Quarterly Groundwater Monitoring Report

Red Hill Bulk Fuel Storage Facility, Pearl Harbor, O‘ahu, Hawai‘i

Latitude: 21°22’15”N
Longitude: 157°53’33”W

DOH Facility ID No. 9-102271
DOH Release ID No. 99051, 010011, 020028

December 2010

Department of the Navy
Naval Facilities Engineering Command, Hawai‘i
400 Marshall Road
Pearl Harbor, HI 96860-3139

Environmental Technical Services
Contract Number N62742-08-D-1930, Contract Task Order HC14

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Prepared for:

Department of the Navy
Naval Facilities Engineering Command, Hawai‘i
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List of Acronyms

<	less than
µg/L	micrograms per liter
COPC	chemical of potential concern
DL	detection limit or MDL
DLNR	Department of Land and Natural Resources
DOH	State of Hawai‘i Department of Health
DON	Department of the Navy
DRO	diesel range organics
DTW (TOC)	depth to water from top of well casing
EAL	Environmental Action Level
EPA	U.S. Environmental Protection Agency
FISC	Fleet and Industrial Supply Center
GRO	gasoline range organics
HAR	Hawai‘i Administrative Rules
IDW	investigation-derived waste
J	Estimated result. Indicates that the compound was identified but the concentration was above the DL and below the LOQ.
JP	Jet Propellant
LCS	laboratory control sample
LNAPL	light non-aqueous phase liquid
LOD	limit of detection
LOQ	limit of quantitation or RL
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NAVFAC	Naval Facilities Engineering Command
ND	not detected
NP	measurement not provided
NT	measurement not taken
PAHs	polynuclear aromatic hydrocarbons
pH	hydrogen activity
PHWS	Pearl Harbor Water System
PPE	personal protective equipment
Q	data qualifier
QC	quality control
RHSF	Red Hill Bulk Fuel Storage Facility
RL	reporting limit
RPD	relative percent difference
SSRBL	site-specific risk-based level
SWL	static water level
TEC	The Environmental Company, Inc.
TIC	tentatively identified compound
TPH	total petroleum hydrocarbons

U	Indicates the compound or analyte was analyzed for but not detected. The result is reported as ND.
U.S.	United States
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compound

Executive Summary

There are 18 active and two inactive, 12.5 million gallon capacity, field-constructed underground storage tanks (USTs) located at the Red Hill Bulk Fuel Storage Facility (RHSF). Previous environmental site investigations indicated a release had occurred and contaminated the groundwater underlying the RHSF.

The United States (U.S.) Navy implemented a groundwater monitoring program, which includes collecting groundwater samples quarterly from U.S. Navy Well 2254-01 (RHMW2254-01) and four groundwater monitoring wells installed within the RHSF lower access tunnel (RHMW01, RHMW02, RHMW03, and RHMW05). The U.S. Navy Well 2254-01 is located approximately 3,000 feet downgradient from the RHSF and provides approximately 24 percent of the potable water to the Pearl Harbor Water System (PHWS). The groundwater samples are analyzed for petroleum constituents and compared against State of Hawai‘i Department of Health (DOH) Drinking Water Environmental Action Levels (EALs) (DOH, 2009).

This groundwater monitoring report presents the analytical results and compares them to the DOH Drinking Water EALs for samples collected on October 18, 19, 20, and November 3, 2010 at the five groundwater monitoring wells (RHMW2254-01, RHMW01, RHMW02, RHMW03, and RHMW05). Contaminant trends that have exceeded DOH Drinking Water EALs are also provided in this report.

October-November 2010 Groundwater Monitoring Results

Laboratory analytical results from the October-November 2010 groundwater monitoring event indicated that total petroleum hydrocarbons (TPH)-diesel range organics (DRO), TPH-gasoline range organics (GRO), and polynuclear aromatic hydrocarbons (PAHs), specifically 1-methylnaphthalene and naphthalene, were present in the groundwater beneath the RHSF at concentrations that exceeded the EALs. All other chemical of potential concern (COPC) concentrations (i.e., volatile organic compounds (VOCs) and dissolved lead) were below the EALs.

In RHMW2254-01, lead (3.3 micrograms per liter (µg/L)) was detected at a concentration which was below the EAL. All other COPC concentrations were not detected at or above the limits of detection (LODs) and the limits of quantitation (LOQs).

In monitoring well RHMW01, naphthalene (0.17 µg/L), acetone (2.4 µg/L), and lead (0.47 µg/L) were detected at estimated concentrations which were below the EALs. All other COPCs in RHMW01 were not detected at or above the LODs and LOQs.

In monitoring well RHMW02, TPH-DRO (1,700 µg/L), TPH-GRO (150 µg/L), 1-methylnaphthalene (15 µg/L), and naphthalene (59 µg/L) were detected at concentrations which exceeded the EALs. Acenaphthene (0.28 µg/L) and 2-methylnaphthalene (5.0 µg/L) were detected at concentrations which were below the EALs. Acenaphthylene (0.14 µg/L), fluorene (0.16 µg/L), ethylbenzene (0.25 µg/L), xylenes (0.60 µg/L), and lead (0.32 µg/L) were detected at estimated concentrations which were below the EALs. All other COPCs in RHMW02 were not detected at or above the LODs and LOQs.

In monitoring well RHMW03, TPH-DRO (330 µg/L) was detected at a concentration which exceeded the EAL. Lead (0.28 µg/L) was detected at an estimated concentration which was below the EAL. All other COPCs in RHMW03 were not detected at or above the LODs and LOQs.

In RHMW05, all COPC concentrations were not detected at or above the LOD and LOQ.

All laboratory detection limits (DLs), LODs, and LOQs were generally below the EALs. In the case where an EAL for a specific COPC is less than the LOQ, it is generally acceptable to consider the LOQ in place of the EAL (DOH, 2009).

TPH-DRO Contaminant Trends

From January 2008 to April 2010, TPH-DRO at RHMW01 fluctuated within the historical range established from September 2005 through September 2007. In July 2010, TPH-DRO decreased to the lowest detected concentration observed to date (228 µg/L), and during October-November 2010, TPH-DRO was not detected at or above the LODs and LOQs.

At RHMW02, TPH-DRO concentrations were relatively stable prior to 2008, after which significant variations occurred. In October-November 2010, TPH-DRO showed a decrease in concentration; however, the TPH-DRO concentration remains within the historical range for this groundwater monitoring well.

From May 2009 through July 2010, TPH-DRO concentrations at RHMW03 were below the LODs and LOQs. However, during October-November 2010, TPH-DRO was detected at the highest concentration to date (330 µg/L) which was above the EAL.

At RHMW05, TPH-DRO had been increasing since it was first sampled in May 2009. However, in April 2010, July 2010, and October-November 2010, TPH-DRO at RHMW05 was not detected at or above the LODs and LOQs.

TPH-GRO Contaminant Trends

TPH-GRO has remained below the EAL or has not been detected in monitoring wells RHMW01, RHMW03, and RHMW05. Since September 2005, TPH-GRO concentrations at RHMW02 had remained below the EAL, except in July 2006, December 2006, March 2007, and October-November 2010 when TPH-GRO was detected at the highest averaged concentration (average of primary and duplicate samples) to date (155 µg/L).

PAHs Contaminant Trends in RHMW02

Since October 2008, the concentrations of 2-methylnaphthalene have remained below the EAL. Naphthalene concentrations decreased to below the EAL in May 2009 and July 2009. However, naphthalene concentrations increased above the EAL in July 2010 and remained above the EAL during this October-November 2010 groundwater monitoring event. Similarly, 1-methylnaphthalene concentrations decreased below the EAL in October 2009 and increased above the EAL during the following groundwater monitoring events, including this October-November 2010 event.

Conclusions

To date, the presence of light non-aqueous phase liquid (LNAPL) has been observed only once (i.e., in January 2008 in RHMW01 and RHMW02 at less than 0.01 feet). This indicates that a significant release from one or more of the USTs at the RHSF has not occurred at this time.

COPC concentrations in samples collected from the U.S. Navy Well 2254-01 have not been detected at or above the LODs and LOQs or are below the EALs. This indicates that elevated COPC concentrations detected in samples collected from monitoring wells within the RHSF are not migrating and impacting the Navy’s potable water source.

COPC concentrations detected in samples collected from monitoring well RHMW05 have decreased to below the EALs for at least three consecutive monitoring events. The data suggest that elevated COPC concentrations detected in samples collected from monitoring wells located adjacent to the USTs are not migrating in the downgradient direction. RHMW05 is an intermediate monitoring point between the USTs and the U.S. Navy Well 22554-01. At this time, there is no indication that COPCs are migrating in a downgradient direction towards the Navy’s potable water source.

COPC concentrations detected in samples collected from monitoring wells adjacent to the USTs (i.e., RHMW01, RHMW02, and RHMW03) are not steadily increasing for more than one consecutive sampling event. The data suggest that the concentrations are relatively stable over time. It is likely that the COPCs are associated with a previous release from the USTs and not a current or active release.

Recommendations

Based on the results of this monitoring event, continuation of the quarterly groundwater monitoring program at the RHSF is recommended. In addition, continuation of monthly free product measurements at RHMW01, RHMW02, RHMW03, and RHMW05; and monthly soil vapor monitoring is also recommended. In response to the Category 2 status of RHMW02, submission of this quarterly report to DOH and initiation of a leak determination program to identify if tanks are leaking are recommended.

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Section 1 Introduction

This report presents the results of the 21st groundwater monitoring event, conducted in October-November 2010 at the RHSF, Pearl Harbor, O'ahu, Hawai'i (Figure 1-1). The RHSF consists of 18 active and two inactive USTs operated by the Fleet and Industrial Supply Center (FISC), Pearl Harbor. The groundwater sampling and analysis event is part of a groundwater monitoring program for the UST site in response to past UST releases, previous environmental investigations, and recommendations from the DOH. The groundwater monitoring was performed by Environet for the Department of the Navy (DON), Naval Facilities Engineering Command (NAVFAC), Hawai'i under Environmental Technical Services, Contract Number N62742-08-D-1930, Contract Task Order HC14.

The field activities performed for the October-November 2010 quarterly groundwater monitoring event were conducted in accordance with the procedures described in the *Work Plan, Long-Term Monitoring, Red Hill Bulk Fuel Storage Facility, Pearl Harbor, O'ahu, Hawai'i* (Environet, 2010).

1.1 Project Objective

The groundwater monitoring was performed to evaluate the presence of COPCs in groundwater underlying the RHSF. The groundwater monitoring was conducted to ensure the DON remains in compliance with DOH UST release response requirements as described in Hawai'i Administrative Rules (HAR) 11-281 Subchapter 7, Release Response Action. Analytical results are compared to the DOH Drinking Water EALs for samples collected from five groundwater monitoring wells (RHMW2254-01, RHMW01, RHMW02, RHMW03, and RHMW05).

1.2 Background

The U.S. Navy implemented a groundwater monitoring program, which includes collecting groundwater samples quarterly from U.S. Navy Well 2254-01 (RHMW2254-01) and four groundwater monitoring wells installed within the RHSF lower access tunnel (RHMW01, RHMW02, RHMW03, and RHMW05). The U.S. Navy Well 2254-01 is located approximately 3,000 feet downgradient from the RHSF and provides approximately 24 percent of the potable water to the PHWS. The groundwater samples are analyzed for petroleum constituents and compared against DOH Drinking Water EALs (DOH, 2009).

1.2.1 Site Description

The RHSF is located on the island of O'ahu, Hawai'i, approximately 2.5 miles northeast of Pearl Harbor in Hālawa Heights (Figure 1-1). Land adjacent to the north of the RHSF is occupied by the Hālawa Correctional Facility and private businesses. Land to the south and west of the facility includes the Coast Guard Reservation and other residential neighborhoods. Moanalua Valley is located east of the facility (Environet, 2010).

The Navy Public Works Department operates a potable water infiltration tunnel approximately 1,550 feet hydraulically downgradient from the RHSF (Environet, 2010). The U.S. Navy Well

2254-01 is located approximately 3,000 feet downgradient (west) of the RHSF and provides approximately 24 percent of the potable water to the PHWS, which serves approximately 52,200 military consumers (The Environmental Company, Inc. (TEC), 2008).

1.2.2 Facility Information

The RHSF consists of 18 active and two inactive USTs operated by Navy FISC Pearl Harbor. Each UST has a capacity of 12.5 million gallons. The RHSF is located approximately 100 feet above the basal aquifer (Dawson Group, Inc., 2006).

1.2.3 UST Information

The USTs were constructed in the early 1940s. The tanks were constructed of steel and currently contain Jet Propellant (JP)-5 fuel, JP-8, and marine diesel fuel (F-76). Previously, several tanks stored Navy Special Fuel Oil, Navy Distillate, aviation gasoline, and motor gasoline. Each tank measures approximately 245 feet in height and 100 feet in diameter. The upper domes of the tanks lie at depths varying between approximately 100 feet and 200 feet below the existing ground surface (TEC, 2006).

1.2.4 Previous Reports

The following groundwater monitoring reports were previously submitted to the DOH:

1. Groundwater Sampling Report, First Quarter 2005 (submitted April 2005);
2. Groundwater Sampling Report, Second Quarter 2005 (submitted August 2005);
3. Groundwater Sampling Report, Third Quarter 2005 (submitted November 2005);
4. Groundwater Sampling Report, Fourth Quarter 2005 (submitted February 2006);
5. Groundwater Monitoring Results, July 2006 (submitted September 2006);
6. Groundwater Monitoring Results, December 2006 (submitted January 2007);
7. Groundwater Monitoring Results, March 2007 (submitted May 2007);
8. Groundwater Monitoring Results, June 2007 (submitted August 2007);
9. Groundwater Monitoring Results, September 2007 (submitted October 2007);
10. Groundwater Monitoring Results, January 2008 (submitted March 2008);
11. Groundwater Monitoring Results, April 2008 (submitted May 2008);
12. Groundwater Monitoring Results, July 2008 (submitted October 2008);
13. Groundwater Monitoring Results, October and December 2008 (submitted February 2009);
14. Groundwater Monitoring Results, February 2009 (submitted May 2009);

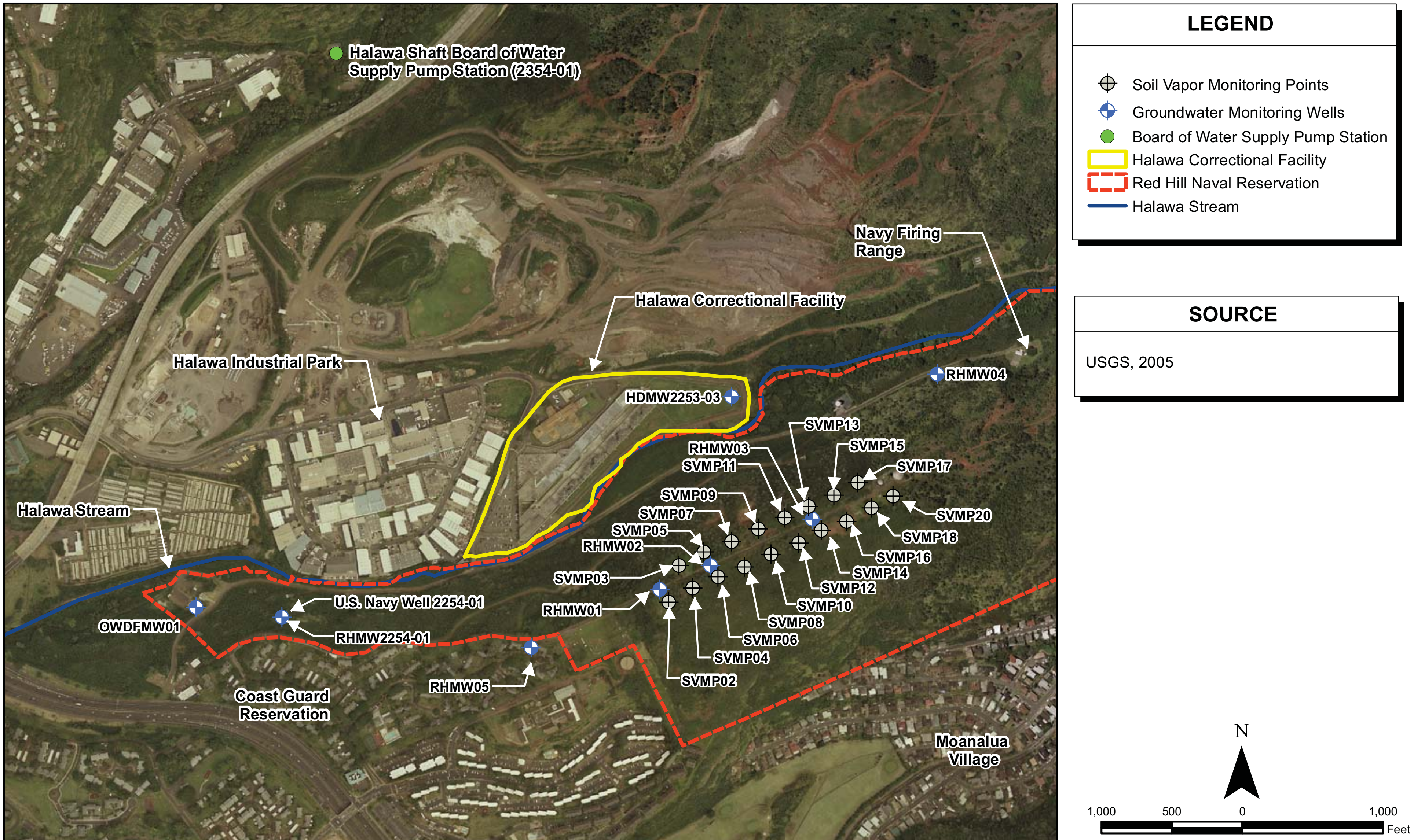

Figure 1-1
Groundwater Monitoring Well Location Map
Quarterly Groundwater Monitoring Report,
Red Hill Bulk Fuel Storage Facility,
Pearl Harbor, O'ahu, Hawai'i

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15. Groundwater Monitoring Results, May 2009 (submitted July 2009);
16. Groundwater Monitoring Results, July 2009 (submitted September 2009);
17. Groundwater Monitoring Results, October 2009 (submitted December 2009);
18. Groundwater Monitoring Results, January, February, and March 2010 (submitted April 2010);
19. Groundwater Monitoring Results, April 2010 (submitted May 2010); and
20. Groundwater Monitoring Results, July 2010 (submitted August 2010).

