

Final First Quarter 2016 - Quarterly Groundwater Monitoring Report Outside Tunnel Wells

**Red Hill Bulk Fuel Storage Facility
Joint Base Pearl Harbor-Hickam, Oahu, Hawaii**

DOH Facility ID No.: 9-102271

DOH Release ID Nos.: 990051, 010011, 020028, and 140010

March 2016



Contract Number N62742-14-D-1884, CTO 0014

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Prepared for:

**Naval Supply Systems Command
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21 March 2016

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ACRONYMS AND ABBREVIATIONS

ACRONYMS/ ABBREVIATIONS	DEFINITION / MEANING
bgs	below ground surface
COC	Chain-of-Custody
COPC	Contaminant of Potential Concern
CTO	Contract Task Order
DLNR	State of Hawaii Department of Land and Natural Resources
DoD	Department of Defense
DOH	State of Hawaii Department of Health
DON	Department of the Navy
DQO	Decision Quality Objective
E2	Element Environmental, LLC
EAL	Environmental Action Level
EPA	Environmental Protection Agency
ESI	Environmental Science International, Inc.
F-76	Marine Diesel Fuel
ID	Identification
JBPHH	Joint Base Pearl Harbor-Hickam
JP-5	Jet Fuel Propellant-5
JP-8	Jet Fuel Propellant-8
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LOD	Limit of Detection
LOQ	Limit of Quantitation
µg/L	microgram per liter
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAVFAC	Naval Facilities Engineering Command
NAVSUP FLC	Naval Supply Systems Command Fleet Logistics Center
ND	Not Detected
PAH	Polycyclic Aromatic Hydrocarbon
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
pH	potential of hydrogen
QC	Quality Control
QSM	Quality Systems Manual
RHSF	Red Hill Bulk Fuel Storage Facility
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
TEC	The Environmental Company, Inc.
TPH	Total Petroleum Hydrocarbons
TPH-d	Total Petroleum Hydrocarbons as diesel
TPH-g	Total Petroleum Hydrocarbons as gasoline
TPH-o	Total Petroleum Hydrocarbons as oil
U.S.	United States
UST	Underground Storage Tank
VOC	Volatile Organic Compound

WP

Work Plan

EXECUTIVE SUMMARY

This quarterly groundwater monitoring report presents the results of the First Quarter 2016 groundwater sampling event, conducted on 19 January 2016, at the outside tunnel wells of the Red Hill Bulk Fuel Storage Facility (RHSF), Joint Base Pearl Harbor-Hickam (JBPHH), Hawaii. The RHSF is located in Halawa Heights on the island of Oahu. There are 18 active and 2 inactive underground storage tanks (USTs) located at the RHSF. The State of Hawaii Department of Health (DOH) Facility Identification (ID) number is 9-102271. The DOH Release ID numbers are 990051, 010011, 020028, and 140010.

The groundwater sampling was conducted as part of the long-term groundwater and soil vapor monitoring program at the RHSF and concurrent with release response activities initiated at Tank 5 in January 2014, for Naval Supply Systems Command Fleet Logistics Center (NAVSUP FLC) Pearl Harbor (formerly Fleet and Industrial Supply Center), under Naval Facilities Engineering Command (NAVFAC) Contract Number N62742-14-D-1884, Contract Task Order (CTO) 0014. The sampling was conducted in accordance with the approved *Work Plan/Sampling and Analysis Plan (WP/SAP)* prepared by Element Environmental, LLC (E2).

The analyte list for the RHSF groundwater monitoring has been reduced to ten contaminants of potential concern (COPCs) as documented in the United States (U.S.) Environmental Protection Agency (EPA)/DOH letter, Enclosure A, Analytes and Action Levels, dated February 4, 2016 (Appendix D). Groundwater samples from existing wells are no longer going to be analyzed for analytes that have not been detected at significant concentrations during previous events, including lead scavengers 1,2-dibromoethane and 1,2-dichloroethane.

On 19 January 2016, E2 personnel collected groundwater samples from the five outside tunnel monitoring wells (OWDFMW01, HDMW2253-03, RHMW04, RHMW06, and RHMW07). In addition, one duplicate groundwater sample was collected from well RHMW04. All groundwater samples were analyzed for petroleum constituents. Analytical results were compared to the DOH Tier 1 Environmental Action Levels (EALs) listed in the U.S. EPA/DOH letter, Enclosure A, Analytes and Action Levels, dated February 4, 2016 (Appendix D). A summary of the analytical results is provided below.

- **OWDFMW01** – The concentration of total petroleum hydrocarbons as diesel (TPH-d) (320 micrograms per liter [µg/L]) was detected above the DOH Tier 1 EAL. TPH as oil (TPH-o) (69 µg/L); polycyclic aromatic hydrocarbons (PAHs) 1-methylnaphthalene (0.030 µg/L), 2-methylnaphthalene (0.020 µg/L) and naphthalene (0.024 µg/L) and volatile organic hydrocarbons (VOCs) 1,2-dichloroethane (0.0096 µg/L) and toluene (0.18 µg/L) were also detected. However, none of these detected concentrations exceeded their respective DOH Tier 1 EALs. Toluene was also detected in the associated trip blank at a similar concentration and is likely the result of laboratory contamination. The consistently elevated potential of hydrogen (pH) detected in well OWDFMW01 suggests contamination from another source may be impacting the well.

- **HDMW2253-03** – Analytes detected in groundwater were TPH-d (43 µg/L), TPH-o (63 µg/L), and VOC toluene (0.24 µg/L). The concentrations did not exceed the DOH Tier 1 EALs. With the exception of one possibly erroneous result obtained during the event in April 2014, TPH-d concentrations have not exceeded the DOH Tier 1 EAL in well HDMW2253-03 since January 2013. Toluene was also detected in the associated trip blank at a similar concentration and is likely the result of laboratory contamination.
- **RHMW04** – Analytes detected in groundwater were TPH-d (36 µg/L) and TPH-o (52 µg/L), neither of which exceeded their respective DOH Tier 1 EALs.
- **RHMW06** – Analytes detected in groundwater were TPH-d (21 µg/L), TPH-o (28 µg/L), and VOC toluene (0.1 µg/L). None of the detected concentrations exceeded their DOH Tier 1 EALs. Toluene was also detected in the associated trip blank at a similar concentration and is likely the result of laboratory contamination.
- **RHMW07** – Analytes detected in groundwater were TPH-d (28 µg/L), TPH-o (44 µg/L), and PAHs 1-methylnaphthalene (0.0046 µg/L), 2-methylnaphthalene (0.0077 µg/L), and naphthalene (0.0038 µg/L). The concentrations did not exceed their respective DOH Tier 1 EALs.

During the January 2016 sampling event, TPH-d was detected at a concentration above the DOH Tier 1 EAL in OWDFMW01. The majority of the TPH-d concentration reported for the sample from OWDFMW01 was caused by a single peak. The compound or compound mixture represented by the single peak did not resemble a petroleum fuel. For both TPH-d and TPH-o in OWDFMW01, the total concentrations reported were likely inaccurate, because they were determined by comparison to a diesel and an oil standard, respectively. Additional scrutiny of the TPH-d concentrations in well OWDFMW01 is warranted. Based on an unnaturally high pH and the historical presence of acetone in well OWDFMW01, the associated sample data may not accurately represent the conditions of the groundwater at the site.

The groundwater contaminant concentrations in the other wells remained at low concentrations and did not change significantly since the previous sampling event (October 2015), or were not detected (ND). No COPCs in wells HDMW2253-03, RHMW04, RHMW06, or RHMW07 were detected at concentrations above their respective DOH Tier 1 EALs.

Based on a suspected 2014 release at the RHSF and the results of the recent groundwater sampling and analysis, continued groundwater monitoring at the RHSF is recommended. If the TPH-d concentrations significantly increase, the monitoring frequency should be increased to monthly, even though wells RHMW04, RHMW06, RHMW07, HDMW2253-03, and OWDFMW01 are not included in the *RHSF Groundwater Protection Plan (HDR, 2014)*.

An alternative means of collecting groundwater samples from the vicinity of well OWDFMW01 should be evaluated if TPH impacts continue to trend upwards and high pH conditions persist.

SECTION 1 – INTRODUCTION

This quarterly groundwater monitoring report presents the results of the First Quarter 2016 groundwater sampling event conducted on 19 January 2016, at the outside tunnel wells of the Red Hill Bulk Fuel Storage Facility (RHSF), Joint Base Pearl Harbor-Hickam (JBPHH), Hawaii. The RHSF is located in Halawa Heights on the island of Oahu. The purpose of the sampling is to (1) assess the condition of groundwater beneath and in the vicinity of the RHSF with respect to chemical constituents associated with jet fuel propellant and marine diesel fuel, and (2) to ensure the Navy remains in compliance with State of Hawaii Department of Health (DOH) underground storage tank (UST) release response requirements as described in Hawaii Administrative Rules 11-281 Subchapter 7, *Release Response Action* (DOH, 2013). The DOH Facility identification (ID) number for the RHSF is 9-102271. The DOH Release ID numbers are 990051, 010011, 020028, and 140010.

The groundwater sampling was conducted as part of the long-term groundwater and soil vapor monitoring program at the RHSF for the Naval Supply Systems Command Fleet Logistics Center (NAVSUP FLC) Pearl Harbor, under Naval Facilities Engineering Command (NAVFAC) Contract Number N62742-14-D-1884, Contract Task Order (CTO) 0014. The sampling was conducted in accordance with the approved *Work Plan/Sampling and Analysis Plan (WP/SAP)* prepared by Element Environmental, LLC (E2) (E2, 2015).

1.1 SITE DESCRIPTION

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

The RHSF contains 18 active and 2 inactive USTs, which are operated by NAVSUP FLC Pearl Harbor. Each UST has a capacity of approximately 12.5 million gallons. The RHSF is located approximately 100 feet above the basal aquifer. The USTs contain Jet Fuel Propellant-5 [JP-5], Jet Fuel Propellant-8 [JP-8], and Marine Diesel Fuel (F-76). The current status of each of the USTs is summarized in Table 1.1.

Five groundwater monitoring wells (OWDFMW01, HDMW2253-03, RHMW04, RHMW06, and RHMW07) are located outside of the RHSF tunnel system. Well HDMW2253-03 is located at the Halawa Correctional Facility (outside the RHSF); well OWDFMW01 is located at the former Oily Waste Disposal Facility near Adit 3; and wells RHMW04, RHMW06, and RHMW07 are

located on the north side of the RHSF along the road to the Navy Firing Range. Four groundwater monitoring wells (RHMW01, RHMW02, RHMW03, and RHMW05) are located within the RHSF lower access tunnel, and one sampling point (RHMW2254-01) is located at the Red Hill Shaft. Monitoring data for the four wells located inside the tunnel and one sampling point at Red Hill Shaft are included in a separate report.

As noted, monitoring wells RHMW01, RHMW02, RHMW03, and RHMW05 are located inside the underground tunnels. Sampling point RHMW2254-01 is located inside the infiltration gallery of the Department of the Navy (DON) drinking water supply Well 2254-01, which is located approximately 2,400 feet down-gradient of the USTs. It provides potable water to the JBPHH Water System, which serves approximately 65,200 military customers. NAVFAC Hawaii Public Works Department operates and maintains the infiltration gallery and DON Well 2254-01.

TABLE 1.1
Current Status of the USTs
Red Hill Bulk Fuel Storage Facility

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

F-76 Marine Diesel Fuel

JP-5 Jet Fuel Propellant-5

JP-8 Jet Fuel Propellant-8

1.2 PHYSICAL SETTING

Climatological conditions in the area of the RHSF consist of warm to moderate temperatures and low to moderate rainfall. The RHSF is leeward of the prevailing northeasterly trade winds. The average annual precipitation is approximately 40 inches, which occurs mainly between November and April (State of Hawaii Department of Land and Natural Resources (DLNR),

1986). Annual pan evaporation is approximately 75 inches (DLNR, 1985). Average temperatures range from the low 60s to high 80s (degrees Fahrenheit) (Atlas of Hawaii, 1983).

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

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

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

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

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

The nearest drinking water supply well is the Red Hill Shaft Well 2254-01, located in the infiltration gallery within the RHSF. The Well 2254-01 is located approximately 2,400 feet down-gradient of the USTs.

The nearest body of surface water is Halawa Stream, an ephemeral stream that is present along the north side of the RHSF. Except for the portion to the east of the Halawa Correctional Facility, the stream is contained by a concrete culvert. The stream is usually dry, but flows after periods of significant rainfall.

