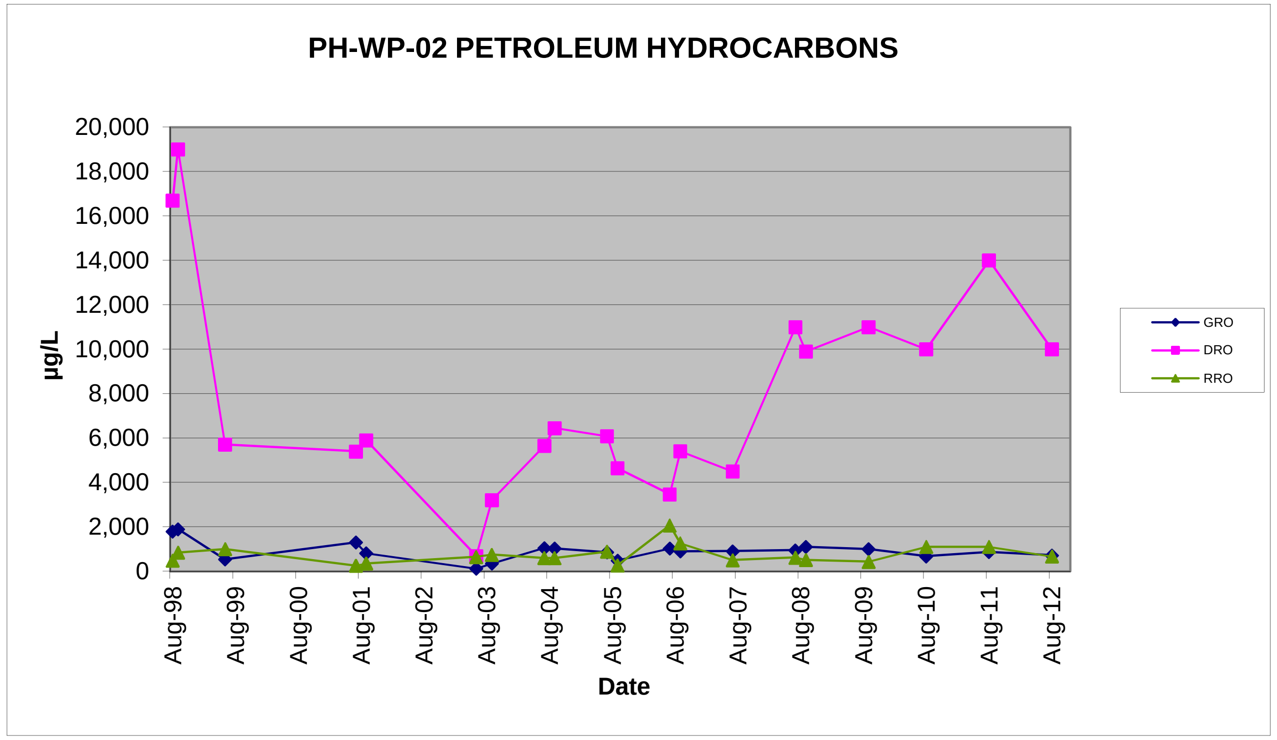
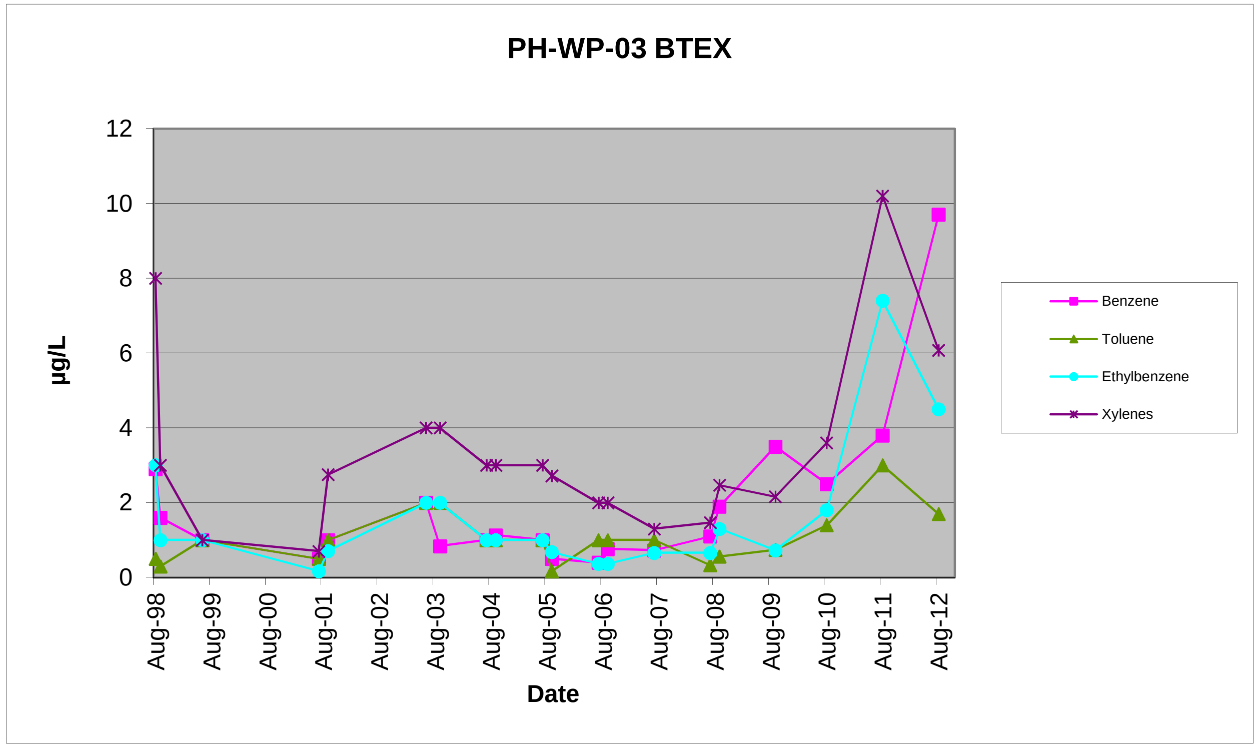

PH-WP-02 PETROLEUM HYDROCARBONS

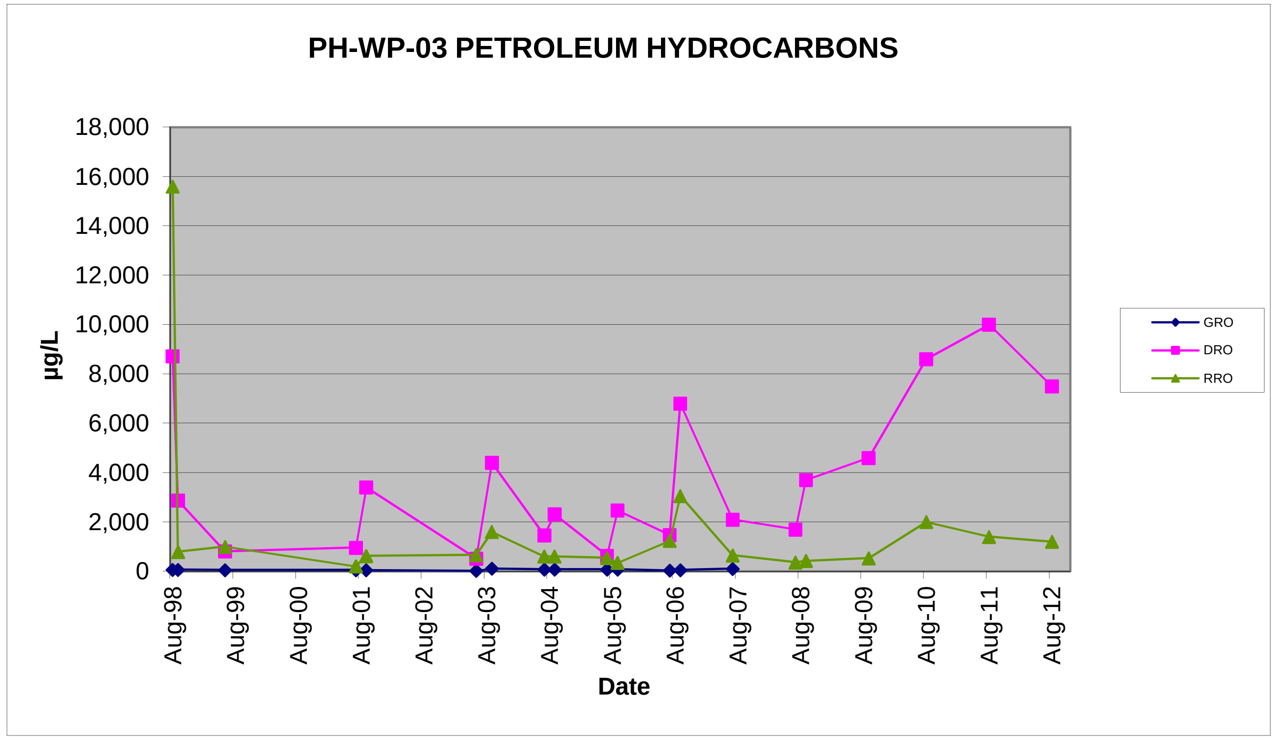
Powerhouse Site

Table A-18. PH-WP-03

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)			Geochemical Parameters				
Well ID	**Collection Date**	**PCE**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**1,300**	**1,500** 1/	**1,100**	--	--	--	--	--
PH-WP-03	8/6/1998	N/A	2.9	0.50 J	3.0	8.0	64	**8,710**	**15,600**	N/A	N/A	N/A	N/A	N/A
	9/22/1998	N/A	1.6	0.30 J	1.0	3.0	63	**2,870**	790	N/A	N/A	N/A	N/A	N/A
	6/30/1999	N/A	1.0 U	1 U	1.0 U	1.0 U	50 U	810	1,000 U	N/A	N/A	N/A	N/A	N/A
	7/27/2001	N/A	0.50 U	0.5 U	0.17 U	0.70	50 U	960 Y	200 UL	86	0.20 UJ	13.8	7.06	N/A
	9/27/2001	N/A	1.0	1 U	0.71	2.75	45 J	**3,400 Y**	620 L	164	0.050 UJ	34.6	9.84	N/A
	6/17/2003	1.2 J	2.0 U	2 U	2.0 U	4.0	21 J	520	660	53	0.080	0	0.43	N/A
	9/3/2003	N/A	0.84 J	2 U	2.0 U	4.0	110	**4,400**	**1,600**	144	0	64	1.96	N/A
	7/26/2004	1.0 U	1.0 U	1 U	1.0 U	3.0 U	80 U	1,460 X	600 U	119	0.10 U	2.0	3.0	39.5
	9/24/2004	1.0 U	1.13	1 U	1.0 U	3.0 U	80 U	**2,310**	600 U	198	0.10 U	21	2.7	71
	7/11/2005	1.0 U	1 U	1 U	1.0 U	3.0 U	80 U	635	545 U	51	0.10 U	0	0.79	13.6
	9/7/2005	1.0 U	0.50 J	0.17 J	0.68 J	2.72 J	80 U	**2,470**	344 J	172	0.10 U	8.0	5.05	62
	7/19/2006	1.0 U	0.40	1 U	0.37 J	2.0 U	32.3 J	1,480	**1,240**	129	0.092 J	11	2.37	54.9
	9/12/2006	1.0 U	0.76	1 U	0.37 J	2.0 U	53 J	**6,800**	**3,060**	150	0.041 J	7.0	4.65	70
PH-WP-03-1	7/28/2007	1.0 U	0.73 J	1 U	0.66 J	1.3	100 U	**2,100**	650	160	0.40	8.0	1.6	61 J
PH-WP-03-1	7/27/2008	N/A	1.1 J	0.33 J	0.66 J	1.47 J	N/A	**1,700 YJ**	360 J	160	0.0	5.9	1.8	87 J
PH-WP-03-2	9/8/2008	N/A	1.9	0.56 U	1.3	2.47 J	N/A	**3,700 Y**	420 J	200	0.0	30.8	3.0	99
PH-WP-03	9/7/2009	N/A	3.5	0.74	0.73	2.16	N/A	**4,600 Y**	530 L	180	0.0	51.1	1.4	7.0
PH-WP-03	8/31/2010	N/A	2.5	1.4	1.8	3.6	N/A	**8,600 Y**	**2000 L**	220	0.0	53.3	1	8.1
PH-WP-03B	8/25/2011	N/A	3.8	3.0	7.4	10.2	N/A	**10,000 Y**	**1,400 L**	280	0	57.7	2.1	19
PH-WP-03B	8/22/2012	N/A	**9.7**	1.7	4.5	6.07	N/A	**7,500 Y**	**1,200 L**	280	0	58.9	3.4	17

For all notes see the acronyms and abbreviations presented at the end of Appendix A



