REPORT TO THE TWENTY-EIGHTH LEGISLATURE
STATE OF HAWAII
2015

PURSUANT TO SENATE CONCURRENT RESOLUTION 73
REQUESTING THE DEPARTMENT OF HEALTH
TO CONVENE A TASK FORCE
TO STUDY THE EFFECTS OF THE JANUARY 2014 FUEL TANK LEAK AT
THE RED HILL FUEL STORAGE FACILITY

PREPARED BY:
STATE OF HAWAII
RED HILL FUEL STORAGE FACILITY TASK FORCE
DECEMBER 2014

Introduction

On April 24, 2014, the Hawaii State Legislature adopted Senate Concurrent Resolution (SCR) 73 which requested the Director of Health to convene a Task Force to study the effects of the January 2014 fuel tank leak at the Red Hill Fuel Storage Facility and submit a report of the Task Force's findings and recommendations, including any proposed legislation, to the Legislature no later than 20 days prior to the convening of the Regular Session of 2015.

Under SCR 73, the Task Force is requested to examine:

1. Short-term and long-term effects of the leak at the Red Hill Fuel Storage Facility, including effects relating to the health of residents, safe drinking water, and the environment,
2. Response strategies to mitigate the effects of future leaks at the Red Hill Fuel Storage Facility,
3. Ways to improve communication between the United States Navy, the State, and the public in the event of future leaks at the Red Hill Fuel Storage Facility; and
4. Implications of closing the Red Hill Fuel Storage Facility.

Task Force members include the State of Hawaii Department of Health (DOH), the United States Environmental Protection Agency (EPA), the United States Navy (Navy), one member from the State House of Representatives, one member from the State Senate, the Department of Land and Natural Resources (DLNR), the Honolulu Board of Water Supply (BWS), and two members from the community. **Appendix A** contains a list of all the Task Force participants and alternates.

The Red Hill Fuel Storage Facility (Facility) is the state's largest field constructed underground storage tank (UST) complex, located in the south-central portion of the Island of Oahu, Hawaii. It is owned and operated by the United States Navy.

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Background Provided By the Navy

From 1940 to 1943, twenty (20) cylindrical tanks, 250 feet tall and 100 feet in diameter, were built in place along the Red Hill ridgeline. The tanks were constructed using 475,000 cubic yards of concrete around 45,000,000 pounds of l/4-inch steel plates forming 2.5 to 4-foot concrete encased steel tanks. Each tank was originally built with a leak detection system that consisted of a series of pipes that could potentially collect any released fuel at a central location. The Navy later determined that this initial leak detection system had design flaws which resulted in numerous false reports. This system was subsequently removed. Eighteen (18) tanks are active, and two (2) are presently not in use. Each tank is able to store up to 12.5 million gallons of fuel. The Facility is located 100 feet above a major groundwater aquifer, which is also used as a source of drinking water. Of the 18 in use tanks, three (3) are empty awaiting various stages of a service life extension program. The remaining fifteen (15) tanks are in use, storing over 180 million gallons of fuel at any given time.

The Navy continues to operate and maintain the fuel tanks to support military operations in the Pacific. Modifications were accomplished to extend the service life of the tanks, add protective coatings, install new leak detection systems, and upgrade the facility's fire protection system.

The first major modification to the tanks came in 1960 when four of the tanks were modified to accommodate volatile fuels and to install inventory monitoring equipment. In 1970, a contract was awarded to clean and inspect tanks 5, 6 and 12. In 1978, the Navy made the determination to extend the service life and modernize all 16 non-volatile fuel storage tanks. During this project, the original leak detection system for each tank was removed as described above. In 1994, the Navy cleaned and inspected tanks 6-10, 12-14 and 16. Additional modifications were performed in 1997 for those same tanks to extend their service life.

The inspections and modifications conducted between 1994 and 1997 greatly resembled the same practices used in today's procedures. Since then the Navy has implemented the most stringent tank inspection and repair practices consistent with the American Petroleum Institute's (API) 653 standards that would apply to the Red Hill tanks. After each tank has been thoroughly inspected, improvements are completed to ensure the operability of the tank for an additional twenty years. The Navy has adopted this program as a modified API 653 certification process which was applied to tanks 1, 6, 15 and 16 between 2004 and 2007. Three tanks have been temporarily removed from service to continuously conduct the API 653 certification process on a rotational basis. Since 2008, the Navy has completed service life extension improvements for tanks 2 and 20 and is currently conducting inspections and improvements on tanks 5, 14, and 17.