1.3 BACKGROUND

The RHSF, consisting of twenty USTs and a series of tunnels, was constructed by the U.S. Government in the early 1940s to supply fuel to the Navy. The USTs were constructed of steel and they currently contain JP-5, JP-8, and F-76. Several tanks in the past have stored DON special fuel oil, DON distillate, aviation gasoline, and motor gasoline (Environet, 2010). The fueling system is a self-contained underground unit that was installed into native rock comprised primarily of basalt with some interbedded tuffs and breccias (Environet, 2010). Each UST measures approximately 250 feet in height and 100 feet in diameter. The upper domes of the tanks lie at depths varying between 100 feet and 200 feet below ground surface (bgs).

In response to increasing concentrations of contaminants of potential concern (COPCs) in the groundwater monitoring wells within the facility (specifically RHMW02) during the 2008 sampling events, quarterly groundwater monitoring was initiated in 2009 at the outside tunnel wells.

In 2009, groundwater samples were collected from wells RHMW04, OWDFMW01, and HDMW2253-03. Samples were collected in August and October 2009. None of the COPCs were detected at concentrations exceeding the current gross contamination or drinking water toxicity DOH Environmental Action Levels (EALs).

In 2010, groundwater samples were collected from wells RHMW04, OWDFMW01, and HDMW2253-03. Samples were collected from well RHMW04 in January and April 2010. Samples were collected from well OWDFMW01 in January, April, and October 2010. Samples were collected from well HDMW2253-03 in January, April, July, and October 2010. The COPCs with concentrations that exceeded current DOH EALs are summarized below.

- **HDMW2253-03** – Total petroleum hydrocarbons as diesel (TPH-d) was detected at a concentration above the DOH EALs for gross contamination and drinking water toxicity in January 2010 (The Environmental Company, Inc. [TEC], 2010a).
- **OWDFMW01** – TPH-d was detected at concentrations above the DOH EALs for gross contamination and drinking water toxicity in January and April 2010 (TEC, 2010a; TEC, 2010b).

In 2011, groundwater samples were collected from wells OWDFMW01 and HDMW2253-03. Samples were collected in January, April, July, and October 2011. None of the COPCs were detected at concentrations exceeding the current DOH EALs for gross contamination or drinking water toxicity. In Fall 2011, the DOH EALs were revised. The drinking water toxicity EAL for TPH-d decreased from 210 to 190 micrograms per liter (µg/L).

In 2012, groundwater samples were collected from wells OWDFMW01 and HDMW2253-03. Samples were collected in January, April, July, and November 2012. TPH-d was detected at a concentration above the DOH EALs in samples collected from wells HDMW2253-03 and OWDFMW01 (Environet, 2012; Environmental Science International, Inc. [ESI], 2013a). The COPCs with concentrations that exceeded current DOH EALs are summarized below.

- **HDMW2253-03** – TPH-d was detected at concentrations above the DOH EALs for gross contamination and drinking water toxicity in April and November 2012.
- **OWDFMW01** – TPH-d was detected at a concentration above the DOH EALs for gross contamination and drinking water toxicity in April 2012.

In 2013, groundwater samples were collected from wells OWDFMW01 and HDMW2253-03. Samples were collected in January, April, July, and October 2013. TPH-d was detected at a concentration above the DOH EALs in samples collected from wells OWDFMW01 and HDMW2253-03 (ESI, 2013b, 2013c, 2013d, and 2014a). The COPCs with concentrations that exceeded current DOH EALs are summarized below.

- **HDMW2253-03** – TPH-d was detected at a concentration above the DOH EALs for gross contamination and drinking water toxicity in January 2013.
- **OWDFMW01** – TPH-d was detected at concentrations above the DOH EALs for gross contamination and drinking water toxicity in all four quarters during 2013.

In 2014, groundwater samples were collected from wells OWDFMW01 and HDMW2253-03. Samples were collected in January, April, July, and October 2014. Well RHMW04 was also sampled in July and October 2014. TPH-d was detected at concentrations above the DOH EALs in samples collected from well OWDFMW01 in January and April 2014. TPH-d was also detected at a concentration above the DOH EALs in a sample collected from well HDMW2253-03 in April 2014; however, this was likely an erroneous result due to a switched sample (ESI, 2014c, 2014d, 2014e, and 2015a). The COPCs with concentrations that exceeded current DOH EALs are summarized below.

- **HDMW2253-03** – TPH-d was detected at a concentration above the DOH EALs for both gross contamination and drinking water toxicity in April 2014. However, as discussed above, this was likely an erroneous result.

- **OWDFMW01** – TPH-d was detected at a concentration above the DOH EALs for gross contamination and drinking water toxicity in April 2014 and above only the EAL for gross contamination in January 2014.

In January 2014, an additional groundwater sampling was conducted at HDMW2253-03 in response to a suspected release from Tank 5. None of the COPC concentrations exceeded the current DOH EALs (ESI, 2014b).

Between August and October 2014, wells RHMW06 and RHMW07 were installed at the RHSF in order to develop a more robust groundwater monitoring network at the site (Battelle, 2015a). Both wells were sampled in October 2014. The polycyclic aromatic hydrocarbon (PAH) 2-methylnaphthalene was detected in the sample collected from well RHMW06. TPH-d, 2-methylnaphthalene, and acetone were detected in the sample collected from well RHMW07. None of the COPC concentrations exceeded the current DOH EALs for gross contamination or drinking water toxicity. In the well installation report, it was speculated that these detections may have been related to the drilling foam used during the installation of the wells.

In January 2015, groundwater samples were collected from wells OWDFMW01, HDMW2253-03, and RHMW04 (ESI, 2015b), and from wells RHMW06 and RHMW07 (Battelle, 2015b). None of the COPC concentrations exceeded the current DOH EALs for drinking water toxicity or gross contamination.

In April 2015, groundwater samples were collected from wells OWDFMW01, HDMW2253-03, RHMW04, RHMW06, and RHMW07 (ESI, 2015d). The COPCs with concentrations that exceeded current DOH EALs are summarized below.

- **OWDFMW01** – TPH-d and TPH as oil (TPH-o) were detected at concentrations above their respective DOH EALs.

In July 2015, groundwater samples were collected from wells OWDFMW01, HDMW2253-03, RHMW04, RHMW06, and RHMW07 (ESI, 2015e). The COPCs with concentrations that exceeded current DOH EALs are summarized below.

- **OWDFMW01** – TPH-d and TPH-o were detected above their respective DOH Tier 1 EALs.

In October 2015, groundwater samples were collected from wells OWDFMW01, HDMW2253-03, RHMW04, RHMW06, and RHMW07 (E2, 2016). The COPCs with concentrations that exceeded current DOH EALs are summarized below.

- **OWDFMW01** – TPH-d and TPH-o were detected above and at their respective DOH Tier 1 EALs.

1.3.1 Previous Reports

The following groundwater monitoring reports for wells located outside the RHSF tunnel system were previously submitted to DOH:

1. Groundwater Monitoring Report, August 2009 (submitted September 2009).
2. Groundwater Monitoring Report, October 2009 (submitted December 2009).
3. Groundwater Monitoring Report, January 2010 (submitted April 2010).
4. Groundwater Monitoring Report, April 2010 (submitted May 2010).
5. Groundwater Monitoring Report, July 2010 (submitted August 2010).
6. Groundwater Monitoring Report, October 2010 (submitted December 2010).
7. Groundwater Monitoring Report, January 2011 (submitted March 2011).
8. Groundwater Monitoring Report, April 2011 (submitted June 2011).
9. Groundwater Monitoring Report, July 2011 (submitted September 2011).
10. Groundwater Monitoring Report, October 2011 (submitted December 2011).
11. Groundwater Monitoring Report, January 2012 (submitted March 2012).
12. Groundwater Monitoring Report, April 2012 (submitted July 2012).
13. Groundwater Monitoring Report, July 2012 (submitted August 2012).
14. Groundwater Monitoring Report, November 2012 (submitted January 2013).
15. Groundwater Monitoring Report, January 2013 (submitted April 2013).
16. Groundwater Monitoring Report, April 2013 (submitted July 2013).
17. Groundwater Monitoring Report, July 2013 (submitted September 2013).
18. Groundwater Monitoring Report, October 2013 (submitted January 2014).
19. Groundwater Monitoring Report for Additional Sampling of HDMW2253-03, January 2014 (submitted February 2014).
20. Groundwater Monitoring Report, January 2014 (submitted April 2014).
21. Groundwater Monitoring Report, April 2014 (submitted June 2014).
22. Groundwater Monitoring Report, July 2014 (submitted September 2014).
23. Groundwater Monitoring Report, October 2014 (submitted January 2015).
24. Groundwater Monitoring Report, January 2015 (submitted March 2015).
25. Draft Monitoring Well Installation Report for RHMW06 and RHMW07, March 2015 (submitted March 2015).
26. Draft Technical Memorandum, Groundwater Sampling Event for RHMW06 and RHMW07, April 2015 (submitted April 2015).

- 27. Groundwater Monitoring Report, April 2015 (submitted August 2015).
- 28. Groundwater Monitoring Report, July 2015 (submitted November 2015).
- 29. Groundwater Monitoring report, October 2015 (submitted February 2016).

SECTION 2 – GROUNDWATER SAMPLING

On 19 January 2016, E2 personnel collected groundwater samples from five monitoring wells (OWDFMW01, HDMW2253-03, RHMW04, RHMW06, and RHMW07). In addition, a duplicate groundwater sample was collected from well RHMW06.

The samples were collected in accordance with the approved *WP/SAP*, which is consistent with DOH UST release response requirements (DOH, 2000); DON Procedure I-C-3, *Monitoring Well Sampling* (DON, 2007); and the *Interim Update, Final RHSF Groundwater Protection Plan* (HDR, 2014). Prior to purging and sampling, the depths to groundwater in the wells were measured by E2 using a Geotech oil/water interface probe. The measurements are included in the groundwater sampling logs. No measurable product, sheen, or petroleum hydrocarbon odor was observed in any of the wells.

2.1 GROUNDWATER SAMPLING

Prior to collecting groundwater samples, the monitoring wells were purged of standing water in the well casings. Wells OWDFMW01 and HDMW2253-03 were purged using disposable bailers. Wells RHMW04, RHMW06, and RHMW07 contain dedicated bladder pumps, which were used to purge the wells and to collect samples. The monitoring wells were purged at rates of approximately 0.06 to 0.1 liter per minute.

To operate the pump, a portable air compressor with an in-line filter was connected to a QED MP50 MicroPurge® Basics Controller box, which was then connected to the pump. The compressor was turned on to power the pump and the controller was used to adjust the pumping rate to less than one liter of water per minute.

Water quality parameters were monitored periodically during well purging. The water quality parameters that were measured included potential of hydrogen (pH), temperature, conductivity, dissolved oxygen, and oxidation-reduction potential. The water quality parameters were evaluated to demonstrate that the natural characteristics of the aquifer formation water were present within the monitoring well before collecting the sample. At least four readings were collected during the purging process. Purging was considered complete when at least three consecutive water quality measurements stabilized within approximately 10%. The readings were recorded on Groundwater Sampling Logs, which are included in Appendix A. The field notes for the event are included in Appendix B.

When the water quality parameters stabilized, groundwater samples were collected from the wells. The disposable bailers or dedicated bladder pump were used to collect the groundwater samples from the monitoring wells. For each monitoring well, the groundwater samples were collected immediately after (no more than two hours after) purging was completed to prevent groundwater interaction with the monitoring well casing and atmosphere. Samples collected for dissolved lead were filtered in the field using new, dedicated 0.45-micron filters.

All samples were labeled and logged on the Sample Inventory Log, placed in resealable bags and sealed, custody sealed, sealed with tape, placed in a cooler with wet ice, and logged onto the Chain-of-Custody (COC) Form. The samples were labeled and logged in accordance with DON Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures* (DON, 2007). All samples were shipped under COC to the analytical laboratory and analyzed for the COPCs as described below in Section 2.2.

2.2 ANALYTICAL RESULTS

The samples were analyzed for TPH as gasoline (TPH-g), TPH-d, and TPH-o using EPA Method 8015M; volatile organic compounds (VOCs) using EPA Methods 8260C, 8260C-SIM, and 8011; and PAHs using EPA Method 8270C SIM. A copy of the laboratory report is included as Appendix C.

Analytical results were compared to the EALs listed in the EPA/DOH letter, Enclosure A, dated February 4, 2016. A copy of Enclosure A (including the list of COPCs and their respective EALs) is included in Appendix D. The results of the first quarter groundwater sampling event are summarized in Table 2.1 and described below. A description of laboratory data qualifiers, definitions of the terms Method Detection Limit (MDL), Limit of Detection (LOD), and Limit of Quantitation (LOQ), and basic concepts of those terms are presented as Appendix E.