1.2.5 Previous Environmental Investigations

1998 to 2001 - From 1998 to 2001, the Navy conducted an investigation at the RHSF to assess potential releases from the fuel storage USTs and piping systems. In February 2001, the Navy installed a one-inch diameter monitoring well RHMW01 (previously known as MW-V1D) to monitor for contamination of the basal aquifer underlying the RHSF. The well was installed and completed at approximately 100 feet below grade within the lower access tunnel. At the time of well completion, depth to water in RHMW01 was measured at 86 feet below grade (Dawson group, Inc., 2006).

In February 2001, groundwater samples collected from RHMW01 contained TPH concentrations ranging from 883 µg/L to 1,050 µg/L and total lead ranging from 10.4 µg/L to 15 µg/L. The total lead concentrations in the samples exceeded the groundwater DOH Tier 1 Action Level of 5.6 µg/L (Dawson Group, Inc., 2006).

2005 Groundwater Sampling - The Navy began quarterly groundwater sampling at existing monitoring wells in 2005. Dawson Group, Inc. collected groundwater samples from RHMW01 and RHMW2254-01 in February 2005, June 2005, September 2005, and December 2005.

Samples collected in February 2005 and June 2005 were not filtered in the field prior to analysis for lead. Analytical results for samples collected from RHMW01 indicated concentrations of total lead were above the DOH Tier 1 Action Level of 5.6 µg/L. The results were not considered appropriate for risk assessment since the sample had not been filtered. In addition, lead was not a component of fuels from the tanks near RHMW01, but was a component in fuels stored in other tanks during the history of the RHSF. Lead may also have been part of the RHSF construction material (TEC, 2007). Previous sampling efforts showed elevated lead concentrations when analyzed as unfiltered samples. Subsequent efforts where the lead samples were filtered had resolved this issue. Samples were filtered in September 2005 and December 2005, and dissolved lead concentrations were below the DOH Tier 1 Action Level. Concentrations of all other COPCs were below the DOH Tier 1 Action Levels.

2005 Site Investigation - As part of a site investigation, TEC installed three groundwater monitoring wells at the RHSF between June 2005 and September 2005. Monitoring well RHMW02 was installed in the lower access tunnel near Tank 05 and Tank 06. Monitoring well RHMW03 was installed in the lower access tunnel near Tank 13 and Tank 14. Monitoring well RHMW04 was installed north of the UST Tank 20 to evaluate groundwater within the basal aquifer upgradient from the RHSF. Monitoring wells RHMW02 and RHMW03 were completed to depths of approximately 125 feet below the tunnel floor, and well RHMW04 was completed to a depth of approximately 300 feet below ground surface outside the tunnel. Groundwater samples were collected from the three newly installed wells and two existing wells (RHMW01 and RHMW2254-01) in September 2005 (TEC, 2010).

Naphthalene and trichloroethylene were detected in samples collected from RHMW02 at concentrations greater than the DOH Tier 1 Action Levels. Lead was detected in the sample collected from RHMW01 at a concentration greater than the DOH Tier 1 Action Level; however, the sample was not filtered in the field prior to analysis. Analytical results for filtered samples obtained by Dawson Group, Inc. during the same period indicated concentrations of dissolved lead were below the DOH Tier 1 Action Level (TEC, 2010).

2006 Site Investigation - Dedicated sampling pumps were installed in five wells (RHMW01, RHMW02, RHMW03, RHMW04, and RHMW2254-01). TEC collected groundwater samples from the wells in July 2006. The groundwater samples were analyzed for petroleum constituents. Naphthalene was detected in samples collected from RHMW02 at concentrations above the DOH Tier 1 Action Level (TEC, 2010).

In September 2006, with concurrence from the DOH, the Navy decided to use the newer DOH EALs for the Red Hill Site Investigation and Risk Assessment project. The EALs provide action levels for more chemicals, and are much more useful for conducting screening risk assessments. Since the DOH (DOH May 2005) Policy Letter stated that the two sets of action levels should not be mixed, the Tier 1 screening levels presented in HAR Section 11-281-78 would no longer be used to evaluate environmental impact at the RHSF (TEC, 2010).

2006 Groundwater Sampling - Groundwater samples were collected in December 2006. Analytical results indicated the following:

- no chemicals were detected in samples collected from RHMW2254-01 or RHMW03;
- TPH-DRO concentrations were detected in samples collected from RHMW01 at concentrations above the DOH Drinking Water EAL; and
- TPH-GRO, TPH-DRO, and naphthalene were detected in samples collected from RHMW02 at concentrations above the DOH Drinking Water EALs (TEC, 2010).

2007 Groundwater Sampling - Groundwater samples were collected in March, June, and September 2007. Analytical results indicated the following:

- no chemicals were detected above DOH Drinking Water EALs at RHMW2254-01;
- TPH-DRO concentrations exceeded the DOH Drinking Water EAL in samples collected from RHMW01 during all three monitoring events;
- TPH-GRO concentrations exceeded the DOH Drinking Water EAL in samples collected from RHMW02 in March;
- TPH-DRO and naphthalene concentrations exceeded DOH Drinking Water EALs in samples collected from RHMW02 during all three monitoring events;

- 1-methylnaphthalene and 2-methylnaphthalene concentrations exceeded DOH Groundwater Gross Contamination EALs in samples collected from RHMW02 during all three monitoring events; and
- TPH-DRO concentrations exceeded DOH Drinking Water EAL in the sample collected from RHMW03 in June.

2008 Groundwater Sampling - Groundwater samples were collected in January, April, July, and October 2008. Analytical results indicated the following:

- no chemicals were detected above the DOH Drinking Water EALs at RHMW2254-01;
- trace detections of 1-methylnaphthalene and naphthalene prompted a resample event in December at RHMW2254-01, no chemicals were detected above the DLs;
- TPH-DRO concentrations exceeded the DOH Drinking Water EAL in samples collected from RHMW01 during all four monitoring events;
- TPH-GRO concentrations did not exceed the DOH Drinking Water EAL in samples collected from RHMW02;
- TPH-DRO, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene concentrations exceeded DOH Drinking Water EALs in samples collected from RHMW02. Additionally, the site-specific risk-based level (SSRBL) of 4,500 µg/L for TPH-DRO was exceeded in the October monitoring event at RHMW02 (Appendix A); and
- TPH-DRO concentrations exceeded the DOH Drinking Water EAL in samples collected from RHMW03 during all four monitoring events.

2009 Groundwater Sampling and RHMW05 Installation - Groundwater samples were collected in February, May, July, and October 2009. In April 2009, a new groundwater monitoring well, RHMW05, was installed by TEC. RHMW05 is located within the lower access tunnel between RHMW01 and RHMW2254-01 (located at the U.S. Navy Well 2254-01). It was installed to identify any contamination migrating past RHMW01 prior to it reaching the U.S. Navy Well 2254-01 (TEC, 2010). Analytical results indicated the following:

- no chemicals have been detected above the DOH Drinking Water EALs at RHMW2254-01;
- TPH-GRO concentrations in samples collected from RHMW2254-01 were detected above the LOD and significantly below the LOQ and DOH EAL in February and May 2009;
- TPH-DRO concentrations exceeded the DOH Drinking Water EAL in samples collected from RHMW01 during all four monitoring events;
- TPH-GRO concentrations did not exceed the DOH Drinking Water EAL in samples collected from RHMW02;
- TPH-DRO concentrations exceeded the DOH Drinking Water EAL in samples collected from RHMW02 during all four monitoring events;

- naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene concentrations exceeded the DOH Drinking Water EALs in samples collected from RHMW02 in February 2009, however, only the 1-methylnaphthalene concentration exceeded the DOH Drinking Water EAL in May 2009 and July 2009 and only the naphthalene concentration exceeded the DOH Drinking Water EAL in October 2009;
- TPH-DRO concentrations exceeded the DOH Drinking Water EAL in samples collected from RHMW03 in February, but not in May or July; and
- TPH-DRO concentration exceeded the DOH Drinking Water EAL in the sample collected from RHMW05 during the July 2009 monitoring event.

2010 Groundwater Sampling - Groundwater samples were collected in January, April, and July 2010 (and TPH-DRO was re-sampled at RHMW02 in February 2010 and March 2010). Analytical results indicated the following:

- no chemicals have been detected above the DOH Drinking Water EALs in samples collected from RHMW2254-01;
- naphthalene concentration in the sample collected from RHMW2254-01 was detected above the LOD and significantly below the LOQ and DOH Drinking Water EAL in January;
- TPH-DRO concentrations exceeded the DOH Drinking Water EAL in samples collected from RHMW01 in January, April, and July;
- TPH-DRO concentrations exceeded the DOH Drinking Water EAL in samples collected from RHMW02 in January, February, March, April, and July, however, significant increases in January and February were attributed to tentatively identified compounds (TICs) apparently not associated with petroleum from the RHSF;
- naphthalene and 1-methylnaphthalene concentrations exceeded the DOH Drinking Water EALs in samples collected from RHMW02 in January, April, and July;
- TPH-DRO concentrations exceeded DOH Drinking Water EAL in samples collected from RHMW05 in January, however, the significant increase was attributed to TICs apparently not associated with petroleum from the RHSF; and
- TPH-DRO concentrations in samples collected from RHMW03 were not detected above the LODs and LOQs in January, April, and July 2010.

1.2.6 Regulatory Updates

During the summer and fall of 2008 DOH updated their EALs which resulted in significant changes to the action levels associated with methylnaphthalenes. The drinking water toxicity EAL for these compounds was 240 µg/L. This concentration presumed that methylnaphthalenes were non-carcinogenic. Evidence that they are human carcinogens has now been accepted by the U.S. Environmental Protection Agency (EPA). As a result, DOH adopted more rigorous EALs of 4.7 µg/L for 1-methylnaphthalene and 24 µg/L for 2-methylnaphthalene, corresponding to a residential tap water scenario, and a one in a million cancer risk (DOH, 2009).

Also, the drinking water EAL for naphthalene was increased from 6.2 µg/L to 17 µg/L (DOH, 2009). Finally, the DOH Drinking Water EAL for TPH-DRO was increased from 100 µg/L to 210 µg/L, although the DOH Groundwater Gross Contamination EAL for TPH-DRO remains 100 µg/L.

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Section 2 Groundwater Monitoring Activities

Groundwater monitoring was conducted at the five monitoring wells (RHMW2254-01, RHMW01, RHMW02, RHMW03, and RHMW05 on October 18, 19, 20, and November 3, 2010 using procedures described in the Work Plan (Environet, 2010). Field activities were documented in the field notebook (Appendix B).

2.1 Oil/Water Interface Measurements

The presence and thickness of LNAPL, otherwise known as “free product,” released from the USTs is monitored at the RHSF. Groundwater gauging measurements were collected at the five monitoring wells prior to purging and sample collection. A Solinst® oil/water interface probe was used to measure the depth to groundwater, as well as detect the presence and thickness of LNAPL to the nearest 0.01 foot, according to the procedures described in Procedure I-C-3, *Monitoring Well Sampling* (DON, 2007).

2.2 Groundwater Sampling

Groundwater samples were collected from the five monitoring wells according to the procedures described in Procedure I-C-3, *Monitoring Well Sampling* (DON, 2007).

2.2.1 Monitoring Well Purging

Each monitoring well was purged using a dedicated bladder pump system. Groundwater was purged at a low flow rate (less than one liter per minute) using the dedicated bladder pump system until three or more successive water quality parameter measurements had stabilized within 10 percent. A Horiba® U-22 multi-parameter water quality meter was used to measure hydrogen activity (pH), temperature, specific conductivity, dissolved oxygen, turbidity, and oxidation reduction potential. At least four to six readings were recorded on Groundwater Sampling Log data sheets (Appendix C).

2.2.2 Groundwater Sample Collection

Groundwater samples were collected using dedicated bladder pump systems. Groundwater samples were collected directly into laboratory provided specially cleaned sample containers already containing the appropriate preservatives (i.e., hydrochloric acid for VOC analysis and nitric acid for dissolved lead analysis). The dissolved lead samples were filtered in the field, except at RHMW01, and placed in polyethylene bottles containing preservatives. The dissolved lead sample collected at RHMW01 was placed into a polyethylene bottle without preservative and was later filtered in the laboratory.

2.2.3 Sample Management and Shipment

Each sample container sent to the laboratory was assigned a project-specific chain of custody identification number and a descriptive identification number. The sample identifiers provided specific data unique to each sample and were entered into the field notebook. The samples were labeled according to the procedures described in Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody* (DON, 2007).

Following sample collection and labeling, the sample containers were bubble-wrapped and placed into individual ZipLoc® bags, then immediately into insulated coolers with ice for preservation. The samples were shipped via FedEx to the laboratory on the following day of collection, with the exception of one sample which was shipped two days following sample collection. The samples were managed under standard chain-of-custody protocol and documentation from collection to delivery to the laboratory. Sample handling, storage, and transport were performed according to the requirements described in Procedure III-F, *Sample Handling, Storage, and Shipping* (DON, 2007).

2.3 Analytical Program

During the October-November 2010 groundwater monitoring event, five sets of primary groundwater samples, one set of duplicate groundwater samples, and one set of quality control (QC) groundwater samples (i.e., matrix spike (MS)/matrix spike duplicate (MSD)) were submitted to APPL, Inc. located in Clovis, California. Groundwater samples were analyzed for VOCs and TPH-GRO by EPA Method 8260B, TPH-DRO by EPA Method 8015B, PAHs by EPA Method 8270D SIM, and dissolved lead by EPA Method 6020. The results of the laboratory analyses are presented and discussed in Section 3.

2.4 Field Quality Control Samples

Field QC procedures were followed to ensure viability and integrity of sample analytical data. Field duplicates were collected according to the procedures described in Procedure III-B, *Field QC Samples (Water, Soil)* (DON, 2007) and the Work Plan (Environet, 2010). Field duplicate samples were collected at a minimum of 10 percent of primary samples and analyzed for the same contaminants. Field rinsate samples were not required since dedicated bladder pump systems were used.

2.5 Laboratory Quality Control Samples

Laboratory QC samples were analyzed as part of the standard laboratory QC protocols as presented in the Work Plan (Environet, 2010). Laboratory QC for the monitoring event consisted of MS/MSD samples for organic analysis. Laboratory QC samples were collected and analyzed according to the procedures described in Procedure III-A *Laboratory QC Samples (Water, Soil)* (DON, 2007). Laboratory QC MS/MSD samples are an aliquot (i.e., a subset) of the field sample. They are not separate samples, but a special designation of an existing sample. Laboratory QC MS/MSD samples were analyzed for the same constituents as the standard samples. At a minimum, one MS/MSD sample pair was required per 20 samples, including duplicates.

2.6 Equipment Decontamination

Decontamination of monitoring equipment was performed to ensure data quality, to prevent cross contamination, and to prevent the potential introduction of contaminants into previously un-impacted areas. Decontamination of monitoring equipment (i.e., Solinst® oil/water interface probe and Horiba® U-22 water quality meter) was conducted between monitoring locations according to the procedures described in Procedure I-F, *Equipment Decontamination* (DON, 2007). Decontamination water was disposed of in the RHSF’s lower tunnel oil/water separator sump.

2.7 Investigation-Derived Waste Management

Investigation-derived waste (IDW) was managed in accordance with the procedures described in Procedure I-A-6, *IDW Management* (DON, 2007). The various potential waste streams included the following:

- personal protective equipment (PPE) including: nitrile gloves, etc.;
- liquids including: equipment rinse water and purged groundwater; and
- disposable sampling equipment and supplies, including: poly sheeting, etc.

