

Corrective Action Report/Conditional Closure Request

**NOAA Site 1/Two Party Agreement Site 1- Former Diesel Tank Farm
NOAA Site 2/Two Party Agreement Site 2- Former Drum Storage Area
St. George Island, Alaska**

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ACRONYMS AND ABBREVIATIONS

AAC	Alaska Administrative Code	MSL	Mean sea level
ADEC	Alaska Department of Environmental Conservation	MS	Matrix spike
AST	Aboveground storage tank	MSD	Matrix spike duplicate
bgs	Below ground surface	NMFS	National Marine Fisheries Service
BTEX	Benzene, toluene, ethylbenzene, and total xylene	NOAA	National Oceanic and Atmospheric Administration
City	City of St. George Island	OSHA	Occupational Safety and Health Administration
cm	Centimeter	PAH	Polynuclear aromatic hydrocarbon
CQC	Contractor quality control	PCB	Polychlorinated biphenyls
CSM	Conceptual site model	PCE	Perchloroethylene
DGPS	Digital global positioning system	PCS	Petroleum-contaminated soil
DQO	Data quality objective	PEL	Permissible exposure limit
DRO	Diesel range organics	PID	Photoionization detector
EA	Environmental assessment	PQL	Practical quantitation limit
EPA	US Environmental Protection Agency	QA/QC	Quality assurance and quality control
ft	Feet	QAP	Master Quality Assurance Plan
ft ²	Square feet	RPD	Relative percent difference
GIS	Geographic information system	RRO	Residual range organics
GPS	Global positioning system	Tanaq	St. George Tanaq Corporation
GRO	Gasoline range organics	TDS	Total dissolved solids
HASP	Master Health and Safety Plan	TLC	Thin-layer chromatography
HAZWOPER	Hazardous waster operations and emergency response	TPA	Two-Party Agreement
HI	Health index	TPH	Total petroleum hydrocarbons
HVO	Halogenated volatile organics	TSP	Trisodium phosphate
LCS	Laboratory control sample	TWA	Time-weighted average
LCSD	Laboratory control sample duplicate	UST	Underground storage tank
LEL	Lower explosive limit	VOC	Volatile organic compounds
mg/kg	Milligrams per kilogram	yd ³	Cubic yards
mg/L	Milligrams per liter		

EXECUTIVE SUMMARY

This report describes the cleanup of two contaminated sites on St. George Island, Alaska: the Former Diesel Tank Farm, designated National Oceanic and Atmospheric (NOAA) Site 1/Two Party Agreement Site 1; and the Former Drum Storage Area, designated NOAA Site 2/Two Party Agreement Site 2. The federal government stored fuel at these sites from the 1950s to the 1970s. Tank and drum leakage, and spillage during fuel transfers, resulted in soil and groundwater contamination at both locations.

Approximately 14,300 cubic yards of contaminated soil were excavated from NOAA Sites 1 and 2 during the fall of 2006. Contaminated soil removal resulted in one large excavation that spanned both sites, which are located adjacent to each other. Soils with contaminant concentrations above applicable cleanup standards were removed to the extent practicable; however, excavation efforts were constrained to the north by the Bering Sea and to the south and west by the City of St. George's sewer system. Excavation depth was mostly limited by the area's water table, which was encountered at about 15 feet below the ground surface; however, bed rock was encountered as shallow as 7.5 feet below the ground surface in one area. The excavated soil was stockpiled at the City of St. George's new landfill for use as municipal waste day-cover. The excavation was backfilled with clean material after collection of cleanup confirmation samples.

Past investigations found free-phase petroleum product in NOAA Site 1 monitoring wells; however, during contaminated soil removal, groundwater exposed at the bottom of the excavation did not have a free-phase product layer greater than sheen. Past investigations also found that groundwater in the vicinity of NOAA Sites 1 and 2 has total dissolved solids concentrations above the Alaska Department of Environmental Conservation (ADEC) drinking water standard. The high dissolved solids concentration is indicative of saltwater intrusion from the Bering Sea, and renders the groundwater in this area unusable for potable water.

This report proposes that NOAA has completed all appropriate actions related to cleanup of NOAA Sites 1 and 2, and includes requests for conditional closure determinations for these sites from ADEC. The requests are based on the fact that all contaminated soils have been removed to the extent practicable, and on the direct observation that groundwater under the sites does not have a free-phase product layer amenable to extraction. NOAA, with concurrence from ADEC, has begun long-term monitoring of groundwater contaminants in the vicinity of NOAA Site 1 and Site 2; this monitoring will continue as long as necessary to ensure protection of human health and the environment.

1.0 INTRODUCTION

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) is responsible for characterization and restoration of specific sites on St. George Island, Alaska under Public Law 104-91 of 1996 and Public Law 106-562 of 2000. A Two-Party Agreement (TPA), signed in 1996 by NOAA and the State of Alaska, provides the framework for corrective action on St. George Island (NOAA 1996). The State of Alaska provides TPA oversight through the Alaska Department of Environmental Conservation (ADEC).

Under the TPA, NOAA is required to comply with State of Alaska regulations that were in effect in 1991:

- 1) The interim soil guidance for non-underground storage tank (UST) soil cleanup levels, dated July 17, 1991 (ADEC 1991);
- 2) The guidance for storage, remediation and disposal of non-UST petroleum-contaminated soils (PCS), dated July 29, 1991;
- 3) For water, the applicable water standards set out in 18 Alaska Administrative Code (AAC) 70; the applicable state and federal regulatory requirements for maximum contaminant levels for drinking water; and the interim guidance for surface and groundwater cleanups, dated September 26, 1990; and
- 4) For releases from regulated underground storage tank systems, 18 AAC 78 (ADEC 2006b).

With ADEC agreement, however, NOAA has chosen to follow more current regulations whenever possible.

The Former Diesel Tank Farm (NOAA Site 1/TPA Site 1) and the Former Drum Storage Area (NOAA Site 2/TPA Site 2), hereafter referred to as “Site 1” and “Site 2”, were contaminated with diesel range organics (DRO) and gasoline range organics (GRO) as a result of fuel storage and transfer operations conducted by the federal government from the 1950s to the 1970s. One soil sample location within Site 2 was also found to be contaminated with toluene, ethylbenzene, and total xylenes. The groundwater beneath these sites is contaminated with DRO, GRO, and benzene; free-phase petroleum product (free product) was observed in monitoring wells TPA1-MW-1 and TPA1-MW-4 (see Figure 6). The following sections provide site backgrounds and describe the contamination investigation and cleanup activities that NOAA has undertaken.

2.0 SITE BACKGROUND

2.1 OWNERSHIP

The City of St. George (the City) is the current owner of Site 1 and Site 2, having received the property from the federal government under a transfer of property agreement (NOAA 1984).

2.2 PROPERTY DESCRIPTION

Site 1 and Site 2 are located within Tract 43, Section 29, Township 41 south, Range 129 west of the Seward Meridian, Alaska, as shown on the Bureau of Land Management, File/Record No. ak2804100s12900w001, February 15, 1985, sheet 1 of 4 (Figures 1 and 2). Site 1 is centered on coordinates latitude 56° 36' 12.67" north and longitude 169° 32' 48.76" west; Site 2 is centered on coordinates latitude 56° 36' 12.81" north and longitude 169° 32' 45.83" west.

2.3 HISTORY

Site 1 – Former Diesel Tank Farm

Site 1 served as a fuel tank farm from the 1950s to the 1970s (E & E 1993). Figure 3 was developed from a 1967 aerial photo, and shows twenty 10,000 gallon above ground storage tanks (ASTs) located at the site, plus an additional AST in the adjacent Site 2. A 1964 Department of the Interior (DOI) drawing identifies two ASTs as being used for gasoline storage (DOI 1964). The DOI drawing also identifies one of the tanks as being damaged, making it a potential source of the GRO contamination found at the site. Site 1 tanks were filled from barges via 3-inch diameter transfer lines routed from the east boat launch and west landing (Figure 3). The tank farm was taken out of operation in the 1970s; the tanks were removed from the site in 1996 (Polarconsult 1997a).

Site 2 – Former Drum Storage Area

Site 2 was used for drum storage of diesel fuel and gasoline (Figure 3). DOI documents indicate that in 1964 there was a 20,000 gallon drum storage capacity for diesel fuel, and a 2,000 gallon drum storage capacity for gasoline. The drum storage area consisted of a soil platform behind a concrete-filled drum retaining wall. Most of the retaining wall was removed during 2006 cleanup activities. The drums were off-loaded full from barges and ships and/or filled from fuel barges via a 2-inch diameter manifold and hose system located on the north side of the site. In 2006, heavily contaminated soil was encountered along the north side of the site; this contamination may have been a result of leakage and spills from the drum filling operations. Site 2 was likely in use until the 1970s when it was taken out of operation along with TPA Site 1.

2.4 GEOLOGY

The geology of the Pribilof Islands consists of lava flows and sills, with lesser amounts of pyroclastic (explosive volcanic ejecta) and tuffaceous material (fine-grained volcanic fragments, particularly ash), as well as glacial deposits (Barth 1956). Bedrock on St. George Island consists of block-faulted, layered basaltic lava flows and minor amounts of pyroclastic material overlying peridotite basement rocks.

Site 1 and Site 2 were filled and leveled to create areas suitable for placement of tank saddles and a drum platform. Based on well installation logs (TTEMI 2005a) and what was encountered during petroleum-contaminated soil (PCS) excavation, vesicular basalt is encountered from 14 to 19 feet below the ground surface (bgs), and is overlain with silty gravel and fill material. The “ground surface”, prior to excavation in 2006, varied considerably within Site 1 due to concrete rubble and dirt piles left there as a result of construction of the City’s current sewer system and closure of the tank farm. Prior to excavation in 2006, Site 2’s “ground surface” was level and elevated about 2 feet behind a concrete-filled drum retaining wall.

2.5 HYDROGEOLOGY

In general, oceanic islands consisting of uniform geology develop a groundwater lens formed by the radial movement of infiltrating freshwater toward the shore. The rate of freshwater recharge, the size of the island, and the permeability of the subsurface dictate the profile and the thickness of the lens. The occurrence of potable groundwater on St. George Island is inferred from known geologic and hydrologic conditions and by analogy to other oceanic volcanic islands. Because the island is relatively narrow, the rate of recharge is low, and the subsurface fairly permeable, the freshwater lens is most likely thin (Anderson 1976).

The City of St. George currently obtains drinking water from four municipal wells located about 1/2 mile southeast of the city, near Upper Lake (Figure 1). Two of these wells were completed in 1987, and two were completed in 1988. The wells are located at elevations between 222 and 227 ft above mean sea level (MSL), with intake screens installed between 228 and 244 ft bgs (TTEMI 2005b). Water is piped from the wells via an insulated aboveground line to a pump house and water tank located adjacent to Upper Lake. The water is normally not treated before being distributed to the community.

The water table in the vicinity of Site 1 and Site 2 is encountered at approximately 15 to 16 feet bgs. Groundwater monitoring found dissolved petroleum contaminants above ADEC cleanup level criteria at both sites, free product in Site 1 monitoring wells, and total dissolved solids (TDS) above ADEC water quality standards throughout the area (TTEMI 2005b). Hydrogeological characterization found that groundwater flow in the vicinity of Site 1 and Site 2 is toward the north and west (Figure 7), away from the City’s drinking water supply wells (TTEMI 2005a). Hydrogeological modeling determined that, even under maximum pumping conditions, groundwater in the vicinity of these sites could not be drawn into the drinking water well area of influence (TTEMI 2005a).

2.6 ENVIRONMENTAL HISTORY

This section provides a chronological summary of environmental investigations and other actions that formed the basis for the corrective actions taken at Site 1 and Site 2. A more detailed summary of past investigation analytical results and findings can be found in NOAA’s corrective action plan (CAP) for Site 1 and Site 2 (NOAA 2004a).

Petroleum-Contaminated Soil Investigations and Actions

1993 Ecology & Environment, Inc. (E & E) conducted a preliminary assessment of St. George Island and found that there were two abandoned pipelines that supplied Site 1; one from the east boat launch and one from the west landing (Figure 3; E & E 1993). The report did not note indications of fuel leakage around these pipelines.

E & E Assessment Recommendation: Perform surface and subsurface soil sampling at TPA Site 1 to determine the level and extent of contamination.

1994 Woodward-Clyde performed an expanded site inspection on St. George that included Sites 1 and 2 (Woodward-Clyde 1995). Eleven test pits were excavated within these sites, from which soil samples and one water sample were collected and analyzed on-site in a field laboratory, and off-site at a fixed laboratory. At the field laboratory, soil samples were analyzed for DRO, GRO, toluene, ethylbenzene, total xylenes, volatile chlorinated solvents, polychlorinated biphenyls (PCBs), and total petroleum hydrocarbons (TPH). At the fixed laboratory, soil samples were analyzed for DRO, GRO, TPH, volatile organic compounds (VOCs), halogenated volatile organics (HVOs), PCBs, and metals (arsenic, cadmium, chromium and lead).

Both field and fixed laboratory results indicated that Site 1 and Site 2 soils were significantly contaminated with DRO and GRO. One soil sample location in Site 2 had toluene, ethylbenzene, and total xylene concentrations above applicable ADEC cleanup criteria. No other organic compounds or metals were found above ADEC cleanup levels for soil.

A water sample was drawn from a test pit located in the northwest corner of Site 2. The sample was collected at 8 feet bgs. The report (Woodward-Clyde 1995) stated the horizon was at a perched water table. The water sample was analyzed for DRO; GRO; TPH; benzene, toluene, ethylbenzene, total xylenes (BTEX); methylene chloride; perchloroethylene (PCE); PCB; arsenic; cadmium; chromium and lead. DRO exceeded the ADEC cleanup criterion; however, all other analytes were either not detected or found at concentrations well below applicable cleanup levels.