Since initial construction, the Navy has commissioned a number of projects and studies to modernize the facility and stay abreast of industry standards. Most notably, the Navy has installed and continues to use a highly sophisticated inventory system that provides real time height measurements of the fuel in each tank and flow rates through pipelines. In 1960, the Navy installed an initial automated tank gauging (ATG) system in tanks 17 – 20. Between 1972 and 1973, an identical ATG system was installed on the remaining 16 tanks to provide full visibility of the inventory levels within all 20 tanks. With the emergence of new technology, the Navy installed a Multi-function Tank Gauge (MTG) system in all 20 tanks by the end of 2002. This system has the capability of detecting a variance in fuel levels of l/16 of an inch and is based on mass and temperature measurements.

Over $156,000,000 was spent between 2006 and 2014 to inspect and improve the pipelines, install ground water and soil vapor monitoring, structurally reinforce the tunnels and passageways, improve the ventilation, upgrade the fire suppression system, and make other improvements. In addition, the Navy is constantly studying the industry's best technologies and practices to incorporate them into the management of this facility. In 2008, over $120,000 was spent researching secondary containment and leak detection technology options to improve the infrastructure. A redacted version of this study is available to the Legislature upon request. A similar study is currently being conducted that will be finalized in March 2015.

Environmental sampling over the years has shown a number of fuel releases dating back to 1947, including an oily waste disposal site. Exact qualities cannot be confirmed.

Installation of Monitoring Wells

After 2005, seven (7) groundwater monitoring wells (RHMW01-RHMW05, RH2254-01 and OWDFMW1) were installed to detect contamination into the groundwater. Upon determination that RH2254-01 (Red Hill Shaft) was also the Navy's Drinking Water Well, drinking water parameters were added to the groundwater list of constituents to be sampled. Refer to **Diagram 1** for the locations of all wells. Additionally, Diagram 1 shows the Commission on Water Resources Management's (CWRM's) Halawa Deep Monitoring Well which is also being monitored by the Navy. The wells are located on the mauka side of the Department of Public Safety's Halawa Correctional Facility. Outside the confines of the Facility are five (5) drinking water wells, (Halawa Shaft, Halawa Wells, Aiea Wells, Aiea Gulch Wells and Moanalua Wells), that are owned and maintained by the Honolulu Board of Water Supply. Only Halawa Shaft is shown in Diagram 1. In this report, there is a distinction made between drinking water samples from the Navy's drinking water well, RH2254-01 and the BWS wells, which are separate from groundwater samples taken at RHMW01-RHMW05 and OWDFMW1.

January 13, 2014 release from Tank No. 5

In the course of refilling Tank 5 following its service life extension work, a suspected fuel release was discovered and verbally reported to DOH on January 13, 2014. A release of Jet Propellant 8, also known as Jet Propulsion fuel, type 8 (JP-8) from Tank 5 was confirmed and reported to the DOH on January 23, 2014. The estimated fuel loss was up to 27,000 gallons. Immediately after the release was detected, the Navy began draining the contents of Tank 5 and collected soil vapor samples from existing vapor monitoring points and groundwater samples from the existing monitoring wells. Results taken in and around Tank 5, indicated a spike in levels of hydrocarbons in soil vapor and groundwater. The elevated groundwater samples came from groundwater monitor well 2 (RHMW02) which is the closest monitor well to Tank 5. However, no free product was detected in the groundwater samples.

In consultation with the EPA and DOH, the Navy is investigating the cause of the reported release from Tank 5 and whether any free product is present outside the tank liner, the concrete surrounding the tank, or in the adjacent basalt rock. In the event that free product is detected, the Navy will remove it to the maximum extent practicable.