Equipment rinse water and purge water was disposed of in the RHSF’s lower tunnel oil/water separator sump.

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Section 3 Groundwater Monitoring Results

This section provides a summary of analytical results for groundwater samples collected from the five monitoring wells on October 18, 19, 20, and November 3, 2010. Complete analytical laboratory reports are provided in Appendix D.

3.1 Results of Oil/Water Interface Measurements

Free product was not measured at RHMW01, RHMW02, RHMW03, and RHMW05 during the October-November 2010 sampling event. The trend of free product measurements over time show that in January 2008, fuel was measured in monitoring wells RHMW01 and RHMW02 at a thickness of less than (<) 0.01 feet, but was not observed in other monitoring wells. Since the trace amounts observed in January 2008, no free product has been observed in any of these RHSF monitoring wells (Table 3-1).

3.2 Summary of Groundwater Analytical Results

All laboratory DLs, LODs, and LOQs were generally below the EALs. In the case where an EAL for a specific COPC is less than the LOQ, it is generally acceptable to consider the LOQ in place of the EAL (DOH, 2009).

RHMW2254-01

Lead (3.3 µg/L) was detected at a concentration which was below both the DOH Drinking Water EAL (15 µg/L) and the DOH Groundwater Gross Contamination EAL (5,000 µg/L). All other COPC concentrations were not detected at or above the LODs and LOQs (Table 3-2 and Appendix D).

RHMW01

Naphthalene (0.17 µg/L), acetone (2.4 µg/L), and lead (0.47 µg/L) were detected at estimated concentrations which were below both the DOH Drinking Water EALs (17 µg/L for naphthalene; 22,000 µg/L for acetone; 15 µg/L for lead) and the DOH Groundwater Gross Contamination EALs (21 µg/L for naphthalene; 20,000 µg/L for acetone; 5,000 for lead). All other COPCs were not detected at or above the LODs and LOQs (Table 3-2 and Appendix D).

RHMW02

TPH-DRO (1,700 µg/L), TPH-GRO (150 µg/L), 1-methylnaphthalene (15 µg/L), and naphthalene (59 µg/L) were detected at concentrations which exceeded both the DOH Drinking Water EALs (210 µg/L for TPH-DRO; 100 µg/L for TPH-GRO, 4.7 µg/L for 1-methylnaphthalene; 17 µg/L for naphthalene) and the DOH Groundwater Gross Contamination EALs (100 µg/L for TPH-DRO; 100 µg/L for TPH-GRO, 10 µg/L for 1-methylnaphthalene; 21 µg/L for naphthalene) (Table 3-2 and Appendix D).

Acenaphthene (0.28 µg/L) and 2-methylnaphthalene (5.0 µg/L) were detected at concentrations which were below both the DOH Drinking Water EALs (370 µg/L for acenaphthene; 24 µg/L for

2-methylnaphthalene) and the DOH Groundwater Gross Contamination EALs (20 µg/L for acenaphthene; 10 µg/L for 2-methylnaphthalene) (Table 3-2 and Appendix D).

Acenaphthylene (0.14 µg/L), fluorene (0.16 µg/L), ethylbenzene (0.25 µg/L), xylenes (0.60 µg/L), and lead (0.32 µg/L) were detected at estimated concentrations which were below both the DOH Drinking Water EALs (240 µg/L for acenaphthylene; 240 µg/L for fluorene; 700 µg/L for ethylbenzene; 10,000 µg/L for xylenes; 15 µg/L for lead) and the DOH Groundwater Gross Contamination EALs (2,000 µg/L for acenaphthylene; 950 µg/L for fluorene; 30 µg/L for ethylbenzene; 20 µg/L for xylenes; 5,000 µg/L for lead). All other COPCs were not detected at or above the LODs and LOQs (Table 3-2 and Appendix D).

RHMW03

TPH-DRO (330 µg/L) was detected at a concentration which exceeded both the DOH Drinking Water EAL (210 µg/L) and the DOH Groundwater Gross Contamination EAL (100 µg/L) (Table 3-2 and Appendix D).

Lead (0.28 µg/L) was detected at estimated concentration which was below both the DOH Drinking Water EAL (15 µg/L) and the DOH Groundwater Gross Contamination EAL (5,000 µg/L). All other COPCs were not detected at or above the LODs and LOQs (Table 3-2 and Appendix D).

RHMW05

All COPC concentrations were not detected at or above the LODs and LOQs (Table 3-2 and Appendix D).

3.3 Groundwater Contaminant Trend

Groundwater samples have been collected and analyzed in monitoring wells RHMW01, RHMW02, RHMW03 since September 2005, and in monitoring well RHMW05 since May 2009 (Appendix A). The following is a discussion of compounds that exceeded DOH Drinking Water EALs during two or more recent consecutive sampling events of increasing or decreasing concentrations, thus establishing a trend:

RHMW2254-01

COPCs have never been detected at RHMW2254-01 at concentrations greater than the DOH Drinking Water EALs. In October-November 2010, all COPCs were not detected at or above the LODs and LOQs, except lead (3.3 µg/L), which was detected at a concentration less than both the DOH Drinking Water EAL and DOH Groundwater Gross Contamination EAL.

RHMW01

Concentrations of TPH-DRO have been greater than the DOH Drinking Water EAL since September 2005, but less than 25 percent of the SSRBL of 4,500 µg/L. TPH-DRO concentrations decreased from October 2008 (459 µg/L) through July 2009 (248F µg/L); increased in October 2009 (299F µg/L), January 2010 (312F µg/L), and April 2010 (377 µg/L);

Table 3-1: Red Hill Oil/Water Interface Measurements, September 2007 through October 2010

	RHMW01			RHMW02			RHMW03			RHMW05		
	Elevation = 102.27 ft.[1]			Elevation = 104.76 ft.[1]			Elevation = 121.06 ft.[1]			Elevation = 101.55 ft.[1]		
Date	DTW (TOC)	SWL	LNAPL	DTW (TOC)	SWL	LNAPL	DTW (TOC)	SWL	LNAPL	DTW (TOC)	SWL	LNAPL
Sep-2007	NT[2]	NT[2]	NT[2]	86.80	17.96	NP	103.44	17.62	NP	~	~	~
Jan-2008	84.67	17.60	<0.01	86.23	18.53	<0.01	NT[3]	NT[3]	NT[3]	~	~	~
Jul-2008	83.37	18.90	0.00	86.10	18.66	0.00	102.45	18.61	0.00	~	~	~
Oct-2008	83.80	18.47	0.00	86.45	18.31	0.00	102.49	18.57	0.00	~	~	~
Nov-2008	83.91	18.36	0.00	86.56	18.20	0.00	102.80	18.26	0.00	~	~	~
Jan-2009	83.13	19.14	0.00	85.79	18.97	0.00	102.04	19.02	0.00	~	~	~
Feb-2009	NT[4]	NT[4]	NT[4]	86.35	18.41	0.00	102.56	18.50	0.00	~	~	~
Mar-2009	83.82	18.45	0.00	86.44	18.32	0.00	102.64	18.42	0.00	~	~	~
May-2009[5]	83.72	18.55	0.00	86.37	18.39	0.00	102.59	18.47	0.00	NT[6]	NT[6]	NT[6]
May-2009	83.50	18.77	0.00	86.15	18.61	0.00	102.41	18.65	0.00	NT[6]	NT[6]	NT[6]
Jul-2009[7]	83.75	18.52	0.00	86.42	18.34	0.00	102.67	18.39	0.00	83.09	18.46	0.00
Aug-2009	84.04	18.23	0.00	86.71	18.05	0.00	102.84	18.22	0.00	83.51	18.04	0.00
Sep-2009	84.21	18.06	0.00	86.84	17.92	0.00	103.07	17.99	0.00	83.61	17.94	0.00
Oct-2009	84.24	18.03	0.00	86.87	17.89	0.00	103.07	17.99	0.00	83.62	17.93	0.00
Nov-2009	83.91	18.36	0.00	86.56	18.20	0.00	102.81	18.25	0.00	83.25	18.30	0.00
Dec-2009	84.12	18.15	0.00	86.75	18.01	0.00	103.00	18.06	0.00	83.53	18.02	0.00
Jan-2010	84.36	17.91	0.00	87.00	17.76	0.00	103.22	17.84	0.00	83.75	17.80	0.00
Feb-2010	84.24	18.03	0.00	86.89	17.87	0.00	103.14	17.92	0.00	83.60	17.95	0.00
Mar-2010	84.53	17.74	0.00	87.15	17.61	0.00	103.38	17.68	0.00	83.96	17.59	0.00
Apr-2010	84.75	17.52	0.00	87.37	17.39	0.00	103.60	17.46	0.00	84.17	17.38	0.00
May-2010	84.80	17.47	0.00	87.43	17.33	0.00	103.66	17.40	0.00	84.23	17.32	0.00
Jun-2010	84.87	17.40	0.00	87.51	17.25	0.00	103.74	17.32	0.00	84.30	17.25	0.00
Jul-2010	85.03	17.24	0.00	87.66	17.10	0.00	103.89	17.17	0.00	84.48	17.07	0.00
Sep-2010	85.30	16.97	0.00	87.92	16.84	0.00	104.13	16.93	0.00	84.71	16.84	0.00
Oct-2010	85.29	16.98	0.00	87.91	16.85	0.00	104.13	16.93	0.00	84.75	16.80	0.00

Notes:

[1] Elevations were updated based on the *Groundwater Flow Direction/Gradient and Tier 3 Risk Assessment Re-evaluation Letter Report, Red Hill Bulk Fuel Storage Facility, 04-D-8514, Task Order 54* , dated April 15, 2010.

[2] A measurement was not taken at RHMW01 in September 2007.

[3] A measurement was not taken at RHMW03 in January 2008 due to equipment malfunction.

[4] A measurement was not taken at RHMW01. The monitoring well was inaccessible due to extensive work being conducted at Tank 02.

[5] The April 2009 measurements were pushed back a week (to 5/6/09) due to RHMW05 installation.

[6] Measurements were not taken at RHMW05 until the installation of the dedicated oil/water interface probe was completed.

[7] The June 2009 measurements were skipped due to the installation of dedicated oil/water interface probes.

Units are in feet (ft.).

Measurements recorded prior to September 2010 were collected by TEC. Measurements recorded in September 2010 and after were collected by Environet.

DTW (TOC) - depth to water from top of well casing

LNAPL - light non-aqueous phase liquid attributed to the Red Hill Bulk Fuel Storage Facility

NP - measurement not provided

NT - measurement not taken

SWL - static water level

~ - period prior to the installation of RHMW05

< - less than

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Table 3-2: Analytical Results for Quarterly Groundwater Monitoring, October-November 2010

Method	Chemical	DOH Drinking Water EALs for Human Toxicity[a]	DOH Groundwater Gross Contamination EALs[a]	RHMW2254-01 (ES004)					RHMW01 (ES009)					RHMW02 (ES002)					RHMW03 (ES001)					RHMW05 (ES005)				
				Result	Q	LOQ	LOD	DL	Result	Q	LOQ	LOD	DL	Result	Q	LOQ	LOD	DL	Result	Q	LOQ	LOD	DL	Result	Q	LOQ	LOD	DL
EPA 8015B (Petroleum)	TPH-DRO	210	100	ND	U	150[b]	80.8	40.4	ND	U	150[b]	80.8	40.4	**1,700**		150[b]	80.8	40.4	**330**		150[b]	80.8	40.4	ND	U	150[b]	80.8	40.4
EPA 8260 B (Petroleum)	TPH-GRO	100	100	ND	U	20.0	12.12	6.06	ND	U	20.0	12.12	6.06	**150**		20.0	12.12	6.06	ND	U	20.0	12.12	6.06	ND	U	20.0	12.12	6.06
EPA 8270D SIM (PAHs)	Acenaphthene	370	20	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	0.28		0.2	0.12	0.06	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06
	Acenaphthylene	240	2,000	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	0.14	J	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06
	Anthracene	1,800	22	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05
	Benzo(a)anthracene	0.092	4.7	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07
	Benzo(g,h,i)perylene	1,500	0.13	ND	U	0.2[b]	0.16	0.08	ND	U	0.2[b]	0.16	0.08	ND	U	0.2[b]	0.16	0.08	ND	U	0.2[b]	0.16	0.08	ND	U	0.2[b]	0.16	0.08
	Benzo(a)pyrene	0.2	0.81	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07
	Benzo(b)fluoranthene	0.092	0.75	ND	U	0.2[b]	0.12	0.06	ND	U	0.2[b]	0.12	0.06	ND	U	0.2[b]	0.12	0.06	ND	U	0.2[b]	0.12	0.06	ND	U	0.2[b]	0.12	0.06
	Benzo(k)fluoranthene	0.92	0.4	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07
	Chrysene	9.2	1	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05
	Dibenzo(a,h)anthracene	0.0092	0.52	ND	U	0.2[b]	0.10	0.05	ND	U	0.2[b]	0.10	0.05	ND	U	0.2[b]	0.10	0.05	ND	U	0.2[b]	0.10	0.05	ND	U	0.2[b]	0.10	0.05
	Fluoranthene	1,500	130	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08
	Fluorene	240	950	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	0.16	J	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06
	Ideno(1,2,3-cd)pyrene	0.092	0.095	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07
	1-Methylnaphthalene	4.7	10	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	**15**		0.2	0.12	0.06	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06
	2-Methylnaphthalene	24	10	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	5.0		0.2	0.12	0.06	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06
	Naphthalene	17	21	ND	U	0.2	0.10	0.05	0.17	J	0.2	0.10	0.05	**59**		0.2	0.10	0.05	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05
	Phenanthrene	240	410	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07
	Pyrene	180	68	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08
EPA 8260 B (VOCs)	1,1,1-Trichloroethane	200	970	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14
	1,1,2-Trichloroethane	5	50,000	ND	U	1.0	0.40	0.20	ND	U	1.0	0.40	0.20	ND	U	1.0	0.40	0.20	ND	U	1.0	0.40	0.20	ND	U	1.0	0.40	0.20
	1,1-Dichloroethane	2.4	50,000	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	1,1-Dichloroethylene (1,1-Dichloroethene)	7	1,500	ND	U	1.0	0.60	0.30	ND	U	1.0	0.60	0.30	ND	U	1.0	0.60	0.30	ND	U	1.0	0.60	0.30	ND	U	1.0	0.60	0.30
	1,2,3-Trichloropropane	0.6	50,000	ND	U	2.0[b]	0.78	0.39	ND	U	2.0[b]	0.78	0.39	ND	U	2.0[b]	0.78	0.39	ND	U	2.0[b]	0.78	0.39	ND	U	2.0[b]	0.78	0.39
	1,2,4-Trichlorobenzene	70	3,000	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21
	1,2-Dibromo-3-chloropropane	0.04	10	ND	U	2.0[b]	1.52	0.76	ND	U	2.0[b]	1.52	0.76	ND	U	2.0[b]	1.52	0.76	ND	U	2.0[b]	1.52	0.76	ND	U	2.0[b]	1.52	0.76
	1,2-Dibromoethane	0.0065	50,000	ND	U	1.0[b]	0.40	0.20	ND	U	1.0[b]	0.40	0.20	ND	U	1.0[b]	0.40	0.20	ND	U	1.0[b]	0.40	0.20	ND	U	1.0[b]	0.40	0.20
	1,2-Dichlorobenzene	600	10	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17
	1,2-Dichloroethane	0.15	7,000	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14
	1,2-Dichloropropane	5	10	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17
	1,3-Dichlorobenzene	180	50,000	ND	U	1.0	0.22	0.11	ND	U	1.0	0.22	0.11	ND	U	1.0	0.22	0.11	ND	U	1.0	0.22	0.11	ND	U	1.0	0.22	0.11
	1,3-Dichloropropene (total of cis/trans)	0.43	50,000	ND	U	1.0[b]	0.36	0.18	ND	U	1.0[b]	0.36	0.18	ND	U	1.0[b]	0.36	0.18	ND	U	1.0[b]	0.36	0.18	ND	U	1.0[b]	0.36	0.18
	1,4-Dichlorobenzene	75	5	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	Acetone	22,000	20,000	ND	U	10.0	1.90	0.95	2.4	J	10.0	1.90	0.95	ND	U	10.0	1.90	0.95	ND	U	10.0	1.90	0.95	ND	U	10.0	1.90	0.95
	Benzene	5	170	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16
	Bromodichloromethane	0.22	50,000	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14
	Bromoform	100	510	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14
	Bromomethane	8.7	50,000	ND	U	2.0	0.48	0.24	ND	U	2.0	0.48	0.24	ND	U	2.0	0.48	0.24	ND	U	2.0	0.48	0.24	ND	U	2.0	0.48	0.24
	Carbon Tetrachloride	5	520	ND	U	1.0	0.20	0.10	ND	U	1.0	0.20	0.10	ND	U	1.0	0.20	0.10	ND	U	1.0	0.20	0.10	ND	U	1.0	0.20	0.10
	Chlorobenzene	100	50	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21
	Chloroethane	8,600	16	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21
	Chloroform	70	2,400	ND	U	1.0	0.14	0.07	ND	U	1.0	0.14	0.07	ND	U	1.0	0.14	0.07	ND	U	1.0	0.14	0.07	ND	U	1.0	0.14	0.07
	Chloromethane	1.8	50,000	ND	U	1.0	0.62	0.31	ND	U	1.0	0.62	0.31	ND	U	1.0	0.62	0.31	ND	U	1.0	0.62	0.31	ND	U	1.0	0.62	0.31
	cis-1,2-Dichloroethylene	70	50,000	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16
	Dibromochloromethane (Chlorodibromomethane)	0.16	50,000	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19
	Ethylbenzene	700	30	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23	0.25	J	1.0	0.46	0.23	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23
	Hexachlorobutadiene	0.86	6	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19
	Methyl ethyl ketone (2-Butanone)	7,100	8,400	ND	U	10.0	1.20	0.60	ND	U	10.0	1.20	0.60	ND	U	10.0	1.20	0.60	ND	U	10.0	1.20	0.60	ND	U	10.0	1.20	0.60
	Methyl isobutyl ketone (4-Methyl-2-pentanone)	2,000	1,300	ND	U	10.0	3.80	1.90	ND	U	10.0	3.80	1.90	ND	U	10.0	3.80	1.90	ND	U	10.0	3.80	1.90	ND	U	10.0	3.80	1.90
	Methyl tert-butyl Ether	12	5	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	Methylene chloride	4.8	9,100	ND	U	5.0[b]	0.70	0.35	ND	U	5.0[b]	0.70	0.35	ND	U	5.0[b]	0.70	0.35	ND	U	5.0[b]	0.70	0.35	ND	U	5.0[b]	0.70	0.35
	Styrene	100	10	ND	U	1.0	0.50	0.25	ND	U	1.0	0.50	0.25	ND	U	1.0	0.50	0.25	ND	U	1.0	0.50	0.25	ND	U	1.0	0.50	0.25
	Tetrachloroethane, 1,1,1,2-	0.52	50,000	ND	U	1.0[b]	0.26	0.13	ND	U	1.0[b]	0.26	0.13	ND	U	1.0[b]	0.26	0.13	ND	U	1.0[b]	0.26	0.13	ND	U	1.0[b]	0.26	0.13
	Tetrachloroethane, 1,1,2,2-	0.067	500	ND	U	1.0[b]	0.20	0.10	ND	U	1.0[b]	0.20	0.10	ND	U	1.0[b]	0.20	0.10	ND	U	1.0[b]	0.20	0.10	ND	U	1.0[b]	0.20	0.10
	Tetrachloroethylene (Tetrachloroethene)	5	170	ND	U	1.0	0.30	0.15	ND	U	1.0	0.30	0.15	ND	U	1.0	0.30	0.15	ND	U	1.0	0.30	0.15	ND	U	1.0	0.30	0.15
	Toluene	1,000	40	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17
	trans-1,2-Dichloroethylene	100	260	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	Trichloroethylene (Trichloroethene)	5	310	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16
	Vinyl chloride	2	3,400	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23
	Xylenes	10,000	20	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	0.60	J	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
EPA 6020	Lead	15	5,000	3.3		0.5	0.22	0.11	0.47	J	0.5	0.22	0.11	0.32	J	0.5	0.22	0.11	0.28	J	0.5	0.22	0.11	ND	U	0.5	0.22	0.11