Woodward-Clyde Site Inspection Recommendation: Removal and/or in-situ treatment of an estimated 5,500 cubic yards (yd³) of petroleum contaminated soil (PCS) at Sites 1 and 2.

1996 Polarconsult Alaska, Inc. (Polarconsult) removed two 1,000-gallon underground storage tanks (USTs) from NOAA Site 3/TPA Site 3 – Inactive Gas Station, which is located south of Site 1 (Figure 3). One UST was used for diesel fuel storage, the other for gasoline storage. During tank removal Polarconsult found that the various piping connections between the supply lines, tanks and dispensers were improperly joined and probably contributed to constant leakage of diesel fuel and gasoline when in use (Polarconsult 1997b). As a result, the fueling shack, dispensing station and approximately 1,624 yd³ of contaminated soil were removed. The leaking fuels likely contributed to DRO, GRO, and BETX contamination of Site 1, which is down-gradient. The Site 3 excavation was constrained to the north by the City's sewer system, which is installed along the south side of Site 1 and Site 2.

Cleanup actions have been completed for Site 3. NOAA received a determination of conditional closure for NOAA Site 3 from ADEC in 2005 (NOAA 2005a).

2001 Tetra Tech Environmental Management Inc. (TTEMI) advanced 23 soil borings in and around Site 1 and Site 2 using a hand-driven boring tool. A total of 56 samples were collected from the borings and analyzed for DRO, GRO, residual range organics (RRO), VOC, semivolatile organic compounds (SVOC) and metals (TTEMI 2003).

TTEMI's analytical results confirmed widespread DRO and GRO contamination within Sites 1 and 2; RRO, VOC, SVOC and metal concentrations were found to be below ADEC cleanup criteria at both sites.

TTEMI Recommendation: Excavation of an estimated 5,165 yd³ of PCS from Sites 1 and 2.

2004 NOAA prepared a Corrective Action Plan (CAP) that included Site 1 and Site 2 (NOAA 2004a); the CAP was subsequently approved by ADEC. The CAP estimate for the volume of PCS at these sites was 10,250 yd³, nearly double the estimates provided by previous investigations. NOAA's estimate was derived from a geographical information system (GIS) spatial modeling tool, with previous sample data and assumed contaminant depths as inputs.

Pursuant to PCS disposal discussions with NOAA, ADEC conducted a risk evaluation of the potential effects to human health from land farming PCS on St. George Island, and determined that all associated risks were well below all risk management standards (ADEC 2004a). NOAA developed a contaminant fate and transport model for PCS placed at the City's new landfill site using Site 1 and Site 2 investigation analytical results and landfill specific data as model parameters (NOAA 2004b). The model indicated that Sites 1 and 2 PCS could be land-spread at the new landfill site (Figure 4) with minimal impact to the environment as long as the following model parameters of average contaminant concentrations and PCS stockpile depth were met:

Table 2-1

Contaminant Fate and Transport Model Parameters		
Contaminant	Maximum Average Concentration	Maximum Height of PCS Stockpile Over Native Surface
DRO	3,478 mg/kg	5.26 feet
GRO	193 mg/kg	5.26 feet
Benzene	0.05 mg/kg	5.26 feet
Toluene	1.53 mg/kg	5.26 feet
Ethylbenzene	0.48 mg/kg	5.26 feet
Xylenes	1.06 mg/kg	5.26 feet

NOAA proposed that the PCS be used beneficially as landfill berm construction material and municipal waste daily cover material; ADEC approved the proposal (NOAA 2004b; ADEC 2004b).

2005 NOAA prepared an Environmental Assessment (EA) to disclose potentially significant impacts to the human environment associated with the treatment and/or disposal of PCS on St. George Island (NOAA 2005b). The EA concluded that the preferred disposal alternative for PCS was to reuse it beneficially in the construction and operations of the City's landfill and on-island bioremediation by landspreading. NOAA and the City came to an agreement regarding use of the City's new landfill for landspreading and other beneficial uses of 20,000 yd³ of NOAA's PCS (NOAA 2005c).

2006 NOAA and ADEC held a public meeting on St. George in April that was attended by concerned island residents and representatives from the City Council and St. George Tribal Office. The purpose of the public meeting was to explain the modeling and associated parameters that led to the EA conclusion that landspreading at the City landfill sites was the preferable alternative for PCS disposal. NOAA and ADEC presented the data, and answered all questions to the satisfaction of those present.

In June 2006, Charles M. Mobley & Associates (Mobley) excavated five trenches within Site 2 (Figure 5) to investigate whether significant archaeological deposits might be disturbed during PCS excavation at Sites 1 and 2 (Mobley 2006). Archaeological trenches were not excavated within Site 1 due to that site being highly disturbed by the tank farm construction in the 1950's, and by mounds of concrete rubble and dirt left behind as a result of tank farm deconstruction and City sewer system installation. Trench locations in Site 2 were chosen based on what local topography suggested as areas where the least amount of site filling and leveling would have been required during the drum storage area construction (see Appendix A, photographs 5 through 7). Artifacts found in the Site 2 trenches included glass and ceramic shards, seal bones, a steel hatchet head, and scraps of leather. Mobley's "Determination of Effect" stated that the artifacts found in the proposed excavation area could not be tied to specific elements of historic villagers' family life or further the scientific knowledge of island conservation or industry, and therefore were not archaeologically significant or contributing to the National Landmark. Mobley judged that NOAA's intent on excavating contaminated soil from Site 1 and Site 2 would have no effect on cultural resources at St. George (Mobley 2006). Mobley encountered obviously contaminated soil between two and three feet bgs in the two westernmost trenches (Figure 5).

2007 NOAA and the City came to an agreement for use of 11,500 yd³ of NOAA PCS, in addition to the 20,000 yd³ of PCS covered by the 2005 agreement, as landfill cover material, and municipal day cover (NOAA 2007).

Groundwater Investigations

2001-2003 TTEMI conducted a hydrogeological investigation of groundwater flow in the vicinity of the City (TTEMI 2005a). The investigation included definition of hydrostratigraphic units, determination of aquifer hydraulic parameters, and tidal influence studies. Data collected from the investigation, plus information about the City's municipal well field's installation and operations, were used as inputs for modeling the expected static groundwater flow directions, and dynamic flow direction under differing municipal well pump rate scenarios. The investigation found that static groundwater flow in the vicinity of Site 1 and Site 2 is toward the Bering Sea to the

north, and to a lesser degree, to the west along the shoreline (Figure 7). The investigation also concluded that, even under maximum pump rates for the City's municipal well system, contaminants in the groundwater in Site 1 and Site 2 would never be drawn south into the well field capture zone.

2001-2004 TTEMI conducted groundwater contaminant characterization investigations at several St. George Island TPA Sites including Site 1 and Site 2. In 2001, monitoring wells TPA1-MW-1 and TPA2-MW-1 were installed at Sites 1 and 2 (Figure 6). In 2003, monitoring wells TPA1-MW-2, TPA1-MW-3, TPA1-MW-4, TPA1-PER-1, TPA1-PER-2, TPA1-PER-3, and TPA2-MW-2 were installed. Groundwater sampling was conducted in 2001, 2002, August 2003, November 2003, January 2004 and May 2004; samples were analyzed for DRO, GRO, VOC, SVOC, TDS and metals with the following results (TTEMI 2005b):

- Free product was observed in wells TPA1-MW-1 and TPA1-MW-4;
- Dissolved-phase DRO and GRO above ADEC Table C criteria (ADEC 2006a) were found in wells TPA1-MW-2, TPA1-MW-3, and TPA2-MW-1;
- Benzene above the Table C criterion was found in wells TPA1-MW-1 and TPA1-MW-3 for all sample events when benzene was an analyte;
- All analytes were below ADEC criteria in well TPA2-MW-2, with one exception being a benzene result slightly above the ADEC criterion in November 2003;
- Samples were not drawn from wells TPA1-PER-1, TPA1-PER-2, and TPA1-PER-3 because they were inadvertently installed in perched water tables not representative of the area's main groundwater aquifer.
- SVOC and metal concentrations were either non-detectable or at levels well below ADEC criteria with the exception of naphthalene which was detected in 2001 in monitoring well TPA1-MW-1. In their 2005 report, TTEMI did not include 2001 dissolved contaminant data from TPA1-MW-1 due to the presence of free product in this well.
- TDS concentrations in Site 1 and Site 2 were found above the ADEC water quality criterion. The likely cause of elevated TDS concentrations is the intrusion of Bering Sea salt water into the fresh water aquifer along the waterfront.

2003 TTEMI conducted an investigation of free product in the vicinity of Site 1. TTEMI attempted to use hydrocarbon bail-down testing coupled with empirical methods to calculate "actual" product thickness on the water table; however, tidal influences prevented this approach (TTEMI 2004). Therefore, the "apparent" (observed in-well) product thickness and assumed aquifer hydraulic parameters of porosity and hydrocarbon saturation were used to estimate free product volume. Studies have shown that observed product thickness in wells can be greater than the actual product thickness in the surrounding aquifer due to capillary action (Testa and Paczkowski 1989). TTEMI estimated the maximum volume of free product in the vicinity of Site 1 to be from 5,842 gallons to 16,754 gallons (TTEMI 2004); however, this is likely an overestimate due to the use of observed product thickness rather than empirically derived "actual" product thickness in the volume calculations.

2004 SLR Alaska (SLR) investigated free product in the vicinity of Site 1. SLR employed a different methodology than TTEMI for calculating actual product thickness, i.e. removing free product and measuring product recovery in test wells over a period of several hours (SLR 2005). SLR also employed well inflow testing to determine aquifer hydraulic parameters. SLR estimated that, based on calculated "actual" product thickness and measured hydraulic parameters, the volume of free product in the vicinity of Site 1 to be 814 gallons.

2005 NOAA produced a long-term groundwater monitoring plan, concurred in by ADEC, that designated four wells in the vicinity of Site 1 and Site 2 that would be monitored semi-annually for contaminant concentration trends and the presence of free product (NOAA 2005d). Monitoring wells TPA1-MW-2, TPA1-MW-3, TPA2-MW-1 and TPA2-MW-2, labeled "plume monitoring wells" in Figure 6, were chosen because previous groundwater investigations had not found free product in these wells. Also, their locations are down-gradient from the estimated location of the potential free product plume (TTEMI 2005b), and presumably would be in the path of any plume movement should it occur. Per the plan, groundwater monitoring will continue for five years after commencement. At the end of the five year period, NOAA and ADEC will evaluate whether continued monitoring is warranted.

2006 In May, NOAA with SLR consulting, excavated two trenches in the northwest area of Site 1 to measure depth to the water table bgs; measure the thickness of free product floating on the water table; measure and sample the “smear zone” at the soil interface between the free product and water table; and determine if any safety and/or health related problems, related to free product, would be encountered during contaminated soil removal throughout the site. SLR planned on using direct observation of the free product for refining product extraction system designs (SLR 2007).

In both trenches (Figure 5), the water table was encountered approximately 15 feet bgs; this depth to water table matched the water table depth indicated on logs from past well installations in this area (TTEMI 2005b). However, a discernable free product layer and corresponding smear zone were not observed in either trench (see Appendix A, photographs 1 through 4). A dark layer of odorous contaminated soil was observed in both trenches starting at about 1 foot bgs and continuing to the bottom of the trenches. Petroleum sheen was observed on the groundwater; however, the sheen may have been attributable to surface water from melting snow running over the contaminated sidewalls of the trenches. Photoionization detector (PID) readings at the top of the excavation indicated very low VOC levels; lower explosive limit (LEL) readings indicated explosive gas and vapor concentrations of 0 percent.

In June 2006, NOAA decommissioned monitoring wells TPA1-PER-1, TPA1-PER-2, TPA1-PER-3, and TPA1-MW-1 in preparation for PCS excavation later in the year. These wells were not being used for long-term groundwater monitoring (NOAA 2005d), and were located in the path of PCS removal.

In October and December 2006, Tanaq Services, Inc. (TSI) sampled four plume sentinel monitoring wells in the vicinity of Sites 1 and 2 (Figure 6) per the requirements of NOAA’s long-term groundwater monitoring plan (NOAA 2005d). Samples from wells TPA1-MW-2, TPA1-MW-3, TPA2-MW-1 and TPA2-MW-2 were analyzed for GRO, DRO, benzene, the contaminants found in concentrations above ADEC cleanup criteria in previous Sites 1 and 2 groundwater investigations. PCE was also analyzed for because it had been found in previous investigations in groundwater in the vicinity of TPA Site 8 – Active Power Plant. TPA Site 8 is located south of Sites 1 and 2. Unfortunately, due to sample container freezing and breakage during transport, DRO analytical results from this sampling round were rejected (TSI 2007a). GRO, benzene and PCE concentration trends did not appear to change significantly (see Table 2.2 below). Free product was not observed in any of the wells.

2007 In May, TSI again sampled four plume monitoring wells in the vicinity of Sites 1 and 2. As in 2006, wells TPA1-MW-2, TPA1-MW-3, TPA2-MW-1 and TPA2-MW-2 were analyzed for GRO, DRO, benzene, and PCE. Analytical results indicate relatively no concentration trend changes for benzene and PCE (TSI 2007b). GRO concentration trends did not change for wells TPA1-MW-2, TPA2-MW-1, and TPA2-MW-2, but indicate an upswing for well TPA1-MW-3. DRO concentrations indicate an upswing for all four wells. Sites 1 and 2 PCS excavation conducted in Fall 2006 in areas near or adjacent to the wells sampled likely influenced groundwater contaminant concentrations. Groundwater monitoring will continue through spring 2011, at a minimum, with contaminant concentration trends monitored and evaluated throughout this time period. Table 2-2 provides a summary of analytical results for the oceanfront sites sentinel wells from August 2003 through May 2007.