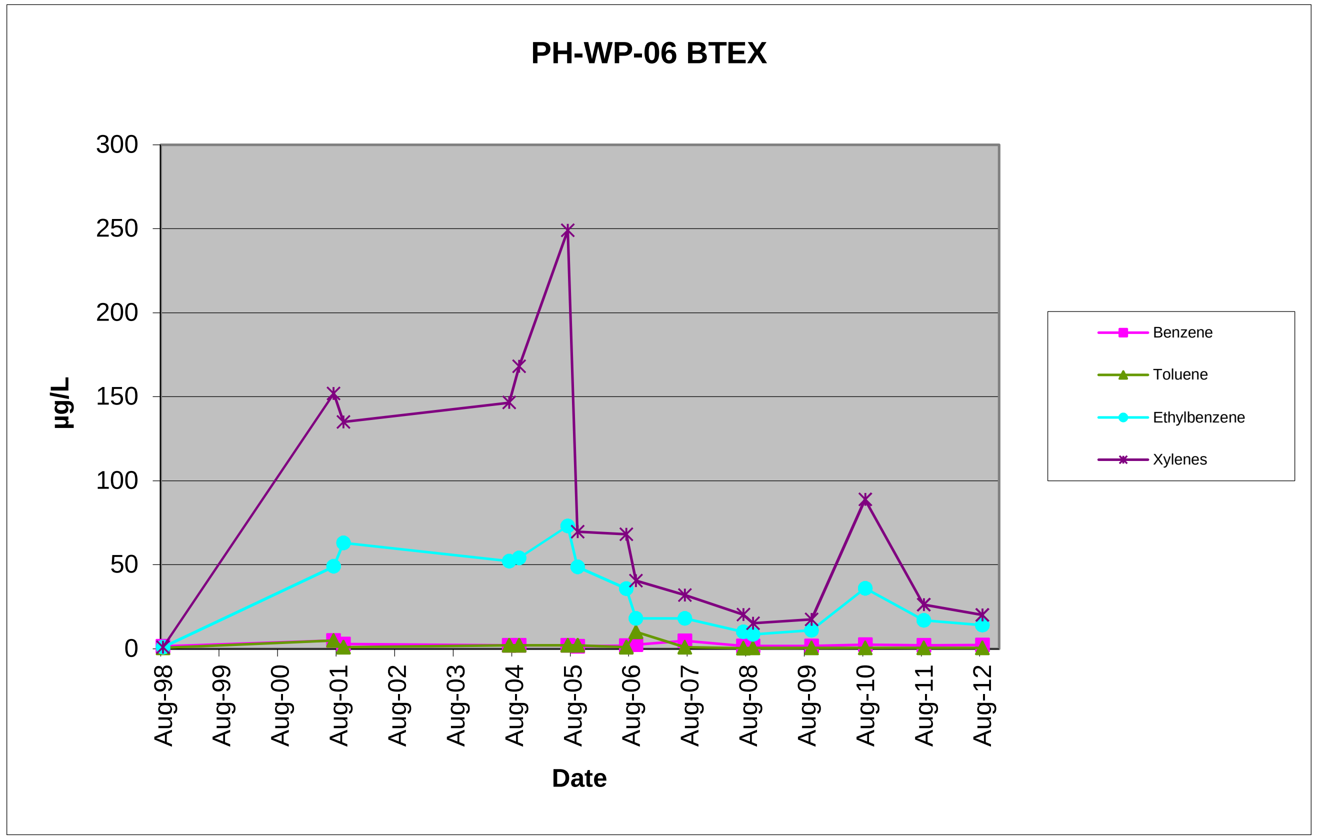


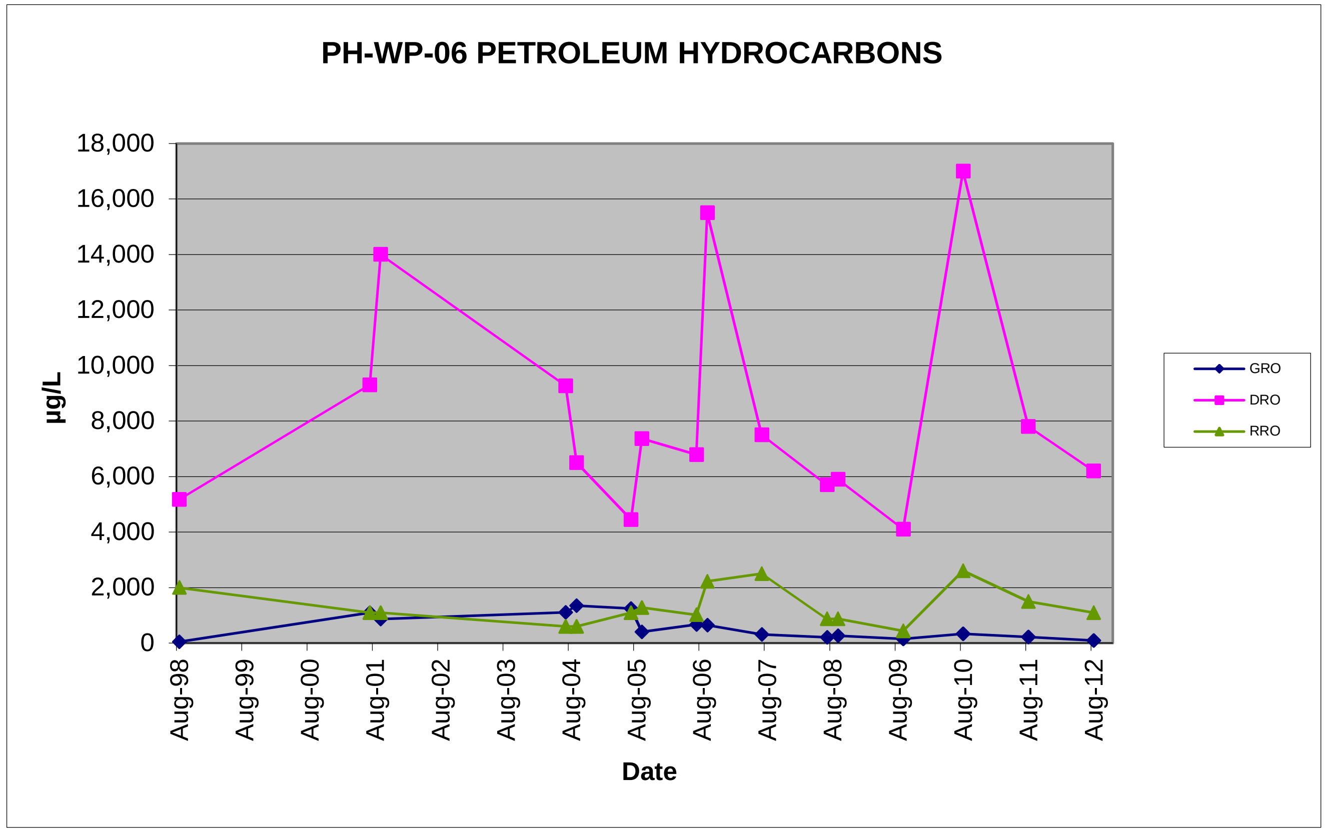
Powerhouse Site

Table A-19. PH-WP-06

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)			Geochemical Parameters				
Well ID	**Collection Date**	**PCE**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**1,300**	**8,200** [1/]	**1,100**	--	--	--	--	--
PH-WP-06	8/6/1998	N/A	1.5 U	0.50 J	1.0 U	1.0 U	50 U	5,180	**2,000**	N/A	N/A	N/A	N/A	N/A
PH-WP-06	7/27/2001	N/A	5.0 U	5.0 U	49	152	1,100 H	**9,300 Y**	1,100 L	174	0.20	50.1	46.8	N/A
PH-WP-06	9/27/2001	N/A	2.9	1.0 U	63	135	860 H	**14,000 Y**	1,100 L	308	0.10 UJ	33.5	64	N/A
PH-WP-06	7/26/2004	2.0 U	2.1	2.0 U	52.1	146.5	1,110	**9,270 X**	600 U	278	0.10 U	0	12.8	2,660 X
PH-WP-06	9/24/2004	2.0 U	2.0 U	2.0 U	54	168	**1,350**	6,500	600 U	365	0.10 U	0	20.7	4,170 X
PH-WP-06	7/12/2005	2.0 U	2.0 U	2.0 U	73.1	249	1,240	4,450	1,090	138	0.10 U	4.0	5.0	2,880 X
PH-WP-06	9/7/2005	2.0 U	1.4 J	2.0 U	48.7	69.6	404	7,370	**1,280**	276	0.10 U	0	15.1	1,440 X
PH-WP-06	7/19/2006	1.0 U	1.85	1.0 U	35.8	68.2	674	6,790	1,020	273	0.10 U	0	19.5	4,280
PH-WP-06	9/12/2006	*10 U*	2.4 J	10 U	18.1	40.6	647	**15,500**	**2,220**	251	0.10 U	0	23.2	7,000
PH-WP-06	7/28/2007	1.0 U	4.7	1.0 U	18	32	310	7,500	*2,500 U*	320	0.40	4.4	2.4	1,400
PH-WP-06	7/27/2008	N/A	1.7 J	0.36 J	10 J	20.3 J	210 YJ	5,700 YJ	870 LJ	260	0.0	30	1.6	2,400 J
PH-WP-06	9/8/2008	N/A	1.7	0.50 U	8.5	15.2	270 Y	5,900 Y	880 L	260	0.0	27.9	2.2	4,300
PH-WP-06	9/6/2009	N/A	1.7	0.50 U	11	17.43 J	150 H	4,100 Y	440 J	320	0.0	38.1	1.6	1,400
PH-WP-06	8/30/2010	N/A	2.4 J	0.50 U	36 J	88.82 J	330 Y	**17,000 Y**	**2,600 J**	350	0.0	15.8	1.2	2,400
PH-WP-06	8/26/2011	N/A	2.0	0.50 U	17	26.21 J	220 H	7,800 Y	**1,500 L**	360	0	21.0	2.2	1,800
PH-WP-06	8/24/2012	N/A	2.3	0.5 U	14	20.12 J	94 J	6,200 Y	1,100 L	400	0	23	3.7	1,800

For all notes see the acronyms and abbreviations presented at the end of Appendix A



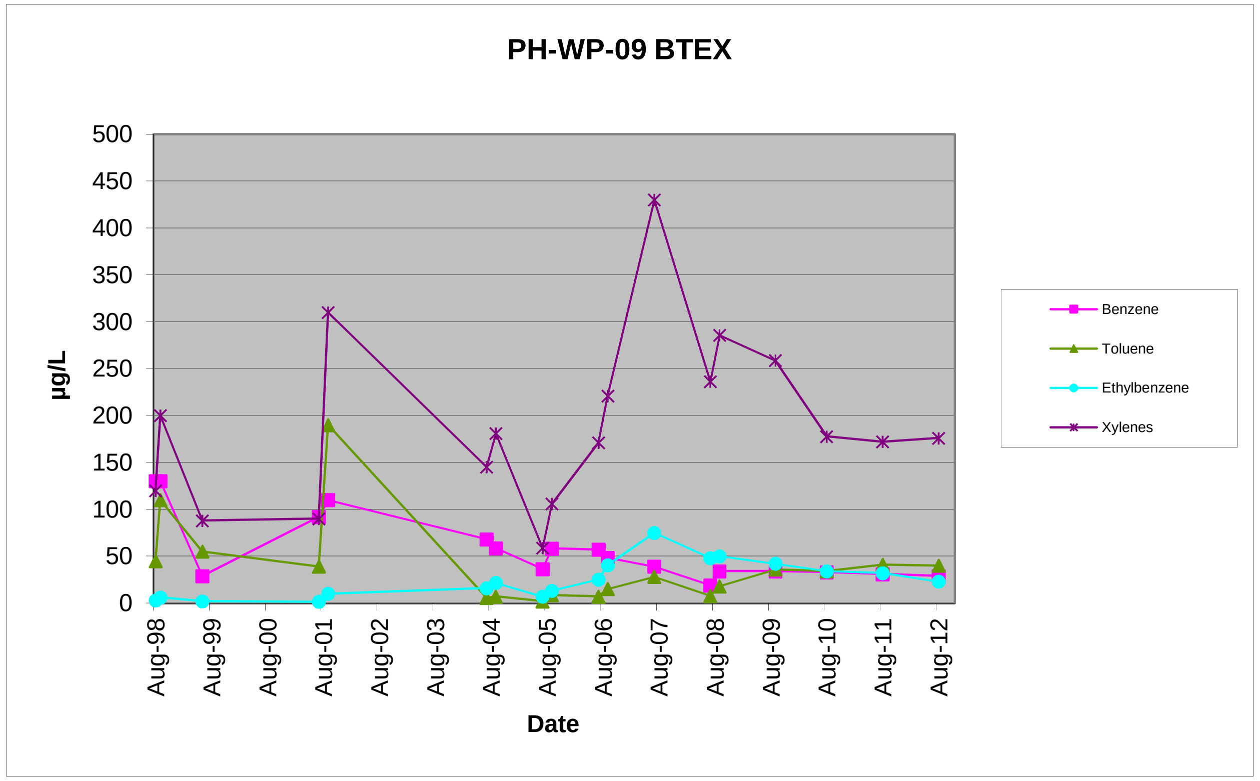


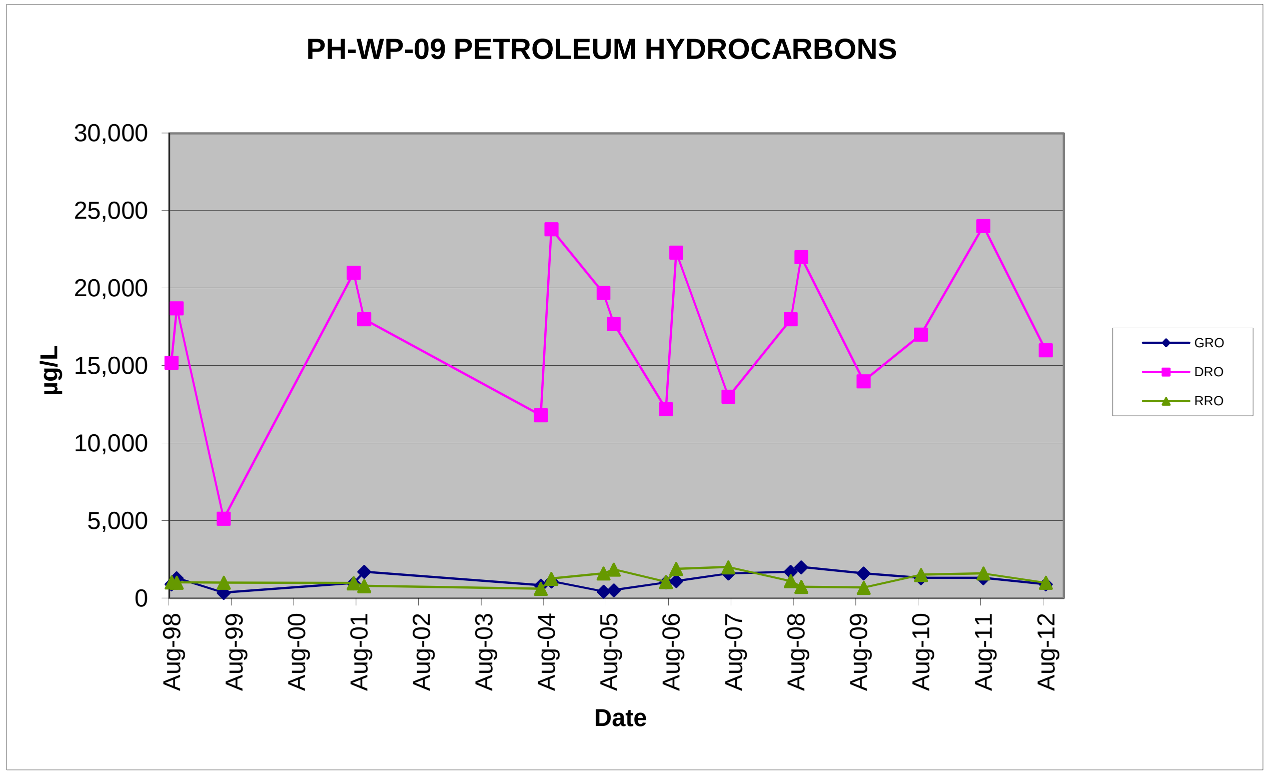
Powerhouse Site

Table A-20. PH-WP-09

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)			Geochemical Parameters				
Well ID	**Collection Date**	**PCE**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater														
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**1,300**	**8,200**[1/]	**1,100**	--	--	--	--	--
PH-WP-09	8/6/1998	N/A	**130**	45	3.0	120	900	**15,200**	1,030	N/A	N/A	N/A	N/A	N/A
	9/22/1998	N/A	**130**	110	6.0	200	1,300	**18,700**	1,010	N/A	N/A	N/A	N/A	N/A
	6/30/1999	N/A	**29**	55	2.0	88	350	5,130	1,000 U	N/A	N/A	N/A	N/A	N/A
	7/27/2001	N/A	**92**	39	1.5	90	960 H	**21,000 Y**	960 L	270	0.20 U	225	71.3	N/A
	9/27/2001	N/A	**110**	190	10	310	**1,700 H**	**18,000 Y**	780 L	284	0.20 UJ	71.6	77.7	N/A
	7/26/2004	1.0 U	**68.2**	5.8	16	145	822	**11,800 X**	600 U	256	0.10 U	0	11.9	299
	9/24/2004	1.0 U	**58.6**	7.1	21.6	181	1,090	**23,800**	**1,250**	337	0.10 U	0	20.9	1,800
	7/12/2005	1.0 U	**36.4**	1.93	6.93	58.7	428	**19,700**	**1,600**	224	0.10 U	0	6.4	307
	9/7/2005	1.0 U	**58.2**	8.67	13.2	105.8	509	**17,700**	**1,850**	266	0.10 U	0	42.6	1,340
	7/19/2006	1.0 U	**57**	7.11	25.1	171	1,020	**12,200**	1,050	220	0.10 U	53	20	1,000
	9/12/2006	1.0 U	**48.3**	15.1	40.6	221	1,100	**22,300**	**1,880**	233	0.0415 J	0	20.4	3,400
PH-WP-09B	7/31/2007	1.0 U	**39**	28	75	430	**1,600**	**13,000**	*2,000 U*	340	0	7.7	1.8	910
PH-WP-09B	7/27/2008	N/A	**19 DJ**	7.7 DJ	48 DJ	236.2 DJ	**1,700 YJ**	**18,000 YJ**	**1,100 LJ**	360	0	13.8	2.0	2,800 J
PH-WP-09B	9/9/2008	N/A	**34 D**	18 DJ	50 D	285.6 D	**2,000 H**	**22,000 Y**	730 LJ	360	0	27.6	1.4	5,100
PH-WP-09B	9/7/2009	N/A	**34**	36	42	258.7 D	**1,600 Y**	**14,000 Y**	680 L	350	0	8.3	2.0	1,100
PH-WP-09B	8/29/2010	N/A	**33**	34	34	177.7 D	1,300 Y	**17,000 Y**	**1,500 L**	340	0	1.2	0.8	5,100
PH-WP-09B	8/26/2011	N/A	**31**	41	32	172 D	1,300 H	**24,000 Y**	**1,600 L**	400	0	1.42	2.0	3,400
PH-WP-09B	8/23/2012	N/A	**29**	40	23	176 D	890 Y	**14,000 Y**	840 L	400	0	0.26 J	2.5	3,000
PH-WP-09B (DUP)	8/23/2012	N/A	**29**	40	22	156 D	850 Y	**16,000 Y**	1,000 L	400	0	0.31 J	3.0	3,200

For all notes see the acronyms and abbreviations presented at the end of Appendix A





Powerhouse Site

Table A-21. Powerhouse Surface Water

		VOCs (µg/L)					Petroleum Hydrocarbons (µg/L)		
Location ID	**Collection Date**	**PCE**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**
Surface Water									
Cleanup Level		**5**	**5**	**1,000**	**700**	**10,000**	**1,300**	**1,500**[1/]	**1,100**
PH-SW-01	8/4/1998	N/A	0.5 U	1 J	0.5 U	0.5 U	50 U	111	200 U
PH-SW-01	9/22/1998	N/A	0.5 U	1 U	1 U	1 U	50 U	100 U	200 U
PH-SW-01	6/30/1999	N/A	1 U	1 U	1 U	1 U	50 U	100 U	1,000 U
PH-SW-01	9/28/2001	N/A	0.5 U	0.5 U	0.5 U	1 U	50 U	100 U	29 U
PH-SW-01	9/24/2004	1 U	1 U	1 U	1 U	3 U	80 U	417 U	N/A
PH-SW-01	9/7/2005	1 U	1 U	1 U	1 U	3 U	80 U	400 U	N/A
PH-SW-01	9/12/2006	1 U	0.4 U	1 U	1 U	2 U	26.6 J	240 J	675
PH-SW-01-1	7/28/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	100 U	250 U	500 U
PH-SW-01-1A	7/28/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	100 U	250 U	500 U
PH-SW-01-1	7/28/2008	N/A	0.50 U	0.31 J	0.50 U	1.0 U	100 U	63 J	46 J
PH-SW-01-2	9/9/2008	N/A	0.50 U	0.50 U	0.50 U	1.0 U	100 U	130 J	95 J
PH-SW-01	9/8/2009	0.50 U	0.050 J	0.50 U	0.50 U	1.0 U	100 U	780 U	490 U
PH-SW-01	8/21/2010	0.50 U	0.500 U	0.50 U	0.50 U	1.0 U	100 U	770 U	480 U
PH-SW-01	8/19/2011	0.50 U	0.50 U	0.50 U	0.50 U	1.00 U	100 U	150 J	520 U
PH-SW-01	8/21/2012	0.5 U	0.5 U	0.5 U	0.5 U	1.0 U	100 U	82 Y	36 J
PH-SW-02	8/4/1998	N/A	0.5 U	0.6 J	0.5 U	0.5 U	50 U	90 J	200 U
PH-SW-02	9/22/1998	N/A	0.5 U	1 U	1 U	1 U	50 U	100 U	200 U
PH-SW-02	6/30/1999	N/A	1 U	1 U	1 U	1 U	50 U	150	1,000 U
PH-SW-02	9/28/2001	N/A	0.5 U	0.5 U	0.5 U	1 U	50 U	100 U	28 U
PH-SW-02	9/24/2004	1 U	1 U	1 U	1 U	3 U	80 U	417 U	N/A
PH-SW-02	9/7/2005	1 U	1 U	1 U	1 U	3 U	80 U	400 U	N/A
PH-SW-02	9/12/2006	1 U	0.4 U	1 U	1 U	2 U	25.0 J	236 J	540
PH-SW-02-1	7/28/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	100 U	250 U	500 U
PH-SW-02-1	7/28/2008	N/A	0.50 U	0.35 J	0.5 U	1.0 U	100 U	60 J	39 J
PH-SW-02-1A	7/28/2008	N/A	0.50 U	0.88	0.5 U	1.0 U	100 U	61 J	42 J
PH-SW-02-2	9/9/2008	N/A	0.50 U	0.75	0.5 U	1.0 U	100 U	76 J	84 J
PH-SW-02-2A	9/9/2008	N/A	0.50 U	0.50 U	0.5 U	1.0 U	100 U	84 J	220 J
PH-SW-02	9/7/2009	0.080 J	0.10 J	0.50 U	0.5 U	0.61 J	100 U	180 U	490 U
PH-SW-02	8/20/2010	0.50 U	0.10 J	0.18 J	0.050 J	0.65 J	100 U	770 U	480 U
PH-SW-02	8/19/2011	0.50 U	0.060 J	0.090 J	0.50 U	0.60 J	100 U	160 J	540 U
PH-SW-02 (DUP)	8/19/2011	0.50 U	0.070 J	0.080 J	0.05 U	0.60 J	100 U	180 J	490 U
PH-SW-02	8/21/2012	0.5 U	0.5 U	0.5 U	0.5 U	1.0 U	100 U	110 Y	60 J
PH-SW-02 (DUP)	8/21/2012	0.5 U	0.5 U	0.5 U	0.5 U	1.0 U	100 U	110 Y	54 J
PH-SW-03	8/4/1998	N/A	0.5 U	0.6	0.5 U	0.5 U	50 U	90 J	40 J
PH-SW-03	9/22/1998	N/A	0.5 U	1 U	1 U	1 U	50 U	100 U	200 U
PH-SW-03	6/30/1999	N/A	1 U	1 U	1 U	1 U	50 U	160	1,000 U
PH-SW-03	9/28/2001	N/A	0.5 U	0.5 U	0.5 U	1 U	50 U	100 U	35 U
PH-SW-03	9/24/2004	1 U	1 U	1 U	1 U	3 U	80 U	417 U	N/A
PH-SW-03	9/7/2005	1 U	1 U	1 U	1 U	3 U	21.5 J	400 U	N/A
PH-SW-03	9/12/2006	1 U	1 U	1 U	1 U	2 U	22.5 J	231 J	519 J
PH-SW-03-1	7/28/2007	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	100 U	250 U	500 U
PH-SW-03-1	7/28/2008	N/A	0.5 U	0.080 J	0.5 U	1.0 U	100 U	56 J	34 J
PH-SW-03-2	9/9/2008	N/A	0.50 U	0.50 U	0.50 U	1.0 U	14 J	92 J	49 J
PH-SW-03	9/7/2009	0.50 UJ	0.090 J	0.50 U	0.50 U	0.24 J	100 U	200 U	480 U
PH-SW-03 (DUP)	9/7/2009	0.50 U	0.060 J	0.50 U	0.50 U	1.0 U	100 U	140 J	490 U
PH-SW-03	8/20/2010	0.50 U	0.110 J	0.23 J	0.05 U	0.6 J	100 U	790 U	500 U
PH-SW-03	8/19/2011	0.50 U	0.060 J	0.13 J	0.05 U	0.60 J	100 U	190 J	500 U
PH-SW-03	8/21/2012	0.5 U	0.07 J	0.57 UJ	0.5 U	1.0 U	100 U	120 Y	67 J

