Tank 5 Initial Release Response Report
Red Hill Bulk Fuel Storage Facility
JBPHH, Oahu, Hawaii

DOH Facility ID No. 9-102271
DOH Release ID No. 140010

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Executive Summary

Commander Navy Region Hawaii (CNRH) prepared this Initial Release Response Report in accordance with the State of Hawaii Department of Health (DOH) Underground Storage Tank (UST) Technical Guidance Manual (DOH, 2000) and in response to the DOH release response letters dated February 12, 2014 and February 26, 2014 for the Red Hill Bulk Fuel Storage Facility. The objective of this report is to describe the actions taken by the Navy in the last 90 days in response to the fuel released from Tank 5.

The Facility is located in the south-central portion of the Island of Oahu, Hawaii, in Halawa Heights. There are 18 active and 2 inactive, 12.5 million gallon, field-constructed USTs located at the Facility.

A confirmed release of Jet Propellant 8, also known as Jet Propulsion fuel, type 8 (JP-8) from Tank 5 was reported on January 24, 2014. Immediately after the release was detected, the Navy began draining the contents of the UST and collected soil vapor samples from existing vapor monitoring points and groundwater samples from monitoring wells. Results indicated the presence of elevated levels of hydrocarbons in soil vapor; however, no free product from Tank 5 was detected in the groundwater samples. Soil vapor and groundwater samples continue to be collected from select locations adjacent to Tank 5.

The Navy has identified several contract actions that would help ensure the drinking water around the facility remains safe. A contract has been awarded to modify the existing Groundwater Protection Plan and develop a recommended approach to effectively update the existing groundwater model and contaminant fate and transport model for the Facility. The Navy is in the process of procuring the services of a contractor to define the nature, extent, and magnitude of soil and groundwater contamination beneath Tank 5, in addition to preparing a vertical migration model, and conducting a pilot study to evaluate free product removal or in-situ remediation.

1.0 Introduction

As required by Hawaii Administrative Rules 11-281-80.1, Release Response Reporting, this Initial Release Response Report presents the following information:

1) A description of all release response actions taken during the first 90-day period (first quarter) following the confirmation of the release of Jet Propellant 8, also known as Jet Propulsion fuel, type 8 (JP-8) from Tank 5, and
2) A plan for future release response actions to be taken.

This report presents a summary of the release response activities performed from January 13, 2014 through April 18, 2014 at the Red Hill Bulk Fuel Storage Facility (hereinafter referred to as "the Facility") located at Joint Base Pearl Harbor-Hickam (JBPHH), Oahu, Hawaii.

1.1 Statement of Purpose

Release response actions were performed to address a fuel release observed in Tank 5.

1.2 Previous Reports

Release confirmation information for Tank 5 was submitted to the State of Hawaii Department of Health (DOH) as Commander Navy Region Hawaii (CNRH) letter 5090 Ser N45/044 dated January 23, 2014.

2.0 Background

The following sections provide a description of the site, information on the Facility and underground storage tanks (USTs), general history of the release, and a description of response and abatement activities.

2.1 Site Description

The Facility is located on federal government land (zoned F1- Military and Federal), located in Halawa Heights, approximately 2.5 miles northeast of Pearl Harbor (Figure 1). It is located on a low ridge on the western edge of the Koolau Mountain Range that divides Halawa Valley from Moanalua Valley. The Facility is bordered on the north by Halawa Correctional Facility and private businesses, on the west by the United States (U.S.) Coast Guard reservation, on the south by residential neighborhoods, and on the east by Moanalua Valley. A quarry is located less than a quarter mile away to the northwest. The Facility occupies 144 acres of land and the majority of the site is at an elevation of approximately 200 to 500 feet above mean sea level (msl) (Environmental Science International, Inc., 2014).

Area wells and aquifers are shown in Figure 2. A site layout of groundwater monitoring wells and soil vapor monitoring points are shown in Figure 3.

2.2 Facility Information

The Facility contains 18 active and 2 inactive USTs, which are operated by Naval Supply Systems Command (NAVSUP) Fleet Logistics Center (FLC) Pearl Harbor (formerly Fleet and Industrial Supply Center). The Facility was constructed by the U.S. Government in the early 1940s. Twenty USTs and a series of tunnels were constructed to supply fuel to the Navy. Each UST has a capacity of approximately 12.5 million gallons. The Facility is located approximately 100 feet above the basal aquifer. The USTs contain Jet Fuel Propellant-5 (JP-5), JP-8, and Marine Diesel Fuel (F-76). Tank 5 is used to store JP-8.

Four groundwater monitoring wells (wells RHMW01, RHMW02, RHMW03, and RHMW05) are located within the lower access tunnel, and one sampling point (RHMW2254-01) is located at Red Hill Shaft. Sampling point RHMW2254-01 is located inside the infiltration gallery of the Department of the Navy (Navy) Well 2254-01. Navy Well 2254-01 is located approximately 2,400 feet down-gradient of the USTs and provides potable water to the JBPHH Water System, which serves approximately 65,200 military customers. Naval Facilities Engineering Command (NAVFAC) Public Works Department operates the infiltration gallery and Navy Well 2254-01.

Two groundwater monitoring wells (well HDMW2253-03 and OWDFMW01) are located outside of the Facility tunnel system (Figure 3). Well HDMW2253-03 is located at the Halawa Correctional Facility (outside the Facility) and well OWDFMW01 is located at the Oily Waste Disposal Facility, near Adit 3.

2.3 UST Information

There are twenty 12.5 million-gallon USTs at the Facility. The USTs were constructed of steel and currently contain JP-5, JP-8, and F-76. Several tanks in the past have stored Navy special fuel oil, Navy distillate, aviation gasoline, and motor gasoline (Environet, 2010). The fueling system is a self-contained underground unit that was installed into native rock comprised primarily of basalt with some interbedded tuffs and breccias (Environet, 2010). Each UST measures approximately 245 feet in height and 100 feet in diameter. The upper domes of the tanks lie at depths varying between 100 feet and 200 feet below ground surface.

