CORRECTIVE ACTION PLAN
FORMER MAKAH AIR FORCE STATION
NEAH BAY, WASHINGTON

Prepared for:
Air Force Civil Engineer Office

Prepared By:
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Seattle District

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ACRONYMS

AF	United States Air Force
AFS	Air Force Station
ARI	Analytical Resources, Inc.
BaP	benzo(a)pyrene
bgs	below ground surface
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
DoD	Department of Defense
DRO	Diesel Range Organics
Ecology	Washington State Department of Ecology
EDB	ethylene dibromide
EPA	United States Environmental Protection Agency
FAA	Federal Aviation Administration
GATR	Ground/Air Transmitter-Receiver Building
GRO	Gasoline Range Organics
IDW	investigation derived waste
mg/kg	milligram per kilogram
µg/kg	microgram per kilogram
µg/L	microgram per liter
MRO	Motor Oil Range Organics
MTCA	Model Toxics Control Act
NWTPH-Dx	Northwest Total Petroleum Hydrocarbon method for Semi-Volatile petroleum products
NWTPH-Gx	Northwest Total Petroleum Hydrocarbon method for Volatile petroleum products
ORP	oxidation reduction potential
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
SI	Site Investigation
SIM	Selective Ion Monitoring
SQL	sample quantitation limits
SVOC	semi-volatile organic compound
TEE	Terrestrial Ecological Evaluation
TRPH	total recoverable petroleum hydrocarbons
USACE	United States Army Corps of Engineers
UST	underground storage tank
UVF	ultraviolet fluorescence spectrophotometer
VOC	volatile organic compound
WAC	Washington Administrative Code
WRCC	Western Regional Climate Center

SECTION 1 – INTRODUCTION

1.1 INTRODUCTION & OBJECTIVES

This document presents the Corrective Action Plan (CAP) to address petroleum hydrocarbon contamination in soil and groundwater at the Former Makah Air Force Station (the Site), located on the Makah Indian Reservation (Figure 1). The Makah Indian Reservation boundary extends approximately ten miles to the south and seven miles to the east of the Former Makah Air Force Station.

The United States Air Force (AF) and the United States Environmental Protection Agency (EPA) have entered an Administrative Order on Consent (Consent Order) under the Resource Conservation and Recovery Act (RCRA) Underground Storage Tank (UST) Program to investigate, remove and remediate the release of petroleum constituents from USTs at or from the Site. Because the Site is located within the Makah Indian Reservation, EPA Region 10 is the implementing agency for the UST program. The Consent Order includes the following requirements:

1) Develop and submit to the EPA a Site Assessment Plan to determine the nature and extent of the release of petroleum constituents from underground storage tanks (USTs) at the site;

2) complete the Site Assessment and submit a Site Assessment Report that describes the results;

3) develop and submit a CAP to identify and evaluate corrective action alternatives and select the preferred alternative necessary to prevent or mitigate any migration or releases of petroleum constituents at or from the site, including a schedule for implementing the CAP; and

4) implement the CAP at the Site as approved or modified by the EPA.

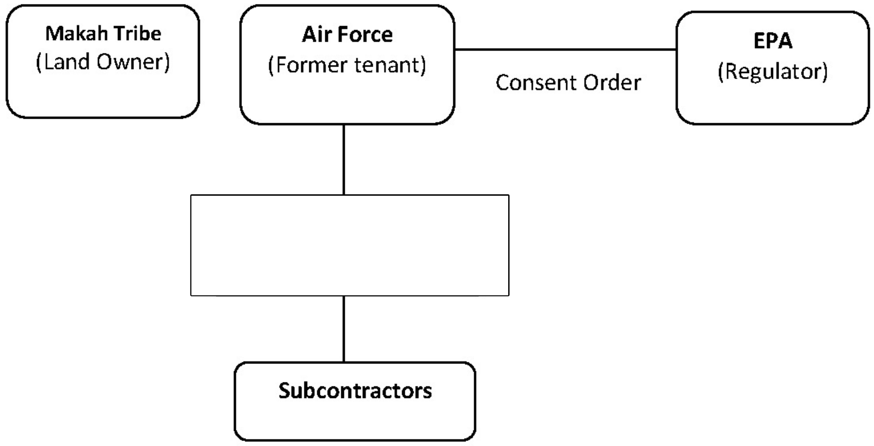
1.2 REPORT ORGANIZATION

This report is organized as follows:

- Section 1.0 introduces the document with the objective and organization of the CAP;
- Section 2.0 describes the Site background which includes a description of the Site, site history, general environmental setting and past investigation activities performed at the site;
- Section 3.0 presents the conceptual site model (CSM) for the Site which includes a description of the Site geology and hydrogeology, identifies exposure pathways, points of compliance, regulatory framework for cleanup levels, and current and future land use for the site.
- Section 4.0 presents the components of the Corrective Action Alternatives Analysis;
- Section 5.0 presents the components of the CAP implementation;
- Section 6.0 presents the performance and compliance monitoring requirements; and
- Section 7.0 presents the references used in preparing this CAP.

1.3 PROJECT TEAM ORGANIZATION

The major stakeholders for the investigation and subsequent corrective actions, if needed, are the Air Force, the Makah Tribe, and the EPA. The United States Army Corps of Engineers (USACE) is providing technical and field support with the assistance of subcontractors to the AF during this effort. The diagram below indicates lines of authority.



SECTION 2 – SITE BACKGROUND

2.1 SITE LOCATION AND DESCRIPTION

The Site lies within the Makah Indian Reservation (the Reservation) which is located in the northwest corner of the Olympic Peninsula in the state of Washington (Figure 1). The AF leased approximately 255 acres from the Makah Tribe. The Reservation encompasses approximately 42 square miles and is bordered on the west by the Pacific Ocean and on the north by the Strait of Juan de Fuca. The city of Port Angeles lies approximately 60 miles east of the Reservation. Neah Bay is the only town on the Reservation.

The military facilities at the Site were separated into four main areas: Cantonment, family housing, Top Camp, and trailer court/family campground. The former USTs are located within the Top Camp and Cantonment Areas (Figures 2 and 3). Table 1 lists 26 USTs, installation dates, and other basic information as determined from literature review of available reports. Table 1 also lists the current status of 26 USTs.

The Wa'atch River is the source of domestic water for the town of Neah Bay. Industrial and residential supply wells have been drilled in and around the town. Ridolfi (2005) also reports that at least three public supply wells were drilled for the town by the U.S. Department of Health but were abandoned due to naturally-occurring inferior water quality and insufficient yield. Groundwater flow is to the southwest in the Cantonment Area (Figure 3).

The Top Camp is located on Bahokus Peak at an elevation of 1,500 feet above mean sea level. Access is via a steep, single-lane gravel road.

2.2 SITE HISTORY

The Site was a radar surveillance station operated by the AF. The station began operations in the 1950s and was closed in 1988.

The Cantonment Area was constructed in the early 1950s to support the former Makah AFS; it is located on Cape Flattery Road near the beaches and estuary where the Wa'atch River flows into Makah Bay. Buildings and structures in the former Cantonment Area included housing, barracks, maintenance shops, and administration offices.

The Cantonment Area served as the Makah AFS administrative headquarters until the station was closed. Buildings and structures at the Cantonment Area included offices, motor equipment garages, medical treatment facilities, various shops, a chapel, a dining hall, a boiler building, a gas station, dormitories, and recreational facilities, including tennis courts, a bowling center, a gymnasium and a weight room (Radian, 1987).

There were ten former USTs (UST A, B, C, D, E, F, G, Y1, Y2, and Y3) within the Cantonment Area. Nine groundwater monitoring wells (MW-01 through MW-09) were installed in the Cantonment Area in the vicinity of and downgradient of the former USTs (Figure 2). USACE understands that MW-09 was destroyed during Summer 2019 during routine grounds maintenance work.

The Top Camp Area consists of several small sub-areas which include the Microwave Tower Site (USTs H through O, P, R, S, and W), the Radar Dome Area (USTs T, U, and V), the Ground/Air Transmitter-Receiver (GATR) building (UST X), and former building 102 (UST Q) (Figure 3).

The Top Camp consisted of the radar surveillance transmitting and receiving equipment, control centers, and accompanying support equipment. According to Ridolfi (2013b; original references unavailable), the Department of Defense (DoD) first leased the 10-acre radar dome area from the Makah Tribe in 1941 as part of the Cape Flattery Battery Lease. USACE subsequently constructed an access road from Neah Bay to the top of Bahokus Peak. Between 1945 and 1947, the U.S. Army Air Force (precursor to the U.S. Air Force) operated an aircraft radio relay warning station at the Radar Dome Area. In 1949, the lease expired and the 10-acre parcel was returned to the Makah Tribe. In the 1950s, the same parcel was leased again to the AF for use as part of the Makah AFS. The Radar Dome Area became part of the Bahokus Peak Operation Area or “Top Camp,” which included the nearby Microwave Tower, Ground/Air Transmitter-Receiver Building (GATR) facilities, and former Building 102. The Microwave Tower area was the location of the Engineering Plant Building (Building 100), which supplied power for the Top Camp. Gasoline and diesel were stored in various USTs in the Top Camp Area during AFS operation. The Top Camp facilities were used as an early warning radar station until the AFS closed in 1988.

After the AFS closed, all the land leases, except one, were terminated and the property was transferred back to the Makah Tribe. The remaining lease, which contained the Top Camp areas, was transferred to the Federal Aviation Administration (FAA) in June 1989. The FAA continues to maintain radar operations on Bahokus Peak.

In June 2009, EPA received seven *Certification of Completed Closure* forms from the AF documenting that 24 USTs were permanently closed at the Site between the years 1988 and 1989. After 2009, the closed UST count increased to 26 USTs as it was determined that UST Y was actually three USTs. These USTs were renamed UST Y1, UST Y2, and UST Y3. Records describing the closures are referenced in Table 1 and in Section 2.3.

2.3 Summary of Previous Investigations, Cleanup Actions, and Data Gaps

This section summarizes earlier investigation and cleanup actions associated with known USTs. Several site investigations and cleanup activities were previously conducted in the Cantonment and Top Camp areas under various DoD contracts and include the following:

- 1987 Hazard Evaluation Report (Radian, 1987)
- 1988 Asbestos and UST survey (TetraTech, 1988)
- 1989 USACE geotechnical survey (USACE, 1989).
- 1989 Pesticide Tank (UST G) investigation (TetraTech, 1989a)
- 1989 Cantonment area soil and groundwater investigation (Shannon & Wilson, 1990)

- 1997 Management Action Plan (Radian, 1997)
- 2003-Present. Cantonment groundwater monitoring (Ridolfi, 2003; 2009b;2010; 2011, 2013a)
- 2004 Cantonment test pit investigation (Ridolfi, 2005)
- 2007 Cantonment geoprobe investigation (Ridolfi, 2008a)
- 2007-2008 Microwave Tower investigation (Ridolfi, 2008b)
- 2009 Cantonment Area monitoring well installation (Ridolfi, 2009a)
- 2012 Microwave Tower removal action (Ridolfi, 2012)
- 2012 Bahokus Peak Radar Dome site investigation (Ridolfi, 2013b)
- 2014 Cantonment groundwater monitoring (USACE, 2015a)
- 2016 Phase II Site Investigation (USACE, 2016)
- 2016 UST G (Phase III) Site Investigation (USACE, 2016)
- 2017 Phase IV Site Investigation Report- Underground Storage Tanks C/D, E, and G (USACE, 2021)
- 2021 Vapor Intrusion (VI) Investigations (Olgoonik FPM JV, 2021; Olgoonik FPM JV, 2022)

Details of these activities including soil and groundwater chemical analytical data are presented in the reports listed above. Result summary tables for soil samples collected during Phase II and Phase IV are presented in Appendix A. Groundwater results from Phase I, Phase II, and Phase IV are presented in Appendix B. A short summary for each UST by geographic area is provided in the sections below and in Appendix C. VI results are presented in Appendix D.

2.3.1 CANTONMENT AREA

2.3.1.1 USTs A and B

Former USTs A and B were 8,000 and 2,000 gallon steel tanks, respectively, located between buildings 2 and 19. UST A was installed in 1951 and was situated southeast of UST B which was installed in 1979. Both USTs stored No. 2 diesel fuel for emergency backup generators (TetraTech, 1989b) and were removed in June 1989 by Baker Pacific.

<u>Soil</u>

In 1989, USACE collected a soil sample from a test pit (89-BH-4) located between the two USTs. No detections of petroleum hydrocarbons above 200 milligrams per kilogram (mg/kg) were reported (USACE, 1989; Shannon & Wilson, 1990).

In 2007, Ridolfi collected soil samples in the vicinity of USTs A and B at depths of 5 to 12 ft bgs. The samples were analyzed for DRO (diesel range organics) and MRO (motor oil range organics) using the Northwest Total Petroleum Hydrocarbon method for semi volatile petroleum products (NWTPH-Dx) (Ridolfi, 2008a). DRO in one sample located near UST A exceeded the Model Toxics Control Act (MTCA) Method A soil cleanup level of 2,000 mg/kg.

In March 2015, USACE collected soil samples using a step out method from previously detected soil samples to delineate lateral and vertical extent of contamination. USACE utilized an ultraviolet fluorescence (UVF) Analytical Kit to measure estimated DRO concentrations in the field (USACE, 2016). The UVF Analytical Kit informed which sample depths were submitted for laboratory analysis and confirmed vertical extent of contamination. Soil probes were continued until DRO was below MTCA Method A or until refusal. DRO concentrations exceeded the MTCA Site-Specific Terrestrial Ecological Evaluation (TEE) soil cleanup level of 200 mg/kg in two samples (GP-11-A4-12, GP-11-A4-8, and GP-11-A6-8) at depths ranging from 4-12 ft bgs. The maximum concentration was estimated at 4,000 mg/kg. Both samples were centrally located between the adjacent buildings (Figure 5). No soil exceedances were observed in samples immediately adjacent to the existing buildings. Benzene was non-detect in all samples; however, the sample quantitation limits (SQL) exceeded the soil cleanup levels in one of the two samples with DRO exceedances.

No further investigation of UST B was conducted (USACE, 2014, 2015a), and existing information and previous sampling results are considered sufficient for an affirmative closure decision.

Groundwater

Monitoring well MW-04 is located hydraulically downgradient (southeast) of former USTs A and B. In 1989 (when MW-04 was installed), Total Recoverable Petroleum Hydrocarbons (TRPH) was not detected in groundwater or soil samples taken from the MW-04 boring (Shannon & Wilson, 1990). Since 2003, neither DRO nor MRO have been detected in MW-04 (Ridolfi, 2003; 2009b; 2010; 2011; 2013a; USACE, 2015a). Lead was detected in 2010 at 25 micrograms per liter (µg/L) which exceeds the MTCA Method A groundwater cleanup value of 15 µg/L. Subsequent groundwater lead concentrations in 2013-2014 (0.2 to 1.5 µg/L) were below the cleanup value.

In March 2015, DRO exceeded the cleanup level (500 ug/L) in groundwater grab sample AQA1 (Figure 5). Absence of DRO in the downgradient monitoring well suggests that the contamination in groundwater near AQA1 (730 J ug/L) has not migrated downgradient to MW-04 (<100 ug/L).

2.3.1.2 USTs C and D

Former USTs C and D were 10,000 and 8,000 gallon steel tanks used to store No. 2 diesel fuel for the boilers in the adjacent heating plant (Building 14). Former contents also included bunker fuel (No. 5 diesel). USTs C and D were installed[1] in 1979 and 1976, respectively (TetraTech, 1988; 1989b).

Soil

In February 1989, USACE collected test pit sample 89-BH-1 between former USTs C and D prior to their removal; TRPH was reported above 200 mg/kg. In June 1989, both USTs C and D were removed by Baker Pacific.

In 2007, Ridolfi collected soil samples and fuel-saturated upper soils and strong odors were noted in several of the boring locations. DRO and/or MRO exceeded MTCA Method A soil cleanup levels in multiple samples. Maximum concentrations for DRO and MRO were 20,000 and 2,100 mg/kg, respectively.

In March 2015, USACE collected soil samples using a step out method from previously detected soil samples to delineate lateral and vertical extent of contamination. USACE utilized an UVF Analytical Kit to measure estimated DRO concentrations in the field (USACE, 2016). The UVF Analytical Kit informed which sample depths were submitted for laboratory analysis and confirmed vertical extent of contamination. Soil probes were continued until DRO was below MTCA Method A or until refusal. DRO concentrations exceeded the MTCA Site-Specific TEE soil cleanup level of 200 mg/kg in more than one third of the collected soil samples (Figure 6) at depths ranging from 0-15 ft bgs. The maximum estimated concentration was 34,000 mg/kg. No MRO detections exceeded the MTCA Method A soil cleanup level of 2,000 mg/kg.

[1] Radian (1987) lists the installation dates for USTs C and D as 1951. The installation dates cited by the newer TetraTech (1989b) UST survey documentation are 1979 and 1976, respectively.

Other chemicals that exceeded soil cleanup levels in one or more of the soil samples included naphthalenes and polycyclic aromatic hydrocarbons (PAH) (USACE, 2016).

In October 2017, soil samples were collected to further delineate extent of contamination. Sample locations included two beneath Building 18, one from downgradient of Building 18 and one from upgradient of the former location of USTs C and D. No samples had concentrations detected above the MTCA Method A soil cleanup levels indicating the extent of contamination in soil has been fully delineated.

<u>Groundwater</u>

Monitoring well MW-05 is located hydraulically downgradient from former USTs C and D. DRO has consistently exceeded the MTCA Method A cleanup level for groundwater (500 µg/L). DRO was most recently detected at 1,760 µg/L in May 2018.

Lead has been detected occasionally at MW-05 but has not exceeded the MTCA Method A groundwater cleanup level of 15 µg/L since October 2012 (USACE, 2015a).

Monitoring well MW-08 is located approximately 150 ft further downgradient (southeast) than MW-05. DRO has consistently been below the MTCA Method A groundwater cleanup level with the exception of the October 2012 sample (580 µg/L). DRO was most recently detected at 149 µg/L in May 2018.

In March 2015, two groundwater grab samples were collected near locations with highest concentrations of DRO in soil and were analyzed for petroleum constituents. The maximum DRO and MRO concentrations (10,000 and 490 µg/L, respectively) were detected at groundwater grab sample AQCD2 (Figure 6). DRO was detected above the MTCA Method A groundwater cleanup level in all samples. Naphthalene (210 µg/L) was the only VOC detected above its corresponding MTCA Method A cleanup level (i.e. 160 µg/L) at AQCD2 (Figure 6).

In October 2017, five groundwater grab samples were collected downgradient and adjacent to previous groundwater grab samples collected in March 2015. Only AQCD6 exceeded the MTCA Method A groundwater cleanup level of 500 µg/L for DRO. This location is directly downgradient of AQCD1. AQCD5 had low detections of DRO indicating there is a narrow plume of groundwater above the cleanup level under the roadway. AQCD7 and AQCD3 had detections of DRO below the cleanup level and AQCD4 was non-detect. Sample locations are shown on Figure 6. These results indicate the extent of groundwater contamination above the MTCA Method A groundwater cleanup level of 500 µg/L does not continue off site or to the Wa'atch River.

2.3.1.3 UST E

Former UST E was a 2,000 gallon steel tank used to both unleaded and leaded gasoline for refueling motor vehicles. UST E was installed in 1953 and located northeast of Building 16. A former dispenser island is located hydraulically upgradient from UST E.

<u>Soil</u>

In February 1989, USACE collected test pit soil sample 89-BH-3 downgradient of UST E. TRPH was reported above 200 mg/kg. Ethylbenzene and total xylenes were also detected, although concentration data are unavailable. UST E was removed in June 1989 by Baker Pacific.

In 2007, soil samples were collected near UST E. DRO, GRO (gasoline range organics) and benzene, toluene, ethylbenzene, and xylene (BTEX) compounds were detected in multiple samples. Two samples had GRO detections above the MTCA Method A soil cleanup value of 100 mg/kg with a maximum detection of 1,700 mg/kg. Lead was not detected in any soil samples.

In March 2015, USACE collected soil samples using a step out method from previously detected soil samples to delineate lateral and vertical extent of contamination. USACE utilized a UVF Analytical Kit to measure estimated GRO concentrations in the field (USACE, 2016). The UVF Analytical Kit informed which sample depths were submitted for laboratory analysis and confirmed vertical extent of contamination. Soil probes were continued until GRO was below MTCA Method A or until refusal. GRO concentrations exceeded the MTCA Method A cleanup level of 100 mg/kg in three samples (GP-11-E6-10, GP-11-E11-10 and GP-11-E11-15) at depths ranging from 5-15 ft bgs (Figure 7). The maximum concentration was 1,900 mg/kg. No DRO or MRO detections exceeded their cleanup levels of 200 and 2,000 mg/kg, respectively.

In October 2017, soil samples were collected to further delineate extent of contamination. Two of the four direct push borings (GP-11-E15 and -E17) were directed at a 45 degree angle in order to investigate potential soil contamination under Building 16. Neither sample location exceeded MTCA Method A cleanup level of 100 mg/kg; however, there were detections of GRO in both samples which indicate contamination may be under Building 16. Maximum GRO concentrations were detected at 98.8 mg/kg (GP-11-E15) which is below the MTCA Method A cleanup level of 100 mg/kg. GP-11-E15 is located cross-gradient of GP-11-E11 which had the highest concentration of GRO during the 2015 soil investigation. GRO contamination at GP-11-E11 and GP-11-E15 could be from the pipes connecting former UST E to the dispenser. GP-11-E16 was located between UST E and MW-06 and had no GRO detections and GP-11-E18 was located downgradient of Building 16 and had no detections above the MTCA Method A cleanup level which indicate soil contamination detected in GP-11-E11 and -E6 in October 2017 is localized.

Groundwater

Monitoring well MW-06 is located hydraulically downgradient (southeast) of UST E. Elevated concentrations of GRO in groundwater have been detected in MW-06 since 1989. Since 2002, GRO has been consistently detected in MW-06 at concentrations in excess of the MTCA Method A cleanup level (1,000 µg/L). GRO was most recently detected at 407 µg/L in May 2018 which was the first time GRO concentrations in MW-06 have been detected below the cleanup level. DRO has not been detected above the cleanup level of 500 µg/L since 2014.

The maximum lead concentration (20 µg/L) was detected in January 2010; subsequently, groundwater lead concentrations have remained consistently below the MTCA Method A cleanup value of 15 µg/L.

Arsenic in groundwater has been analyzed occasionally at MW-06 (in 2003 and 2012). In 2012, arsenic was detected at a concentration of 5.1 µg/L, just slightly above the MTCA Method A groundwater cleanup level of 5 µg/L. Arsenic is not required for testing at sites with petroleum releases (MTCA 173-340-900 Table 830-1).

In March 2015, GRO and DRO exceeded the groundwater cleanup levels (800 ug/L with benzene and 500 ug/L, respectively) in the grab sample AQE1 (GRO 27,000 J ug/L; DRO 730 ug/L)located near GP- 11-E11. Although detected at AQE2, GRO and DRO did not exceed groundwater cleanup levels at this location. The source of the DRO in groundwater is unknown; all historical documents indicate that UST E contained gasoline. One possible source is UST A, located hydraulically upgradient of UST E, which previously contained DRO and sample results from March 2015 indicate there was a release to soil and groundwater. However, monitoring well MW-04 located between UST A and UST E has not had detections of DRO since 2003 (Ridolfi, 2003; 2009b; 2010; 2011; 2013a; USACE, 2015a).

In October 2017, the four groundwater grab samples were co-located with corresponding soil sampling locations. GRO was detected at 1,650 µg/L (AQE4) which exceeds the MTCA Method A cleanup level of 1,000 µg/L. This indicates that groundwater contamination could be from an alternate source since this location is cross gradient from UST E. The drawings of UST E in the 1989 USACE Geotechnical Report indicate that there was a fuel dispenser island upgradient of UST E. It is possible gasoline leaked from the lines leading from UST E to the fuel dispenser.

AQE5 is co-located with GP-11-E16 and had no GRO detections. This indicates there is no hydraulic connection between groundwater contamination identified in AQE1, AQE4 and MW-06. Therefore, the contamination found in MW-06 is from an alternate source.

GRO was detected at 620 µg/L (AQE6) and 5,510 µg/L (AQE7) which is above the MTCA Method A cleanup level of 1,000 µg/L. These results along with AQE4 indicate that groundwater contamination is migrating downgradient from the source area identified by GP11-E11 and under Building 16.

DRO was detected in all groundwater grab samples but did not exceed the cleanup level. As previously stated, the source of the DRO is unknown because all historical documents indicate that UST E contained gasoline.

2.3.1.4 UST F

Former UST F was a 550 gallon steel tank installed in 1954 and located southeast of Building 43. UST F stored No. 2 diesel used to refuel motor vehicles.

<u>Soil</u>

In February 1989, USACE collected a soil sample from test pit (89-BH-2) located adjacent to UST F and no detections of petroleum hydrocarbons above 200 mg/kg were reported (USACE, 1989; Shannon & Wilson, 1990). UST F was subsequently removed in June 1989 by Baker Pacific.

In 2007, nine soil samples were collected from four direct push borings in the vicinity of UST F at depths ranging from 4 to 12 feet and analyzed for DRO and MRO via NWTPH-Dx (Ridolfi, 2008a). DRO and/or MRO were detected in three of nine samples at maximum concentrations of 65 and 140 mg/kg, respectively. No DRO or MRO detections exceeded their MTCA Method A soil cleanup levels.

<u>Groundwater</u>

Groundwater has been monitored periodically in the nearest downgradient well, MW-03. During the June 2014 Phase I sampling, no target analytes exceeded MTCA Method A groundwater cleanup levels (USACE, 2015).

No further investigation of UST F was conducted during the Phase II activities (USACE, 2014, 2015a) and existing information is considered sufficient for an affirmative closure decision.

2.3.1.5 UST G

Former UST G was a 600 gallon cylindrical, concrete tank located southeast of the Paint Shop (Building 44) beyond a fenced drum storage area (EIGov, 2016). The system was constructed to receive pesticide rinse wastes from a sink in the Engineering Maintenance Shop (Building 43). The tank was removed by G.L. Construction in 1989. Two leach lines extended south and southwest from the former tank. During the Phase III investigation, the status of the leach lines was investigated. The majority of the east and west leach lines were identified to be intact and in good condition though some uncertainty remains regarding the exact origin of each line. The west leach line was determined to be approximately 75 feet long and the east leach line determined to be approximately 70 feet long. Given the past removal of the former Tank G, it is likely that some of the lines were removed at the same time, however this cannot be confirmed

Soil

In October 1988, TetraTech collected subsurface soil samples next to UST G, along the two leach lines and from two background locations. Pesticides, PCBs, VOCs, and metals were detected in one or more samples. Diazinon was non-detect (< 3.0 µg/kg) in all samples. Methylene chloride concentrations in two samples (509.9 and 821.4 µg/kg) exceeded the MTCA Method A cleanup level of 20 µg /kg but may reflect laboratory contamination. Chromium concentrations were equal to or greater than the MTCA Method A cleanup value of 19mg/kg for hexavalent chromium (Cr VI). No chromium detections exceeded the cleanup value of 2,000 mg/kg for the less toxic trivalent form chromium (Cr III).

In 2004, Ridolfi, collected five soil samples near the former UST G, two soil samples near the former drain field southeast of former UST G, and four samples were collected in the location of the former burn pit. The Ridolfi investigation confirmed the removal of UST G, however the status of the leach lines was not verified.

Petroleum hydrocarbons, selected metals, pesticides and SVOCs were detected. Chromium and benzo(a)pyrene exceeded corresponding MTCA Method A cleanup levels. Total chromium concentrations in all samples exceeded the MTCA Method A cleanup level of 19 mg/kg for Cr VI but were well below the Cr III cleanup level of 2,000 mg/kg. The measured chromium concentrations are generally less than or only slightly above the background value in all samples. Benzo(a)pyrene (180 µg/kg) exceeded the MTCA Method A cleanup level of 100 µg/kg in one sample located in the UST G drainfield.

In 2015, a total of seven subsurface soil samples and one duplicate sample were collected at the terminus, middle and beginning of each leach line and at the former location of UST G (EIGov, 2016).

Target analytes that did not exceed their corresponding MTCA Method A cleanup level included benzo(a)pyrene, organophosphorus pesticides, chlorinated pesticides, chlorinated herbicides and glyphosate. For methylene chloride, results using the more sensitive LL8260 analysis were rejected based on exceeding the EPA-approved holding time. For the standard/medium-level 8260C analysis, the sampling quantitation limit (SQL) exceeded the MTCA Method A cleanup level for five of the eight samples. Only one sample had an SQL lower than the MTCA Method A cleanup level. Methylene chloride concentrations in two samples were above the MTCA Method A cleanup level but were considered as estimates (biased high) because of the contamination in the laboratory method blank.

To determine if the methylene chloride exceedances from the 2015 Phase III investigation were solely due to laboratory contamination, samples were collected from the identical locations in October 2017 during the Phase IV investigation. Eight soil samples were collected and analyzed for VOCs to determine if methylene chloride associated with use of UST G was present. Methylene chloride concentrations (0.56 – 2.27 µg/kg) did not exceed the MTCA Method A cleanup level of 20 µg/kg.

Groundwater

Groundwater has been monitored periodically in the nearest downgradient well, MW-03. During the June 2014 Phase I sampling, no target analytes exceeded MTCA Method A groundwater cleanup levels (USACE, 2015).