For all notes see the acronyms and abbreviations presented at the end of Appendix A

Table A-22. Powerhouse Soil

			VOCs (mg/kg)				Petroleum Hydrocarbons (mg/kg)		
Boring ID	**Depth Range feet-bgs (inches)**	**Collection Date**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**RRO (AK 103)**
Soil									
Cleanup Level			--	--	--	--	**1,400**	**12,500**	--
PH-B1	0.8-1 (10-12)	8/19/2010	0.075 U	0.075 U	0.075 U	0.15 U	30 U	150 H	790 O
	2.3-2.5 (28-30)	8/19/2010	0.77 U	0.77 U	0.77 U	0.154 U	24.0 J	990 Y	94 J
PH-B2	0.8-1 (10-12)	8/19/2010	0.20 U	0.023 J	0.20 U	0.40 U	45 U	310 H	2,500 DO
	2.3-2.5 (28-30)	8/19/2010	0.063 U	0.063 U	0.063 U	0.126 U	34 U	1,900 DHJ	12,000 DOJ
PH-B3	0-1 (0-12)	8/19/2010	0.074 U	0.074 U	0.074 U	0.148 U	16 J	990 Y	62 J
	2.3-2.5 (28-30)	8/19/2010	0.049 U	0.0068 J	0.015 J	0.086 J	12 J	320 Y	65 J
PH-B4	0-1 (0-12)	8/19/2010	0.10 U	0.030 J	0.10 U	0.12 J	27 U	91 Y	120 OJ
	2.5 (30)	8/19/2010	0.58 UJ	0.58 UJ	1.6	10.5	97 J	210 JZ	1,400 JZ
PH-B5	0-1 (0-12)	8/19/2010	0.055 U	0.055 U	0.055 U	0.11 U	71 H	7,500 Y	430 L
	2.5 (30)	8/19/2010	0.062 U	0.062 U	0.062 U	0.252 J	95 H	1,200 Y	54 J
PH1-B1	3.0-3.8	8/10/2012	0.044 U	0.044 U	0.0052 J	0.012 J	2.2 J	200 H	N/A
PH1-B2	1.0-2.0	8/10/2012	0.027 U	0.027 U	0.0086 J	0.018 J	9.2 U	27 H	N/A
PH3-B3	3.5-4.5	8/10/2012	0.022 U	0.022 UJ	0.022 U	0.022 U	26 J	950 Y	N/A
PH3-B4	1.5-2.5	8/10/2012	0.034 U	0.034 UJ	0.034 U	0.034 U	49 J	1,700 Y	N/A
PH5-B5	1.5-2.0	8/10/2012	0.01 J	0.032 U	0.15	0.635	4.3 J	1,100 H	N/A
PH4-B6	1.0-2.5	8/11/2012	0.024 J	0.077 J	0.59	5	97 J	2,200 Y	N/A
PH4-B6 (DUP)	1.0-2.5	8/11/2012	0.022 J	0.065 J	0.57	4.6	85 J	1,000 Y	N/A
PH4-B7	3.0-4.0	8/11/2012	0.066 U	0.066 U	0.029 J	0.71	83 J	4,000 Y	N/A
PH4-B8	2.5-3.5	8/11/2012	0.31 J	0.21 J	1.4 J	15.5 J	130 J	6,300 Y	N/A
PH4-B9	2.5-3.5	8/11/2012	0.039 U	0.039 U	0.23 J	1.99 J	85 J	2,200 Y	N/A
PH4-B10	2.5-3.5	8/11/2012	0.029 U	0.029 U	0.18	0.414	51 J	2,200 Y	N/A
PH4-B11	4.0-4.8	8/11/2012	0.049 U	0.049 U	0.078	0.47	46 J	2,400 Y	N/A

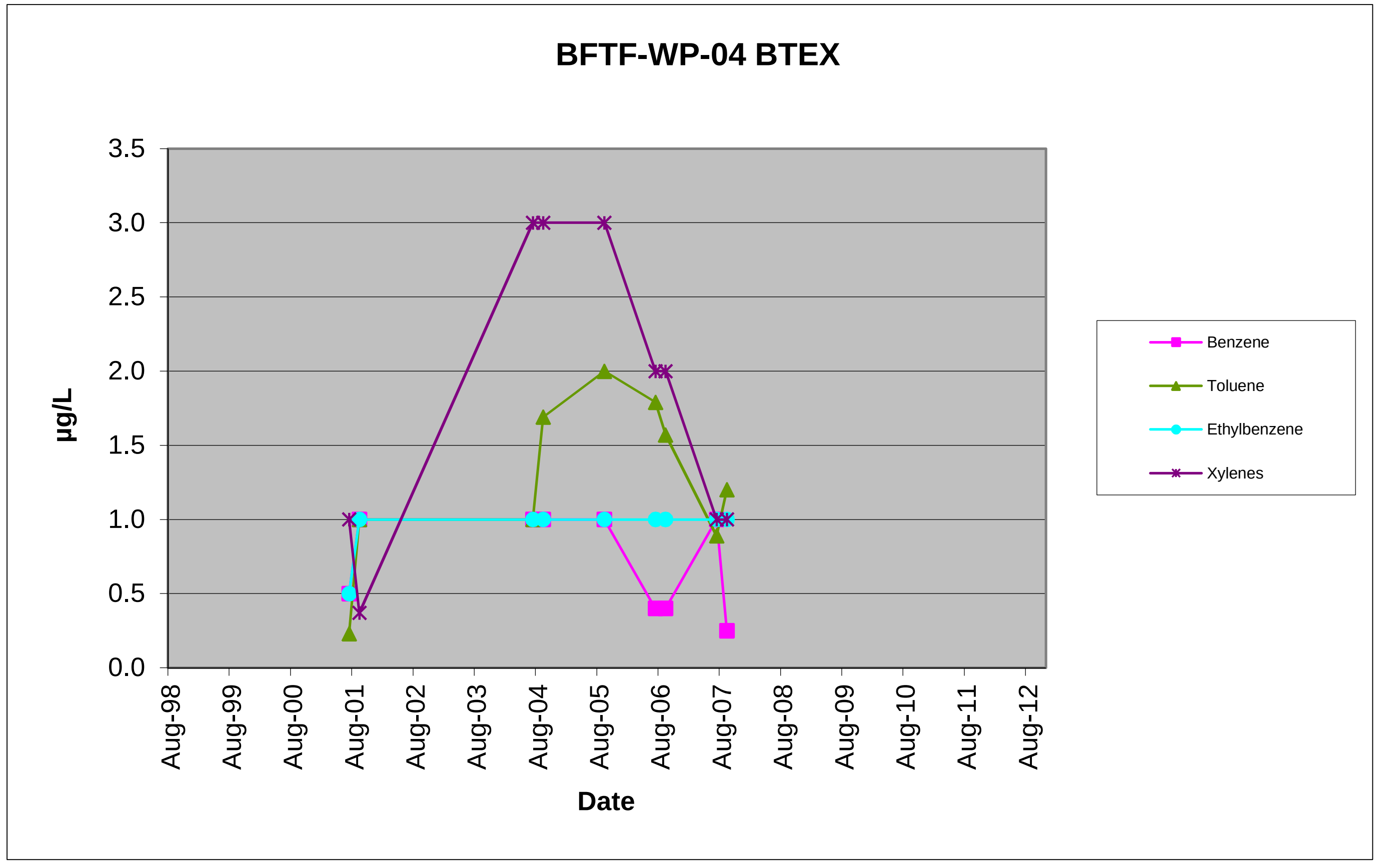
For all notes see the acronyms and abbreviations presented at the end of Appendix A

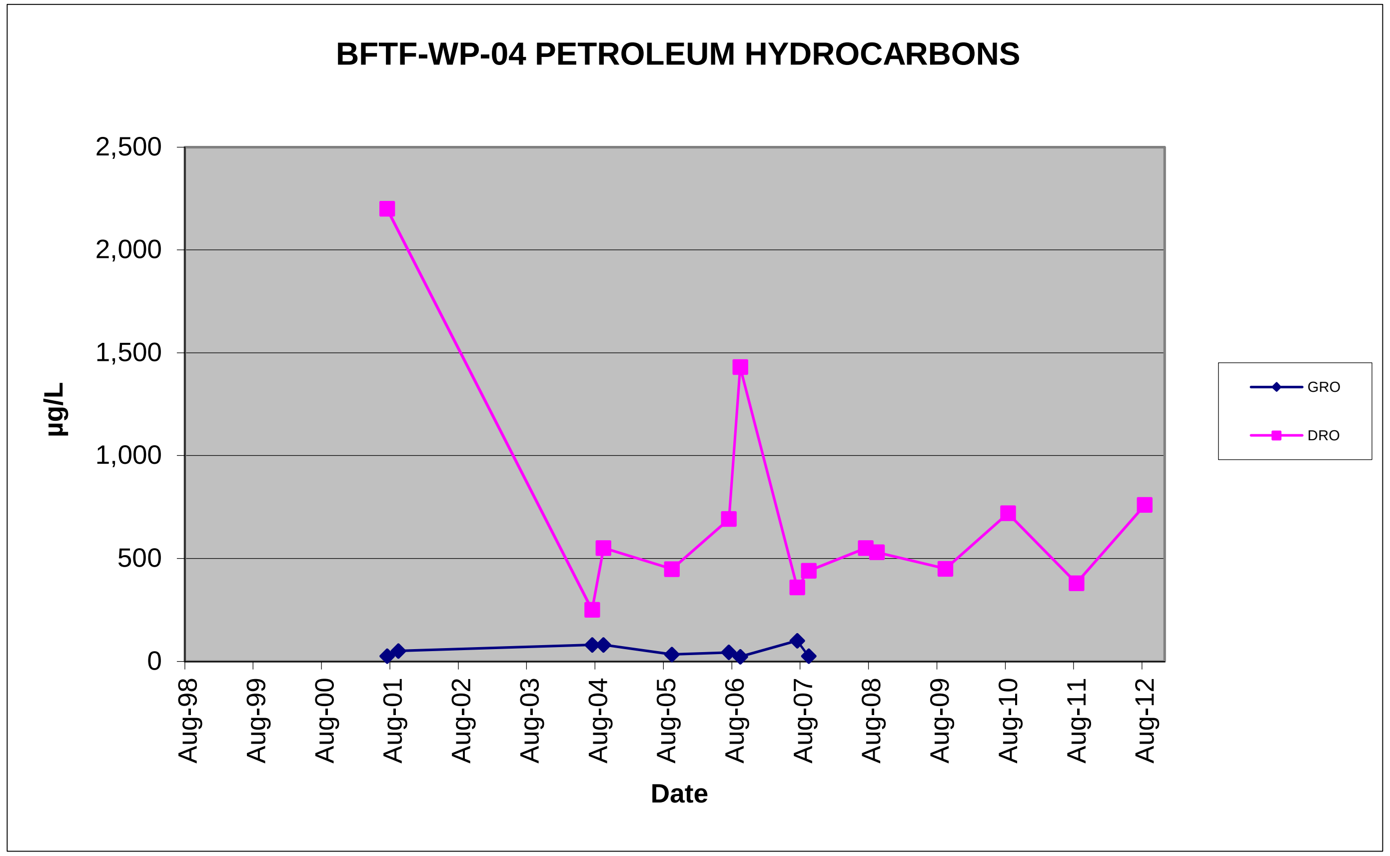
Former Bulk Fuel Tank Farm Site

Table A-23. BFTF-WP-04

		VOCs (µg/L)								Petroleum Hydrocarbons (µg/L)				Metals (µg/L)		Geochemical Parameters							
Well ID	**Collection Date**	**Benzene**		**Toluene**		**Ethylbenzene**		**Xylenes**		**GRO (AK 101)**		**DRO (AK 102)**		**Lead**		**Alkalinity mg/L**	**Nitrate mg/L**		**Sulfate mg/L**		**Iron mg/L**	**Methane µg/L**	
Active Zone Groundwater																							
Cleanup Level		**5**		**1,000**		**700**		**18**		**267**		**923**		**3.2**		--	--		--		--	--	
BFTF-WP-04	7/28/2001	0.50	U	0.23	U	0.50	U	1.0	U	25	UJ	**2,200**	**Z**	N/A		N/A	N/A		N/A		N/A	N/A	
	9/26/2001	1.0	U	1.0		1.0	U	0.37	J	50	U	#N/A		N/A		N/A	N/A		N/A		N/A	N/A	
	7/23/2004	1.0	U	1.0	U	1.0	U	3.0	U	80	U	250	U	N/A		145	0.1	U	0		13.6	3,160	X
	9/23/2004	1.0	U	1.69		1.0	U	3.0	U	80	U	551	X	N/A		195	0.1	U	0		21.6	2,980	X
	9/8/2005	1.0	U	2.0		1.0	U	3.0	U	33.5	J	448		N/A		199	0.10	U	0.0		20.8	2,600	X
	7/20/2006	0.4	U	1.79		1.0	U	2.0	U	43.6	J	692		N/A		175	0.10	U	0.0		35.8	6,060	
	9/13/2006	0.4	U	1.57		1.0	U	2.0	U	22.2	J	**1,430**		N/A		165	0.045	J	0.0		23.1	3,800	
BFTF-WP-04B-1	7/31/2007	1.0	U	0.89	J	1.0	U	1.0	U	100	U	360		N/A		240	0.0		1.0	U	1.6	550	
BFTF-WP-04-B-2	9/13/2007	0.25	J	1.2		1.0	U	1.0	U	25	U	440		N/A		210	0.20	U	1.0	U	38.7	1,300	
BFTF-WP-04B	7/25/2008	N/A		N/A		N/A		N/A		N/A		550	J	0.291	J	240	0.0		0.30		1.4	3,500	J
BFTF-WP-04B	9/4/2008	N/A		N/A		N/A		N/A		N/A		530	J	0.60	U	260	0.0		0.80		1.8	1,600	
BFTF-WP-04B	9/2/2009	N/A		N/A		N/A		N/A		N/A		450	J	0.204		260	13.2		0.53		0.60	850	
BFTF-WP-04B	8/26/2010	N/A		N/A		N/A		N/A		N/A		720	J	0.082		360	0.0		1.93		1.20	2,200	
BFTF-WP-04B	8/24/2011	N/A		N/A		N/A		N/A		N/A		380	J	0.6	U	280	0.0		0.43		0.9	1,300	
BFTF-WP-04B	8/14/2012	N/A		N/A		N/A		N/A		N/A		760	Y	0.154	UJ	300	0.0		0.59		2.4	1,300	

For all notes see the acronyms and abbreviations presented at the end of Appendix A