- **OWDFMW01** – The concentration of TPH-d (320 µg/L) was detected above the DOH Tier 1 EAL. TPH-o (69 µg/L); PAHs 1-methylnaphthalene (0.030 µg/L), 2-methylnaphthalene (0.020 µg/L) and naphthalene (0.024 µg/L) and VOCs 1,2-dichloroethane (0.0096 µg/L) and toluene (0.18 µg/L) were also detected. However, none of these detected concentrations exceeded their respective DOH Tier 1 EALs. Toluene was also detected in the associated trip blank at a similar concentration and is likely the result of laboratory contamination. The consistently elevated pH detected in well OWDFMW01 suggests contamination from another source may be impacting the well.
- **HDMW2253-03** – Analytes detected in groundwater were TPH-d (43 µg/L), TPH-o (63 µg/L), and VOC toluene (0.24 µg/L). The concentrations did not exceed the DOH Tier 1 EALs. With the exception of one possibly erroneous result obtained during the event in April 2014, TPH-d concentrations have not exceeded the DOH Tier 1 EAL in well HDMW2253-03 since January 2013. Toluene was also detected in the associated trip blank at a similar concentration and is likely the result of laboratory contamination.
- **RHMW04** – Analytes detected in groundwater were TPH-d (36 µg/L) and TPH-o (52 µg/L), neither of which exceeded their respective DOH Tier 1 EALs.
- **RHMW06** – Analytes detected in groundwater were TPH-d (21 µg/L), TPH-o (28 µg/L), and VOC toluene (0.1 µg/L). None of the detected concentrations exceeded their DOH Tier 1 EALs. Toluene was also detected in the associated trip blank at a similar concentration and is likely the result of laboratory contamination.
- **RHMW07** – Analytes detected in groundwater were TPH-d (28 µg/L), TPH-o (44 µg/L), and PAHs 1-methylnaphthalene (0.0046 µg/L), 2-methylnaphthalene (0.0077 µg/L) and

naphthalene (0.0038 µg/L). The concentrations did not exceed their respective DOH Tier 1 EALs.

2.3 GROUNDWATER CONTAMINANT TRENDS

The historical groundwater contaminant concentration trends for COPCs that exceeded the DOH Tier 1 EALs are illustrated in Appendix F. A summary of groundwater contaminant trends is provided below.

- **OWDFMW01** – TPH-d was detected in this well at concentrations exceeding the DOH Tier 1 EAL. Concentrations of all other COPCs detected during this round of quarterly sampling were consistent with historical data.
- **HDMW2253-03** – TPH-d and TPH-o were detected in this well at concentrations below the respective DOH Tier 1 EALs. With the exception of one possibly erroneous result obtained during the event in April 2014, TPH-d concentrations have not exceeded the DOH Tier 1 EAL in this well since January 2013.
- **RHMW04** – Concentrations of TPH-d and TPH-o were detected in this well below the respective DOH Tier 1 EALs. Concentrations of all other COPCs detected during this round of quarterly sampling were below the laboratory detection limits.
- **RHMW06** – This well was installed in September 2014 and first sampled in October 2014. To date, no COPCs have been detected at concentrations exceeding the DOH Tier 1 EALs.
- **RHMW07** – This well was installed and first sampled in October 2014. To date, no COPCs have been detected at concentrations exceeding the DOH Tier 1 EALs.

2.4 WASTE DISPOSAL

The purged groundwater and decontamination water generated during sampling of the wells were placed in two 55-gallon drums along with the purged water and decontamination water generated during sampling of the inside tunnel wells. The drums will be properly profiled and manifested following the next quarterly sampling event, or when they reach 90% full.

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TABLE 2.1
Analytical Results for Groundwater Sampling (19 January 2016)
Red Hill Bulk Fuel Storage Facility - Outside Tunnel Wells
January 2016 Quarterly Monitoring Report

Well (EPA / Field Sample ID):			OWDFMW01 (ERH016)					HDMW2253-03 (ERH015)					RHMW04 (ERH019)					RHMW06 (ERH018)					RHMW07 (ERH017)				
Method	Analyte	DOH EAL	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 8015C	TPH-g	100	ND	U	50	25	8.3	ND	U	50	25	8.3	ND	U	50	25	8.3	ND	U	50	25	8.3	ND	U	50	25	8.3
	TPH-d	100	320	B,Z	54	22	12	43	B,J	54	22	12	36	B,J	54	23	13	21	B,J	54	22	12	28	B,J	54	22	12
	TPH-o	100	69	B,J	110	54	21	63	B,J	110	54	21	52	B,J	110	56	22	ND	B,U	110	54	21	44	B,J	110	54	21
EPA 8270D SIM	1-Methylnaphthalene	4.7	0.030		0.020	0.0050	0.0035	ND	U	0.020	0.0050	0.0035	ND	U	0.020	0.0050	0.0035	ND	U	0.020	0.0050	0.0035	0.0046	J	0.020	0.0050	0.0035
	2-Methylnaphthalene	10	0.020		0.020	0.0050	0.0023	ND	U	0.020	0.0050	0.0023	ND	U	0.020	0.0050	0.0023	ND	U	0.020	0.0050	0.0023	0.0077	J	0.020	0.0050	0.0023
	Naphthalene	17	0.024		0.020	0.0050	0.0038	ND	U	0.020	0.0050	0.0038	ND	U	0.020	0.0050	0.0038	ND	U	0.020	0.0050	0.0038	0.0038	J	0.020	0.0050	0.0038
EPA 8260C / 8260-SIM / 8011	1,2-Dibromoethane (EDB)	0.04	ND	U	0.0097	0.004	0.003	ND	U	0.0097	0.0040	0.0030	ND	U	0.0097	0.0040	0.0030	ND	U	0.0097	0.0040	0.0030	ND	U	0.0097	0.0040	0.0030
	1,2-Dichloroethane (DCA)	5	0.0096	J	0.020	0.015	0.0058	ND	U	0.020	0.015	0.0058	ND	U	0.020	0.015	0.0058	ND	U	0.020	0.015	0.0058	ND	U	0.020	0.015	0.0058
	Benzene	5	ND	U	0.50	0.10	0.062	ND	U	0.50	0.10	0.062	ND	U	0.50	0.10	0.062	ND	U	0.50	0.10	0.062	ND	U	0.50	0.10	0.062
	Ethylbenzene	30	ND	U	0.50	0.10	0.050	ND	U	0.50	0.10	0.050	ND	U	0.50	0.10	0.050	ND	U	0.50	0.10	0.050	ND	U	0.50	0.10	0.050
	Toluene	40	0.18	Tb, J	0.50	0.10	0.054	0.24	Tb, J	0.50	0.10	0.054	ND	U	0.50	0.10	0.054	0.1	Tb, J	0.50	0.10	0.054	ND	U	0.50	0.10	0.054
	Xylenes, Total	20	ND	U	1.0	0.20	0.18	ND	U	1.0	0.20	0.18	ND	U	1.0	0.20	0.18	ND	U	1.0	0.20	0.18	ND	U	1.0	0.20	0.18

Only COPCs listed in the EPA/DOH Letter, Enclosure A, dated February 4, 2016 and 1,2-dibromoethane and 1,2-dichloroethane are included in this table.

Bold, shaded values exceeded the DOH Tier 1 EALs.

Data are reported in µg/L.

DL Detection Limit
DOH EAL Department of Health Tier 1 Environmental Action Levels for groundwater where groundwater is a current drinking water source (DOH, Fall 2011).
EPA Environmental Protection Agency
LOD Limit of Detection
LOQ Limit of Quantization
ND Not Detected
Q Qualifiers (listed below)

J The result is an estimated value.

Tb The analyte was also detected in the associated trip blank at a similar concentration.

U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.

B Compound identified during validation in the method blank. Result was changed to ND if the reported concentration was below the concentration detected in the blank. Results remain reported in the laboratory provided report.

D The reported result is from a dilution.

X The results reported for several analyses in sample ERH024 may contain a slight bias. The chromatogram indicated the presence of non-target background components. The matrix interference may have resulted in a slight high bias in the affected samples. The results were flagged with "X" to indicate the issue.

Z The chromatographic fingerprint does not resemble a petroleum product.

I The MRL/MDL or LOQ/LOD is elevated due to a chromatographic interference.

L The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.

Y The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.

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SECTION 3 – DATA QUALITY ASSESSMENT

A data quality assessment, which consists of a review of the overall groundwater sample collection and analysis process, was performed in order to determine whether the analytical data generated met the decision quality objectives (DQOs) for the project and if the data is usable for the intended purpose. The data quality assessment was performed in accordance with the approved *WP/SAP* (E2, 2015). The field Quality Control (QC) program consisted of standardized sample collection and management procedures, and the collection of field duplicate samples and matrix spike (MS)/MS duplicate (MSD) samples. Trip blank samples were also collected by the laboratory and accompanied the sample container shipment from the laboratory, during sample collection and back to the laboratory. The laboratory quality assurance program consisted of the use of standard analytical methods and the preparation and analyses of MS/MSD samples, surrogate spikes, blanks, Laboratory Control Samples (LCSs)/Laboratory Control Sample Duplicates (LCSDs).

3.1 DATA VALIDATION AND ASSESSMENT

The objective of data validation is to ensure the data provided is of known quality for project decisions. Data quality is judged in terms of Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity (PARCCS). A number of factors may affect the quality of data, including: sample collection methods, sample analysis methods, and adherence to established procedures for sample collection, preservation, management, shipment, and analysis.

Precision

Precision is defined as the reproducibility of replicate measurements. Precision is evaluated by Relative Percentage Difference (RPD) of field duplicate, LCS/LCSD, and MS/MSD results. Field duplicate and MS/MSD samples were collected at a rate of approximately 25% of project samples. Field duplicates were sent to the laboratory under fictitious sample IDs, along with the primary samples.

The RPDs of detected analytes for the primary and field duplicate samples ERH019 and ERH020 (collected from well RHMW04) are provided in Table 3.1. An RPD of less than 50% for duplicate pairs is required by the DON *Project Procedures Manual* to be considered acceptable (DON, 2007). The RPDs for duplicate sample pairs for all detected analytes met acceptance criteria.

RPDs for MS/MSD and LCS/LCSD pairs for all other analytes were within the control limits, and the data precision is considered acceptable with the exception of the MS/MSD for PAHs by 8270C SIM. Due to a laboratory error, the replicate MS/MSD KWG1600624-1 and KWG1600624-2 were not spiked with the compounds of interest. The recoveries in the replicate LCSs/LCSDs KWG1600624-3 and KWG1600624-4 were acceptable, which indicated the analytical batch was in control. No further corrective action was necessary.

Accuracy

Accuracy is defined as the degree of conformity of a measurement to a standard or true value. Accuracy is evaluated through measurement of the percent recovery of an analyte in a reference standard or spiked sample. Accuracy limits for surrogates, LCS, MS, and MSD samples are either prescribed by the Department of Defense (DoD) or established by the individual laboratory. The acceptance criteria for accuracy are dependent on the analytical method and are based on historical laboratory or DoD data.

Between August 2009 and July 2010, naphthalene was analyzed for by both EPA Methods 8260B and 8270C-SIM, and beginning in October 2010, only results using EPA Method 8270C-SIM were reported. Naphthalene was ND in groundwater from either well OWDFMW01 or HDMW2253-03 until November 2012 and has never been detected in RHMW04; however, when both methods were used for samples collected from inside well RHMW02, concentrations of naphthalene detected by EPA Method 8260B were generally two to three times higher than those detected by EPA Method 8270C-SIM. This is likely due to the better preservation of VOCs associated with the use of EPA Method 8260B. This suggests that the naphthalene results provided by EPA Method 8270C-SIM may be biased low. Naphthalene concentrations in samples collected beginning in October 2010 were analyzed using EPA Method 8270C-SIM and results may be biased low. However, naphthalene concentrations in project samples have been orders of magnitude below DOH EALs, and this potential low bias should not affect project decisions.

Similarly, the fairly large error inherent to the analysis of TPH-d and TPH-o by EPA Method 8015 should be considered when results are compared to each other, to action levels, and to results from previous sampling events. Any comparative analysis of the results should take into consideration the fairly wide method acceptance limits (36-132%) as per DoD Quality Systems Manual (QSM) Version 5.0 (DoD, 2013).