Table 2-2 Sentinel Well Monitoring Results

Analyte	ADEC Cleanup Level ^{a,b}	Sample Identification and Sample Date											
		TPA1-MW-2						TPA1-MW-3					
		Aug-03	Nov-03	Jan-04	May-04	Oct-06	May-07	Aug-03	Nov-03	Jan-04	May-04	Oct-06	May-07
GRO	1,300	100	250U	230	200	510	290	1,200	710	2,300	2,100	3,100	4,800
DRO	1,500	2,100	1,900	2,400	2,700	R	5,400	3,700	4,200	6,800	5,700	R	7,400
Benzene	5	1U	1U	1U	1U	1U	1U	50	220	260	220	94	59
PCE	5	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U

Analyte	ADEC Cleanup Level ^{a,b}	Sample Identification and Sample Date											
		TPA2-MW-1						TPA2-MW-2					
		Aug-03	Nov-03	Jan-04	May-04	Oct-06	May-07	Aug-03	Nov-03	Jan-04	May-04	Oct-06	May-07
GRO	1,300	50U	50 U	160	50 U	100U	51	110	110	79	92	120	180
DRO	1,500	360J	5,600	1,800	200	R	990	800	640	630	670	R	1,600
Benzene	5	1U	8	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
PCE	5	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U

Notes:

a Cleanup levels shown are from Title 18 of the Alaska Administrative Code, Section 75.345, Table C (Table C).

b Cleanup levels and analytical results expressed as micrograms/liter.

Shaded Indicates a result that exceeds the Table C cleanup level.

ADEC State of Alaska Department of Environmental Conservation

GRO Gasoline Range Organics

DRO Diesel Range Organics

PCE Perchloroethylene

J The quantitation is an estimate

R Analytical result rejected due to sample container freezing and breaking during transport.

U The analyte was analyzed for but was not detected; the associated number is the reporting limit.

3.0 REMOVAL METHODOLOGY

The cleanup objective for Site 1 and Site 2 is the removal of all PCS, to the extent practicable. The CAP (NOAA 2004a) specifies that ADEC Method Two (ADEC 2006a) will be used to establish the cleanup criteria for these sites. Past investigations identified DRO, GRO, and to a lesser extent, toluene, ethylbenzene, and xylenes as the soil contaminants at these sites. DRO, GRO and benzene are known groundwater contaminants in this area. Use of ADEC Method Two requires ensuring that select polynuclear aromatic hydrocarbon (PAH) concentrations meet cleanup criteria; although, these contaminants were not found at the sites. Table 3-1 presents the most stringent cleanup levels for the contaminants of concern at Sites 1 and 2, based on Method Two tables B1 and B2 “Under 40 Inch Zone” criteria.

Table 3-1 ADEC Method Two Cleanup Levels for Soil at Site 1 and Site 2

Analysis Type	Laboratory Method	Cleanup Level, mg/kg
GRO ^a	AK-101	300
DRO ^a	AK-102	250
RRO ^a	AK-103	10,000
Acenaphthene ^a	EPA 8270C	210
Anthracene ^a	EPA 8270C	4,300
Benzo(a)anthracene ^a	EPA 8270C	6
Benzo(b)fluoranthene ^b	EPA 8270C	11
Benzo(k)fluoranthene ^b	EPA 8270C	110
Benzo(a)pyrene ^b	EPA 8270C	1
Chrysene ^a	EPA 8270C	620
Dibenzo(a,h)anthracene ^b	EPA 8270C	1
Fluorene ^a	EPA 8270C	270
Indeno(1,2,3-c,d)pyrene ^b	EPA 8270C	11
Naphthalene ^a	EPA 8270C	43
Pyrene ^a	EPA 8270C	1,500

Analysis Type	Laboratory Method	Cleanup Level, mg/kg
Benzene ^a	AK-101	0.5 ^c
Toluene ^a	AK-101	5.4
Ethylbenzene ^a	AK-101	5.5
Total Xylenes ^a	AK-101	78

a Cleanup level based on Under 40 Inch Zone, Migration to Groundwater Maximum Allowable Concentration.

b Cleanup level based on Under 40 Inch Zone, Ingestion Maximum Allowable Concentration.

c 1991 cleanup level for benzene which NOAA is allowed to use per Two Party Agreement requirements (see Section 1.0).

The presence of the City's sewer system limited PCS removal on the south sides of Sites 1 and 2, and on the west end of Site 1. The system includes sewer collection piping, settling tanks, and discharge piping that leads to a Bering Sea outfall (Figure 8). To prevent damage by heavy equipment, a five foot set-back was established on the north side of the system within which equipment was excluded as much as possible. From the edge of the five foot set-back, PCS removal was conducted at an approximate 1 to 1 slope from the excavation surface to its bottom to prevent undercutting the system during excavation (see Appendix A, photograph 24).

Sites 1 and 2 abut the Bering Sea along their north sides. To address the danger of storm surge causing site flooding and subsequent release of contaminants, an approximate ten-foot buffer zone was established between the excavation and the beach line.

PCS removal (1) did not continue deeper than 15 ft bgs (depth of hazardous substance ingestion and inhalation protection), (2) was stopped approximately one foot above the water table, and (3) was stopped if equipment refusal was encountered. Equipment refusal is defined as the presence of consolidated soil and rock which causes the excavator bucket to release water vapor or smoke due to friction. Refusal was encountered from 7.5 to 13 feet bgs in the western corner of the Site 1 excavation (Figure 10); however, throughout most of the excavation, PCS removal depth was determined by either reaching the CAP cleanup goals, or encountering the water table at about 15 feet bgs.

Contaminated soil within the sites was generally discernable visually and by odor. PCS excavation started in the southwest corner of Site 1, and continued east through Site 1 and Site 2 until excavation limits (City sewer system, Bering Sea buffer, or depth restrictions) were reached or the cleanup goal obtained. At the start of the excavation, NOAA attempted to use Thin Layer Chromatography (TLC) for field screening. However, the TLC's results indicated low DRO concentrations which were not consistent with the obviously contaminated soil samples. Additionally, the DRO dye patterns present on the TLC development plates did not resemble dye patterns observed in previous, successful TLC projects. Fixed laboratory analytical results confirmed that the TLC results were indicating falsely low DRO concentrations. The cause of the false low results was not positively identified. TLC analysis is based on the soil DRO concentration, and one plausible explanation is that the presence of weathered gasoline and/or BTEX interfered with the TLC analysis. Throughout the excavation work, NOAA's contractor used PID head-space analysis for field screening, as allowed for by the CAP. Due to the presence of gasoline and BTEX, the PID head-space analysis proved reliable for providing a relative measure of soil contamination levels. Therefore, site excavation was guided by visual and olfactory indications, backed up by field screening using PID head-space analysis. TLC was dropped as a field screening method for Sites 1 and 2.

4.0 FIELD ACTIVITIES

In August 2006 NOAA awarded contract number AB133C-06-NC-1723 to ChemTrack LLC (ChemTrack) for the excavation of PCS from Sites 1 and 2. On September 5, 2006 ChemTrack and NOAA mobilized to St. George Island to start the project; the project was completed November 18, 2006. The following sections summarize project field activities. Appendix B contains copies of the contract daily quality control reports which provide details on the daily progress, problems encountered and decisions made during the course of the project. Appendix C contains copies of contractor field logs which document day to day decision making, field conditions, sample information, etc.

4.1 CONTRACTORS AND EQUIPMENT

NOAA provided three Kenworth 14-cubic yard dump trucks, a Caterpillar D5 bulldozer, a John Deere 624J loader, and a Caterpillar 320B excavator. NOAA also provided survey support using real-time kinematic global positioning system (GPS) instruments. ChemTrack, the prime contractor, provided the project manager, crew superintendent, heavy equipment operator/mechanic, and an environmental technician. ChemTrack also hired local labor as equipment operators, truck drivers, and flaggers. Subcontractors to ChemTrack included the St. George Tanaq Corporation, which supplied a field office, a Caterpillar 325 excavator, a crew pickup truck and the source for excavation backfill; the City, which supplied a crew break area within the Public Safety Building, road grading/maintenance services for the PCS haul route, and two dump trucks with drivers; and the island's Traditional Council, which provided a second pickup. Laboratory analytical services were subcontracted to Test America - Analytical Testing Corporation (Beaverton, Oregon) for all confirmation and characterization samples; and Analytica International, Inc. (Anchorage, AK) for quick turnaround analysis for evaluating TLC results.

4.2 PCS EXCAVATION

September 5 through September 12, 2006. Preparations were made for the excavation of PCS and moving it to the new City landfill for use as municipal waste day-cover. ChemTrack's project manager, a certified trainer, provided 8-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) refresher training to island residents who had already completed the 40-hour HAZWOPER course and were interested in working on the project. Ten island residents attended the training; eight were subsequently hired by ChemTrack. Concrete AST saddles and large rocks were removed from rubble piles in Site 1 and placed as riprap along the Bering Sea waterfront (Appendix A, photographs 8 through 16). A temporary access road was constructed with 720 yd³ of clean material from the east end of Site 2 to the west end of Site 1. The access road allowed dump trucks to be loaded with PCS without having to drive across contaminated soil, and was removed with the PCS as the excavation progressed from west to east (Appendix A, photographs 18 and 19). Two access ramps were constructed with 660 yd³ of clean material for dump truck access into the new City landfill's interior for building PCS day-cover stockpiles per the agreement between NOAA and the City (NOAA 2005c). The access ramps (Appendix A, Photograph 53) will be left in place after completion of all island PCS excavation for use by the City when moving day cover over municipal waste. Fencing was installed around the excavation site. Equipment maintenance and repair was performed during the preparation period, and was continued throughout the project.

September 12 through October 18, 2006. Approximately 14,280 yd³ of PCS and 720 yd³ of temporary access road material were excavated from Sites 1 and 2. Excavated soil was transported to the City's new landfill (Figure 4) where it was stockpiled for use as municipal waste day-cover (Appendix A, photograph 54). PCS characterization samples were collected daily, and day-cover stockpile heights were kept at 5 feet or less to ensure adherence to contaminant fate and transport model parameters (NOAA 2004b). Characterization samples were also collected from NOAA's clean backfill stockpile which was mined in 2005 from the island's red scoria borrow pit (Figure 1). Scrap metal and debris collected during excavation were either disposed of at the new City landfill, or placed at the City scrap metal collection area near the old City landfill.

PCS removal generally proceeded from the west end of Site 1 to the east end of Site 2 in one continuous excavation. Soil contamination was easily discernable by sight and odor. PCS was removed laterally to the south until the City sewer system set-back was reached; to the north until the Bering Sea buffer was reached; and to the west until excavation was no longer practicable due to the convergence of the City sewer system, the Bering Sea buffer, and beach area slopes which limited excavator access (Figure 9). Excavation to the east proceeded until field screening indicated that cleanup goals had likely been met. Vertically, PCS removal was limited by reaching refusal from 7.5 to 13 feet bgs in the western end of Site 1, and reaching the water table at approximately 15 feet bgs in the remainder of the excavation. The excavation bottom was maintained about one foot above the water table by periodically digging test pits to track the water table elevation. The Bering Sea buffer was erroneously breached in one location due to miscommunication between the ChemTrack project manager and excavator operator (Appendix A, photograph 31). The breach was backfilled immediately with concrete rubble as a temporary breakwater in the event of storm surge. On October 14, the excavator was moved from the east end of Site 2 to the west end of Site 1 to complete excavation in an area where the City sewer system, Bering Sea buffer and

increasingly shallow hard basalt converged (Figure 10; Appendix A, photograph 45). The final excavation bottom for Sites 1 and 2 had an area of approximately 24,468 square feet.

ChemTrack used PID head-space analysis for field screening throughout the PCS removal project. The PID proved valuable in qualitative assessment of soil contaminant levels with readings varying between 0 and over 500 parts per million (ppm). Soil samples were collected for fixed laboratory confirmation analysis based on highest PID readings. At the beginning of the Site 1 excavation, NOAA's TLC results indicated DRO concentrations that were often below 250 milligrams/kilogram (mg/kg). The project team considered these TLC results suspiciously low judging by the odorous and discolored soil samples. The higher PID readings were indicative of volatile compounds such as gasoline and BTEX, known contaminants at the sites. NOAA's field TLC measures only DRO concentration; therefore, the team thought it possible that the site was primarily contaminated with gasoline and BTEX rather than diesel fuel as past investigations had indicated. Soil samples were sent to a fixed-laboratory with a quick analysis turn-around requested; the resulting analyses confirmed DRO concentrations that were much higher than what TLC had indicated for the same sample locations. Also, site PCS samples were spiked with known concentrations of diesel fuel (1,000 and 5,000 mg/kg) and analyzed by TLC. The spiked TLC analysis results returned DRO concentrations that were falsely low. In August 2006, at another St. George Island site contaminated with DRO, TLC had provided results with good fixed-laboratory analysis correlation (PSD 2007). The project team concluded that matrix or contaminant interference specific to Sites 1 and 2 was the cause for the consistently low TLC results for DRO. The project team consulted with commercial laboratory and NOAA chemists, who reviewed confirmation sample chromatograms for indications of the presence of chemicals that could interfere with the TLC process. Ultimately, the reason for the poor TLC performance was not positively identified. Weathered gasoline, BTEX, or possibly overflows and leakage from the adjacent City sewer system may have interfered with the process of TLC plate development. TLC analysis was dropped as the primary field screening method for the Sites 1 and 2. PID head-space analysis, olfactory and visual indications were satisfactorily used to direct excavation activity and determine confirmation sampling locations.