Based on the results of Phase IV no further investigation of UST G was conducted and existing information is considered sufficient for an affirmative closure decision.

2.3.1.6 USTs Y1, Y2 and Y3

Former USTs Y1, Y2, and Y3 consisted of three steel tanks with capacities of 2,000, 2,000 and 3,000 gallons, respectively, located southeast of Building 28. Installed in 1962, USTs Y1, Y2, Y3 stored unleaded, super unleaded, and regular leaded gasoline, respectively, for refueling motor vehicles.

Soil

TRPH was measured above 200 mg/kg at test pit station 89-BH-5, collected shortly before the tanks were removed in June 1989 by Baker Pacific (USACE, 1989; Shannon & Wilson, 1990).

In 2007, soil samples were collected from six geoprobe borings in the vicinity of USTs Y1, Y2, and Y3 at depths ranging from 6.5 to 12 ft; a subset of samples were analyzed for GRO, BTEX, lead, and DRO/MRO (four samples) (Ridolfi, 2008a). Although petroleum odors were noted during sample collection, DRO, GRO, BTEX, and lead were not detected in any samples. MRO was detected in one sample at a concentration of 16 mg/kg, which does not exceed the MTCA Method A cleanup level of 2,000 mg/kg.

Groundwater

MW-07, installed in 2009, is the nearest downgradient groundwater monitoring well. Borehole soil samples analyzed during the well's installation in 2009 were also non-detect for GRO, DRO, BTEX, and lead. MRO was detected in only one depth interval (1-5 ft) at 17 mg/kg (Ridolfi, 2009a).

MW-07 has been non-detect for GRO, DRO, and MRO since groundwater monitoring began in 2009.

No further investigation of USTs Y1, Y2, and Y3 was planned during the Phase II investigation (USACE, 2014) and existing information is considered sufficient for an affirmative closure decision.

2.3.2 TOP CAMP AREA

2.3.2.1 USTs H through O

A cluster of eight former USTs (H, I, J, K, L, M, N, and O) was located near the Engineering Plant Building (Building 100, also known as the "power plant") at the Microwave Site. With the exception of UST H (7,000 gallons), all USTs were 10,000 gallon capacity steel tanks. All eight USTs were installed in 1960 to store diesel fuel for the power plant. All eight USTs were subsequently removed in 1988 during base closure. At this time, the power plant was also demolished, and the building debris was used as backfill in the excavation from which USTs H through O were removed.

Soil

In February 2008, 13 soil samples were collected via test pits from 11 locations at depths of 7 to 12 ft bgs near USTs H through O. Removal of the USTs was confirmed, although the presence of debris in a few locations prevented further advancement of some of the test pits. DRO and MRO were detected in all 13 soil samples. DRO exceeded the MTCA Method A cleanup level (2,000 mg/kg) in one sample and MRO exceeded the MTCA Method A cleanup level (2,000 mg/kg) in one sample (Ridolfi, 2008b).

In October 2012, the building and facility debris in the area of the former USTs H through O was excavated and removed. The excavation was backfilled with soil stockpiled during the excavation and regraded; erosion control matting was installed. Suspected petroleum-contaminated soil (PCS) was detected in the excavation but was not removed. Collection of confirmation soil samples was planned, but not performed (Ridolfi, 2012).

In March 2015, soil samples were collected in the vicinity of USTs H through O. DRO was detected in all soil samples. Six locations exceeded the MTCA Site-Specific TEE soil cleanup level with a maximum concentration of 3,000 mg/kg at location GP-06-H3-12. No VOC detections exceeded soil cleanup levels. Benzene had non-detect SQL that exceeded the soil cleanup level of 30 µg/kg in three samples (GP-06-H3-10, GP-06-H3-12, and GP-06-H5-10). Although benzene is required for analysis for DRO releases, it is more commonly associated with gasoline. Heavier fuels such as diesel fuel typically have much less benzene present. Given that USTs H through O only stored diesel fuel for fueling the power house, and all other benzene detections at USTs H through O are well below the MTCA Method A cleanup level of 30 µg/kg, the presence of benzene in soil above the cleanup level is unlikely.

Groundwater

There are no monitoring wells associated with these USTs. No groundwater samples have been collected near USTs H through O. One direct push boring for groundwater collection was attempted midway between -H1, -H2, and -H3 (Figure 7). No groundwater sample was collected due to insufficient yield.

2.3.2.2 UST P

Former UST P was a 550 gallon steel tank installed south of the Engineering Plant Building (Building 100) in 1960 that contained waste oil (Radian, 1987). UST P was removed in 1988 by Pease Construction as part of alterations and improvements to the Top Camp Area (USACE, 1988a).

Soil

In 2008, soil samples were collected from four test pit locations at depths of 3 to 6 ft bgs and analyzed for petroleum hydrocarbons and lead. DRO and MRO were detected in all samples with maximum concentrations of 71 and 31 mg/kg, respectively. Lead was detected in one sample at 6 mg/kg. No DRO, MRO, or lead detections exceeded the MTCA Method A soil cleanup levels (Ridolfi, 2008b).

The 2008 investigation did not conduct analyses for PCBs or carcinogenic polycyclic aromatic hydrocarbons (cPAHs). MTCA requires testing for both of these analyte groups when the former tank contents include waste oil and unknown oil.

In March 2015, four soil samples were collected and analyzed for compounds associated with petroleum hydrocarbon contamination. No target analytes exceeded soil cleanup levels.

Groundwater

There are no monitoring wells associated with this UST.

In 2015, saturated soils were encountered in sample location GP-06-P1 below about 10 ft bgs. One direct push boring for groundwater sampling was attempted, but a groundwater sample could not be collected due to a combination of high turbidity and insufficient yield.

Based on the results of Phase II no further investigation of UST P was conducted and existing information is considered sufficient for an affirmative closure decision.

2.3.2.3 UST Q

Former UST Q was a 550 gallon steel tank located near former Building 102. Radian (1987) states that UST Q was installed in 1951, stored diesel fuel, and was reported abandoned in place. No additional documentation of the tank's removal is available.

Soil

In 2007, one soil sample was collected from a test pit at a depth of 4 ft bgs in the vicinity of the former Building 102. The exact location of former UST was unknown; according to communications with Ridolfi personnel, the sample was located adjacent to the foundation on the north side of former Building 102. No petroleum hydrocarbons were detected in the soil sample.

Groundwater

There are no monitoring wells associated with this UST. No groundwater samples have been collected near UST Q.

No further investigation of UST Q was conducted during the Phase II activities (USACE, 2014, 2015a) and existing information is considered sufficient for an affirmative closure decision.

2.3.2.3 USTs R and S

Former UST R was a 500 gallon steel tank located near former Building 103. Radian (1987) listed the installation date as 1951 and reported the tank as abandoned in place (emptied and filled with sand). UST R stored diesel fuel. The exact former locations of USTs R and S are unknown.

Former UST S was a 200 gallon steel tank also located near former Building 103. Radian (1987) listed UST S as Navy property; the tank contents were gasoline. USACE (1988) states that two tanks (one above ground and one underground) were removed at building 103. Further identifying information is not provided, although it appears likely that UST R, UST S, or both were removed.

Soil

In 2007, Ridolfi attempted to collect soil samples near USTs R and S, but samples could not be collected due to the presence of newer facilities in the presumed location of former USTs R and S.

In June 2014, Ground Penetrating Radar (GPR) was attempted to locate former USTs R and S but vegetation was too thick for the GPR to be successful.

In March 2015, soil samples were collected and analyzed for compounds associated with petroleum hydrocarbon contamination. No target analytes exceeded soil cleanup levels. Although the status of the tanks is unconfirmed, no tanks were encountered during the investigation.

Groundwater

There are no monitoring wells associated with these USTs. No groundwater samples have been collected near USTs R and S. Saturated soils were not encountered during the Phase II investigation.

Based on the results of Phase II no further investigation of USTs R and S was conducted and existing information is considered sufficient for an affirmative closure decision.

2.3.2.5 USTs T, U and V

Former USTs T, U, and V consisted of a 6,000, 550, and 550 gallon steel tanks, respectively, and were located at the northwest end of the Radar Dome Area. USTs T, U, and V were installed in 1953, 1962, and 1953, respectively. All three tanks stored diesel fuel.

USTs T, U, and V were removed in 1988. Their removal is documented in a USACE (1988) memo that references the removal of "Tank Nos. 2, 3, and 4" near former Building 108. The building number and tank numbers correspond with the Top Camp improvement and demolition 1988 as-builts (USACE, 1988b). A septic tank, labeled as Tank No. 1 on the as-built, was left in place.

Soil

In 2012, surface soil grab samples were collected downhill from the suspected locations of the USTs. Debris and other man-made items were found in many sampling areas and may have contributed to the scattered DRO and MRO soil exceedances observed (Ridolfi, 2013b).

In March 2015, soil samples and one groundwater grab sample were collected and analyzed for compounds associated with petroleum hydrocarbon contamination. DRO exceeded the MTCA Site-specific TEE soil cleanup level in five samples (GP-05-T3-10,GP-05-T3-12, GP-05-T2-10, GP-05-T2-12, and GP-05-TUV4-3) located near former UST T at a depth of 0-12 ft bgs. DRO also exceeded the Site-specific TEE soil cleanup level (200 mg/kg) in three samples collected near UST V from at a depth of 0 to 8 ft bgs. These samples were located underneath the existing paved access road leading to the FAA facilities. One or more samples collected near UST T had detected concentrations of DRO and MRO.

Groundwater

There are no monitoring wells associated with these USTs. In March 2015, DRO exceeded the groundwater cleanup level in the groundwater grab sample AQTUV1 taken adjacent to GP-05-T3.

2.3.2.6 UST W

Soil

Former UST W was a 2,000 gallon steel tank located near Building 117 at the Microwave Tower site. UST W was installed in 1959 and stored diesel fuel (Radian, 1987). UST W was reported as properly abandoned (emptied and filled with sand) by Radian (1987).

In 2007, two soil samples were collected at depths of 2 to 3 ft bgs from two locations in the vicinity of former UST W near former Building 117 (Ridolfi, 2008b). The sampling locations were selected based on accessibility and institutional knowledge of the tanks by a former AF employee. DRO and MRO were detected in both samples at concentrations below MTCA Method A soil cleanup levels. UST W was not encountered nor was its removal confirmed during the 2007 investigation.

Groundwater

There are no monitoring wells associated with this UST. No groundwater samples have been collected near UST W. Groundwater is not likely to be present at this location. Former UST W was located near USTs R and S where saturated soils were not encountered during the Phase II investigation.

No further investigation of UST W was conducted during the Phase II activities (USACE, 2014, 2015a) and existing information is considered sufficient for an affirmative closure decision.

SECTION 3 – CONCEPTUAL SITE MODEL AND POINTS OF COMPLIANCE

Based on the findings of site characterization activities, soil and groundwater at the site was contaminated by historic undocumented release(s) of petroleum hydrocarbons.

3.1 GEOLOGY AND HYDROGEOLOGY

3.1.1 CANTONMENT AREA GEOLOGY

Three geologic units were encountered during previous site investigations, fill soil, unconsolidated alluvium and siltstone bedrock.

The fill soil consisted of brown silty fine sand gravel- and cobble- sized siltstone fragments and wood. It was reportedly obtained from adjacent hillsides to form a level surface for the station. The fill layer is continuous over the site, ranging in thickness between about 3 and 7 feet. Where it contains little gravel and cobble material, the fill material is difficult to distinguish from the underlying native alluvium.

The unconsolidated alluvium consists of brown to dark gray, slightly silty, very fine to fine sand with occasional shell fragments and peat. The alluvium thickness varies across the site, with the unit pinching out against the base of the hill at the northwest edge of the station. The thickness exceeds 20 feet beneath most of the station where the bedrock surface declines to the southeast beneath the Wa'atch River.

The bedrock consists of an unnamed moderately hard, brown to greenish-gray siltstone and sandstone deposited during the Middle to Upper Eocene. It is similar to the Lyre and Twin River formations located to the east. The rock was encountered at depths of 7.5 and 16.5 feet in borings for MW-01 and MW-04, respectively, at the north end of the Site and exceeding 22 feet elsewhere on-site (Ridolfi, 2008a; Shannon & Wilson, 1990).

3.1.2 CANTONMENT AREA HYDROGEOLOGY

A single unconfined aquifer was identified beneath the station, occurring in the alluvium and some lower parts of the overlying fill soil. The base of the aquifer is formed by the siltstone bedrock. The water table occurs between about 4 to 7 feet below ground surface. The water table has a gradient of about 65 feet per mile, sloping to the southeast, toward the Wa'atch River.

Local recharge to the aquifer occurs directly from precipitation onto the permeable soil from the site, from surface and subsurface runoff from the adjacent hills bordering the site, and possibly from groundwater discharging from the bedrock into the aquifer, although this last source is expected to be minor. According to the Western Regional Climate Center (WRCC), the average annual precipitation at Neah Bay is approximately 100.5 inches (WRCC, 2018). Three quarters of the annual precipitation occurs during the six-month period from October through March.

The groundwater moves across the Cantonment Area to the southeast (Figure 4) and likely discharges into the channel of the Wa'atch estuary. The water table does not appear to fluctuate more than about 0.1 feet with the tide (Shannon & Wilson, 1990).

The hydraulic conductivity of the aquifer material (very fine to fine sand) is estimated to be between 10 and 1,000 gal/day/ft^2 (10^{-4} to 10^{-2} cm/sec). This estimate is based on visual observation of the soil samples (Shannon & Wilson, 1990).

3.1.3 Top Camp Area

The Top Camp is situated on the Bahokus Peak Ridge. The topography of the area is very steep and rocky. The soils are reported to be sandy, and much of the area is underlain by rocks at shallow depths (Radian, 1989; Radian, 1997). This was confirmed during Phase II investigations. Groundwater is not used at the site. During Phase II activities, groundwater was only encountered at one location (Radar Dome Area) in sufficient quantity to allow sample collection (i.e. AQTUV1). There are no monitoring wells installed at the Top Camp.

3.2 Exposure Pathways and Receptor Summary

An exposure pathway is considered complete if a human or ecological receptor can be exposed to a contaminant via that pathway. This section describes the exposure pathways for contaminants in soil, groundwater and air (soil gas).

Potential human health exposure pathways for soil are: direct contact including inhalation and ingestion; migration of soil vapor to indoor/outdoor air; and leaching from soil to groundwater beneath the site. Potential exposure pathways for groundwater include: dermal contact and ingestion of groundwater contaminant volatilization to indoor/outdoor air.

Because soil contamination was not detected above MTCA Method A cleanup levels in the surface soils (0-5 ft bgs) in the Cantonment Area at USTs A and E and the Top Camp Area at USTs H through O, P, R, S, T, U, and V there would only be human exposure during excavation of soils. USTs C/D was the only area that had detections in soil above MTCA Method A cleanup levels in surface soils.

Potential ecological exposure pathways include direct contact and uptake for plants, soil invertebrates, small and large mammals, and birds. Under MTCA, risks to ecological receptors from soil contamination is evaluated following the Terrestrial Ecological Evaluation process as indicated in Washington Administrative WAC Sections 173-340-7490 through 7494. The point of compliance for ecological receptors in soil is 15 ft bgs. Each of the USTs were evaluated following the TEE process separately since the USTs have been investigated and will be remediated independently. Based on a review of available information, contamination was present within the point of compliance at each of the UST sites evaluated in this CAP. Therefore, the sites do not qualify for an exclusion from the TEE process. Additionally, none of the UST sites meet the requirements outlined for a Simplified TEE therefore, a Site-Specific TEE was completed for each UST (Appendix E).

There are currently no drinking water wells installed in the Cantonment Area or Top Camp, however there are no controls prohibiting productions wells from being installed.

3.2.1 Vapor Intrusion Assessment

EPA Guidance for addressing VI at Leaking Underground Storage Tank Sites was released in June 2015 (EPA, 2015). The guidance recommends the following actions for addressing VI:

1. Assess and mitigate immediate threats to safety.
2. Conduct a site characterization and develop a conceptual site model
3. Delineate a lateral inclusion zone
4. Determine vertical separation distances
5. Evaluate vapor source and attenuation of petroleum hydrocarbon (PHC) vapors
6. Mitigate VI as appropriate

A preliminary Vapor Intrusion assessment was conducted as part of the Quality Assurance Project Plan (QAPP; USACE, 2013). Results of the preliminary assessment provided evidence that vapor intrusion risk due to dissolved-phase petroleum hydrocarbon contamination is low with the area of primary concern centered around former gasoline UST E. Further investigation of lateral and vertical extent of contamination in relation to overlying buildings was recommended. Site investigations performed in March 2015 and October 2017 provided data to develop a conceptual site model and determine extent of contamination in groundwater and soil.

The lateral inclusion zone was delineated with results from previous sampling efforts. Building 16 and Building 18 were determined to be included in lateral inclusion zone and were further assessed through collection of paired crawl space and indoor air samples. .USACE contractors collected VI samples from Building 16 and Building 18 in March and October 2021, which were intended to represent "wet" and "dry" season sampling conditions, respectively. The "dry" sampling event was originally planned for September, but due to an increase in Covid cases on the Makah Reservation, the sampling was postponed to mid-October and was more representative of "wet" season conditions based on measured groundwater elevations(Olgoonik FPM JV, 2022).
Benzene and naphthalene were reported above Indoor Air Cleanup Levels (Ecology, 2018) in the March 2021 VI results from Building 16 and Building 18(Appendix D). However, gasoline powered equipment (pressure washer) was noted as a potential background source of petroleum contaminants within Building 16 and the outdoor air concentrations were similar to the indoor air and crawl space concentrations (Olgoonik FPM JV, 2021). Prior to the October 2021 sampling event, Building 16 and Building 18 were aired (windows opened during business hours) and gasoline-powered equipment removed for approximately 48 hours before the start of the air sampling event. No petroleum VOCs were reported above Indoor Air Cleanup Levels (Ecology, 2018) during the October 2021 event except for naphthalene in a single crawl space sample from Building 18 and in a duplicate sample from Building 16 (Appendix D).Based on the results of the VI sampling, no further air sampling was recommended as vapor intrusion does not appear to be occurring at either Building 16 or Building 18 (Olgoonik FPM JV, 2022).

While the vapor intrusion exposure pathway does not appear to be complete at this time, the remediation of contaminated soil and groundwater near Building 16 and Building 18 will minimize the likelihood of potential receptor exposure in the future by reducing petroleum concentrations.

3.3 Points of Compliance

The contaminants are contained within the Cantonment Area and Top Camp Area and therefore exposure pathways do not extend beyond property boundaries. The points of compliance for soils and groundwater beneath the Site are at the locations of the existing and proposed onsite monitoring wells and the direct push groundwater sampling locations from Site Investigations Phase II and Phase IV within and beyond the impacted area. As such, the point of compliance is all soils throughout the site. (MTCA 173.340.740(6)(b)).

3.4 Cleanup Levels

The AF and the United States Environmental Protection Agency (EPA) have entered an Administrative Order on Consent (Consent Order) under the Resource Conservation and Recovery Act (RCRA) UST Program to investigate, remove and remediate the release from USTs of petroleum constituents at or from the Site. Because the Site is located within the Makah Indian Reservation, EPA Region 10 is the implementing agency for the UST program. EPA uses MTCA cleanup levels established by the Washington State Department of Ecology (Ecology) as a guide for determining appropriate cleanup levels for petroleum releases in Indian Country in Washington State. MTCA Method A is designed for cleanups that are relatively straight-forward or involve only a few hazardous substances; MTCA Method A cleanup levels are considered appropriate for the Site and are appropriate for unrestricted land use. MTCA regulations and cleanup levels have been promulgated chapter 173-340 of the Washington Administrative Code (WAC). Based on a review of MTCA Method A soil cleanup levels (Table 740-1) and the Site-Specific TEE soil cleanup levels (Table 749-2), DRO is the only site Contaminant of Interest (COI) for which the MTCA TEE soil cleanup level (200 mg/kg) is lower than the MTCA Method A cleanup level (2,000 mg/kg). Therefore, the MTCA Method A cleanup levels will be used for all COI except DRO, which will use the MTCA TEE soil cleanup level.

The Makah Tribe is concerned about the groundwater to surface water transport pathway for contaminants originating from the Cantonment Area's contaminated groundwater. Because surface waters in the Cantonment Area (Cub Creek) and the Wa'atch River are likely in communication with groundwater, groundwater standards should be protective of these nearby surface water resources. (https://www.epa.gov/sites/production/files/2014-12/documents/makah-tribe-wqs.pdf). Although no surface water samples were collected during the UST investigation, there is a possibility for groundwater to connect with surface water at the Wa'atch River. In addition, only three analytes (benzene, toluene, and ethylbenzene) from the groundwater sampling analyte list were also listed in the Tribe's water quality standards. The only reference to petroleum in the water quality standards is that all waters shall be free from visible oils, including crude oil and petroleum scum, foam, grease, and other floating materials and suspended substances of a persistent nature resulting from anthropogenic causes.

3.5 Current and Future Land Use

Current land use of the Cantonment Area is a mixture of commercial and/or industrial. Former dormitories and other structures have been converted into office space used by the local tribal government. Other buildings have retained their original intended uses including mechanical, maintenance, and repair shops. Inactive heavy equipment was observed parked on the southeast portion of the Cantonment Area near the former burn pit. During weekdays, the Cantonment Area is a hub of activity during business hours. There are no known private residences or homes within the Cantonment Area.

Current land use for the Top Camp Area varies by location. The Federal Aviation Administration (FAA) leases and operates the buildings and radar dome located within a fenced enclosure at the Radar Dome Area. The FAA usually has an on-site caretaker at the facility for a few hours each weekday. However, FAA staff presence at the site was limited during the Phase II investigation. The Microwave Tower Site has two fenced areas. Each fenced enclosure contains one tower with associated support structures and facilities. The southern fenced tower and associated facilities are operated by the United States Coast Guard (USCG). The northern fenced area tower and building are marked "Peninsula Telephone," but are currently operated by Century Link. The GATR and Building 102 areas are down the road from the Microwave Tower Site and are no longer used.

USACE is not aware of any planned changes for future uses of the Cantonment and Top Camp Areas. However, the Makah Tribe has requested that the future use of the Cantonment and Top Camp Areas be considered Unrestricted Use.

Section 4 – Corrective Action Alternatives

This corrective action alternatives analysis identifies and evaluates corrective action alternatives for the petroleum contamination in soil and groundwater at the site. This analysis supports selection of the preferred corrective action alternatives that reasonably meet the corrective action objectives and MTCA requirements for cleanup actions described in WAC 173-340-360. Per Section 8.1 of the AOC, following the EPA's conditional approval of the proposed CAP, the proposed CAP will be made available for public review and comment in accordance with the requirements of 40 CFR §280.67.

The following sections present the corrective action objectives, screening of corrective action alternatives, and selection of the most permanent and practicable corrective action alternatives.

4.1 Corrective Action Objectives

The objectives of the cleanup are:

- To complete a corrective action that is protective of human health and the environment
- To complete a remedial action that is permanent to the maximum extent practicable

Cleanup levels (CULs) for contaminated soils and groundwater will be achieved to the extent practicable unless the cost and risk of additional excavation are disproportionate to the incrementally additional contaminant removal benefit. While as much contaminated soil will be removed from the source areas as feasible, inaccessible contaminated soil may require additional treatment. Further, groundwater quality will improve over time once the contaminated soil source has been treated or removed and with active treatment. If cleanup levels are not met by the initial corrective action, additional characterization and/or remediation may be required. It is anticipated that an iterative approach may be necessary to reach unrestricted closure.

CULs for the COI are identified in Table 3. Soil COIs were selected based on contaminants that exceeded MTCA Method A soil values in one or more soil samples during the Phase I – IV investigations. Likewise, groundwater COIs were selected based on contaminants that exceeded MTCA Method A groundwater values in one or more groundwater samples during the Phase I - IV investigations.

Preference is placed on remedies that can be implemented in a shorter time, based on potential environmental risks and effects on current site use and associated site and surrounding area resources.

4.2 Identification and Screening of Corrective Action Alternatives

Corrective action alternatives identified and evaluated for the Site are described in Table 4. Corrective action alternatives evaluated for mitigation of gasoline- and diesel-contaminated soil and groundwater include several passive and active remediation technologies.

4.3 Preferred Corrective Actions

The preferred corrective actions are described below by location. Corrective action footprints and depths in each UST area were designed to encircle all sample locations from the Phase I – IV investigations where at least one COI exceeded its CUL. These correction actions were selected because they meet the corrective action objectives within a reasonable timeframe.

4.3.1 UST A

The preferred corrective action for the UST A area is Soil Excavation, Off-site Treatment and Disposal of Excavated Materials, and Enhanced Aerobic Biodegradation outside Limits of Excavation. Backfill will include ORC amendment from the bottom of the excavation up to 3 feet bgs. See Section 5.1 for additional details.

4.3.2 USTs C and D

The preferred corrective action for the USTs C and D area is Soil Excavation, Off-site Treatment and Disposal of Excavated Materials, and Enhanced Aerobic Biodegradation outside the Limits of Excavation. Backfill will include ORC amendment from the bottom of the excavation up to 3 feet bgs.

4.3.3 UST E

The preferred corrective action for the UST E area is Soil Excavation, Off-site Treatment and Disposal of Excavated Materials, and Enhanced Aerobic Biodegradation outside the Limits of Excavation. Backfill will include ORC amendment from the bottom of the excavation up 3 feet bgs.

4.3.4 USTs H through O

The preferred corrective action for the USTs H through O area is Soil Excavation and Off-site Treatment and Disposal of Excavated Materials. Groundwater was not encountered during the Phase II investigation, so it is expected that contaminated soil can be addressed by excavation and off-site treatment/disposal alone. Enhanced aerobic biodegradation injections below the water table are not expected to be necessary. Additionally, any excavated soil that is to be re-used as backfill will be mixed with dry ORC powder prior to its use as backfill. See Section 5.4 for additional details.

4.3.5 USTs T, U, and V

The preferred corrective action for the USTs T, U, and V area is Soil Excavation and Off-site Treatment and Disposal of Excavated Materials. Subsurface water was encountered during the Phase II investigation; however, this water likely represents a small volume of perched water rather than an actual aquifer. Because this UST area is located on top of a steep hill, the presence of the water encountered in Phase II is theorized to be perched and transient. Thus, it is assumed that only excavation and off-site disposal will be necessary. Backfill will include ORC amendment from the bottom of the excavation up 5 feet bgs to further address any groundwater contamination that may be in the area and elevated soil concentrations (though less than CULs) in adjacent areas. However, the corrective action will be modified if groundwater is encountered during the excavation and it is determined that the target excavation depth cannot be reached practicably and safely. See Section 5.5 for additional details.

Section 5 – Corrective Action Plan Implementation

This section contains the plans for implementing the preferred corrective action alternatives to mitigate the contaminated media and potential exposure pathways at the Site in accordance with MTCA regulations. The potential exposure pathways for the Site and the elements of the proposed cleanup remedy that address each potential exposure are shown in Table 5.

The corrective action for each UST area will include obtaining the necessary permits and coordinating and scheduling field activities with the Air Force Civil Engineering Office (AFCEO), the Makah Tribe, and applicable contractors. Corrective action implementation is expected to occur during the summer when groundwater levels are the lowest.

5.1 UST A

The proposed corrective action for the UST A area includes:

- Excavate and remove accessible impacted soil from the site to the extent practicable and safe without risking damage to the nearby buildings. Target excavation depth, if practicable and safe, is 15 feet bgs. The planned excavation footprint is shown in Figure 5. Initially, excavate, segregate, and stockpile clean overburden soil (clean stockpile) to access the deeper impacted soil. If there is evidence of contamination in overburden soil that was expected to be clean (e.g., sheen, stain, odor), the overburden soil would not be placed into the clean stockpile. Then, the excavation will target locations with high concentration areas at deeper depths (i.e. A4 and A6) and resemble a test pit and move laterally outward from there. In order to minimize the generation of hazardous waste, saturated PCS will be initially stockpiled in the excavation area

after the clean overburden is removed to allow the PCS to dewater. Soil will be field screened (see Section 6.1.2) for the presence of petroleum contamination. Excavated soil will be temporarily staged on site or loaded directly into trucks for transportation and disposal.
- Obtain cleanup confirmation soil samples for chemical analysis to document that concentrations of contaminants of concern above CULs at the final horizontal limits of the remedial excavation have been successfully removed (Ecology, 2016). Soil excavation will be conducted until the horizontal extent of concentrations of contaminants of interest (COIs) in the remaining soil meets site CULs or it is unsafe to excavate further.
- Obtain confirmation soil samples from the clean stockpiled soil to document that concentrations of COIs in the stockpile are below CULs (Ecology, 2016).
- Direct application and mixing of oxygen release compound (ORC) slurry or similar at the base of the open excavation.
- Reuse the non-contaminated stockpile soil and/or imported fill as backfill within the excavation at the site.
- Backfill from the bottom of the excavation to 3 feet bgs with ORC-amended backfill (mix ORC with backfill material in accordance with manufacturer/supplier instructions). Finish backfilling the excavation to the ground surface with imported or non-contaminated native soil and restore the site surface to approximately pre-cleanup elevations.
- Direct injection of ORC slurry or similar between the maximum excavation depth achieved and 15 feet bgs to cover the footprint shown in Figure 5. The purpose of ORC slurry or similar injection is to treat soil and/groundwater contamination that could not be removed by excavation. The estimated maximum distance between ORC slurry or similar injection points is 12 feet[2]; proposed injection points are also shown in Figure 5.
- Restore the site surface to pre-cleanup conditions.
- After one year, obtain confirmation soil samples from near A4 and A6 to document that soil below maximum achieved excavation depth has been treated such that that contaminant concentrations are below CULs (Ecology, 2016). Also, obtain a confirmation groundwater sample near AQA1 to document that contaminant concentrations in groundwater have been treated to below CULs (Ecology, 2016).