All surrogate spike recoveries met the control limit criteria indicating that laboratory procedures were meeting method analyte recovery criteria with the following exceptions:

- For EPA Method 8260C, the upper control criterion was exceeded for 1,2-dichloroethane-d4 in sample ERH019 (well RHMW04). No target analytes were detected in the sample. The error associated with an elevated recovery equated to a high bias. The quality of the sample data was not significantly affected. No further corrective action was necessary.
- For EPA Method 8260C SIM, the control criteria were exceeded for toluene-d8 in LCS KWG1600798-3, and KWG1600835-3 and MS/MSD Batch QC. The associated MS recoveries of target compounds were in control, indicating the analysis was in control. The surrogate outlier was flagged accordingly. No further corrective action was necessary.

The data accuracy for this monitoring event is considered acceptable.

Representativeness

Representativeness is the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness was achieved by conducting sampling in accordance with the sample collection procedures described in the approved *WP/SAP*, which includes standardized sample collection methods (E2, 2015).

Representativeness is also evaluated through the compliance with the standardized sample holding time and sample preservation methods, and through the analysis of blank samples, including method blank and trip blank samples. For this sampling event, all sample holding times and sample preservation were consistent with EPA guidance.

For this sampling event, one trip blank was included with the cooler containing samples for VOC and TPH-g analyses to assess the potential for contamination during sample transport. Toluene was detected in the trip blank at a concentration below the LOQ. Subsequently, toluene results for primary samples were flagged "Tb" in Tables 2.1 and 3.1.

Additionally, TPH-d and TPH-o were detected in the method blank at concentrations below their respective LOQs. Presence of these compounds at comparable levels in project samples likely indicate positive interference from laboratory procedures (laboratory contamination). Subsequently, detections for compounds identified in the method blank were changed to ND in Tables 2.1 and 3.1 if the reported concentration was below the concentration detected in the method blank.

The consistently high pH (10 to 13) observed over several sampling events in well OWDFMW01 is atypical for the groundwater in the area and suggests, along with the historical presence of acetone, that there may be a deficiency in the concrete or bentonite sealing materials used in the construction of the well, or some other localized condition in the vicinity of the well. Consequently, the associated sample data from sample ERH016 (well OWDFMW01) may not accurately represent the conditions of the groundwater at the site.

With the exceptions noted above, the groundwater sample data are considered representative of the groundwater quality at the site. A summary of the trip blank results is provided in Table 3.1.

Completeness

Completeness is defined as the overall percentage of valid analytical results (including estimated results) compared to the total number of analytical results reported by the laboratory. No data were rejected for this project, and therefore the completeness goal for this project (90%) was successfully met.

Comparability

Comparability expresses the confidence with which one data set can be compared to another data set. Comparability can be related to accuracy and precision because these quantities are measures of data reliability. Data with acceptable precision and accuracy are considered comparable if collection techniques, analytical procedures, methods, and reporting are equivalent. For this monitoring event, the samples were collected using approaches consistent with those in the previous events, and the same analytical methods/procedures were used to measure the concentration of COPCs. The field and laboratory personnel followed standard operating procedures. With the exceptions noted below, the results are considered comparable within this data set and with the data collected from previous sampling events.

All samples collected from wells OWDFMW01, HDMW2253-03, and RHMW04 from the October 2010 event to and including February 2015 were analyzed by Calscience Environmental Laboratories located in Garden Grove, CA (now known as Eurofins Calscience). Samples collected from wells RHMW06 and RHMW07 in October 2014 and January 2015 were analyzed by APPL Laboratories, Inc. of Clovis, CA and EMAX Laboratories of Torrance, CA. Samples collected from all five wells in April, July, and October 2015 were analyzed by ALS Environmental located in Kelso, WA. Analytical MDLs, LODs, and LOQs were lower for most analytes than they had been prior to April 2015, and several VOCs and PAHs have been detected since April 2015 at concentrations that would have been below previous LODs and therefore ND. The method used to analyze 1,2-dichloroethane, bromodichloromethane, dibromochloromethane, and 1,1,2,2-tetrachloroethane was changed from EPA Method 8260 to EPA Method 8260-SIM to improve sensitivity. Correspondingly, analysis of 1,2-dibromo-3-chloropropane and 1,2-dibromoethane was changed from EPA Method 8260 to EPA Method 8011 for the same reason. The significantly improved reporting limits should be considered when results are compared to data from previous events.

Additionally, during the April 2015 event, TPH-o was added to the analyte list. There are very few previous TPH-o results to compare this data to.

The TPH-g analysis of samples through July 2010 was performed using EPA Method 8015. Between October 2010 and January 2015, TPH-g analysis was performed using EPA Method 8260. Beginning in April 2015, the use of EPA Method 8015 was reestablished. There was no event where both methods were used; consequently, there is no way to directly compare the results obtained by the two methods and to assess potential bias. However, there is no reason to believe that using either method should bias the data significantly, and the TPH-g data for all events should be comparable with respect to the limits of the analytical method.

Other than the lower detection limits, the addition of TPH-o to the analyte list, the large uncertainty inherent to EPA Method 8015, and the naphthalene bias discussed above, no other issues with comparability were identified. The results are considered comparable within this data set and with the data collected from recent sampling events.

Sensitivity

The LOQs are established by the laboratory based on the LODs or instrument detection limits, historical data, and EPA limits established for the various methods. The LOQs and LODs for samples may require adjustment by the laboratory due to matrix interference or if high levels of target analytes necessitate dilution before analysis. Matrix interference and sample dilutions have the effect of decreasing sensitivity and increasing the LOQs/LODs. There are no results with increased LOQs or LODs in this data set that have impacted sensitivity and data usability.

All LODs were sufficiently low to satisfy project DQOs. The limits for several analytes were significantly lower than in historical sampling events. The impact on comparability of the data to historical data is described in the comparability section of this report. The laboratory, in several cases, indicated issues with relative response factors determined for initial calibrations or calibration verifications of certain VOCs. In every case, the laboratory verified that the sensitivity was sufficient to detect the affected compounds at their respective LOQs. All LOQs for the affected analytes were below the EALs, indicating that any potential impact on sensitivity was minor and irrelevant in terms of project decisions.

3.2 DATA ASSESSMENT AND USABILITY CONCLUSIONS

The PARCCS criteria were evaluated, and with some exceptions, all criteria were met. Results associated with QC data that failed acceptance criteria are discussed in detail above in Section 3.1. There are no data quality issues that need to be taken into account for project decisions during this monitoring event.

Finally, it should be noted that analytical MDLs, LODs, and LOQs decreased beginning with the April 2015 sampling event compared to monitoring data from previous events due to a change of laboratories and the utilization of alternative methods. Analytes that were detected during the current event and were ND at or above the higher MDLs during past events include chloromethane, acenaphthene, phenanthrene, 1-methylnaphthalene, 2-methylnaphthelene and toluene in OWDFMW01; chloromethane toluene and dissolved lead in HDMW2253-03; acetone, toluene, benzo(a)anthracene and dissolved lead in RHMW04; toluene and dissolved lead in RHMW06; and acetone, benzo(a)anthracene, 1-methylnaphthalene, 2-methylnaphthelene, naphthalene and dissolved lead in RHMW07. Consequently, these analytes may have been present at the currently detected concentrations during previous events without being detected and do not necessarily indicate any trend. These compounds were also identified in the method blank and may indicate that at these very low levels, laboratory contamination may lead to false low level hits. Furthermore, it should be noted that, in general, detections below the LOQ in primary samples, laboratory method blanks and trip blanks should be subject to scrutiny as they could be false low level hits resulting from positive interference from laboratory analytical processes (i.e., laboratory contamination).

The data assessment concludes that all data generated during this event are usable for the intended purpose, with the limitations described above.

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TABLE 3.1
Quality Control Results for Groundwater Sampling (19 January 2016)
Red Hill Bulk Fuel Storage Facility-Outside Tunnel Wells
January 2016 Quarterly Monitoring Report

Well (EPA / Field Sample ID):			RHMW04 (ERH019) Primary					RHMW04 (ERH020) Field Duplicate					RPD Duplicate %	Trip Blank				
Method	Analyte	DOH EAL	Result	Q	LOQ	LOD	DL	Result	Q	LOQ	LOD	DL		Result	Q	LOQ	LOD	DL
EPA 8015C	TPH-g	100	ND	U	50	25	8.3	ND	U	50	25	8.3	NA	-	-	-	-	-
	TPH-d	100	36	B,J	54	23	13	29	B,J	53	21	12	5.4%	-	-	-	-	-
	TPH-o	100	52	B,J	110	56	22	ND	B,U	110	53	20	11.2%	-	-	-	-	-
EPA 8270D SIM	1-Methylnaphthalene	4.7	ND	U	0.020	0.0050	0.0035	ND	U	0.020	0.0050	0.0035	NA	-	-	-	-	-
	2-Methylnaphthalene	10	ND	U	0.020	0.0050	0.0023	ND	U	0.020	0.0050	0.0023	NA	-	-	-	-	-
	Naphthalene	17	ND	U	0.020	0.0050	0.0038	ND	U	0.020	0.0050	0.0038	NA	-	-	-	-	-
EPA 8260C / 8260-SIM / 8011	1,2-Dibromoethane (EDB)	0.04	ND	U	0.010	0.0040	0.0030	ND	U	0.0097	0.0040	0.0030	NA	ND	U	2.0	0.20	0.10
	1,2-Dichloroethane (DCA)	5	ND	U	0.020	0.015	0.0058	ND	U	20	15	5.8	NA	ND	U	0.020	0.015	0.0058
	Benzene	5	ND	U	0.50	0.10	0.062	ND	U	0.50	0.10	0.062	NA	ND	U	0.50	0.10	0.062
	Ethylbenzene	30	ND	U	0.50	0.10	0.050	ND	U	0.50	0.10	0.050	NA	ND	U	0.50	0.10	0.05
	Toluene	40	ND	U	0.50	0.10	0.054	0.11	Tb, J	0.50	0.10	0.054	NA	0.19	J	0.50	0.10	0.054
	Xylenes, Total	20	ND	U	1.00	0.20	0.18	ND	U	1.0	0.20	0.18	NA	ND	U	1.0	0.20	0.18

Only COPCs listed in the EPA/DOH Letter, Enclosure A, dated February 4, 2016 and 1,2-dibromoethane and 1,2-dichloroethane are included in this table.
Data are reported in µg/L.

- Not analyzed
- DOH EAL DOH Tier 1 Environmental Action Levels for groundwater where groundwater is a current drinking water source (DOH, FALL 2011).
- DL Detection Limit
- EPA Environmental Protection Agency
- LOD Limit of Detection
- LOQ Limit of Quantitation
- NA Not Available
- ND Not Detected
- Q Qualifiers (listed below)
 - B Compound identified during validation in the method blank. Result was changed to ND if the reported concentration was below the concentration detected in the blank. Results remain reported in the laboratory provided report.
 - J The result is an estimated value.
 - Tb The analyte was also detected in the associated trip blank at a similar concentration.
 - U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.

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SECTION 4 – SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The groundwater sampling was conducted as part of the long-term groundwater and soil vapor monitoring program at the RHSF for NAVSUP FLC Pearl Harbor, under NAVFAC Contract Number N62742-14-D-1884, CTO 0014.

This quarterly monitoring report presents the results of groundwater sampling conducted on 19 January 2016, from five monitoring wells (OWDFMW01, HDMW2253-03, RHMW04, RHMW06, and RHMW07) at the RHSF, JBPHH, Hawaii. The sampling was conducted in accordance with the approved *WP/SAP* and *Technical Addendum* (E2, 2015). A summary of the analytical results is provided below.

- **OWDFMW01** – The concentration of TPH-d (320 µg/L) was detected above the DOH Tier 1 EAL. TPH-o (69 µg/L); PAHs 1-methylnaphthalene (0.030 µg/L), 2-methylnaphthalene (0.020 µg/L) and naphthalene (0.024 µg/L) and VOCs 1,2-dichloroethane (0.0096 µg/L) and toluene (0.18 µg/L) were also detected. However, none of these detected concentrations exceeded their respective DOH Tier 1 EALs. Toluene was also detected in the associated trip blank at a similar concentration and is likely the result of laboratory contamination. The consistently elevated pH detected in well OWDFMW01 suggests contamination from another source may be impacting the well.
- **HDMW2253-03** – Analytes detected in groundwater were TPH-d (43 µg/L), TPH-o (63 µg/L), and VOC toluene (0.24 µg/L). The concentrations did not exceed the DOH Tier 1 EALs. With the exception of one possibly erroneous result obtained during the event in April 2014, TPH-d concentrations have not exceeded the DOH Tier 1 EAL in well HDMW2253-03 since January 2013. Toluene was also detected in the associated trip blank at a similar concentration and is likely the result of laboratory contamination.
- **RHMW04** – Analytes detected in groundwater were TPH-d (36 µg/L) and TPH-o (52 µg/L), neither of which exceeded their respective DOH Tier 1 EALs.
- **RHMW06** – Analytes detected in groundwater were TPH-d (21 µg/L), TPH-o (28 µg/L), and VOC toluene (0.1 µg/L). None of the detected concentrations exceeded their DOH Tier 1 EALs. Toluene was also detected in the associated trip blank at a similar concentration and is likely the result of laboratory contamination.
- **RHMW07** – Analytes detected in groundwater were TPH-d (28 µg/L), TPH-o (44 µg/L), and PAHs 1-methylnaphthalene (0.0046 µg/L), 2-methylnaphthalene (0.0077 µg/L) and naphthalene (0.0038 µg/L). The concentrations did not exceed their respective DOH Tier 1 EALs.