The current status of each of the USTs is summarized in Table 1. The release was observed on the lower access tunnel wall, beneath Tank 5. Table 2, "Summary of UST Information," summarizes the available UST information for Tank 5.

Table 1
Current Status of the USTs

Tank Identification	Fuel Type	Status	Capacity
1	None	Inactive	12.5 million gallons
2	JP-8	Active	12.5 million gallons
3	JP-8	Active	12.5 million gallons
4	JP-8	Active	12.5 million gallons
5	JP-8	Temporarily Out of Use	12.5 million gallons
6	JP-8	Active	12.5 million gallons
7	JP-5	Active	12.5 million gallons
8	JP-5	Active	12.5 million gallons
9	JP-5	Active	12.5 million gallons
10	JP-5	Active	12.5 million gallons
11	JP-5	Active	12.5 million gallons
12	JP-5	Active	12.5 million gallons
13	F-76	Active	12.5 million gallons
14	F-76	Temporarily Out of Use	12.5 million gallons
15	F-76	Active	12.5 million gallons
16	F-76	Active	12.5 million gallons
17	JP-5	Temporarily Out of Use	12.5 million gallons
18	JP-5	Active	12.5 million gallons
19	None	Inactive	12.5 million gallons
20	JP-5	Active	12.5 million gallons

F-76 Marine Diesel Fuel
JP-5 Jet Fuel Propellant-5
JP-8 Jet Fuel Propellant-8

Table 2
Summary of UST Information

Facility ID	9-102271
Release ID	140010
UST ID	5
UST Capacity	12,500,000 gallons
UST Construction	Field-constructed, steel-lined concrete
Substance stored	JP-8
Date Installed	1941
UST Owner	Commander Navy Region Hawaii
UST Operator	Naval Supply Systems Command Fleet Logistics Center Pearl Harbor/ Defense Logistics Agency (Funding Agent for the Release)

3.0 General History of the Release

A 4-year project to clean, inspect, and repair Tank 5 was completed in December 2013. Fuel was added to the tank beginning on December 9, 2013. Due to the enormous size of the tanks at the Facility, filling operations typically take approximately one month. In January 2014, tank filling operations were near completion.

The fuel release from Tank 5 was discovered at 7:30 am on January 13, 2014. The tank level indicator and visual evidence alerted fuel operators of the fuel loss. Fuel operators observed an unscheduled fuel movement alarm on January 11, 2014. Following the alarm, five manual tank gauges were taken from January 11 to January 13, 2014. The tank gauges showed a decrease of 3/16" in the fuel level. In addition, a wet spot was noticed on the tunnel wall the evening of January 12, 2014. The wet spot was later determined to be a petroleum substance.

To determine the amount of fuel lost, all fuel transactions (gains and losses) from Tank 5 between the date the tank was placed back into service (December 9, 2013) and the date the release was detected (January 13, 2014) were added. Manual tank gauges were used and fuel levels were calculated based on a current strapping chart. The estimated cumulative total of all gains and losses was 27,000 gallons.

4.0 Initial Response and Abatement

The following sections describe activities that were performed during the first four weeks after the discovery of the suspected release of JP-8 from Tank 5.

4.1 Tank Draining

As a precaution, when notified of the decrease in tank level, the NAVSUP FLC Pearl Harbor Fuel and Facility Management Director had fuel operators initiate tank draining at 6:00 am on January 13, 2014. The NAVSUP FLC Pearl Harbor Fuel and Facility Management Director conducted further investigation by looking at the log numbers in the control room and the wet spot on the tunnel wall. At 7:30 am on January 13, 2014, the NAVSUP FLC Pearl Harbor Fuel and Facility Management Director made the official determination that there was a potential leak and began the notification process. Draining of Tank 5 began prior to the discovery of the release.

The tank was drained to the bottom at 2:20 am on January 18, 2014. Following venting of Tank 5, the tank was certified gas-free and safe to enter. Approximately 250 gallons of residual product was removed from the tank bottom on April 9, 2014. After all Health and Safety requirements are met, a detailed visual inspection shall be conducted and a forensic report on the integrity of the tank shall be delivered by the tank inspection experts.

4.2 Oil/Water Interface Measurements

Oil/water interface measurements were taken at monitoring wells RHMW01, RHMW02, and RHMW05 and sampling point RHMW2254-01 on January 15, 2014 and for ten consecutive weekdays from January 22 through February 4, 2014. Oil/water interface measurements were taken at monitoring wells RHMW01, RHMW02, and RHMW05 on February 10, 2014.

The water level at each well and sampling point was gauged and measured for the presence of light non-aqueous phase liquids (LNAPLs) using an interface meter. The interface meter was lowered into the wells and sampling point to determine the depth of water to the nearest 0.01 foot, and the existence of any immiscible layers (LNAPL). No LNAPL was detected.

4.3 Soil Vapor Sampling

Soil vapor sampling was performed at Tank 5 on January 15, 2014 and at all active and accessible tanks on January 30, 2014.

Soil vapor samples were collected and analyzed in the field for volatile organic compound (VOC) concentrations using a photo-ionization detector (PID). Soil vapor monitoring points (SVMPs) were given a SV prefix, followed by the associated tank number, and then the location under the tank: "S" for shallow or front of the UST, "M" for mid depth or middle or the UST, and "D" for deep or outer edge of the UST. Typical SVMP construction details are shown in Figure 4 and Figure 5.