5.2 USTs C and D

The proposed corrective action for the USTs C and D area includes:

- Excavate and remove accessible impacted soil from the site to the extent practicable without risking damage to the nearby buildings. Target excavation depth, if practicable and safe, is 15 feet bgs. The planned excavation footprint is shown in Figure 6. Initially, excavate, segregate, and

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[2] Injection well spacing was determined using the underlying geology of the region as described by monitoring wells and bore logs. The injection locations are focused on the Cantonment area on the sandy floodplain of the Wa'atch River. During the use of the site, fill was brought in and placed on top of the sandy silt that was originally there. This has created a sharp contact between the original sediment and the overlying layer. The fill (USCS GP) is also poorly sorted with gravels, sands, and fines mixed from two to seven feet bgs. The underlying sandy silt (USCS SM) is fairly uniform with medium to fine sand and silt or silty sand. The porosity value was known to be 0.22 generally across the injection area. The water table is also fairly shallow, with groundwater encountered at 1.6 to 4 feet bgs. Groundwater flow has been observed to generally flow toward the southeast. The injection is planned to target soils from 5 to 15 feet bgs which will include both the poorly sorted gravel fill and the silty sand. The planned oxidant can be injected as a slurry with a minimum percentage of 35% solution in water.

Based on site conditions and recommendations outlined for similar injections by ISRRIWG (2009), the recommended maximum spacing between each injection is 12 feet. This will ensure good overlap between each injection point and will also account for any unknown heterogeneity that may be in the subsurface. The planned injection solution is also a slurry that sets after 30 minutes, so the spacing also takes this viscosity into consideration.

stockpile clean overburden soil (clean stockpile), if any (not anticipated that there is any clean overburden soil near the location of former USTs C and D, but there may be clean overburden elsewhere), to access the deeper impacted soil. If there is evidence of contamination in overburden soil that was expected to be clean (e.g., sheen, stain, odor), the overburden soil would not be placed into the clean stockpile. Then, the excavation will target known high concentration areas (resembling a test pit) and move laterally outward from there. In order to minimize the generation of hazardous waste, saturated PCS will be initially stockpiled in the excavation area after the clean overburden is removed to allow the PCS to dewater. Soil will be field screened (see Section 6.1.2) for the presence of petroleum contamination. Excavated soil will be temporarily staged on site or loaded directly into trucks for transportation and disposal.

- Obtain cleanup confirmation soil samples for chemical analysis to document that concentrations of contaminants of concern above CULs at the final horizontal limits of the remedial excavation have been successfully removed (Ecology, 2016). Soil excavation will be conducted until the horizontal extent of concentrations of contaminants of interest (COIs) in the remaining soil meets site CULs or it is unsafe to excavate further.
- Obtain confirmation soil samples from the clean stockpiled soil to document that concentrations of COIs in the stockpile are below CULs (Ecology, 2016).
- Direct application and mixing of oxygen release compound (ORC) slurry or similar at the base of the open excavation.
- Reuse the non-contaminated stockpile soil and/or imported fill as backfill within the excavation at the site.
- Backfill from the bottom of the excavation to 3 feet bgs with ORC-amended backfill (mix ORC with backfill material in accordance with manufacturer/supplier instructions). Finish backfilling the excavation to the ground surface with imported or non-contaminated native soil and restore the site surface to approximately pre-cleanup elevations.
- Replace MW-05 if damaged or destroyed by the excavation activities.
- Direct injection of ORC slurry or similar between the maximum excavation depth achieved and 15 feet bgs to cover the footprint shown in Figure 6. The purpose of ORC or similar injection is to treat soil and/groundwater contamination that could not be removed by excavation. The estimated maximum distance between ORC or similar injection points is 12 feet; proposed injection points are also shown in Figure 6.
- Restore the site surface to pre-cleanup conditions.
- After one year, obtain confirmation soil samples from near CD1, CD2, CD3, CD5, CD6, CD8, CD16, and CD18 to document that soil below maximum achieved excavation depth has been treated such that contaminant concentrations are below CULs (Ecology, 2016). Also, obtain confirmation groundwater samples near AQCD1, AQCD2, and AQCD6 to document that contaminant concentrations in groundwater have been treated to below CULs (Ecology, 2016).
- Collect groundwater samples from existing monitoring wells MW-05 and MW-08 quarterly to document that contaminant concentrations in groundwater have been treated to below CULs. This monitoring is expected to continue for one year.

5.3 UST E

The proposed corrective action for the UST E area includes:

- Excavate and remove accessible impacted soil from the site to the extent practicable without risking damage to the nearby buildings. Target excavation depth, if practicable and safe, is 15 feet bgs. The planned excavation footprint is shown in Figure 7. Initially, excavate, segregate, and stockpile clean overburden soil to access the deeper impacted soil. If there is evidence of contamination in overburden soil that was expected to be clean (e.g., sheen, stain, odor), the overburden soil would not be placed into the clean stockpile. Then, the excavation will target known high concentration areas (resembling a test pit) and move laterally outward from there. In order to minimize the generation of hazardous waste, saturated PCS will be initially stockpiled in the excavation area after the clean overburden is removed to allow the PCS to dewater. Soil will be field screened (see Section 6.1.2) for the presence of petroleum contamination. Excavated soil will be temporarily staged on site or loaded directly into trucks for transportation and disposal.

- Obtain cleanup confirmation soil samples for chemical analysis to document that concentrations of contaminants of concern above CULs at the final horizontal limits of the remedial excavation have been successfully removed (Ecology, 2016). Soil excavation will be conducted until the horizontal extent of concentrations of contaminants of interest (COIs) in the remaining soil meets site CULs or it is unsafe to excavate further.
- Obtain confirmation soil samples from the clean stockpiled soil to document that concentrations of COIs in the stockpile are below CULs (Ecology, 2016).
- Direct application and mixing of oxygen release compound (ORC) slurry or similar at the base of the open excavation.
- Reuse the non-contaminated stockpile soil and/or imported fill as backfill within the excavation at the site.
- Backfill from the bottom of the excavation to 3 feet bgs with ORC-amended backfill (mix ORC with backfill material in accordance with manufacturer/supplier instructions). Finish backfilling the excavation to the ground surface with imported or non-contaminated native soil and restore the site surface to approximately pre-cleanup elevations.
- Direct injection of ORC slurry or similar between the maximum excavation depth achieved and 15 feet bgs to cover the footprint shown in Figure 7. The purpose of ORC or similar injection is to treat soil and/groundwater contamination that could not be removed by excavation. The estimated maximum distance between ORC or similar injection points is 12 feet; proposed injection points are also shown in Figure 7.
- Install a groundwater monitoring well (CW-E1) immediately downgradient of Building 16.
- Restore the site surface to pre-cleanup conditions.
- After one year, obtain confirmation soil samples from near E6, E11, and E15 to document that soil below maximum achieved excavation depth has been treated such that that contaminant concentrations are below CULs (Ecology, 2016). Also, obtain confirmation groundwater sample near AQE1, AQE4, AQE5, and AQE7 to document that contaminant concentrations in groundwater have been treated to below CULs (Ecology, 2016).
- Collect groundwater samples from the new monitoring well CW-E1 and existing monitoring well MW-06 quarterly to monitor an apparent groundwater plume beneath or near Building 16 and document that contaminant concentrations in groundwater, including those beneath Building 16, have been treated to below CULs. This monitoring is expected to continue for one year.

5.4 USTs H through O

The proposed corrective action for the USTs H through O area includes the following measures:

- Excavate and remove accessible impacted soil from the site to a target depth of 12 feet bgs. The planned excavation footprint is shown in Figure 8. The excavation will target known high concentration areas (resembling a test pit) and move laterally outward from there. In order to minimize the generation of hazardous waste, saturated PCS will be initially stockpiled in the excavation area after any clean overburden is removed to allow the PCS to dewater. Soil will be field screened (see Section 6.1.2) for the presence of petroleum contamination. Excavated soil will be temporarily staged on site or loaded directly into trucks for transportation and disposal.
- Obtain cleanup confirmation soil samples for chemical analysis to document that concentrations of contaminants of concern above CULs at the final limits of the remedial excavation have been successfully removed (Ecology, 2016). Soil excavation will be conducted until concentrations of

contaminants of interest (COIs) in the remaining soil meets site CULs, unless excavation is limited by physical constraints.

- Obtain confirmation soil samples from any clean stockpiled soil to document that concentrations of COIs in the stockpile are below CULs (Ecology, 2016).
- Direct application and mixing of dry oxygen release compound (ORC) powder or similar at the base of the open excavation.
- Mix dry ORC powder or similar with the non-contaminated stockpile soil and/or imported clean soil (mix ORC with backfill material in accordance with manufacturer/supplier instructions) and backfill the excavation at the site to approximately pre-cleanup elevations.
- Restore the site surface to pre-cleanup conditions.

5.5 USTs T, U, and V

The proposed corrective action for the USTs T, U, and V area includes:

- Excavate and remove accessible impacted soil from the site to a target depth of 12 feet bgs. The planned excavation footprint is shown in Figure 9. The excavation will target known high concentration areas (resembling a test pit) and move laterally outward from there. In order to minimize the generation of hazardous waste, saturated PCS will be initially stockpiled in the excavation area after any clean overburden is removed to allow the PCS to dewater. Soil will be field screened (see Section 6.1.2) for the presence of petroleum contamination. Excavated soil will be temporarily staged on site or loaded directly into trucks for transportation and disposal.
- Obtain cleanup confirmation soil samples for chemical analysis to document that concentrations of contaminants of concern above CULs at the final limits of the remedial excavation have been successfully removed (Ecology, 2016). Soil excavation will be conducted until concentrations of contaminants of interest (COIs) in the remaining soil meets site CULs, unless excavation is limited by physical constraints.
- Obtain confirmation soil samples from any clean stockpiled soil to document that concentrations of COIs in the stockpile are below CULs (Ecology, 2016).
- Direct application and mixing of dry oxygen release compound (ORC) powder or similar at the base of the open excavation.
- Backfill from the bottom of the excavation to 5 feet bgs with ORC-amended backfill (mix ORC with backfill material in accordance with manufacturer/supplier instructions). Finish backfilling the excavation to the ground surface with imported or non-contaminated native soil and restore the site surface to approximately pre-cleanup elevations.
- Restore the site surface to pre-cleanup conditions.
- After one year, obtain confirmation groundwater samples near AQTUV1 to document that contaminant concentrations in groundwater have been treated to below CULs (Ecology, 2016).

If groundwater is encountered during excavation area prior to reaching the target excavation depth, and it is determined that the target excavation depth cannot be reached practicably and safely, the preferred corrective action will be modified as follows:

- Limit excavation depth to the that which is practicable and safe.
- Direct application and mixing of oxygen release compound (ORC) slurry or similar at the base of the open excavation instead of dry ORC powder.
- Reuse the non-contaminated stockpile soil and/or imported fill as backfill within the excavation at the site.
- Backfill from the bottom of the excavation to 5 feet bgs with ORC-amended backfill (mix ORC with backfill material in accordance with manufacturer/supplier instructions). Finish backfilling

the excavation to the ground surface with imported or non-contaminated native soil and restore the site surface to approximately pre-cleanup elevations.
- Direct injection of ORC slurry or similar between the maximum excavation depth achieved and 12 feet bgs to cover the excavation footprint (shown in Figure 9). The purpose of ORC or similar injection is to treat soil and/groundwater contamination that could not be removed by excavation. The estimated maximum distance between ORC or similar injection points is 12 feet.
- Restore the site surface to pre-cleanup conditions.
- After one year, obtain confirmation soil samples from near T3 to document that soil maximum achieved excavation depth has been treated such that that contaminant concentrations are below CULs (Ecology, 2016). Also, obtain confirmation groundwater sample near AQTUV1 to document that contaminant concentrations in groundwater have been treated to below CULs (Ecology, 2016).

5.6 Estimated Soil Excavation Volumes and ORC Injection Volumes

The estimated volumes of soil to be excavated and handled, along with the volume of ORC injection solution, required for corrective actions in each of the UST areas are shown in Table 6. Estimated soil excavation volumes were calculated by multiplying the area of the excavation by the estimated excavation depths (split into likely non-contaminated soil and COI-impacted soil). Non-contaminated soil is assumed to occur above the first incidence of soil above CULs (e.g., 4 feet bgs in the UST A area). COI-impacted soil to be removed is assumed to occur below the non-contaminated soil, but above the approximate summer water table of 7 feet bgs in the Cantonment Area; the water table is not expected to impact excavations in the Top Camp Area. These assumptions are for the purpose of estimating ONLY. The intent, as stated in the proposed corrective actions for each UST area (Sections 5.1 through 5.5) is to remove as much contaminated soil by excavation as is practicable and safe without damaging buildings, regardless of the water table elevation. The actual excavation volumes will depend on the practicability and safety of achieving the target excavation depths, which will be determined in the field immediately before and during excavation.

ORC is expected to be injected using a Geoprobe method according to methods outlined by the ORC manufacturer/supplier. Estimated ORC injection volumes were calculated by multiplying the number of proposed injection points, area of each injection (assuming a diameter of 12 feet) to be impacted by the ORC injections, the length of the estimated depth interval over which ORC solution is assumed to be injected, and a representative site porosity of 0.22. This calculation results in the total void space of the volume proposed to be affected by ORC injections. The assumed injection diameter spacing of 12 feet was based on the available soil information from previous investigations and professional judgement. The actual spacing of the injection points will be determined in the field based on above and below ground obstacles, observed radius of influences, and other information obtained during the excavation.

5.7 Site Safety Plan

A Health and Safety Plan (HASP) will be used by personnel during the cleanup action. Copies of the HASP used by the remedial contractor and others on-site will be kept on-site and will be made available to authorized visitors for general information.

5.8 Final Cleanup Report

A final cleanup report will be submitted to EPA documenting the activities and compliance sampling associated with the cleanup action.

5.9 Schedule for Implementation of Corrective Actions

The general schedule for implementation of the corrective action is contingent on the availability of funds and weather conditions. Table 7 summarizes the proposed implementation schedule.

SECTION 6 – PERFORMANCE AND COMPLIANCE MONITORING

6.1 SAMPLING AND ANALYSIS PLAN

A generalized summary of performance monitoring for the cleanup and soil and groundwater confirmation monitoring is provided below. Sample handling and collection procedures will be consistent with handling and collection procedures followed in the Phase I through IV Investigations and in accordance with the approved Quality Assurance Project Plan (QAPP; USACE, 2014).

Table 8 summarizes the proposed soil and groundwater sampling frequency.

6.1.2 EXCAVATION CONFIRMATION SAMPLING

Confirmation soil sampling at the limits of the excavations will include the following:

- Obtain at least one sample from each side of the excavation and one soil sample from the bottom of the excavation (minimum of five samples). For larger excavations, obtain soil samples from the limits of the excavations at a rate of approximately one sample per 400 square feet of excavation base and 400 square feet of excavation sidewall surface area (Ecology, 2016).
- Sampling locations will be where field screening of representative soil indicates the potential for the highest concentrations of petroleum-related contaminants. Field screening of soil samples for evidence of petroleum contaminants will be completed using field observations such as visual staining and odor and using a SiteLab UVF-3100A.
- Document sample locations and depths in the field.
- Segregate soil based on field screening evidence.
- Analyze cleanup confirmation soil samples for gasoline-range petroleum hydrocarbons by method NWTPH-Gx, diesel- and oil-range petroleum hydrocarbons by method NWTPH-Dx, EPA Method 8260C for volatile organic compounds (VOCs), and EPA Method 8270D-SIM for semi-volatile organic compounds (SVOCs).

6.1.3 CONTAMINATED AND OVERBURDEN SOIL CHARACTERIZATION

The impacted soil has been characterized by previous assessment results. However, at least one sample of contaminated soil (per UST area) will be additionally tested following excavation to confirm the presence of contaminants of concern. Beyond that, additional analytical testing will generally not be conducted unless requested by the landfill facility.

Non-contaminated soil will be analyzed by the same methods identified in section 6.1.2 to confirm that COIs are not present at concentrations above CULs prior to reuse. The minimum number of samples is based on the volume of stockpiled soil, as shown in the Table 8 (Ecology, 2016).

6.1.4 POST-CONSTRUCTION SOIL CHARACTERIZATION

One year following the ORC (or similar) injections to COI-impacted areas, discrete soil samples will be collected from locations and depth intervals that exceeded the CULs in Phase I through IV investigations if that soil was not removed by excavation and backfilled with clean soil. Soil will be analyzed by the same methods identified in section 6.1.2 to confirm that COIs are not present at concentrations above CULs. Sampling locations should be close to Phase II and IV investigation soil samples A4, A6, CD1, CD2, CD3, CD5, CD6, CD8, CD16, CD18, E6, E11, and E15 and any confirmation sampling locations where concentrations were above CULs. If the target excavation depth at USTs in the Top Camp (i.e. USTs H-O and TUV) cannot be met for practicability and safety reasons, leading to the injection of ORC slurry (see Section 5.5), then an additional soil sample will be collected near the Phase II investigation soil samples and confirmation samples where concentrations were above CULs.

6.1.5 Post-construction Groundwater Characterization

One year following the ORC (or similar) injections to COI-impacted areas, discrete groundwater samples will be collected from locations and depth intervals that exceeded the CULs in Phase I through IV investigations. Sampling locations should be close to Phase II and IV investigation groundwater grab samples AQA1, AQCD1, AQCD2, AQCD6, AQE1, AQE4, AQE5, AQE7, and AQTUV1.

Additionally, quarterly groundwater monitoring will occur in existing monitoring wells MW-04, MW-05, MW-08, and MW-06. A new monitoring well will be installed immediately downgradient of Building 16, followed by quarterly monitoring. Quarterly groundwater monitoring in these wells is proposed to document that contaminant concentrations in groundwater, including those beneath Building 16, have been treated to below CULs.

Groundwater samples will be analyzed for gasoline-range petroleum hydrocarbons by method NWTPH-Gx, diesel- and oil range petroleum hydrocarbons by method NWTPH-Dx, and EPA Method 8260C for VOCs to confirm that COIs are not present at concentrations above CULs.

6.2 Supplemental Corrective Actions

If performance and compliance monitoring results do not show that CULs are achieved in all compliance monitoring samples, supplemental corrective actions will be proposed in the draft Cleanup Report. Supplemental corrective actions may include, but are not limited to, additional site characterization, monitoring, or corrective actions.

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TABLES

Table 1. Cantonment and Top Camp USTs

UST	Former Contents	Former Use (if known)	Capacity in gallons	Year Installed	Tank Status	Pre-Phase II Known MTCA A Soil Exceedances	Soil Analytes Above Cleanup Levels (Phase II)	Soil Analytes Above Cleanup Levels (Phase IV-Data Gap Investigation)	Corrective Action Plan Status	Comments
Cantonment Area										
A	No. 2 diesel	fuel for emergency backup generators	8,000	1951	Tank removed in 1989.	DRO	DRO, EDB, benzene	NA (Not investigated)	Excavation of soil exceeding cleanup levels and injection of ORC.	EDB and benzene were non detect with SQLs > soil cleanup levels in one sample. EDB was a gasoline additive and is not a required analyte for diesel petroleum releases. EDB and benzene are more commonly associated with gasoline.
B	No. 2 diesel	fuel for emergency backup generators	2,000	1979	Tank removed in 1989.	None	NA (Not investigated)	NA (Not investigated)	No Further Action is required	
C	No. 2 diesel (previously bunker fuel, #4 diesel)	fueling boilers operating 24 hrs/day	10,000	1979	Tank removed in 1989.	DRO, MRO	DRO, (total) naphthalenes, cPAHs, EDB, benzene, m,p-xylenes,	None	Excavation of soil exceeding cleanup levels and injection of ORC.	EDB, benzene, and/or m,p-xylene exceedances were non detect with elevated SQLs in up to 10 samples.
D	No. 2 diesel (previously bunker fuel, #4 diesel)	fueling boilers operating 24 hrs/day	8,000	1976	Tank removed in 1989.	DRO, MRO				
E	Unleaded (previously leaded) gasoline	motor vehicle refueling	2,050	1953	Tank removed in 1989.	GRO	GRO, EDB, benzene	None	Excavation of soil exceeding cleanup levels and injection of ORC.	EDB was non detect with elevated SQL > soil cleanup level in three samples. Maximum benzene exceedance was also ND with elevated SQL > soil cleanup level in two samples; benzene was detected above soil cleanup level in one sample.
F	No. 2 diesel	motor vehicle refueling	550	1954	Tank removed in 1989.	None	NA (Not investigated)	NA (Not investigated)	No Further Action is required	
G	Waste chemicals pesticide rinse	Received pesticide rinse wastes from building 43	1,000	Est. 1975	Tank removed in 1989.	Drainfield, Benzo(a)pyrene, chromium	Methylene Chloride (lab blank contamination)	None	No Further Action is required	UST G was investigated in 2015 by EIGov. Leach lines were delineated. Soil samples were collected and analyzed for VOCs. Lab blanks had detections of methylene chloride above the MTCA A Soil cleanup level.
Y1	Gasoline (unleaded)	motor vehicle refueling	2,000	1962	Tank removed in 1989.	None	NA (Not investigated)	NA (Not investigated)	No Further Action is required	
Y2	Gasoline (super unleaded)	motor vehicle refueling	2,000	1962	Tank removed in 1989.	None	NA (Not investigated)	NA (Not investigated)	No Further Action is required	
Y3	Gasoline (regular leaded)	motor vehicle refueling	3,023	1962	Tank removed in 1989.	None	NA (Not investigated)	NA (Not investigated)	No Further Action is required	
Microwave Tower Site										
H	Diesel Fuel	Fuel for Engineering Plant building	7,000	1960	Tanks removed in 1988.	DRO, MRO	DRO, EDB, benzene	NA (Not investigated)	Excavation of soil exceeding cleanup levels.	EDB and benzene were non detect with SQLs > soil cleanup levels in two samples. EDB was a gasoline additive and is not a required analyte for diesel petroleum releases. EDB and benzene are more commonly associated with gasoline.
I			10,000	1960				NA (Not investigated)		
J			10,000	1960				NA (Not investigated)		
K			10,000	1960				NA (Not investigated)		
L			10,000	1960				NA (Not investigated)		
M			10,000	1960				NA (Not investigated)		
N			10,000	1960				NA (Not investigated)		
O			10,000	1960				NA (Not investigated)		
P	Waste oil	Stored waste oil	550	1960	Tank removed in 1988.	None	None	NA (Not investigated)	No Further Action is required	
R	Diesel fuel		550	1951	Status unconfirmed: Tank reported abandoned in place (Radian 1987). Memo dated 28 September 1988 indicates that one above ground and one below ground tanks were removed at building 103. Either or both Tanks R and S may have been the subject tanks removed. Tank not encountered during Phase II investigation.	No Data	None	NA (Not investigated)	No Further Action is required	

UST	Former Contents	Former Use (if known)	Capacity in gallons	Year Installed	Tank Status	Pre-Phase II Known MTCA A Soil Exceedances	Soil Analytes Above Cleanup Levels (Phase II)	Soil Analytes Above Cleanup Levels (Phase IV-Data Gap Investigation)	Corrective Action Plan Status	Comments
S	Gasoline (unleaded, leaded, and super unleaded)		200	Unknown	Status unconfirmed: Tank belonged to Navy and was listed as operational in Radian 1987 HER. Memo dated 28 September 1988 indicates that one above ground and one below ground tanks were removed at building 103. Either or both Tanks R and S may have been the subject tanks removed. Tank not encountered during Phase II investigation.	No Data	None	NA (Not investigated)	No Further Action is required	
W	Diesel Fuel		2,000	1959	Status unconfirmed: Reported abandoned in place (Radian 1987). Memo data 28 September 1988 indicates that on above ground and one below ground tanks were removed at building 103. UST W was listed by Radian as being adjacent to Building 117, so memo listing may not be referring to UST W.	None	NA (Not investigated)	NA (Not investigated)	No Further Action is required	
Radar Dome Area										
T	Diesel Fuel		6,000	1953	Tank removed in 1988. Tank was not encountered during Phase II investigation.	No Data	DRO	NA (Not investigated)	Excavation of soil exceeding cleanup levels. If groundwater is encountered during excavation, ORC will be used.	
U	Diesel Fuel (#4)		550	1962	Tank removed in 1988. Tank was not encountered during Phase II investigation.	No Data		NA (Not investigated)		
V	Diesel Fuel		550	1953	Tank removed in 1988. Tank was not encountered during Phase II investigation.	No Data		NA (Not investigated)		
Former Building 102										
Q	Diesel Fuel		550	1951	Status unconfirmed: Tank reported abandoned in place (Radian 1987). Tank not encountered during 2007/2008 soil investigation (Ridolfi 2008).	None	NA (Not investigated)	NA (Not investigated)	No Further Action is required	

Table 2. Groundwater Screening and Cleanup Levels for Petroleum Compounds

Compound	Method A Groundwater Cleanup Level (ug/L)	Groundwater PVI Screening Level (ug/L)	Maximum Detected Concentration (ug/L)
Benzene	5	2.4	0.7
1,2-Dichloroethane	5	4.2	ND
Naphthalene	160	8.9	**210**
Xylenes	1000	333	102.2

Table 3. Soil and Groundwater Cleanup Levels

COI	Soil (mg/kg)	Groundwater (µg/L)
DRO	200**	500
GRO	30*	800*
Naphthalene	5	160
Benzene	0.03	--
Benzo(a)pyrene TTEC	0.1	--
Benzo(a)pyrene	0.1	--
Total Naphthalenes	5	--
MTBE	0.1	--

Key
COI - Contaminant of Interest
DRO - Diesel range organics
GRO - Gasoline range organics
mg/kg - milligrams per kilogram
µg/L - micrograms per liter
-- - Not detected in groundwater above MTCA Method A groundwater values
Note:

*The GRO cleanup levels are the MTCA Method A values for GRO with benzene present; benzene was detected in one or more soil samples AND one or more groundwater sample in the UST E area during the Phase II or Phase IV Investigations.
**The soil DRO cleanup levels are the MTCA Site-Specific Terrestrial Ecological Evaluation (TEE) values for DRO.

Table 5. Potential Exposure Pathways

Pathway	Corrective Action
Direct Contact with Soil or Groundwater	Excavate soil and placement/injection of ORC
Soil Leaching to Groundwater	Excavate soil and placement/injection of ORC
Groundwater Ingestion	Excavate soil and placement/injection of ORC
Soil and/or Groundwater Contaminant Volitalization to Indoor Air	Excavate soil and placement/injection of ORC

Table 6. Estimated Soil Excavation Volumes and ORC Injection Volumes

UST Area	Description	Estimated Quantity	Estimated Depth in Feet Below Existing Ground Surface (bgs)
A	Likely non-contaminated soil	43 cubic yards (in place volume)	0 - 4
	COI-impacted soil above limit of safe and practicable excavation	32 cubic yards (in place volume)	4 - 7
	COI-impacted soil and groundwater below limit of safe and practicable excavation	86 cubic yards (in place volume) 4,500 gallons ORC solution	7 - 15
	UST A excavation area	161 cubic yards (in place volume)	0 -15
C and D	Likely non-contaminated soil	0 cubic yards	0 (near the former location of USTs C and D)
		776 cubic yards (in place volume)	0 - 5 elsewhere
	COI-impacted soil above limit of safe and practicable excavation	428 cubic yards (in place volume)	0 - 7 (near former locations of USTs C and D)
		311 cubic yards (in place volume)	5 - 7 elsewhere
	COI-impacted soil and groundwater below limit of safe and practicable excavation	1732 cubic yards (in place volume) 64,000 gallons ORC solution	7 - 15
	UST C and D excavation area	3427 cupic yards (in place volume)	0 - 15
E	Likely non-contaminated soil	94 cubic yards (in place volume)	0 - 5
	COI-impacted soil above limit of safe and practicable excavation	37 cubic yards (in place volume)	5 - 7
	COI-impacted soil and groundwater below limit of safe and practicable excavation	150 cubic yards (in place volume) 28,000 gallons ORC solution	7 - 15
	UST E excavation area	281 cubic yards (in place volume)	0 - 15
H through O	COI-impacted soil above limit of safe and practicable excavation	612 cubic yards (in place volume)	0 - 12
	H through O excavation area	612 cubic yards (in place volume)	0 - 12
T, U, and V	COI-impacted soil above limit of safe and practicable excavation	243 cubic yards (in place volume)	0 - 12

Table 7. Schedule for Implementation

Description	Dates
Preliminary Draft Corrective Action Plan (CAP)	12/29/2018
Air Force (AF)/EPA Review Preliminary Draft CAP	2/7/2019
Respond to AF/EPA Comments	4/12/2019
Preliminary EPA approval of CAP	8/15/2019
Coordinate review of CAP with Makah Tribe	9/14/2019
Respond to Makah Tribe Comments	8/15/2022
Public Comment	9/1/2022
Respond to Public Comment	10/1/2022
Final EPA Approval of CAP	10/30/2022
Procure necessary contractors, permits, and funding	by 12/31/2022
Implement CAP	by 9/30/2023
Complete quarterly groundwater monitoring at wells MW-04, MW-05, MW-08, MW-06, and CW-E1	by 12/31/2024
Post-construction soil and groundwater compliance monitoring	by 12/31/2024
Submit draft Cleanup Report	by 2/28/2025
EPA review of draft Cleanup Report	Within 30 days after receipt of draft report.
Respond to EPA Comments	Within 30 days after receipt of EPA comments on the draft report.