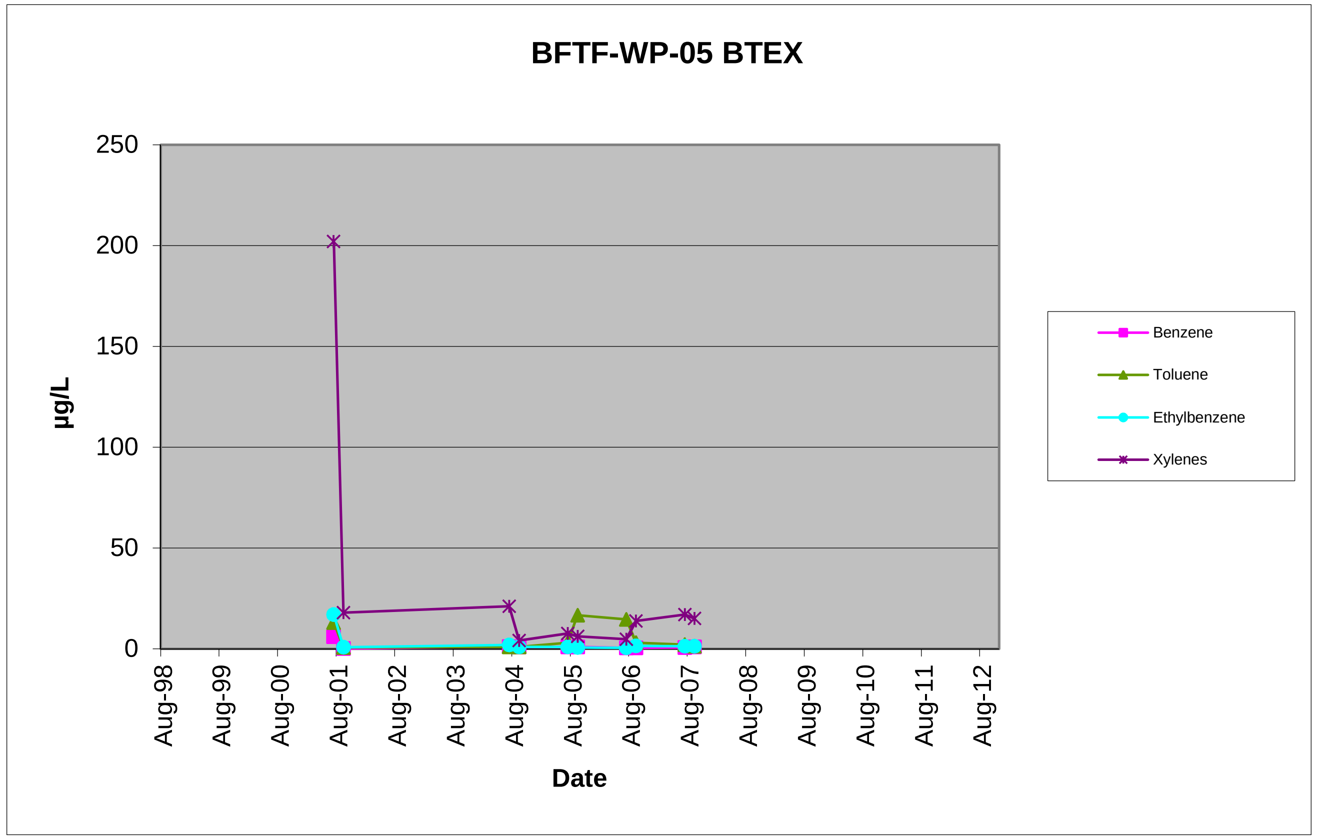


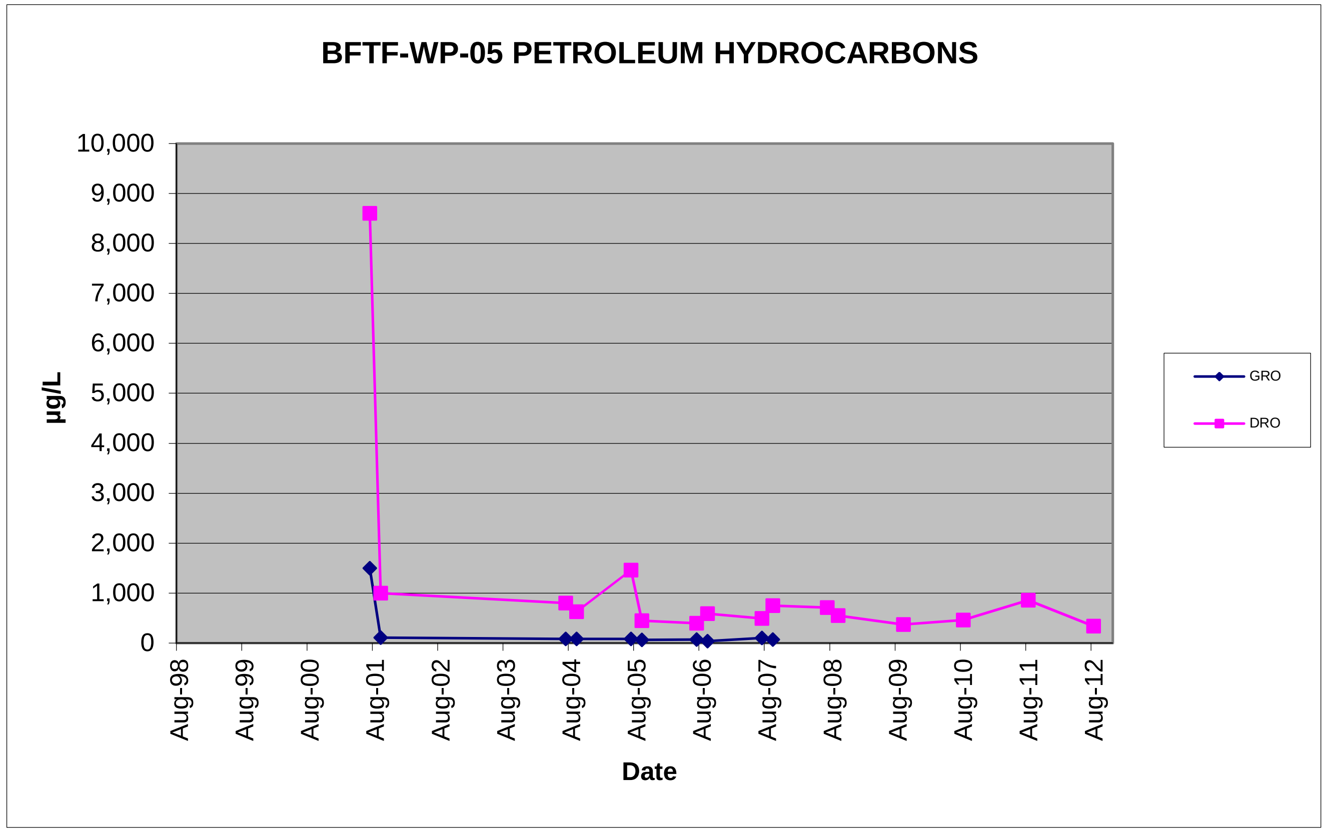
Former Bulk Fuel Tank Farm Site

Table A-24. BFTF-WP-05

		VOCs (µg/L)				Petroleum Hydrocarbons (µg/L)		Metals (µg/L)	Geochemical Parameters				
Well ID	Collection Date	Benzene	Toluene	Ethylbenzene	Xylenes	GRO (AK 101)	DRO (AK 102)	Lead	Alkalinity mg/L	Nitrate mg/L	Sulfate mg/L	Iron mg/L	Methane µg/L
Active Zone Groundwater													
Cleanup Level		**5**	**1,000**	**700**	**18**	**267**	**923**	**3.2**	--	--	--	--	--
BFTF-WP-05	7/28/2001	**6**	13	17	**202**	**1,500 H**	**8,600 Y**	N/A	161	0.20 U	10	35.6	N/A
	9/26/2001	0.18 J	0.60	0.71	17.9	110 H	**1,000 Y**	N/A	2 U	0.50 UJ	0.30	72.9	N/A
	7/23/2004	1.08	1.0 U	1.88	**21.12**	80 U	800 X	N/A	313	0.10 U	0.0	4.7	2,620 X
	9/23/2004	1.0 U	1.0 U	1.0 U	4.02	80 U	626 X	N/A	236	0.10	0.0	16.5	2,170 X
	7/11/2005	1.0 U	2.91	1.0 U	7.64	80 U	**1,460 X**	N/A	210	0.10 U	0.0	34.25	11,400 X
	9/8/2005	1.0 U	16.6	0.53 J	6.17	63.9 J	449	N/A	224	0.10 U	0.0	2.73	5,730 X
	7/20/2006	0.4 U	14.6	0.37 J	4.73	70.8 J	395	N/A	170	0.10 U	0.0	31.8	5,670
	9/13/2006	0.4 U	2.91	1.45	13.8	35.3 J	590	N/A	120	0.077 J	0.0	22.6	4,700
BFTF-WP-05-1	7/29/2007	0.53 J	2.0	1.3	17	100 U	490	N/A	220	0.0	1.0 U	2.0	2,500
BFTF-WP-05-2	9/13/2007	0.93 J	1.3	1.2	15	71	750 J	N/A	190	0.20 U	1.1	59.5	2,200 ER
BFTF-WP-05-1	7/24/2008	N/A	N/A	N/A	N/A	N/A	710 J	1.38	220	0.0	1.0	1.6	3,200
BFTF-WP-05-2	9/3/2008	N/A	N/A	N/A	N/A	N/A	550 J	0.946 U	260	0.0	2.1	2.6	5,400
BFTF-WP-05	9/2/2009	N/A	N/A	N/A	N/A	N/A	370 J	**5.09**	240	0.0	4.21	1.4	900
BFTF-WP-05B	8/26/2010	N/A	N/A	N/A	N/A	N/A	460 J	0.039	200	0.0	1.65	1.0	4,300
BFTF-WP-05B	8/24/2011	N/A	N/A	N/A	N/A	N/A	860 Y	0.600 U	200	0.0	0.47	1.0	1,400
BFTF-WP-05B	8/14/2012	N/A	N/A	N/A	N/A	N/A	340 Y	0.122 UJ	240	0.0	1.35	2.4	2,300

For all notes see the acronyms and abbreviations presented at the end of Appendix A



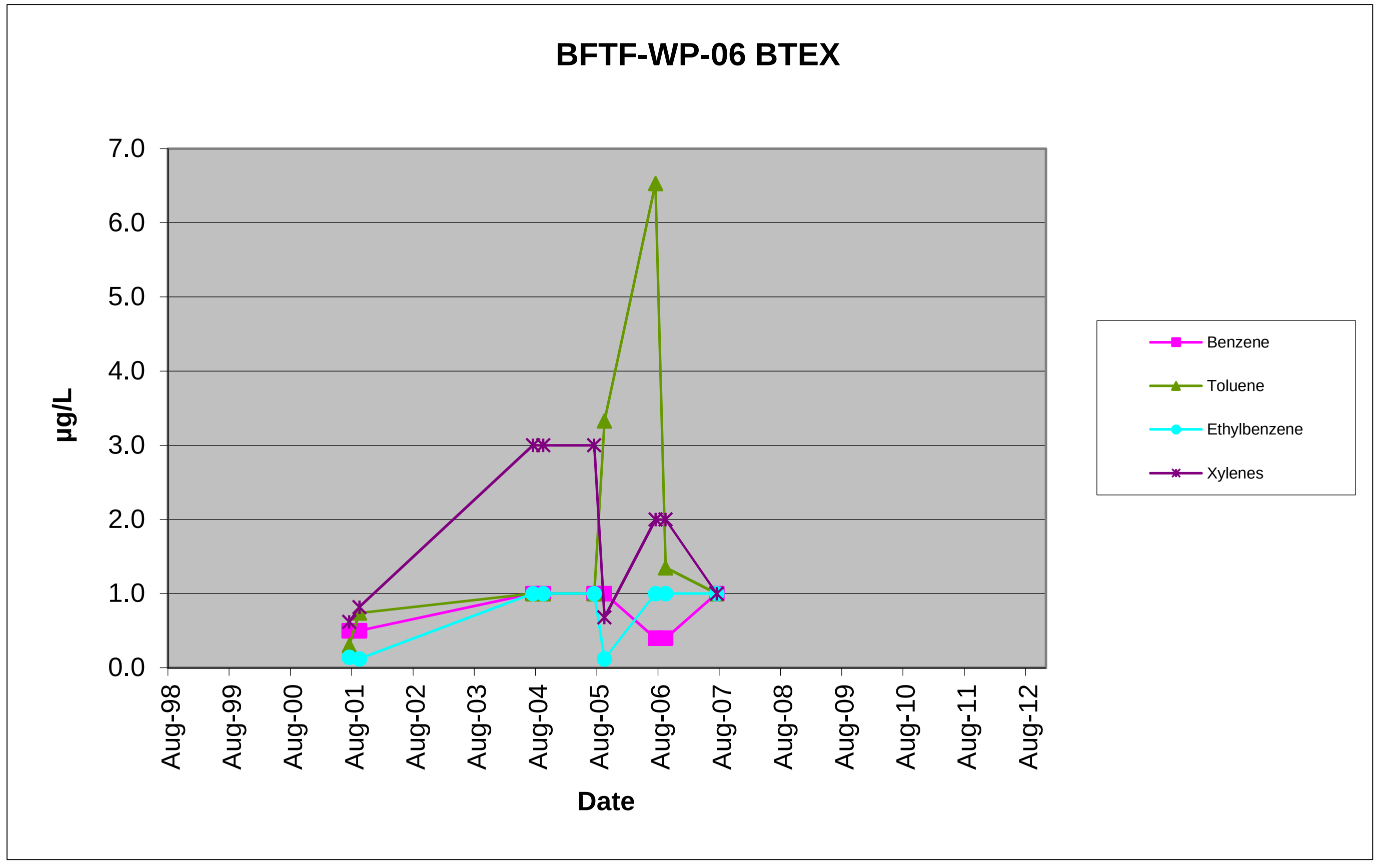


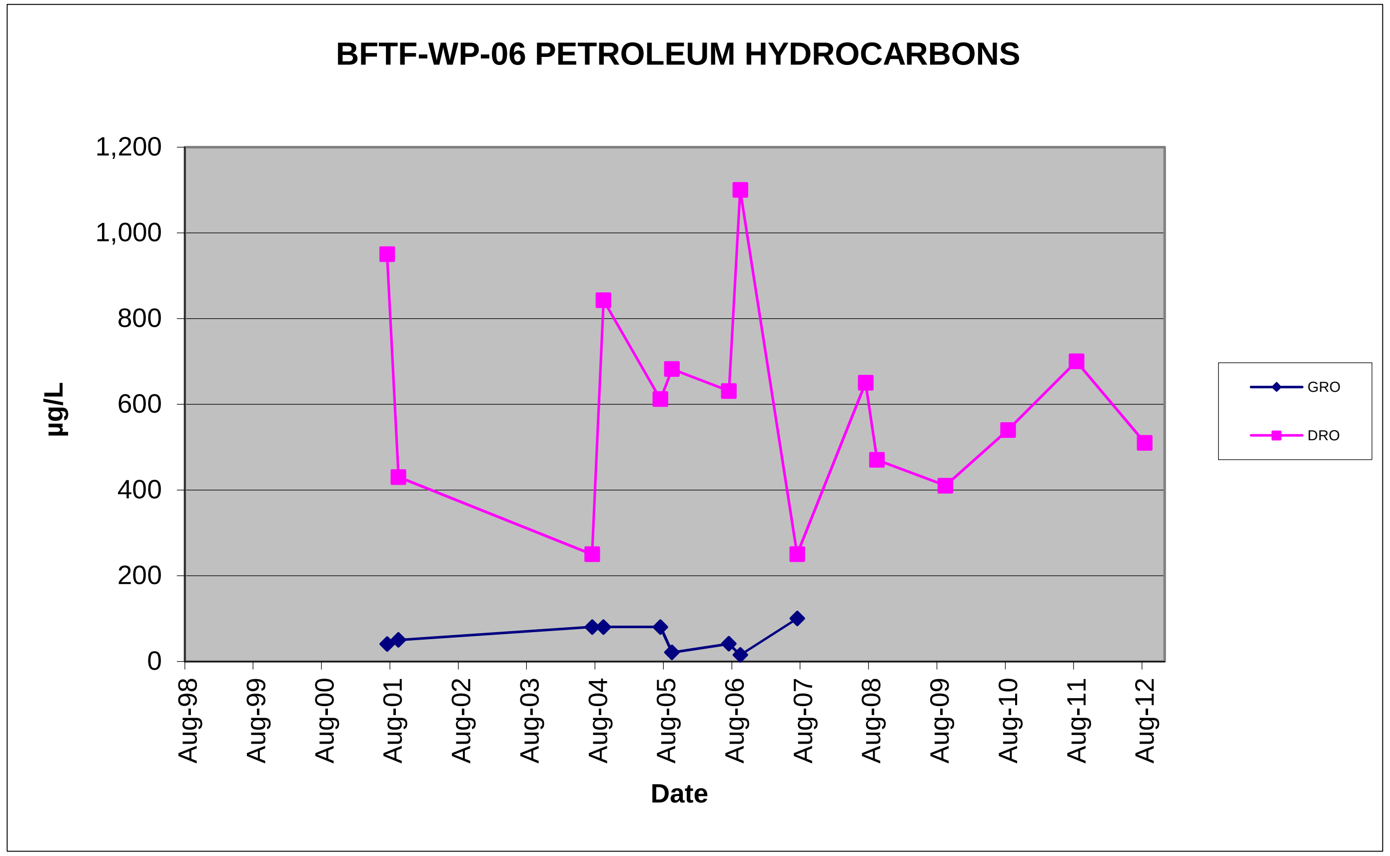
Former Bulk Fuel Tank Farm Site

Table A-25. BFTF-WP-06

		VOCs (µg/L)				Petroleum Hydrocarbons (µg/L)		Metals (µg/L)	Geochemical Parameters				
Well ID	**Collection Date**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**Lead**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater													
Cleanup Level		**5**	**1,000**	**700**	**18**	**267**	**923**	**3.2**	--	--	--	--	--
BFTF-WP-06	7/28/2001	0.50 U	0.30 U	0.14 J	0.62	40 J	**950 Z**	N/A	N/A	N/A	N/A	N/A	N/A
	9/26/2001	0.50 U	0.74	0.12 J	0.82	50 U	430 Y	N/A	N/A	N/A	N/A	N/A	N/A
	7/23/2004	1.0 U	1.0 U	1.0 U	3.0 U	80 U	250 U	N/A	319	0.10 U	0.0	0.21	10,900
	9/23/2004	1.0 U	1.0 U	1.0 U	3.0 U	80 U	843 X	N/A	245	0.10 U	0.0	27	17,000
	7/11/2005	1.0 U	1.0 U	1.0 U	3.0 U	80 U	612	N/A	217	0.10 U	0.0	38.5	10,300 X
	9/8/2005	1.0 U	3.33	0.12 J	0.68 J	20.6 J	682	N/A	353	0.10 U	0.0	44.8	5,550 X
	7/20/2006	0.4 U	6.53	1.0 U	2.0 U	40.9 J	631	N/A	220	0.10 U	0.0	70.2	5,670
	9/13/2006	0.4 U	1.35	1.0 U	2.0 U	14.8 J	**1,100**	N/A	187	0.173	0.0	62.2	3,400
BFTF-WP-06-1	7/29/2007	1.0 U	1.0 U	1.0 U	1.0 U	100 U	250 UJ	N/A	200	0.0	1.0	2.0	990
BFTF-WP-06-1	7/24/2008	N/A	N/A	N/A	N/A	N/A	650 J	0.627 J	300	0.0	0.7	2.0	2,800
BFTF-WP-06-2	9/3/2008	N/A	N/A	N/A	N/A	N/A	470 J	0.6 U	320	0.0	1.2	2.2	1,900
BFTF-WP-06	9/3/2009	N/A	N/A	N/A	N/A	N/A	410 J	0.164	320	0.0	0.45	3.0	1,900
BFTF-WP-06B	8/26/2010	N/A	N/A	N/A	N/A	N/A	540 J	0.342	380	0.0	1.5	1.8	9,100
BFTF-WP-06B	8/23/2011	N/A	N/A	N/A	N/A	N/A	700 J	0.776 U	400	0.0	0.37 J	1.1	4,900
BFTF-WP-06B	8/15/2012	N/A	N/A	N/A	N/A	N/A	510 Y	0.216 UJ	300	0.0	0.5 Ui	2.4	4,200

For all notes see the acronyms and abbreviations presented at the end of Appendix A