The PCS was odorous during excavation from Sites 1 and 2, and when stockpiling it at the City landfill for use as day cover. The odor strength varied from day to day depending on where it was excavated from. BTEX are known contaminants at the sites; of these, benzene has the most stringent Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL). The project team used a Draeger air sampler and a Gas Alert Micro 5 PID to measure the air concentration of BTEX in the work zones, conservatively assuming any reading was due solely to benzene. The OSHA action level for benzene is 0.5 ppm; concentrations above 0.5 ppm necessitate worksite air monitoring. The OSHA PEL for benzene is 1.0 ppm, time-weighted average (TWA) over an eight hour work day. Air readings at the excavation sites never exceeded the OSHA action level of 0.5 ppm. On September 23, 2007, the BTEX concentration at the landfill measured 0.5 to 0.7 ppm. As a result, for the remainder of the Sites 1 and 2 excavations, air sampling was performed four times per day at the landfill to ensure the benzene PEL was not exceeded. The ChemTrack project manager, project superintendent, and heavy equipment operator/mechanic were qualified to wear respirators in the event the PEL was exceeded; however, no local operators were qualified. Subsequently, a local hire was flown to Anchorage for medical clearance and fit testing for respirator use. Fortunately, all air readings after September 23, 2007 were at background concentrations and did not exceed the OSHA action level.

The excavation bottom was maintained approximately one foot above the area water table to avoid water saturated soils and potentially highly contaminated "smear zone" PCS. Depth to groundwater was checked periodically during excavation by digging test pits into the water table. Direct observation of soil and groundwater conditions in these test pits matched those seen during exploratory trenching in May 2006 (see Section 2.6). The observations support the absence of a discernable "smear zone" and petroleum on the groundwater as a sheen (Appendix A, photographs 25, 32 through 34) with no free-phase product layer amenable to extraction.

On the west end of Site 1, a 4-inch diameter clay pipe running through the excavation was uncovered (Appendix A, photograph 41) about four feet bgs. The ends of the pipe were not found; however, judging by the angle of the of the pipe run, it is possible the pipe originated from a sump in the floor of a vehicle maintenance pit within the old machine shop located just south of the Site 1. As a precautionary measure, and with permission by the City, the sump was sealed with concrete.

October 19 through October 23, 2006. Approximately 1,200 yd³ of PCS were removed from NOAA Site 29, the Port Fuel Supply Line – East (Figure 3). PCS characterization and confirmation samples were taken. Field screening was accomplished utilizing PID head-space analysis. Deteriorating weather conditions raised project concerns about the ability to backfill excavations prior to haul routes becoming unusable due to snow and freezing conditions. Consequently, PCS removal was suspended at Site 29, and was resumed during the 2007 field season. NOAA will provide a separate Corrective Action Report (CAR) for Site 29.

October 24 through November 9, 2006. Sites 1, 2, and 29 were backfilled with clean scoria. A ramp was built into the bottom of the Site 1/2 excavation with clean material to allow dump truck access (Appendix A, photographs 46 and 47). Two additional dump trucks were leased from the City to expedite backfilling the excavations. Backfill was placed in lifts and compacted with NOAA's D5 bulldozer. Approximately 10,910 yd³ of clean backfill was placed into Sites 1 and 2. The discrepancy between the volume of PCS removed (14,280 yd³) and the backfill that replaced it (10,910 yd³) is mainly due to the fact that the original ground surface included dirt mounds in Site 1 and an elevated dirt "bench" behind a retaining wall around 3 sides of Site 2 (Appendix A, photographs 10 and 17). These features were removed and the final surface contours left flat.

June 22 through June 26, 2007. Final site contouring and old debris removal from around the perimeter of the excavation were completed. Approximately 450 pounds of fertilizer and 40 lbs of native grass seed mix were applied to the site; fertilizer and seed were then tilled in using a fence section towed behind an ATV (Appendix A, photographs 51 and 52).

4.3 INVESTIGATION-DERIVED WASTE MANAGEMENT

IDW generated during this corrective action included:

- Used nitrile sampling gloves, disposable sampling tools and plastic bags; disposed of at the local municipal landfill.
- Soil not extracted during TLC screening analysis was placed on the day-cover stockpile at the City's new landfill.
- Spent methylene chloride and small vials of soil that had been extracted using methylene chloride for TLC screening analyses were containerized and stored for future off-island disposal.
- Silica gel plates that had been spotted with methylene chloride during TLC screening sample analyses were containerized and stored for future off-island disposal.

4.4 SITE SURVEYING

Sample point locations, excavation extents and other site features were surveyed by NOAA using a survey-grade Trimble Total Station 5700[®] differential GPS. The Trimble Total Station 5700[®] is a GPS and GIS data collection and mapping system that combines a high performance, dual-channel GPS receiver and antenna with a local base station and real-time differential correction system to provide survey-grade accuracy in real time. Horizontal positions of surveyed locations were determined to within plus or minus 1 centimeter (cm), and elevations were measured within plus or minus 2 cm. GPS data were collected in latitude and longitude referenced to the World Geodetic System (WGS) 84 Datum, Universal Transverse Mercator Zone 2 coordinate system in meters.

5.0 SAMPLING METHODS

PID head-space analysis, TLC field screening and sample collection for fixed laboratory analysis were conducted consistent with NOAA's Master Quality Assurance Plan (QAP; NOAA 2006). PID head-space analysis, performed by ChemTrack, was the primary field screening method used during excavation of Sites 1 and 2. Confirmation samples were collected from locations with the highest PID readings and submitted for fixed laboratory analyses. Characterization samples of the excavated PCS and backfill materials were also collected and submitted for fixed laboratory analysis.

The following subsections provide an overview of sampling methods.

5.1 PID HEAD-SPACE ANALYSIS

Photoionizing detectors respond to organic vapors in air and provide a measurement of vapor concentration relative to a calibration standard. The following PID procedure, combined with visual, olfactory, and knowledge of the site's contamination history, were used for excavation decisions and determination of confirmation sample locations:

- Collect a soil sample from a freshly uncovered location.
- Fill a clean sealable plastic bag 1/3 full with the sample to be analyzed, quickly seal the bag.
- Allow headspace vapors to develop for about 10 minutes, agitate bag contents.
- Take a PID reading by opening the bag minimally and inserting the instrument probe midway into the bag headspace while avoiding uptake of soil particles and moisture. Record the PID reading in the field notebook.
- If the PID reading is 100 ppm or greater and olfactory/visual clues indicate PCS, then the sample location is considered contaminated for decision making purposes. Contamination is likely gasoline or other volatile substance as this reading was taken with a "cold" sample.
- If the PID reading is under 100 ppm, warm the bag up by taking indoors or placing in a vehicle with defrost on; repeat taking and recording the PID reading. If the PID reading increased for the warmed sample, the sample location is considered potentially contaminated with DRO. If the PID reading remains low, then the sample location is considered likely uncontaminated.
- The locations with the highest PID readings were selected for confirmation sample collection within an excavated area.

5.2 CONFIRMATION SAMPLES

ChemTrack collected confirmation samples for off-site laboratory analysis to document the DRO, GRO, RRO, BTEX and PAH concentrations remaining in the site's soil after completion of remedial activities. Per the CAP, the number of PAH sample analyses was 10% that of DRO/GRO. Confirmation samples were collected according to the following procedure. First, a minimum of six inches of soil was removed from the sampling location just prior to sample collection. Soil was placed directly from the sampling location into 4-ounce glass jars. For BTEX and GRO analyses, the samples were field preserved with methanol. For DRO, RRO, and PAH analyses, samples were homogenized prior to being placed in the jars. Soil samples were then placed in coolers with gel ice packs. Confirmation samples were packaged and shipped to off-site laboratories for the following analyses:

- GRO/BTEX by ADEC Method AK101/EPA Method 8021B
- DRO by ADEC Method AK102
- RRO by ADEC Method AK103
- PAHs by EPA SW-846 Method 8270C Selected Ion Monitoring

Seventy-five confirmation samples plus quality assurance samples, i.e. matrix spike/matrix spike duplicates (MS/MSD) and field duplicates, were submitted for fixed laboratory analyses from the Site 1 and 2 excavation (Figure 10). Analytical results are summarized in Section 6.0; quality assurance results are discussed in Section 7.0.

5.3 PCS CHARACTERIZATION

A grab sample was taken daily, at random, from a PCS load being hauled to the City landfill site. These samples were analyzed for DRO, GRO, RRO, BTEX and PAH (at rate of 10% DRO/GRO analyses) at a fixed laboratory to characterize the PCS placed at the landfill, and to document that contaminant concentrations did not exceed fate and transport model parameters for the use of PCS as day cover (see Section 2.6, Table 2.1).

Thirty-two characterization samples, plus quality assurance samples, were submitted for analyses. Analytical results, summarized in Section 6.0, indicate that model parameters were met. Quality assurance results are discussed in Section 7.0.

5.4 BACKFILL CHARACTERIZATION

In 2005, NOAA mined and stockpiled approximately 15,500 yd³ of scoria at the island borrow pit (Figure 1). To confirm the scoria backfill material was uncontaminated, Chemtrack gathered three samples from random locations, 18 inch below the stockpile surface. The samples were sent to a fixed laboratory and analyzed for DRO, GRO, RRO, BTEX and total lead. Analytical results, summarized in Section 6.0, indicate analyte concentrations were either non-detect or well below ADEC cleanup standards. 670 yd³ of backfill was also obtained from decommissioned groundwater monitoring well access pads located at various TPA sites around the City. Monitoring well pad material was screened by PID head-space analysis, and one sample was sent to a fixed laboratory. Table 6.3 provides backfill characterization analytical results.

5.5 THIN-LAYER CHROMATOGRAPHY SCREENING SAMPLES

Due to unexplained false-negative results, TLC was not used as a field screening method for directing excavation activity and determining the location of confirmation samples. However, the following summarizes the TLC methodology used for those field samples on which TLC was attempted.

TLC consists of solid-liquid chromatography for the semi-quantitative analysis of DRO in soil. Chemtrack collected TLC screening samples from the excavation, placing the soil into a clean, sealable plastic bag. Each sample was homogenized and kept cool until it could be processed at the NOAA field laboratory.

The TLC procedure involves solvent extraction of DRO from soil samples. Measured portions of the extracts are deposited onto a glass plate that is coated with a porous medium. Commercially prepared diesel standards of varying concentrations are also spotted on the plate. By using standards of diesel concentrations equal to, above, and below the ADEC DRO cleanup criterion of 250 mg/kg, the analyst is able to determine whether the excavation soil sample contains concentrations above or below the cleanup level; in addition, the analyst is able to determine the approximate concentration of DRO in each sample.

6.0 ANALYTICAL RESULTS

The following subsections summarize the fixed-laboratory analytical results for samples collected to document contaminant levels remaining at the excavation site, contaminant levels in excavation backfill material and contaminant levels in PCS stockpiled for day cover at the City landfill. Appendix D provides the analytical data packages for the fixed-laboratory analyses.

6.1 EXCAVATION CONFIRMATION SAMPLES

Analytical results for confirmation samples taken from the Site 1 and 2 excavation indicate that PCS remains only in areas precluded from further excavation. These areas include the south excavation wall near the City sewer system; in the western half of the bottom of the excavation, between 11.5 and 14 feet bgs; and in the west/northwest end of the excavation along the Bearing Sea buffer and near monitoring well TPA1-MW-3. Figure 10 provides the final excavation extents, confirmation sample locations, and color coding indicating whether analytical results for each sample location were above or below ADEC cleanup criteria. Table 6.1 provides a summary of analytical results for DRO, GRO, RRO, and BTEX. Table 6.1 also provides the PID reading for each sample location. Per the CAP, samples were analyzed for PAH at 10% of the number of DRO/GRO analyses.

With the exception of one sample location, remaining PCS is contaminated only with DRO above the ADEC cleanup criterion. Sample location SG01-CS-006-140 is contaminated with DRO, GRO, benzene, ethylbenzene, and total xylenes above applicable ADEC cleanup criteria (Figure 10 and Table 6-1). All PAH analytical results were non-detect or well below cleanup criteria (see Table 3.1 and Appendix D).