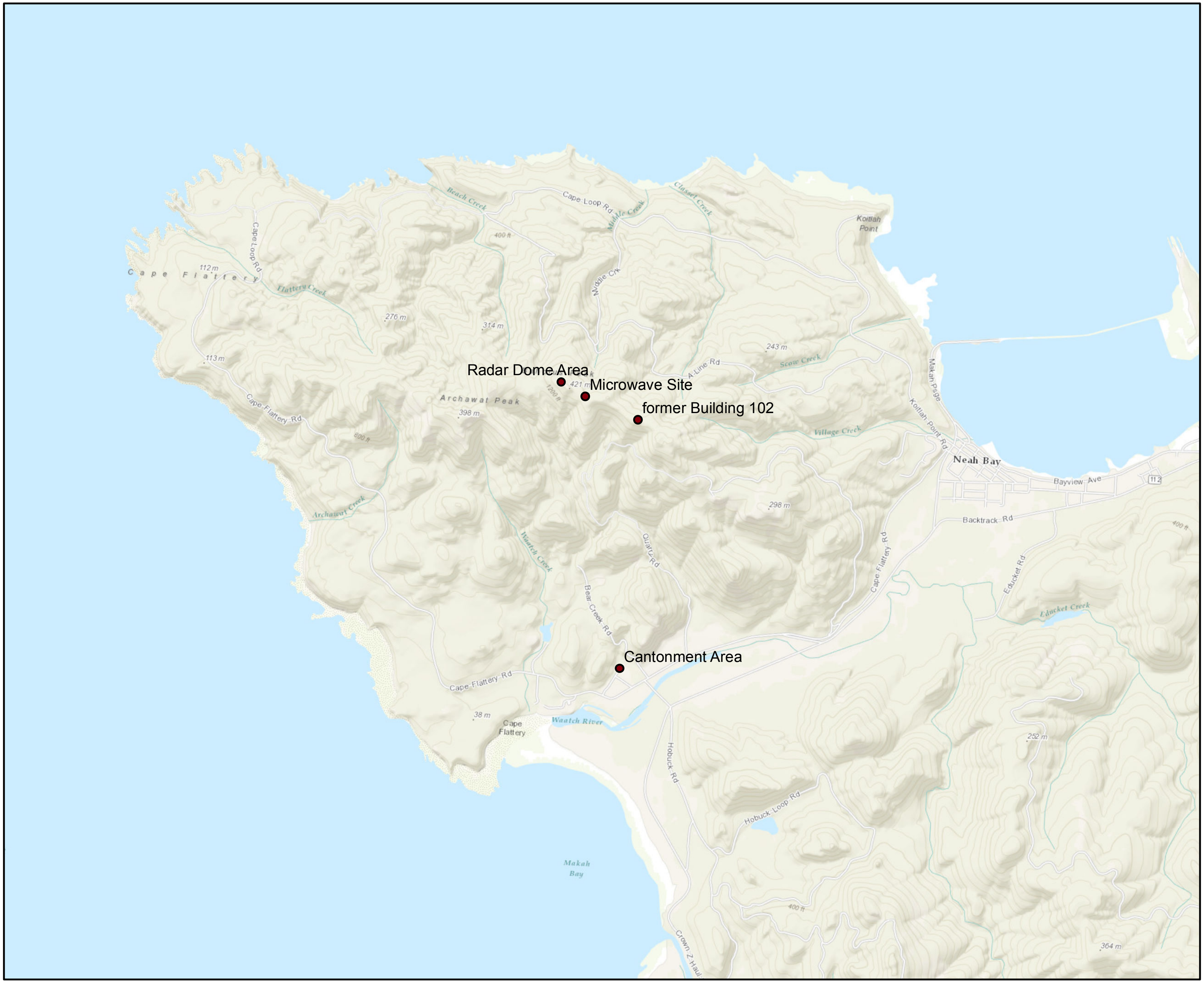
Table 8. Sampling and Analysis Program

<table>
<tr><th>Analytical Phase</th><th colspan="2">Frequency</th></tr>
<tr><td>Excavation Confirmation Samples from Base and Sidewalls</td><td colspan="2">One discrete sample minimum per 400 square feet of excavation base and one discrete soil sample per approximately 400 square feet of excavation side wall. Soil Samples will be obtained from locations that are representative of unexcavated soil.
Typically, the soil samples exhibiting the highest field screening results, if any, for each area will be submitted for analytical testing.</td></tr>
<tr><td rowspan="6">Excavated Soil for Reuse</td><td>Bulk Cubic Yards (Stockpiled Soil)</td><td>Minimum Number of Samples</td></tr>
<tr><td>0 - 100</td><td>3</td></tr>
<tr><td>101 - 500</td><td>5</td></tr>
<tr><td>501 - 1,000</td><td>7</td></tr>
<tr><td>1,000 - 2,000</td><td>10</td></tr>
<tr><td>> 2,000</td><td>10 + 1 for each additional 500 cubic yards</td></tr>
<tr><td>Post-Construction Soil Samples below the extent of excavation</td><td colspan="2">One year following completion of ORC injections, one discrete soil sample at each sample location and depth interval that exceeded CULs in Phase I through IV investigations if that soil was not removed by excavation and backfilled with clean soil. These locations are as follows: A4, A6, CD1, CD2, CD3, CD5, CD6, CD8, CD16, CD18, E6, E11, E15, and T3. Additionally, one discrete soil sample from each confirmation sample at each confirmation sample location that exceeded cleanup levels and could not be removed by excavation and backfilled with clean soil.</td></tr>
<tr><td>Post-construction Groundwater Samples</td><td colspan="2">One year following completion of ORC injections, one or more discrete groundwater sample near sample locations and depth intervals that exceeded CULs in Phase I through IV investigations. These locations are as follows: AQA1, AQCD1, AQCD2, AQCD6, AQE1, AQE4, AQE5, AQE7, and AQTUV1.

Quarterly groundwater monitoring at existing monitoring wells MW-04, MW-05, MW-08, and MW-06. Quarterly monitoring is expected to occur for one year.
Installation of new monitoring well CW-E1, followed by quarterly groundwater monitoring for one year.</td></tr>
</table>

FIGURES

Figure 1. Study Area



Legend

● Sites

Former Makah AFS
UST Site Investigation

Location Map

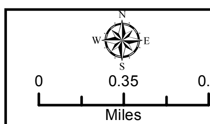


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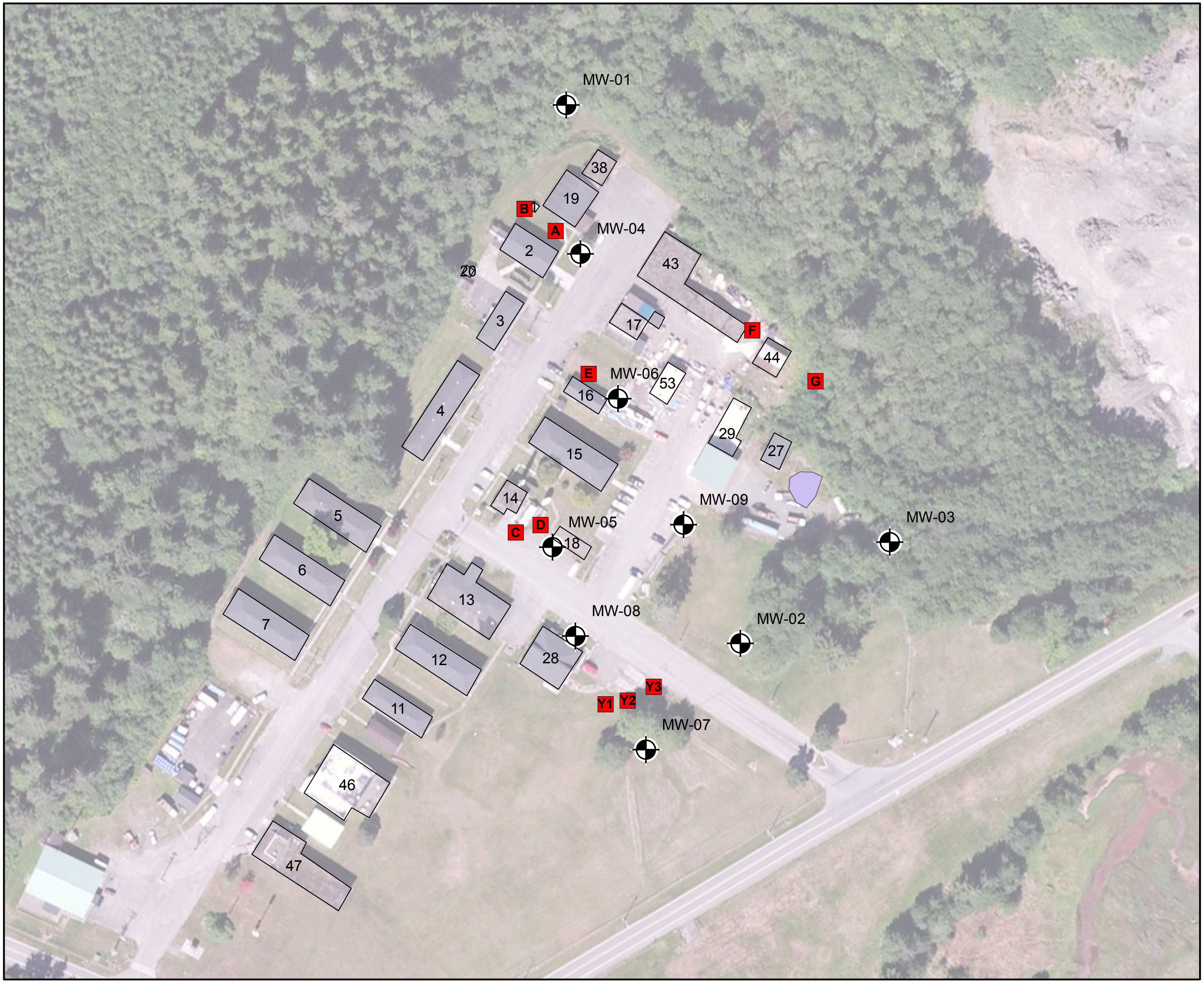
Figure 2. Cantonment Area USTs and Monitoring Wells



Legend

Underground Storage Tank
Building
Monitoring well
Burnpit

N

Former Makah AFS
UST Site Investigation

Location Map

0 70 140
Feet

DISCLAIMER - While the United States Army Corps of Engineers, (hereinafter referred to USACE) has made a reasonable effort to insure the accuracy of the maps and associated data, its should be explicitly noted that USACE makes no warranty, representation or guaranty, either express or implied, as to the content, sequence, accuracy, timeliness or completeness of any of the data provided herein. The USACE, its officers, agents, employees, or servants shall assume no liability of any nature for any errors, omissions, or inaccuracies in the information provided regardless of how caused. The USACE, its officers, agents, employees or servants shall assume no liability for any decisions made or actions taken or not taken by the user of the maps and associated data in reliance upon any information or data furnished here. By using these maps and associated data the user does so entirely at their own risk and explicitly acknowledges that he/she is aware of and agrees to be bound by this disclaimer and agrees not to present any claim or demand of any nature against the USACE, its officers, agents, employees or servants in any forum whatsoever for any damages of any nature whatsoever that may result from or may be caused in any way by the use of the maps and associated data.

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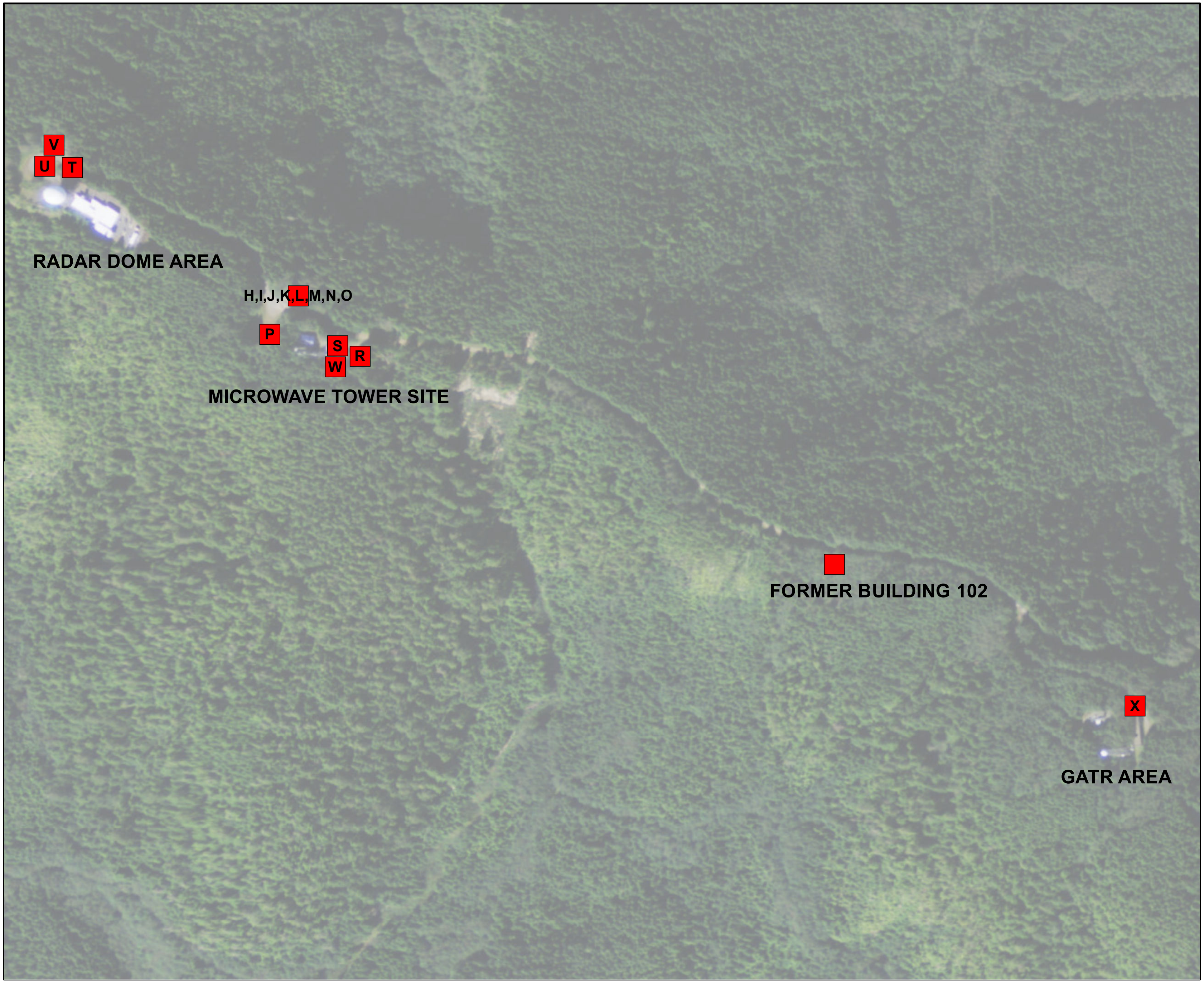
Figure 3. Top Camp Overview



Legend

Underground Storage Tank (approximate)

N

0 200 400

Feet

Former Makah AFS
UST Site Investigation

Location Map

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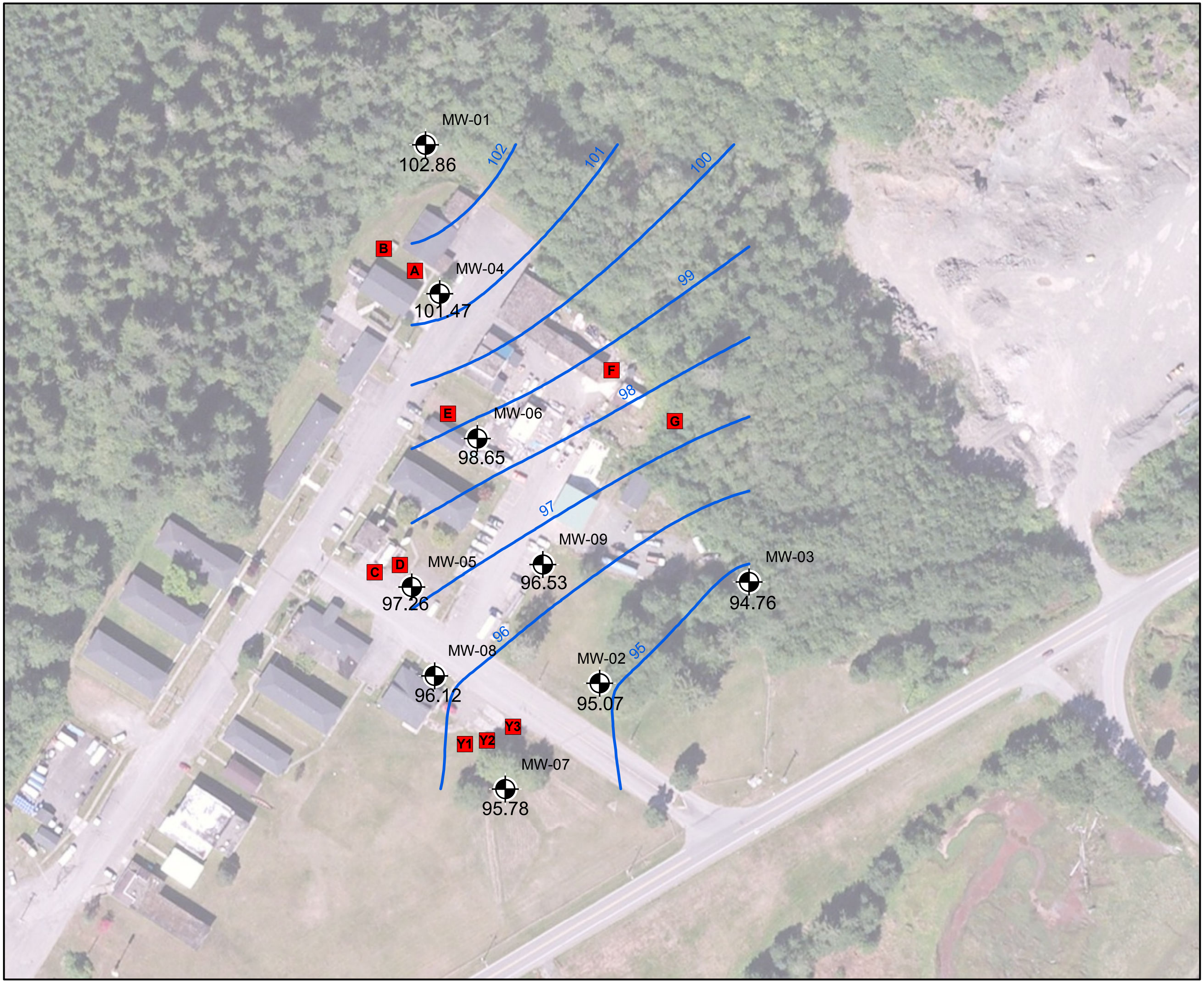
Figure 4. March 2015 Cantonment Area Groundwater Elevations



Legend

Underground Storage Tank

Monitoring well

Water Level Contour (relative ft)

N

Elevations reference a common control point assigned an arbitrary elevation of 100 ft.

Former Makah AFS UST Site Investigation

Location Map

0 70 140
Feet

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Figure 5. UST A Proposed Corrective Action

*It is intended that contaminated soil be removed to the maximum depth that is practicable and safe, and that contaminated soil and groundwater below the depth of excavation be treated by ORC (or similar) injections.

Figure 6. USTs C and D Corrective Action Proposed

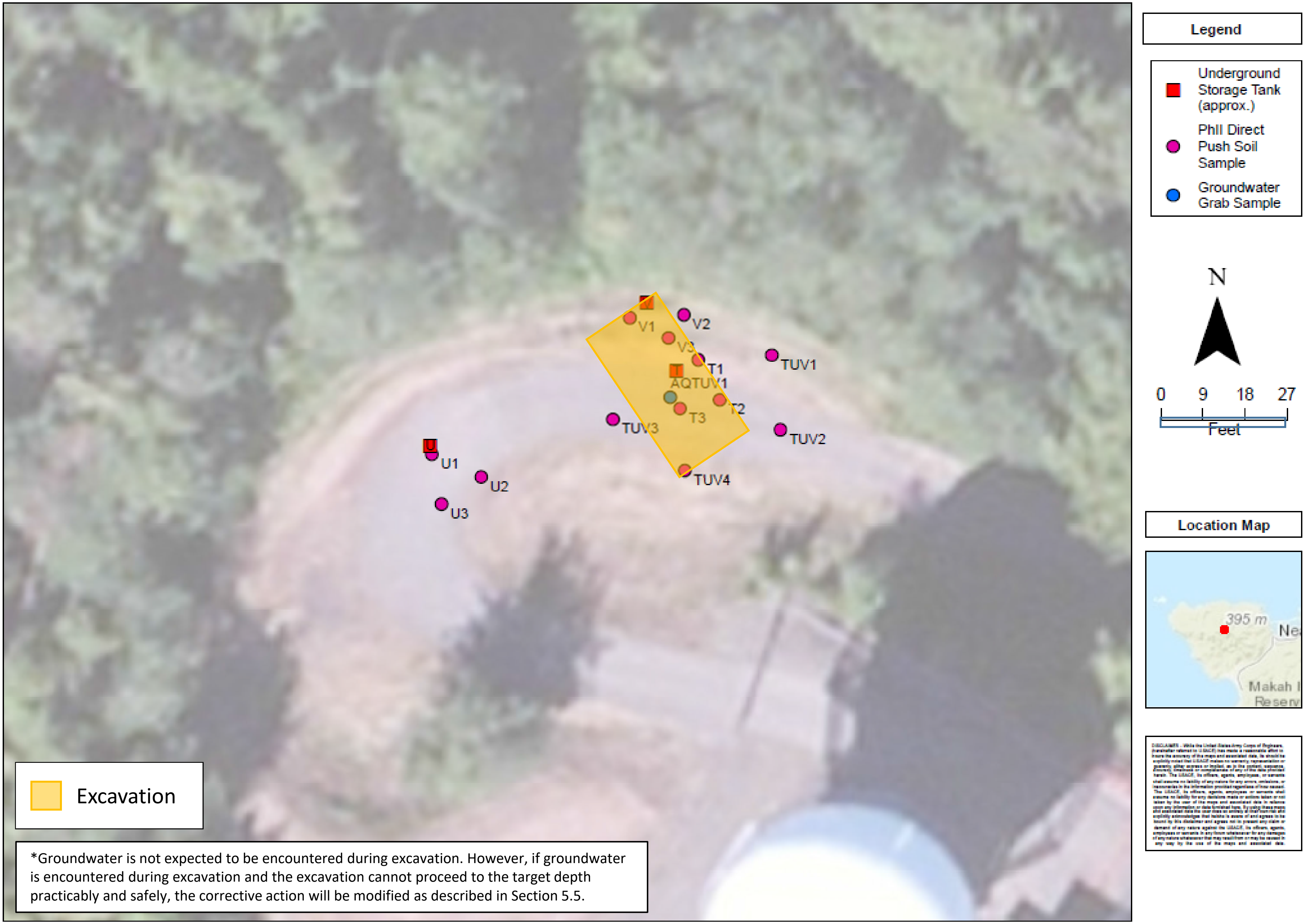
*It is intended that contaminated soil be removed to the maximum depth that is practicable and safe, and that contaminated soil and groundwater below the depth of excavation be treated by ORC (or similar) injections.

Figure 7. UST E Proposed Corrective Action

*It is intended that contaminated soil be removed to the maximum depth that is practicable and safe, and that contaminated soil and groundwater below the depth of excavation be treated by ORC (or similar) injections.

Figure 8. USTs H through O Proposed Corrective Action

Figure 9. USTs T, U, and V Proposed Corrective Action



*Groundwater is not expected to be encountered during excavation. However, if groundwater is encountered during excavation and the excavation cannot proceed to the target depth practicably and safely, the corrective action will be modified as described in Section 5.5.

Appendix A

Table of Soil Results from Phase II and Phase IV Site Investigations

Table 8. Soil Analytical Results at UST A

	Sample ID	GP-11-A4-8	GP-11-A4-12	GP-11-A5-10	GP-11-A5-15	GP-11-A6-8	GP-11-A6-13	GP-11-A7-8	GP-11-A7-13	GP-11-A8-10	GP-11-A8-15	GP-11-A9-5	GP-11-A9-10	GP-11-A10-10	GP-11-A10-15
	Location	GP11A4	GP11A4	GP11A5	GP11A5	GP11A6	GP11A6	GP11A7	GP11A7	GP11A8	GP11A8	GP11A9	GP11A9	GP11A10	GP11A10
	Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Sample Date	3/3/2015	3/3/2015	3/3/2015	3/3/2015	3/3/2015	3/3/2015	3/3/2015	3/3/2015	3/10/2015	3/10/2015	3/10/2015	3/10/2015	3/10/2015	3/10/2015
	Start Depth (ft)	4	8	5	10	4	8	4	8	5	10	0	5	5	10
	End Depth (ft)	8	12	10	15	8	13	8	13	10	15	5	10	10	15
Analyte	MTCA A Unrestricted														
Diesel Range Organics by Method NWTPH-Dx (mg/kg)															
Diesel Range Organics	200*	**1800**	**2500**	6 U	6.20 U	**4000 J**	**210**	**6.8**	**9.8**	**50**	**6.4**	**28**	**50**	**7.7**	**3.90 J**
Motor Oil Range Organics	2000	120 U	120 U	12 U	12 U	**160 J**	120 U	12 U	12 U	**30**	**7.40 J**	**25**	**130**	**10 J**	12 U
VOCs by Method 8260 (ug/kg)															
1,2-Dibromoethane (Ethylene dibromide)	5	1.30 U	90 U	1.20 U	1.10 U	1 U	1.10 U	1.10 U	1.30 U	1.20 U	1.20 U	1.20 U	1 U	1 U	1.10 U
Benzene	30	1.30 U	90 U	1.20 U	1.10 U	1 U	1.10 U	1.10 U	1.30 U	1.20 U	1.20 U	1.20 U	1 U	1 U	1.10 U
Ethylbenzene	6000	1.30 U	90 U	1.20 U	1.10 U	1 U	1.10 U	1.10 U	1.30 U	1.20 U	1.20 U	1.20 U	1 U	1 U	1.10 U
m,p-Xylenes	9000	1.30 U	90 U	1.20 U	1.10 U	1 U	1.10 U	1.10 U	1.30 U	1.20 U	1.20 U	1.20 U	1 U	1 U	1.10 U
Methyl Tert-Butyl Ether	100	1.30 U	90 U	1.20 U	1.10 U	1 U	1.10 U	1.10 U	1.30 U	1.20 U	1.20 U	1.20 U	1 U	1 U	1.10 U
Naphthalene	5000	6.50 U	450 U	5.80 U	5.60 U	4.80 U	5.60 U	5.40 U	6.40 U	5.80 U	6 U	5.80 U	5.20 U	5.10 U	5.30 U
o-Xylene	9000	1.30 U	90 U	1.20 U	1.10 U	1 U	1.10 U	1.10 U	1.30 U	1.20 U	1.20 U	1.20 U	1 U	1 U	1.10 U
Toluene	7000	**2.4**	90 U	1.20 U	1.10 U	**1.7**	**1.3**	**1.2**	**1.3**	**0.90 J**	1.20 U	**0.60 J**	**0.70 J**	**0.60 J**	1.10 U

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

Cleanup level for Xylenes is for total xylenes (m,p, and o)