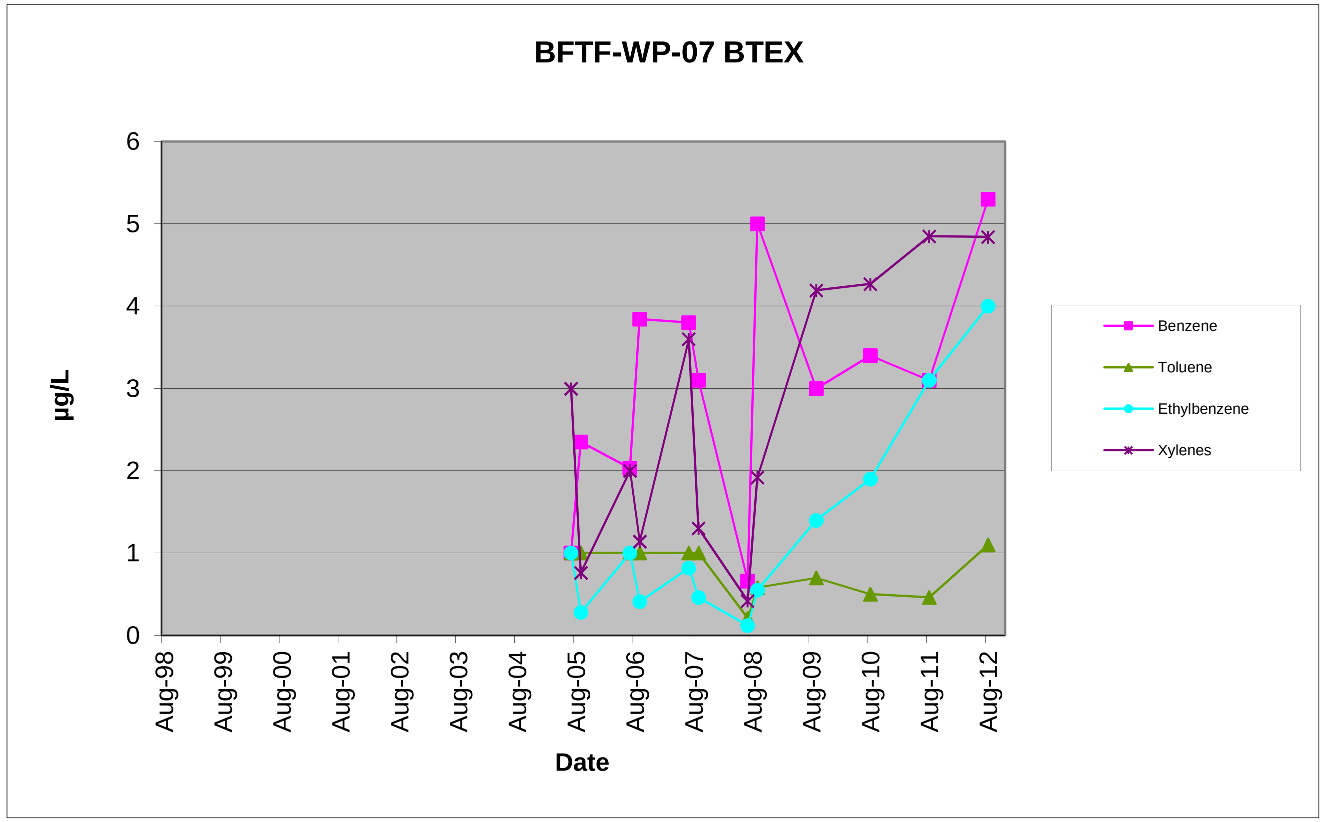


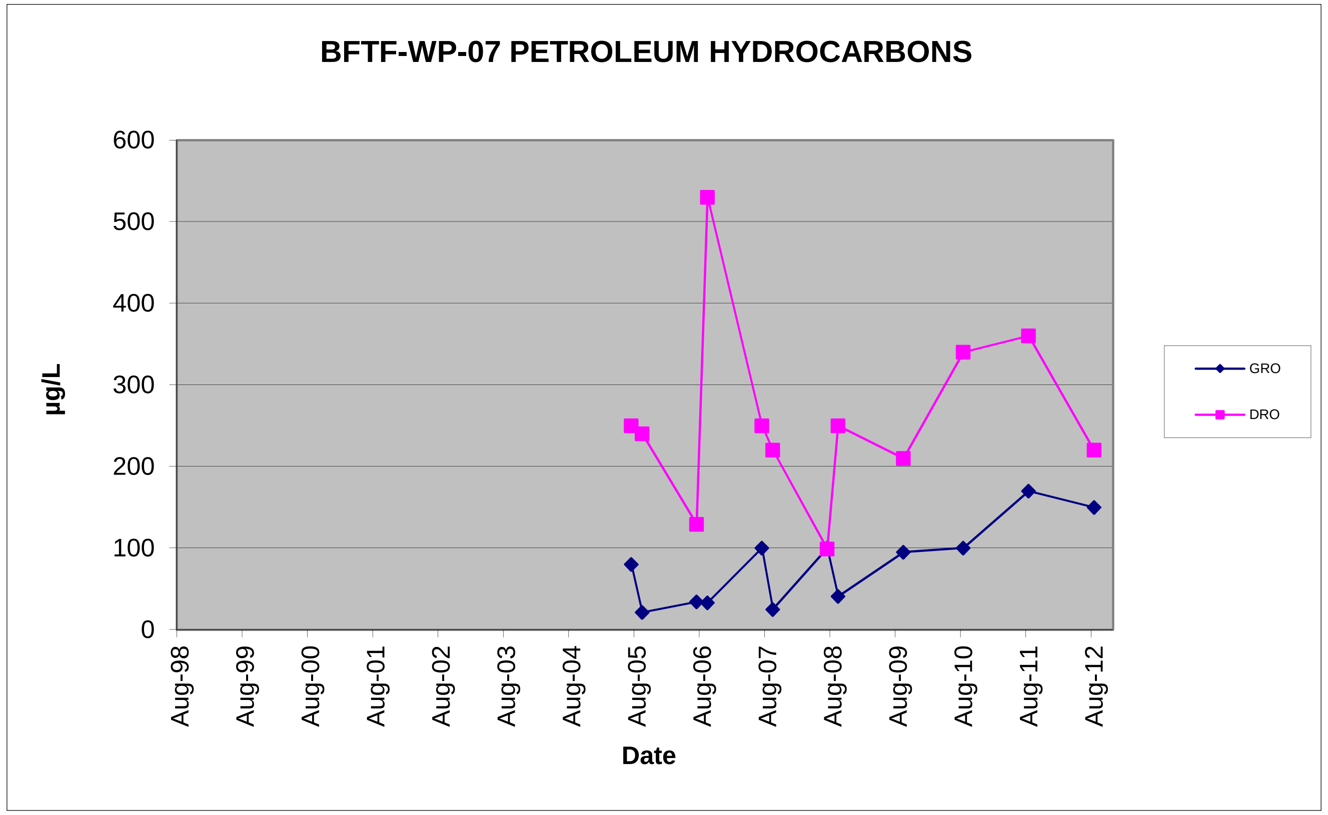
Former Bulk Fuel Tank Farm Site

Table A-26. BFTF-WP-07

		VOCs (µg/L)				Petroleum Hydrocarbons (µg/L)		Metals (µg/L)	Geochemical Parameters				
Well ID	Collection Date	Benzene	Toluene	Ethylbenzene	Xylenes	GRO (AK 101)	DRO (AK 102)	Lead	Alkalinity mg/L	Nitrate mg/L	Sulfate mg/L	Iron mg/L	Methane µg/L
Active Zone Groundwater													
Cleanup Level		**5**	**1,000**	**700**	**18**	**267**	**923**	**3.2**	--	--	--	--	--
BFTF-WP-07	7/28/2001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	48	0.80 J	12.6	12.5	N/A
	9/26/2001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	74	0.50 UJ	2.4	57	N/A
	7/23/2004	N/A	N/A	N/A	N/A	N/A	N/A	N/A	128	0.0	0.0	2.99	2,350 X
	9/23/2004	N/A	N/A	N/A	N/A	N/A	N/A	N/A	163	0.0	0.0	16.2	9,360 X
	7/11/2005	1.0 U	1.0 U	1.0 U	3.0 U	80 U	250 U	N/A	89	0.10 U	3.0	1.0	1,250 X
	9/8/2005	2.35	1.0 U	0.28 J	0.76 J	21.3 J	240 U	N/A	140	0.07 J	0.0	7.3	2,030 X
	7/20/2006	2.03	1.0 U	1.0 U	2.0 U	34.3 J	129 J	N/A	120	0.178	0.0	7.2	3,880
	9/13/2006	3.84	1.0 U	0.41 J	1.14 J	33.1 J	530	N/A	118	0.103	0.0	13.6	9,500
BFTF-WP-07	7/29/2007	3.8	1.0 U	0.82 J	3.6	100 U	250 UJ	N/A	180	0.0	1.0 U	2.2	2,600
BFTF-WP-07	9/13/2007	3.1	1.0 U	0.46 J	1.3	25 U	220	N/A	110	0.2 U	1.0 U	54.5	2,200 ER
BFTF-WP-07	7/25/2008	0.66 J	0.21 J	0.12 J	0.42 J	100 UJ	99 J	0.333	140	0.0	8.6	2.0	1,600 J
BFTF-WP-07	9/4/2008	5.0	0.58 U	0.55	1.92	41 J	250 J	0.60 U	240	0.0	0.2	1.8	10,000
BFTF-WP-07B	9/3/2009	3.0	0.70 U	1.4	4.19	95 J	210 J	0.073	200	0.0	10.2	3.4	1,900
BFTF-WP-07B	8/25/2010	3.4	0.50 U	1.9	4.27	100 Y	340 J	0.048	240	0.0	32.6	3.8	1,900
BFTF-WP-07B	8/24/2011	3.1	0.44 J	3.0	4.85	170 Y	300 J	0.078	220	0.0	7.8	1.2	2,500
BFTF-WP-07B (DUP)	8/24/2011	2.9	0.46 J	3.1	4.55	160 Y	360 J	0.060	220	0.0	7.7	1.0	2,500
BFTF-WP-07B	8/14/2012	**5.3**	1.1	4	4.84	150 Y	220 Y	0.162 UJ	250	0.0	6	2.9	3,400

For all notes see the acronyms and abbreviations presented at the end of Appendix A



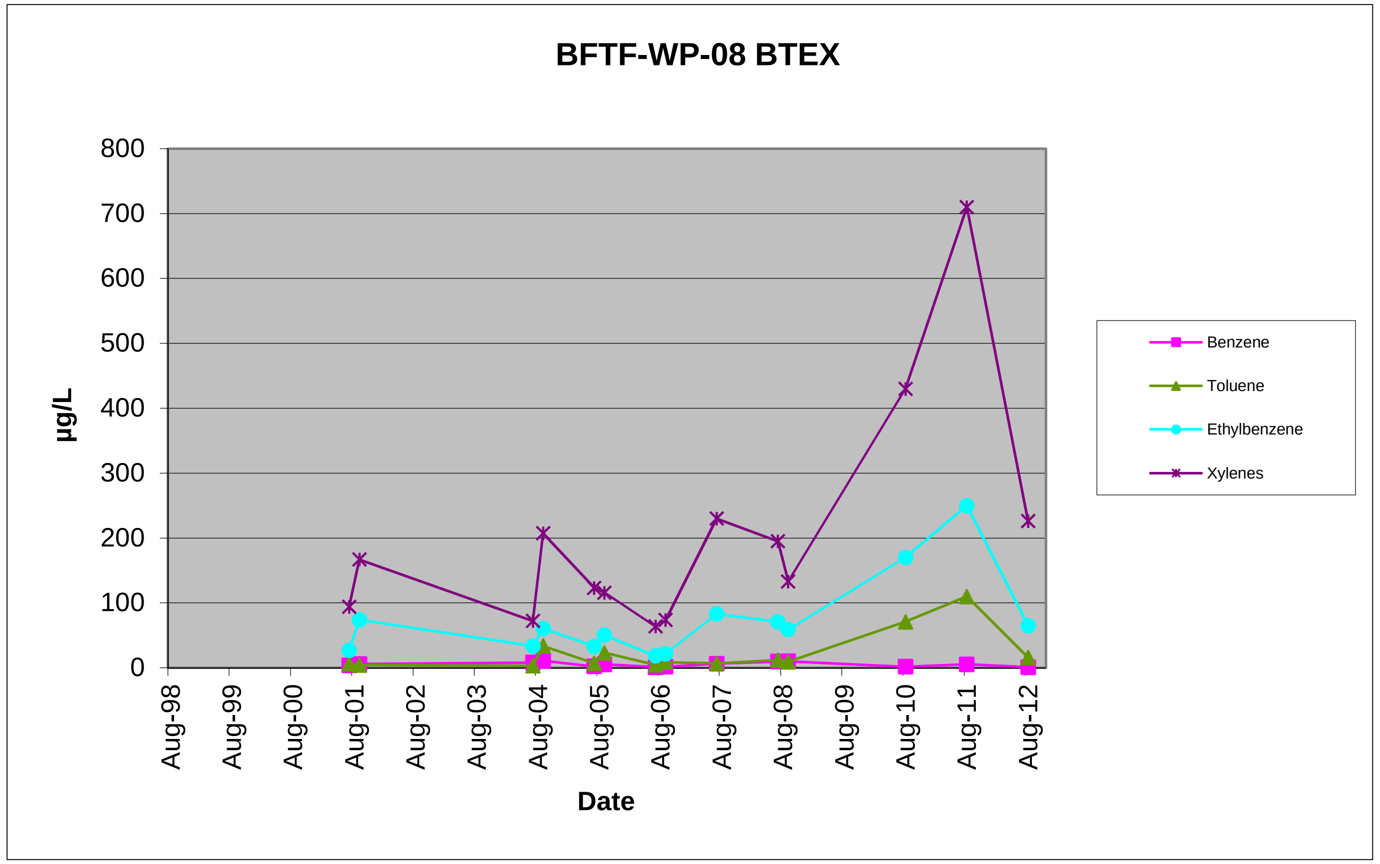


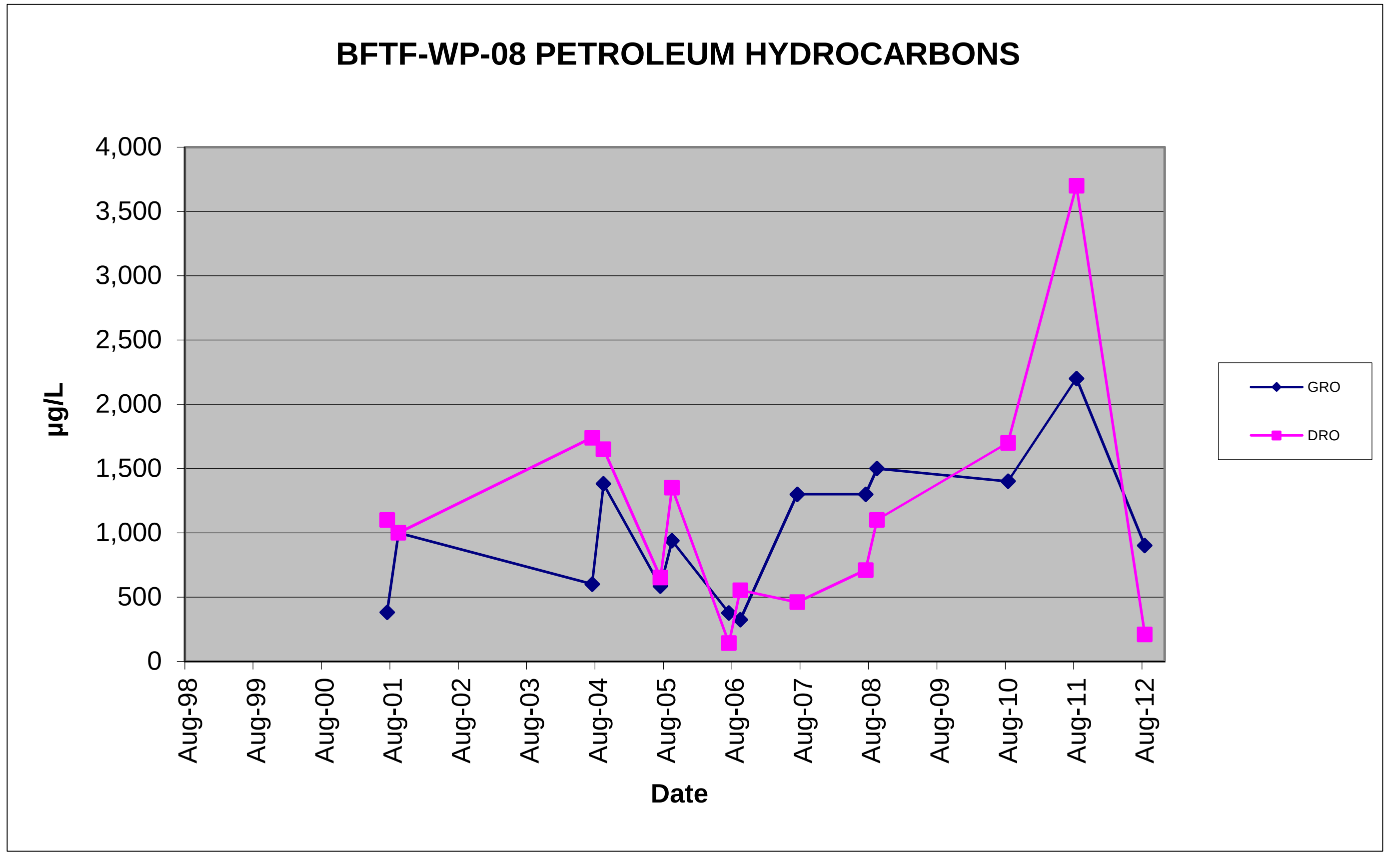
Former Bulk Fuel Tank Farm Site

Table A-27. BFTF-WP-08

		VOCs (µg/L)				Petroleum Hydrocarbons (µg/L)		Metals (µg/L)	Geochemical Parameters				
Well ID	**Collection Date**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**Lead**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater													
Cleanup Level		**5**	**1,000**	**700**	**18**	**267**	**923**	**3.2**	--	--	--	--	--
BFTF-WP-08	7/28/2001	3.6	6.1	27	**94**	**380 Y**	**1,100 Z**	N/A	60	0.78	60.3	31.5	N/A
	9/26/2001	**5.9**	4.3	74	**167**	**1,000 Z**	**1,000 Y**	N/A	N/A	N/A	N/A	N/A	N/A
	7/23/2004	**8.2**	3.29	33.6	**72.2**	**600**	**1,740 X**	N/A	180	0.1 U	0	0.83	2,230
	9/23/2004	**10.9**	33.7	60.6	**207.2**	**1,380**	**1,650 X**	N/A	193	0.1 U	0	14.3	2,810
	7/11/2005	2.32	7.11	33.1	**123.3**	**584**	651 X	N/A	40	0.1 U	500	32.75	504 X
	9/8/2005	**5.53**	23.1	50.5	**115.9**	**937**	**1,350 J**	N/A	183	0.04 J	150	6.1	949 X
	7/20/2006	1.02	4.64	18.4	**63.9**	**375**	141 J	N/A	67	0.0615 J	840	36.8	260
	9/13/2006	1.76	8.61	21.7	**73.8**	**323**	553 J	N/A	80	0.15	1,250	18	1,200
BFTF-WP-08	7/30/2007	**6.5**	6.8	83	**230**	**1,300**	460 J	N/A	160	0.0	760	2.4	440
BFTF-WP-08	7/26/2008	**9.6 J**	12 J	71 DJ	**195 DJ**	**1,300 YJ**	710 J	2.490	180	0.0	522	3.0	4,300 J
BFTF-WP-08	9/4/2008	**10**	9.4	59	**133 D**	**1,500 Y**	**1,100 Y**	2.460	400	0.0	305	1.8	3,800
BFTF-WP-08B	9/3/2009	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BFTF-WP-08C	8/27/2010	1.6	71 D	170 D	**430 D**	**1,400 Y**	**1,700 Y**	0.430	300	0.0	624	1.0	5,400
BFTF-WP-08C	8/23/2011	**5.4**	110 D	250 D	**710 D**	**2,200 Z**	**3,700 Y**	0.600	320	0.0	32.2	1.0	4,400
BFTF-WP-08C	8/19/2012	0.87	16	65 D	**226 D**	**900 Y**	210 Y	0.372 UJ	160	0.0	1,790	4.0	600