Groundwater Contaminant Trends

Historical groundwater contaminant concentration trends of COPCs that exceeded the DOH EALs are presented in Appendix F. A summary of groundwater contaminant trends for the five monitoring wells is provided below.

- **OWDFMW01** – TPH-d was detected in this well at concentrations exceeding the DOH Tier 1 EAL. Concentrations of all other COPCs detected during this round of quarterly sampling were consistent with historical data.
- **HDMW2253-03** – TPH-d and TPH-o were detected in this well at concentrations below the respective DOH Tier 1 EALs. With the exception of one possibly erroneous result obtained during the event in April 2014, TPH-d concentrations have not exceeded the DOH Tier 1 EAL in this well since January 2013.
- **RHWMW04** – Concentrations of TPH-d and TPH-o were detected in this well below the respective DOH Tier 1 EALs. Concentrations of all other COPCs detected during this round of quarterly sampling were below the laboratory detection limits.
- **RHWMW06** – This well was installed in September 2014 and first sampled in October 2014. To date, no COPCs have been detected at concentrations exceeding the DOH Tier 1 EALs.
- **RHWMW07** – This well was installed and first sampled in October 2014. To date, no COPCs have been detected at concentrations exceeding the DOH Tier 1 EALs.

Conclusions and Recommendations

During the January 2016 sampling event, TPH-d was detected at a concentration above the DOH Tier 1 EAL in OWDFMW01. The majority of the TPH-d concentration reported for the samples from OWDFMW01 was caused by a single peak. The compound or compound mixture represented by the single peak did not resemble a petroleum fuel. For both TPH-d and TPH-o in OWDFMW01, the total concentrations reported are likely inaccurate, because they were determined by comparison to a diesel and an oil standard, respectively. Additional scrutiny of the TPH-d concentrations in well OWDFMW01 is warranted.

Acetone has been detected in well OWDFMW01 at low concentrations occasionally since October 2010 and then in every groundwater sampling event since April 2013. The well also has an unnaturally high pH in the range of 10 to 13. As discussed in Section 3, these conditions are likely unrelated to a release from the USTs at RHSF and may be a result of a deficiency in the well sealing material or another condition isolated to the immediate area of the well. This suggests that the associated sample data may not accurately represent the conditions of the groundwater at the site.

The groundwater contaminant concentrations in wells HDMW2253-03, RHWMW04, RHWMW06, and RHWMW07 remained low and did not change significantly since the previous sampling event (October 2015), or were ND. No COPCs were detected at concentrations above their respective DOH Tier 1 EALs in these four wells.

Detections of TPH-d, TPH-o, and PAHs below the LOQ were likely a result of low level laboratory contamination as seen in the laboratory method blank.

Lead scavengers 1,2-dibromoethane and 1,2-dichloroethane have not been detected at concentrations above their respective DOH Tier 1 EALs for four consecutive quarters.

Subsequently, and in accordance with the EPA/DOH letter, Enclosure A, Analytes and Action Levels dated February 4, 2016, analysis for lead scavengers and all but the ten COPCs listed in Enclosure A, will be discontinued.

An alternative means of collecting groundwater samples from the vicinity of well OWDFMW01 should be evaluated if TPH impacts continue to trend upwards and high pH conditions persist.

Based on a suspected 2014 release at the RHSF and the results of the recent groundwater sampling and analysis, continued groundwater monitoring at the RHSF is recommended. If the TPH-d concentrations significantly increase, the monitoring frequency should be increased to monthly, even though wells OWDFMW01, HDMW2253-03, RHMW04, RHMW06, and RHMW07 are not included in the *RHSF Groundwater Protection Plan*. |

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SECTION 5 – FUTURE WORK

Future work includes the Second Quarter 2016 groundwater monitoring, which is tentatively scheduled for April 2016. A quarterly groundwater monitoring report will be prepared to document the sampling.

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APPENDIX A

Groundwater Sampling Logs

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GROUNDWATER SAMPLING LOG

WELL NO. RH MW 04 LOCATION: RHFS PROJECT NO. 150037
DATE: 1/19/2016 TIME: 1455 CLIMATIC CONDITIONS: Sunny, clear skies, no wind
TIDAL CONDITIONS: Rising ☐ HIGH TIDE: CURRENT TIDE:
Falling ☐ LOW TIDE:

STATIC WATER LEVEL (FT.) and TIME: 293.61 @ 1512 TOTAL DEPTH (FT.):
WELL PURGING: LENGTH OF SATURATED ZONE: LINEAR FT.

a VOLUME OF WATER TO BE EVACUATED: GALs. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)
METHOD OF REMOVAL: dedicated submersible bladder pump PUMPING RATE: mL/min

WELL PURGE DATA:

DATE/TIME	DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (µS/cm)	D.O. (mg/L)	TURB. (NTU)	TEMP. (°C)	ORP (mV)	SAL (ppt)
<u>1/19/16 @ 1542</u>	<u>293.61</u>	<u>0.25</u>	<u>0.31</u>	<u>6.74</u>	<u>478.2</u>	<u>8.20</u>	<u>2.7</u>	<u>23.0</u>	<u>65.0</u>	<u>0.23</u>
<u>1544</u>	<u>293.61</u>	<u>0.50</u>	<u>0.30</u>	<u>6.33</u>	<u>465.5</u>	<u>8.26</u>	<u>1.5</u>	<u>22.6</u>	<u>85.0</u>	<u>0.22</u>
<u>1546</u>	<u>293.61</u>	<u>0.75</u>	<u>0.30</u>	<u>6.16</u>	<u>463.2</u>	<u>8.26</u>	<u>1.8</u>	<u>22.5</u>	<u>95.0</u>	<u>0.22</u>
<u>1548</u>	<u>293.61</u>	<u>1.00</u>	<u>0.30</u>	<u>6.00</u>	<u>463.6</u>	<u>8.20</u>	<u>1.6</u>	<u>22.4</u>	<u>108.0</u>	<u>0.22</u>
<u>1551</u>	<u>293.61</u>	<u>1.25</u>	<u>0.30</u>	<u>5.83</u>	<u>463.4</u>	<u>8.20</u>	<u>1.5</u>	<u>22.2</u>	<u>120.8</u>	<u>0.22</u>
<u>1555</u>	<u>293.61</u>	<u>1.50</u>	<u>0.30</u>	<u>5.69</u>	<u>464.3</u>	<u>8.02</u>	<u>1.8</u>	<u>22.5</u>	<u>137.7</u>	<u>0.22</u>

SAMPLE WITHDRAWAL METHOD: dedicated submersible bladder pump

APPEARANCE OF SAMPLE: COLOR: clear
SEDIMENT: light
OTHER: no odor

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES TPH-DRO/ORO/GRO CHCl₃,
VOCs CHCl₃, PAHs (NONE), DISSOLVED LEAD CHNO₃, EOB (Na₂S₂O₇)

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: 1x1 LAMBER, 2x500mL AMBERS,
1x500 mL POLY, 7x90mL VOAs (TOTAL = 11)

SAMPLE IDENTIFICATION NUMBER(S) ERH 019 @ 1555, ALSO COLLECTED DUPLICATE ERH 020 @ 1630"
DECONTAMINATION PROCEDURES: NAVY PM I-F

NOTES: SAMPLES WERE FIELD FILTERED FOR DISSOLVED LEAD.

SAMPLED BY: ALB

SAMPLES DELIVERED TO: ALS, KELSO, WA TRANSPORTER: TRACIE SOBER, ALS

DATE: 1/21/2016 TIME: 0900

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

Figure I-C-3-1: Groundwater Sampling Log

GROUNDWATER SAMPLING LOG

WELL NO. RH MW 06 LOCATION: RHFS PROJECT NO. 150037
DATE: 1/19/2016 TIME: 1345 CLIMATIC CONDITIONS: Sunny, clear skies, no wind
TIDAL CONDITIONS: Rising ☐ HIGH TIDE: _____
Falling ☐ LOW TIDE: _____
CURRENT TIDE: _____

STATIC WATER LEVEL (FT.) and TIME: 240.69 @ 13:48 TOTAL DEPTH (FT.): _____

WELL PURGING: _____ LENGTH OF SATURATED ZONE: _____ LINEAR FT. _____

a VOLUME OF WATER TO BE EVACUATED: _____ GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)

METHOD OF REMOVAL: dedicated submersible bladder pump PUMPING RATE: _____ mL/min

WELL PURGE DATA:

DATE/TIME	DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (µS/cm)	D.O. (mg/L)	TURB. (NTU)	TEMP. (°C)	ORP (mV)	SAL (ppt)
1/19/16 @ 1356	240.69	0.25	1.16	7.55	1,787	7.69	2.2	24.8	56.5	0.90
1400	240.69	0.90	1.15	6.67	1,764	7.04	2.5	23.9	94.8	0.89
1400	240.69	0.75	1.06	6.62	1,627	7.00	8.8	23.5	85.2	0.82
1402	240.69	1.00	1.04	6.63	1,597	6.84	4.9	23.4	62.6	0.80
1404	240.69	1.25	1.03	6.72	1,588	6.92	3.6	23.4	33.0	0.80
1406	240.69	1.50	1.03	6.76	1,583	6.87	3.2	23.3	6.0	0.80
1408	240.69	1.75	1.03	6.84	1,585	6.96	3.4	23.3	-25.0	0.80

SAMPLE WITHDRAWAL METHOD: dedicated submersible bladder pump

APPEARANCE OF SAMPLE: COLOR: clear

SEDIMENT: none

OTHER: no odor

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES TPH-DRO/ORO/GRO (HCl), VOCs (HCl), PAHs (NONE), DISSOLVED LEAD (HNO₃), EOB (Na₂S₂O₃)

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: 1 x 1L AMBER, 2 x 500 mL AMBERS, 1 x 500 mL POLY, 7 x 40 mL VOAS (TOTAL = 11)

SAMPLE IDENTIFICATION NUMBER(S) ERH 019 @ 1410, ALSO COLLECTED MS/MSD SAMPLES

DECONTAMINATION PROCEDURES: NAVY PPM I-F

NOTES: 1410 ORP -30.4 / 1411 ORP -35.7 / SAMPLE WAS FIELD FILTERED FOR DISSOLVED LEAD.