Table 6-1 Confirmation Samples Analytical Results

Sample ID	Depth ft bgs	DRO mg/kg	GRO mg/kg	PID ppm	Benzene mg/kg	Toluene mg/kg	Ethylben- zene mg/kg	Xylenes mg/kg	RRO mg/kg
Cleanup Level	-	250	300	-	0.5	5.4	5.5	78	10,000
SG01-CS-001-075	7.5	2050	241	111	ND<0.0573	0.197	1.73	2.49	ND<27.4
SG01-CS-002-065	6.5	3190	229	176	0.0513	0.233	2.46	4.38	ND<56.4
CS-002-Field Dup	6.5	2770	244	176	ND<0.0528	0.206	2.32	4.05	ND<56.9
SG01-CS-003-095	9.5	1750	126	71	0.0673	0.227	1.60	2.08	ND<27.4
SG01-CS-004-080	8	ND<13.5	ND<1.79	18	ND<0.0112	ND<0.0223	ND<0.0223	ND<0.0447	ND<27.1
SG01-CS-005-050	5	2770	209	179	ND<0.0459	0.175	2.61	5.80	56.5
SG01-CS-006-140	14	3420	398	513	0.522	1.33	20.6	78.8	ND<55.8
SG01-CS-007-130	13	1180	232	149	0.206	0.892	3.20	4.17	ND<27.8
SG01-CS-008-120	12	889	157	171	0.0616	0.244	1.58	2.36	ND<27.0
SG01-CS-009-130	13	483	29.2	113	ND<0.0106	0.0347	0.315	0.479	ND<28.5
SG01-CS-010-135	13.5	ND<13.4	ND<1.19	9	ND<0.00744	ND<0.0149	ND<0.0149	ND<0.0297	ND<26.8
SG01-CS-011-085	8.5	ND<13.3	ND<1.39	7	ND<0.00869	ND<0.0174	ND<0.0174	ND<0.0348	ND<26.6
SG01-CS-012-080	8	2900	198	141	ND<0.103	2.00	ND<0.205	4.12	ND<27.4
CS-012- Field Dup	8	3030	205	141	ND<0.102	2.10	ND<0.204	4.49	ND<26.8
SG01-CS-013-100	10	ND<13.8	ND<1.69	6	ND<0.0105	ND<0.0211	ND<0.0211	ND<0.0421	ND<27.6
SG01-CS-014-120	12	3020	235	208	ND<0.110	2.36	0.923	3.12	ND<27.2
SG01-CS-015-085	8.5	2580	15.3	40	ND<0.0125	ND<0.0250	ND<0.0250	0.169	ND<27.9
SG01-CS-016-050	5	15.0	ND<1.82	11	ND<0.0114	ND<0.0227	ND<0.0227	ND<0.0454	ND<29.1
SG01-CS-017-140	14	211	9.89	80	ND<0.00718	0.0932	ND<0.0144	0.115	ND<26.8
SG01-CS-018-140	14	ND<13.6	ND<1.05	17	ND<0.00659	ND<0.0132	ND<0.0132	ND<0.0264	ND<27.3
SG01-CS-019-140	14	1290	21.3	280	ND<0.00764	0.266	0.0193	0.412	ND<28.7
CS-019-MS/MSD	14	1380	18.0	280	ND<0.00665	0.244	0.0178	0.374	ND<28.2
SG01-CS-020-140	14	576	24.8	255	0.00945	0.260	0.0225	0.833	ND<28.8
SG01-CS-021-085	8.5	2340	57.6	77	ND<0.0115	0.256	0.0244	0.750	36.2
SG01-CS-022-100	10	ND<14.2	ND<2.30	8	ND<0.0144	ND<0.0288	ND<0.0288	ND<0.0576	ND<28.3
SG01-CS-023-065	6.5	127	2.36	33	ND<0.0135	ND<0.0270	ND<0.0270	ND<0.0539	ND<27.8
CS-023- Field Dup	6.5	49.6	3.52	33	ND<0.0114	ND<0.0228	ND<0.0228	ND<0.0455	ND<28.3
SG01-CS-024-100	10	106	10.4	52	ND<0.0130	0.0814	ND<0.0259	0.136	40.3
SG01-CS-025-055	5.5	ND<14.2	ND<1.80	12	ND<0.0113	ND<0.0225	ND<0.0225	ND<0.0450	ND<28.4
SG01-CS-026-095	9.5	ND<14.3	ND<1.61	9	ND<0.0101	ND<0.0202	ND<0.0202	ND<0.0403	ND<28.6
SG01-CS-027-140	14	ND<14.0	ND<1.44	18	ND<0.00899	ND<0.0180	ND<0.0180	ND<0.0360	ND<27.9
SG01-CS-028-130	13	2410	10.1	102	ND<0.00959	0.0916	ND<0.0192	0.225	62.7
SG01-CS-029-140	14	37.6	3.32	14	ND<0.00924	0.0230	ND<0.0185	0.0462	ND<27.0
SG01-CS-030-140	14	91.4	3.00	15	ND<0.00912	0.0205	ND<0.0182	0.0459	ND<28.2
SG01-CS-031-020	2	62.5	ND<2.25	6	ND<0.0140	ND<0.0281	ND<0.0281	ND<0.0562	ND<32.8
SG01-CS-032-015	1.5	ND<15.7	ND<2.50	5	ND<0.0157	ND<0.0313	ND<0.0313	ND<0.0626	ND<31.4
CS-032- Field Dup	1.5	ND<16.2	ND<3.74	5	ND<0.0234	ND<0.0468	ND<0.0468	ND<0.0935	ND<32.3
SG01-CS-033-025	2.5	ND<16.1	ND<2.41	8	ND<0.0151	ND<0.0301	ND<0.0301	ND<0.0602	ND<32.2
SG01-CS-034-070	7	ND<15.6	ND<2.18	5	ND<0.0136	ND<0.0272	ND<0.0272	ND<0.0545	ND<31.2
SG01-CS-035-040	4	ND<15.7	ND<2.05	4	ND<0.0128	ND<0.0256	ND<0.0256	ND<0.0512	ND<31.4
SG01-CS-036-080	8	ND<18.1	ND<2.64	5	ND<0.0165	ND<0.0330	ND<0.0330	ND<0.0660	ND<36.3

Sample ID	Depth ft bgs	DRO mg/kg	GRO mg/kg	PID ppm	Benzene mg/kg	Toluene mg/kg	Ethylben- zene mg/kg	Xylenes mg/kg	RRO mg/kg
Cleanup Level	-	250	300	-	0.5	5.4	5.5	78	10,000
SG01-CS-037-050	5	ND<14.7	ND<1.93	5	ND<0.0121	ND<0.0242	ND<0.0242	ND<0.0484	ND<29.4
SG01-CS-038-065	6.5	ND<14.7	ND<1.81	4	ND<0.0113	ND<0.0226	ND<0.0226	ND<0.0452	ND<29.4
CS-038-MS/MSD	6.5	ND<15.0	ND<2.02	4	ND<0.0126	ND<0.0252	ND<0.0252	ND<0.0505	ND<30.1
SG01-CS-039-065	6.5	ND<14.9	ND<1.74	4	ND<0.0109	ND<0.0218	ND<0.0218	ND<0.0435	ND<29.8
SG01-CS-040-070	7	ND<14.6	ND<2.05	4	ND<0.0128	ND<0.0256	ND<0.0256	ND<0.0513	ND<29.3
SG01- CS-041-0651	6.5	407	6.32	54	ND<0.0111	0.0448	ND<0.0223	0.173	ND<29.4
SG01-CS-042-070	7	ND<14.3	ND<1.82	12	ND<0.0113	ND<0.0227	ND<0.0227	ND<0.0454	ND<28.6
SG01-CS-043-080	8	ND<13.9	ND<2.17	10	ND<0.0136	ND<0.0272	ND<0.0272	ND<0.0544	ND<27.7
SG01-CS-044-075	7.5	ND<15.0	ND<2.00	9	ND<0.0125	ND<0.0250	ND<0.0250	ND<0.0500	ND<30.0
SG01-CS-045-105	10.5	ND<14.1	ND<1.93	9	0.0333	ND<0.0241	ND<0.0241	ND<0.0482	ND<28.2
CS-045- Field Dup	10.5	ND<14.4	ND<2.27	9	ND<0.0142	ND<0.0284	ND<0.0284	ND<0.0567	ND<28.9
SG01-CS-046-100	10	ND<15.4	ND<1.95	7	ND<0.0122	ND<0.0244	ND<0.0244	ND<0.0488	ND<30.8
SG01-CS-047-090	9	ND<14.4	ND<1.96	7	ND<0.0123	ND<0.0245	ND<0.0245	ND<0.0490	ND<28.9
SG01-CS-048-070	7	ND<14.5	ND<1.79	6	ND<0.0112	ND<0.0223	ND<0.0223	ND<0.0446	ND<29.1
SG01-CS-049-110	11	ND<14.3	ND<1.85	6	ND<0.0116	ND<0.0231	ND<0.0231	ND<0.0462	ND<28.7
SG01-CS-050-100	10	ND<14.2	ND<1.67	6	ND<0.0104	ND<0.0209	ND<0.0209	ND<0.0417	ND<28.5
SG01-CS-051-030	3	ND<17.6	ND<2.08	4	ND<0.0130	ND<0.0261	ND<0.0261	ND<0.0521	ND<35.1
CS-051- Field Dup	3	ND<15.3	ND<1.92	4	ND<0.0120	ND<0.0240	ND<0.0240	ND<0.0479	ND<30.6
SG01-CS-052-065	6.5	ND<14.3	ND<1.82	8	ND<0.0114	ND<0.0227	ND<0.0227	ND<0.0454	ND<28.6
CS-052-MS/MSD	6.5	ND<13.9	ND<1.91	8	ND<0.0119	ND<0.0238	ND<0.0238	ND<0.0476	ND<27.8
SG01-CS-053-105	10.5	1970	2.73	49	ND<0.0117	ND<0.0233	0.0687	0.113	56.8
SG01-CS-054-125	12.5	1550	42.6	137	0.0324	0.0865	0.558	0.868	ND<27.3
SG01-CS-055-100	10.0	ND<13.9	ND<1.75	14	ND<0.0109	ND<0.0219	ND<0.0219	ND<0.0438	ND<27.8
SG01-CS-056-080	8.0	1380	52.1	145	ND<0.00836	0.0395	0.716	0.940	ND<27.2
SG01-CS-057-035	3.5	ND<14.0	ND<1.73	8	ND<0.0108	ND<0.0216	ND<0.0216	ND<0.0433	ND<28.0
CS-057-MS/MSD	3.5	ND<14.4	ND<1.77	8	ND<0.0111	ND<0.0221	ND<0.0221	ND<0.0442	ND<28.7
SG01-CS-058-070	7.0	137	2.32	41	ND<0.0109	ND<0.0218	ND<0.0218	ND<0.0436	ND<27.4
SG01-CS-059-040	4.0	4640	266	302	ND<0.0622	0.364	2.69	4.57	ND<58.8
SG01-CS-060-030	3.0	4310	21.9	126	ND<0.0232	ND<0.0464	0.0905	0.474	459
SG01-CS-061-060	6.0	2540	123	331	0.0585	0.257	1.58	2.02	ND<27.9
SG01-CS-062-050	5.0	5810	132	377	0.169	0.312	2.82	11.3	ND<56.3
CS-062- Field Dup	5.0	5980	190	377	0.269	0.532	3.63	14.1	ND<55.9
SG01-CS-063-115	11.5	4160	181	407	0.261	0.548	3.03	6.13	ND<54.9
SG01-CS-064-095	9.5	ND<13.5	ND<1.45	24	ND<0.00906	ND<0.0181	ND<0.0181	ND<0.0362	ND<27.0
SG01-CS-065-025	2.5	ND<14.3	ND<2.13	19	ND<0.0133	ND<0.0266	ND<0.0266	ND<0.0533	ND<28.6
SG01-CS-066-045	4.5	ND<13.7	ND<1.72	2	ND<0.0108	ND<0.0215	ND<0.0215	ND<0.0431	ND<27.5
SG01-CS-067-030	3.0	ND<14.6	ND<1.90	3	ND<0.0119	ND<0.0238	ND<0.0238	ND<0.0475	ND<29.3
SG01-CS-068-105	10.5	ND<13.9	ND<1.90	2	ND<0.0119	ND<0.0237	ND<0.0237	ND<0.0474	ND<27.8
SG01-CS-069-080	8.0	ND<14.9	ND<1.85	0	ND<0.0116	ND<0.0231	ND<0.0231	ND<0.0462	ND<29.7
SG01-CS-070-050	5.0	ND<14.6	ND<2.08	3	ND<0.0130	ND<0.0259	ND<0.0259	ND<0.0519	ND<29.2
CS-070- Field Dup	5.0	ND<14.6	ND<2.19	3	ND<0.0137	ND<0.0273	ND<0.0273	ND<0.0547	ND<29.3
SG01-CS-071-100	10.0	ND<14.7	ND<1.67	1	ND<0.0104	ND<0.0208	ND<0.0208	ND<0.0417	ND<29.4

Sample ID	Depth ft bgs	DRO mg/kg	GRO mg/kg	PID ppm	Benzene mg/kg	Toluene mg/kg	Ethylben- zene mg/kg	Xylenes mg/kg	RRO mg/kg
Cleanup Level	-	250	300	-	0.5	5.4	5.5	78	10,000
SG01-CS-072-135	13.5	36.1	ND<1.02	4	ND<0.00634	ND<0.0127	ND<0.0127	ND<0.0254	ND<28.7
SG01-CS-073-140	14.0	206	ND<1.11	3	ND<0.00693	ND<0.0139	ND<0.0139	ND<0.0277	ND<28.4
SG01-CS-074-120	12.0	ND<14.3	ND<1.54	3	ND<0.00960	ND<0.0192	ND<0.0192	ND<0.0384	ND<28.5
CS-074-MS/MSD	12.0	ND<15.0	ND<1.62	3	ND<0.0101	ND<0.0203	ND<0.0203	ND<0.0405	ND<30.0
SG01-CS-075-095	9.5	ND<14.2	ND<1.75	2	ND<0.0109	ND<0.0218	ND<0.0218	ND<0.0437	ND<28.5

Note 1- Sample location SG01-CS-041-065 excavated out after laboratory results received, area subsequently sampled clean (SG01-CS-074-120).

MS/MSD- Matrix spike/matrix spike duplicate sample

PID – Photoionization detector; GRO – gasoline-range organics; DRO - diesel range organics; RRO – residual-range organics mg/kg – milligrams/kilogram; ppm – parts per million; ft bgs – feet below ground surface

ND – Non-detect

Shaded analytical results indicate contaminant concentrations above cleanup criteria shown in Table 3-1.

6.2 EXCAVATED PCS CHARACTERIZATION SAMPLES

Table 6.2 presents the analytical results for the daily characterization samples that were taken to determine the average contaminant concentrations of the PCS stockpiled at the City landfill for use as municipal waste day cover. Comparisons of Table 6.2 concentration averages with Table 2-1, Contaminant Fate and Transport Parameters, shows the model parameters were not exceeded. For non-detect analytical results, one-half of the detection level was used for averaging. Quality assurance samples, i.e. matrix spike/matrix spike duplicate (MS/MSD) and field duplicates, were not included in the average. All PAH analytical results were non-detect or well below Table 3.1 cleanup criteria (see Appendix D).