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Level

Table 9. Soil Analytical Results at USTs C and D

Sample ID		GP-11-CD1-5	GP-11-CD1-10	GP-11-CD2-10	GP-11-CD2-11	GP-11-CD3-10	GP-11-CD31-10	GP-11-CD3-15	GP-11-CD4-5	GP-11-CD4-10	GP-11-CD5-5	GP-11-CD5-10	GP-11-CD5-18	GP-11-CD6-5	GP-11-CD6-10	GP-11-CD6-20	GP-11-CD7-5	GP-11-CD7-10
Location		GP11CD1	GP11CD1	GP11CD2	GP11CD2	GP11CD3	GP11CD3	GP11CD3	GP11CD4	GP11CD4	GP11CD5	GP11CD5	GP11CD5	GP11CD6	GP11CD6	GP11CD6	GP11CD7	GP11CD7
Sample Type		N	N	N	N	N	FD	N	N	N	N	N	N	N	N	N	N	N
Sample Date		3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015	3/4/2015
Start Depth (ft)		0	5	5	10	5	5	10	0	5	0	5	15	0	5	15	0	5
End Depth (ft)		5	10	10	11	10	10	15	5	10	5	10	18	5	10	20	5	10
Analyte	MTCA A Unrestricted																	
Diesel Range Organics by Method NWTPH-Dx (mg/kg)																		
Diesel Range Organics	200*	**11,000**	**4800 J**	**11,000 J-**	**74**	**5300 J**	**5100 J**	**890**	**67**	**1400**	**24,000 J**	**10,000 J**	**65**	**34,000 J**	**10,000**	**43**	**47**	**19**
Motor Oil Range Organics	2000	**400**	1200 UJ	**1400**	**24**	1200 UJ	1200 UJ	120 U	**82**	120 U	**210 J**	1200 UJ	**34**	**380 J**	120 U	12 U	**210**	**44**
SVOCs by Method 8270D-SIM (ug/kg)																		
Naphthalene		**2800**	**1000**	**480 J+**	**74**	**220**	**180**	**31**	**38**	**57**	**1000**	**1800**	**60**	**2000**	**2900**	**34**	**7.9**	**8.9**
1-Methylnaphthalene		**35000**	**13000**	**20000 J-**	**170**	**10000**	**11000**	**2300**	**42**	**330**	**84000**	**25000**	**190**	**56000**	**18000**	**92**	**30**	**54**
2-Methylnaphthalene		**35000**	**13000**	**890**	**110**	**2200**	**2500**	**340**	**46**	**140**	**120000**	**38000**	**250**	**55000**	**22000**	**120**	**43**	**66**
Total Naphthalenes(ND = 0)	5000	*72800*	*27000*	*21370*	*354*	*12420*	*13680*	*2671*	*126*	*527*	*205000*	*64800*	*500*	*113000*	*42900*	*246*	*80.9*	*128.9*
Total Naphthalenes(ND = SQL/2)	5000	*72800*	*27000*	*21370*	*354*	*12420*	*13680*	*2671*	*126*	*527*	*205000*	*64800*	*500*	*113000*	*42900*	*246*	*80.9*	*128.9*
Benzo(a)anthracene		**440**	**76**	**3400**	**110**	**64**	**55**	**10**	**3.70 J**	46 U	450 U	**37 J**	**4.30 J**	**90**	**23 J**	**3 J**	**3.20 J**	4.60 U
Benzo(a)pyrene	100	**320**	**51**	**2400**	**36**	**51**	**44 J**	**5**	**5.2**	46 U	450 U	49 U	**2.50 J**	**36 J**	45 U	4.50 U	4.90 U	4.60 U
Chrysene		**570**	**120**	**3600**	**97**	**85**	**93**	**16**	**7.6**	**30 J**	**300 J**	**80**	**14**	**210**	**53**	**9.1**	**8.4**	**3.20 J**
Dibenz(a,h)anthracene		**34 J**	44 U	**320**	**4.30 J**	46 U	45 U	4.60 U	**2.70 J**	46 U	450 U	49 U	4.70 U	49 U	45 U	4.50 U	4.90 U	4.60 U
Indeno(1,2,3-cd)pyrene		**120**	44 U	**1000**	**13**	46 U	**31 J**	4.60 U	**8.9**	46 U	450 U	49 U	4.70 U	49 U	45 U	4.50 U	4.90 U	4.60 U
Total Benzofluoranthenes		**570**	**110**	**4600**	**72**	**81**	**82**	**11**	**11**	46 U	450 U	49 U	**6.3**	**76**	**45 U**	**5.2**	**4.70 J**	4.60 U
Benzo(a)pyrene TTEC (ND = 0)	*100*	*442.1*	*70.8*	*3368*	*56.9*	*66.4*	*61.7*	*7.3*	*7.9*	*0.3*	*3*	*4.5*	*3.7*	*54.7*	*2.8*	*0.9*	*0.9*	*0.03*
Benzo(a)pyrene TTEC (ND = SQL/2)	*100*	*442.1*	*75.2*	*3368*	*56.9*	*71.0*	*64.0*	*7.7*	*7.9*	*32.4*	*519.8*	*36.4*	*8.0*	*59.6*	*32.1*	*3.6*	*3.8*	*3.25*
Benzo(a)pyrene TTEC (Kaplan-Meier)	*100*	*442.1*	*73.2*	*3368*	*56.9*	*68.0*	*63.7*	*7.6*	*7.9*	*1.8*	*18*	*13.5*	*4.3*	*68.2*	*8.5*	*1.6*	*1.7*	*0.19*
Benzo(a)pyrene TTEC (robust ROS)	*100*	*442.1*	*73.2*	*3368*	*56.9*	*68.0*	*63.2*	*7.6*	*7.9*	*0.3*	*3.0*	*14.2*	*4.2*	*62.9*	*8.9*	*1.4*	*1.6*	*0.0*
VOCs by Method 8260 (ug/kg)																		
1,2-Dibromoethane (Ethylene dibromide)	5	68 U	76 U	72 U	1.20 U	1.10 U	70 U	1.10 U	0.90 U	1.10 U	250 U	66 U	1.30 U	110 U	68 U	1.20 U	1.20 U	1.40 U
Benzene	30	68 U	76 U	72 U	1.20 U	1.10 U	70 U	1.10 U	0.90 U	1.10 U	250 U	66 U	**0.80 J**	110 U	68 U	**1.10 J**	1.20 U	1.40 U
Ethylbenzene	6000	**100 J+**	**110 J+**	**140 J+**	**0.80 J**	**0.70 J**	**36 J**	1.10 U	0.90 U	1.10 U	**3200 J+**	**250 J+**	**1.40 J+**	**150 J+**	**41 J**	1.20 U	1.20 U	1.40 U
m,p-Xylenes	9000	68 U	76 U	72 U	1.20 U	**1 J**	**56 J**	1.10 U	0.90 U	1.10 U	250 U	66 U	1.30 U	110 U	68 U	**0.60 J**	1.20 U	1.40 U
Methyl Tert-Butyl Ether	100	68 U	76 U	72 U	1.20 U	1.10 U	70 U	1.10 U	0.90 U	1.10 U	250 U	66 U	1.30 U	110 U	68 U	1.20 U	1.20 U	1.40 U
Naphthalene	5000	**3300**	**2100**	**2300**	**6.80**	**21**	**580**	**4.40 J**	**1.10 J**	5.50 U	**2900**	**11000**	**32**	**5300**	**11000**	**46**	5.80 U	**4.80 J**
o-Xylene	9000	68 U	76 U	72 U	1.20 U	**0.90 J**	70 U	1.10 U	0.90 U	1.10 U	250 U	66 U	1.30 U	110 U	68 U	1.20 U	1.20 U	1.40 U
Toluene	7000	68 U	76 U	72 U	**4.60**	**3.10**	70 U	**1.50**	**0.90**	**3.20**	250 U	66 U	1.30 U	110 U	68 U	**1.60**	1.20 U	**2.90**

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

Total benzofluoranthenes includes Benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(j)fluoranthene.

MTCA A for Xylenes is for total xylenes (m,p, and o).

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Level

Table 9. Soil Analytical Results at USTs C and D

	Sample ID	GP-11-CD8-6	GP-11-CD8-10	GP-11-CD9-10	GP-11-CD9-15	GP-11-CD91-15	GP-11-CD10-5	GP-11-CD10-10	GP-11-CD11-5	GP-11-CD11-10	GP-11-CD12-5	GP-11-CD12-10	GP-11-CD13-5	GP-11-CD13-10	GP-11-CD14-5	GP-11-CD14-10	GP-11-CD15-5	GP-11-CD15-10
	Location	GP11CD8	GP11CD8	GP11CD9	GP11CD9	GP11CD9	GP11CD10	GP11CD10	GP11CD11	GP11CD11	GP11CD12	GP11CD12	GP11CD13	GP11CD13	GP11CD14	GP11CD14	GP11CD15	GP11CD15
	Sample Type	N	N	N	N	FD	N	N	N	N	N	N	N	N	N	N	N	N
	Sample Date	3/3/2015	3/3/2015	3/3/2015	3/3/2015	3/3/2015	3/12/2015	3/12/2015	3/12/2015	3/12/2015	3/12/2015	3/12/2015	3/12/2015	3/12/2015	3/12/2015	3/12/2015	3/10/2015	3/10/2015
	Start Depth (ft)	0	6	5	10	10	0	5	0	5	0	5	0	5	0	5	0	5
	End Depth (ft)	6	10	10	15	15	5	10	5	10	5	10	5	10	5	10	5	10
Analyte	MTCA A Unrestricted																	
Diesel Range Organics by Method NWTPH-Dx (mg/kg)																		
Diesel Range Organics	200*	**3900**	**5000 J-**	5.90 U	6.10 U	6 U	**21**	5.20 U	**93**	**33**	**4.80 J**	**3.30 J**	**33**	5.80 U	**150**	**32**	**14**	**4.20 J**
Motor Oil Range Organics	2000	**170**	120 U	12 U	12 U	12 U	12 U	10 U	**240**	**25**	**20**	12 U	**76**	12 U	450	140	120	12 U
SVOCs by Method 8270D-SIM (ug/kg)																		
Naphthalene		**140**	**46**	4.70 U	**4.60 J**	**4.20 J**	**3.60 J**	**2.90 J**	**10 J**	**10**	**7.2**	**3.50 J**	**6.9**	**3.50 J**	**120**	**68 J-**	**5.6**	**11**
1-Methylnaphthalene		**2900**	**420 J**	**4.50 J**	**6.30**	**6.50**	**4.50 J**	4.70 U	**20**	**14**	**8.4**	**4.20 J**	**9.4**	**4.20 J**	**260**	**200 J-**	**6.3**	**18**
2-Methylnaphthalene		**330**	20 U	**5.70**	**8.40**	**9.10**	**5.90**	**4.80**	**33**	**26**	**12**	**6.30**	**11**	**5.20 J**	**330**	**270 J-**	**8.2**	**24**
Total Naphthalenes(ND = 0)	5000	*3370*	*466*	*10.2*	*19.3*	*19.8*	*14*	*7.7*	*63*	*50*	*27.6*	*14*	*27.3*	*12.9*	*710*	*538*	*20.1*	*53*
Total Naphthalenes(ND = SQL/2)	5000	*3370*	*476*	*12.55*	*19.3*	*19.8*	*14*	*10.05*	*63*	*50*	*27.6*	*14*	*27.3*	*12.9*	*710*	*538*	*20.1*	*53*
Benzo(a)anthracene		**210**	**180**	4.70 U	4.80 U	4.80 U	4.70 U	4.70 U	15 U	4.70 U	4.70 U	4.60 U	**2200**	**100**	**3.90 J**	**7.60 J**	4.90 U	4.60 U
Benzo(a)pyrene	100	**150**	**120**	4.70 U	4.80 U	4.80 U	4.70 U	4.70 U	15 U	4.70 U	4.70 U	4.60 U	**1700**	**77**	**3 J**	15 U	4.90 U	4.60 U
Chrysene		**230**	**180**	4.70 U	**2.90 J**	**2.50 J**	4.70 U	4.70 U	**12 J**	**3.30 J**	**7.6**	4.60 U	**2200**	**100**	**9.8**	**31 J-**	4.90 U	**3.30 J**
Dibenz(a,h)anthracene		**23 J**	**18 J**	4.70 U	4.80 U	4.80 U	4.70 U	4.70 U	15 U	4.70 U	4.70 U	4.60 U	**320**	**17**	4.90 U	15 U	4.90 U	4.60 U
Indeno(1,2,3-cd)pyrene		**73**	**44**	4.70 U	4.80 U	4.80 U	4.70 U	4.70 U	15 U	4.70 U	4.70 U	4.60 U	**800**	**36**	4.90 U	15 U	4.90 U	4.60 U
Total Benzofluoranthenes		**290**	**220**	4.70 U	4.80 U	4.80 U	4.70 U	4.70 U	15 U	**2.50 J**	**4 J**	4.60 U	**3200**	**140**	**4.70 J**	**15**	**2.60 J**	4.60 U
Benzo(a)pyrene TTEC (ND = 0)	*100*	*212*	*168*	*0*	*0.03*	*0.03*	*0*	*0*	*0.12*	*0.28*	*0.48*	*0*	*2374*	*107*	*4.0*	*2.6*	*0.26*	*0.03*
Benzo(a)pyrene TTEC (ND = SQL/2)	*100*	*212*	*168*	*3.3*	*3.4*	*3.4*	*3.3*	*3.3*	*10.6*	*3.3*	*3.5*	*3.2*	*2374*	*107*	*4.2*	*11.6*	*3.5*	*3.3*
Benzo(a)pyrene TTEC (Kaplan-Meier)	*100*	*212*	*168*	*NA*	*0.2*	*0.15*	*NA*	*NA*	*0.72*	*0.85*	*1.4*	*NA*	*2374*	*107*	*5.7*	*8.3*	*0.93*	*0.20*
Benzo(a)pyrene TTEC (robust ROS)	*100*	*212*	*168*	*NA*	*0.0*	*0.0*	*NA*	*NA*	*0.1*	*0.9*	*1.5*	*NA*	*2374*	*107*	*5.7*	*7.9*	*0.3*	*0.0*
VOCs by Method 8260 (ug/kg)																		
1,2-Dibromoethane (Ethylene dibromide)	5	1.40 U	1.10 U	1.30 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	1.20 U	1.10 U	1.40 U	1.10 U	1.10 U	1.20 U	1.10 U	1.10 U
Benzene	30	1.40 U	1.10 U	1.30 U	1.10 U	1.10 U	1.10 U	1.10 U	**0.70 J**	1.10 U	1.20 U	1.10 U	1.40 U	1.10 U	**2.10**	1.20 U	1.10 U	1.10 U
Ethylbenzene	6000	**0.90 J**	1.10 UJ	1.30 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	1.20 U	1.10 U	1.40 U	1.10 U	1.10 U	1.20 U	1.10 U	1.10 U
m,p-Xylenes	9000	**0.80 J**	**0.60 J**	1.30 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	1.20 U	1.10 U	1.40 U	1.10 U	1.10 U	1.20 U	1.10 U	1.10 U
Methyl Tert-Butyl Ether	100	1.40 U	1.10 U	1.30 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	1.20 U	1.10 U	1.40 U	1.10 U	1.10 U	1.20 U	1.10 U	1.10 U
Naphthalene	5000	**3600**	5.60 U	6.40 U	5.70 U	5.60 U	5.50 U	5.40 U	5.70 U	5.70 U	6 U	5.70 U	7 U	5.50 U	**7.10**	5.90 U	5.70 U	5.40 U
o-Xylene	9000	1.40 U	1.10 UJ	1.30 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	1.20 U	1.10 U	1.40 U	1.10 U	1.10 U	1.20 U	1.10 U	1.10 U
Toluene	7000	**0.80 J**	**2.50 J-**	**0.80 J**	1.10 U	1.10 U	1.10 U	**0.60 J**	**0.60 J**	**0.60 J**	**0.70 J**	**0.80 J**	1.40 U	1.10 U	1.10 U	1.20 U	**0.60 J**	**1.30**

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

Total benzofluoranthenes includes Benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(j)fluoranthene.

MTCA A for Xylenes is for total xylenes (m,p, and o).

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Level

Table 9. Soil Analytical Results at USTs C and D

	Sample ID	GP-11-CD151-10	GP-11-CD16-5	GP-11-CD16-10	GP-11-CD16-15	GP-11-CD17-5	GP-11-CD17-10	GP-11-CD18-10	GP-11-CD181-10	GP-11-CD18-15	GP-11-CD19-5	GP-11-CD19-10	GP-11-CD191-10	GP-11-CD20-10	GP-11-CD20-15
	Location	GP11CD15	GP11CD16	GP11CD16	GP11CD16	GP11CD17	GP11CD17	GP11CD18	GP11CD18	GP11CD18	GP11CD19	GP11CD19	GP11CD19	GP11CD20	GP11CD20
	Sample Type	FD	N	N	N	N	N	N	FD	N	N	N	FD	N	N
	Sample Date	3/10/2015	3/11/2015	3/11/2015	3/11/2015	3/11/2015	3/11/2015	3/12/2015	3/12/2015	3/12/2015	3/11/2015	3/11/2015	3/11/2015	3/11/2015	3/11/2015
	Start Depth (ft)	5	0	5	10	0	5	5	5	10	0	5	5	5	10
	End Depth (ft)	10	5	10	15	5	10	10	10	15	5	10	10	10	15
Analyte	MTCA A Unrestricted														
Diesel Range Organics by Method NWTPH-Dx (mg/kg)															
Diesel Range Organics	200*	**4.90 J**	**5000**	**12000 J**	**490**	**220**	**22**	**3600 J-**	**3700 J-**	**780**	**29**	**22**	**16**	**12**	**32**
Motor Oil Range Organics	2000	**8.80 J**	110 U	**1100**	120 U	**1100**	**56**	100 J-	110 UJ	**14**	**130**	**120**	**92**	**37**	**190**
SVOCs by Method 8270D-SIM (ug/kg)															
Naphthalene		**5**	**40**	44 U	**47**	**31**	**28**	**110**	**89**	**120**	**3.80 J**	**5.3**	**11 J**	**10**	**14**
1-Methylnaphthalene		**7.4**	**2700**	**9100 J-**	**390**	**90**	**31**	**2800**	**1800**	**650**	**5**	**8.7**	**14**	**16**	**21**
2-Methylnaphthalene		**10**	**2400**	**9500 J**	**430**	**74**	**53**	**1300**	**770**	**620**	**6.50**	**13**	**21**	**25**	**25**
Total Naphthalenes(ND = 0)	5000	*22.4*	*5140*	*18600*	*867*	*195*	*112*	*4210*	*2659*	*1390*	*15.3*	*27*	*46*	*51*	***60***
Total Naphthalenes(ND = SQL/2)	5000	*22.4*	*5140*	*18622*	*867*	*195*	*112*	*4210*	*2659*	*1390*	*15.3*	*27*	*46*	*51*	*60*
Benzo(a)anthracene		5 U	**17**	**30 J**	6.70 U	**9.60 J**	4.90 U	**38**	**33**	**9.60 J**	5 U	4.60 U	14 U	4.60 U	**3 J**
Benzo(a)pyrene	100	5 U	16 U	44 U	6.70 U	**18**	4.90 U	**27**	**24**	**6.10 J**	5 U	4.60 U	14 U	4.60 U	4.60 U
Chrysene		5 U	**48**	**71**	**8.5**	**37**	**4.20 J**	**50**	**49**	**16**	**3 J**	**8.8**	**21**	**4.7**	**7.2**
Dibenz(a,h)anthracene		5 U	16 U	44 U	6.70 U	**8 J**	4.90 U	**3.30 J**	20 U	12 U	5 U	4.60 U	14 U	4.60 U	4.60 U
Indeno(1,2,3-cd)pyrene		5 U	16 U	44 U	6.70 U	**10 J**	4.90 U	**11**	20 U	12 U	5 U	4.60 U	14 U	4.60 U	4.60 U
Total Benzofluoranthenes		5 U	**10 J**	44 U	**3.10 J**	**34**	4.90 U	**50**	**51**	**6.70 J**	**2.40 J**	4.60 U	14 U	4.60 U	**2.60 J**
Benzo(a)pyrene TTEC (ND = 0)	*100*	*0*	*3.2*	*3.8*	*0.40*	*24.5*	*0.04*	*37.7*	*32.9*	*7.9*	*0.27*	*0.088*	*0.21*	*0.047*	*0.63*
Benzo(a)pyrene TTEC (ND = SQL/2)	*100*	*3.5*	*12.8*	*32.3*	*4.8*	*24.5*	*3.5*	*37.7*	*34.9*	*9.1*	*3.5*	*3.3*	*10*	*3.3*	*3.4*
Benzo(a)pyrene TTEC (Kaplan-Meier)	*100*	*NA*	*5.6*	*58.6*	*1.2*	*24.5*	*0.25*	*37.7*	*33.9*	*11*	*0.81*	*0.53*	*1.3*	*0.28*	*1.3*
Benzo(a)pyrene TTEC (robust ROS)	*100*	*NA*	*5.4*	*58.6*	*1.2*	*24.5*	*0.0*	*37.7*	*33.9*	*10.9*	*0.9*	*0.1*	*0.2*	*0.0*	*1.2*
VOCs by Method 8260 (ug/kg)															
1,2-Dibromoethane (Ethylene dibromide)	5	1.20 U	70 U	69 U	1.20 U	1.20 U	1.40 U	1.10 U	1.40 U	1.10 U	1.10 U	1.30 U	1.40 U	1.40 U	1.10 U
Benzene	30	1.20 U	70 U	69 U	1.20 U	**1 J**	1.40 U	1.10 U	1.40 U	**0.60 J**	1.10 U	**0.70 J**	1.40 U	1.40 U	1.10 U
Ethylbenzene	6000	1.20 U	70 U	69 U	1.20 U	1.20 U	1.40 U	**6**	**10**	**3.40**	1.10 U	1.30 U	1.40 U	1.40 U	1.10 U
m,p-Xylenes	9000	1.20 U	70 U	69 U	1.20 U	1.20 U	1.40 U	1.10 U	1.40 U	**0.60 J**	1.10 U	1.30 U	1.40 U	1.40 U	1.10 U
Methyl Tert-Butyl Ether	100	1.20 U	70 U	69 U	1.20 U	1.20 U	1.40 U	1.10 U	1.40 U	1.10 U	1.10 U	1.30 U	1.40 U	1.40 U	1.10 U
Naphthalene	5000	6.20 U	350 U	350 U	6.20 U	5.90 U	**21**	**33**	**39**	**140**	5.30 U	6.30 U	6.90 U	7.20 U	5.60 U
o-Xylene	9000	1.20 U	70 U	69 U	1.20 U	1.20 U	1.40 U	1.10 U	1.40 U	1.10 U	1.10 U	1.30 U	1.40 U	1.40 U	1.10 U
Toluene	7000	**0.60 J**	70 U	69 U	**0.90 J**	**1.40**	**1.30 J**	**1.40**	**1.90**	**1.40**	1.10 U	**1.20 J**	**1.20 J**	**1.60**	**2.20**

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

Total benzofluoranthenes includes Benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(j)fluoranthene.

MTCA A for Xylenes is for total xylenes (m,p, and o).

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Level

Table 10. Soil Analytical Results at UST E

Sample ID		GP-11-E5-10	GP-11-E5-15	GP-11-E51-15	GP-11-E6-10	GP-11-E6-15	GP-11-E7-10	GP-11-E7-15	GP-11-E8-5	GP-11-E8-10	GP-11-E9-5	GP-11-E9-10	GP-11-E10-10	GP-11-E10-15	GP-11-E11-10	GP-11-E11-15	GP-11-E12-10	GP-11-E12-15	GP-11-E13-5	GP-11-E13-10	GP-11-E14-5	GP-11-E14-10
Location		GP11E5	GP11E5	GP11E5	GP11E6	GP11E6	GP11E7	GP11E7	GP11E8	GP11E8	GP11E9	GP11E9	GP11E10	GP11E10	GP11E11	GP11E11	GP11E12	GP11E12	GP11E13	GP11E13	GP11E14	GP11E14
Sample Type		N	N	FD	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sample Date		3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/13/2015	3/13/2015	3/13/2015	3/13/2015	3/13/2015	3/13/2015
Start Depth (ft)		5	10	10	5	10	5	10	0	5	0	5	5	10	5	10	5	10	0	5	0	5
End Depth (ft)		10	15	15	10	15	10	15	5	10	5	10	10	15	10	15	10	15	5	10	5	10
Analyte	MTCA A Unrestricted																					
Gasoline Range Organics by Method NWTPH-Gx (mg/kg)																						
Gasoline Range Organics	100	7 U	7.10 U	7.20 U	**130**	7 U	6.90 U	6.90 U	6.60 U	7 U	6.20 U	6.70 U	6.80 U	7.30 U	**1900**	**420**	7.10 U	11 U	7.90 U	6.80 U	9.60 U	9 U
Diesel Range Organics by Method NWTPH-Dx (mg/kg)																						
Diesel Range Organics	200*	**8.4**	6.10 U	6.10 U	**69**	6 U	6.10 U	6.30 U	**20**	**6.9**	5.70 U	6.10 U	6.20 U	6 U	**15**	**15**	5.90 U	6.10 U	**41**	**65**	**32**	**50**
Motor Oil Range Organics	2000	12 U	12 U	12 U	**14**	12 U	12 U	12 U	**35**	12 U	11 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U	**110**	**340**	**100**	**260**
VOCs by Method 8260 (ug/kg)																						
1,2-Dibromoethane (Ethylene dibromide)	5	1.10 U	1 U	1.10 U	59 U	1.10 U	1.10 U	1.20 U	1.10 U	1.20 U	1.20 U	1.10 U	1 U	1 U	63 U	66 U	1 U	1.20 U	1.10 U	1.10 U	1.10 U	1.10 U
Benzene	30	1.1	1 U	1.10 U	**41 J**	**0.90 J**	**1.8**	1.20 U	**4.4**	**0.90 J**	1.20 U	1.10 U	1 U	1 U	63 U	66 U	1 U	1.20 U	1.10 U	**0.50 J**	1.10 U	1.10 U
Ethylbenzene	6000	**0.60 J**	1 U	1.10 U	**270**	1.10 U	1.10 U	1.20 U	**2.8**	1.20 U	1.20 U	1.10 U	1 U	1 U	**160**	**91**	1 U	1.20 U	1.10 U	**0.60 J**	1.10 U	1.10 U
m,p-Xylenes	9000	**2.3**	1 U	1.10 U	**220**	**1.2**	**2.8**	1.20 U	**20**	**1.8**	**1.10 J**	1.10 U	1 U	1 U	**970**	**510**	1 U	1.20 U	**0.80 J**	**2**	1.10 U	**0.80 J**
Methyl Tert-Butyl Ether	100	1.10 U	1 U	1.10 U	59 U	1.10 U	1.10 U	1.20 U	1.10 U	1.20 U	1.20 U	1.10 U	1 U	1 U	63 U	66 U	1 U	1.20 U	1.10 U	1.10 U	1.10 U	1.10 U
Naphthalene	5000	**5 J**	5.10 U	5.30 U	**2900**	5.50 U	5.50 U	5.80 U	**3.80 J**	5.80 U	5.90 U	5.40 U	5.20 U	4.80 U	**1500**	**510**	5.20 U	5.90 U	5.30 U	5.40 U	5.40 U	5.50 U
o-Xylene	9000	**0.70 J**	1 U	1.10 U	59 U	1.10 U	**1.3**	1.20 U	**8.3**	**0.60 J**	1.20 U	1.10 U	1 U	1 U	**62 J**	**49 J**	1 U	1.20 U	1.10 U	1.10 U	1.10 U	1.10 U
Toluene	7000	**2.2**	1 U	1.10 U	**130**	**1.9**	**3.7**	1.20 U	**14**	**1.8**	**1.10 J**	**0.90 J**	1 U	1 U	63 U	66 U	1.2	1.20 U	1.10 U	**0.60 J**	1.10 U	1.10 U

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Level

Table 11. Soil Analytical Results at USTs H thru O

	Sample ID	GP-06-H1-5	GP-06-H1-8	GP-06-H2-10	GP-06-H2-11	GP-06-H3-10	GP-06-H3-12	GP-06-H4-5	GP-06-H4-9	GP-06-H5-5	GP-06-H5-10
	Location	GP06H1	GP06H1	GP06H2	GP06H2	GP06H3	GP06H3	GP06H4	GP06H4	GP06H5	GP06H5
	Sample Type	N	N	N	N	N	N	N	N	N	N
	Sample Date	3/9/2015	3/9/2015	3/9/2015	3/9/2015	3/6/2015	3/6/2015	3/6/2015	3/6/2015	3/6/2015	3/6/2015
	Start Depth (ft)	0	5	5	10	5	10	0	5	0	5
	End Depth (ft)	5	8	10	11	10	12	5	9	5	10
Analyte	MTCA A Unrestricted										
Diesel Range Organics by Method NWTPH-Dx (mg/kg)											
Diesel Range Organics	200*	**1200**	**250**	**270**	**350**	**680**	**3000**	**120**	**210**	**160**	**380**
Motor Oil Range Organics	2000	**1500**	**140**	**110**	**120**	**120**	**260**	**240**	**160**	**130**	**79**
VOCs by Method 8260 (ug/kg)											
1,2-Dibromoethane (Ethylene dibromide)	5	1.30 U	1 U	1.10 U	1 U	58 U	76 U	0.90 U	0.90 U	1 U	62 U
Benzene	30	1.30 U	1 U	1.10 U	1 U	58 U	76 U	0.90 U	**0.50 J**	1 U	62 U
Ethylbenzene	6000	1.30 U	1 U	1.10 UJ	1 U	40 J	**250**	0.90 U	0.90 U	1 U	62 U
m,p-Xylenes	9000	1.30 U	**0.60 J**	1.10 UJ	1 U	49 J	**93**	0.90 U	**0.50 J**	1 U	62 U
Methyl Tert-Butyl Ether	100	1.30 U	1 U	1.10 U	1 U	58 U	76 U	0.90 U	0.90 U	1 U	62 U
Naphthalene	5000	6.40 U	5.20 U	5.70 UJ	4.90 U	**350**	**1700**	4.60 U	**3.50 J**	5 U	**100 J**
o-Xylene	9000	1.30 U	1 U	1.10 UJ	1 U	58 U	76 U	0.90 U	0.90 U	1 U	62 U
Toluene	7000	1.30 U	1 U	**1.10 J-**	**1.2**	58 U	76 U	0.90 U	**0.50 J**	**0.70 J**	62 U

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

MTCA A for Xylenes is for total xylenes (m,p, and o)

Method A soil cleanup value for Naphthalenes is a total value for naphthalene,
1-methyl naphthalene and 2-methyl naphthalene.
*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Leve