A conservative approach to assess the integrity of the associated tank system is to measure if VOC concentrations exceed 280,000 parts per billion by volume (ppbv) in soil vapor monitoring probes beneath tanks containing JP-5 or JP-8, or 14,000 ppbv in soil vapor monitoring probes beneath tanks containing marine diesel fuel. These values are 50 percent of the calculated vapor concentration from fuel-saturated water.

The soil vapor VOC concentrations at Tank 5 increased significantly in the middle and outer edge SVMPs during the January 15, 2014 sampling event. The VOC concentration in the middle SVMP was 225,000 ppbv compared to 622 ppbv detected during the previous sampling event on December 23, 2013. The VOC concentration in the outer edge SVMP was 204,000 ppbv compared to 794 ppbv on December 23, 2013. The VOC concentration in the front SVMP was relatively unchanged at 96 ppbv, compared to 50 ppbv on December 23, 2013.

Soil vapor samples were collected from beneath 17 of the 18 active tanks on January 30, 2014. Tank 14 was not accessible due to construction work. The soil vapor VOC concentrations in SV05M and SV05D (150,000 and 175,000 ppbv, respectively) decreased since the previous sampling event on January 15, 2014. Significant increases in VOC concentrations in SVMPs at nearby Tanks 3, 6, 7, 8, and 9 were observed. Moderate increases in VOC concentrations were observed in SVMPs SV17M, SV17D, and SV18D. There were no significant changes in VOC concentration in the other SVMPs.

Soil vapor sampling results from March 24, 2008 through January 30, 2014 are presented in Appendix B.

4.4 Groundwater Sampling

Groundwater samples were collected from monitoring wells RHMW01, RHMW02, RHMW05, and sampling point RHMW2254-01 on January 15 and 16, 2014, then again on January 28 and 29, 2014.

Groundwater samples were collected from the Halawa Deep Monitoring Well HDMW2253-03 on January 22 and 27, 2014.

All groundwater samples were analyzed for the target analytes for releases of jet fuel as listed in Table 9-5 of the DOH Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan (DOH, 2013). The target analytes for jet fuel are total petroleum hydrocarbons as diesel (TPH-d), benzene, toluene, ethylbenzene and total xylenes (BTEX), naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene.

Concentrations of TPH-d were detected above the DOH Environmental Action Levels (EALs) for both Drinking Water Toxicity and Gross Contamination in samples collected from RHMW01 and RHMW02 on January 15, 2014 (DOH, 2011). The concentration of TPH-d at RHMW02 in January 15, 2014 also exceeded the site specific risk based level (SSRBL) of 4,500 micrograms per liter (ug/L).

Concentrations of TPH-d were detected above the DOH Groundwater Gross Contamination EAL at RHMW01 on January 30, 2014. TPH-d was detected at concentrations above the DOH EALs for both Drinking Water Toxicity and Gross Contamination, but below the SSRBL in samples collected from RHMW02 on January 30, 2014.

Over half of the TPH-d analytical results were flagged with the data qualifier “HD”, which indicates the chromatographic pattern was inconsistent with the profile of the reference fuel standard.

Naphthalene and 1-methylnaphthalene were detected at RHMW02 at concentrations above the DOH EAL for Drinking Water Toxicity but below the DOH Groundwater Gross Contamination EAL on January 15 and 28, 2014.

Concentrations of all other target analytes were below DOH EALs or not detected. Analytical results are presented in Table 3.

4.5 Drinking Water Sampling

As a precautionary measure the Red Hill Water Shaft was shut down on January 16, 2014 and an alternative water source used to supply water to the Pearl Harbor Naval Complex. Drinking

Table 3
Summary of Laboratory Analytical Results for
Groundwater Samples
January 15 through 29, 2014

Well Name	Date Sampled		8015	8270			8260			
		Lab ID No.	TPH-d (µg/l)	Naphthalene (µg/l)	1,-Methylnaphthalene	2,-Methylnaphthalene	Benzene (µg/l)	Toluene	Ethylbenzene	Xylenes, Total (p/m-, o-xylene)
DOH EAL Drinking Water Toxicity	**-**	**-**	190	17	4.7	24	5	1,000	700	10,000
DOH EAL Gross Contamination	**-**	**-**	100	21	10	10	170	40	30	20
RHMW01	**1/15/14**	**ES048**	**250 HD**	0.062J	0.040J	0.039J	<0.5	2.5	<0.5	<1.5
RHMW01	**1/28/14**	**ES056**	**130 HD**	0.045 J	<0.050	<0.050	<0.5	1.3	<0.5	<1.0
RHMW02	**1/15/14**	**ES046/047d**	**5,200**	**18**	**6.0**	4.9	<0.5	<0.5	0.17J	0.48J
RHMW02	**1/28/14**	**ES057/057d**	**2,300 HD**	**18**	**9.0**	5.9	0.15 J	<0.5	0.20 J	0.38 J
RHMW05	**1/16/14**	**ES049**	<20	<0.050	<0.050	<0.050	<0.5	<0.5	<0.5	<1.5
RHMW05	**1/29/14**	**ES061**	16J, HD	<0.050	<0.050	<0.050	<0.5	<0.5	<0.5	<1.0
RHMW2254-01	**1/16/14**	**ES050**	<20	0.046J	<0.049	<0.049	<0.5	<0.5	<0.5	<1.5
RHMW2254-01	**1/29/14**	**ES060**	<20	0.049J	<0.050	<0.050	<0.5	<0.5	<0.5	<1.0
HDMW2253-03	**1/22/14**	**ES051/052d**	18J, HD	<0.051	<0.051	<0.051	<0.50	<0.50	<0.50	<1.5
HDMW2253-03	**1/27/14**	**ES055**	35J, HD	0.064 J	<0.051	<0.051	<0.50	<0.50	<0.50	<1.0

NOTES: Results were evaluated to the Method Detection Limit (DL). Concentrations greater than or equal to the DL but less than the Limit of Quantitation (LOQ), if found, are qualified with a "J" flag. Data in ***Bold*** are equal to or above the Hawaii DOH Drinking Water Toxicity Environmental Action Level (EAL). µg/l = Micrograms per liter. "<" indicates *non-detect* at the value equal to the Limit of Detection (LOD) given. d = Duplicate.