Notes:

All units are in micrograms per liter (µg/L).

[a] DOH EALs (DOH, 2009): Table D-1b. Groundwater Action Levels (Groundwater is a current or potential drinking water resource; surface water body is not located within 150 meters of release site).

[b] In the case where an EAL for a specific chemical is less than the LOQ for a commercial laboratory, it is generally acceptable to consider the LOQ in place of the action level (DOH, Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater 2008, updated March 2009).

DL - detection limit or method detection limit (MDL)
DRO - diesel range organics
GRO - gasoline range organics
J - Estimated result. Indicates that the compound was identified but the concentration was above the DL and below the LOQ.
LOD - limit of detection
LOQ - limit of quantitation or reporting limit (RL).
ND - not detected
PAHs - polynuclear aromatic hydrocarbons
Q - data qualifier
TPH - total petroleum hydrocarbons
U - Indicates the compound or analyte was analyzed for but not detected. The result is reported as ND.
VOC - volatile organic compound
Bold - Result exceeds one or both DOH EALs.

decreased in July 2010 (228F µg/L); and was not detected at or above the LOD and LOQ in October-November 2010. TPH-GRO has remained below the EAL or has not been detected (Appendix A).

RHMW02

The averages of primary and duplicate samples were used for determining contaminant trends. From September 2005 through February 2009, TPH-DRO exceeded the DOH Drinking Water EAL of 210 µg/L and was greater than 50 percent of the SSRBL (estimated solubility limit of 4,500 µg/L). The concentration of TPH-DRO was relatively stable until July 2008 and October 2008 when the concentrations increased, with the October 2008 average also exceeding the SSRBL of 4,500 µg/L (Appendix A).

However, TPH-DRO concentrations decreased from October 2008 through July 2009. In May 2009 and July 2009, TPH-DRO remained above the DOH Drinking Water EAL, but was below 50 percent of the SSRBL of 4,500 µg/L. In October 2009, TPH-DRO began an increasing trend greater than 50 percent of the SSRBL which continued through February 2010 when it exceeded the SSRBL due to TICs apparently not associated with petroleum from the RHSF (TEC, 2010). In March 2010 (2,490 µg/L) and April 2010 (2,215 µg/L), TPH-DRO exhibited a decreasing trend and the TICs detected in the two previous monitoring events were not observed. During July 2010, TPH-DRO concentrations at RHMW02 increased to an averaged concentration of 3,085 µg/L, above 50 percent of the SSRBL of 4,500 µg/L. During October-November 2010, TPH-DRO concentrations decreased to 1,700 µg/L, below 50 percent of the SSRBL (Appendix A).

Since September 2005, TPH-GRO concentrations have remained below the EAL, except in July 2006, December 2006, March 2007, and October-November 2010 (Appendix A).

From September 2005 through October 2008, naphthalene concentrations remained above the EAL and were relatively stable. In February 2009, naphthalene concentrations began decreasing and reached its lowest average concentration in May 2009 (2 µg/L) which was below the EAL. From July 2009 through July 2010, concentrations increased above the EAL. Then in October-November 2010, naphthalene concentrations decreased slightly to a concentration which was still above the EAL (Appendix A).

Similar to the naphthalene concentration trend, 1-methylnaphthalene concentrations remained relatively stable from September 2005 through October 2008. In February 2009, 1-methylnapthalene concentrations began decreasing and reached its lowest average concentration in October 2009 (3.2 µg/L) which was below the EAL. In January 2010, 1-methylnaphthalene concentrations increased above the EAL; then decreased in April 2010; and increased in July and October-November 2010 (Appendix A).

The average concentration in October-November 2010 for 1-methylnaphthalene (15.0 µg/L) exhibited an increase, after decreasing in April 2010 (to 6.3 µg/L) from the January 2010 average concentration (8.7 µg/L). Consequently, the October-November 2010 1-methylnaphthalene concentration remains above the DOH Drinking Water EAL of 4.7 µg/L. Since October 2008, the concentration of 2-methylnaphthalene has remained below the EAL (Appendix A).

RHMW03

Historically, concentrations of TPH-DRO have fluctuated around the DOH Drinking Water EAL, but have been significantly lower than corresponding values observed at RHMW01 and RHMW02. TPH-DRO concentrations have decreased since October 2008 dropping below the DLs in May 2009 through July 2010. However, during this October-November 2010 groundwater monitoring event, TPH-DRO was detected at the highest concentration to date (330 µg/L) which was above the EAL. TPH-GRO has remained below the EAL or has not been detected (Appendix A).

RHMW05

There had been an increasing trend for TPH-DRO since it was first sampled in May 2009. Starting with the July 2009 monitoring event, TPH-DRO concentrations were greater than the DOH Drinking Water EAL (210 µg/L) with the highest concentration of 2,060 µg/L being observed in January 2010. It is important to note that the January 2010 concentration contained TICs apparently not associated with petroleum from the RHSF. However, in April 2010, July 2010, and October-November 2010, TPH-DRO concentrations exhibited a significant decrease and were not detected at or above the LODs and LOQs. TPH-GRO has remained below the EAL or has not been detected (Appendix A).

3.4 Groundwater Status

Facility-specific contaminants of concern are defined as petroleum-related chemicals that have been observed in the groundwater samples above the DOH Drinking Water EALs. In accordance with the Red Hill Bulk Fuel Storage Facility Final Groundwater Protection Plan (TEC, 2008), Table 3-3 defines these RHSF-specific compounds and their associated SSRBLs and updated EALs (DOH, 2009).

In addition, the Groundwater Protection Plan defines four Results Categories of groundwater status for the RHSF, based on concentrations of COPCs detected in samples collected from RHMW2254-01, RHMW01, RHMW02, RHMW03, and RHMW05, and requires specific responses when these categories are observed during quarterly groundwater sampling (Table 3-4). The current Results Categories for the monitoring wells were determined using the October-November 2010 analytical data (Table 3-5).

Table 3-3: Action Levels for Contaminants of Concern

Chemical	DOH Drinking Water EAL (µg/L)	SSRBL (µg/L)
Petroleum Mixtures		
TPH-DRO	210	4,500
TPH-GRO	100	4,500
Semi-Volatile Compounds		
1-Methylnaphthalene	4.7	N/A
2-Methylnaphthalene	24	N/A
Naphthalene	17	N/A

Notes:
N/A – not applicable
SSRBLs are applicable at RHMW01, RHMW02, RHMW03, and RHMW05
EALs are applicable at RHMW2254-01

Table 3-4: Results Categories and Response Actions to Changes in Groundwater Status

Results Category	RHMW02, RHMW03, or RHMW05*	RHMW01	RHMW2254-01
Results Category 1: Result above detection limit but below drinking water EAL and trend for all compounds stable or decreasing	A	A	A, D, M, E
Results Category 2: Trend for any compound increasing or drinking water EAL exceeded	A, B	A, B	A, B, C, D, E, F, G, K, L, O
Results Category 3: Result Between 1/10X SSRBL and SSRBL for benzene, or between 1/2X SSRBL and SSRBL for TPH	A, B, G, H, I, J	A, B, E, G, H, I, J	A, B, C, D, E, F, G, I, J, K, L, O
Results Category 4: Result Exceeding any SSRBL or petroleum product observed	A, C, D, E, F, I, J, K, M, N	A, C, D, E, F, I, J, K, M, N, O	A, C, D, E, F, G, I, J, K, L, O

Notes:
*RHMW05 was installed in April 2009 and has been subsequently been added to this table.
Specific Responses:
A. Send quarterly reports to DOH.
B. Begin program to determine the source of leak.
C. Notify DOH verbally within one day and follow with written notification in 30 days.
D. Notify FISC Chain of Command within one day.
E. Send Type 1 Report (see box below) to DOH
F. Send Type 2 Report (see box below) to DOH
G. Increase monitoring frequency to once per month (if concentrations increasing).
H. Notify DOH verbally within seven days and follow with written notification in 30 days.
I. Remove sampling pumps, measure product in pertinent wells with interface probe, re-install pumps if product is not detected.
J. Immediately evaluate tanks for leaks.
K. Collect samples from nearby Hālawa Deep Monitoring Well (2253-03) and OWDFMW01. For permission to sample 2253-03, call Department of Land and Natural Resources (DLNR) Commission on Water Resource Management 808-587-0214, DLNRCWR@Hawaii.gov.
L. Provide alternative water source at RHMW2254-01.
M. Prepare for alternative water source at RHMW2254-01.
N. Re-measure for product every month with reports to DOH.
O. Install additional monitoring well downgradient.

Report Types

DOH Type 1 Report

- Re-evaluate Tier 3 Risk Assessment/groundwater model results.
- Proposal to DOH on course of action.

DOH Type 2 Report

- Proposal for groundwater treatment.

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Table 3‑5: Summary of Result Categories and Response Actions, October-November 2010

Results Category	**RHMW2254-01[1]**	**RHMW01**	**RHMW02**	**RHMW03**	**RHMW05**
Results Category 1: Result above detection limit but below drinking water EAL and trend for all compounds stable or decreasing	No	Yes	No	No	No
Results Category 2: Trend for any compound increasing or drinking water EAL exceeded	No	No	Yes	Yes	No
Results Category 3: Result Between 1/10X SSRBL and SSRBL for benzene, or between 1/2X SSRBL and SSRBL for TPH	No	No	No	No	No
Results Category 4: Result Exceeding any SSRBL or petroleum product observed	No	No	No	No	No
Previous Category: Category prior to October-November monitoring event	None	Category 2	Category 3	None	Category 1
New Category: Category assignment based on results of the October-November monitoring event	None	Category 1	Category 2	Category 2	None
Response Actions: Requirements of new category	None	1. Quarterly Reports to be sent to DOH	1. Quarterly reports to be sent to DOH 2. Initiation of a leak determination program to identify if tanks are leaking	1. Quarterly reports to be sent to DOH 2. Initiation of a leak determination program to identify if tanks are leaking	None

Notes:

[1] Although a trace concentration of lead was detected at RHMW2254-01 during the October-November 2010 monitoring event, it does not place the well into the Category 1 status. No contamination trend (i.e., two or more consecutive events of detectable concentrations) has been established, therefore, RHMW2254-01 does not meet the Category 1 definition.

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Section 4 Data Quality Assessment

Data quality assessment consists of a review of the overall groundwater sample collection and analyses process in order to determine whether the analytical data generated meets the quality objectives for the project.

The field QC program consisted of standardized sample collection and management procedures and the collection of field duplicate samples and trip blank samples.

The laboratory quality assurance program consisted of the use of standard analytical methods and the preparation and analyses of MS/MSD samples, surrogate spikes, method blanks, and laboratory control samples (LCS).

4.1 Data Validation

The usability of the data collected during this investigation depends upon its quality. A number of factors relate to the quality of data, including: sample collection methods, sample analysis methods, and adherence to established procedures for sample collection, preservation, management, shipment, and analysis. Data quality is judged in terms of its precision, accuracy, representativeness, completeness, and comparability.

4.1.1 Quality Control Program

LOQs are established by the laboratory based on the method DLs or instrument DLs, historical data, and EPA limits established for the methods. The LOQs for samples may require adjustment due to matrix interference or if high levels of target analytes necessitate dilution before analysis. Matrix interference and sample dilutions have the effect of increasing the LOQs. None of the reporting limits were adjusted for this project.

4.1.2 Data Assessment

Precision

Precision is defined as the agreement between a set of replicate measurements without assumption and knowledge of the true value. Precision limits for laboratory measurements were evaluated from the sample/sample duplicate results. Field duplicate samples were collected at a rate of approximately 10 percent of project samples. Field duplicates are duplicates of the primary samples that are sent to the primary laboratory with dummy sample numbers to serve as a check of the primary laboratory’s internal precision.

Field sampling precision was evaluated from the original sample/sample duplicate results using the following criteria:

- For analytes with the sample concentration greater than five times the reporting limit, the duplicate sample results should agree within approximately 50 percent for groundwater samples.
- For analytes with either or both sample concentrations less than five times the reporting limit, duplicate groundwater sample concentrations should agree within approximately five times the reporting limit.

Precision was measured by comparing one group of samples. This group contained the primary field sample ES002 and field duplicate sample ES003 collected from RHMW02, and met the relative percent difference (RPD) precision criteria for all field duplicate analytes. Duplicate sample results from monitoring well RHMW02 are reported in this document as RHMW02D (Table 4-1).

None of the analyzed constituents were detected in any of the laboratory method blank samples. All of the LCS and surrogate spike recoveries for all analyzed constituents were within acceptable percent recovery limits. In addition, the MS/MSD and surrogate spike recoveries for all analyzed constituents were within acceptable percent recovery limits, except for 1-methylnaphthalene, 2-methylnaphthalene, naphthalene, and acetone. However, since the recoveries were only slightly to moderately out of the control limits, the COPC concentrations detected in the associated groundwater sample results would not be significantly affected. Therefore, the laboratory results are precise.

Accuracy

Accuracy is defined as the degree of agreement of a measurement to an accepted reference or true value. Accuracy is measured as the percent recovery of an analyte in a reference standard or spiked sample. Accuracy limits for laboratory control spike, MS, and MSD samples are established by the individual laboratory. The acceptance criteria for accuracy are dependent on the analytical method, and are based on historical laboratory data.

Laboratory MS and MSD analysis was used to assess analytical accuracy and precision in response to potential matrix interference. All of the MS and MSD recoveries were within laboratory specified ranges, except for 1-methylnaphthalene, 2-methylnaphthalene, naphthalene, and acetone. However, since the recoveries were only slightly to moderately out of the control limits, there would be no significant effect on the associated groundwater sample results. Therefore, all data is considered to be accurate.