SAMPLED BY:

AL, BB

SAMPLES DELIVERED TO: ALS, KELSO, WA TRANSPORTER: TRACIE ROBER, ALS

DATE: 1/21/2016 TIME: 0900

CAPACITY OF CASING (GALLONS/LINEAR FOOT)

2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

1410 240.69

GROUNDWATER SAMPLING LOG

WELL NO. RHMW 07 LOCATION: RHFS PROJECT NO. 150037
DATE: 1/19/2016 TIME: 1150 CLIMATIC CONDITIONS: Sunny, Clear skies, very light wind
TIDAL CONDITIONS: Rising ☐ HIGH TIDE: _____
Falling ☐ LOW TIDE: _____
CURRENT TIDE: _____

STATIC WATER LEVEL (FT.) 1205 BB TOTAL DEPTH (FT.): _____
and TIME: 198.24 @ 1200 noon
WELL LENGTH OF SATURATED ZONE: _____ LINEAR FT. _____
PURGING: _____
a VOLUME OF WATER TO BE _____ GALs. (Gals/Linear ft. X linear feet of
EVACUATED: _____ saturation X 3-casing volumes)
METHOD OF REMOVAL: Dedicated submersible bladder pump PUMPING RATE: _____ mL/min

WELL PURGE DATA:

DATE/ TIME	DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (µS/cm)	D.O. (mg/L)	TURB. (NTU)	TEMP. (°C)	ORP (mV)	SAL (ppt)
1/19/16 @ 1209	198.24	0.25	1.19	8.19	1,836	7.43	3.3	26.2	68.0	0.93
1216	198.24	0.50	1.16	7.71	1,790	6.03	1.1	24.2	106.4	0.91
1218	198.24	0.15	1.20	7.49	1,848	3.99	0.9	23.7	100.1	0.94
1220	198.24	1.00	1.20	7.29	1,844	3.97	1.1	23.5	89.8	0.94
1222	198.24	1.25	1.20	7.29	1,851	3.20	3.3	23.6	62.5	0.94
1224	198.24	1.50	1.20	7.29	1,848	3.12	1.2	23.5	67.0	0.94
1226	198.24	1.75	1.20	7.23	1,842	3.33	1.4	23.3	68.5	0.93

SAMPLE WITHDRAWAL METHOD: Dedicated submersible bladder pump
APPEARANCE OF SAMPLE: COLOR: clear
SEDIMENT: none
OTHER: no odor

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES TPH-DRO/ORO/GRO (HCl),
VOCs (HCl), PAHs (NONE), DISSOLVED LEAD (HNO₃), EPB (Na₂S₂O₇)

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: 1 x 1L AMBER, 2 x 500 mL AMBERS,
1 x 500 mL POLY, 7 x 40 mL VOA's (TOTAL=11)

SAMPLE IDENTIFICATION NUMBER(S) ERH 07 @ 1226

DECONTAMINATION PROCEDURES: NAVY PPM I-F

NOTES: SAMPLE WAS FIELD FILTERED FOR DISSOLVED LEAD.

SAMPLED BY: ALB

SAMPLES DELIVERED TO: ALS, KELSO, WA TRANSPORTER: TRACIE SOBER, ALS

DATE: 1/21/2016 TIME: 0900

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

Figure I-C-3-1: Groundwater Sampling Log

GROUNDWATER SAMPLING LOG

WELL NO. OWDF MW 01 LOCATION: RHFS PROJECT NO. 150037
DATE: 1/19/2016 TIME: 1050 CLIMATIC CONDITIONS: SUNNY, CLEAR SKIES, NO WIND
TIDAL CONDITIONS: Rising ☐ HIGH TIDE: _____
Falling ☐ LOW TIDE: _____
CURRENT TIDE: _____
STATIC WATER LEVEL (FT.) and TIME: 119.82' @ 10:57 TOTAL DEPTH (FT.): _____
WELL PURGING: LENGTH OF SATURATED ZONE: _____ LINEAR FT. _____
a VOLUME OF WATER TO BE EVACUATED: _____ GALs. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)
METHOD OF REMOVAL: 300 Bailer (Keflon) PUMPING RATE: _____ mL/min

WELL PURGE DATA:

DATE/ TIME	DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (µS/cm)	D.O. (mg/L)	TURB. (NTU)	TEMP. (°C)	ORP (mV)	SAL (ppt)
1/19/16 @ 1107	119.82	0.15	2.26	11.19	3,486	5.15	4.0	23.9	-102	1.83
1109	119.82	0.56	2.29	11.24	3,518	5.15	19.8	23.8	-87.8	1.85
1112	119.82	0.15	2.28	11.24	3,506	5.05	9.0	23.8	-70.7	1.84
1114	119.82	1.00	2.28	11.25	3,508	4.97	6.4	23.8	-67.2	1.84
1117	119.82	1.25	2.28	11.26	3,514	4.45	7.1	23.9	-66.8	1.84
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

SAMPLE WITHDRAWAL METHOD: bailer (keflon)

APPEARANCE OF SAMPLE: COLOR: clear

SEDIMENT: light

OTHER: no odor

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES TPH-DRO/ORO/GRO (HCl),
VOCs (HCl), PAHs (NONE), DISSOLVED LEAD (ANO3), EDB (Na2S2O7)

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: 1 x 1L AMBER, 2 x 500mL AMBERS,
1 x 500mL POLY, 7 x 40mL VOAS (TOTAL=11)

SAMPLE IDENTIFICATION NUMBER(S) ERH 016 @ 1117

DECONTAMINATION PROCEDURES: NAVY PPM I-F

NOTES: SAMPLE WAS FIELD FILTERED FOR DISSOLVED LEAD.

SAMPLED BY: AL, BB

SAMPLES DELIVERED TO: ALS, KGLSD, WA

TRANSPORTER: TRACIE SOBER, ALS

DATE: 1/21/2016 TIME: 0900

CAPACITY OF CASING (GALLONS/LINEAR FOOT)

2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

GROUNDWATER SAMPLING LOG

WELL NO. HMW2253-03 LOCATION: HALAWA PROJECT NO. 150031
DATE: 1/19/2016 TIME: 0845 CLIMATIC CONDITIONS: Sunny, clear skies, no wind
TIDAL CONDITIONS: Rising ☐ HIGH TIDE: _____
Falling ☐ LOW TIDE: _____
CURRENT TIDE: _____
STATIC WATER LEVEL (FT.) and TIME: 207.42 @ 0903 TOTAL DEPTH (FT.): 1575'
WELL PURGING: _____ LENGTH OF SATURATED ZONE: _____ LINEAR FT. _____
a VOLUME OF WATER TO BE EVACUATED: _____ GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)
METHOD OF REMOVAL: Bailer (teflon) PUMPING RATE: _____ mL/min

WELL PURGE DATA:

DATE/ TIME	DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (µS/cm)	D.O. (mg/L)	TURB. (NTU)	TEMP. (°C)	ORP (mV)	SAL (ppt)
<u>1/19/16 0920</u>	<u>207.42</u>	<u>0.1</u>	<u>0.35</u>	<u>5.87</u>	<u>546</u>	<u>3.72</u>	<u>49.1</u>	<u>22.0</u>	<u>-40.5</u>	<u>0.26</u>
<u>0924</u>	<u>207.42</u>	<u>0.4</u>	<u>0.33</u>	<u>6.00</u>	<u>507</u>	<u>3.09</u>	<u>43.3</u>	<u>22.0</u>	<u>-50.7</u>	<u>0.24</u>
<u>0930</u>	<u>207.42</u>	<u>0.7</u>	<u>0.33</u>	<u>5.98</u>	<u>502</u>	<u>3.55</u>	<u>42.5</u>	<u>22.0</u>	<u>-49.7</u>	<u>0.24</u>
<u>0935</u>	<u>207.42</u>	<u>0.9</u>	<u>0.32</u>	<u>6.09</u>	<u>499</u>	<u>3.33</u>	<u>48.3</u>	<u>22.2</u>	<u>-53.6</u>	<u>0.24</u>
<u>0940</u>	<u>207.42</u>	<u>1.2</u>	<u>0.33</u>	<u>6.06</u>	<u>503</u>	<u>3.78</u>	<u>45.5</u>	<u>22.0</u>	<u>-20.6</u>	<u>0.24</u>
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

SAMPLE WITHDRAWAL METHOD: Bailer (teflon)

APPEARANCE OF SAMPLE: COLOR: clear

SEDIMENT: slight

OTHER: no odor / some floating algae observed

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES TPH-DRO / ORO / GRO CHCl₃,
VOCs CHCl₃, PAHs (NONE), DISSOLVED LEAD (HNO₃), ED13 (Na₂S₂O₇)

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: 1 x 1L AMBER, 2 x 500mL AMBERS,
1 x 500mL POLY, 7 x 40 mL VOAS (TOTAL = 11)

SAMPLE IDENTIFICATION NUMBER(S) RH-MW2253-GW116 / ERH 015 @ 0940

DECONTAMINATION PROCEDURES: NAVY PPM I-F

NOTES: SAMPLE WAS FIELD FILTERED FOR DISSOLVED LEAD.

SAMPLED

BY: AL, BR

SAMPLES DELIVERED TO: ALS, KELSO, WA

TRANSPORTER: TRACIE SOBER, ALS

DATE: 1/21/2016 TIME: 0900

CAPACITY OF CASING (GALLONS/LINEAR FOOT)

2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

APPENDIX B

Field Notes

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TUESDAY 1-19-2016

ACTIVITY: GW MONITORING (OUTSIDE WELLS)

TEAM: AUSTIN LUTLEY (AL), BERNICE BALGTE (BB)

ROBERT "BOB" CHENET, HAWAII ^{DLNR} _{CDWRM} & DARREN UCHIMA, NAVFAC HI

PPE LEVEL: D

WEATHER: 66°F, 81% HUMIDITY, WINDS 0 MPH NNW (CLEAR SKIES)

REFERENCES: WP/SAP, HSP, NAVY PPM

0825 BB ARRIVES ONSITE & MEETS RC, DLNR

0835 AL ARRIVES ONSITE & WE CHECK IN WITH HALAWA PRISON GUARD

0842 ARRIVE @ WELL & CONDUCT H&S BRIEFING

0845 SETUP EQUIPMENT & CALIBRATE YSI WATER QUALITY METER

0900 START PURGING ^{HW} MW2253⁻⁰³ IN LOCKED GATED ENCLOSURE (WL = 207.42' @ 0903)

0940 END PURGING AND COLLECT SAMPLE ^(ERH015) USING TEFLON BAILER (METALS FILTERED)

1017 LEAVE WELL AND CALL DU, NAVY WHO NEEDS TO ESCORT AL

1021 RC, DLNR CHECKS OUT WITH HALAWA PRISON GUARD

YSI CALIBRATION LOTS: EC 1413 GEOTECH LOT SAA927

ORP 220mV \pm 1.5% @ 25°C SAA241

PH 4.0 GEOTECH LOT SAA923

1040 DU, NAVY ARRIVES TO ESCORT US INSIDE

1045 PLACE DRUM (EMPTY) ON SPILL PALLET @ IDW STORAGE AREA

1050 SETUP EQUIPMENT @ MW OWDFMW01 NEARBY (WL = 119.82' @ 1057)

1105 START PURGING

1117 END PURGING AND COLLECT SAMPLE USING TEFLON BAILER (METALS FILTERED)

1145 LEAVE WELL (ERH016)

1150 ARRIVE @ MW RHMW07 AND SETUP EQUIPMENT USING PREVIOUS CONTROL SETTINGS:

PUMP - PRESSURE 110 PSI (GANG)

DISCHARGE - 40 SEC

CO₂ TANK - PRESSURE 160 PSI

FILL TIME - 30 SEC

1205 ^{HW} * START PURGING (WL = 198.24')

1226 END PURGING AND COLLECT SAMPLE USING DEDICATED SUBMERSIBLE (ERH017)
BLADDER PUMP / TUBING (METALS FILTERED)

1244 LEAVE WELL

1246 ENTER TUNNELS @ ADIT 5 TO PLUG IN GOLF CART FOR USE TOMORROW
AND TAKE A RESTROOM BREAK

1312 DRIVE TO MW RHMW06 AND TAKE LUNCH BREAK

1345 END LUNCH BREAK

1-19-2016 TUESDAY

SAMPLE LOG:

EPA ID:

SAMPLE ID:

DATE:

TIME:

CONT:

ERH015

RH-MW2253-GW116

01-19-16

0940

11

ERH016

RH-OWDFMW01-GW116

01-19-16

1117

11

ERH017

RH-MW07-GW116

01-19-16

1226

11

ERH018 (MS/MSD)