For all notes see the acronyms and abbreviations presented at the end of Appendix A



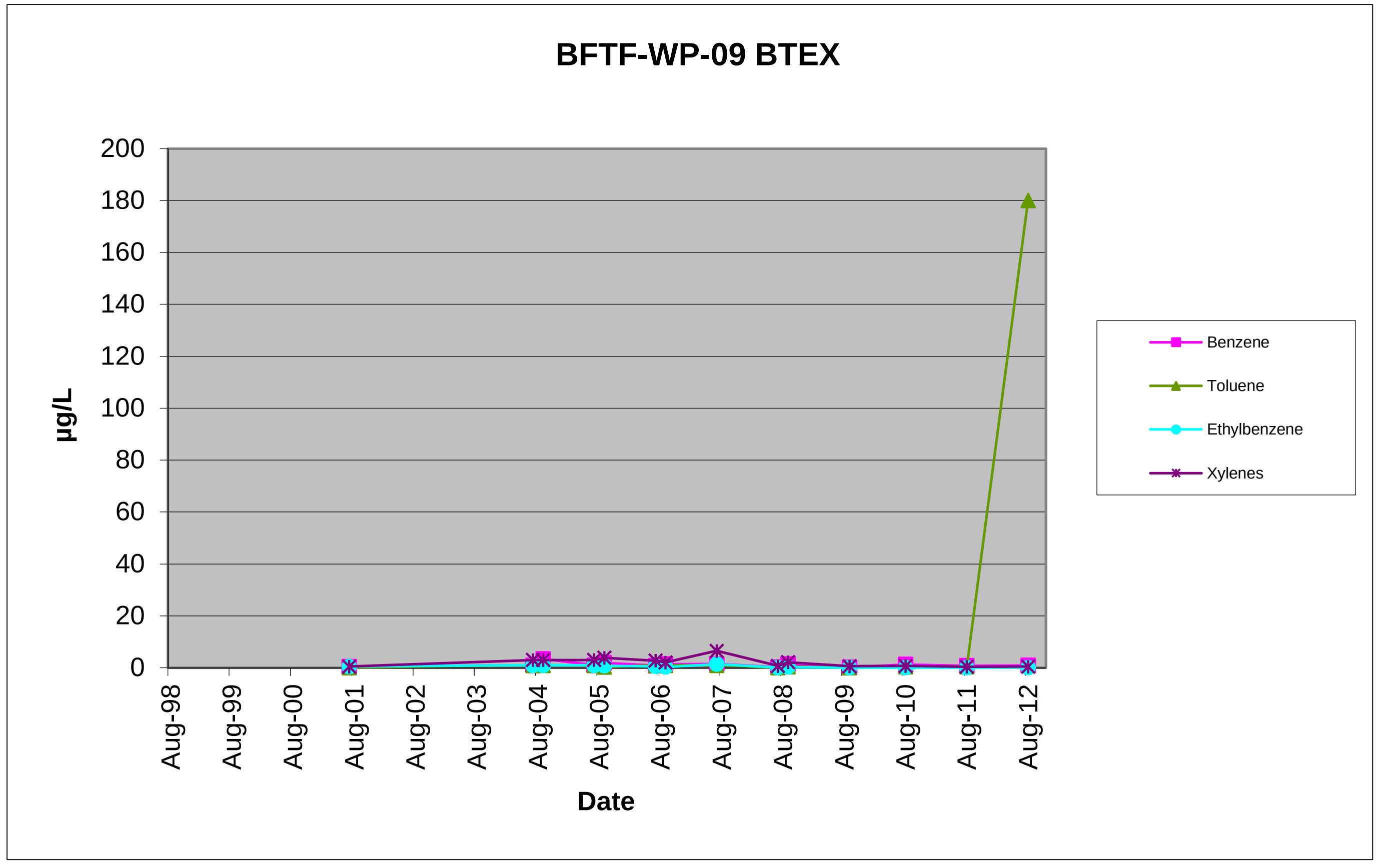


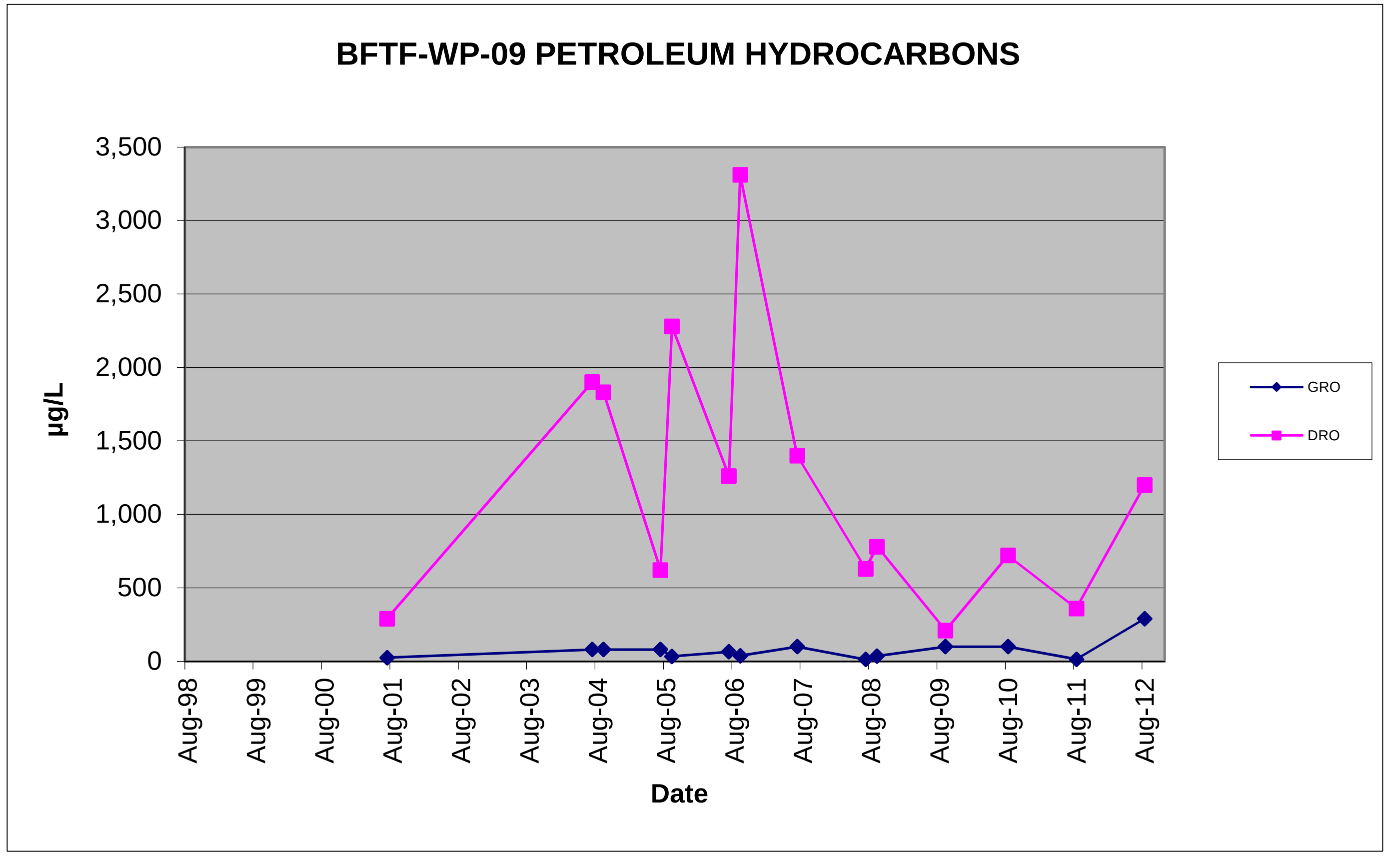
Former Bulk Fuel Tank Farm Site

Table A-28. BFTF-WP-09

		VOCs (µg/L)				Petroleum Hydrocarbons (µg/L)		Metals (µg/L)	Geochemical Parameters				
Well ID	**Collection Date**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**Lead**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater													
Cleanup Level		**5**	**1,000**	**700**	**18**	**267**	**923**	**3.2**	--	--	--	--	--
BFTF-WP-09	7/28/2001	0.50 U	0.13 U	0.50 U	0.50 U	25 UJ	290 Z	N/A	40	0.46 J	1,080	95.6	N/A
	7/23/2004	1.0 U	1.0 U	1.0 U	3.0 U	80 U	**1,900 X**	N/A	196	0.10 U	0.0	1.12	972
	9/23/2004	3.45	1.0 U	1.0 U	3.0 U	80 U	**1,830 X**	N/A	214	0.10 U	0.0	2.3	4,830
	7/11/2005	1.0 U	1.0 U	1.0 U	3.0 U	80 U	621 X	N/A	122	0.37	150	1.25	583 X
	9/8/2005	1.89	0.29 J	0.79 J	3.85	33.3 J	**2,280**	N/A	252	0.10 U	72	2.1	1,100 X
	7/20/2006	0.86	1 U	0.53 J	2.79	65.3 J	**1,260**	N/A	220	0.157	160	17	529
	9/13/2006	1.4	1 U	0.31 J	2.08	37.5 J	**3,310**	N/A	252	0.13	0.0	3.4	2,500
BFTF-WP-09	7/30/2007	1.5	1 U	1.4	6.5	100 U	**1,400 J**	N/A	220	0.0	2.4	1.6	740
BFTF-WP-09	7/25/2008	0.22 J	0.08 J	0.11 J	0.75 J	13 J	630 J	1.940	N/A	N/A	310	N/A	410 J
BFTF-WP-09	9/5/2008	1.4	0.50 U	0.33 J	2.15	36 J	780 Y	1.100	220	0.0	86	1.8	1,300
BFTF-WP-09	9/3/2009	0.17 J	0.05 J	0.05 J	0.62 J	100 U	210 J	0.248 J	210	0.0	1,100	3.4	210
BFTF-WP-09	8/27/2010	1.3	0.50 U	0.08 J	0.73 J	100 U	720 J	1.330	220	0.0	340	1.0	2,300
BFTF-WP-09	8/23/2011	0.82	0.50 U	0.050 J	0.40 J	14 J	360 J	0.600 U	200	0.0	1,170	2.1	930
BFTF-WP-09	8/15/2012	0.94	180 D	0.12 J	0.49 J	**290 Z**	810 Y	0.186 UJ	180	0.0	1,370	2.4	2,500
BFTF-WP-09 (DUP)	8/15/2012	0.93	180 D	0.13 J	0.48 J	**290 Z**	**1,200 Y**	0.202 UJ	200	0.0	1,340	2.5	2,600

For all notes see the acronyms and abbreviations presented at the end of Appendix A



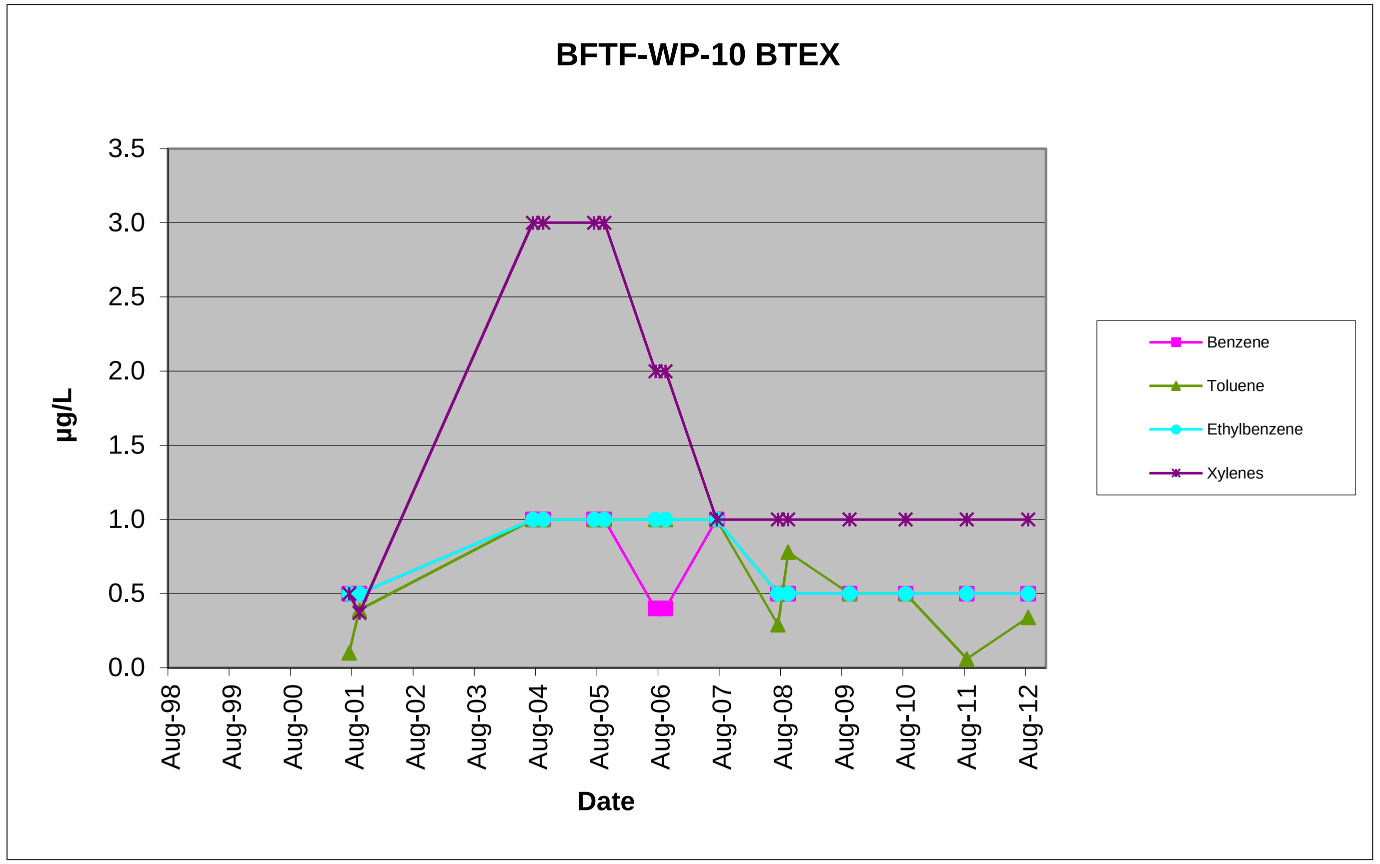


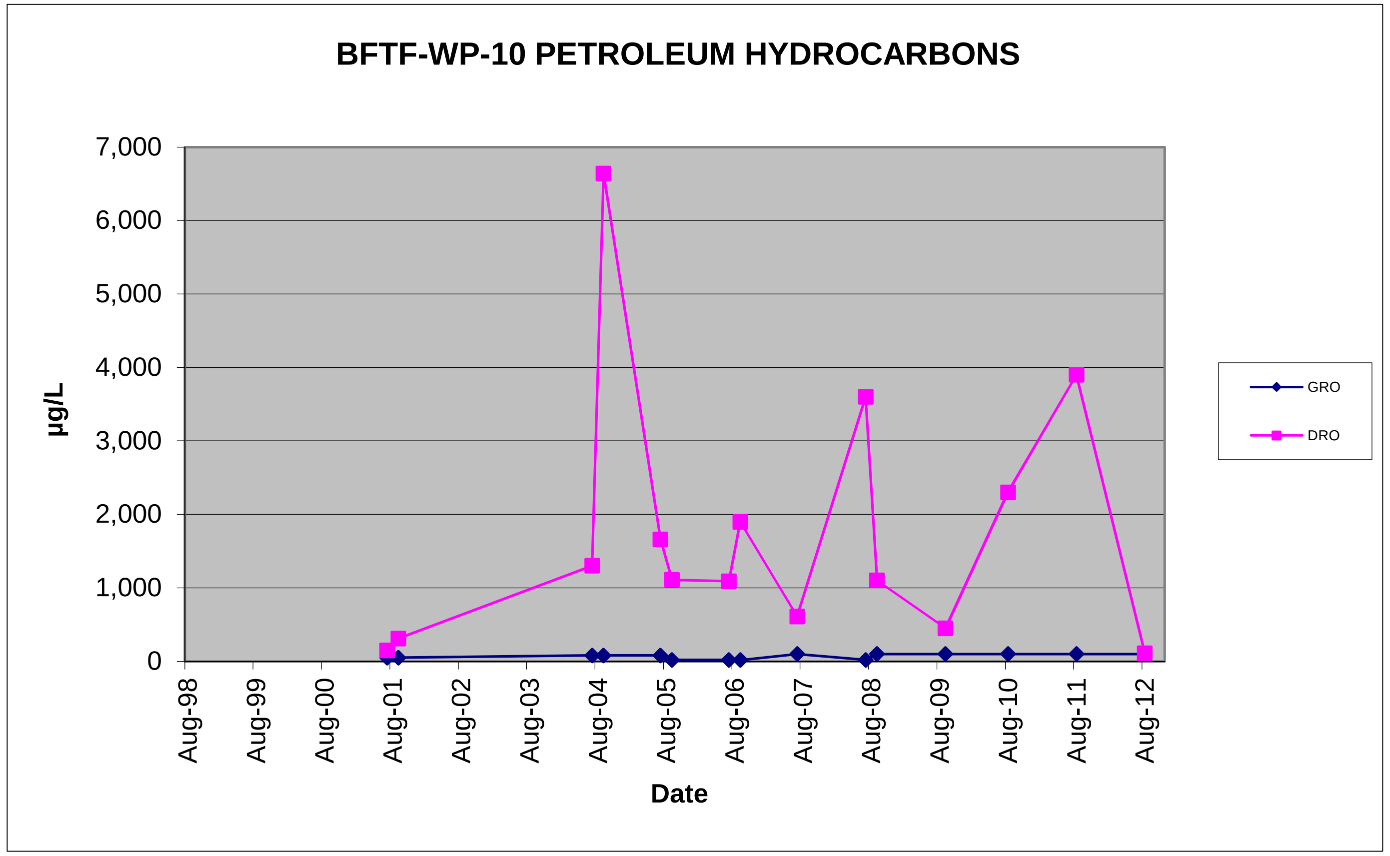
Former Bulk Fuel Tank Farm Site

Table A-29. BFTF-WP-10

		VOCs (µg/L)				Petroleum Hydrocarbons (µg/L)		Metals (µg/L)	Geochemical Parameters				
Well ID	**Collection Date**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**GRO (AK 101)**	**DRO (AK 102)**	**Lead**	**Alkalinity mg/L**	**Nitrate mg/L**	**Sulfate mg/L**	**Iron mg/L**	**Methane µg/L**
Active Zone Groundwater													
Cleanup Level		**5**	**1,000**	**700**	**18**	**267**	**923**	**3.2**	**--**	**--**	**--**	**--**	**--**
BFTF-WP-10	7/28/2001	0.50 U	0.10 U	0.50 U	0.50 U	50 U	150 Z	N/A	10	1.1	1,080	10.1	N/A
	9/26/2001	0.5 U	0.39 J	0.5 U	0.37 J	50 U	310 Y	N/A	2 U	0.5 U	1,120	73.6	N/A
	7/23/2004	1.0 U	1.0 U	1.0 U	3.0 U	80 U	**1,300 X**	N/A	227	0.1 U	0.0	1.0	11.7
	9/23/2004	1.0 U	1.0 U	1.0 U	3.0 U	80 U	**6,640 X**	N/A	449	0.1 U	770	0.21	67.7
	7/11/2005	1.0 U	1.0 U	1.0 U	3.0 U	80 U	**1,660 X**	N/A	217	0.1 U	525	32.5	52.4 X
	9/8/2005	1.0 U	1.0 U	1.0 U	3.0 U	18.9 J	**1,110**	N/A	137	1.0 U	1,300	3.05	5.86
	7/20/2006	0.40 U	1.0 U	1.0 U	2.0 U	19.4 J	**1,090**	N/A	144	0.0425 J	400	2.27	9.4
	9/13/2006	0.40 U	1.0	1.0	2.0 U	17.1 J	**1,900**	N/A	136	0.127	1,000	3.8	15
BFTF-WP-10	7/30/2007	1.0 U	1.0 U	1.0 U	1.0 U	100 U	610 J	N/A	280	0.0	810	2.0	3.9
BFTF-WP-10	7/24/2008	0.50 U	0.29 J	0.50 U	1.0 U	18 J	**3,600 Y**	1.730	220	0.0	246	1.8	4.8
BFTF-WP-10	9/3/2008	0.50 U	0.78 U	0.50 U	1.0 U	100 U	**1,100 Y**	0.60 U	180	0.0	1,010	3.2	4.1
BFTF-WP-10	9/4/2009	0.50 U	0.50 U	0.50 U	1.0 U	100 U	450 J	0.407 J	140	0.0	1,750	2.2	1.0
BFTF-WP-10	8/26/2010	0.50 U	0.50 U	0.50 U	1.0 U	100 U	**2,300 Y**	0.286	220	0.0	898	1.2	9.7
BFTF-WP-10	8/24/2011	0.50 U	0.060 J	0.50 U	1.00 U	100 U	**3,900 Y**	0.6 U	240	0.0	713	1.0	6.1
BFTF-WP-10	8/19/2012	0.5 U	0.34 J	0.5 U	1.0 U	100 U	110 Y	0.352 UJ	180	0.0	1,780	2.4	7.8