"J" flagged data are estimated. The "HD" flag indicates that the chromatographic pattern was inconsistent with the profile of the reference fuel standard.

water samples were collected from the post-treatment regulatory compliance sampling point (360-011, Tap Outside Cl2 Building) on January 14, 16, 21 and 28, 2014 and from the pre-treatment regulatory sampling point (360-001, Red Hill Shaft Pumphead) on January 16, 2014. These samples were analyzed for VOCs, Semi-volatile Organic Compounds (SVOCs) and JP-8 using EPA Methods 524.2, 525.2, and 8015B.

All test results for the drinking water system were below the Maximum Contaminant Levels (MCLs) and acceptable for distribution. Minimal concentrations of bromoform were detected in the samples collected from 360-011 on January 16, 21, and 28, 2014, dibromochloromethane in the samples collected from 360-011 on January 21 and 28, 2014, and bromodichloromethane in the sample collected from 360-011 on January 28. 2014. All total trihalomethanes results were well below the MCL of 80 parts per billion (ppb). The Red Hill Drinking Shaft 360-001 was re-opened on February 6, 2014.

All other analytes were not detected in the drinking water samples collected during this period. A summary of the drinking water sampling is provided in Table 4.

5.0 Site Sampling for Release Verification

The following sections describe activities that were performed from February 24, 2014 to April 18, 2014.

5.1 Oil/Water Interface Measurements

Oil/water interface measurements were taken at monitoring wells RHMW01 and RHMW02 on February 24, March 4, 14, 27, and April 7, 2014. Oil/water interface measurements were taken at monitoring wells RHMW05 on February 27, March 14, 27, and April 7, 2014. No LNAPL was detected.

5.2 Soil Vapor Sampling

Soil vapor sampling was performed as follows:

- February 24 – All active and accessible tanks
- March 5 – Tanks 2 through 10
- March 10 – Tanks 2 through 10
- March 21 – Tanks 5, 6, 7, and 8
- March 25 and 28 – All active and accessible tanks
- April 3 – Tanks 5, 6, 7, and 8
- April 7 – Tanks 2 through 10
- April 16 – Tanks 5, 6, 7, and 8

Table 4
Drinking Water Sampling Summary
Red Hill Tank 5

	360-011, Tap Outside CL2 Bldg			Pumphead, 360-001			
Sample Date	**524.2; 525.2**	**8015B**	**200.8**	**524.2; 525.2**	**8015B**	**200.8**	**Detections and Comments**
1/14/2014	ND	ND	N/A	N/A	N/A	N/A	
1/16/2014	ND	ND	N/A	ND	ND	N/A	Bromoform detected in the 524.2 analysis for the 360-011 sample.
1/21/2014	ND	ND	N/A	N/A	N/A	N/A	Bromoform, Dibromochloromethane were detected
1/28/2014	ND	ND	N/A	N/A	N/A	N/A	Bromoform, Bromodichloromethane, Dibromochloromethane were detected.
2/11/2014	ND	ND	5.2 ppb	N/A	N/A	3.7 ppb	Bromoform, Dibromochloromethane, and Lead were detected. Result for lead at old post-chlorination sampling point was ND.
2/28/2014	N/A	N/A	ND	N/A	N/A	ND	Result for lead at old post-chlorination sampling point was 10 ppb.
3/11/2014	ND	ND	ND	N/A	N/A	ND	Bromoform was detected. Result for lead at old post-chlorination sampling point was ND.
4/8/2014							Results not received to date.
5/13/2014							Scheduled sampling for Lead at 360-011 only
6/10/2014							Scheduled sampling for Lead at 360-011 only
7/8/2014							Scheduled sampling for 524.2, 525.2, 8015B, Lead at 360-011.
10/14/2014							Scheduled sampling for 524.2, 525.2, 8015B, Lead at 360-011.

EPA Method 524.2 for volatile organic compounds (VOCs)
EPA Method 525.2 for semi-volatile organic compounds
EPA Method 8015 for JP8 (C8-C18) gas chromatograph
EPA Method 200.8 for lead

Soil vapor VOC concentrations at Tank 5 exceeded 280,000 ppbv during the April 3, 7, and 16 sampling events. Soil vapor VOC concentrations significantly increased at Tanks 2, 3, 4, 7, 8, 9, and 10 during the March 25, 2014 sampling event. Soil vapor VOC concentrations significantly increased at Tank 6 during the April 3, 2014 sampling event. A possible reason for the increase in VOC concentrations is that Tank 5 was being vented during this time.

Between December 23, 2013 and March 28, 2014, a strong increase in VOC concentrations was observed in SVMPs at Tank 17. During the same period, a strong decrease in soil vapor VOC concentrations was observed in SVMPs at Tank 18. The reason for the change in VOC concentrations at Tanks 17 and 18 is unknown.

Soil vapor sampling results from March 24, 2008 through April 16, 2014 are presented in Appendix C.

5.3 Groundwater Sampling

Groundwater sampling was performed as follows:

- February 24 – RHMW01, RHMW02
- March 5 and 6 – RHMW01, RHMW02, RHMW05, RHMW2254-01
- March 10 – RHMW01, RHMW02
- March 25 and 26 – RHMW01, RHMW02, RHMW05, RHMW2254-01
- April 7 – RHMW01, RHMW02

All groundwater samples were analyzed for the target analytes for releases of jet fuel: TPH-d, BTEX, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene. Groundwater samples collected from RHMW2254-01 were also analyzed for total and dissolved lead. A summary of the analytical results is provided in the following sections.