Representativeness

Representativeness is the degree that data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness was achieved by conducting sampling in compliance with the sample collection procedures described in the Work Plan specifically written for this project (Environet, 2010).

Representativeness is also evaluated through the collection of trip blank samples. The trip blank samples are used to determine if offsite contamination was introduced to the sample containers during sample shipment from and to the laboratory. For this sampling event three trip blank samples were collected (Table 4-1). The trip blank samples for the October-November 2010 monitoring event were all not detected at or above the LODs and LOQs, except for acetone in the trip blank dated October 19, 2010. Acetone was detected at an estimated concentration of 1.3 μg/L, which is below both the DOH Drinking Water EAL (22,000 μg/L) and the DOH Groundwater Gross Contamination EAL (20,000 μg/L) (Table 4-1). Therefore, the data does not impact data quality and the groundwater sample data are suitable for the intended use.

Table 4-1: Field QC Results, October-November 2010

Method	Chemical	DOH Drinking Water EALs for Human Toxicity[a]	DOH Groundwater Gross Contamination EALs[a]	RHMW02 (ES002)					RHMW02D (ES003)					RPD Duplicate (%)	Trip Blank (10/18/10)					Trip Blank (10/19/10)					Trip Blank (11/3/10)				
				Result	Q	LOQ	LOD	DL	Result	Q	LOQ	LOD	DL		Result	Q	LOQ	LOD	DL	Result	Q	LOQ	LOD	DL	Result	Q	LOQ	LOD	DL
EPA 8015B (Petroleum)	TPH-DRO	210	100	**1,700**		150[b]	80.8	40.4	**1,700**		150[b]	80.8	40.4	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EPA 8260 B (Petroleum)	TPH-GRO	100	100	**150**		20.0	12.12	6.06	**160**		20.0	12.12	6.06	6.45	ND	U	20.0	12.12	6.06	ND	U	20.0	12.12	6.06	ND	U	20.0	12.12	6.06
EPA 8270D SIM (PAHs)	Acenaphthene	370	20	0.28		0.2	0.12	0.06	0.27		0.2	0.12	0.06	3.64	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Acenaphthylene	240	2,000	0.14	J	0.2	0.12	0.06	0.13	J	0.2	0.12	0.06	7.41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Anthracene	1,800	22	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Benzo(a)anthracene	0.092	4.7	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Benzo(g,h,i)perylene	1,500	0.13	ND	U	0.2[b]	0.16	0.08	ND	U	0.2[b]	0.16	0.08	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Benzo(a)pyrene	0.2	0.81	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Benzo(b)fluoranthene	0.092	0.75	ND	U	0.2[b]	0.12	0.06	ND	U	0.2[b]	0.12	0.06	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Benzo(k)fluoranthene	0.92	0.4	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Chrysene	9.2	1	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dibenzo(a,h)anthracene	0.0092	0.52	ND	U	0.2[b]	0.10	0.05	ND	U	0.2[b]	0.10	0.05	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Fluoranthene	1,500	130	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Fluorene	240	950	0.16	J	0.2	0.12	0.06	0.15	J	0.2	0.12	0.06	6.45	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ideno(1,2,3-cd)pyrene	0.092	0.095	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	1-Methylnaphthalene	4.7	10	**15**		0.2	0.12	0.06	**15**		0.2	0.12	0.06	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2-Methylnaphthalene	24	10	5.0		0.2	0.12	0.06	6.3		0.2	0.12	0.06	23.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Naphthalene	17	21	**59**		0.2	0.10	0.05	**54**		0.2	0.10	0.05	8.85	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Phenanthrene	240	410	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Pyrene	180	68	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EPA 8260 B (VOCs)	1,1,1-Trichloroethane	200	970	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	0	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14
	1,1,2-Trichloroethane	5	50,000	ND	U	1.0	0.40	0.20	ND	U	1.0	0.40	0.20	0	ND	U	1.0	0.40	0.20	ND	U	1.0	0.40	0.20	ND	U	1.0	0.40	0.20
	1,1-Dichloroethane	2.4	50,000	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	0	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	1,1-Dichloroethylene (1,1-Dichloroethene)	7	1,500	ND	U	1.0	0.60	0.30	ND	U	1.0	0.60	0.30	0	ND	U	1.0	0.60	0.30	ND	U	1.0	0.60	0.30	ND	U	1.0	0.60	0.30
	1,2,3-Trichloropropane	0.6	50,000	ND	U	2.0[b]	0.78	0.39	ND	U	2.0[b]	0.78	0.39	0	ND	U	2.0[b]	0.78	0.39	ND	U	2.0[b]	0.78	0.39	ND	U	2.0[b]	0.78	0.39
	1,2,4-Trichlorobenzene	70	3,000	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	0	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21
	1,2-Dibromo-3-chloropropane	0.04	10	ND	U	2.0[b]	1.52	0.76	ND	U	2.0[b]	1.52	0.76	0	ND	U	2.0[b]	1.52	0.76	ND	U	2.0[b]	1.52	0.76	ND	U	2.0[b]	1.52	0.76
	1,2-Dibromoethane	0.0065	50,000	ND	U	1.0[b]	0.40	0.20	ND	U	1.0[b]	0.40	0.20	0	ND	U	1.0[b]	0.40	0.20	ND	U	1.0[b]	0.40	0.20	ND	U	1.0[b]	0.40	0.20
	1,2-Dichlorobenzene	600	10	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	0	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17
	1,2-Dichloroethane	0.15	7,000	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	0	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14
	1,2-Dichloropropane	5	10	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	0	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17
	1,3-Dichlorobenzene	180	50,000	ND	U	1.0	0.22	0.11	ND	U	1.0	0.22	0.11	0	ND	U	1.0	0.22	0.11	ND	U	1.0	0.22	0.11	ND	U	1.0	0.22	0.11
	1,3-Dichloropropene (total of cis/trans)	0.43	50,000	ND	U	1.0[b]	0.36	0.18	ND	U	1.0[b]	0.36	0.18	0	ND	U	1.0[b]	0.36	0.18	ND	U	1.0[b]	0.36	0.18	ND	U	1.0[b]	0.36	0.18
	1,4-Dichlorobenzene	75	5	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	0	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	Acetone	22,000	20,000	ND	U	10.0	1.90	0.95	ND	U	10.0	1.90	0.95	0	ND	U	10.0	1.90	0.95	1.3	J	10.0	1.90	0.95	ND	U	10.0	1.90	0.95
	Benzene	5	170	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	0	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16
	Bromodichloromethane	0.22	50,000	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	0	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14
	Bromoform	100	510	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	0	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14
	Bromomethane	8.7	50,000	ND	U	2.0	0.48	0.24	ND	U	2.0	0.48	0.24	0	ND	U	2.0	0.48	0.24	ND	U	2.0	0.48	0.24	ND	U	2.0	0.48	0.24
	Carbon Tetrachloride	5	520	ND	U	1.0	0.20	0.10	ND	U	1.0	0.20	0.10	0	ND	U	1.0	0.20	0.10	ND	U	1.0	0.20	0.10	ND	U	1.0	0.20	0.10
	Chlorobenzene	100	50	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	0	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21
	Chloroethane	8,600	16	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	0	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21
	Chloroform	70	2,400	ND	U	1.0	0.14	0.07	ND	U	1.0	0.14	0.07	0	ND	U	1.0	0.14	0.07	ND	U	1.0	0.14	0.07	ND	U	1.0	0.14	0.07
	Chloromethane	1.8	50,000	ND	U	1.0	0.62	0.31	ND	U	1.0	0.62	0.31	0	ND	U	1.0	0.62	0.31	ND	U	1.0	0.62	0.31	ND	U	1.0	0.62	0.31
	cis-1,2-Dichloroethylene	70	50,000	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	0	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16
	Dibromochloromethane (Chlorodibromomethane)	0.16	50,000	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	0	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19
	Ethylbenzene	700	30	0.25	J	1.0	0.46	0.23	0.32	J	1.0	0.46	0.23	24.56	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23
	Hexachlorobutadiene	0.86	6	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	0	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19
	Methyl ethyl ketone (2-Butanone)	7,100	8,400	ND	U	10.0	1.20	0.60	ND	U	10.0	1.20	0.60	0	ND	U	10.0	1.20	0.60	ND	U	10.0	1.20	0.60	ND	U	10.0	1.20	0.60
	Methyl isobutyl ketone (4-Methyl-2-pentanone)	2,000	1,300	ND	U	10.0	3.80	1.90	ND	U	10.0	3.80	1.90	0	ND	U	10.0	3.80	1.90	ND	U	10.0	3.80	1.90	ND	U	10.0	3.80	1.90
	Methyl tert-butyl Ether	12	5	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	0	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	Methylene chloride	4.8	9,100	ND	U	5.0[b]	0.70	0.35	ND	U	5.0[b]	0.70	0.35	0	ND	U	5.0[b]	0.70	0.35	ND	U	5.0[b]	0.70	0.35	ND	U	5.0[b]	0.70	0.35
	Styrene	100	10	ND	U	1.0	0.50	0.25	ND	U	1.0	0.50	0.25	0	ND	U	1.0	0.50	0.25	ND	U	1.0	0.50	0.25	ND	U	1.0	0.50	0.25
	Tetrachloroethane, 1,1,1,2-	0.52	50,000	ND	U	1.0[b]	0.26	0.13	ND	U	1.0[b]	0.26	0.13	0	ND	U	1.0[b]	0.26	0.13	ND	U	1.0[b]	0.26	0.13	ND	U	1.0[b]	0.26	0.13
	Tetrachloroethane, 1,1,2,2-	0.067	500	ND	U	1.0[b]	0.20	0.10	ND	U	1.0[b]	0.20	0.10	0	ND	U	1.0[b]	0.20	0.10	ND	U	1.0[b]	0.20	0.10	ND	U	1.0[b]	0.20	0.10
	Tetrachloroethylene (Tetrachloroethene)	5	170	ND	U	1.0	0.30	0.15	ND	U	1.0	0.30	0.15	0	ND	U	1.0	0.30	0.15	ND	U	1.0	0.30	0.15	ND	U	1.0	0.30	0.15
	Toluene	1,000	40	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	0	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17
	trans-1,2-Dichloroethylene	100	260	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	0	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	Trichloroethylene (Trichloroethene)	5	310	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	0	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16
	Vinyl chloride	2	3,400	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23	0	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23
	Xylenes	10,000	20	0.60	J	1.0	0.38	0.19	0.51	J	1.0	0.38	0.19	16.22	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
EPA 6020	Lead	15	5,000	0.32	J	0.5	0.22	0.11	1.2		0.5	0.22	0.11	115.79	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

All units are in micrograms per liter (µg/L).

RHMW02D is a duplicate sample of RHMW02.

[a] DOH EALs (DOH, 2009): Table D-1b. Groundwater Action Levels (Groundwater is a current or potential drinking water resource; surface water body is not located within 150 meters of release site).

[b] In the case where an EAL for a specific chemical is less than the LOQ for a commercial laboratory, it is generally acceptable to consider the LOQ in place of the action level (DOH, Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater 2008, updated March 2009).

DL - detection limit or method detection limit (MDL)

DRO - diesel range organics

GRO - gasoline range organics

J - Estimated result. Indicates that the compound was identified but the concentration was above the DL and below the LOQ.

LOD - limit of detection

LOQ - limit of quantitaion or reporting limit (RL)

ND - not detected

PAHs - polynuclear aromatic hydrocarbons

Q - data qualifier

RPD - relative percent difference

TPH - total petroleum hydrocarbons

U - Indicates the compound or analyte was analyzed for but not detected. The result is reported as ND.

VOC - volatile organic compound

-- not analyzed

Bold - Result exceeds one or both DOH EALs.

Completeness

Completeness is defined as the overall percentage of valid analytical results (including estimated values) compared to the total number of analytical results reported by the laboratory. The completeness goal for this project is 90 percent, which was successfully met. Successful completion of data acquisition can only be accomplished if both the field and laboratory portions of the project are performed according to the procedures described in the Work Plan (Environet, 2010).

Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability can be related to accuracy and precision because these quantities are measures of data reliability. Data are considered comparable if collection techniques, measurement procedures, methods and reporting are equivalent for the samples within a sample set. Comparability for sampling was determined to be acceptable based on the following criteria:

- A consistent approach to sampling was applied throughout the program.
- Samples were consistently preserved.
- All sampling was performed during the same time of year and under similar physical conditions.

The above criteria were met throughout the course of this event and therefore comparability of the data set is acceptable.

The precision, accuracy, representativeness, completeness, and comparability criteria were met. Therefore, the data assessment concludes that all data generated during this event are suitable for the intended use.

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Section 5 Summary, Conclusions, and Recommendations

5.1 Summary

There is no indication of an immediate threat of disruption to drinking water resources of RHMW2254-01 as a result of the October-November 2010 data. Based on the October-November 2010 groundwater monitoring event, RHMW2254-01 does not fall into any Results Category of the Groundwater Protection Plan (TEC, 2008).

5.1.1 Results of Oil/Water Interface Measurements

Free product was not measured at RHMW01, RHMW02, RHMW03, and RHMW05 during the October-November 2010 sampling event. The trend of free product measurements over time shows that in January 2008, fuel was measured in monitoring wells RHMW01 and RHMW02 at a thickness of <0.01 feet, but was not observed in other monitoring wells. Since the trace amounts observed in January 2008, no free product has been observed in any of these RHSF monitoring wells (Table 3-1).

5.1.2 Summary of Groundwater Analytical Results

Laboratory analytical results from the October-November 2010 groundwater monitoring event indicated that TPH-DRO, TPH-GRO, and PAHs, specifically 1-methylnaphthalene and naphthalene, were present in the groundwater beneath the RHSF at concentrations that exceeded the EALs. All other COPCs concentrations were below the EALs. All laboratory DLs, LODs and LOQs were generally below the EALs. In the case where an EAL for a specific COPC is less than the LOQ, it is generally acceptable to consider the LOQs in place of the EAL (DOH, 2009).

In RHMW2254-01, lead (3.3 µg/L) was detected at a concentration which was below the EAL. All other COPC concentrations were not detected at or above the LODs and LOQs.

In monitoring well RHMW01, naphthalene (0.17 µg/L), acetone (2.4 µg/L), and lead (0.47 µg/L) were detected at estimated concentrations which were below the EALs. All other COPCs in RHMW01 were not detected at or above the LODs and LOQs.

In monitoring well RHMW02, TPH-DRO (1,700 µg/L), TPH-GRO (150 µg/L), 1-methylnaphthalene (15 µg/L), and naphthalene (59 µg/L) were detected at concentrations which exceeded the EALs. Acenaphthene (0.28 µg/L) and 2-methylnaphthalene (5.0 µg/L) were detected at concentrations which were below the EALs. Acenaphthylene (0.14 µg/L), fluorene (0.16 µg/L), ethylbenzene (0.25 µg/L), xylenes (0.60 µg/L), and lead (0.32 µg/L) were detected at estimated concentrations which were below the EALs. All other COPCs in RHMW02 were not detected at or above the LODs and LOQs.

In monitoring well RHMW03, TPH-DRO (330 µg/L) was detected at a concentration which exceeded the EAL. Lead (0.28 µg/L) was detected at an estimated concentration which was below the EAL. All other COPCs in RHMW03 were not detected at or above the LODs and LOQs.

In RHMW05, all COPC concentrations were not detected at or above the LODs and LOQs.

5.2 Conclusions

To date, the presence of LNAPL has been observed only once (i.e., in January 2008 in RHMW01 and RHMW02 at less than 0.01 feet). This indicates a significant release from one or more of the USTs at the RHSF has not occurred at this time.

COPC concentrations in samples collected from the U.S. Navy Well 2254-01 have not been detected at or above the LODs and LOQs or are below the EALs. This indicates that elevated COPC concentrations detected in samples collected from monitoring wells within the RHSF are not migrating and impacting the Navy's potable water source.

COPC concentrations detected in samples collected from monitoring well RHMW05 have decreased to below the EALs for at least three consecutive monitoring events. The data suggest that elevated COPC concentrations detected in samples collected from monitoring wells located adjacent to the USTs are not migrating in the downgradient direction. RHMW05 is an intermediate monitoring point between the USTs and the U.S. Navy Well 22554-01. At this time, there is no indication that COPCs are migrating in a downgradient direction towards the Navy's potable water source.

COPC concentrations detected in samples collected from monitoring wells adjacent to the USTs (i.e., RHMW01, RHMW02, and RHMW03) are not steadily increasing for more than one consecutive sampling event. The data suggest that the concentrations are relatively stable over time. It is likely that the COPCs are associated with a previous release from the USTs and not a current or active release.