For all notes see the acronyms and abbreviations presented at the end of Appendix A





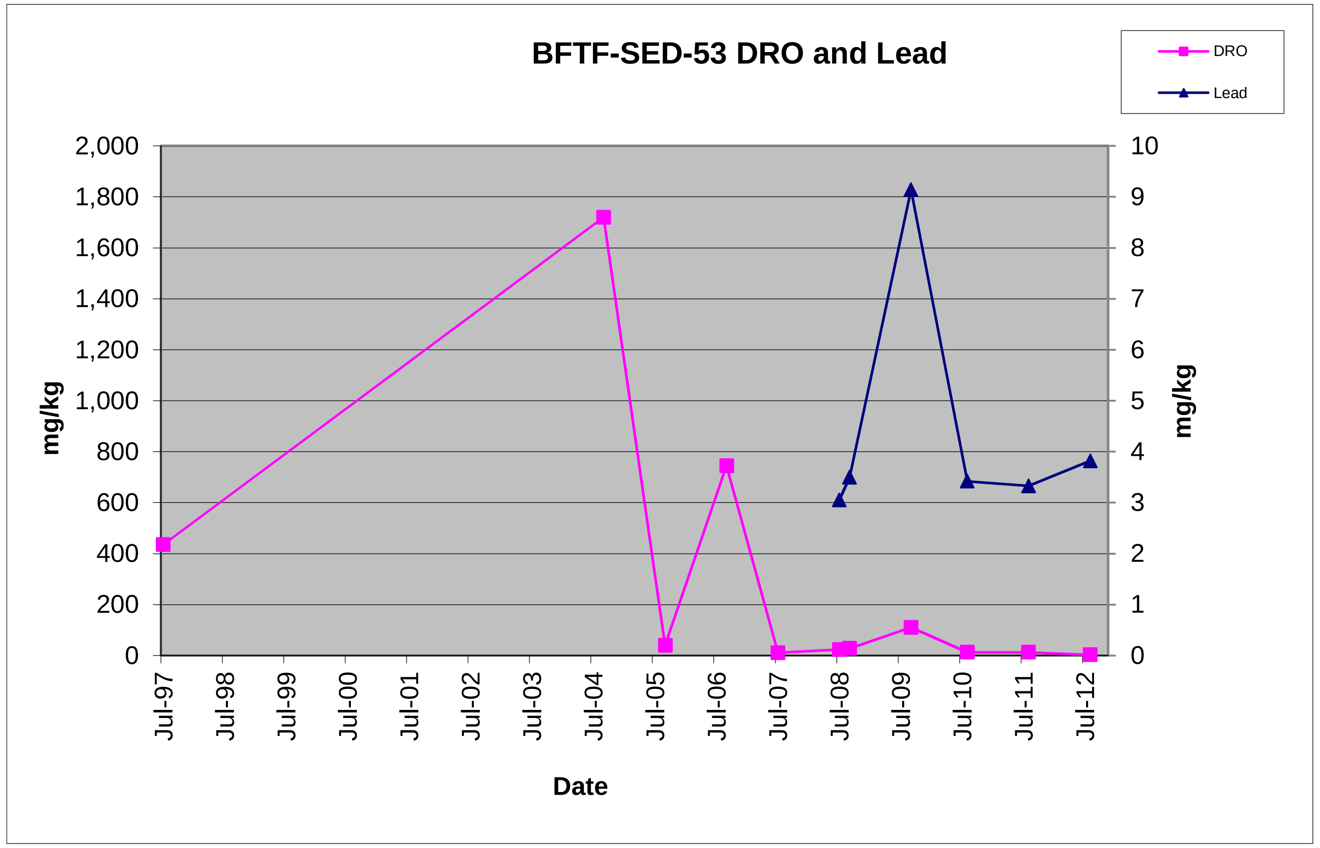
Former Bulk Fuel Tank Farm Site

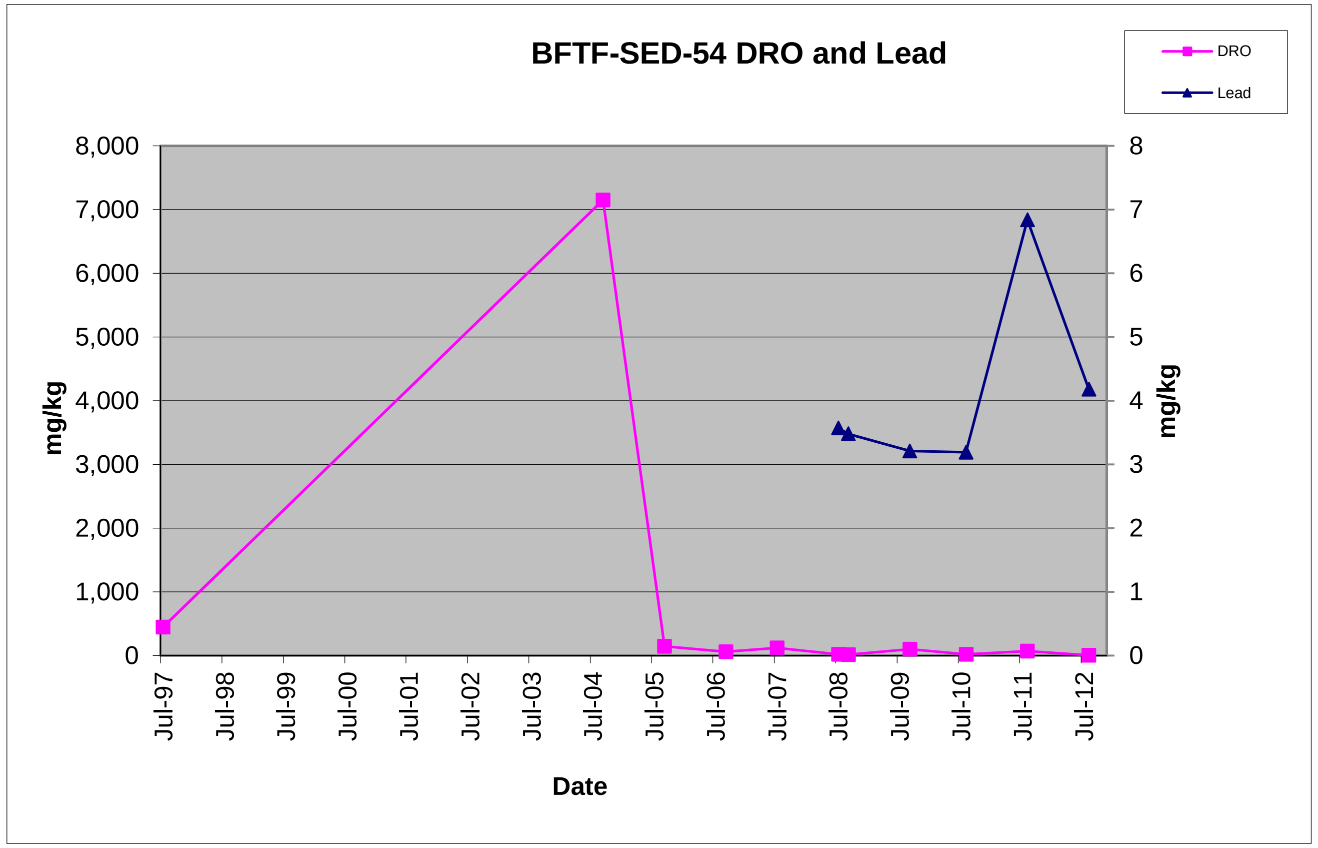
Table A-30. BFTF-SED-53

		Petroleum Hydrocarbons (mg/kg)				Metals (mg/kg)	
Location ID	Collection Date	GRO (AK 101)		DRO (AK 102)		Lead	
Sediment							
Cleanup Level		N/A		N/A		N/A	
BFTF-SED-53 [2/]	1997	1.65	U	436		#N/A	
BFTF-SED-53	9/23/2004	5.03		1,720		#N/A	
BFTF-SED-53	9/8/2005	1.33	J	40.5		#N/A	
BFTF-SED-53	9/13/2006	4.31	U	745		#N/A	
BFTF-SED-53	7/1/2007	4.9	U	11		#N/A	
	7/26/2008	5.9	UJ	24	UJ	3.05	
Duplicate	7/26/2008	5.5	UJ	11	J	3.49	
	9/4/2008	4.6	UJ	28	Y	3.50	
Duplicate	9/4/2008	4.5	UJ	27	Y	16.9	
	9/7/2009	190	Y	110	ZJ	9.140	J
	8/21/2010	42	U	13	J	3.420	
Duplicate	8/21/2010	28	U	41	Y	3.520	
BFTF-SED-53	8/18/2011	38	U	13	J	3.330	
BFTF-SED-53	8/19/2012	2.4	J	2.9	J	3.82	J

Table A-31. BFTF-SED-54

		Petroleum Hydrocarbons (mg/kg)				Metals (mg/kg)	
Location ID	Collection Date	GRO (AK 101)		DRO (AK 102)		Lead	
Sediment							
Cleanup Level		N/A		N/A		N/A	
BFTF-SED-54 [2/]	1997	1.54	U	448		#N/A	
BFTF-SED-54	9/23/2004	52.8		7,150		#N/A	
BFTF-SED-54	9/8/2005	2.84		147		#N/A	
BFTF-SED-54	9/13/2006	2.15	U	58.5		#N/A	
BFTF-SED-54	7/1/2007	10	U	120		#N/A	
	7/26/2008	5.6	UJ	17	J	3.57	
	9/4/2008	5.8	UJ	12	J	3.48	
	9/7/2009	28	U	99	Z	3.210	J
	8/21/2010	36	U	19	J	3.190	
BFTF-SED-54	8/18/2011	99	U	70	Z	6.840	
BFTF-SED-54	8/19/2012	19	U	2	J	4.18	J
BFTF-SED-54 (DUP)	8/19/2012	14	U	1.8	J	3.65	J

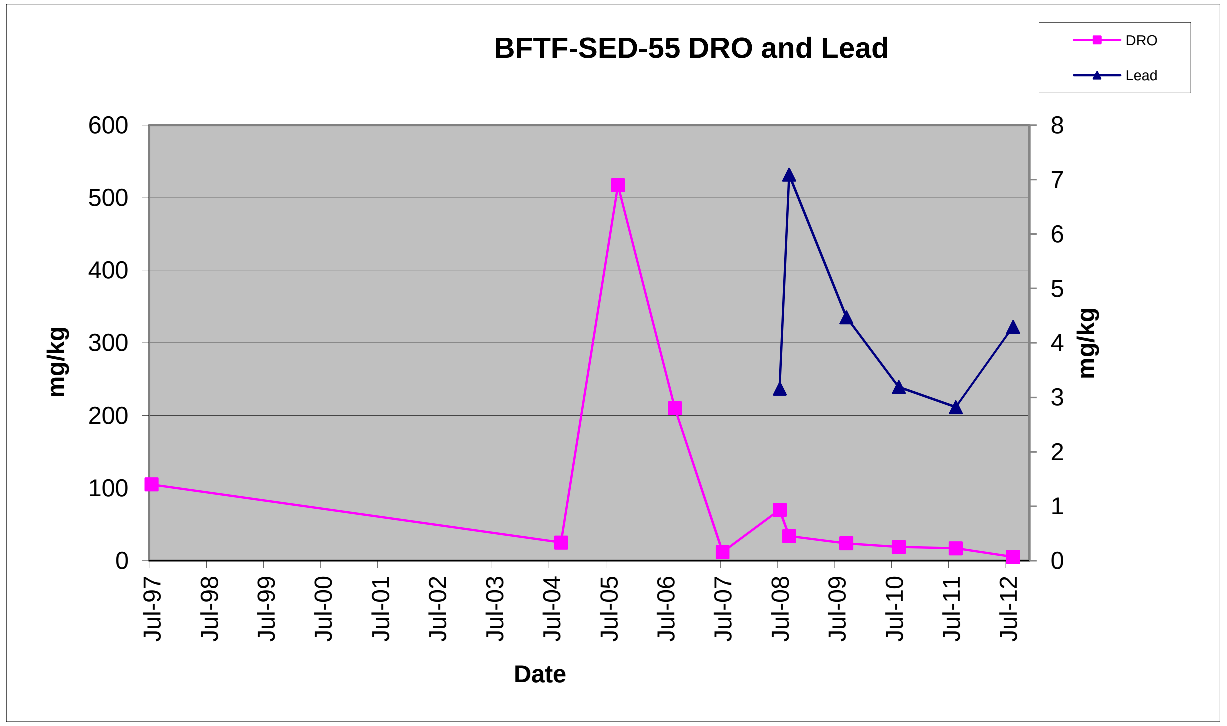




Former Bulk Fuel Tank Farm Site

Table A-32. BFTF-SED-55

		Petroleum Hydrocarbons (mg/kg)		Metals (mg/kg)
Location ID	Collection Date	GRO (AK 101)	DRO (AK 102)	Lead
Sediment				
Cleanup Level		**N/A**	**N/A**	**N/A**
BFTF-SED-55 [2/]	1997	0.91 U	105	#N/A
BFTF-SED-55	9/23/2004	2.85	25 U	#N/A
BFTF-SED-55	9/8/2005	2.32 U	517	#N/A
BFTF-SED-55	9/13/2006	3.48 UJ	210	#N/A
BFTF-SED-55	7/1/2007	4.4 U	12	#N/A
	7/26/2008	7.6 UJ	70 YJ	3.16
	9/4/2008	5.3 UJ	34 Y	7.09
	9/7/2009	26 U	24 U	4.470 J
Duplicate	9/7/2009	31 U	23 U	4.430 J
	8/21/2010	36 U	19 J	3.190
BFTF-SED-55	8/18/2011	43 U	17 J	2.82
BFTF-SED-55 (DUP)	8/18/2011	52 U	17 J	3.140
BFTF-SED-55	8/19/2012	16 U	5.4 J	4.29 J



Acronyms and Abbreviations For All Appendix A Tables

Bold data exceeds the associated cleanup level

Italized data is a non-detect result where the reporting limit exceeds the cleanup level

* BTEX value estimated. Data are from AK101/8021B run, instrument was not evaluated for BTEX compounds.

[1/] For DRO in the Airstrip and Powerhouse wells the cleanup level is 1,500 µg/L except for the inland wells where the 8,200 µg/L cleanup level applies.

[2/] The source table for this data (Table 7-2, Final 2006 Annual Monitoring Report) only provides the sample year. The full sample date including month and day could not be located in the historical documentation available.

-- Not Established
AK - Alaska
bgs - below ground surface
BTEX - Benzene, Toluene, Ethylbenzene, Xylenes
1,2-DCA - 1,2-Dichloroethane
D - Concentration is reported from a diluted analysis.
DRO - Diesel Range Organics
DUP - Duplicate
E - The result is an estimated amount because the value exceeded the instrument calibration range.
GRO - Gasoline Range Organics
H - The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
ID - Identification
J - Estimated concentration
K - Concentration is estimated due to sample being analyzed past hold time
L - The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
µg/L - micrograms per liter
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
N/A - Not Analyzed or Not Available
NS - Not sampled, well was dry
O - The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
PCE - Tetrachloroethene
R - Quality control indicates the data is not usable.
RRO - Residual Range Organics
TAH - Total Aromatic Hydrocarbons
U - Not detected at associated detection limit
Ui - The analyte is not detected at the indicated level of detection, the detection limit is elevated due to interference.
VOCs - Volatile Organic Compounds
W - The reporting limit for this analyte was raised due to the high analyte concentration present in the sample.
X - The detected hydrocarbons appear to be due to weathered, heavy gas/light diesel components.
X - D-1 The detected hydrocarbons in the diesel range do not have a distinct diesel pattern and may be due to heavily weathered diesel or possibly biogenic interference.
Y - The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
Z - The chromatographic fingerprint does not resemble a petroleum product.

APPENDIX B

Interview Responses

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INTERVIEW PARTICIPANT

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INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
December 2007 through December 2012
Type 1 Interview – Department of Defense Personnel
Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm Sites
Naval Arctic Research Laboratory (NARL)
Barrow, Alaska

Individual Contacted: Tommie Baker
Title: Community Involvement Coordinator
Organization: USAF, 611th CES
Telephone: (907) 552-4506
E-mail: Tommie.Baker@us.af.mil
Address: 611 CES/CEAR, 10471 20th Street, Suite 340, Joint Base Elmendorf-Richardson, AK 99506-2201

Contact made by: Nicole Rangel
Response type: e-mail
Date: May 15, 2012

Summary of Communication

1. Since the last 5 year review completed in 2008, are you aware of any changes in land uses, public access, or other site conditions that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: No

2. Are you aware of any changes in site conditions that might be the result of long-term climate change (such as a progressive loss of permafrost) and that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: The loss of permafrost and wildlife migratory habits has been broached during discussions and conversations at the Restoration Advisory Board meetings.