5.3.1 RHMW01

TPH-d was detected at concentrations below DOH EALs for both Drinking Water and Toxicity and Gross Contamination, except during the April 7, 2014. A TPH-d concentration of 140 ug/L was detected during the April 7, 2014 sampling event. The TPH-d DOH EAL for Drinking Water Toxicity is 190 ug/L. The TPH-d DOH Groundwater Gross Contamination EAL is 100 ug/L.

Naphthalene, 2-methylnaphthalene, and dissolved lead were detected at estimated concentrations below DOH EALs for both Drinking Water and Toxicity and Gross Contamination.

5.3.2 RHMW02

TPH-d and naphthalene were detected at concentrations above DOH EALs for both Drinking Water and Toxicity and Gross Contamination, but below the SSRBL of 4,500 ug/L. The polycyclic aromatic hydrocarbon (PAH) 1-methylnaphthalene was detected at concentrations

above the DOH EAL for Drinking Water Toxicity, but below the DOH Groundwater Gross Contamination EAL.

The PAH 2-methylnaphthalene was detected at concentrations below DOH EALs for both Drinking Water and Toxicity and Gross Contamination. Ethylbenzene, xylenes, and dissolved lead were detected at estimated concentrations below their respective DOH EALs.

5.3.3 RHMW05

TPH-d, naphthalene, and dissolved lead were detected at estimated concentrations below DOH EALs for both Drinking Water and Toxicity and Gross Contamination

5.3.4 RHMW2254-01

Total and dissolved lead were detected at estimated concentrations below the DOH EALs for both Drinking Water and Toxicity and Gross Contamination

Concentrations of all other target analytes in the three monitoring wells (RHMW01, RHMW02, RHMW05) and one sampling point (RHMW2254-01) were below DOH EALs or not detected.

A summary of laboratory analytical results from October 21, 2013 through April 7, 2014 is presented in Table 5.

5.4 Drinking Water Sampling

Drinking water samples were collected from the post-treatment regulatory compliance sampling point (360-011, Tap Outside Cl2 Building) on February 11, March 11 and April 8, 2014. In addition to the analyses conducted on the drinking water samples collected in January, these samples were also analyzed for lead using EPA Method 200.8.

Samples were also collected from the pre-treatment regulatory sampling point (360-001, Red Hill Shaft Pumphead) and the Old Post Chlorination Sample Point on February 11, February 28, March 11, and April 8, 2014. These samples were only analyzed for lead using EPA Method 200.8.

Bromoform was detected in the samples collected on February 11 and March 11, 2014. Dibromochloromethane was detected in the sample collected on February 11, 2014. All Total Trihalomethanes results were well below the MCL of 80 ppb.

Lead was detected in the samples collected at 360-011 and 360-001 on February 11 and at the Old Post-Chlorination Sample Point on February 28. All detected lead concentrations were below the EPA Action Level of 15 ppb.

No other analytes were detected in the drinking water samples collected during this period. A summary of the drinking water sampling is provided in Table 4. Results for the samples collected on April 8, 2014 have not been received to date.

6.0 Subsurface Conditions/Water Quality

Climatological conditions in the area of the Facility consist of warm to moderate temperatures and low to moderate rainfall. The Facility is leeward of the prevailing northeasterly trade winds. The average annual precipitation is approximately 40 inches, which occurs mainly between November and April (State of Hawaii Department of Land and Natural Resources [DLNR], 1986). Annual pan evaporation is approximately 75 inches (DLNR, 1985). Average temperatures range from the low 60's to high 80's (degrees Fahrenheit) (Atlas of Hawaii, 1983).

Oahu consists of the eroded remnants of two shield volcanoes, Waianae and Koolau. The Facility is located on the southwest flank of the Koolau volcanic shield. Lavas erupted during the shield-building phase of the volcano belong to the *Koolau Volcanic Series* (Stearns and Vaksvik, 1935). Following formation of the Koolau shield, a long period of volcanic quiescence occurred, during which the shield was deeply eroded. Following this erosional period, eruptive activity resumed. Lavas and pyroclastic material erupted during this period belong to the *Honolulu Volcanic Series* (Stearns and Vaksvik, 1935).

In the immediate area of the Facility, Koolau Volcanic Series lavas dominate, although there are consolidated and unconsolidated non-calcareous deposits in the vicinity that consist of alluvium generated during erosion of the Koolau volcanic shield. South-southwest of the Site, and in isolated exposures to the west, are pyroclastic deposits formed during eruptions from three Honolulu Volcanic Series vents, Salt Lake, Aliamanu, and Makalapa (Stearns and Vaksvik, 1935). Based on established geology and records of the drilled wells (Stearns and Vaksvik, 1938), the Facility is underlain by Koolau Volcanic Series basalts. The area of the Facility is classified as *Rock Land*, where 25 to 90% of the land surface is covered by exposed rock and there are only shallow soils (Foote, et al., 1972).

Groundwater in Hawaii exists in two principal types of aquifers. The first and most important type, in terms of drinking water resources, is the basal aquifer. The basal aquifer exists as a lens of fresh water floating on and displacing seawater within the pore spaces, fractures, and voids of the basalt that forms the underlying mass of each Hawaiian island. In parts of Oahu, groundwater in the basal aquifer is confined by the overlying caprock and is under pressure. Waters that flow freely to the surface from wells that tap the basal aquifer are referred to as *artesian*.

The second type of aquifer is the caprock aquifer, which consists of various kinds of unconfined and semi-confined groundwater. Commonly, the caprock consists of a thick sequence of nearly impermeable clays, coral, and basalt, which separates the caprock aquifer from the basal aquifer. The impermeable nature of these materials and the artesian nature of the basal aquifer severely restrict the downward migration of groundwater from the upper caprock aquifer. In the area of the Facility, there is no discernible caprock.