Table 11. Soil Analytical Results at USTs H thru O

	Sample ID	GP-06-H6-5	GP-06-H7-5	GP-06-H7-7	GP-06-H8-10	GP-06-H8-12	GP-06-H9-10	GP-06-H9-13	GP-06-H91-13
	Location	GP06H6	GP06H7	GP06H7	GP06H8	GP06H8	GP06H9	GP06H9	GP06H9
	Sample Type	N	N	N	N	N	N	N	FD
	Sample Date	3/9/2015	3/17/2015	3/17/2015	3/17/2015	3/17/2015	3/17/2015	3/17/2015	3/17/2015
	Start Depth (ft)	0	0	5	5	10	5	10	10
	End Depth (ft)	5	5	7	10	12	10	13	13
Analyte	MTCA A Unrestricted								
Diesel Range Organics by Method NWTPH-Dx (mg/kg)									
Diesel Range Organics	200*	**300**	**240**	**1000**	**250**	**950**	**250**	**590**	**550**
Motor Oil Range Organics	2000	**120**	**670**	**640**	**86**	120 U	**96**	**150**	**160**
VOCs by Method 8260 (ug/kg)									
1,2-Dibromoethane (Ethylene dibromide)	5	1.30 U	1.10 U	1 U	1.10 U	0.90 U	1 U	1.20 U	1.20 U
Benzene	30	1.30 U	1.10 U	**1.1**	1.10 U	0.90 U	**0.60 J**	**1.7**	**1.2**
Ethylbenzene	6000	1.30 U	1.10 U	**2**	1.10 U	**0.50 J**	**2.5**	**7.3**	**1.7**
m,p-Xylenes	9000	1.30 U	1.10 U	**3**	1.10 U	0.90 UJ	**7.6**	**3.3**	**0.80 J**
Methyl Tert-Butyl Ether	100	1.30 U	1.10 U	1 U	1.10 U	0.90 U	1 U	1.20 U	1.20 U
Naphthalene	5000	6.50 U	5.30 U	**13**	5.70 U	4.60 U	**39**	**18**	5.80 U
o-Xylene	9000	1.30 U	1.10 U	1 U	1.10 U	0.90 UJ	**0.70 J**	**1.2**	1.20 U
Toluene	7000	**1 J**	1.10 U	**0.60 J**	1.10 U	0.90 UJ	**1.3**	**1.7**	**0.70 J**

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

MTCA A for Xylenes is for total xylenes (m,p, and o)

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Leve

Table 12. Soil Analytical Results at UST P

	Sample ID	GP-06-P1-10	GP-06-P1-14	GP-06-P2-5	GP-06-P2-10
	Location	GP06P1	GP06P1	GP06P2	GP06P2
	Sample Type	N	N	N	N
	Sample Date	3/6/2015	3/6/2015	3/6/2015	3/6/2015
	Start Depth (ft)	5	10	0	5
	End Depth (ft)	10	14	5	10
Analyte	MTCA A Unrestricted				
SVOCs by Method 8270D-SIM (ug/kg)					
Naphthalene		**6.2**	**9.8**	**17**	**7.2**
1-Methylnaphthalene		**10**	**14**	**18**	**8.6**
2-Methylnaphthalene		**13**	**21**	**53**	**16**
Total Naphthalenes (ND = 0)	5000	*29.2*	*44.8*	*88*	*31.8*
Total Naphthalenes(ND = SQL/2)	5000	*29.2*	*44.8*	*88*	*31.8*
Benzo(a)anthracene		4.70 U	4.80 U	**7.50**	**11**
Benzo(a)pyrene	100	4.70 U	4.80 U	**7.40**	**9**
Chrysene		4.70 U	4.80 U	**9**	**13**
Dibenz(a,h)anthracene		4.70 U	**3.30 J**	5 U	**3.30 J**
Indeno(1,2,3-cd)pyrene		4.70 U	4.80 U	**5**	**5.80**
Total Benzofluoranthenes		4.70 U	**2.40 J**	**15**	**17**
Benzo(a)pyrene TTEC (ND = 0)	100	*0*	*0.6*	*10.2*	*12.8*
Benzo(a)pyrene TTEC (ND = 1/2 LOQ)	100	*3.3*	*3.5*	*10.5*	*12.8*
Benzo(ap)pyrene TTEC (K-M)	100	NA	*1.2*	*10.3*	*12.8*
Benzo(a)pyrene TTEC (robust ROS)	100	NA	*1.4*	*10.3*	*12.8*
PCBs by Method 8082 (ug/kg)					
Aroclor 1016		19 U	18 U	18 U	19 U
Aroclor 1221		19 U	18 U	18 U	19 U
Aroclor 1232		19 U	18 U	18 U	19 U
Aroclor 1242		19 U	18 U	18 U	19 U
Aroclor 1248		19 U	18 U	18 U	19 U
Aroclor 1254		19 U	18 U	18 U	19 U
Aroclor 1260		19 U	18 U	18 U	19 U
Total PCBs	1000	19 U	18 U	18 U	19 U

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

Method A soil cleanup value for Naphthalenes includes naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.
Total benzofluoranthenes includes Benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(j)fluoranthene

Table 13. Soil Analytical Results at USTs R and S

	Sample ID	GP-06-RS1-5	GP-06-RS2-4	GP-06-RS3-3	GP-06-RS4-3	GP-06-RS5-3	GP-06-RS6-5	GP-06-RS61-5	GP-06-RS7-3	GP-06-RS8-2
	Location	GP06RS1	GP06RS2	GP06RS3	GP06RS4	GP06RS5	GP06RS6	GP06RS6	GP06RS7	GP06RS8
	Sample Type	N	N	N	N	N	N	FD	N	N
	Sample Date	3/9/2015	3/9/2015	3/9/2015	3/17/2015	3/10/2015	3/9/2015	3/9/2015	3/10/2015	3/10/2015
	Start Depth (ft)	0	0	0	0	0	0	0	0	0
	End Depth (ft)	5	4	3	3	3	5	5	3	2
Analyte	MTCA A Unrestricted									
Gasoline Range Organics by Method NWTPH-Gx (mg/kg)										
Gasoline Range Organics	100	9.30 U	5.20 U	6 U	5.30 U	5.50 U	8.10 U	7.20 U	5.10 U	6.10 U
Diesel Range Organics by Method NWTPH-Dx (mg/kg)										
Diesel Range Organics	200*	**62**	**5.8**	**18**	**32**	**9.8**	**5.20 J**	**9.8**	**34**	**110**
Motor Oil Range Organics	2000	**150**	**17**	**34**	**84**	**37**	**23**	**45**	**180**	**390**
VOCs by Method 8260 (ug/kg)										
1,2-Dibromoethane (Ethylene dibromide)	5	1.10 U	1 U	1.10 U	0.90 U	1.10 U	1.10 U	1.50 U	1.20 U	1 U
Benzene	30	1.10 U	1 U	1.10 U	0.90 U	1.10 U	1.10 U	1.50 U	1.20 U	1 U
Ethylbenzene	6000	1.10 U	1 U	1.10 U	0.90 U	1.10 U	1.10 U	1.50 U	1.20 U	1 U
m,p-Xylenes	9000	1.10 U	1 U	1.10 U	0.90 U	1.10 U	1.10 U	1.50 U	1.20 U	1 U
Methyl Tert-Butyl Ether	100	1.10 U	1 U	1.10 U	0.90 U	1.10 U	1.10 U	1.50 U	1.20 U	1 U
Naphthalene	5000	5.40 U	4.90 U	5.50 U	**2.70 J**	5.40 U	5.60 U	7.30 U	6 U	4.80 U
o-Xylene	9000	1.10 U	1 U	1.10 U	0.90 U	1.10 U	1.10 U	1.50 U	1.20 U	1 U
Toluene	7000	**1 J**	**1.1**	**0.80 J**	**0.50 J**	1.10 U	**0.60 J**	**1.20 J**	**0.60 J**	**0.80 J**
Metals by Method 6020 (mg/kg)										
Lead	250	**5.80 J**	**4.6**	**7.6**	**7 J**	**6.1**	**5.1**	**5.3**	**20.6**	**14.7**

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

MTCA A for Xylenes is for total xylenes (m,p, and o)

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Level

Table 14. Soil Analytical Results at USTs T, U, and V

Sample ID		GP-05-T1-5	GP-05-T1-8	GP-05-T2-10	GP-05-T2-12	GP-05-T3-10	GP-05-T3-12	GP-05-T3-5	GP-05-U1-5	GP-05-U1-10	GP-05-U2-5	GP-05-U2-10	GP-05-U2-12	GP-05-U3-5	GP-05-U3-9	GP-05-V1-5	GP-05-V1-7	GP-05-V2-5	GP-05-V2-8	GP-05-V3-5
Location		GP05T1	GP05T1	GP05T2	GP05T2	GP05T3	GP05T3	GP05T3	GP05U1	GP05U1	GP05U2	GP05U2	GP05U2	GP05U3	GP05U3	GP05V1	GP05V1	GP05V2	GP05V2	GP05V3
Sample Type		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sample Date		3/16/2015	3/16/2015	3/16/2015	3/16/2015	3/16/2015	3/16/2015	3/16/2015	3/17/2015	3/17/2015	3/17/2015	3/17/2015	3/17/2015	3/18/2015	3/18/2015	3/16/2015	3/16/2015	3/17/2015	3/17/2015	3/16/2015
Start Depth (ft)		0	5	5	10	5	10	0	0	5	0	5	10	0	5	0	5	0	5	0
End Depth (ft)		5	8	10	12	10	12	5	5	10	5	10	12	5	9	5	7	5	8	5
Analyte	MTCA A Unrestricted																			
Diesel Range Organics by Method NWTPH-Dx (mg/kg)																				
Diesel Range Organics	200*	**200**	**83**	**510**	**860**	**500**	**2100**	**160**	**68**	**30**	**64**	**120**	**24**	**140**	**97**	**500**	**1200 J-**	**96**	**44**	**160**
Motor Oil Range Organics	2000	**300**	110 U	**220**	**260**	**240**	**440**	**310**	**360**	**110**	**150**	**140**	**120**	**170**	**110**	**900**	**340**	**130**	**100**	**240**
VOCs by Method 8260 (ug/kg)																				
1,2-Dibromoethane (Ethylene dibromide)	5	1.20 U	1.10 U	1 U	1.10 U	1.10 U	1 U	0.90 U	0.90 U	1 U	1.20 U	1 U	1 U	1 U	1 U	1.10 U	1.20 UJ	1.10 U	1.30 U	1 U
Benzene	30	1.20 U	1.10 U	1 U	1.10 U	1.10 U	1 U	0.90 U	0.90 U	1 U	1.20 U	1 U	1 U	1 U	1 U	1.10 U	**0.80 J**	1.10 U	1.30 U	1 U
Ethylbenzene	6000	1.20 U	1.10 U	1 U	1.10 U	1.10 U	1 U	0.90 U	0.90 U	1 U	1.20 U	1 U	1 U	1 U	**1.4**	1.10 U	**10 J-**	1.10 U	1.30 U	1 U
m,p-Xylenes	9000	1.20 U	**1 J**	**1.5**	**0.80 J**	1.10 U	1 U	0.90 U	0.90 U	**1.4**	1.20 U	**0.50 J**	1 U	1 U	**1**	1.10 U	**6.30 J-**	1.10 U	1.30 U	1 U
Methyl Tert-Butyl Ether	100	1.20 U	1.10 U	1 U	1.10 U	1.10 U	1 U	0.90 U	0.90 U	1 U	1.20 U	1 U	1 U	1 U	1 U	1.10 U	1.20 U	1.10 U	1.30 U	1 U
Naphthalene	5000	5.80 U	5.50 U	4.90 U	5.30 U	5.40 U	5.20 U	4.30 U	4.40 U	4.90 U	5.80 U	5.20 U	4.90 U	4.90 U	4.80 U	5.60 U	**40**	5.70 U	6.60 U	5.10 U
o-Xylene	9000	1.20 U	**1.1**	**0.80 J**	1.10 U	1.10 U	1 U	0.90 U	0.90 U	**0.70 J**	1.20 U	1 U	1 U	1 U	**1.2**	1.10 U	**3.10 J-**	1.10 U	1.30 U	1 U
Toluene	7000	**0.60 J**	**0.80 J**	**1.7**	**1.3**	1.10 U	**0.50 J**	0.90 U	0.90 U	**1.7**	1.20 U	**1.1**	**1.2**	1 U	**3.3**	1.10 U	**1.60 J-**	**0.80 J**	**0.90 J**	1 U

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

MTCA A for Xylenes is for total xylenes (m,p, and o)

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Level

Table 14. Soil Analytical Results at USTs T, U, and V

Sample ID		GP-05-V3-8	GP-05-TUV1-5	GP-05-TUV1-8	GP-05-TUV2-5	GP-05-TUV2-10	GP-05-TUV3-5	GP-05-TUV3-6	GP-05-TUV4-3	GP-05-TUV41-3
Location		GP05V3	GP05TUV1	GP05TUV1	GP05TUV2	GP05TUV2	GP05TUV3	GP05TUV3	GP05TUV4	GP05TUV4
Sample Type		N	N	N	N	N	N	N	N	FD
Sample Date		3/16/2015	3/18/2015	3/18/2015	3/18/2015	3/18/2015	3/18/2015	3/18/2015	3/18/2015	3/18/2015
Start Depth (ft)		5	0	5	0	5	0	5	0	0
End Depth (ft)		8	5	8	5	10	5	6	3	3
Analyte	MTCA A Unrestricted									
Diesel Range Organics by Method NWTPH-Dx (mg/kg)										
Diesel Range Organics	200*	**1400**	**62**	5.70 U	**25**	**8.6**	**57**	**67**	**1100**	**99**
Motor Oil Range Organics	2000	**190**	**70**	**9.20 J**	**64**	**43**	**110**	**310**	**1600**	**120**
VOCs by Method 8260 (ug/kg)										
1,2-Dibromoethane (Ethylene dibromide)	5	1.20 U	1 U	0.90 U	0.90 U	1.10 U	1.10 U	1.10 U	1 U	1 U
Benzene	30	1.20 U	1 U	0.90 U	0.90 U	1.10 U	1.10 U	1.10 U	1 U	1 U
Ethylbenzene	6000	**6.2**	1 U	0.90 U	0.90 U	1.10 U	1.10 U	1.10 U	1 U	1 U
m,p-Xylenes	9000	**14**	1 U	0.90 UJ	0.90 U	1.10 U	1.10 U	1.10 U	1 U	1 U
Methyl Tert-Butyl Ether	100	1.20 U	1 U	0.90 U	0.90 U	1.10 U	1.10 U	1.10 U	1 U	1 U
Naphthalene	5000	**84**	4.90 U	4.50 UJ	4.70 U	5.40 U	5.40 U	5.60 U	4.80 U	5.20 U
o-Xylene	9000	**5.1**	1 U	0.90 U	0.90 U	1.10 U	1.10 U	1.10 U	1 U	1 U
Toluene	7000	**1 J**	**0.80 J**	**1**	0.90 U	1.10 U	**2.1**	**1.7**	1 U	1 U

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

MTCA A for Xylenes is for total xylenes (m,p, and o)

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Level

Table 8. Soil Analytical Results at UST A

	Sample ID	GP-11-G1	GP-11-G2	GP-11-G3	GP-11-G4	GP-11-G5	GP-11-G6	GP-11-G7	GP-11-G8
	Location	GP-11-G1	GP-11-G2	GP-11-G3	GP-11-G4	GP-11-G5	GP-11-G6	GP-11-G7	GP-11-G8
	Sample Type	N	N	N	N	N	N	N	FD
	Sample Date	10/12/2017	10/12/2017	10/12/2017	10/12/2017	10/12/2017	10/12/2017	10/12/2017	10/12/2017
	Start Depth (ft)								
	End Depth (ft)								
Analyte	MTCA A Unrestricted								
VOCs by Method 8260 (ug/kg)									
Methylene Chloride	20	1.67 U	2.27 U	2.20 U	1.97 U	**0.70 J**	1.94 U	**1.14 J**	**0.56 J**
Benzene	30	0.84 U	1.14 U	**0.38 J**	0.99 U	0.93 U	0.97 U	1.12 U	0.89 U
Toluene	7000	0.84 U	1.14 U	**0.49 J**	0.99 U	0.93 U	**0.54 J**	1.12 U	0.89 U
1,2-Dibromoethane (Ethylene dibromide)	5	0.84 U	1.14 U	1.10 U	0.99 U	0.93 U	0.97 U	1.12 U	0.89 U
Ethylbenzene	6000	0.84 U	1.14 U	1.10 U	0.99 U	0.93 U	**0.35 J**	1.12 U	0.89 U
m,p-Xylenes	9000	1.67 U	2.27 U	2.20 U	1.97 U	1.85 U	**1.35 J**	2.25 U	1.77 U
o-Xylene	9000	0.84 U	1.14 U	1.10 U	0.99 U	0.93 U	**1.03**	1.12 U	0.89 U
Naphthalene	5000	4.18 U	5.69 U	5.49 U	4.93 U	4.64 U	4.86 U	5.62 U	4.43 U
Methyl Tert-Butyl Ether	100	0.84 U	1.14 U	1.10 U	0.99 U	0.93 U	0.97 U	1.12 U	0.89 U

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

Cleanup level for Xylenes is for total xylenes (m,p, and o)

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

Table 9. Soil Analytical Results at USTs C and D

Sample ID			GP-11-CD21-10	GP-11-CD121-15	GP-11-CD21-15	GP-11-CD22-15	GP-11-CD22-20	GP-11-CD23-8	GP-11-CD23-12
Location			GP-11-CD21	GP-11-CD121	GP-11-CD21	GP-11-CD22	GP-11-CD22	GP-11-CD23	GP-11-CD23
Sample Type			N	FD	N	N	N	FD	N
Sample Date			10/10/2017	10/10/2017	10/10/2017	10/10/2017	10/10/2017	10/10/2017	10/10/2017
Start Depth (ft)			5	10	10	10	15	4	8
End Depth (ft)			10	15	15	15	20	8	12
Analyte	MTCA A Unrestricted	TEF							
Diesel Range Organics by Method NWTPH-Dx (mg/kg)									
Diesel Range Organics	200*		**31.7**	6.31 U	6.11 U	**144**	6.21 U	5.39 U	**5.21 J**
Motor Oil Range Organics	2000		**45.0**	**5.57 J**	**5.32 J**	**8.46 J**	**3.81 J**	10.8 U	**9.41 J**
SVOCs by Method 8270D-SIM (ug/kg)									
Naphthalene			5.96 U	6.22 U	6.19 U	**27.4**	**3.68 J**	5.39 U	**19.0**
2-Methylnaphthalene			**6.86**	**4.76 J**	**6.78**	**58.1**	**5.19 J**	5.39 U	**37.6**
1-Methylnaphthalene			**4.20 J**	**4.02 J**	**5.45 J**	**38.6**	**5.71 J**	5.39 U	**35.4**
Total Naphthalenes(ND = 0)	5000		*11.06*	*8.78*	*12.23*	*124.1*	*14.58*	*0*	*92*
Total Naphthalenes(ND = SQL/2)	5000		*14.04*	*11.89*	*15.325*	*124.1*	*14.58*	*5.385*	*92*
Benzo(a)anthracene			5.96 U	6.22 U	6.19 U	**24.3**	6.15 U	5.39 U	6.23 U
Benzo(a)pyrene	100		5.96 U	6.22 U	6.19 U	**14.9**	6.15 U	5.39 U	6.23 U
Chrysene			5.96 U	6.22 U	6.19 U	**27.9**	6.15 U	5.39 U	**3.96 J**
Dibenz(a,h)anthracene			5.96 U	6.22 U	6.19 U	**3.17 J**	6.15 U	5.39 U	6.23 U
Indeno(1,2,3-cd)pyrene			5.96 U	6.22 U	6.19 U	**6.23 J**	6.15 U	5.39 U	6.23 U
Benzo(b)fluoranthene			5.96 U	6.22 U	6.19 U	**16.2**	1.88 J	5.39 U	**2.04 J**
Benzo(k)fluoranthene			5.96 U	6.22 U	6.19 U	**7.95**	6.15 U	5.39 U	6.23 U
Benzo(a)pyrene TTEC (ND = 0)	*100*		*0*	*0*	*0*	*20.964*	*0.188*	*0*	*0.2436*
Benzo(a)pyrene TTEC (ND = SQL/2)	*100*		*4.2018*	*4.3851*	*4.4*	*20.2*	*4.2*	*3.8*	*4.3*
Benzo(a)pyrene TTEC (Kaplan-Meier)	*100*		*--*	*--*	*--*	*1.8*	*--*	*--*	*--*
Benzo(a)pyrene TTEC (robust ROS)	*100*		*--*	*--*	*--*	*0.3*	*--*	*--*	*7.6*
VOCs by Method 8260 (ug/kg)									
1,2-Dibromoethane (Ethylene dibromide)	5		1.05 U	1.02 U	0.99 U	1.04 U	1.12 U	0.98 U	1.08 U
Benzene	30		1.05 U	1.02 U	**0.33 J**	**0.48 J**	1.12 U	0.98 U	**0.41 J**
Ethylbenzene	6000		1.05 U	1.02 U	0.99 U	1.04 U	1.12 U	0.98 U	1.08 U
m,p-Xylenes	9000		2.11 U	2.03 U	1.98 U	**0.46 J**	2.24 U	1.96 U	2.15 U
Methyl Tert-Butyl Ether	100		1.05 U	1.02 U	0.99 U	1.04 U	1.12 U	0.98 U	1.08 U
Naphthalene	5000		5.27 U	5.09 U	4.95 U	5.21 U	5.60 U	4.89 U	5.38 U
o-Xylene	9000		1.05 U	1.02 U	0.99 U	1.04 U	1.12 U	0.98 U	1.08 U
Toluene	7000		**0.37 J**	1.02 U	**0.30 J**	1.04 U	1.12 U	0.98 U	**0.36 J**

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

Total benzofluoranthenes includes Benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(j)fluoranthene.

MTCA A for Xylenes is for total xylenes (m,p, and o).

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Level

Table 10. Soil Analytical Results at UST E

	Sample ID	GP-11-E15-15	GP-11-E15-20	GP-11-E16-10	GP-11-E16-15	GP-11-E17-15	GP-11-E17-20	GP-11-E171-20	GP-11-E18-15	GP-11-E18-20
	Location	GP-11-E15	GP-11-E15	GP-11-E16	GP-11-E16	GP-11-E17	GP-11-E17	GP-11-E17	GP-11-E18	GP-11-E18
	Sample Type	N	N	N	N	N	N	FD	N	N
	Sample Date	10/11/2017	10/11/2017	10/11/2017	10/11/2017	10/11/2017	10/11/2017	10/11/2017	10/11/2017	10/11/2017
	Start Depth (ft)	10	15	5	10	10	15	15	10	15
	End Depth (ft)	15	20	10	15	15	20	20	15	20
Analyte	MTCA A Unrestricted									
Gasoline Range Organics by Method NWTPH-Gx (mg/kg)										
Gasoline Range Organics	100	**98.8**	**3.74 J**	6.70 U	6.78 U	**20.7**	6.27 U	6.99 U	**10.5**	7.34 U
Diesel Range Organics by Method NWTPH-Dx (mg/kg)										
Diesel Range Organics	200*	**3.64 J**	**2.95 J**	5.79 U	**3.11 J**	6.01 U	**3.92 J**	6.03 U	6.10 U	**3.58 J**
Motor Oil Range Organics	2000	12.4 U	**3.92 J**	**3.60 J**	**4.21 J**	12.0 U	12.1 U	12.1 U	12.2 U	**4.14 J**
VOCs by Method 8260 (ug/kg)										
1,2-Dibromoethane (Ethylene dibromide)	5	1.03 U	0.99 U	0.97 U	0.96 U	0.89 U	0.98 U	0.93 U	0.94 U	1.06 U
Benzene	30	1.03U	0.99 U	**0.57 J**	**0.63 J**	**0.88 J**	**0.61 J**	**0.78 J**	**0.90 J**	**0.96 J**
Ethylbenzene	6000	**0.51 J**	0.99 U	**0.39 J**	**0.30 J**	**0.77 J**	**0.45 J**	**0.73 J**	**2.45**	**2.48**
m,p-Xylenes	9000	**1.57 J**	1.98 U	**1.10 J**	**0.95 J**	**2.15**	**1.37 J**	**2.06**	**8.11**	**5.99**
Methyl Tert-Butyl Ether	100	1.03 U	0.99 U	**0.97 J**	0.96 U	0.89 U	0.98 U	0.93 U	**0.94 J**	1.06 U
Naphthalene	5000	**5.16 J**	4.95 U	4.84 U	**0.66 J**	**0.89 J**	**1.31 J**	4.65 U	**7.30**	**6.80**
o-Xylene	9000	**0.48 J**	0.99 U	**0.31 J**	**0.38 J**	**0.51 J**	**0.41 J**	**0.41 J**	**0.83 J**	**0.61 J**
Toluene	7000	**1.04**	**0.29 J**	**1.09**	**0.93 J**	**1.41**	**1.09**	**1.22**	**2.06**	**1.58**
SVOCs by Method 8270D-SIM (ug/kg)										
Naphthalene		**8.28**	**5.49 J**	**8.01**	**12.7**	**12.5**	**14.1**	**14.4**	**20.4**	**16.8**
2-Methylnaphthalene		**21.7**	**12.5**	**11.6**	**24.5**	**18.1**	**17**	**23.5**	**14.1**	**21.2**
1-Methylnaphthalene		**16.2**	**10.6**	**6.75**	**17.6**	**17.5**	**21.4**	**22**	**32.9**	**26.8**
Total Naphthalenes(ND = 0)	5000	*46.18*	*23.1*	*26.36*	*54.8*	*48.1*	*52.5*	*59.9*	*67.4*	*64.8*
Total Naphthalenes(ND = SQL/2)	5000	*46.18*	*23.1*	*26.36*	*54.8*	*48.1*	*52.5*	*59.9*	*67.4*	*64.8*
Benzo(a)anthracene		**6.20 J**	6.06 U	5.81 U	6.00 U	6.00 U	6.09 U	6.02 U	6.03 U	6.01 U
Benzo(a)pyrene	100	**6.20 J**	6.06 U	5.81 U	6.00 U	6.00 U	6.09 U	6.02 U	6.03 U	6.01 U
Chrysene		**3.52 J**	**3.65 J**	5.81 U	6.00 U	6.00 U	6.09 U	6.02 U	6.03 U	**4.47 J**
Dibenz(a,h)anthracene		6.20 U	6.06 U	5.81 U	6.00 U	6.00 U	6.09 U	6.02 U	6.03 U	6.01 U
Indeno(1,2,3-cd)pyrene		6.20 U	6.06 U	5.81 U	6.00 U	6.00 U	6.09 U	6.02 U	6.03 U	6.01 U
Total Benzofluoranthenes		**2.70 J**	**2.30 J**	5.81 U	6.00 U	6.00 U	6.09 U	6.02 U	6.03 U	6.01 U
Benzo(a)pyrene TTEC (ND = 0)	*100*									
Benzo(a)pyrene TTEC (ND = SQL/2)	*100*									
Benzo(a)pyrene TTEC (Kaplan-Meier)	*100*									
Benzo(a)pyrene TTEC (robust ROS)	*100*									

Notes:

Detections shown in **bold.**

Exceeds cleanup level.

Calculated value (e.g. summation).

U =nondetect

J = estimated

UJ = estimated non detect

Method A soil cleanup value for Naphthalenes is a total value for naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.