Table 6-2 PCS Characterization Samples Analytical Results

Sample ID	DRO mg/kg	GRO mg/kg	PID ppm	Benzene mg/kg	Toluene mg/kg	Ethylbenzene mg/kg	Xylenes mg/kg	RRO mg/kg
Cleanup Level	250	300	-	0.5	5.4	5.5	78	10,000
SG01-DC-001-080	1580	68.8	NM	ND<0.0840	0.0325	0.111	0.354	ND<109
SG01-DC-002-040	4340	128	NM NA	ND<0.0708	0.0146	0.223	0.861	ND<109
SG01-DC-003-040	3460	66.2	NM NA	ND<0.0762	ND<0.254	0.217	0.649	ND<230
SG01-DC-004-100	2140	143	NM NA	ND<0.0849	ND<0.283	0.719	1.30	ND<109
SG01-DC-005-130	2610	188	NM NA	ND<0.0307	0.0133	0.991	2.43	ND<108
SG01-DC-006-130	563	66.5	NM NA NM	ND<0.0207	0.00545	0.0885	0.445	3.98
SG01-DC-007-100	7.68	ND<2.73	NM	ND<0.00819	0.00636	0.00281	0.00759	ND<2.17
DC-007-Field Dup	6.09	ND<2.51	NM NA	ND<0.00752	0.00353	0.00243	ND<0.0501	ND<2.11
DC-007-MS/MSD	6.24	0.907	NM	ND<0.00844	0.00726	0.00670	0.0209	ND<2.16
SG01-DC-008-045	3530	209	NM	ND<0.0526	0.220	1.99	3.18	28.8
SG01-DC-009-070	3090	374	NM	ND<0.119	0.266	3.58	8.10	ND<26.4
SG01-DC-010-060	ND<14.3	ND<2.14	5	ND<0.0134	ND<0.0268	ND<0.0268	ND<0.0536	ND<28.6
SG01-DC-011-080	4240	15.1	68	0.308	ND<0.0223	0.107	0.355	64.4
SG01-DC-012-045	8690	34.6	843	0.335	1.05	1.47	7.67	136
SG01-DC-013-120	805	24.1	34	0.0440	0.287	0.420	2.19	96.7
SG01-DC-014-100	1020	28.2	102	0.0224	0.0205	0.163	0.426	ND<27.5
SG01-DC-015-080	390	4.81	22	ND<0.0112	0.0274	0.0327	0.0804	ND<28.8

Sample ID	DRO mg/kg	GRO mg/kg	PID ppm	Benzene mg/kg	Toluene mg/kg	Ethylbenzene mg/kg	Xylenes mg/kg	RRO mg/kg
Cleanup Level	250	300	-	0.5	5.4	5.5	78	10,000
SG01-DC-016-040	4800	125	264	ND<0.0297	1.78	0.101	6.88	ND<59.8
SG01-DC-017-075	990	9.43	22	ND<0.0128	ND<0.0256	ND<0.0256	0.169	38.0
SG01-DC-018-065	738	31.9	137	0.0108	0.532	0.0265	0.836	56.7
SG01-DC-019-055	3900	15.9	102	ND<0.0105	0.209	0.0349	0.410	74.7
SG01-DC-020-045	3450	23.9	387	ND<0.0126	0.0844	ND<0.0252	0.355	71.6
SG01-DC-021-065	2180	27.4	175	ND<0.00994	0.235	ND<0.0199	0.420	ND<29.5
SG01-DC-022-085	2930	18.4	73	ND<0.0120	ND<0.0240	0.214	0.505	87.2
SG01-DC-023-060	2120	7.10	42/127	ND<0.0124	ND<0.0247	0.0670	0.139	55.0
SG01-DC-024-065	3830	17.1	51	ND<0.0138	ND<0.0276	0.156	0.382	69.0
DC-024-Field Dup	3760	18.5	51	ND<0.0129	ND<0.0259	0.179	0.372	66.0
SG01-DC-025-045	1780	6.09	80	0.0926	ND<0.0269	0.0300	0.069	ND<31.1
SG01-DC-026-080	1890	8.25	62	0.161	ND<0.0253	0.0609	0.170	ND<31.5
SG01-DC-027-040	763	10.1	63	0.0144	ND<0.0270	0.0879	0.236	ND<30.3
DC-027-MS/MSD	1200	9.76	63	ND<0.0130	ND<0.0259	0.0829	0.208	ND<30.3
SG01-DC-028-040	611	ND<1.92	5	ND<0.0120	ND<0.0240	ND<0.0240	ND<0.0479	ND<31.0
SG01-DC-029-090	2820	229	176	0.163	0.477	3.77	7.98	ND<27.4
SG01-DC-030-110	413	30.9	74	0.0189	0.0503	0.530	1.06	ND<28.3
DC-030-Field Dup	198	26.1	74	0.0113	0.0331	0.380	0.738	ND<28.0
SG01-DC-031-095	2270	113	193	ND<0.00919	0.171	2.21	3.81	79.9
SG01-DC-032-090	14.7	ND<1.51	6	ND<0.00941	ND<0.0188	ND<0.0188	ND<0.0376	ND<28.5
DC-032-Field Dup	ND<14.7	ND<1.82	6	ND<0.0114	ND<0.0227	ND<0.0227	ND<0.0454	ND<29.4
Average	1,067	35	NA	.036	.043	.30	.64	26
Model Limit	3,478	193	NA	.05	1.53	.48	1.06	NA

MS/MSD- Matrix spike/matrix spike duplicate sample

PID – Photoionization detector; GRO – gasoline-range organics; DRO - diesel range organics; RRO – residual-range organics
mg/kg – milligrams/kilogram; ppm – parts per million

NA – Not applicable; ND- Non-detect

Shaded analytical results indicate contaminant concentrations above cleanup criteria shown in Table 3-1.

6.3 BACKFILL CHARACTERIZATION SAMPLES

Backfill was obtained from the St. George Island borrow area and from decommissioned groundwater monitoring well access pads. Nine samples were collected and field screened with a PID; of these, three samples from the stockpiled borrow material (SG01-BF-001-350, SG01-BF-002-350, SG01-BF-003-450), and one sample from well pad material (SG01-BF-008-030) were submitted for fixed laboratory analyses. Sample analytical results indicate that concentrations of all contaminants were either non-detect or well below ADEC Method Two cleanup levels.

Table 6-3 Backfill Characterization Samples Analytical Results

Sample ID	DRO mg/kg	GRO mg/kg	PID ppm	Benzene mg/kg	Toluene mg/kg	Ethylben- zene mg/kg	Xylenes mg/kg	Total Lead mg/kg	RRO mg/kg
Cleanup Level	250	300	-	0.5	5.4	5.5	78	400	10,000
SG01- BF-001-350	2.74	ND<2.86	0	0.00573	0.0112	0.00739	0.0283	ND<2.38	31.5
SG01- BF-002-350	5.5	ND<3.92	0	ND<0.0118	0.00620	ND<0.0392	ND<0.0785	ND<2.55	57.4
SG01- BF-003-450	3.69	ND<2.63	1	ND<0.00790	0.00403	0.00187	ND<0.0527	ND<2.17	37.3
SG01- BF-004-070	NM	NM	1	NM	NM	NM	NM	NM	NM
SG01- BF-005-065	NM	NM	0	NM	NM	NM	NM	NM	NM
SG01- BF-006-060	NM	NM	1	NM	NM	NM	NM	NM	NM
SG01- BF-007-050	NM	NM	2	NM	NM	NM	NM	NM	NM
SG01- BF-008-030	ND<13.3	ND<2.45	3	ND<0.0153	ND<0.0306	ND<0.0306	ND<0.0612	NM	ND<26.6
SG01- BF-009-020	NM	NM	2	NM	NM	NM	NM	NM	NM

PID – Photoionization detector; GRO – gasoline-range organics; DRO - diesel range organics; RRO – residual-range organics
mg/kg – milligrams/kilogram; ppm – parts per million

ND- Non-detect

NM- Not submitted for fixed laboratory analysis.

7.0 QUALITY ASSURANCE AND QUALITY CONTROL

To ensure that analytical results accurately represent site conditions, quality assurance and quality control (QA/QC) procedures were followed for soil sampling and laboratory analysis. The QAP (NOAA 2006) establishes the QA/QC requirements; this section provides an overview.

7.1 FIELD PROCEDURES

Several field QA/QC procedures were implemented to ensure sample integrity and the accurate representation of site conditions.

Qualified Samplers

Samples were collected, controlled and shipped by ChemTrack personnel who were qualified in accordance with 18 AAC 75 (ADEC 2006a) and the ADEC UST Procedures Manual (ADEC 2002). Appendix D provides sampler qualification documentation.

Sample Control Procedures

Sample collection protocols, described in Section 5.0, ensured that samples were collected in the same representative manner from one sample to the next. After each sample was collected, the sample container was labeled with a unique identification number that was also recorded on a chain-of-custody (COC) form and in the field logbook. Fixed laboratory confirmation and characterization samples were kept cool and in ChemTrack's custody until they were shipped directly to the laboratory. The appropriate COC forms accompanied each sample shipment to the laboratory.

Documentation

Field activities were documented by ChemTrack in bound field logbooks. Field procedures, sample collection information, and sample identification information were recorded to ensure that samples were properly acquired, preserved, and identified in the field. Appendix C provides a copy of the field logbook generated during the corrective action.

7.2 ANALYTICAL PROCEDURES

Several QA/QC procedures were followed during this corrective action, both in the field and in the laboratory, to ensure accurate analytical representation of site conditions. Section 7.3 provides a review of the QA/QC results. Test America Analytical Testing Corporation (Beaverton, OR) and Analytica Environmental Laboratories (Anchorage, AK) provided laboratory analyses for DRO, GRO, RRO, BTEX, and select PAHs; both laboratories are ADEC approved in accordance with 18 AAC 78 *Underground Storage Tanks* (ADEC 2006b).

Trip Blanks

Trip blanks are used to verify that contamination is not originating from sample containers or other external factors during sample transport. A trip blank originates at the laboratory as a container with clean sand (for soil samples) that is transported to the site with the empty containers to be used for field sample collection. The trip blanks are stored at the site until the field samples have been collected. Each trip blank is extracted with methanol in the same manner as field samples, and is then analyzed for BTEX and GRO. Nine trip blanks were generated for the project excavation sampling. GRO and benzene were not detected in any samples; toluene, ethylbenzene, and total xylenes were detected in one trip blank at very low concentrations. Appendix D contains trip blank analytical results. Sample contamination during transport is not considered an issue.

Equipment Rinsate Blanks

Sampling equipment was disposable, one time use; rinsate blanks were not collected.

Field Duplicate Samples

Field duplicate samples are collected and analyzed to evaluate the precision of the project's soil testing process, which includes sample collection, shipment and analysis. Field duplicate samples are collected at the same time and from the same location as regular samples, assigned a unique ID number, and submitted to the laboratory for analysis. Evaluated together for trends, the relative percent differences (RPD) between the duplicates and their corresponding regular sample analytical results are used to assess the reproducibility of the soil testing program. An individual RPD outside an acceptable range may only be an indication of heterogeneous soil contaminant conditions; however, trends of RPD's outside acceptable ranges may indicate problems in the soil testing program such as improper sample collection or poor laboratory procedures.

The QAP (NOAA 2006) requires duplicate samples be collected at a minimum rate of 10 percent of the number of regular samples collected. During this project, 12 duplicate samples were collected to evaluate 110 excavation confirmation and day cover characterization samples. ChemTrack also collected seven samples that were identified as "matrix spike/ matrix spike duplicate (MS/MSD)" samples. These samples were collected in the same manner as field duplicate samples, and can be evaluated as field duplicate samples. Duplicate samples were analyzed for DRO, GRO, RRO, and BTEX. Appendix D contains the laboratory analytical report for duplicate samples; field duplicate samples are designated by "9" in the first digit of the last three digits of the sample ID; e.g., SG01-CS-002-965. ChemTrack's seven MS/MSD samples are identified as such by the sample identification number. Section 7.3 provides an assessment of the soil testing precision.

Matrix Spike and Matrix Spike Duplicates

Field sample aliquots are spiked by the laboratory with known concentrations of the target analytes to measure the accuracy of applicable analytical methods for a sample matrix, e.g., site soils. These laboratory-prepared samples are referred to as matrix spike (MS) samples. Percent recovery is determined for each sample spike analyte. Acceptable percent recoveries differ, depending on the matrix and analytical method used. The laboratory also prepares a duplicate of the spiked sample (MSD). MS/MSD samples are prepared at a rate of 1 for every 20 field

samples analyzed. The RPD between the MS and MSD analysis can be calculated to evaluate analytical precision. In the event that a sample displays a percent recovery or RPD outside the allowable range, sample data in that particular analytical batch are flagged by the laboratory with a qualifier indicating the discrepancy. Flags are typically posted adjacent to the laboratory’s reported value (see Appendix D). Section 7.3 provides an assessment of the analytical accuracy.

Laboratory Quality Assurance and Quality Control

Additional laboratory QA/QC procedures include: duplicate analysis of field samples; laboratory control samples (LCS), LCS duplicates (LCSD), method blanks, and surrogate spiking. These QA/QC procedures are established by the laboratory in accordance with its standard operating procedures and certification requirements. The results of the laboratory QA/QC are generally discussed in the laboratory’s data package narrative and indicated, when appropriate, as flagged qualifiers. Section 7.3 provides an assessment of the laboratory QA/QC results.

7.3 DATA QUALITY OBJECTIVES AND RESULTS

The following subsections provide a summary of the objectives and results for precision, accuracy, representativeness, completeness, and comparability associated with analytical data resulting from the Oceanfront Sites 1 and 2 sampling. More details on data quality results can be found in Appendix D, which contains data validation checklists, laboratory data quality narratives and analytical results. Appendix D data validation is arranged by work order number; for reference, Table 7-1 below correlates work order numbers with the sample identification numbers found in Figure 10 and Tables 6-1, 6-2, 6-3 and 7-2.