Groundwater in the area of the Facility is part of the *Waimalu Aquifer System* of the *Pearl Harbor Aquifer Sector*. The aquifer is classified as a basal, unconfined, flank-type; and is currently used as a drinking water source. The aquifer is considered fresh with less than 250 milligrams per liter of chloride and is considered an irreplaceable resource with a high vulnerability to contamination (Mink and Lau, 1990).

The nearest drinking water supply well is the Navy Well 2254-01, located in the infiltration gallery within the Facility. Navy Well 2254-01 is located approximately 2,400 feet down-gradient of the USTs (Figure 3).

8.0 Potential Migration Pathways

Potential migration pathways were presented in the Technical Report for the Facility (TEC, 2007) and the Groundwater Protection Plan (TEC, 2008). Potential receptors include persons using the basal groundwater. Migration pathways of potential concern include the following:

- Vertical movement through basalt to basal groundwater;
- Movement in basal groundwater to down-gradient potable water wells; and
- Expected isolation of the Red Hill groundwater basin from City and County of Honolulu Board of Water Supply (BWS) wells due to the depth of the North Halawa Valley and Moanalua Valley fills.

The following information on the local geology is provided in the Technical Report (TEC, 2007):

> "At a nearby drilling site, approximately 2,000 ft southwest of V1D, it was reported (Earth Tech, 1999) the basalt bedrock appeared completely dry and massive at approximately 20 ft above msl, which was distinct from the highly fractured basalt overlying this unit and significantly different from the log of V1D. At the southwest location, basal groundwater was encountered directly beneath this massive unit at an elevation of approximately 1 to 2 ft below msl. After the monitoring wells were installed, the potentiometric groundwater surface stabilized at an elevation of approximately 16 ft above msl, suggesting that the massive lower basalt acts as a localized low-permeability layer, resulting in the confined groundwater conditions exhibited by the basal aquifer. However, Mink (Mink, 1999) states that although the a'a lava can act as a local confining unit, it tends to be very limited in extent, and therefore, unconfined conditions may be encountered in close proximity.
>
> Information in the Willbros Engineers, Inc. (Willbros) report (Willbros, 1998) supports Mink's findings and states that the Facility is bounded on each side by deep alluvial fills and sedimentary caprock (marine and terrestrial sediments) in the down-gradient direction. In the area of the lower tunnel and the Red Hill portion of the Harbor Tunnel, the basal aquifer is located in permeable basalt on which the tunnel and tanks are located (Willbros, 1998). This further supports Mink's theory that confined conditions are generally limited in extent."

Table 5
Summary of Laboratory Analytical Results for Groundwater Samples
October 21, 2013 through April 7, 2014
Red Hill Bulk Fuel Storage Facility