*MTCA Simplified Terrestrial Ecological Evaluation Cleanup Level

Appendix B

Table of Groundwater Results from Phase I, Phase II and Phase IV Site Investigations

				Petroleum Hydrocarbons			Volatile Organic Compounds									Metals		Anions		Dissolved Gases		
			Chemical	Gasoline Range Organics	Diesel Range Organics	Motor Oils	1,2-Dibromo-ethane (ethylene dibromide) (see note)	1,2-DICHLOROETHANE	BENZENE	ETHYLBENZENE	M,P-XYLENE	Methyl Tert-Butyl Ether (MTBE)	NAPHTHALENE	O-XYLENE	Toluene	Manganese	LEAD	Nitrate	Sulfate as SO4	Ethane	Ethene	Methane
			Method	NWTPH-GX	NWTPH-DX	NWTPH-DX	8260C	8260C	8260C	8260C	8260C	8260C	8260C	8260C	8260C	6020	6020	300.0	300.0	RSK-175	RSK-175	RSK-175
			Method A Groundwater	1000	500	500	0.01	5	5	700		20	160				15					
			Alternate AL	800 (if Benzene Present)																		
			Unit	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l	ug/l	ug/l	ug/l
Well ID/Sample Location	Sample Id	Sample Type	Sample Date																			
UST A																						
AQA1	AQA1	N	3/13/2015		730 J-	170 J	0.20 U	0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 UJ	0.20 U	0.20 U	258		0.10	5.50	1.20 U	1.10 U	48.30
MW-04	20140610-MW04	N	6/10/2014	250 U	100 U	200 U		0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 U	0.20 U	0.20 U	551	0.30	1.50	12.40	1.20 U	1.10 U	0.70 U
UST C/D																						
AQCD1	AQCD1	N	3/12/2015		8500	440 J-	1 U	1 U	0.70 J	0.70 J	2 U	2.50 U	130 J-	1 U	1 U	1410		0.10 U	0.50	1.20 U	1.10 U	1840
AQCD1	AQCD7	FD	3/12/2015		6200	280	1 U	1 U	0.65 J	0.70 J	2 U	2.50 U	130 J-	1 U	1 U	1400		0.10	1.80	1.20 U	1.10 U	1780
AQCD2	AQCD2	N	3/12/2015		10000	490	1 U	1 U	2	16	2 U	2.50 U	210 J-	1 U	0.65 J	1360		0.10 U	0.40	1.20 U	1.10 U	1210
AQCD3	AQCD3	N	10/10/2017		113	249	0.20 U		0.09J	0.20 U	0.06J	0.50U	0.50U	0.04J	0.11J							
AQCD4	AQCD4	N	10/10/2017		100 U	103 J	0.20 U		0.03J	0.20 U	0.40U	0.50U	0.50U	0.20 U	0.04J							
AQCD41	AQCD41	FD	10/10/2017		100 U	87 J	0.20 U		0.03J	0.20 U	0.06 J	0.50U	0.50U	0.20 U	0.05J							
AQCD5	AQCD5	N	10/10/2017		151	221	0.20 U		0.04J	0.20 U	0.06 J	0.50U	0.50U	0.20 U	0.07J							
AQCD6	AQCD6	N	10/10/2017		5,690	420	0.20 U		0.08J	0.23	0.13 J	0.50U	1.13	0.11J	0.15J							
AQCD7	AQCD7	N	10/10/2017		166	104 J	0.20 U		0.05J	0.20 U	0.40 U	0.50U	0.50U	0.20 U	0.07J							
MW-05	20140609-MW05	N	6/9/2014	250 U	580	200 U		0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 U	0.20 U	0.20 U	311	1.20	0.10 U	58.60	1.20 U	1.10 U	490
MW-05	AQMW05	N	3/8/2015		2200	280	0.20 U	0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 UJ	0.20 U	0.20 U	320		0.10 U	5.80	1.20 U	1.10 U	962
MW-05	17AQMW05	N	10/10/2017		228	68	0.20 U		0.20 U	0.20 U	0.40U	0.50U	0.16J	0.20 U	0.20 U							
MW-08	20140609-MW08	N	6/9/2014	250 U	310	200 U		0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 U	0.20 U	0.20 U	410		0.10	6.70	1.20 U	1.10 U	69.90
MW-08	AQMW08	N	3/8/2015		280	200 U	0.20 U	0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 UJ	0.20 U	0.20 U	282		0.40	4.10	1.20 U	1.10 U	71.70
MW-08	17AQMW08	N	10/10/2017		600	113	0.20 U		0.04J	0.20 U	0.40U	0.50U	0.50U	0.20 U	0.20 U							
UST E																						
AQE1	AQE1	N	3/13/2015	27000 J-	730	200 U	0.20 U	0.20 U	0.26 J+	17 J+	94 J+	0.50 U	10 J	8.20 J+	1 J+	297		0.10	5.60	1.20 U	1.10 U	51.80
AQE2	AQE2	N	3/16/2015	200 J	60 J	200 U	0.20 U	0.20 U	0.64	1.10	0.85	0.50 U	0.50 UJ	0.12 J	0.49	290		0.10	1.80	1.20 U	1.10 U	932
AQE3	AQE3	N	3/16/2015	250 U	100 U	200 U	0.20 U	0.20 U	0.20 U	0.20 U	0.10 J	0.50 U	0.50 UJ	0.20 U	0.16 J	74.90		0.30	4.70	1.20 U	1.10 U	32
AQE4	AQE4	N	10/11/2017	1,650	99 J	67 J	0.20 U		0.20 U	0.10J	0.28J	0.50U	0.50U	0.09J	0.19J							
AQE5	AQE5	N	10/11/2017	100U	118	126 J	0.20 U		0.20 U	0.20 U	0.40U	0.50U	0.50U	0.20 U	0.06J							
AQE6	AQE6	N	10/11/2017	620	142	170 J	0.20 U		0.22	0.67	1.18	0.50U	3.28	0.13J	0.40							
AQE7	AQE7	N	10/11/2017	5,510	271	108 J	0.20 U		0.51	9.7	27.6	0.50U	42.3	0.20 U	1.23							
AQE8	AQE8	FD	10/11/2017	100U	194	196 J	0.20 U		0.20 U	0.20 U	0.06J	0.50U	0.50U	0.20 U	0.05J							
MW-06	20140610-MW06	N	6/10/2014	3000	290	200 U	0.01 U	0.20 U	0.20 U	0.28	1.20	0.50 U	0.79	0.13 J	0.13 J	43.40	1.30	0.10 U	3.40	1.20 U	1.10 U	61.60
MW-06	20140610-MW10	FD	6/10/2014	2800	310	200 U	0.01 U	0.20 U	0.20 U	0.25	1.10	0.50 U	0.50 U	0.12 J	0.11 J	46	0.80	0.10 U	4.20	1.20 U	1.10 U	61.10
MW-06	AQMW06	N	3/8/2015	3700	390	200 U	0.20 U	0.20 U	0.20 U	0.68	3	0.50 U	0.50 UJ	0.38	0.20 U	44.40		0.10 U	2.70	1.20 U	1.10 U	32.70
MW-06	AQMW10	FD	3/8/2015	3500	420	200 U	0.20 U	0.20 U	0.20 U	0.61	2.50	0.50 U	0.50 UJ	0.34	0.20 U	46		0.10 U	4	1.20 U	1.10 U	41.70
MW-06	17AQMW06	N	10/11/2017	1,750	159	100	0.20 U		0.20 U	1.03	2.08	0.50U	1.91	0.94	0.14J							
MW-09	20140609-MW09	N	6/9/2014	250 U	100 U	200 U		0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 U	0.20 U	0.20 U	230		0.10	3	1.20 U	1.10 U	265
MW-09	AQMW09	N	3/8/2015	250 U	100 U	200 U	0.20 U	0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 UJ	0.20 U	0.20 U	166		0.10 U	4.90	1.20 U	1.10 U	318
MW-09	17AQMW09	N	10/11/2017	14.4	50U	57	0.20 U		0.20 U	0.20 U	0.40U	0.50U	0.16J	0.20 U	0.20 U							
UST TUV																						
AQTUV1	AQTUV1	N	3/18/2015		900	250	0.20 U	0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 U	0.20 U	0.20 U	74		0.20	13.20	1.20 U	1.10 U	0.70 U
Background																						

				Petroleum Hydrocarbons			Volatile Organic Compounds									Metals		Anions		Dissolved Gases		
			Chemical	Gasoline Range Organics	Diesel Range Organics	Motor Oils	1,2-Dibromo-ethane (ethylene dibromide) (see note)	1,2-DICHLOROETHANE	BENZENE	ETHYLBENZENE	M,P-XYLENE	Methyl Tert-Butyl Ether (MTBE)	NAPHTHALENE	O-XYLENE	Toluene	Manganese	LEAD	Nitrate	Sulfate as SO4	Ethane	Ethene	Methane
			Method	NWTPH-GX	NWTPH-DX	NWTPH-DX	8260C	8260C	8260C	8260C	8260C	8260C	8260C	8260C	8260C	6020	6020	300.0	300.0	RSK-175	RSK-175	RSK-175
			Method A Groundwater	1000	500	500	0.01	5	5	700		20	160				15					
			Alternate AL	800 (if Benzene Present)																		
			Unit	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l	ug/l	ug/l	ug/l
Well ID/Sample Location	Sample Id	Sample Type	Sample Date																			
MW-01	20140610-MW01	N	6/10/2014	250 U	100 U	200 U		0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 U	0.20 U	0.20 U	**0.70**	0.10 U	**0.60**	**11**	1.20 U	1.10 U	0.70 U
Downgradient Wells																						
MW-02	20140610-MW02	N	6/10/2014	250 U	100 U	200 U		0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 U	0.20 U	0.20 U	**671**		0.10 U	**0.70**	1.20 U	1.10 U	**3810**
MW-03	20140610-MW03	N	6/10/2014	250 U	200	200 U		0.20 U	0.35	0.20 U	0.40 U	0.50 U	0.50 U	0.20 U	0.20 U	**1090**		**0.10**	**0.30**	1.20 U	1.10 U	**6200**
MW-07	20140609-MW07	N	6/9/2014	250 U	100 U	200 U		0.20 U	0.20 U	0.20 U	0.40 U	0.50 U	0.50 U	0.20 U	0.20 U	**101**		**0.10**	**1.90**	1.20 U	1.10 U	**663**

Appendix C

Sampling Rationale for Cantonment Area and Top Camp Area during Phase II Site Investigation

Phase II Top Camp Proposed Soil Analytes Summary

Tank	Former Contents	Phase II Soil Analytes	Logic Comments
P	Waste Oil	cPAHs (8270-SIM)	Per MTCA table 830-1 footnote 8, testing for cPAHs is required for waste oils and unknown oils. cPAHs were not previously investigated.
		Naphthalenes (8270-SIM)	Per MTCA Table 830-1, footnote 14c, if naphthalenes are found in GW, the soil must be tested. No prior GW data available. Naphthalenes will be reported in method 8270 (to be used for cPAHs).
		PCBs	Per MTCA table 830-1 footnote 8, testing for PCBs is required for waste oils and unknown oils. PCBs were not previously investigated.
R, S	Diesel, gasoline	GRO	No previous investigation conducted. Former contents were diesel(R) and gasoline (S).
		DRO	
		BTEX	Per MTCA Table 830-1, BTEX analysis is required for GRO and DRO petroleum releases.
		MTBE, EDC, EDB	Per MTCA Table 830-1, footnotes 10 and 11, soil testing for volatile fuel additives and MTBE is required if detected in GW. No prior GW data available. Fuel additives will be reported along with BTEX in method 8260.
		Lead	Footnote 12. Testing is required for lead unless it can be demonstrated that lead was not part of the release. No prior data exists for USTs R and S. Lead will be tested.
		Naphthalene (8260)	Per MTCA Table 830-1, footnote 14c, if naphthalenes are found in GW, the the soil must be tested. No prior GW data available. Naphthalenes will be reported in method 8260.
H thru O	Diesel	DRO	Confirm previous DRO soil exceedance(s)
		BTEX	Per MTCA Table 830-1, BTEX analysis is required for GRO and DRO petroleum releases.
		MTBE, EDC, EDB	Per MTCA Table 830-1, footnotes 10 and 11, soil testing for volatile fuel additives and MTBE is required if detected in GW. No prior GW data available. Fuel additives will be reported along with BTEX in method 8260.
		Naphthalene (8260)	Per MTCA Table 830-1, footnote 14c, if naphthalenes are found in GW, the the soil must be tested. No prior GW data available. Naphthalenes will be reported in method 8260.
T, U, V	Diesel	DRO	No previous investigation conducted. Known former tank content was diesel.
		BTEX	Per MTCA Table 830-1, BTEX analysis is required for GRO and DRO petroleum releases.
		MTBE, EDC, EDB	Per MTCA Table 830-1, footnotes 10 and 11, soil testing for volatile fuel additives and MTBE is required if detected in GW. No prior GW data available. Fuel additives will be reported along with BTEX in method 8260.
		Naphthalene (8260)	Per MTCA Table 830-1, footnote 14c, if naphthalenes are found in GW, the the soil must be tested. No prior GW data available. Naphthalenes will be reported in method 8260.

Phase II Cantonment Area Summary of Proposed Groundwater and Soil Analytes.

Tank	Former Contents	Downgradient Well(s)	Phase I Analyte	Logic Comments
A	No. 2 diesel	MW-04	DRO	Confirm previously observed DRO soil exceedance.
			GRO	GRO not expected to occur given former tank contents. If GRO is detected in GW, then investigate for GRO soil contamination. No prior GRO soil data available.
			BTEX	Per MTCA Table 830-1, Footnotes 6 and 7, testing soil for BTEX is required for GRO and DRO petroleum releases. Testing GW for BTEX is required when a petroleum release to GW is known or suspected.
			MTBE, EDC EDB	Per MTCA Table 830-1, Footnotes 10 and 11, GW and soil testing for volatile fuel additives and MTBE are required if GRO is found in GW. Given tank content history (diesel) and upgradient location relative to other tanks, EDB in GW will not be analyzed. Fuel additives in soil samples will be reported along with BTEX (required) via Method 8260.
			Napthalene (8260)	Per MTCA Table 830-1, Footnote 14, naphthalene testing in soil is required if detected in GW. Naphthalene will be reported along with BTEX (required) via Method 8260.
C,D	No. 2 diesel (previously bunker fuel, #4 diesel)	MW-05, MW-08	DRO	Confirm previously observed DRO and MRO soil exceedances.
			GRO	GRO not expected to occur given former tank contents. If GRO is detected in GW, then investigate for GRO soil contamination. No prior GRO soil data available.
				Analyte not associated with former tank content history.
			BTEX	Per MTCA Table 830-1, Footnotes 6 and 7, testing soil for BTEX is required for GRO and DRO petroleum releases. Testing GW for BTEX is required when a petroleum release to GW is known or suspected.
			MTBE, EDC EDB	Per MTCA Table 830-1, Footnotes 10 and 11, GW and soil testing for volatile fuel additives and MTBE are required if GRO is found in GW. GRO was non-detect in MW-05 in the 2012 GW monitoring; therefore EDB will not be analyzed in GW. Fuel additives in soil samples will be reported along with BTEX (required) via method 8260.
			Naphthalene (8260)	Per MTCA Table 830-1, Footnote 14, naphthalene testing in soil is required if detected in GW. Naphthalene will be reported along with BTEX (required) via Method 8260.
			cPAHs	Per MTCA Table 830-1, footnote 13, soil testing for cPAHs is required for DRO and heavy oils. USTs C, D reportedly previously held bunker fuel.
E	unleaded (previously leaded) gas	MW-06, MW-09	DRO	**No previous soil GRO exceedances and/or tank content history does not indicate DRO contamination; however, DRO in GW exceeded MTCA A in 2012. DRO in soil around UST E was detected but well below MTCA A in 2007 Ridolfi investigation; further DRO soil testing may be unnecessary.
			GRO	GRO soil exceedance(s) previously observed in 2007 Ridolfi investigation.
			BTEX	GRO soil exceedance(s) previously observed. Testing GW for BTEX is required when a petroleum release to GW is known or suspected.
			MTBE, EDC EDB	Per MTCA Table 830-1, footnotes 10 & 11. Soil testing for volatile fuel additives and MTBE is required if detected in GW. Fuel additives in soil samples will be reported along with BTEX (required) via method 8260.
			Naphthalene (8260)	Per MTCA Table 830-1, Footnote 14, naphthalene testing in soil is required if detected in GW. Naphthalene will be reported along with BTEX (required) via Method 8260.

Appendix D

VI Sampling Results

Key Features

- Monitoring well
- Crawlspace Air Sample
- Indoor Air Sample
- Outdoor Air Sample
- Building
- Underground Storage Tank

Former Makah AFS
VI Investigation
Neah Bay, Washington

FIGURE 3

Former Makah AFS
Building 16
Air Sample Locations

2021

NOTES:
Revision Date: 11/16/2021

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Basemap Date: December 16, 2020

0 15 30
Feet

N
W E
S

Path: Y:\GIS_Projects\Makah\Projects\Reports\Oct_2021\Figure3_Bldg_16.mxd

Key Features

- Monitoring well
- Crawlspace Air Sample
- Indoor Air Sample
- Outdoor Air Sample
- Building
- Underground Storage Tank

Former Makah AFS
VI Investigation
Neah Bay, Washington

FIGURE 4

Former Makah AFS
Building 18
Air Sample Locations

2021

NOTES:
Revision Date: 11/16/2021

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Basemap Date: December 16, 2020

0 15 30 Feet

N W E S

Olgoonik FPM JV, LLC

Path: Y:\GIS_Projects\Makah\Projects\Reports\Oct_2021\Figure4_Bldg_18.mxd

Table 2
Air Analytical Results
Building 16
March 2021

Sample ID	Ecology Indoor Air	16CA01	16CA02	16CA03	16OA01	16IA01	16IA02	16IA02D	16IA03
Matrix	**Cleanup Levels[1]**	**Crawlspace**	**Crawlspace**	**Crawlspace**	**Outdoor**	**Indoor**	**Indoor**	**Indoor**	**Indoor**
Sample Type	**µg/m3**	**Parent**	**Parent**	**Parent**	**Parent**	**Parent**	**Parent**	**Duplicate**	**Parent**
Sample Date	**-**	**3/17/2021**	**3/17/2021**	**3/17/2021**	**3/17/2021**	**3/17/2021**	**3/17/2021**	**3/17/2021**	**3/17/2021**
Petroleum equivalent carbon (EC) fractions[2]									
EC5-8 (aliphatics)	-	ND	ND	ND	ND	ND	ND	ND	ND
EC9-12 (aliphatics)	-	ND	ND	ND	ND	ND	ND	ND	ND
EC9-10 (aromatics)	-	ND	ND	ND	ND	ND	ND	ND	ND
Petroleum VOCs									
benzene	0.32	**0.73**	**0.35**	**0.36**	**0.34**	**0.63**	**0.57**	**0.54**	**0.57**
ethylbenzene	-	0.12 J	0.052 J	0.058 J	0.063 J	0.36	0.32	0.33	0.37
toluene	-	0.83	0.27	0.32	0.33	2.5	1.8	1.8	2.2
xylenes	-	0.28	0.14 J	0.14	0.18	1.4	1.2	1.2	1.4
o-xylene	-	0.11 J	0.059 J	0.062 J	0.076 J	0.58	0.51	0.51	0.57
naphthalene	0.074	0.026 J	ND	0.025 J	ND	0.048 J	**0.11 J**	**0.11 J**	**0.21**
TPH	140	2.096	0.871	0.965	0.989	5.518	4.51	4.49	5.32

Table 2
Air Analytical Results
Building 16
March 2021

Notes:

1 - Table 1 in Petroleum Vapor Intrusion (PVI): Updated Screening Levels, Cleanup Levels, and Assessing PVI Threats to Future Buildings Implementation Memorandum No. 18, January 2018.

2 - The three carbon fractions listed should be analyzed using the Massachusetts DEP APH Test Methods WSC-CAM-IX, July 2010 rather than a bulk analysis of TPHg and TPHd. This is because diesel range organics can contain a significant amount of lighter end compounds, especially EC5-8. aliphatics.

J - The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

ND - Compound was analyzed for, but not detected above the laboratory reporting limit.

TPH - Total Petroleum Hydrocarbons

Bold indicates an exceedance of the indoor air standard.

Table 3
Air Analytical Results
Building 16
October 2021

Sample ID	Ecology Indoor Air Cleanup Levels[1]	16CA04	16CA05	16CA06	16OA02	16IA04	16IA05	16IA05D	16IA06
Matrix		Crawlspace	Crawlspace	Crawlspace	Outdoor	Indoor	Indoor	Indoor	Indoor
Sample Type	µg/m3	Parent	Parent	Parent	Parent	Parent	Parent	Duplicate	Parent
Sample Date	-	10/18/2021	10/18/2021	10/18/2021	10/18/2021	10/18/2021	10/18/2021	10/18/2021	10/18/2021
Petroleum equivalent carbon (EC) fractions[2]									
EC5-8 (aliphatics)	-	ND	ND	ND	ND	ND	ND	ND	ND
EC9-12 (aliphatics)	-	ND	ND	ND	ND	ND	ND	ND	ND
EC9-10 (aromatics)	-	ND	ND	ND	ND	ND	ND	ND	ND
Petroleum VOCs									
benzene	0.32	0.22	0.20	0.16	0.21	0.21	0.22	0.22	0.22
ethylbenzene	-	ND	ND	ND	ND	ND	ND	ND	ND
toluene	-	0.27	0.22	0.16	0.28	0.95	0.88	0.92	1.0
xylenes	-	ND	ND	ND	0.17	0.27	0.25	0.27	0.28
o-xylene	-	ND	ND	ND	ND	ND	ND	ND	ND
naphthalene	0.074	ND	ND	ND	ND	ND	ND	**0.27**	ND
TPH	140	0.49	0.42	0.32	0.66	1.43	1.35	1.68	1.5

Table 3
Air Analytical Results
Building 16
October 2021

Notes:
1 - Table 1 in Petroleum Vapor Intrusion (PVI): Updated Screening Levels, Cleanup Levels, and Assessing PVI Threats to Future Buildings Implementation Memorandum No. 18, January 2018.
2 - The three carbon fractions listed should be analyzed using the Massachusetts DEP APH Test Methods WSC-CAM-IX, July 2010 rather than a bulk analysis of TPHg and TPHd. This is because diesel range organics can contain a significant amount of lighter end compounds, especially EC5-8. aliphatics.
ND - Compound was analyzed for, but not detected above the laboratory reporting limit.
TPH - Total Petroleum Hydrocarbons
Bold indicates an exceedance of the indoor air standard.

Table 4
Air Analytical Results
Building 18
March 2021

Sample ID	**Ecology Indoor Air**	**18CA01**	**18CA02**	**18CA03**	**18OA01**	**18IA01**	**18IA02**	**18IA03**
Matrix	**Cleanup Levels[1]**	**Crawlspace**	**Crawlspace**	**Crawlspace**	**Outdoor**	**Indoor**	**Indoor**	**Indoor**
Sample Type	**µg/m3**	**Parent**	**Parent**	**Parent**	**Parent**	**Parent**	**Parent**	**Parent**
Sample Date	**-**	**3/17/2021**	**3/17/2021**	**3/17/2021**	**3/17/2021**	**3/17/2021**	**3/17/2021**	**3/17/2021**
Petroleum equivalent carbon (EC) fractions[2]								
EC5-8 (aliphatics)	-	ND	ND	ND	ND	ND	ND	ND
EC9-12 (aliphatics)	-	ND	ND	ND	ND	24	ND	ND
EC9-10 (aromatics)	-	ND	ND	ND	ND	ND	ND	ND
Petroleum VOCs								
benzene	0.32	0.29	0.29	0.32	0.31	**0.65**	**0.33**	**0.36**
ethylbenzene	-	0.037 J	0.045 J	0.057 J	0.041 J	0.43	0.12 J	0.091 J
toluene	-	0.20	0.25	0.24	0.24	2.8	0.76	0.75
xylenes	-	0.10 J	0.12 J	0.12 J	0.11 J	1.5	0.38	0.26
o-xylene	-	0.043 J	0.053 J	0.055 J	0.046 J	0.56	0.16	0.12
naphthalene	0.074	ND	ND	0.023 J	ND	**0.078 J**	0.074 J	ND
TPH	140	0.67	0.758	0.815	0.747	6.018	1.824	1.49

Table 4
Air Analytical Results
Building 18
March 2021

Notes:
1 - Table 1 in Petroleum Vapor Intrusion (PVI): Updated Screening Levels, Cleanup Levels, and Assessing PVI Threats to Future Buildings Implementation Memorandum No. 18, January 2018.
2 - The three carbon fractions listed should be analyzed using the Massachusetts DEP APH Test Methods WSC-CAM-IX, July 2010 rather than a bulk analysis of TPHg and TPHd. This is because diesel range organics can contain a significant amount of lighter end compounds, especially EC5-8 aliphatics.
J - The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
ND - Compound was analyzed for, but not detected above the laboratory reporting limit.
TPH - Total Petroleum Hydrocarbons
Bold indicates an exceedance of the indoor air standard.

Table 5
Air Analytical Results
Building 18
October 2021

Sample ID	Ecology Indoor Air Cleanup Levels[1]	18CA04	18CA05	18CA06	18OA02	18IA04	18IA05	18IA06
Matrix		**Crawlspace**	**Crawlspace**	**Crawlspace**	**Outdoor**	**Indoor**	**Indoor**	**Indoor**
Sample Type	**µg/m3**	**Parent**	**Parent**	**Parent**	**Parent**	**Parent**	**Parent**	**Parent**
Sample Date	**-**	**10/18/2021**	**10/18/2021**	**10/18/2021**	**10/18/2021**	**10/18/2021**	**10/18/2021**	**10/18/2021**
Petroleum equivalent carbon (EC) fractions[2]								
EC5-8 (aliphatics)	-	ND	ND	ND	ND	ND	ND	ND
EC9-12 (aliphatics)	-	ND	18	14	ND	14	ND	ND
EC9-10 (aromatics)	-	ND	ND	ND	ND	ND	ND	ND
Petroleum VOCs								
benzene	0.32	0.21	0.22	0.20	0.20	0.22	0.22	0.23
ethylbenzene	-	ND	ND	ND	ND	0.18	0.25	0.21
toluene	-	0.44	0.75	0.30	0.22	1.3	1.2	1.4
xylenes	-	0.14	0.16	0.038	ND	0.47	0.56	0.57
o-xylene	-	ND	ND	ND	ND	0.19	0.21	0.22
naphthalene	0.074	ND	ND	**0.13**	ND	ND	ND	ND
TPH	140	0.79	1.13	0.668	0.42	2.36	2.44	2.63

Table 5
Air Analytical Results
Building 18
October 2021

Notes:

1 - Table 1 in Petroleum Vapor Intrusion (PVI): Updated Screening Levels, Cleanup Levels, and Assessing PVI Threats to Future Buildings Implementation Memorandum No. 18, January 2018.

2 - The three carbon fractions listed should be analyzed using the Massachusetts DEP APH Test Methods WSC-CAM-IX, July 2010 rather than a bulk analysis of TPHg and TPHd. This is because diesel range organics can contain a significant amount of lighter end compounds, especially EC5-8 aliphatics.

ND - Compound was analyzed for, but not detected above the laboratory reporting limit.

TPH - Total Petroleum Hydrocarbons

Bold indicates an exceedance of the indoor air standard.

Appendix E

Terrestrial Ecological Evaluation

Terrestrial Ecological Evaluation for the

Corrective Action Plan, Former Makah Air Force Station, Neah Bay, Washington

This document presents the Terrestrial Ecological Evaluation (TEE) in support of the Corrective Action Plan (CAP) to address petroleum hydrocarbon contamination in soil and groundwater at the Former Makah Air Force Station (the Site), located on the Makah Indian Reservation. The AF and the United States Environmental Protection Agency (EPA) have entered an Administrative Order on Consent (Consent Order) under the Resource Conservation and Recovery Act (RCRA) UST Program to investigate, remove and remediate the release from USTs of petroleum constituents at or from the Site. Because the Site is located within the Makah Indian Reservation, EPA Region 10 is the implementing agency for the UST program. EPA uses MTCA cleanup levels established by the Washington State Department of Ecology (Ecology) as a guide for determining appropriate cleanup levels for petroleum releases in Indian Country in Washington State. Under MTCA, cleanup levels protective of ecological receptors potentially exposed to soil contamination are evaluated following the Terrestrial Ecological Evaluation process as indicated in Washington Administrative (WAC) Sections 173-340-7490 through 7494.

MTCA presents a stepwise process for conducting Terrestrial Ecological Evaluations (TEE). Based on the outcome of each step, the need for the subsequent step is determined and in warranted a cleanup level may be identified. The steps outlined in WAC 173-340-7490 through 173-340-7494 in the following:

1. TEE Exclusions
2. Applicability of a Simplified Terrestrial Ecological Evaluation
3. Simplified TEE
4. Site-specific TEE

The following memorandum describes the study area, the UST sites considered under this CAP, and the TEE process conducted in support of the CAP.

1. Background

The Site lies within the Makah Indian Reservation (the Reservation) located in the northwest corner of the Olympic Peninsula in the state of Washington (Figure 1). The AF leased approximately 255 acres from the Makah Tribe. The Reservation encompasses approximately 42 square miles and is bordered on the west by the Pacific Ocean and on the north by the Strait of Juan de Fuca. The city of Port Angeles lies approximately 60 miles east of the Reservation. Neah Bay is the only town on the Reservation and is located on the Strait of Juan de Fuca. The terrain of the Reservation is hilly and rugged with steep slopes and deep, narrow valleys. The lower valleys of the Sooes River and Wa'atch River, however, are low, broad, and marshy. The land surface of the Reservation ranges in altitude from sea level to almost 2,000 feet above sea level. The average annual precipitation at Neah Bay is approximately 100 inches (WRCC 2019). Three quarters of the annual precipitation occurs during the six–month period from October through March.

The Air Force facilities at the Site were separated into four main areas: Cantonment, family housing, Top Camp, and trailer court/family campground. The former USTs are located within the Cantonment and Top Camp Areas (Figures 2 and 3).

The Cantonment Area is located on Cape Flattery Road near the Pacific beaches and an estuary where the Wa'atch River flows into Makah Bay (Figure 1). The Cantonment Area is approximately 15 feet above sea level. The ground surface throughout the site is relatively flat, and slopes slightly downward towards the southeast. A small creek begins near the northern portion of the site and runs southeast through the wooded area bordering the northeast edge of the site (Figure 2). The Cantonment Area was built in the 1950s and served as the Makah AFS headquarters until the station was closed in 1988. Buildings and structures in the Cantonment Area include housing, barracks, maintenance shops, and administration offices. Near the eastern edge of the site, the creek flows towards the east, runs beneath Cape Flattery Road through a culvert, and drains into the Wa'atch River. A drainage ditch located on the east side of the site runs northeast and connects with the southeast–trending creek before the culvert. Groundwater flow is to the southwest in the Cantonment Area.

The Top Camp area is located along a ridge leading to Bahokus Peak at an elevation of 1500 feet above sea level (Figure 3). Top camp facilities include the Radar Dome Area, the Microwave Tower, and the former Building 102 (down the road from the Microwave Tower). Each of the Top Camp facilities is separated by undeveloped land along the ridgetop and is bounded by steep slopes. Access is via a steep, single-lane gravel road. Limited groundwater has been found at the Top Camp UST sites.