3. Are you aware of concerns from the local community regarding remedy implementation or overall environmental protectiveness of the selected remedies for the Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm sites?

   Response: No

4. To the best of your knowledge, were the soil excavation and treatment (including landfarming and hot air vapor extraction) components of the remedies completed in

accordance with the decision documents? To the best of your knowledge, were these remedy components effective in protecting human health and the environment?

Response: Yes

5. Do you believe that the monitoring performed at these sites since Fall of 2007 has met the intent of the decision documents, including sufficiently documenting the quality of surface water, active zone water, and sediment, documenting contaminant migration trends, and evaluating the occurrence of natural attenuation of contaminants?

   Response: Yes

6. Are you aware of any unexpected difficulties associated with site monitoring since Fall 2007?

   Response: No

7. Are you aware of any substantial changes to monitoring requirements or activities? If so, do you feel that these changes have impacted the protectiveness of the remedies selected in the decision documents?

   Response: No

8. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at the Airstrip, Powerhouse, or Former Bulk Fuel Tank Farm sites at NARL?

   Response: No

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
December 2007 through December 2012
Type 4 Interview – Community/Landowner Member
Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm Sites
Naval Arctic Research Laboratory (NARL)
Barrow, Alaska

Individual Contacted: Arnold Brower, Jr.
Title: Real Estate Specialist
Organization: Ukpeaġvik Iñupiat Corporation (UIC)
Telephone: (907) 852-4460
E-mail: arnold.brower@ukpik.com
Address: PO Box 890, Barrow, AK 99723

Contact made by: Nicole Rangel
Response type: e-mail
Date: May 15, 2012

Summary of Communication

1. Do you feel well informed about the progress of environmental cleanup activities for the Powerhouse and Former Bulk Fuel Tank Farm sites at NARL?

   Response: No. Lack of communication and any schedule for use of land during cleanup, etc.

2. Are you satisfied with the level and quality of information provided to the Restoration Advisory Board (RAB) through RAB meetings and associated presentations?

   Response: No, I am not privy to such information.

3. What is your overall impression of the on-going environmental cleanup activities at these sites since the last five year review completed in 2008?

   Response: Too slow, it is holding up progress for staging areas.

4. Do you have any suggestions regarding implementation and monitoring of the remedies? If so, please give details.

   Response: Yes, give or grant a ROW to UIC RE for surface uses.

5. What effects on the community (or on the environment) have you observed as a result of on-going remedy implementation, especially since 2007 or the last 5 year review?

   Response: Delay or loss of revenue for staging areas lease to entities work in or near Barrow, AK.

6. Are you aware of any community concerns regarding implementation of the remedies? If so, please give details.

   Response: Yes, surface use only could have a more positive use impact.

7. a) Since the last 5 year review, are you aware of any events, incidents, or activities (e.g., vandalism or emergency response) related these sites? If so, please provide details of the events and results of the responses. b) Do you believe sufficient safety procedures have been implemented to ensure safety of personnel on the sites?

   Response: No. N/A

8. Are you aware of any changes in land use or site conditions (including any changes that might be the result of long-term climate change) that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: No.

9. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at the Powerhouse and Former Bulk Fuel Tank Farm sites at NARL?

   Response: It should be transferred to UIC, for surface use only if other mediation is pending.

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
December 2007 through December 2012
Type 4 Interview – Community Member
Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm Sites
Naval Arctic Research Laboratory (NARL)
Barrow, Alaska

Individual Contacted: Thomas C. Brower III
Title: Land Management Specialist
Organization: North Slope Borough Land Management (NSB)
Telephone: (907) 852-0440, ext. 223
E-mail: tommy3brower3@yahoo.com, thomas.browerIII@north-slope.org
Address: P.O. Box 69 Barrow, Alaska 99723

Contact made by: Nicole Rangel
Response type: e-mail
Date: May 15, 2012

Summary of Communication

1. Do you feel well informed about the progress of environmental cleanup activities for the Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm sites at NARL?

   Response: The Barrow RAB has been very informed on the progress and the past five years of the monitoring program the Navy has implemented for these sites.

2. Are you satisfied with the level and quality of information provided to the Restoration Advisory Board (RAB) through RAB meetings and associated presentations?

   Response: I as the Co-Chair has been satisfied with the information provided by the Navy, but this is myself as I always am persistent to the level of information for the community to be provided.

3. What is your overall impression of the on-going environmental cleanup activities at these sites since the last five year review completed in 2008?

   Response: The only site I believe that there is still concerns of the clean up level is the Bulk Fuel Tank Farm. Some community members still complain about the smell of the fuel and have stated that the land farming is not the effective way to remediate this site.

4. What effects on the community (or on the environment) have you observed as a result of on-going remedy implementation, especially since 2007 or the last 5 year review?

   Response: This question should also be asked to UIC if there are concerns of the sites inside the UIC/NARL since they have employees that are working within these sites other then Bulk Fuel Tank Farm.

5. Are you aware of any community concerns regarding implementation of the remedies? If so, please give details.

   Response: Only the Bulk Fuel Tank Farm the community members that has summer cabins in close proximity to this site no longer use them due to odor, some folks have blamed this site for illness to there parents and passed on but there is no way to prove it. This is only the assumption by the users of summer camp area.

6. a) Since the last 5 year review, are you aware of any events, incidents, or activities (e.g., vandalism or emergency response) related these sites? If so, please provide details of the events and results of the responses. b) Do you believe sufficient safety procedures have been implemented to ensure safety of personnel on the sites?

   Response: This question should be asked to UIC Administration to see if there are concerns from the employees and check the status of the long term employees if there has been any events leading to personnel safety and health from exposure.

7. Are you aware of any changes in land use or site conditions (including any changes that might be the result of long-term climate change) that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: No I am not aware of any changes to land use but the question I feel is miss-leading when it states long-term climate change. But again if climate change is used to as to site conditions, maybe these site should be revisited to see if any effects are being done to the sites, like perma-froze thawing and the level of contamination is being raised.

8. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at the Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm sites at NARL?

   Response: The Powerhouse when it was visited for the level of contamination we felt that the cleanup was not done adequately and only spot were excavated and

not the whole area where there were issues brought out during the RAB meeting. The Bulk Fuel Tank Farm when land farming was to do the natural insinuation process, the community feels that this is not effective way to have mother nature too the work, one can stick his or her hand into the gravel and still smell fuel odor. The Airstrip should be revisited to see if any additional fuel that was not located has migrated to the test bore holes and see if the ice wall is still effective or has failed due to climate change or other words warming trend of the Arctic.

I am recommending that interviews be done to other organizations; Native Village of Barrow, UIC President, Realty Director or the Land Chief, Inupiat Community of Arctic Slope (ICAS), ADEC Representative who has over seen the cleanup of these sites.

One final recommendation is to do a presentation of all these sites from the beginning (before the cleanup), during, and to where it is at today before any attempt to do the close out of these sites.

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
December 2007 through December 2012
Type 1 Interview – Department of Defense Personnel
Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm Sites
Naval Arctic Research Laboratory (NARL)
Barrow, Alaska

Individual Contacted: Kendra Liebman
Title: Remedial Project Manager
Organization: NAVFAC NW
Telephone: (360) 396-0022
E-mail: kendra.liebman@navy.mil
Address: 1101 Tautog Circle, Silverdale, WA 98315-1101

Contact made by: Nicole Rangel
Response type: e-mail
Date: May 15, 2012

Summary of Communication

1. Since the last 5 year review completed in 2008, are you aware of any changes in land uses, public access, or other site conditions that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: No

2. Are you aware of any changes in site conditions that might be the result of long-term climate change (such as a progressive loss of permafrost) and that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: Increasing temperatures in soil caused by increasing air temperatures may result in deeper active zone depths (i.e., deeper thaw of the permafrost). This may result in the release of petroleum hydrocarbons that hover above the permafrost in the summer months.

3. Are you aware of concerns from the local community regarding remedy implementation or overall environmental protectiveness of the selected remedies for the Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm sites?

   Response: No

4. To the best of your knowledge, were the soil excavation and treatment (including landfarming and hot air vapor extraction) components of the remedies completed in accordance with the decision documents? To the best of your knowledge, were these remedy components effective in protecting human health and the environment?

   Response: Yes/Yes

5. Do you believe that the monitoring performed at these sites since Fall of 2007 has met the intent of the decision documents, including sufficiently documenting the quality of surface water, active zone water, and sediment, documenting contaminant migration trends, and evaluating the occurrence of natural attenuation of contaminants?

   Response: Yes

6. Are you aware of any unexpected difficulties associated with site monitoring since Fall 2007?

   Response: No

7. Are you aware of any substantial changes to monitoring requirements or activities? If so, do you feel that these changes have impacted the protectiveness of the remedies selected in the decision documents?

   Response: No

8. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at the Airstrip, Powerhouse, or Former Bulk Fuel Tank Farm sites at NARL?

   Response: The Navy is conducting a soil investigation at the Airstrip and Powerhouse sites in July/Aug 2012. The soil investigation focuses on the areas of concern that may be contributing to the increasing trends in the active zone water as well as areas of historical petroleum spills, monitoring wells that exhibit contaminant exceedances, and excavation areas associated with the former NARL facility. The soil investigation is designed to illustrate the vertical and horizontal extent of residual petroleum contamination, and whether there are isolated pockets of contamination and/or widespread low-level contamination. The information obtained from this investigation and site geophysical information known from previous investigations will be used to determine whether the contaminants are migrating towards the monitoring wells, and will

facilitate the development of preliminary cleanup or monitoring recommendations for the Airstrip and Powerhouse sites.

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
December 2007 through December 2012
Type 3 Interview – Land Owner
Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm Sites
Naval Arctic Research Laboratory (NARL)
Barrow, Alaska

Individual Contacted: Susan Flora
Title: Environmental Scientist
Organization: United States Bureau of Land Management (BLM)
Telephone: (907) 474-2303
E-mail: slfora@blm.gov
Address: P.O. Box 250 Barrow, Alaska 99723

Contact made by: Nicole Rangel
Response type: e-mail
Date: May 15, 2012

Summary of Communication

1. Do you feel well informed about the environmental cleanup activities and progress for the Airstrip site at NARL, since the last five year review completed in 2008?

   Response: The progress of the spill site located partially on withdrawn lands and partially on NPR-A lands (in the low spot between the Navy and Air Force hangars) should be more clearly delineated and more actively remediated. The focus to date has assumed the subsurface flow is to the lake to the south. However visual observations of sheening of surface waters to the east indicate that the flow is also (or primarily) to the east. Monitoring wells should be placed to the east, on NPR-A lands to track the eastward flow and concentrations of the plume. Also, signage and summer season use of sorbants/booming in the shallow surface water (where sheening is occurring) should be implemented.

   Ripped up Marstan Matting around the hangar is a physical hazard that has not been addressed. This could be removed in association with the Air Force removal of damaged matting around their hangar.

   Although a good effort was exerted in 2011 to remove abandoned power lines and research projects in the Antenna Farm area, the contractor identified an equal amount of work remaining. I urge the Navy to adopt the recommendations of the contractor.

2. What is your overall impression of the on-going environmental cleanup activities at the Airstrip site since Fall of 2007?

   Response: See response 1, above.

3. Are you aware of any changes in site conditions (including any changes that might be the result of long-term climate change) that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: I have had virtually no on-the-ground experience at these sites.

4. Do you have any suggestions regarding implementation and monitoring of the remedies? If so, please give details.

   Response: See response to 1, above. Furthermore, many of the monitoring wells are in unusable condition and need to be properly plugged/abandoned. New monitoring wells should be installed to track the eastward subsurface flow of POLs onto NPR-A lands. A permit would have to be applied for and granted to do this needed work.

5. Are you aware of any community concerns regarding implementation of the remedies? If so, please give details.

   Response: The community, as represented in comments given at RABs over the years, wants the runway site—at least on the north end—to remain in use for the picnic area and whale harvesting/butchering activities. Since the Marstan Matting is in good shape in this area, its existence may be why the site is preferred. At the Antenna Farm, the community wants the solid wastes, remains of various experiments, unused power lines, etc. removed so that clearance to construct an inland road to NARL can commence. At the other sites, the community wants assurance that contaminants that could adversely impact their subsistence food sources are removed.

6. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at the Airstrip site at NARL?

   Response: Cooperating with the Air Force in 2011 to jointly address cleanup activities at adjacent sites was incredibly efficient and effective. And, the joint projects utilized a local contractor. This was win-win for all parties and the community.

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
December 2007 through December 2012
Type 1 Interview – Department of Defense Personnel
Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm Sites
Naval Arctic Research Laboratory (NARL)
Barrow, Alaska

Individual Contacted: Ronald Pflum
Title: Remedial Project Manager
Organization: USACE
Telephone: (907) 753-5785
E-mail: ronald.j.pflum@usace.army.mil
Address:

Contact made by: Nicole Rangel
Response type: e-mail
Date: May 15, 2012

Summary of Communication

1. Since the last 5 year review completed in 2008, are you aware of any changes in land uses, public access, or other site conditions that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: No

2. Are you aware of any changes in site conditions that might be the result of long-term climate change (such as a progressive loss of permafrost) and that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: No

3. Are you aware of concerns from the local community regarding remedy implementation or overall environmental protectiveness of the selected remedies for the Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm sites?

   Response: No

4. To the best of your knowledge, were the soil excavation and treatment (including landfarming and hot air vapor extraction) components of the remedies completed in accordance with the decision documents? To the best of your knowledge, were these remedy components effective in protecting human health and the environment?

Response: Yes to both questions to the best of my knowledge.

5. Do you believe that the monitoring performed at these sites since Fall of 2007 has met the intent of the decision documents, including sufficiently documenting the quality of surface water, active zone water, and sediment, documenting contaminant migration trends, and evaluating the occurrence of natural attenuation of contaminants?

   Response: Don’t know. I have not been kept informed of required monitoring by the Navy.

6. Are you aware of any unexpected difficulties associated with site monitoring since Fall 2007?

   Response: I have not been informed of any unexpected difficulties with site monitoring.

7. Are you aware of any substantial changes to monitoring requirements or activities? If so, do you feel that these changes have impacted the protectiveness of the remedies selected in the decision documents?

   Response: No

8. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at the Airstrip, Powerhouse, or Former Bulk Fuel Tank Farm sites at NARL?

   Response: No. Note that I do not have a copy of the decision document nor have I read it. The only information I know about these sites is what has been presented by the Navy.

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
December 2007 through December 2012
Type 1 Interview – Department of Defense Personnel
Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm Sites
Naval Arctic Research Laboratory (NARL)
Barrow, Alaska

Individual Contacted: Lori Roy
Title: Remedial Project Manager
Organization: USAF, 611th CES
Telephone: (907) 552-7697
E-mail: lori.roy@elmendorf.af.mil
Address: 611 CES/CEVR, 10471 20th Street, Suite 302, Elmendorf AFB, AK 99506-2270

Contact made by: Nicole Rangel
Response type: e-mail
Date: May 15, 2012

Summary of Communication

1. Since the last 5 year review completed in 2008, are you aware of any changes in land uses, public access, or other site conditions that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: No

2. Are you aware of any changes in site conditions that might be the result of long-term climate change (such as a progressive loss of permafrost) and that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: No

3. Are you aware of concerns from the local community regarding remedy implementation or overall environmental protectiveness of the selected remedies for the Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm sites?

   Response: No

4. To the best of your knowledge, were the soil excavation and treatment (including landfarming and hot air vapor extraction) components of the remedies completed in

accordance with the decision documents? To the best of your knowledge, were these remedy components effective in protecting human health and the environment?

Response: Yes

5. Do you believe that the monitoring performed at these sites since Fall of 2007 has met the intent of the decision documents, including sufficiently documenting the quality of surface water, active zone water, and sediment, documenting contaminant migration trends, and evaluating the occurrence of natural attenuation of contaminants?

   Response: Yes

6. Are you aware of any unexpected difficulties associated with site monitoring since Fall 2007?

   Response: No

7. Are you aware of any substantial changes to monitoring requirements or activities? If so, do you feel that these changes have impacted the protectiveness of the remedies selected in the decision documents?

   Response: No

8. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at the Airstrip, Powerhouse, or Former Bulk Fuel Tank Farm sites at NARL?

   Response: No

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
December 2007 through December 2012
Type 2 Interview – Regulatory Agency
Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm Sites
Naval Arctic Research Laboratory (NARL)
Barrow, Alaska

Individual Contacted: Tamar Stephens
Title: Environmental Program Specialist
Organization: ADEC
Telephone: (907) 451-2131
E-mail: tamar.stephens@alaska.gov
Address: ADEC Contaminated Sites Program, 610 University Avenue, Fairbanks, AK 99709-3643

Contact made by: Nicole Rangel
Response type: e-mail
Date: May 15, 2012

Summary of Communication

1. Since the last 5 year review completed in 2008, are you aware of any changes in land uses, public access, or other site conditions that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: No

2. Are you aware of any changes in site conditions that might be the result of long-term climate change (such as a progressive loss of permafrost) and that you feel may impact the protectiveness of the remedies selected in the decision documents?

   Response: No

3. Do you feel well informed about site activities at the Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm sites?

   Response: Yes

4. To the best of your knowledge, since the last 5 year review completed in 2008 have there been any new scientific findings that relate to potential site risks and that might call into question the protectiveness of the remedies for Airstrip, Powerhouse, and

Former Bulk Fuel Tank Farm sites? Have there been any changes to the ARARs upon which the remedy decision was based?

Response: Yes. Investigation of a tundra pond on the adjacent USAF property identified fuel contamination that is almost certainly resulting from migration of contaminants through active zone water at the Airstrip site. The Air Force and Navy are coordinating on installation of additional monitoring wells and on an expanded monitoring program for the Airstrip site.

5. Since the fall of 2007, have there been any complaints, violations, or other incidents related to the Airstrip, Powerhouse, or Former Bulk Fuel Tank Farm sites that required a response by your office?

   Response: No

6. Are you aware of any community concerns regarding implementation of the remedies at the Airstrip, Powerhouse, or Former Bulk Fuel Tank Farm sites? If so, please give details.

   Response: No

7. Do you have any suggestions regarding implementation of the remedies (including monitoring)? If so, please give details.

   Response: No

8. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at the Airstrip, Powerhouse, and Former Bulk Fuel Tank Farm sites at NARL?

   Response: The Navy is planning additional soil investigation this summer to look for additional soil that may serve as an ongoing source of contamination of active zone water at the Powerhouse and Airstrip sites. I support this effort. These are challenging sites, so additional soil characterization may yield valuable information that will allow for improved management of these sites.