	EPA Method	8015		8015		8015		8260B		8260B		8260B		8260B		8260B		8260B		8270C		8270C		8270C		6020		200.8	
		TPH-d		TPH-g		TPH-o		TPH-g		Benzene		Ethylbenzene		Napthalene		Toluene		Xylenes, Total (p/m-, o-)		1,-Methylnaphthalene		2,-Methylnaphthalene		Naphthalene		Dissolved Lead (filtered)		Total Lead (unfiltered)	
		(µg/l)		(µg/l)				(µg/l)		(µg/l)		(µg/l)		(µg/l)		(µg/l)		(µg/l)		(µg/l)		(µg/l)		(µg/l)		(µg/l)		(µg/l)	
DOH EAL Drinking Water Toxicity	-	190		100		4400		100		5		700		17		1,000		10,000		4.7		24		17		15			
DOH EAL Gross Contamination	-	100		100		100		100		170		30		21		40		20		10		10		21		50,000			
RHMW01	10/21/2013	**92**	**HD**	-		**-**		**15**	**B,J**	< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	< 0.052	U	< 0.052	U	< 0.052	U	**2.06**		-	
102.27' TOC ELEV	1/15/2014	**250**	**HD**	-		**-**		**-**		< 0.50	U	< 0.50	U	-		**2.5**		<1.0	U	**0.040**	**J**	**0.039**	**J**	**0.062**	**J**	**-**		-	
	1/28/2014	**130**	**HD**	-		**-**		**26**	**B,J**	< 0.50	U	< 0.50	U	-		**1.3**		<1.0	U	<0.050	U	<0.050	U	**0.045**	**J**	**0.205**	**J**	-	
	2/24/2014	**89**	**HD**	-		**-**		<30	U	< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	<0.050	U	<0.050	U	**0.037**	**J**	**0.195**	**J**	-	
	3/5/2014	**93**		-		-		-		< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	<0.050	U	**0.038**	**J**	<0.050	U	**0.112**	**J**		
	3/10/2014	**38**	**HD**	-		-		-		< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	<0.052	U	<0.052	U	<0.052	U	<0.200	U	-	
	3/25/2014	**82**	**HD**	-		-		-		< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	<0.051	U	<0.051	U	<0.051	U	**0.110**	**J**	-	
	4/7/2014	**140**	**HD**	-		-		-		< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	<0.050	U	<0.050	U	<0.050	U	<0.200	U	-	
RHMW02	10/21/2013	**2,400**	**HD**	**-**		**-**		**48**	**B,J**	< 0.50	U	**0.14**	**J**	-		< 0.50	U	**0.37**	**J**	**9.0**		**9.0**		**30**		< 0.200	U	-	
104.76' TOC ELEV	10/21/2013*	**2,400**	**HD**	**-**		**-**		**63**	**B**	< 0.50	U	< 0.50	U	-		< 0.50	U	**0.37**	**J**	**7.5**		**7.5**		**25**		< 0.200	U	-	
	1/15/2014	**5,000**		**-**		**-**		**-**		< 0.50	U	**0.17**	**J**	-		< 0.50	U	**0.48**	**J**	**6.0**		**4.9**		**18**		-		-	
	1/15/2014*	**5,200**		**-**		**-**		**-**		< 0.50	U	**0.17**	**J**	-		< 0.50	U	**0.45**	**J**	**5.3**		**4.3**		**17**		-		-	
	1/28/2014	**2,300**	**HD**	**-**		**-**		**50**	**B**	**0.14**	**J**	**0.20**	**J**	-		< 0.50	U	**0.38**	**J**	**8.8**		**5.4**		**18**		<0.200	U	-	
	1/28/2014*	**2,100**	**HD**	**-**		**-**		**52**	**B**	**0.15**	**J**	**0.20**	**J**	-		< 0.50	U	**0.34**	**J**	**9.0**		**5.9**		**18**		<0.200	U	-	
	2/24/2014	**2,200**	**HD**	**-**		**-**		**40**	**J**	< 0.50	U	**0.15**	**J**	-		< 0.50	U	**0.29**	**J**	**5.2**		**2.5**		**15**		<0.200	U	-	
	3/5/2014	**2,100**		-		-		-		< 0.50	U	**0.15**	**J**	-		< 0.50	U	**0.29**	**J**	**2.6**		**1.5**		**10**		<0.200	U	-	
	3/5/2014*	**2,200**		-		-		-		< 0.50	U	**0.15**	**J**	-		< 0.50	U	**0.32**	**J**	**3.9**		**2.9**		**13**		<0.200	U	-	
	3/10/2014	**930**		-		-		-		< 0.50	U	<0.50	U	-		< 0.50	U	**0.30**	**J**	**3.7**		**2.5**		**11**		<0.200	U	-	
	3/10/2014*	**890**		-		-		-		< 0.50	U	<0.50	U	-		< 0.50	U	**0.31**	**J**	**4.2**		**3.0**		**12**		<0.200	U	-	
	3/25/2014	**1,700**	**HD**	-		-		-		< 0.50	U	**0.15**	**J**	-		< 0.50	U	**0.38**	**J**	**9.0**		**4.9**		**33**		<0.200	U	-	
	3/25/2014*	**1,700**	**HD**	-		-		-		< 0.50	U	**0.16**	**J**	-		< 0.50	U	**0.41**	**J**	**8.1**		**4.0**		**33**		**0.116**	**J**	-	
	4/7/2014	**3,500**	**HD**							< 0.50	U	**0.18**	**J**			< 0.50	U	**0.40**	**J**	**6.2**		**4.4**		**25**		**0.200**	**J**		
	4/7/2014*	**3,300**	**HD**	-		-		-		< 0.50	U	<0.50	U	-		< 0.50	U	**0.33**	**J**	**9.0**		**7.6**		**31**		<0.200	U	-	
RHMW03	10/21/2013	**54**	**HD**	**-**		**-**		**23**	**B,J**	< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	< 0.050	U	< 0.050	U	< 0.050	U	< 0.200	U	-	
121.06' TOC ELEV	1/28/2014	**74**		**-**		**-**		**20**	**B,J**	< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	<0.050	U	<0.050	U	**0.15**	**J**	<0.200	U	-	
RHMW05	10/22/2013	< 20	U	**-**		**-**		**17**	**B,J**	< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	< 0.051	U	< 0.051	U	**0.17**	**J**	< 0.200	U	-	
101.55' TOC ELEV	1/16/2014	< 20	U	**-**		**-**		**-**		< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	< 0.050	U	< 0.050	U	< 0.050	U	**-**		-	
	1/29/2014	**16**	**J,HD**	**-**		**-**		**23**	**B,J**	< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	<0.050	U	<0.050	U	**0.064**	**J**	<0.200	U	-	
	3/6/2014	<21	U	**-**		**-**		**-**		<0.50	U	<0.50	U	-		<0.50	U	<1.0	U	<0.050	U	<0.050	U	**0.038**	**J**	<0.200	U	-	
	3/26/2014	**17**	**J,HD**	**-**		**-**		**-**		<0.50	U	<0.50	U	-		<0.50	U	<1.0	U	<0.050	U	<0.050	U	**0.092**	**J**	**0.286**	**J**	-	
RHMW2254-01	10/22/2013	< 20	U	**-**		**-**		**13**	**B,J**	< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	< 0.050	U	< 0.050	U	**0.036**	**J**	**-**		<0.0898[i]	U
	1/16/2014	< 20	U	**-**		**-**		**-**		< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	< 0.049	U	< 0.049	U	**0.046**	**J**	**-**		-	
	1/29/2014	<20	U	**-**		**-**		**16**	**B,J**	< 0.50	U	< 0.50	U	-		< 0.50	U	<1.0	U	<0.050	U	<0.050	U	**0.049**	**J**	**-**		<0.0898[i]	U
	3/6/2014	<20	U	**-**		**-**		**-**		<0.50	U	<0.50	U	-		<0.50	U	<1.0	U	<0.050	U	<0.050	U	**0.081**	**J**	<0.200	U	**0.155[i]**	**J**
	3/26/2014	<10	U	**-**		**-**		**-**		<0.50	U	<0.50	U	-		<0.50	U	<1.0	U	<0.050	U	<0.050	U	<0.050	U	**0.207**	**J**	**0.140[i]**	**J**

Notes:

* duplicate samples

January 2008 to November 2009 depth to water measurements were entered in previous reports a tenth of a foot to high, adjustments were made to correct.