Table 7-1 Sample ID Correlation To Work Order Number

Sample ID	Work Order	Sample ID	Work Order	Sample ID	Work Order	Sample ID	Work Order
SG01-CS-001-075	PPJ0006	SG01-CS-030-140	PPJ0447	CS-057-MS/MSD	PPK0211	SG01-DC-010-060	PPJ0006
SG01-CS-002-065	PPJ0006	SG01-CS-031-020	PPJ0808	SG01-CS-058-070	PPK0211	SG01-DC-011-080	PPJ0006
CS-002-Field Dup	PPJ0006	SG01-CS-032-015	PPJ0808	SG01-CS-059-040	PPK0211	SG01-DC-012-045	PPJ0006
SG01-CS-003-095	PPJ0006	CS-032- Field Dup	PPJ0808	SG01-CS-060-030	PPK0211	SG01-DC-013-120	PPJ0006
SG01-CS-004-080	PPJ0006	SG01-CS-033-025	PPJ0808	SG01-CS-061-060	PPK0211	SG01-DC-014-100	PPJ0006
SG01-CS-005-050	PPJ0006	SG01-CS-034-070	PPJ0808	SG01-CS-062-050	PPK0211	SG01-DC-015-080	PPJ0447
SG01-CS-006-140	PPJ0006	SG01-CS-035-040	PPJ0808	CS-062- Field Dup	PPK0211	SG01-DC-016-040	PPJ0447
SG01-CS-007-130	PPJ0006	SG01-CS-036-080	PPJ0808	SG01-CS-063-115	PPK0211	SG01-DC-017-075	PPJ0447
SG01-CS-008-120	PPJ0006	SG01-CS-037-050	PPJ0808	SG01-CS-064-095	PPK0211	SG01-DC-018-065	PPJ0447
SG01-CS-009-130	PPJ0006	SG01-CS-038-065	PPJ0808	SG01-CS-065-025	PPK0211	SG01-DC-019-055	PPJ0447
SG01-CS-010-135	PPJ0006	CS-038-MS/MSD	PPJ0808	SG01-CS-066-045	PPK0211	SG01-DC-020-045	PPJ0447
SG01-CS-011-085	PPJ0006	SG01-CS-039-065	PPJ0808	SG01-CS-067-030	PPK0211	SG01-DC-021-065	PPJ0447
SG01-CS-012-080	PPJ0447	SG01-CS-040-070	PPJ0808	SG01-CS-068-105	PPK0211	SG01-DC-022-085	PPJ1114
CS-012- Field Dup	PPJ0447	SG01-CS-041-0651	PPJ0808	SG01-CS-069-080	PPK0211	SG01-DC-023-060	PPJ1114
SG01-CS-013-100	PPJ0447	SG01-CS-042-070	PPJ0808	SG01-CS-070-050	PPK0211	SG01-DC-024-065	PPJ1114
SG01-CS-014-120	PPJ0447	SG01-CS-043-080	PPJ0808	CS-070- Field Dup	PPK0211	DC-024-Field Dup	PPJ1114
SG01-CS-015-085	PPJ0447	SG01-CS-044-075	PPJ0808	SG01-CS-071-100	PPK0211	SG01-DC-025-045	PPJ1114
SG01-CS-016-050	PPJ0447	SG01-CS-045-105	PPJ0808	SG01-CS-072-135	PPK0211	SG01-DC-026-080	PPJ1114
SG01-CS-017-140	PPJ0447	CS-045- Field Dup	PPJ0808	SG01-CS-073-140	PPK0211	SG01-DC-027-040	PPJ1114
SG01-CS-018-140	PPJ0447	SG01-CS-046-100	PPJ0808	SG01-CS-074-120	PPK0393	DC-027-MS/MSD	PPJ1114
SG01-CS-019-140	PPJ0447	SG01-CS-047-090	PPJ0808	CS-074-MS/MSD	PPK0393	SG01-DC-028-040	PPJ1114
CS-019-MS/MSD	PPJ0447	SG01-CS-048-070	PPJ0808	SG01-CS-075-095	PPK0393	SG01-DC-029-090	PPJ1114

Sample ID	Work Order	Sample ID	Work Order	Sample ID	Work Order	Sample ID	Work Order
SG01-CS-020-140	PPJ0447	SG01-CS-049-110	PPJ0808	SG01-DC-001-080	BP10628	SG01-DC-030-110	PPJ1114
SG01-CS-021-085	PPJ0447	SG01-CS-050-100	PPJ0808	SG01-DC-002-040	BP10628	DC-030-Field Dup	PPJ1114
SG01-CS-022-100	PPJ0447	SG01-CS-051-030	PPJ1108	SG01-DC-003-040	BP10628	SG01-DC-031-095	PPJ1114
SG01-CS-023-065	PPJ0447	CS-051- Field Dup	PPJ1108	SG01-DC-004-100	BP10628	SG01-DC-032-090	PPK0393
CS-023- Field Dup	PPJ0447	SG01-CS-052-065	PPJ1108	SG01-DC-005-130	BP10628	DC-032-Field Dup	PPK0393
SG01-CS-024-100	PPJ0447	CS-052-MS/MSD	PPJ1108	SG01-DC-006-130	BP10628	SG01-BF-001-350	BP10628
SG01-CS-025-055	PPJ0447	SG01-CS-053-105	PPJ1114	SG01-DC-007-100	BP10628	SG01-BF-002-350	BP10628
SG01-CS-026-095	PPJ0447	SG01-CS-054-125	PPK0211	DC-007-Field Dup	BP10628	SG01-BF-003-450	BP10628
SG01-CS-027-140	PPJ0447	SG01-CS-055-100	PPK0211	DC-007-MS/MSD	BP10628	SG01-BF-008-030	PPK0211
SG01-CS-028-130	PPJ0447	SG01-CS-056-080	PPK0211	SG01-DC-008-045	PPJ0006		
SG01-CS-029-140	PPJ0447	SG01-CS-057-035	PPK0211	SG01-DC-009-070	PPJ0006		

Data Precision

The degree of soil testing variation introduced during sample collection, shipping and analysis is assessed by determining the analytical RPDs between field samples and field duplicate samples; field samples and laboratory duplicates; LCS/LCSD pairs and MS/MSD pairs. For a sample set, the smaller the RPDs, the greater the inferred precision or reproducibility, and the higher the confidence that the analytical results represent actual site conditions. The RPD between field samples and field sample duplicates can be heavily influenced by heterogeneous soil conditions such as those found at NOAA Sites 1 and 2. Variation in a contaminant concentration at a soil sample location, particularly if the concentration is near the analytical detection limit, can produce high a RPD value regardless of the precision of the sampling process. RPD values for MS/MSD pairs, LC/LCD pairs, and laboratory duplicates are measures of the laboratory's analysis precision because they are derived from a single sample, not two samples from one sample location.

Table 7.2 (below) provides the DRO, GRO, and BTEX RPD between field samples and (1) field duplicates and (2) field samples ChemTrack collected for MS/MSD analysis. Analytical results for field duplicate and MS/MSD samples for RRO were all either non-detect or at very low concentrations (see Appendix D), therefore RRO RPDs are not listed on Table 7.2.

Table 7.2 RPDs are calculated using the following equation:

$$RPD = 100 \times 2(D1 - D2)/(D1+D2)$$

D1= Concentration of analyte in normal field sample

D2= Concentration of analyte in duplicate sample

The QAP (NOAA 2006) establishes data quality objectives (DQO) for precision RPD values as follows: DRO and RRO \pm 30 %; GRO, benzene, toluene, ethylbenzene and xylenes \pm 35 %. RPD values highlighted in yellow in Table 7.2 do not meet the precision DQO.

Evaluation of sample pairs SG01-CS-023-065/ SG01-CS-023-965 (GRO RPD -39), SG01-CS-045-105/ SG01-CS-045-905 (benzene RPD 80), SG01-DC-007-100/ SG01-DC-007-900 (toluene RPD 57, xylenes RPD 200), SG01-DC-007-100/ SG01-DC-007-MS/DS (ethylbenzene RPD -82, xylenes RPD -93), and SG01-DC-027-040/ SG01-DC-027-MS/DS (benzene RPD 200), reveals that these RPD values above DQO target objectives are for analytes whose concentrations are near or below analytical detection limits. These high RPDs are not indicative of poor precision. Analytical results for these pairs were very close, but at such low concentrations, that slightly different results produced high RPDs.

Evaluation of sample pairs SG01-CS-062-050/ SG01-CS-062-950 (GRO RPD -36, benzene RPD -46, toluene RPD -52) and SG01-DC-030-110/ SG01-DC-030-910 (DRO RPD 70, benzene RPD 50, toluene RPD 41, xylenes

RPD 36) reveals that duplicate samples were consistently either higher in concentration (negative RPD) or lower in concentration (positive RPD) for all analytes. These differences can be attributed to site heterogeneousness and the likelihood that the duplicate sample was either more contaminated or less contaminated than its corresponding field sample. Duplicate samples are taken from the same location as the field samples, but are not a split from the field sample. Soil heterogeneousness can contribute to high RPD values. RPD values for both sample pairs are just outside the DQO targets; therefore these high RPDs likely do not indicate a soil testing precision problem.

Evaluation of sample pairs SG01-CS-023-065/ SG01-CS-023-965 (DRO RPD 88) and SG01-DC-027-040/ SG01-DC-027-MS/DS (DRO RPD -45) indicate RPD values outside of the DQO target of $\pm 30\%$. However, the differences in DRO concentrations between the field samples and their duplicates are relatively small and can be reasonably attributed to soil heterogeneousness.

Review of RPD values for laboratory duplicates, MS/MSD pairs and LC/LCD pairs (see Appendix D) reveals that:

The BTEX RPD value for one laboratory duplicate pair from Work Order #PPJ0447 was outside the laboratory control limits while the surrogate recoveries were within control limits. The RPD data was qualified; however, the laboratory considered all sample data from the sample data group representative and valid.

The DRO RPD values for two laboratory duplicate sample groups from Work Order #PPJ0808 exceeded laboratory control limits due to heterogeneous sample matrices. The laboratory determined that data quality was not affected and that all sample group data was representative and valid.

In summary, the precision of the soil testing program for NOAA Sites 1 and 2 is satisfactory; no systemic sample processing issues were identified.

Table 7-2 Field Sample Precision Results

Sample ID ¹	DRO (mg/kg)	RPD (%)	GRO (mg/kg)	RPD (%)	Benzene (mg/kg)	RPD (%)	Toluene (mg/kg)	RPD (%)	Ethylbenzene (mg/kg)	RPD (%)	Xylenes (mg/kg)	RPD (%)
SG01-CS-002-065	3190	14	229	-6	0	0	0.233	12	2.46	6	4.38	8
SG01-CS-002-965	2770		244		0		0.206		2.32		4.05	
SG01-CS-012-080	2900	-4	198	-3	0	0	2.00	-5	0	0	4.12	-9
SG01-CS-012-980	3030		205		0		2.10		0		4.49	
SG01-CS-019-140	1290	-7	21.3	17	0	0	0.266	9	0.0193	8	0.412	10
SG01-CS-019-MS/MSD	1380		18.0		0		0.244		0.0178		0.374	
SG01-CS-023-065	127	88	2.36	-39	0	0	0	0	0	0	0	0
SG01-CS-023-965	49.6		3.52		0		0		0		0	
SG01-CS-032-015	0	0	0	0	0	0	0	0	0	0	0	0
SG01-CS-032-915	0		0		0		0		0		0	
SG01-CS-038-065	0	0	0	0	0	0	0	0	0	0	0	0
SG01-CS-038-MS/MSD	0		0		0		0		0		0	
SG01-CS-045-105	0	0	0	0	0.0333	80	0	0	0	0	0	0
SG01-CS-045-905	0		0		0		0.0142		0		0	
SG01-CS-051-030	0	0	0	0	0	0	0	0	0	0	0	0
SG01-CS-051-930	0		0		0		0		0		0	
SG01-CS-052-065	0	0	0	0	0	0	0	0	0	0	0	0
SG01-CS-052-MS/MSD	0		0		0		0		0		0	

Sample ID ¹	DRO (mg/kg)	RPD (%)	GRO (mg/kg)	RPD (%)	Benzene (mg/kg)	RPD (%)	Toluene (mg/kg)	RPD (%)	Ethyl- benzene (mg/kg)	RPD (%)	Xylenes (mg/kg)	RPD (%)
SG01-CS-057-035	0		0		0		0		0		0	
SG01-CS-057-MS/ MSD	0	0	0	0	0	0	0	0	0	0	0	0
SG01-CS-062-050	5810	-3	132	-36	0.169	-46	0.312	-52	2.82	-25	11.3	-22
SG01-CS-062-950	5980		190		0.269		0.532		3.63		14.1	
SG01-CS-070-050	0	0	0	0	0	0	0	0	0	0	0	0
SG01-CS-070-950	0		0		0		0		0			
SG01-CS-074-120	0	0	0	0	0	0	0	0	0	0	0	0
SG01-CS-074-MS/ MSD	0		0		0		0		0			
SG01-DC-007-100	7.68	23	0	0	0	0	0.00636	57	0.0028	15	0.0076	200
SG01-DC-007-900	6.09		0		0		0.00353		0.0024		0	
SG01-DC-007-100	7.68	21	0	0	0	0	0.00636	-13	0.0028	-82	0.0076	-93
SG01-DC-007- MS/MSD	6.24		0.907		0		0.00726		0.0067		0.0209	
SG01-DC-024-065	3830	2	17.1	-8	0	0	0	0	0.156	-14	0.382	3
SG01-DC-024-965	3760		18.5		0		0		0.179		0.372	
SG01-DC-027-040	763	-45	10.1	3	0.0144	200	0	0	0.0879	6	0.236	13
SG01-DC-027- MS/MSD	1200		9.76		0		0		0.0829		0.208	
SG01-DC-030-110	413	70	30.9	17	0.0189	50	0.0503	41	0.530	33	1.06	36
SG01-DC-030-910	198		26.1		0.0113		0.0331		0.380		0.738	
SG01-DC-032-090	0	0	0	0	0	0	0	0	0	0	0	0
SG01-DC-032-990	0		0		0		0		0		0	

Note 1. Field duplicates indicated with “9” in first digit of last three digits; “CS” in sample ID indicates excavation confirmation sample; “DC” indicates day cover characterization sample.