5.3 Recommendations

Based on the results of this monitoring event, continuation of the quarterly groundwater monitoring program at the RHSF is recommended. In addition, continuation of monthly free product measurements at RHMW01, RHMW02, RHMW03, and RHMW05; and monthly soil vapor monitoring is also recommended. In response to the Category 2 status of RHMW02, submission of this quarterly report to DOH and initiation of a leak determination program to identify if tanks are leaking are recommended.

Section 6 References

Dawson Group, Inc., 2006. *Fourth Quarter 2005 Groundwater Sampling Report, Red Hill Fuel Storage Facility, Hawaii*. February.

DOH, 2009. *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater*. Updated March 2009.

DON, 2007. *Project Procedures Manual, U.S. Navy Environmental Restoration Program, NAVFAC Pacific*. February.

Environet, 2010. *Work Plan, Long-Term Monitoring, Red Hill Bulk Fuel Storage Facility, Pearl Harbor, O‘ahu, Hawai‘i*. September.

Hawai‘i Administrative Rules, Title 11, Chapter 281, Subchapter 7.

TEC, 2006. *Red Hill Bulk Fuel Storage Facility, Final – Addendum Planning Documents, Pearl Harbor, Hawaii*. May.

_____, 2007. *Red Hill Bulk Fuel Storage Facility, Final Technical Report, Pearl Harbor, Hawaii*. August.

_____, 2008. *Red Hill Bulk Fuel Storage Facility, Final Groundwater Protection Plan, Pearl Harbor, Hawaii*. January 2008 revised in December 2009.

_____, 2010. *Quarterly Groundwater Monitoring Report, Red Hill Fuel Storage Facility, Pearl Harbor, Oahu, Hawaii*. August.

U.S. Geological Survey (USGS), 2005. Aerial Image. http://hawaii.wr.usgs.gov/index.html.

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Appendix A
Quarterly Groundwater Monitoring Results for TPH and PAHs, September 2005 through October-November 2010