HDOH, EHE Guidance Final EALs for Final Drinking Water Action Levels for Human Toxicity (Table D-3a) and Groundwater Gross Contamination Action Levels where groundwater IS a current or potential source of drinking water (Table G-1)

Grey highlight - exceeds EALs

Bold - detected values

B - analyte was present in the associated method blank

i - the MRL/MDL has been elevated due to a chromatographic interference

HD - the chromatographic pattern was inconsistent with the profile of the reference fuel standard

J - indicates an estimated value

SSRBL at RHMW01, RHMW02, RHMW03, RHMW05 (TEC, 2008)

TPH-d = 4500 ug/L

Benzene = 750 ug/L

8.1 Groundwater Usage

The Facility is located up-gradient of the Hawaii State Underground Injection Control Line (UIC), which separates potable groundwater from non-potable groundwater. The nearest public drinking water well (BWS Halawa Shaft well 2354-01) is located hydraulically cross-gradient of the site. This drinking water well is approximately 5,000 feet to the northwest of the Facility and pumps water from the basal aquifer.

Navy well 2254-01 is located near the site. This well is approximately 3,000 feet to the west of the site and is potentially down-gradient from the Facility (TEC, 2008).

8.2 Risk Summary

Current and future ecological risk is considered negligible because the Facility is underground and the migration pathway to ground surface or surface water via seeps is not complete.

The human health risk assessment was conducted assuming that future storage will remain jet fuel and heavier fuel mixtures. Under this assumption, the following determinations were made (TEC, 2008):

- The current and future risk of exposure via migration from soil gas to indoor air is considered negligible.
- The primary environmental risks at the Facility were determined to be due to a future scenario in which groundwater from beneath the site was extracted for residential tapwater use, including drinking. Currently, no extraction wells lie in the vicinity of Tank 5.
- If a release produces a large source of LNAPL on the water table, dissolved contaminants or free product may result in unacceptable concentrations of petroleum in the Red Hill sub-basin, which feeds into the Navy well 2254-01 potable water system. Such a release could decrease the amount of potable water available to JBPHH Water System consumers.

9.0 Surrounding Populations and Land Use

9.1 Surrounding Populations

Populated areas closest to the Facility are Pearl City and Aiea to the west and Honolulu to the south and east. There is a Coast Guard and Navy housing complex in Aliamanu Crater to the southwest of the Facility. Pearl Harbor also lies to the southwest of the Facility. The nearest residential area is located southeast of the Facility in Moanalua Valley, directly adjacent to the Facility perimeter (TEC, 2007).

9.2 Land Use

The Facility is located on federal government land and there are no occupied buildings above ground. Public land is located to the immediate north and northeast. Immediately north of the public land is forest and Halawa Correctional Facility. An industrial development is located to

the north and northwest. Residential land consisting of single-family homes is located immediately adjacent, and south and southeast of the Facility. A high cliff face with a 100 to 200-foot elevation difference exists between the Facility and this residential area. Residences, townhouses and apartment buildings are located to the southwest of the Facility, and a public school is also present in the area (Figure 6).

The closest residential property to the Facility is the area zoned for apartment buildings located approximately 305 feet southwest of Tank 2. Red Hill Elementary School is located approximately 1,080 feet southwest of Tank 2. The Moanalua Village residential development is located approximately 880 feet south of Tank 2.

The area zoned for apartment buildings is located approximately 2,113 feet southwest of Tank 20 (the tank farthest east), and Red Hill Elementary School is located approximately 2,850 feet from Tank 20. The Moanalua Village residential development is located approximately 875 feet south of Tank 20 (TEC, 2007).

10.0 Summary of Findings

Significant increases of soil vapor VOC concentrations beneath Tank 5 and nearby tanks may be attributed to the release of JP-8 from Tank 5 in January 2014.

Results of oil/water interface measurements, groundwater sampling and analysis, and drinking water sampling and analysis indicate the release of JP-8 from Tank 5 has not impacted the underlying groundwater.

11.0 Planned Future Release Response Actions

The following sections describe release response actions that are currently being pursued.

11.1 Groundwater Protection Plan Update

A contract was awarded in March 2014 to modify the 2008 Groundwater Protection Plan and 2009 revisions to comply with the requirements of Environmental Hazard Evaluations as specified in the DOH-HEER Guidance.

11.2 Groundwater Flow Model

A contract was awarded in March 2014 to develop a plan to update the groundwater model and contaminant fate and transport analysis (analysis) to effectively evaluate the risk of the suspected Tank 5 release transport to drinking water shafts/wells in the area. The plan is to include a prioritized list of recommendations for additional data collection efforts required to achieve the purpose of the groundwater model and analysis.

11.3 Site Characterization

A contract is being prepared to characterize the nature and extent of contamination resulting from the release of JP-8 at Tank 5. The Site Characterization Work Plan will address methods

and locations of soil and groundwater borings to most efficiently characterize the extent of contamination.

11.4 Vertical Migration Model

Funding has been requested for a contract to develop a model to estimate downward vertical migration of free product from Tank 5 to the groundwater table.

11.5 Remediation of Contamination

Funding has been requested for a contract to assess the possibility of free product removal if found during site characterization, and conduct a pilot treatability study for remediation.

11.6 Installation of Additional Wells

The Navy has hired a consultant to evaluate existing data and provide recommendations for additional monitoring wells to serve as sentinel wells for the BWS Halawa Pump Station and Moanalua Pump Station. Funding will be requested for a contract to install the recommended additional groundwater monitoring wells.

12.0 Conclusions

Significant increases in soil vapor sampling results may be attributed to the release of JP-8 from Tank 5 in January 2014.

Results of oil/water interface measurements, groundwater sampling and analysis, and drinking water sampling and analysis indicate the release of JP-8 from Tank 5 has not impacted the underlying groundwater.

Additional release response actions, including site characterization, remediation of contamination, and installation of additional groundwater monitoring wells, are recommended to protect the drinking water sources located down-gradient of the Facility.

The next quarterly release response report will be submitted in July 2014 and will cover the release response actions completed between April 19 and July 11, 2014.

13.0 References

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