RH-MW06-GW116

01-19-16

1416

11 x 3 = 33

ERH019

RH-MW04-GW116

01-19-16

1555

11

ERH020

RH-MW04-GW116-DUP

01-19-16

1630

11

- 1345 SETUP EQUIPMENT @ MW RHMW06, WL = 240.69 @ 1348
 PUMP - PRESSURE 130 PSI (GAUGE)
 - DISCHARGE TIME 30 SEC } PURGE / 40 SEC } SAMPLE
 - FILL TIME 20 SEC } WQ READINGS 30 SEC }
- CO₂ TANK PRESSURE 160 PSI
- 1355 START PURGING
- 1416 END PURGING AND COLLECT SAMPLE USING DEDICATED SUBMERSIBLE BLADDER PUMP / TUBING (METALS FILTERED) (ERH018, MS, AND MSD)
- 1450 LEAVE WELL / WAIT WHILE DU, NAVY REQUESTS GUARD OPEN GATE TO NEXT WELL
- 1454 GUARD OPENS GATE AND WE PARK @ MW RHMW04 (FLUSH MOUNT)
- 1455 SETUP EQUIPMENT, OPEN WELL, AND DRAIN WATER FROM ANNULUS.
 * CAP CAME OFF, ALSO EYELET ON WELL COVER MAY ALLOW CABLE THROUGH -
 ADDED A CARABINER TO EYELET TO HOLD CABLE IN CASE IT SLIPS OUT.
- 1512 WL = 293.61'
 PUMP - PRESSURE 170 PSI (GAUGE)
 - DISCHARGE TIME ~~30~~³⁰ SEC } PURGE / 50 SEC } SAMPLE
 - FILL TIME ~~20~~⁴⁰ SEC } WQ READINGS 60 SEC }
- CO₂ TANK - PRESSURE 180 PSI
- 1515 START PURGING
- 1538 FIRST WATER IS PURGED
- 1555 END PURGING AND COLLECT SAMPLE USING DEDICATED SUBMERSIBLE BLADDER PUMP / TUBING (METALS FILTERED) ERH019
- (1630) TIME USED FOR DUPLICATE SAMPLE ERH020
- 1622 CO₂ TANK RUNS OUT
- 1630 DU / AL GO TO AL'S CAR TO GET TOOLS TO CHANGE OUT TANK
- 1643 RETURN WITH TOOLS & CHANGE TANK
- ~~1720~~ LEAVE WELL / DU CLOSES GATE
 * AIR / WATER LINES SLIPPED OUT OF QUICK CONNECTS / SECURED W/ ZIP TIES
 NEED TO CHECK BEFORE NEXT EVENT
- 1737 LEAVE SITE AFTER EMPTYING 10N WATER IN NEW DRUM-002

Handwritten:
 1/19/16

APPENDIX C

**Laboratory Report
(included on attached CD)**

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APPENDIX D

**EPA/DOH Letter, Enclosure A, Analytes and
Action Levels, February 4, 2016**

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ENCLOSURE A
ANALYTES AND ACTION LEVELS

TABLE 1
ANALYTES AND ACTION LEVELS FOR RED HILL MONITORING WELLS
RHMW01, RHMW02, AND RHMW03

ANALYTE	Environmental Action Level µg/L	SSRBL µg/L
TPH-g	100	NA
TPH-d	100	4500
TPH-o	100	NA
Benzene	5	750
Ethylbenzene	30	NA
Toluene	40	NA
Total Xylenes	20	NA
Naphthalene	17	NA
1-Methylnaphthalene	4.7	NA
2-Methylnaphthalene	10	NA

NA - Not Applicable

TABLE 2
ANALYTES AND ACTION LEVELS FOR RED HILL MONITORING WELLS
RHMW04, RHMW05, RHMW06, RHMW07, RHMW2254-01,
HDMW2253, AND OWDFMW01

ANALYTE	Environmental Action Level µg/L
TPH-g	100
TPH-d	100
TPH-o	100
Benzene	5.0
Ethylbenzene	30
Toulene	40
Total Xylenes	20
Naphthalene	17
1-Methylnaphthalene	4.7
2-Methylnaphthalene	10

ENCLOSURE A
ANALYTES AND ACTION LEVELS

TABLE 3
ANALYTES AND ACTION LEVELS FOR FUTURE RED HILL MONITORING
WELLS RHMW08, RHMW09, RHMW10, AND RHMW11

ANALYTE	Environmental Action Level µg/L
TPH-g	100.0
TPH-d	100.0
TPH-o	100.0
Benzene	5.0
Ethylbenzene	30.0
Toulene	40.0
Total Xylenes	20.0
Naphthalene	17.0
1-Methylnaphthalene	4.7
2-Methylnaphthalene	10.0
1,2 Dichloroethane*	5.0
1,2 Dibromoethane*	0.04

*Lead Scavengers can be discontinued after one year of sampling if all samples result in non-detection.

APPENDIX E

Fact Sheet, Quantitation & Detection

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As a Project Manager or decision-maker, you may use environmental data to accomplish one or more of the following tasks:

- Determine whether a chemical substance is present in an environmental sample at or above some threshold value or action level;
- Verify that a pollutant concentration remains below a permit limit;
- Evaluate potential risks to human health or the environment;
- Monitor changes in concentrations of contaminants; or
- Determine the effectiveness of remediation activities.

Making correct decisions in these cases often depends on the ability of an analytical method to detect and measure extremely low concentrations of a substance.

This fact sheet has been prepared to: 1) provide Project Managers and data users with basic information about detection and quantitation concepts; and 2) acquaint the reader with detection and quantitation terminology and requirements contained in the *DoD Quality Systems Manual for Environmental Laboratories (DoD QSM)*, Version 4.1. This information should help clarify the uncertainty associated with reporting low-concentration data. It should also help project teams understand the importance of selecting analytical methods that are sensitive enough for their intended uses, i.e., capable of generating reliable data (data of known precision and bias) at the project-specific decision levels.

Measures of Sensitivity — Basic Concepts

The following terms are used to describe the routine sensitivity of analytical procedures:

- DL – Detection Limit
- LOD – Limit of Detection
- LOQ – Limit of Quantitation

All measures of sensitivity are specific to the analyte, sample matrix, test method, instrumentation, and analyst/laboratory performance. Therefore, analytical performance must be demonstrated for each variable (e.g., it is possible that two “identical” instruments from the same manufacturer may exhibit different sensitivities).

The Detection Limit (DL) is the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. In other words, if a substance is detected at or above the DL, it can be reliably stated (with 99% confidence) that the analyte is present (there is a 1% chance that the analyte is not present (a false positive)). Note that for reporting purposes, any result at or above the DL must also meet qualitative identification criteria required by the test method. Although a result at or above the DL indicates that the analyte is present, the absence of a result at or above the DL is inconclusive (i.e., one cannot confidently state whether the analyte is present or absent), because the false negative rate at the DL is 50%.

The Limit of Detection (LOD) is the smallest amount or concentration of a substance that must be present in a sample in order to be detected at a 99% confidence level. In other words, if a sample has a true concentration at the LOD, there is a minimum probability of 99% of reporting a “detection” (a measured value \geq DL) and a 1% chance of reporting a non-detect (a false negative).

The failure to obtain a “detection” should be reported as “<LOD,” because the false negative rate at the LOD is 1%. Reporting the sample result as “<DL” is inappropriate because, as stated above, the false negative rate at the DL is 50%.

The Limit of Quantitation (LOQ) is the lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias. The LOQ is typically larger than the LOD (but may be equal to the LOD, depending upon the acceptance limits for precision and bias); therefore, the following is true:

$$DL < LOD \leq LOQ$$

Quantitative results can only be achieved at or above the LOQ. Measurements between the DL and the LOQ assure the *presence* of the analyte with confidence, but their numeric values are estimates.

Types of Procedures for Estimating Sensitivity

Numerical estimates of the DL, LOD, or LOQ for a specific analyte, matrix, and method can be calculated using various statistical procedures, which involve spiking reagent water or other specific matrix with low concentrations of the analyte of interest. At this time, unfortunately, universally accepted statistical procedures do not exist.

The estimator that has been most commonly used by environmental laboratories is the EPA Method Detection Limit (MDL), which is an approximation of the DL. EPA has defined the MDL as the “minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero, and is determined from analysis of a sample in a given matrix containing the analyte.”¹ Calculating the MDL at 99% confidence means there is a 1% probability that a sample having a result at or above the MDL is a false positive. The EPA MDL was designed to protect against false positives.

Uses and Limitations of the MDL

When performed correctly and consistently, MDLs determined using the EPA procedure can be useful for comparing different laboratories’ performance using the same methods, or the performance of different methods within the same laboratory. Laboratories typically determine the MDL in reagent water, resulting in a “best-case” MDL, which provides limited information about method performance on real-world samples.

The EPA MDL procedure has been criticized as a poor estimator of the DL for the following reasons:

1. It is a single laboratory, short-term estimator that fails to account for analytical bias, changing instrument conditions, or analyst skill.
2. It assumes uniform variance across all possible spike concentrations, failing to account for the fact that variance increases at higher concentrations.
3. It assumes that measured values at the spike concentration are normally distributed. By using this procedure and spiking at very low concentrations, laboratories have been able to calculate MDLs that cannot be achieved in practice.

DoD QSM Requirements

For the reasons discussed in the previous paragraph, the DoD QSM requires that laboratories verify measures of method sensitivity, in terms of the LOD and LOQ, at least quarterly. Requirements for the LOD and the LOQ are contained in DoD QSM Boxes D-13 and D-14, respectively, which follow:

¹ 40 Code of Federal Regulations (CFR) Part 136, Appendix B, rev. 1.11.

Box D-13

Limit of Detection (LOD): Determination and Verification (Requirement)

A laboratory shall establish a detection limit (DL) using a scientifically valid and documented procedure for each suite of analyte-matrix-method, including surrogates. The detection limit shall be used to determine the LOD for each analyte and matrix as well as for all preparatory and cleanup methods routinely used on samples, as follows:

After each detection limit determination, the laboratory must immediately establish the LOD by spiking a quality system matrix at approximately two to three times the detection limit (for a single-analyte standard) or one to four times the detection limit (for a multi-analyte standard). This spike concentration establishes the LOD. It is specific to each combination of analyte, matrix, method (including sample preparation), and instrument configuration. The LOD must be verified quarterly. The following requirements apply to the initial detection limit/LOD determinations and to the quarterly LOD verifications.

- The apparent signal to noise ratio at the LOD must be at least three and the results must meet all method requirements for analyte identification (e.g., ion abundance, second-column confirmation, or pattern recognition.) For data systems that do not provide a measure of noise, the signal produced by the verification sample must produce a result that is at least three standard deviations greater than the mean method blank concentrations.
- If a laboratory uses multiple instruments for a given method the LOD must be verified on each.
- If the LOD verification fails, then the laboratory must repeat the detection limit determination and LOD verification at a higher concentration or perform and pass two consecutive LOD verifications at a higher concentration and set the LOD at the higher concentration.
- The laboratory shall maintain documentation for all detection limit determinations and LOD verifications.

Box D-14

Limit of Quantitation (LOQ): Establishment and Verification of LOQ (Requirement)

For DoD projects, the LOQ must be set within the calibration range prior to sample analysis. At a minimum, the LOQ must be verified quarterly.

The laboratory procedure for establishing the LOQ must empirically demonstrate precision and bias at the LOQ. The LOQ and associated precision and bias must meet client requirements and must be reported. If the method is modified, precision and bias at the new LOQ must be demonstrated and reported.

Establishing Project-Specific Requirements for Method Sensitivity

Project teams should establish their project-specific requirements for method sensitivity in terms of a Reporting Limit (RL) for each analyte and matrix. As defined in the DoD QSM, the RL is the lowest concentration value specified by the client that meets project requirements for reporting quantitative data with known precision and bias for a specific analyte in a specific matrix. The LOQ cannot be greater than the RL, if precision and bias of the RL and LOQ are the same. If the LOQ for a particular analytical method or laboratory cannot meet the RL, then a project team has three options:

1. Improve analyst performance or modify the method to achieve a lower LOQ.
2. Select a different method with an LOQ less than or equal to the RL.
3. Raise the RL.

Please note that precision and bias must be taken into consideration when assessing the LOQ versus the RL. Also note that data below the RL can be reported; however they are estimated values if less than the LOQ.

Reporting and Flagging Analytical Data

Although data reporting and flagging requirements are project-specific, all reported LOD and LOQ shall be adjusted for the size of sample aliquots, concentration/dilution factors, and percent solids. In addition, the following example (based on Box 47 of DoD QSM Version 4.1) illustrates the proper use of the “U” and “J” data qualifier flags for non-detect and estimated analytical results, respectively.

- U – Analyte was not detected and is reported as less than the LOD or as defined by the client. The LOD has been adjusted for any dilution or concentration of the sample (* see Example, below).
- J – The reported result is an estimated value (e.g., matrix interference was observed or the analyte was detected at a concentration outside the quantitation range, see Box 33).

Example: DL = 2, LOD = 4, LOQ = 20, and RL = 30 with the precision and bias of the LOQ meeting those of the RL and all samples are undiluted.

Sample #1: Analytical result: Non-detect	Reported result: <4 U
Sample #2: Analytical result: 3	Reported result: 3 J
Sample #3: Analytical result: 10	Reported result: 10 J
Sample #4: Analytical result: 20	Reported result: 20
Sample #5: Analytical result: 30	Reported result: 30

Understanding and Documenting Uncertainty for Low-Concentration Data

As mentioned above, detection and quantitation limits are laboratory specific. Following are some steps Project Managers can take to document measurement uncertainty for low concentration data.