Natural History

The Makah Indian Reservation is located on the Olympic Peninsula of Washington State and is characterized by a wet, temperate climate (WRCC 2019; EPA 1986). The reservation is generally mountainous with Sooes Peak at its highest point (2,000 ft.) and many smaller hills and ridges ranging from 500 to 1,000 ft elevation. There are two low lying valleys formed by the Wa'atch and Sooes Rivers.

The reservation is considered within the Sitka Spruce botanical zone (Franklin and Dyrness 1973), where the wet, mild climate and fine forest soils support productive coniferous forests. The majority of the reservation is forested with second growth forest, with areas of old growth forest. The Makah Forestry Department estimated that in areas of old growth forest, 80% is composed of western hemlock, 10% cedar, 5% Sitka spruce, and 5% alder (MTC 1978). In the second-growth forests, hemlock remains the overall dominant, comprising 75% of all the second growth forests of the reservation. Alder is an early successional species and dominates areas recently disturbed by logging, fires, or slides.

The forest understory includes a variety of species, depending on the successional stage. The understory in old growth forest is heavily shaded and less dense, with salal, huckleberry, devil's club, lady fern, deer fern and a variety of mosses (MTC 1978). The understory in recently disturbed areas (e.g. second growth) can range from dense shrubby thickets, dominated by salmonberry, red elderberry, huckleberries, salal, rhododendron, vine maple, and sword fern to early second growth forest with red alder and lesser amounts of understory.

Biota in the forested areas of the reservation include small and large mammals including Roosevelt elk, black-tailed deer, and Black bear. Small mammals include raccoon, Mountain beaver, deer mouse, and northern redback meadow mouse (MTC 1978). Mink, Pacific marten, Pacific fisher, and river otter may also be present in the nearshore areas of the Wa'atch River and Pacific Ocean beaches. A wide diversity of songbirds utilizes this habitat, including swallows, thrushes, warblers, finches, and sparrows. Osprey, Bald eagle, and Great blue heron feed in nearshore areas. In some portions of the reservation Marbled murrelet may using the upland forests for nesting areas (EPA 2010). The Wa'atch River and associated streams are spawning and rearing habitat for coho, chinook, and chum salmon, trout, steelhead.

The Cantonment area is an open, grassy area situated between conifer forests and the Wa'atch River and associated estuary, approximately 1,000 ft. by 950 ft (Figure 2). USTs A, B, F and G are located immediately southeast of contiguous forest. USTs D, C, and E are approximately 120 – 150 ft southeast of the continuous forest. USTs Y1, Y2, and Y3 are approximately 120 ft. southwest of the forest and approximately 500 ft. northwest of the Wa'atch River and estuary. The Top Camp area is located on a rocky ridge and each UST is immediately adjacent to the contiguous forests (Figure 3). The Top Camp area is a rocky, forested ridge with steep slopes. Each of the USTs are immediately adjacent to densely forested areas with plants native to Washington State.

2. Terrestrial Ecological Evaluation

The UST sites at the former Makah Air Force Station vary in terms of their location, site characteristics, and extent of soil contamination. Each of the USTs that are being evaluated in the CAP were considered a "site" and was evaluated for terrestrial ecological risk individually. This section evaluates the UST Sites following the TEE process as defined in Ecology (2019) and WAC Chapters 173-340-7490 through 173-340-7494.

2.1 TEE Exclusions

Under Step 1 of the TEE process, the site and contaminant characteristics are evaluated for potential exclusion from further evaluation of ecological risk. There are four potential exclusions four TEE exclusionary criteria are as follows:

1. *Contamination below the point of compliance*. This means all soil contamination shall be below the standard point of compliance (ground surface to a depth of 15 feet), or below the conditional point of compliance (ground surface to a depth of 6 feet). The conditional point of compliance may only be used in conjunction with institutional controls which would prevent excavation of deeper soils.

2. *Incomplete exposure pathway*: The primary pathway to soils for ecological receptors would be direct contact and ingestion. The pathway could be considered incomplete if there were barriers for plants or animals to contact soils (e.g. pavement and buildings).

3. *Type of contamination and proximity to ecological receptors*. For sites contaminated with hazardous substances other than those specified below (PAHs, DRO and GRO are not excluded); there must be less than 1.5 acres of contiguous undeveloped land on the site or within 500 feet of any area located on the site.

4. *Concentrations below background lev*els. For certain naturally occurring contaminants, or for contaminated sites found in urban areas, there may be contamination that is not directly attributable to the site.

Evaluation of Exclusions

Exclusion 1: Exclusion 1 does not apply to the UST sites. Petroleum hydrocarbons were detected at the UST sites between 0 to 15 ft below the ground surface and would be above the point of compliance. Note that petroleum hydrocarbons were detected above both the TEE point of compliance, as well as the conditional point of compliance of 6 ft.

Exclusion 2: Exclusion 2 does not apply to any of the UST sites. While there are some buildings and roads in the cantonment area, the physical barriers are discontinuous and large, forested areas are near each of the UST sites.

Exclusion 3: Exclusion 3 does not apply to any of the UST sites. For each UST site, there is undeveloped land within 500 ft. and that undeveloped land is greater than 1.5 acres.

Exclusion 4: Exclusion 4 does not apply to any of the UST sites. The contaminants found in soils near the USTs are not naturally occurring and are unlikely to be present from other sources.

None of the UST sites evaluated under this CAP qualify for the exclusions under WAC 173-340. Once it has been established that none of the exclusionary criteria apply, either a simplified or site-specific terrestrial ecological evaluation is required. WAC 173-340-7492 of MTCA specifically refers to the process of determining the type of evaluation that is required (simplified or site-specific) as "Applicability of a Simplified Terrestrial Ecological Evaluation."

2.2 Applicability of a Simplified Terrestrial Ecological Evaluation

WAC 173-340-7492 lists four criteria that are to be used to determine whether a Simplified TEE can be used. If any of the below criteria apply, then a site-specific terrestrial ecological evaluation is necessary. Those criteria are as follows:

(i) **Natural areas.** The site is located on, or directly adjacent to, an area where management or land use plans will maintain or restore native or semi-native vegetation (e.g., green-belts, protected wetlands, forestlands, locally designated environmentally sensitive areas, open space areas managed for wildlife, and some parks or outdoor recreation areas.

(ii) **Vulnerable species.** The site is used by a threatened or endangered species; a wildlife species classified by the Washington state department of fish and wildlife as a "priority species" or "species of concern" under Title 77 RCW; or a plant species classified by the Washington state department of natural resources natural heritage program as "endangered," "threatened," or "sensitive" under Title 79 RCW. For plants, "used" means that a plant species grows at the site or has been found growing at the site. For animals, "used" means that individuals of a species have been observed to live, feed or breed at the site.

(iii) **Extensive habitat.** The site is located on a property that contains at least ten acres of native vegetation within 500 feet of the site, not including vegetation beyond the property boundaries.

(iv) **Risk to significant wildlife populations.** The department determines that the site may present a risk to significant wildlife populations.

Each of the UST sites are located within 200 ft. of continuous coniferous forest that is over an area of greater than 10 acres. Trees and understory vegetation are comprised of plants native to the state of Washington (Franklin and Dryness 1973, Ecology 2019). USACE is not aware of any planned changes for future uses of the Cantonment and Top Camp Areas that would result in significant changes in the forested areas. Given that the USTs are in natural areas provides extensive habitat, a site-specific TEE is required.

2.3 Site-Specific TEE

The site-specific TEE process is designed to assess ecological risk at any site and to provide the basis for a cleanup level protective of terrestrial ecological receptors at the site; including sites with protected status species. Under WAC 173-340-7493, a site-specific TEE shall include the following steps:

- Problem formulation
- Selection of appropriate evaluation method(s)
- Conducting the evaluation
- Establish ecologically protective soil concentration

Data used for the site-specific TEE included soil and groundwater samples collected during the Phase II (USACE 2016) and Phase IV investigations (USACE 2021). Soil samples were collected from each of the UST sites and were analyzed for organic contaminants including Diesel Range Organics (DRO), Gasoline Range Organics (GRO), and Motor Oil Range Organics (MRO), as well as PAHs and selected semi-volatile organic compounds (SVOCs). The sampling efforts, types of samples, and sample results are summarized in Section 2.3 of the main body of this CAP Report, as well as Appendix A and B.

2.3.1 Problem Formulation

The Problem Formulation section of the TEE provides the basis for the evaluation and can be viewed as the planning and/or descriptive phase of the process. Exposure related information, such as contaminant concentrations in various media, is also presented in the Problem Formulation section. Therefore, this section identifies contaminants or chemicals of concern, ecological resources potentially at risk, and exposure pathways that may be important. Three components are addressed during problem formulation. Those three components are:

- Contaminants of ecological concern
- Exposure pathways
- Terrestrial ecological receptors of concern

<u>Contaminants of Ecological Concern</u>

The contaminants of ecological concern were determined by comparing soil concentrations observed at each UST site to ecological screening values (SL) presented in Table 5.1 of Ecology (2019; MTCA Table 749-3). Table 5.1 provides SL values for plants, soil biota, and wildlife for a group of selected analytes. For each UST site, the maximum reported concentration (regardless of station or depth interval) was compared to the lowest available screening value. The data collected during the Phase II and Phase IV investigations and the comparison to the SL values is summarized in Table 1. The full data set for the UST sites are reported in Appendixes A and B of the main report.

GRO data was available for UST sites E and R/S. The maximum concentration for UST E was 1,900 mg/kg, above the 100 mg/kg SL for soil biota. Diesel Range Organics (DRO) was measured and detected in soils at each of the UST sites. The maximum concentration observed in soils from UST sites A, C/D, H through O and TUV exceeded the soil biota SL value of 200 mg/kg, with maximum values ranging from 2,100 to 5,300 mg/kg. Motor Oil Range Organics (ORO) were compared to the MTCA Level A value of 2,000 mg/kg, since there were no SLs listed for ORO in Table 5.1. None of the maximum values was greater than the MTCA Level A SL. Based on a comparison of SL values, GRO and DRO are CEPCs.

Benzo(a)pyrene and toluene maximum concentrations were well below the SL values for Table 5.1 of Ecology (2019; MTCA Table 749-3). The SL value for acenaphthene (20,000 µg/kg) was used to screen low-molecular weight PAHs; for high-molecular weight PAHs, the SL value for benzo(a)pyrene was used to screen soil samples. Where measured, the total naphthalene concentration was well below the SL for acenaphthene. The concentrations of chrysene, dibenz(a,h)anthracene, indeno (1,2,3-cd)pyrene, and benzofluoranthenes were all below the soil invertebrate-based SL of 12,000 µg/kg (Table 5.1). Based on a comparison to the SL values, none of the individual PAHs were considered to be CEPCs.

Table 1. Summary of Data Collected for UST Sites and Comparison to TEE Screening Levels[a]

Contaminant of Potential Concern	WAC 173-340-900, Table 749-3 Lowest Screening Level	Number of Stations		Depth of Detected Hydrocarbons	Samples	Detects	Detection Frequency	Mean	Max	HQ Max/SL
		Phase II	Phase IV							
UST A										
Diesel Range Organics (mg/kg)		10	0	0 to 15						
Diesel Range Organics	200				14	12	86%	723	4000[b]	**20**
Motor Oil Range Organics	2000				14	6	43%	60	160	<1
SVOCs (ug/kg)										
Benzo(a)pyrene	12,000				--	--	--	--	--	
Toluene	200,000				14	9	64%	1.2	2.4	
UST C/D										
Diesel Range Organics (mg/kg)		20	3	0 to 15						
Diesel Range Organics	200				51	40	84%	2223	5300	**26**
Motor Oil Range Organics	2000				44	30	73%	29	100	<1
SVOCs (ug/kg)										
Benzo(a)pyrene	12,000				44	19	43%	283	2400	<1
Toluene	200,000				40	17	41%	1	3	<1
UST E										
Gasoline Range Organics (mg/kg)		14	4	0 to 15						
Gasoline Range Organics	100				29	7	24%	817	1900	**19**
Diesel Range Organics (mg/kg)										
Diesel Range Organics	200				29	13	45%	25.6	69	<1
Motor Oil Range Organics	2000				29	10	34%	123	340	<1
SVOCs (ug/kg)										
Benzo(a)pyrene	12,000				9	1	11%	6.2	6.2	<1
Toluene	200,000				29	18	62%	14	130	<1

Contaminant of Potential Concern	WAC 173-340-900, Table 749-3 Lowest Screening Level	Number of Stations		Depth of Detected Hydrocarbons	Samples	Detects	Detection Frequency	Mean	Max	HQ
		Phase II	Phase IV							
USTs H through O										
Diesel Range Organics (mg/kg)		9	0	0 to 13						
Diesel Range Organics	200				17	17	100%	237	3000	**15**
Motor Oil Range Organics	2000				17	16	94%	274	1500	<1
SVOCs (ug/kg)										
Benzo(a)pyrene	12,000				--	--	--	--	--	
Toluene	200,000				17	7	41%	1	2	<1
UST R/S										
Gasoline Range Organics (mg/kg)		8	0	0 to 5						
Gasoline Range Organics	100				8	0	0%	ND	ND	<1
Diesel Range Organics (mg/kg)										
Diesel Range Organics	200				8	8	100%	32	110	<1
Motor Oil Range Organics	2000				8	8	100%	99	390	<1
SVOCs (ug/kg)										
Benzo(a)pyrene	12,000				--	--	--	--	--	
Toluene	200,000				20	9	45%	22	130	<1
UST TUV										
Diesel Range Organics (mg/kg)		13	0	0 to 12						
Diesel Range Organics	200				27	26	96%	340	2100	**10**
Motor Oil Range Organics	2000				27	26	96%	295	1600	<1
SVOCs (ug/kg)										
Benzo(a)pyrene	12,000				--	--	--	--	--	
Toluene	200,000				27	16	59%	1	3	<1

a: Table shows selected constituents. The full list of constituents analyzed at each site are presented in Appendix A and Appendix B.

b: highlighted values are concentrations that exceed the SL or HQ values greater than 1.

Exposure Pathways

Complete and significant exposure pathways warranting assessment in this TEE are identified below:

- Risks to terrestrial plants due to direct contact with and uptake of soil COPCs;
- Risks to terrestrial soil-dwelling invertebrates due to direct contact with and ingestion of soil COPCs;
- Risks to small and large mammals due to direct contact with and uptake of soil COPCs;
- Risks to birds from uptake of soil COPC.

Groundwater has been characterized in the Cantonment Area. Based on the Phase IV report (USACE 2021), the petroleum contamination in groundwater is limited to the study area and does not extend to Wa'atch Creek. Groundwater has generally not been found in the Top Camp area, with the exception of ephemeral perched groundwater. Groundwater contamination was not considered to be a complete pathway to surface water at the UST sites.

Terrestrial Ecological Receptors of Concern

This step includes the identification of current or potential future terrestrial ecological receptor groups reasonably likely to live or feed at the site. Potential terrestrial species groups for the UST sites include:

- Vascular plants
- Soil-associated invertebrates
- Ground-feeding birds
- Ground-feeding small mammal predators
- Herbivorous small and large mammals

2.3.2 Selection of an Evaluation Method

The TEE methods allow several methods to evaluate the potential for terrestrial ecological effects and, if necessary, establish soil concentrations protective of terrestrial ecological receptors. They are as follows:

- Table values
- Soil Bioassays
- Wildlife exposure model
- Biomarkers
- Site – specific field studies
- Weight of evidence
- Literature surveys

2.3.3 Conducting the Evaluation

For the purposes of evaluating the potential ecological risks associated with soils at each of the UST sites, the concentrations of DRO and GRO were compared to the screening values in Table 5.1 of Ecology (2019; MTCA Table 749-3). A hazard quotient (HQ) was calculated for each UST site by dividing the soil concentration at the UST site by the SL value. Those HQ values greater than 1 represent soil concentrations that may pose a risk to terrestrial ecological receptors. For the purposes of this evaluation, the HQ values were calculated using the maximum value observed across all stations and all depth intervals. The SL values represented the lowest value for the three taxonomic groups presented in Table 5.1. The SL value for DRO was 200 mg/kg and the SL value for GRO was 100 mg/kg.

For DRO, HQ values were greater than 1 at UST sites A, C/D, H through O, and TUV, with HQ value ranging from 10 to 26. The HQ value for DRO was below 1 for UST site R/S. DRO was not reported for UST site E.

For GRO, the HQ value was greater than 1 for UST site E, with an HQ value of 19. The HQ for GRO was below 1 in soils collected from UST site R/S. GRO was not reported for UST sites A, C/D, H through O, and TUV.

Based on the comparison of DRO and GRO soil values to TEE screening levels, there is unacceptable risk to terrestrial ecological receptors from exposure to soils at UST sites A, C/D, E, H through O, and TUV. No unacceptable risk was observed for terrestrial ecological receptors at UST site R/S.

As indicated in the TEE guidance (Ecology 2019), the screening levels provided in Table 5.1 are conservative thresholds for ecological risk. However, the HQ values were substantially higher than the SL values and are appropriately identifying those UST stations where there is unacceptable risk to terrestrial wildlife. The use of maximum values for SL comparison is also a conservative approach given that the horizontal and vertical distribution of hydrocarbon contamination at most UST sites. While this may lead to a conservative estimate of risk, the distribution of hydrocarbon contamination in soils will be addressed in the CAP design.

2.3.4 Selecting the Cleanup Level

Under WAC 173-340-7493 Section 3, the screening values in Table 5.1 of Ecology (2019) and MTCA Table 749-3 may be used as the cleanup level when terrestrial ecological risk drives the cleanup level. The values presented in Table 5.1 are considered to be concentrations protective of plants, soil invertebrates, and wildlife including threatened or endangered species (Ecology 2019).

For the purposes of the CAP removal project, the Air Force and EPA have elected to use the values in MTCA Table 749-3 as cleanup levels for the purposes of protecting soil plants, invertebrates and wildlife. It is understood that these are conservative values, and that higher, site-specific protective cleanup levels may be derived using bioassays or one of the other alternative approaches.

Based on the two CEPCs identified for the UST Sites, the following MTCA-based cleanup levels for ecological risk are proposed:

Diesel-Range Organics	200 mg/kg
Gasoline Range Organics	100 mg/kg

As indicated above, the Table 5.1 (Ecology 2019) values are conservative cleanup levels. The use of more site-specific methods that consider site soil characteristics, bioavailability, and area use by terrestrial receptors could result in less conservative cleanup levels. However, when used in combination with MTCA A values for unrestricted use, these values are appropriate for use at these UST sites.

3. Summary and Conclusions

The AF and the EPA have entered a Consent Order under the RCRA UST Program to investigate, remove and remediate the release from USTs of petroleum constituents at or from the Former Makah Air Force Station, located on the Makah Indian Reservation. In support of the Corrective Action Plan, MTCA Terrestrial Ecological Evaluations were conducted to develop a list of contaminants of ecological concern and to develop cleanup levels protective of ecological receptors at the UST sites.

Based on the TEE process as indicated in (WAC) Sections 173-340-7490 through 7494 and Ecology (2019), the following findings are reported here:

- None of the UST sites qualify for TEE exemptions due to the proximity of large natural areas comprised of vegetation and wildlife native to Washington State.
- Hydrocarbons have been observed in soils at the UST sites that are within the point of compliance, which is the upper 15 ft of soil below ground surface.
- Chemical concentrations of DRO and GRO were above the TEE screening levels and both DRO and GRO were considered CEPCs.
- Based on comparisons of the maximum concentration of DRO and GRO observed in soils for each UST site, HQ values greater than 1 were observed at UST sites A, C/D, E, H through O, and TUV.
- The recommended **soil cleanup value for DRO is 200 mg/kg** based on terrestrial ecological risk.
- The recommended **soil cleanup value for GRO is 100 mg/kg** based on terrestrial ecological risk.

Figure 1. Study Area

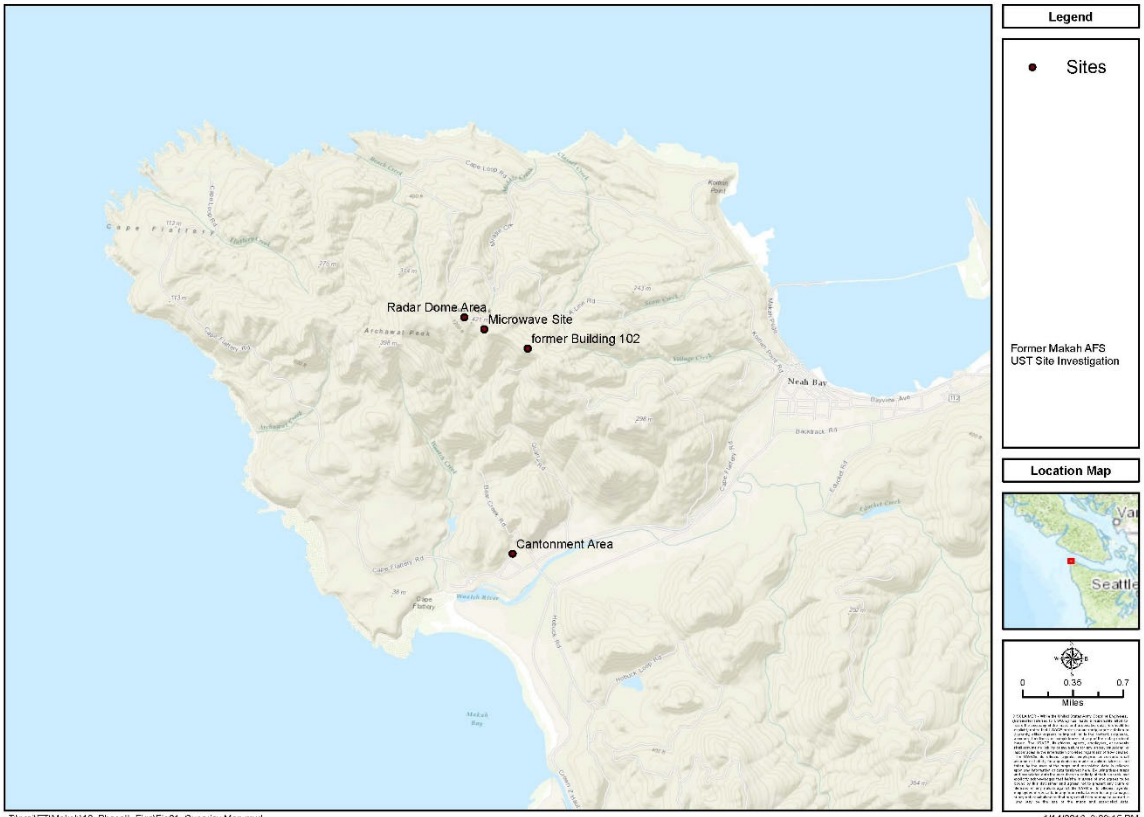


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Figure 2. Cantonment Area USTs and Monitoring Wells

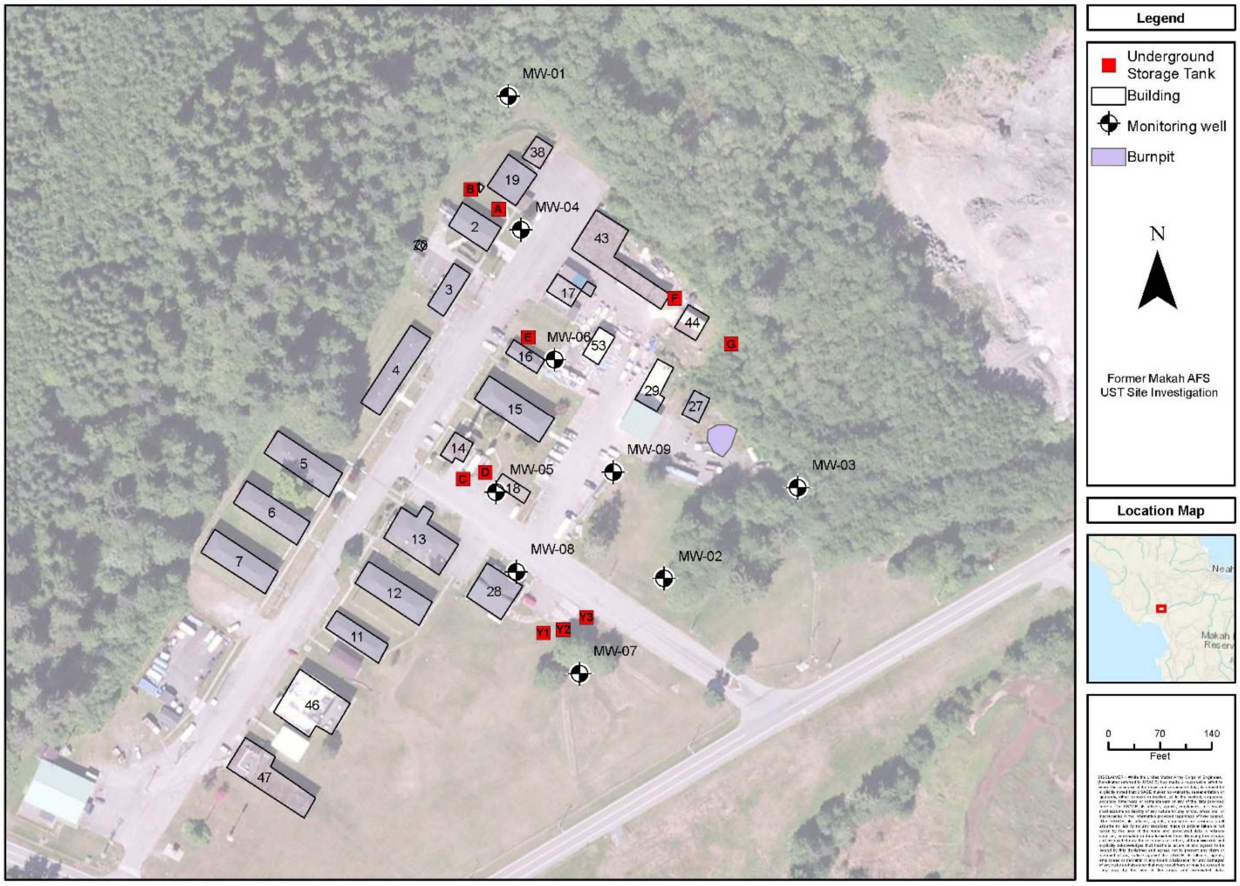
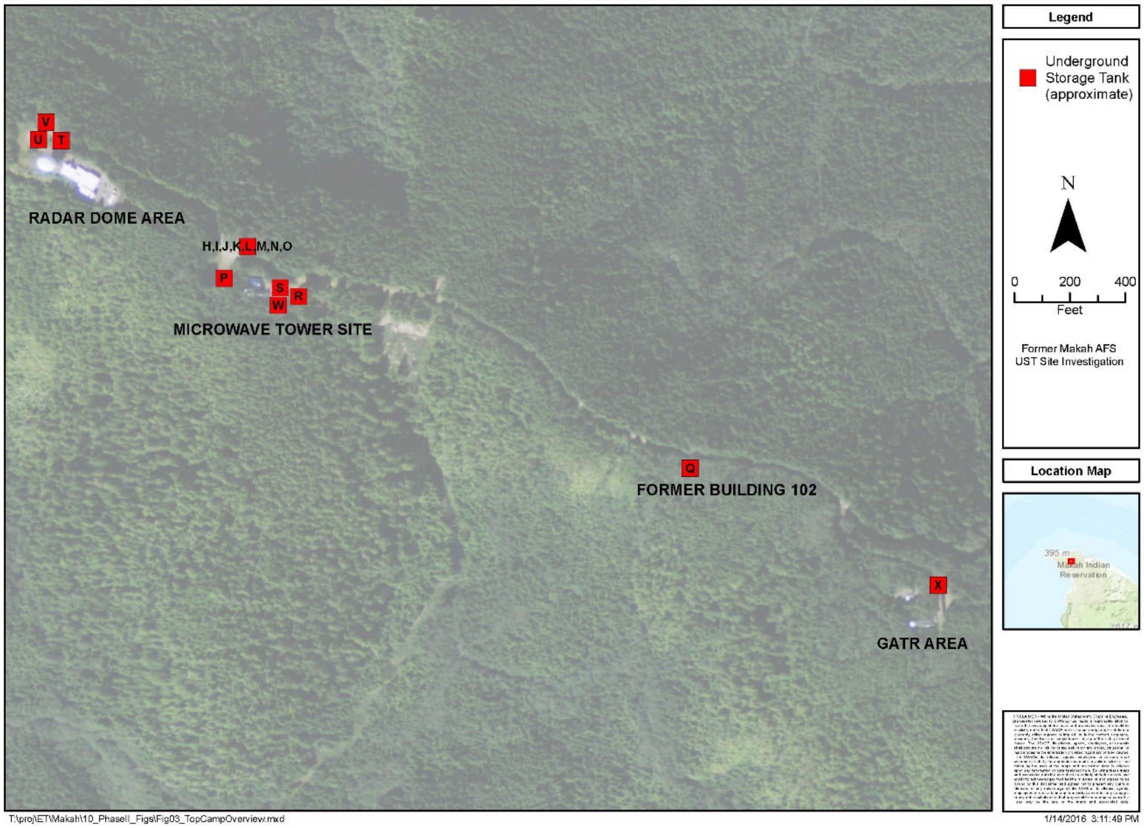


Figure 3. Top Camp Overview



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