RPD = relative percent difference; DRO = diesel range organics; GRO = gasoline range organics

Shaded RPD values do not meet the Master Quality Assurance Plan (NOAA 2006) quality control objectives of $\pm 30\%$ for DRO and $\pm 35\%$ for GRO and BTEX.

Data Accuracy

Accuracy refers to the degree to which a measurement agrees with its true value. Laboratories spike samples with known concentrations of target analytes to assess analytical accuracy by determining the percent recovery of the spike. MS, MSD, LCS, LCSD and blank samples are used for accuracy determination. Surrogate standards are also added to samples analyzed for organic constituents.

Surrogate recoveries for some analyses in Work Orders #'s PPJ0006, PPJ0447, PPJ0808, PPJ1114, and PPK-0211 fell outside laboratory control limits due to sample matrix interference (see Appendix D). The laboratory determined that data quality was not affected.

Surrogate recovery for DRO analysis under Work Order PPJ0006 was outside laboratory controls; the laboratory determined the cause was solvent evaporation from the surrogate container prior to spiking the sample. The samples were reanalyzed, and the resulting data found to acceptable.

All sample data from the sample groups under the affected work orders was found to be representative and valid. Data accuracy is considered acceptable for the Sites 1 and 2 analytical results.

Data Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the true site characteristics being measured. This project ensured representative data by adhering to QA/QC procedures during sample collection, storage, shipping and analysis. Soil samples were analyzed for contaminants that were previously identified through several site investigations. Samplers and laboratories met applicable ADEC qualification criteria.

The sample results provided by this report are judged to be representative of true site conditions based on observation of ChemTrack's sampling techniques, and review of analytical precision and accuracy data.

Data Completeness

Completeness is a measure of the percentage of project-specific data that are valid. When all data validation is completed, the percent completeness value is calculated by dividing the number of useable sample results by the total number of sample results obtained.

The QAP DQO for completeness is 85 percent or greater; 100 percent data completeness was achieved for this project.

Comparability

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data is achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data.

This project used standard procedures for both field and laboratory processes, and the units used to express sample results are reasonable for concentrations encountered. Data sets for this project are, therefore, deemed comparable.

8.0 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) is used to evaluate exposure pathways for human health and ecological receptors. The following subsections provide an evaluation for each of the elements of the CSM for NOAA Sites 1 and 2 including: contamination sources, release mechanisms, impacted media, migration pathways, exposure routes, potential receptors, and a cumulative risk assessment. NOAA Sites 1 and 2 are evaluated together because they're located adjacent to each other, with contamination and subsequent cleanup occurring across their common boundary.

8.1 SOURCES OF CONTAMINATION AND RELEASE MECHANISMS

The sources of contamination at these sites were ASTs, fuel drums, fuel transfer piping, and fuel transfer operations which, due to leaks and sloppy operations, released an unknown amount of diesel fuel, gasoline and BTEX to the ground from the 1950s to 1970s.

8.2 IMPACTED MEDIA

NOAA Sites 1 and 2 have soil contaminated with DRO, GRO, benzene, ethylbenzene and xylenes above ADEC Method Two cleanup criteria. Groundwater underlying Sites 1 and 2 is contaminated with DRO, GRO and benzene above ADEC groundwater cleanup criteria.

8.3 MIGRATION PATHWAYS

Operations at NOAA Sites 1 and 2 stopped in the 1970s. Storage tanks, fuel drums and above ground transfer piping were removed between the 1970s and the 1990s. Site 1 was largely covered by soil excavated during installation of a nearby sewer system; both sites became overgrown by native tundra grasses. Surface transport pathways no longer exist.

Subsurface transport pathways include vertical migration through the vadose zone and lateral migration in groundwater.

8.4 EXPOSURE ROUTES

Direct exposure pathways involve direct contact (human or ecological) with contaminated media. Indirect exposure pathways involve contamination traveling through the environment to a location at which the receptors (human or ecological) are exposed.

Potential direct exposure pathways include dermal contact with or ingestion of petroleum contaminated soil. Corrective action at these sites has resulted in either the complete removal of PCS, or leaving PCS with contaminant concentrations below the ADEC Method Two ingestion criteria for DRO, GRO and BTEX (see Table 8.1 below). Dermal contact remains a possibility if future excavations in the area expose PCS left in place shallower than 15 feet bgs.

Potential indirect exposure pathways include inhalation of contaminated soil particles transported off site by the wind, and ingestion of surface water or groundwater containing dissolved contaminant phases. PCS remaining at these sites is not located at the ground surface, therefore contaminant transportation off site by wind or surface water is not possible. Corrective action at these sites has resulted in either the complete removal of PCS, or leaving PCS below the ground surface with contaminant concentrations below the ADEC Method Two inhalation criteria for DRO, GRO and BTEX (see Table 8.1 below).

Hydrogeological studies (TTEMI 2005a) have determined that contaminated groundwater in the vicinity NOAA Sites 1 and 2 does not pose a threat to the island's drinking water supply. Groundwater underlying these sites flows toward the Bering Sea (Figure 7). Hydrogeological modeling indicates that, even under maximum pumping conditions, the groundwater underlying NOAA Sites 1 and 2 will not fall within the municipal water well area of influence due to distance and geological features, such as faults, between the wells and these sites. Investigations (TTEMI 2005b) have found that the total dissolved solids (TDS) concentration in the groundwater in the vicinity of NOAA Sites 1 and 2 exceeds the ADEC drinking water quality standard of 500 milligrams per liter (mg/L). The elevated TDS concentration is indicative of saltwater intrusion from the nearby Bering Sea into the island water table, and means that groundwater in the vicinity of NOAA Sites 1 and 2 will likely never be used as a drinking water source. Sheen attributable to Sites 1 and 2 petroleum contamination has not been observed on the Bering Sea. There are no indirect exposure pathways for ingestion of surface or groundwater.

8.5 POTENTIAL RECEPTORS

NOAA Sites 1 and 2 are undeveloped and primarily used by island residents for access to the Bering Sea. There is a potential for dermal contact with DRO and GRO contaminated soil by future workers who excavate in areas where PCS has been left in place below the ground surface, i.e. along the north side of the City sewer system or in the Bering Sea buffer zone (see Figure 10). Direct exposure to benzene, ethylbenzene and xylenes is not likely because there is only one location, at 14 feet bgs, where these contaminant concentrations were left above the applicable ADEC cleanup criteria (see Figure 10). There is no discernable indirect exposure pathway for human or ecological receptors within Sites 1 and 2.

8.6 CUMULATIVE RISK ASSESSMENT

Cumulative risk is defined as the sum of risks resulting from multiple sources and pathways to which humans are exposed. When more than one hazardous substance is present at a site or multiple exposure pathways exist, the cleanup levels in Table B1 of 18 AAC 75.341 and Table C of 18 AAC 75.345 may need to be adjusted downward. In accordance with the requirements outlined in 18 AAC 78.600, NOAA must ensure that the cumulative cancer risk remaining after the completion of the corrective action does not exceed 1 in 100,000 (1×10^{-5}) and that the cumulative non-carcinogenic hazard index (HI) does not exceed 1.0. Each contaminant detected above one-tenth of the Table B1 inhalation or ingestion or Table C cleanup levels must be included in cumulative risk calculations for exposure pathways that are shown to be complete based on the site-specific CSM. For NOAA Sites 1 and 2,

the only known complete exposure pathway is potential dermal contact by anyone excavating in this area in the future.

Site 1 and Site 2 contaminants requiring cumulative risk evaluation are benzene, toluene, ethylbenzene and xylenes. ADEC does not include DRO, GRO and RRO in cumulative risk analysis. As shown in Table 8-1 below, remaining benzene and toluene concentrations do not exceed one-tenth of their corresponding Table B1 cleanup levels. Ethylbenzene and xylenes are not carcinogenic, and their Health Index (HI) equals 7.3×10^{-3} .

To summarize, the cumulative cancer risk for contaminants remaining at Sites 1 and 2 does not exceed 1×10^{-5} , and the cumulative non-carcinogenic hazard index is 7.3×10^{-3} , well below ADEC's criterion of 1.0.

Table 8-1 Cumulative Risk Determination

Chemical of Concern	DRO	GRO	Benzene	Toluene	Ethylbenzene	Xylenes
Table B.1 Soil Cleanup Level (mg/kg) ¹						
Ingestion	10,250	1,400	290	20,300	10,000	203,000
Inhalation	12,500	1,400	9	180	89	81
One-Tenth Table B.1 Cleanup Level (mg/kg)						
Ingestion	NA	NA	29	2,030	1,000	20,300
Inhalation	NA	NA	0.9	18	8.9	8.1
Highest Site Concentration (mg/kg) ²	5,980	398	0.522	2.36	20.6	78.8
Site Concentration > 1/10 Table Criteria?	NA	NA	No	No	Yes	Yes
Carcinogenic/Non-carcinogenic (C/NC)?	-	-	-	-	NC	NC
Risk-Based Concentration (RBC, mg/kg) ³						
Ingestion	-	-	-	-	10,100	203,000
Inhalation	-	-	-	-	4,500	-
Health Quotient (HQ) ⁴						
Ingestion	-	-	-	-	2×10^{-3}	0.3×10^{-3}
Inhalation	-	-	-	-	5×10^{-3}	-
Health Index (HI) = Σ all HQs = 7.3×10^{-3}						

Note 1 – Table B.1 Cleanup Level based on “Under 40-Inch Zone”.

Note 2 – Highest Site Concentration obtained from confirmation sample analytical results listed in Table 6-1.

Note 3 - RBC based on “Under 40-Inch Zone” found in Appendix B of ADEC Cumulative Risk Guidance.

Note 4 – HQ = Site concentration/applicable RBC

NA – ADEC does not include DRO, GRO and RRO in cumulative risk calculations.

9.0 CONCLUSIONS AND RECOMMENDATIONS

The following subsections present conclusions and recommendations for NOAA Sites 1 and 2 based on corrective actions performed in 2006 and 2007.

9.1 CONCLUSIONS

Petroleum-contaminated soil has been removed from NOAA Sites 1 and 2 to the extent practicable. Contaminated soil remains in a strip, starting at about 3 feet bgs, running along the north side of the community's sewer system, and at one location just to the south of the sewer system at 10.5 feet bgs (sample location SG01-CS-053-105, Figure 10). Further excavation toward the sewer line would endanger it. Contaminated soil remains along the earthen barrier, starting at about 4 feet bgs, in the western end of Site 1 where it slopes toward the Bearing Sea (Figures 9 and 10). This buffer was left in place between Bering Sea and the site excavation to reduce the potential for storm seas breaching the excavation and carrying fill material and contamination to sea, a scenario of concern to the community. Contaminated soil also remains at refusal, between 7.5 and 13 feet bgs, in the western

end of the excavation; and from 14 feet bgs to the water table at 15 feet bgs primarily in the western half of the excavation (Figure 10). Further soil removal vertically is not practicable because of the presence of either hard basalt or the water table.

Confirmation sample analytical results show that the remaining soil contaminant concentrations are well below the ADEC cleanup criteria for inhalation and ingestion (see Tables 6-1 and 8-1). The cumulative cancer risk for remaining contaminants does not exceed 1×10^{-5} , and the cumulative non-carcinogenic hazard index is 7.3×10^{-3} , well below ADEC's criterion of 1.0.

The depth to the water table in the vicinity of Sites 1 and 2 is approximately 15 feet bgs. Due to its shallow depth and the history of these sites, it is likely that the groundwater became contaminated with petroleum products soon after fuel storage operations began in the 1950's. The removal of 14,280 cubic yards of PCS from these sites, most of what was present, should largely mitigate further introduction of contaminants to the groundwater. During PCS excavation, the water table was exposed in test pits to keep track of its depth. These test pits were left open as the excavation progressed, and no more than product sheen was observed accumulated on the exposed water. Environmental investigations have shown that the groundwater in vicinity of Sites 1 and 2 is not potable due to elevated TDS concentrations as a result of sea water intrusion. Hydrogeological investigations have determined that contaminated groundwater in this area will not be drawn into the community's drinking water wells, even under maximum pumping conditions. Given the lack of free product greater than sheen on the water table, the elevated TDS concentrations in the groundwater, and the lack of threat the contaminated groundwater poses to the community drinking water, further direct groundwater cleanup action, such as extraction wells, is not warranted and not practicable. NOAA has committed to long-term groundwater monitoring to determine the effectiveness of the cleanup actions undertaken at Sites 1 and 2.

9.2 RECOMMENDATION

NOAA requests written confirmation from ADEC that all appropriate corrective actions have been completed for mitigating petroleum contamination at NOAA Sites 1 and 2 on St. George Island, Alaska, and that ADEC grants a conditional closure not requiring further remedial action from NOAA. NOAA understands ADEC will/may require additional containment, investigation, or cleanup if subsequent information indicates that the level of contamination that remains does not protect human health, safety, or welfare, or the environment.