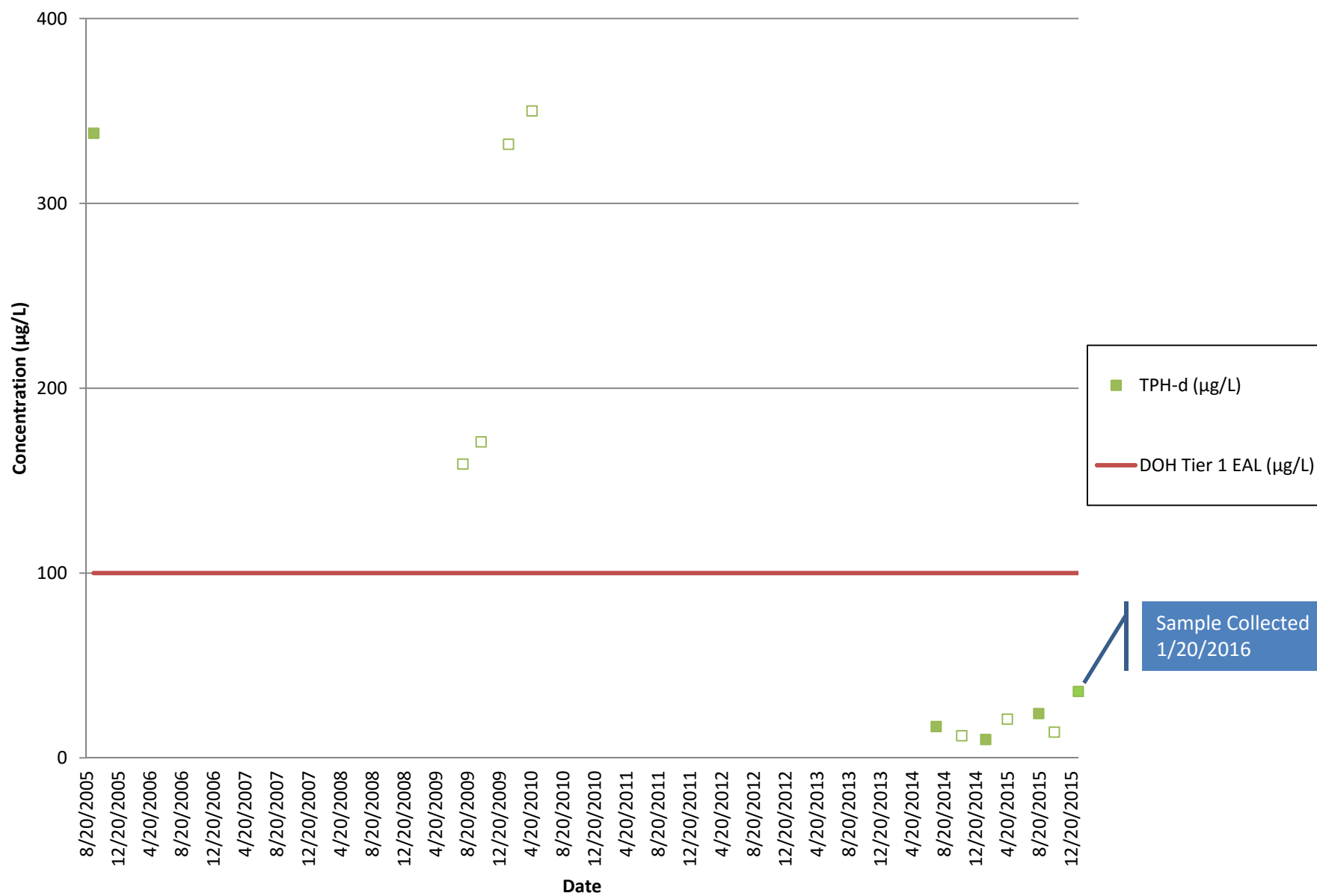
- As part of the laboratory selection process, provide the laboratory with project-specific RLs, including precision and bias, for each analyte and matrix. Ask the laboratory to provide its DL, LOD, and LOQ with associated precision and bias for each target analyte, in each matrix of concern (e.g., reagent water, clean sand, etc.), and verify that these values meet project-specific RLs. Request laboratory SOPs for establishing the DL and for establishing and verifying the LOD and LOQ.
- Ask the laboratory to verify the LOD by processing an LOD verification check sample with each batch of samples. This is a quality control sample that is spiked at a concentration at or slightly above the LOD to evaluate whether the analyte of interest is in fact “detectable” in the matrix of interest. To confidently report non-detects, set the reporting for non-detects to less than the LOD.
- If the project involves the collection of unusual or difficult matrices, or if the project-specific RL is near the LOQ, ask the laboratory to verify the LOQ in the project-specific matrix by analyzing a minimum of four replicate samples with known concentrations at the LOQ.
- Review the raw data (e.g., chromatograms) for low-concentration data. If a result is reported above the DL, make sure that the signal-to-noise ratio is at least 3.
- Compare sample results with blank results. If sample results (including chromatograms) cannot be distinguished from blank results, then they are not meaningful.

APPENDIX F

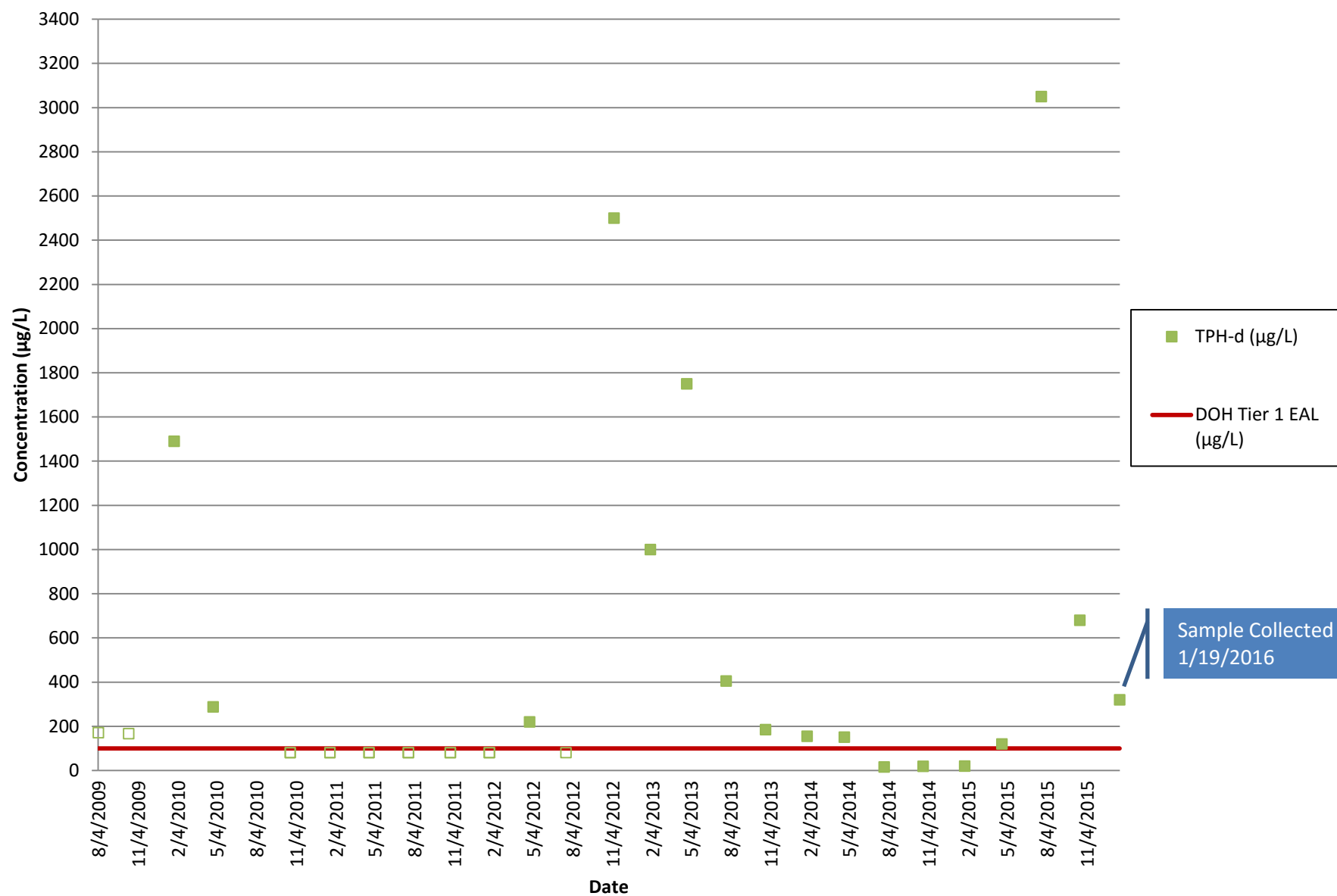
Historical Groundwater Exceedance Trends

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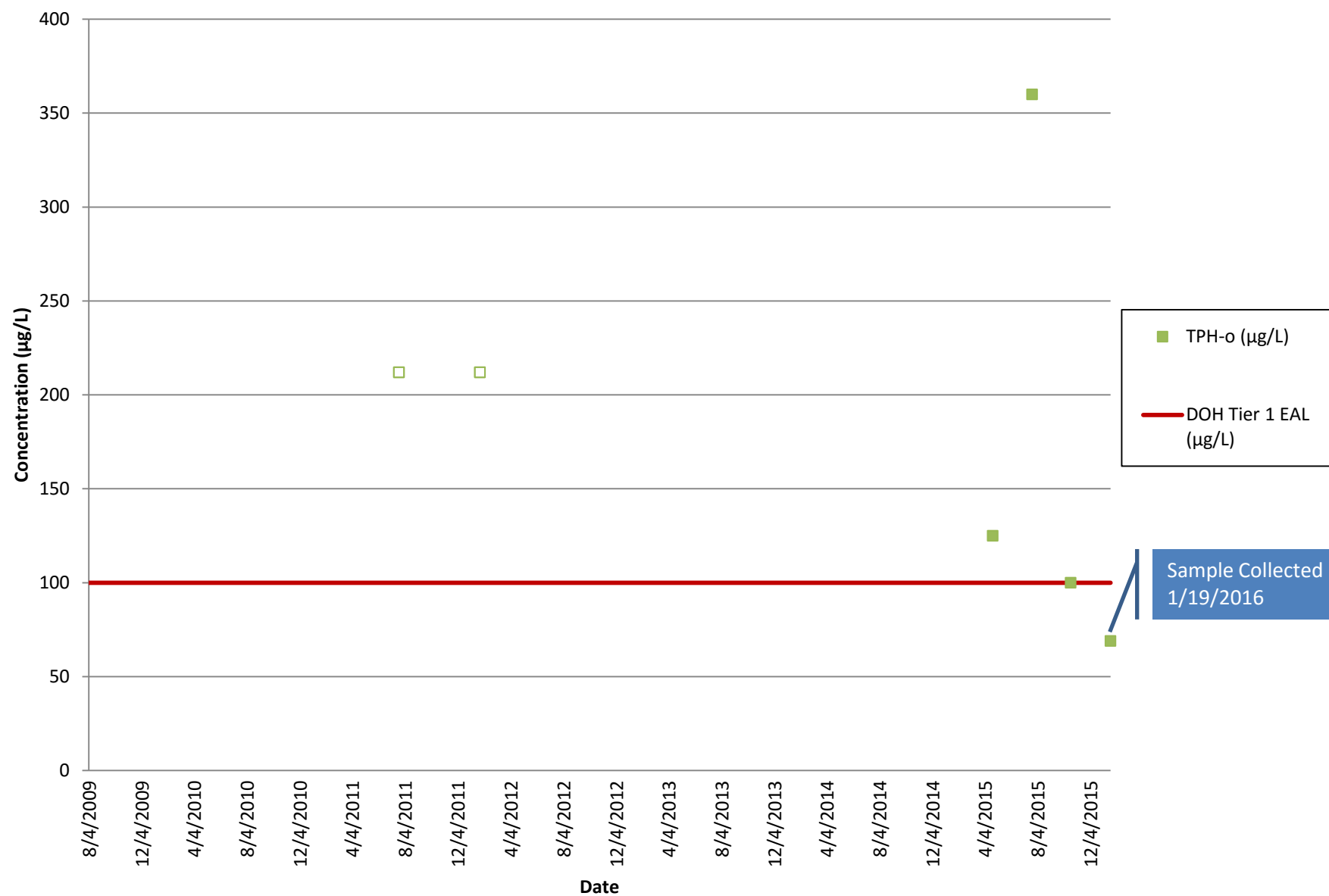
TPH-d Concentrations for RHMW04



TPH-d Concentrations for OWDFMW01



TPH-o Concentrations for OWDFMW01



TPH-d Concentrations for HDMW2253-03