Figure A-1: TPH at RHMW2254-01
Quarterly Monitoring Results

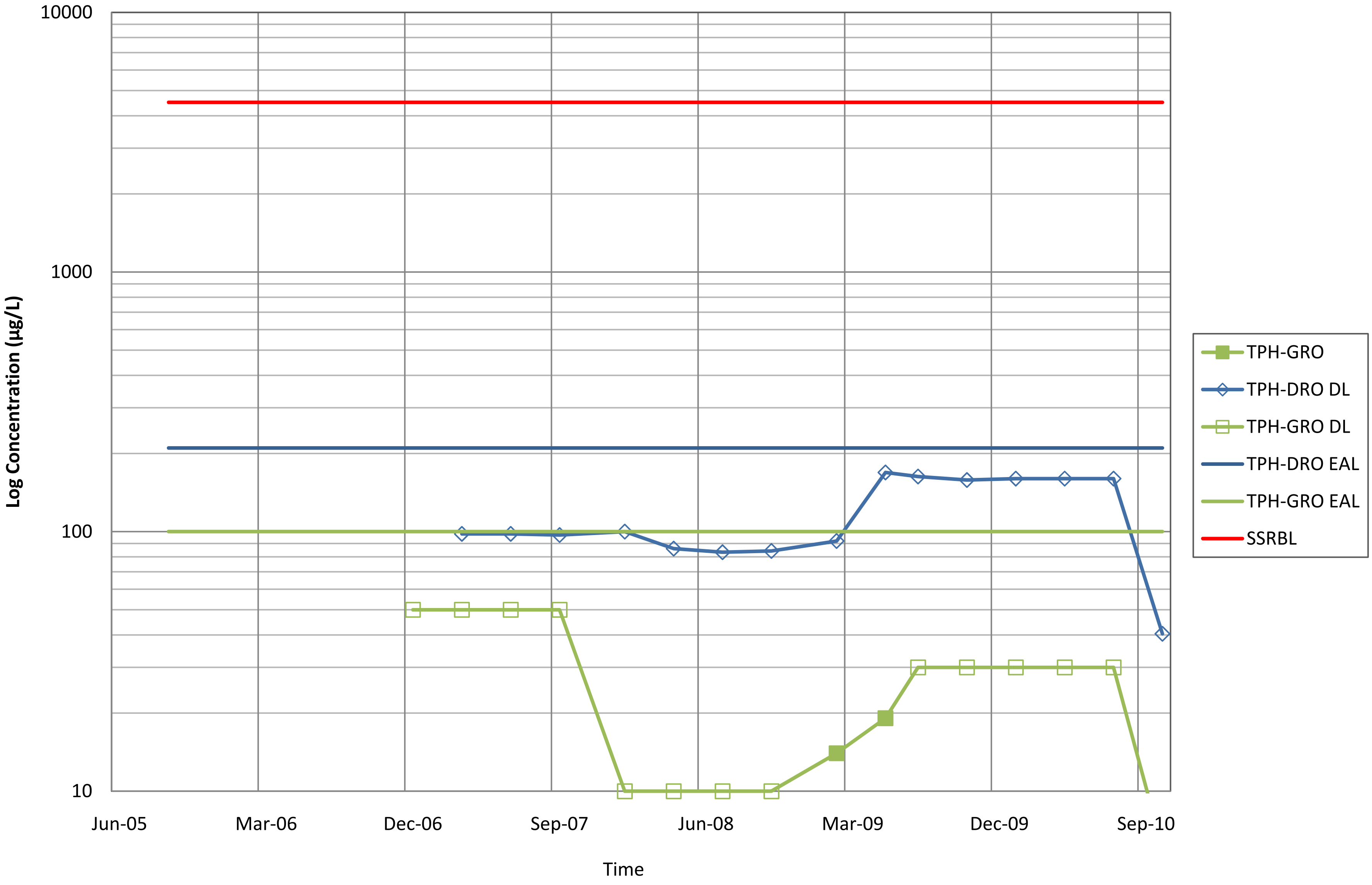


Figure A-2: TPH at RHMW01
Quarterly Monitoring Results

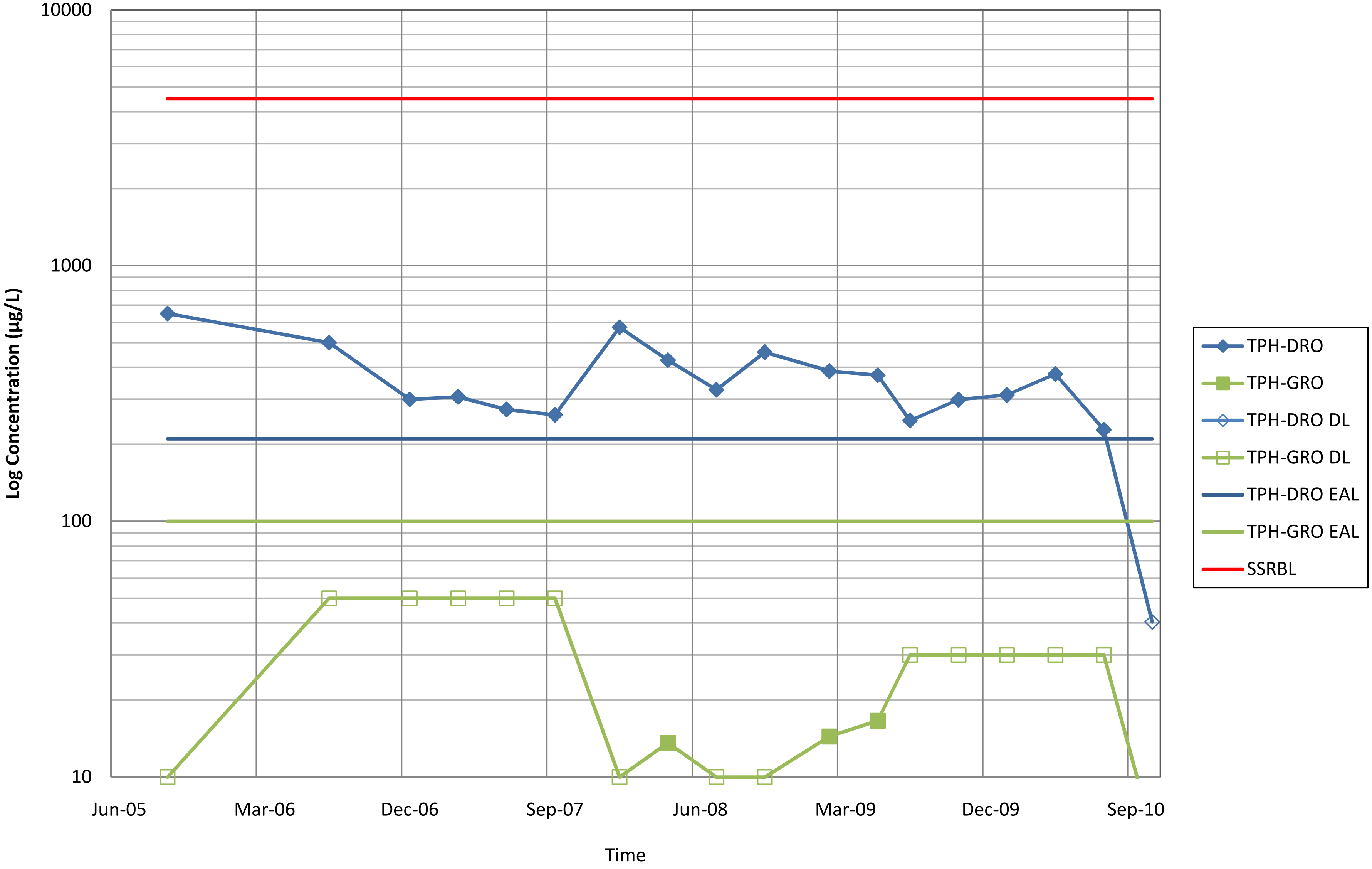


Figure A-4: TPH at RHMW03
Quarterly Monitoring Results

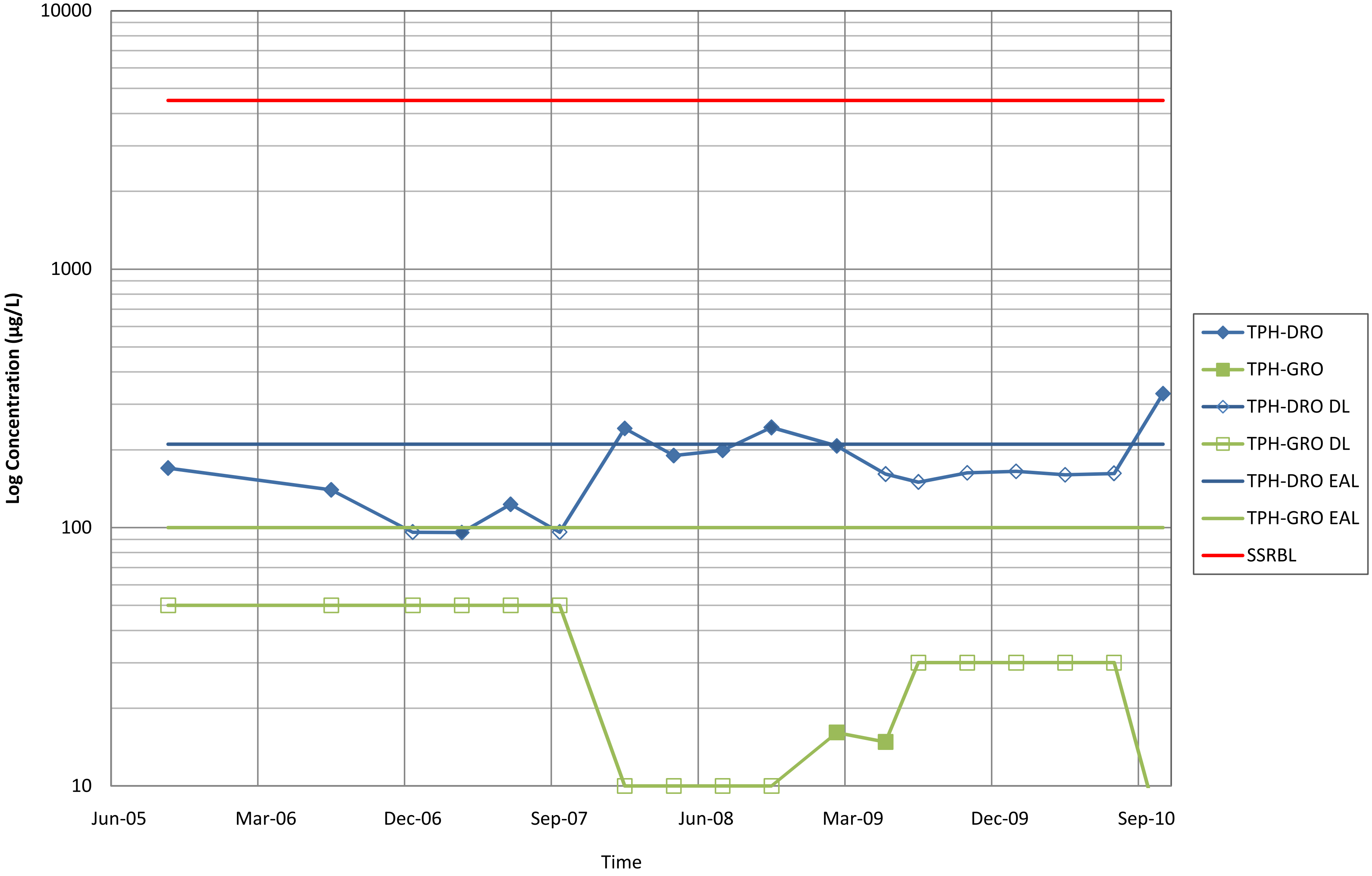


Figure A-3: TPH at RHMW02
Quarterly Monitoring Results

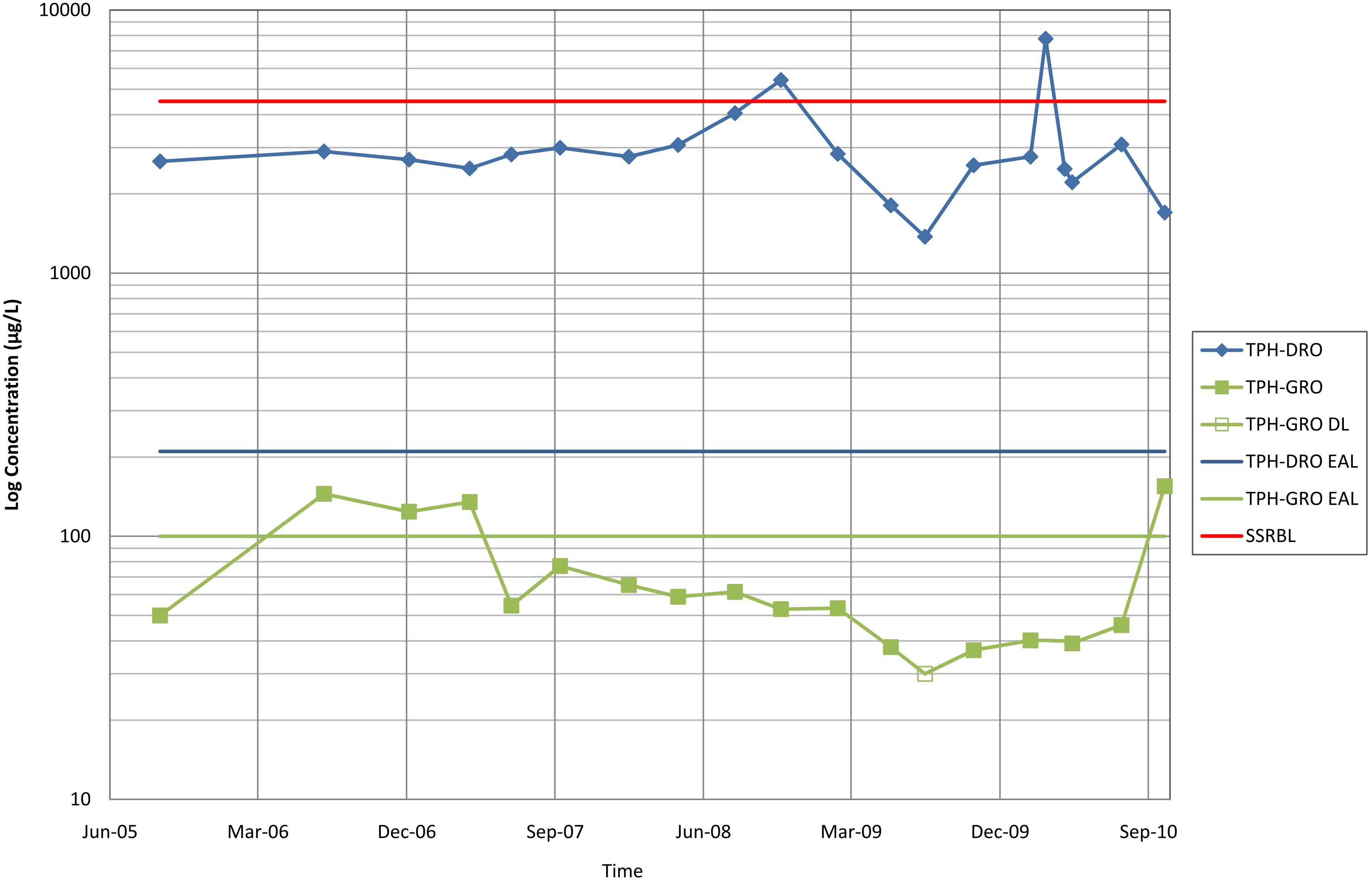
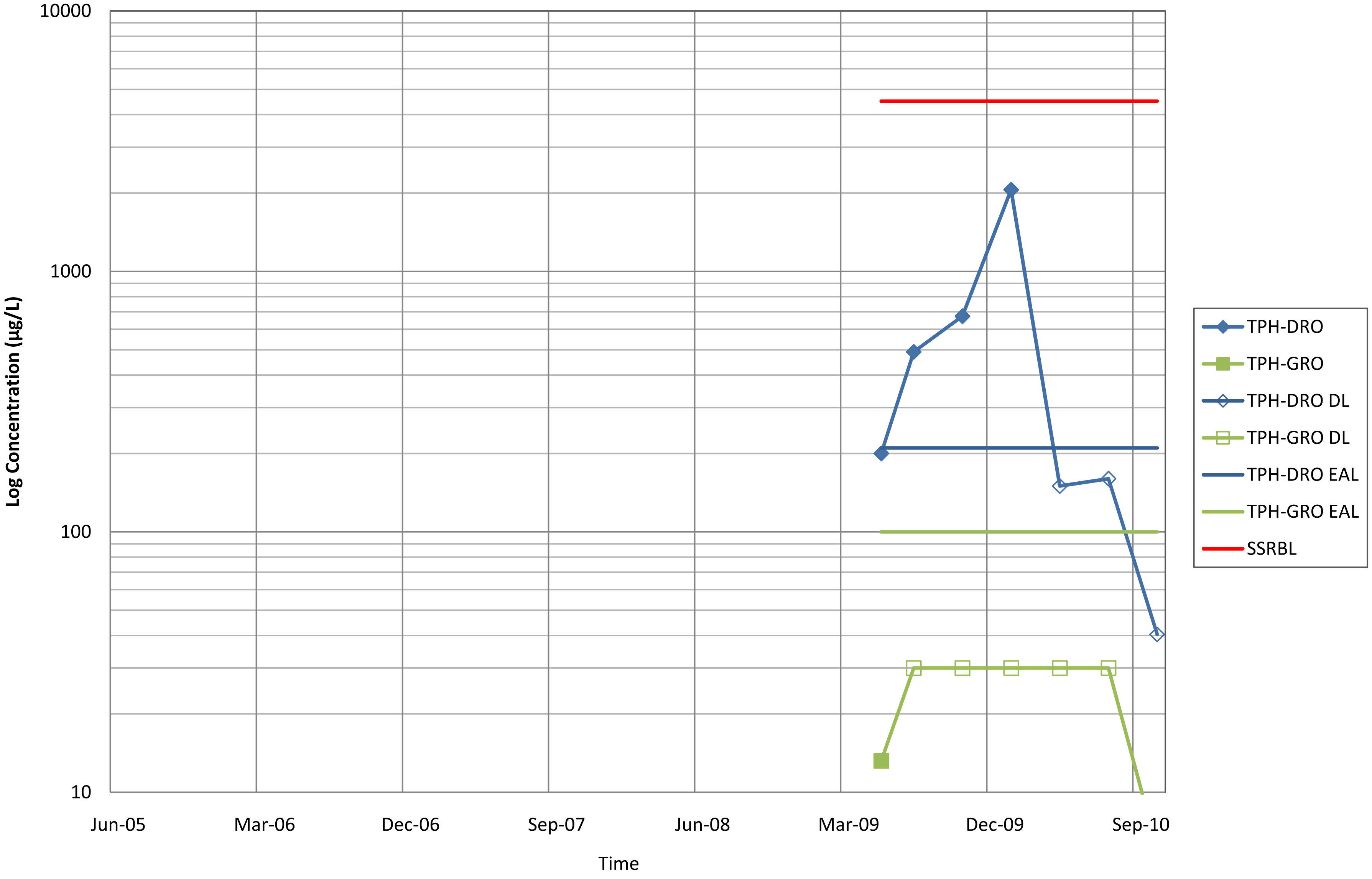


Figure A-5: TPH at RHMW05
Quarterly Monitoring Results



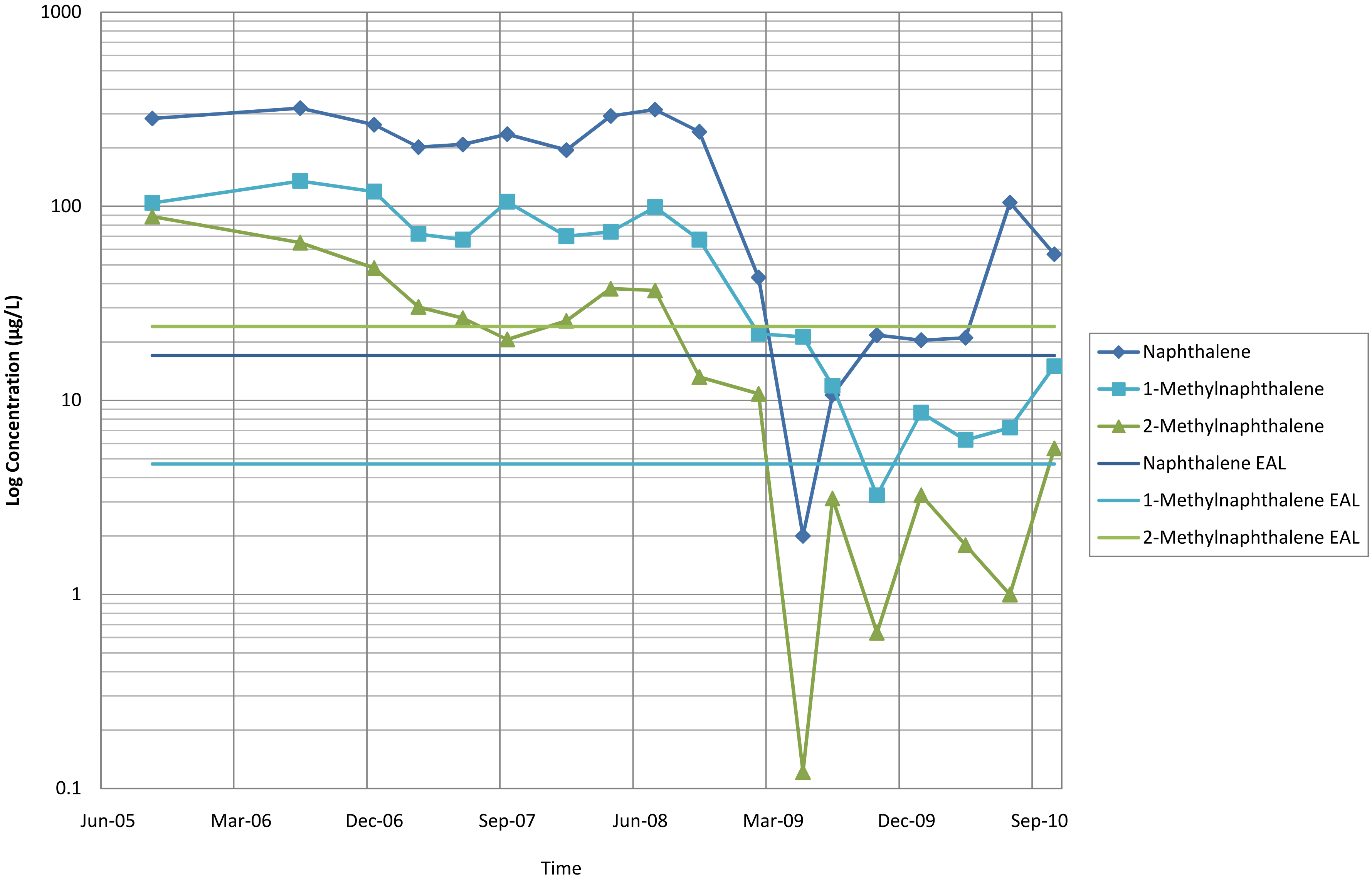


Figure A-6: PAHs at RHMW02
Quarterly Monitoring Results

Appendix B
Field Notebook, October-November 2010

1022-015 LTM Red Hill Bulk Fuel Storage Facility

October 18, 2010

Task: Quarterly GW monitoring + monthly soil vapor and oil/water interface monitoring.

Personnel: VD, SF, MS, & MC

Weather: Outside the tunnel, Sunny

PPE: Level D, hearing protection

Equipment: Horiba U22, ppbRae Plus, mini~~ppb~~Rae 2000, pump controller, vacuum chamber, compressor, elec pump.

Safety Meeting: Conducted by MS

0645 MS + MC left Dole Office to pick up Key from Pearl Harbor Bldg 1757 (FISC).

0700 VD + SF Left Dole office, stop by storage unit + and buy ice + drinks

0800 Arrived at Adit 3, meet for the safety meeting

0820 MS + MC left Adit 3 to Adit 5 to conduct soil vapor monitoring

*ppbRae calibrated outside the tunnel

* MiniRae calibrated at the office

0830 Waited for the tunnel train

1022-015 LTM Red Hill Bulk Storage Facility

0900 Horiba U22 calibrated

Readings: pH = 3.96 S/m DO = 8.20 g/m

cond = 0.452 Temp = 26.0 °C

Turb = 0.0 NTU Sal = 0.2

ORP = 304 mV

0920 Arrive at RHMW01 Background level at MW is 0.4 ppm

0.3 ppm inside well.

Well Diameter is 1.5 inches.

0925 85.29 Ft. No product.

2 extension cords were not able to reach the outlet. We were not able to sample RHMW01 today.

Office: 471-0630 Train

Sump Tanks 1-8: 474-6683

Tanks 9-16: 474-3711

call to Schedule Pick ups.

1100 Left MW01

1105 Arrive MW 03 via Train

Background is 0.8 ppm

Inside well 0.0 ppm

October 18, 2010

1115 Product monitoring "NO" product

1137 Started purging

1150 → Took Sample at MW3 ES001.
104.81 ft after purge

1235 Depth to. bottom of well is greater than 110 ft. Extension cord reaches.

1325 Arrive at RHMW2
Background level from PID 1ppm
Inside well: 1.0ppm

1400 Collected sample ES002 + ES003
Rate is good at 70psi

1440 Finished and took train to Adit 3.
Tomorrow call number in Adit 3 when ready for pickup.

1700 Filled out COC for todays samples.
arrived at the office.

October 18, 2010

Activity: Soil vapor Monitoring
Personnel: MS, MC
Equipment: PPb Rae, Vacuum, pump, tedlar bags.

08:40 - Calibrate PPb Rae, set up, H&S meeting. enter Adit 5.

09:03 - Arrive at SVMP15, purge. Substitute Yellow tape for Orange (Shallow SVMP) all wells. Missing tube. Meet Ground water team to retrieve part.

10:34: Battery low, take lunch to recharge battery.

11:40 - Back to SVMP15, purge.

12:30 - Collect sample at SVMP15

12:40 - purge SVMP15D

12:45 - sample SVMP15D ambi: 600 ppb

12:53 - arrive at SVMP16 - shallow + mid depth tubes missing. Purge SVMP16D
SVMP 16D - obstructed, could not sample.

13:06 - arrive at SVMP17, under construction, mobilize to SVMP18.

13:08 - purge SVMP18S

13:11 - Sample SVMP18S

13:15 - purge SVMP18D

October 19, 2010

~~Personnel~~ Task: Quarterly Groundwater monitoring inside wells continued

~~Weather~~ Personnel: S. Koide, S. Fineran

Weather: Outside the tunnel - mostly sunny

PPE: Level D, gloves, fall protection

Equipment: Horiba U22, ppmRAE, pump controller, pump compressor, solinst oil/water interface

0735 Leave Dole office

0749 Arrive @ Home Depot to purchase extension cord

0801 Leave Home Depot

0820 pick up ice from 7-11 in Aiea

0837 Arrive at ADIT 3, meet Darren Uchima (Navy) and Tony, unpack

0845 Conduct safety meeting

0850 Miya and Max go to ADIT 5 for soil vapor monitoring; SK, SF, and Darren wait for train

0907 take train to pump Stn.

0914 Arrive @ pump Stn.

0928 SK enter well with fall protection in place.

- PID @ RHMW2254-01 = 0.0 ppm
- Depth to water from Platform hole ≈ 84.85 ft

0946 begin purging

0950 Stopped pump and get bottles

1010 Collect sample = ES004

1035 disconnect and cleanup

1052 move out of pump stn and wait for train

1130 Exit ADIT 3 to call train (was scheduled to have met at 11:15 am)

1145 train arrive, go to RHMW01

1152 arrive at RHMW01, drop off supplies

1208 Exit ADIT 5, Lunch break

1227 Enter ADIT 5 and walk to RHMW01, meet up w/ MS IMC

1244 Arrive at RHMW01

1246 PID = 0.0 ppm

1253 Depth to water = 85.19 ft

try to attach fittings, missing air hose fitting, pulled up pump to check hose (try to determine air line and water line).

1339 Document fitting (take pictures), MS IMC leave

1350 Check extension cord length for RHMW05

1419 Catch train

1443 Leave ADIT 3

1459 Drop off FISC Key @ Bldg 1757

1502 Leave Pearl Harbor

1535 Arrive at Dole office — End of Entry

October 20, 2010

TASK: Quarterly Groundwater Monitoring, inside wells continued

personnel: S. Koide, S. Finecan

weather: outside the tunnel ÷ mostly sunny

PPE: Level D w/ gloves

Equipment: Horiba U22, ppmRAE, pump controller, pump compressor, Solinst oil/water interface probe

0735 Leave Pole office and pick up ice

0815 Pick up FISC key

0834 Arrive at ADIT 3

0836 call train and arrange pickup

0838 Conduct Safety meeting

0844 Load train cart and wait for train

0901 Calibrate Horiba

pH = 4.00 DO = 8.12

Cond = 0.445 temp = 25.9

Turb = 0.1 Sal = 0.2

orp = 326

0907 train arrive

0912 arrive at RHMW05 and set up equipment

0924 PID = 0.0 ppm

0930 Depth to water = 84.75 ft
no fuel product detected.

0939 Begin purging at RHMW05

0943 The pump compressor keeps stopping
→ it runs if you purge the air line.

0948 pump compresser stops completely
troubleshoot

0956 Try increasing flow rate.
Suspect that compresser is too strong

1003 Pump died, start again, purge line (air)
when pumping.

1016 Stop purging water

1020 Depth to water after purging = 84.74 ft

1025 Collect sample = ES005

1052 Load train

1057 Drop off supplies at RHMW01, take break

1109 Setup at RHMW01

1121 Ambient air = 0.0 ppm
PID inside RHMW01 = 0.0 ppm

1132 Depth to water = 85.30 ft

1140 Vilma arrive

1211 Start pump compresser – not purging
troubleshoot, will take pump to office.

1245 clean up

1259 Leave RHMW01 on train

1318 Exit ADIT 3

1327 Lunch break
1343 Leave Site
1357 Drop off FISC Key
- was told that vilma can go to FISC office and get a duplicate key.

1419 Arrive at PCS and pickup 55 gallon drum for outside well sampling
1430 Arrive at Kmart and buy ice chest and blue ice.
1455. Leave Kmart
1515 Back in office.

End of Entry

October 21, 2010

Task: Continue monthly Soil Vapor monitoring and Quarterly Groundwater monitoring (outside wells)
personnel: S. Korde, S. Fineran, M. Solmssen, V. Dupta.
weather: Sunny, light to no breeze
PPE: Level D w/ gloves
Equipment: PPbRAE, Horiba U22, pump, vaccum chamber, Solinst, bailers

0725 Leave Dole office (SK&SF) go to pickup FISC key
0747 Pickup FISC Key (6)
0808 Arrive at ADIT 5
0810 - Safety meeting
0827 Arrive at SVMP 16
Ambient air = 280 ppb
0831 begin Purging SV16S (purge 2 min)
0834 Collect Sample
0839 begin purging at SV16M
0841 done purging, collect Sample
0846 begin purging at SV16D
0848 done purging, collect Sample
0857 Arrive at SVMP 06
0901 begin purging @ SV06S
0903 stop purging, collect Sample.

1022-015 LTM Red Hill Bulk Fuel Storage Facility
34

October 28, 2010

TASK: Ground water monitoring RHMW01

personnel: SK, SF

weather: outside mostly sunny

PPE: Level D, gloves

Equipment: ppbRAE, Horiba, compressor controller, Sohnsa

SK

0958 ~~Leave Dole office~~
0908 calibrated PID and Horiba

pH	4.00	Temp	24.9
Cond	4.56	Sal	0.2
Turb	0.0	orp	328
DO	8.56		

1015 pickup ADIT 3 Key
1024 pickup ice from 7-11 (Aiea)
1037 Arrive @ ADIT 3
1048 Safety meeting, wait for train
1109 train arrive
1121 Arrive @ RHMW01
1126 PID = 0.0 ppm
Depth to water = 85.31 ft
1143 Start purging = not getting water, slow
1218 Stop purging - set up bailer
1225 bail water. Bailer not working ~~(slow)~~
Bailer working but slow. SK sick decide to leave tunnels.

10-28-10 1022-015 LTM RHSF
35

1324 Train picked up. Left for Adit 3
1414 Dropped off key at Navy (SF)
Went to Storage
1500 Back to office

End of Entry

1022-015 LTM Red Hill RHSF

November 3 2010

Task Groundwater Monitoring at RHMW01

0645 Met at office & got field equipment ready

0710 Called Robert to notify him we are doing gw monitoring

0800 Left office after speaking with Vilma

0815 Stopped by Storage

1037 Stopped by 1757 to pick up adit 3 Key. Halawa Gate had ~~concert~~ SF terrible traffic.

1120 Arrived at Adit 3 just as train arrived.

1135 ~~Man~~ Arrived at RHMW-01

Calibrate PID, PPM PID level 130.0 ppm

Calibrated Horiba: PH 4.01

Cond 0.449

Turb 0.0

DO 8.43

Depth to GW was 85.19ft

1254 Sample time of ES009

Air compressor needs help purging during the discharge cycle or it overheats & turns off

1415 Train picked us up

Controller was working with Discharge at 5 Charge 5 60 psi

11-3-10 1022-015 LTM RHSF

1430 Left tunnels

1450 Arrived at Gaspro to return Nitrogen & purchased a fitting with threads that match nitrogen tank. Compressed air is too heavy & Large.

1520 Arrived at Storage & unloaded

1345 Got back to office

End of Entry

MRS 11/4/10

Stacy L

Appendix C
Groundwater Sampling Logs, October-November 2010

GROUNDWATER SAMPLING LOG

WELL ID: RHMW2254-01 LOCATION: Red Hill Bulk Fuel Storage Facility PROJECT NO: 1022-015

INITIAL WATER LEVEL: not applicable (N/A) DATE: 10/19/2010 TIME: 0930

TOTAL DEPTH OF WELL: unknown PERSONNEL INVOLVED: S. Fineran, S. Koide

LENGTH OF SATURATED ZONE: N/A WEATHER CONDITIONS: N/A

VOLUME OF WATER TO BE REMOVED: N/A METHOD OF REMOVAL: Low flow dedicated bladder pump

WATER LEVEL AFTER PURGING: N/A PUMPING RATE: Approximately 1 L/min

WELL PURGE DATA:

TIME	VOLUME REMOVED	pH	COND (mS/m)	TURBIDITY (NTU)	DO (mg/l)	TEMP (^{o}C)	SALINITY (%)	REDOX (ORP) (mV)
0946	2 L	5.99	55.4	1.1	9.09	21.9	0.0	202
0949	4 L	6.19	55.4	2.1	8.51	21.7	0.0	202
0950	6 L	6.69	54.7	1.7	8.34	21.7	0.0	202
0954	8 L	6.72	54.8	1.7	8.37	22.2	0.0	202
0958	10 L	6.77	54.6	2.0	8.50	21.8	0.0	201
1003	12 L	6.82	54.7	2.2	8.50	21.6	0.0	201

SAMPLE RETRIEVAL METHOD: Low flow dedicated bladder pump

SAMPLE ID: ES004 (RH-RHMW2254-01-GW21)

SAMPLE COLLECTION TIME: 1010

SAMPLED BY: S. Fineran, S. Koide

APPEARANCE OF SAMPLE:

COLOR Clear

TURBIDITY None

SEDIMENT None

OTHER

COMMENTS AND OBSERVATIONS: PID = 0.0 ppm

Depth to water from the platform hole was approximately 84.85 feet.

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES: TPH-GRO (EPA 8260B) & VOCs (EPA 8260B) with hydrochloric acid preservative, TPH-DRO (EPA8015B) & PAHs (EPA 8270D SIM) with no preservative, and dissolved lead (EPA 6020) with nitric acid preservative

NUMBER AND TYPES OF SAMPLE CONTAINERS FILLED: (4) - 40 mL VOAs, (4) - 1 L amber bottle, (1) - 500 mL polyethylene bottle

DECONTAMINATION PROCEDURES: Alconox, triple rinse with distilled water

SAMPLES DELIVERED TO: APPL, Inc. via FedEx TRANSPORTERS: VD, MS

SAMPLE DELIVERY DATE: 10/21/10 (to FedEx) SAMPLE DELIVERY TIME: 1345

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16; 4"-0.65; 6"-1.47; 8"-2.61; 10"-4.08; 12"-5.87

GROUNDWATER SAMPLING LOG

WELL ID: RHMW01 LOCATION: Red Hill Bulk Fuel Storage Facility PROJECT NO: 1022-015

INITIAL WATER LEVEL: 85.19 feet bTOC (below top of casing) DATE: 11/3/2010 TIME: 1146

TOTAL DEPTH OF WELL: unknown PERSONNEL INVOLVED: S. Fineran, M. Solmssen

LENGTH OF SATURATED ZONE: N/A WEATHER CONDITIONS: Rainy (outside of tunnel)

VOLUME OF WATER TO BE REMOVED: N/A METHOD OF REMOVAL: Low flow dedicated bladder pump

WATER LEVEL AFTER PURGING: 85.14 feet bTOC PUMPING RATE: Approximately 0.07 L/min

WELL PURGE DATA:

TIME	VOLUME REMOVED	pH	COND (mS/m)	TURBIDITY (NTU)	DO (mg/l)	TEMP (^{o}C)	SALINITY (%)	REDOX (ORP) (mV)
1214	8 oz (0.2L)	6.74	35.4	26.4	5.80	24.9	0.0	-100
1217	16 oz (0.5L)	6.84	35.1	22.1	3.56	24.9	0.0	-105
1220	24 oz (0.7L)	6.91	35.1	20.5	3.42	24.8	0.0	-108
1224	28 oz (0.8L)	6.97	35.2	15.9	2.77	24.9	0.0	-108
1231	36 oz (1L)	7.02	35.5	11.3	2.28	24.9	0.0	-108
1233	44 oz (1.3L)	7.03	35.3	9.4	1.97	24.9	0.0	-108

SAMPLE RETRIEVAL METHOD: Low flow dedicated bladder pump

APPEARANCE OF SAMPLE:
COLOR Clear
TURBIDITY None
SEDIMENT None
OTHER

SAMPLE ID: ES009 (RH-RHMW01-GW21)
SAMPLE COLLECTION TIME: 1254
SAMPLED BY: S. Fineran, M. Solmssen

COMMENTS AND OBSERVATIONS: PID = 0.0 ppm
Compressor is overheating and keeps turning off.

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES: TPH-GRO (EPA 8260B) & VOCs (EPA 8260B) with hydrochloric acid preservative, TPH-DRO (EPA8015B) & PAHs (EPA 8270D SIM) with no preservative, and dissolved lead (EPA 6020) with no preservative (to be filtered in the laboratory)

NUMBER AND TYPES OF SAMPLE CONTAINERS FILLED: (4) - 40 mL VOAs, (4) - 1 L amber bottle, (1) - 500 mL polyethylene bottle

DECONTAMINATION PROCEDURES: Alconox, triple rinse with distilled water
SAMPLES DELIVERED TO: APPL, Inc. via FedEx TRANSPORTERS: SF
SAMPLE DELIVERY DATE: 11/4/2010 (to FedEx) SAMPLE DELIVERY TIME: 1410

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16; 4"-0.65; 6"-1.47; 8"-2.61; 10"-4.08; 12"-5.87

GROUNDWATER SAMPLING LOG

WELL ID: RHMW02 LOCATION: Red Hill Bulk Fuel Storage Facility PROJECT NO: 1022-015

INITIAL WATER LEVEL: 87.91 feet bTOC DATE: 10/18/2010 TIME: 1335

TOTAL DEPTH OF WELL: unknown PERSONNEL INVOLVED: V. Dupra, S. Fineran

LENGTH OF SATURATED ZONE: N/A WEATHER CONDITIONS: N/A

VOLUME OF WATER TO BE REMOVED: N/A METHOD OF REMOVAL: Low flow dedicated bladder pump

WATER LEVEL AFTER PURGING: 87.90 feet bTOC PUMPING RATE: Approximately 1 L/min

WELL PURGE DATA:

TIME	VOLUME REMOVED	pH	COND (mS/m)	TURBIDITY (NTU)	DO (mg/l)	TEMP (^{o}C)	SALINITY (%)	REDOX (ORP) (mV)
1344	2 L	6.37	53.5	2.4	1.45	24.5	0.0	-102
1345	3 L	6.30	52.7	2.2	0.74	24.2	0.0	-102
1346	4 L	6.26	52.5	2.0	0.65	24.2	0.0	-103
1347	5 L	6.28	52.8	2.1	0.71	24.3	0.0	-100
1350	6 L	6.28	52.9	1.9	0.77	24.4	0.0	-90
1352	7 L	6.24	53.2	1.6	0.47	24.5	0.0	-87
1354	8 L	6.26	53.5	1.6	0.43	24.5	0.0	-88
1355	9 L	6.21	53.7	1.6	0.48	24.5	0.0	-85
1356	10 L	6.22	53.4	1.7	0.46	24.6	0.0	-84
1357	11 L	6.22	53.5	1.8	0.47	24.2	0.0	-80
1358	12 L	6.24	53.8	1.8	0.48	24.2	0.0	-79

SAMPLE RETRIEVAL METHOD: Low flow dedicated bladder pump

SAMPLE ID: ES002 (RH-RHMW02-GW21)

SAMPLE COLLECTION TIME: 1400

SAMPLED BY: V. Dupra, S. Fineran

APPEARANCE OF SAMPLE:

COLOR Clear

TURBIDITY None

SEDIMENT None

OTHER

COMMENTS AND OBSERVATIONS: PID = 0.0 ppm

Collected MS/MSD sample

Collected duplicate sample = ES003 (RH-RHMW02-GW21 Dup)

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES: TPH-GRO (EPA 8260B) & VOCs (EPA 8260B) with hydrochloric acid preservative, TPH-DRO (EPA8015B) & PAHs (EPA 8270D SIM) with no preservative, and dissolved lead (EPA 6020) with nitric acid preservative

NUMBER AND TYPES OF SAMPLE CONTAINERS FILLED: Primary and duplicate: (4) - 40 mL VOAs, (4) - 1 L amber bottle, (1) - 500 mL polyethylene bottle

MS/MSD: (7) - 40 mL VOAs, (6) - 1 L amber bottle, (2) - 500 mL polyethylene bottle

DECONTAMINATION PROCEDURES: Alconox, triple rinse with distilled water

SAMPLES DELIVERED TO: APPL, Inc. via FedEx TRANSPORTERS: VD, SF

SAMPLE DELIVERY DATE: 10/19/10 (to FedEx) SAMPLE DELIVERY TIME: 1200

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16; 4"-0.65; 6"-1.47; 8"-2.61; 10"-4.08; 12"-5.87

GROUNDWATER SAMPLING LOG

WELL ID:	RHMW03	LOCATION:	Red Hill Bulk Fuel Storage Facility	PROJECT NO:	1022-015

INITIAL WATER LEVEL: 104.13 feet bTOC
DATE: 10/18/2010
TIME: 1141
TOTAL DEPTH OF WELL: unknown
PERSONNEL INVOLVED: V. Dupra, S. Fineran
LENGTH OF SATURATED ZONE: N/A
WEATHER CONDITIONS: N/A
VOLUME OF WATER TO BE REMOVED: N/A
METHOD OF REMOVAL: Low flow dedicated bladder pump
WATER LEVEL AFTER PURGING: 104.81 feet bTOC
PUMPING RATE: Approximately 1 L/min

WELL PURGE DATA:

TIME	VOLUME REMOVED	pH	COND (mS/m)	TURBIDITY (NTU)	DO (mg/l)	TEMP (^oC)	SALINITY (%)	REDOX (ORP) (mV)
1141	4 L	6.39	90.5	6.2	0.65	26.9	0.0	219
1142	5 L	6.43	93.6	1.5	0.49	26.9	0.0	169
1143	6 L	6.40	88.0	0.1	0.50	26.8	0.0	129
1144	7 L	6.41	92.1	0.5	0.54	26.8	0.0	104
1145	8 L	6.47	90.4	0.0	0.66	26.8	0.0	85
1146	9 L	6.45	85.9	0.1	0.67	26.8	0.0	78
1147	11 L	6.50	90.7	0.1	0.61	26.8	0.0	74
1148	12 L	6.47	87.5	1.7	0.59	26.8	0.0	69

SAMPLE RETRIEVAL METHOD: Low flow dedicated bladder pump
SAMPLE ID: ES001 (RH-RHMW03-GW21)
SAMPLE COLLECTION TIME: 1150
SAMPLED BY: V. Dupra

APPEARANCE OF SAMPLE:
COLOR Clear
TURBIDITY None
SEDIMENT None
OTHER

COMMENTS AND OBSERVATIONS: PID = 0.0 ppm

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES: TPH-GRO (EPA 8260B) & VOCs (EPA 8260B) with hydrochloric acid preservative, TPH-DRO (EPA8015B) & PAHs (EPA 8270D SIM) with no preservative, and dissolved lead (EPA 6020) with nitric acid preservative

NUMBER AND TYPES OF SAMPLE CONTAINERS FILLED: (4) - 40 mL VOAs, (4) - 1 L amber bottle, (1) - 500 mL polyethylene bottle

DECONTAMINATION PROCEDURES: Alconox, triple rinse with distilled water
SAMPLES DELIVERED TO: APPL, Inc. via FedEx
TRANSPORTERS: VD, SF
SAMPLE DELIVERY DATE: 10/19/10 (to FedEx)
SAMPLE DELIVERY TIME: 1200

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16; 4"-0.65; 6"-1.47; 8"-2.61; 10"-4.08; 12"-5.87

GROUNDWATER SAMPLING LOG

WELL ID: RHMW05 LOCATION: Red Hill Bulk Fuel Storage Facility PROJECT NO: 1022-015

INITIAL WATER LEVEL: 84.75 feet bTOC DATE: 10/20/2010 TIME: 0939

TOTAL DEPTH OF WELL: unknown PERSONNEL INVOLVED: S. Fineran, S. Koide

LENGTH OF SATURATED ZONE: N/A WEATHER CONDITIONS: N/A

VOLUME OF WATER TO BE REMOVED: N/A METHOD OF REMOVAL: Low flow dedicated bladder pump

WATER LEVEL AFTER PURGING: 84.74 feet bTOC PUMPING RATE: Approximately 0.25 L/min

WELL PURGE DATA:

TIME	VOLUME REMOVED	pH	COND (mS/m)	TURBIDITY (NTU)	DO (mg/l)	TEMP (^oC)	SALINITY (%)	REDOX (ORP) (mV)
0942	2 L	6.11	27.9	125.0	7.73	22.7	0.0	216
0958	3 L	6.77	27.8	40.2	7.44	23.5	0.0	212
1001	4 L	6.84	28.5	27.8	7.30	23.0	0.0	208
1012	6 L	6.85	29.3	14.6	7.29	22.8	0.0	213
1014	7 L	6.87	29.6	34.1	7.30	22.3	0.0	212
1016	8 L	6.86	29.9	27.1	7.29	22.3	0.0	212

SAMPLE RETRIEVAL METHOD: Low flow dedicated bladder pump

SAMPLE ID: ES005 (RH-RHMW05-GW21)

SAMPLE COLLECTION TIME: 1025

SAMPLED BY: S. Fineran, S. Koide

APPEARANCE OF SAMPLE:

COLOR Clear

TURBIDITY None

SEDIMENT None

OTHER

COMMENTS AND OBSERVATIONS: PID = 0.0 ppm

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES: TPH-GRO (EPA 8260B) & VOCs (EPA 8260B) with hydrochloric acid preservative, TPH-DRO (EPA8015B) & PAHs (EPA 8270D SIM) with no preservative, and dissolved lead (EPA 6020) with nitric acid preservative

NUMBER AND TYPES OF SAMPLE CONTAINERS FILLED: (4) - 40 mL VOAs, (4) - 1 L amber bottle, (1) - 500 mL polyethylene bottle

DECONTAMINATION PROCEDURES: Alconox, triple rinse with distilled water

SAMPLES DELIVERED TO: APPL, Inc. via FedEx TRANSPORTERS: MS, VD

SAMPLE DELIVERY DATE: 10/21/2010 (to FedEx) SAMPLE DELIVERY TIME: 1345

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16; 4"-0.65; 6"-1.47; 8"-2.61; 10"-4.08; 12"-5.87

Appendix D
Laboratory Analytical Results, October-November 2010 (on CD-ROM)