Following the reported release, drinking water samples were collected at an increased frequency from the Navy's Drinking Water Well Shaft (2254-01/Red Hill Shaft) and the Honolulu Board of Water Supply (BWS) Halawa Shaft, Halawa Wells, Aiea Wells, Aiea Gulch Wells and Moanalua Wells. Test

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results for of the BWS wells and the Navy's Drinking Water Well, were non-detect for petroleum constituents in the months following the release. Laboratory analytical results showed that the water was within applicable safe drinking water standards. Note, there is no drinking water standard for Total Petroleum Hydrocarbons as diesel (TPH(d)) and naphthalene.

In 2008, the Navy developed and implemented a Groundwater Protection Plan (GWPP), which the DOH approved. The plan was updated in 2009 and 2010. A 2014 interim update is under review by DOH. The Navy in consultation with the DOH, and EPA has initiated planning efforts to update the existing Groundwater Flow Model and Contaminant Transport Analysis which will also be incorporated into the GWPP. This Plan and the 2009 and 2010 updates are available online at: http://health.hawaii.gov/shwb/underground-storage-tanks/.

Negotiated Agreement Between EPA, DOH and the Navy

Separate from the Task Force activities, DOH, EPA, and the Navy continue to work together on a negotiated agreement to assess the reported release of petroleum and minimize the threat of future releases.

Senate Concurrent Resolution 73 & Red Hill Task Force

Meetings were held on September 3, October 7, November 6 and December 11, 2014 to discuss the effects of the January 2014 release, results of on-going Navy investigations on the tank leak, Navy response actions since the leak was discovered and recommendations for improving operations to ensure protection of Hawaii's drinking water. These included regulatory requirements, facility improvements and improved communication to the public. Three additional subgroup meetings were held on November 17, November 26, and December 3, 2014 to compile this report. Materials from the four Task Force meetings, and the three subgroup meetings, including attendance lists, minutes and other supportive materials are posted online at: http://health.hawaii.gov/shwb/underground-storage-tanks/.

This report contains the Task Force's findings and recommendations for each of the review topics in accord with SCR 73.

Findings and Recommendations

1. **Short-Term and Long-Term Effects of the leak at the Red Hill Fuel Storage Facility including effects relating to the health of residents, safe drinking water, and the environment**

   Finding of Facts

   Short-term effects

In the 2008 Groundwater Protection Plan, Site-Specific Risk-Based Levels (SSRBLs) were established for this facility and these levels were approved by DOH. These SSRBLs raised the Environmental Action Levels (EALs) from 100 ppb to 4500 ppb for TPH (d), for instance. Justification was made

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because of the low solubility of jet fuel in water. Any exceedances of this level would evoke increased monitoring, notification and other actions. Refer to **Appendix F** for more information about SSRBLs for the Facility compared to EALs provided by the DOH.

After the January release, increased groundwater and soil vapor monitoring indicated contamination in the environment outside of Tank 5. Groundwater monitoring in RHMW02, located near tank 5, showed an increase in total petroleum hydrocarbons diesel (TPH(d)) of up to 5000 ppb, 500 ppb higher than the SSRBL approved by DOH. The Navy increased their sampling frequency to every two weeks.

During the same period, soil vapor results increased from 794 ppbv to 204,000 ppbv (parts per billion by volume) under Tank 5. There were also increases in soil vapor beneath the tanks closest to Tank 5. Refer to **Appendix B** for a summary of the maximum groundwater results at the Facility and soil vapor monitoring analysis from Tank 5 in the past and following the release. Refer to **Appendix C** for the Navy's current monitoring plan and an explanation of EALs and Site Specific Risk Based Levels (SSRBLs) from the Navy.

The Navy's sampling and analysis indicated that the increases of soil vapor volatile organic compound (VOC) concentrations beneath Tank 5 and nearby tanks may be attributed to the release of JP-8 from Tank 5 in January 2014. According to the Navy, results of groundwater sampling and analysis indicate the release of JP-8 from Tank 5 has had limited impact on the underlying groundwater and has not impacted any drinking water source. While, there has been detection of low levels of various petroleum chemicals in the RH2254-01 (Red Hill Shaft), there have been no detections from the accelerated and long-term monitoring since the reported January 2014 release.

Drinking water samples were collected from the 5 BWS drinking water sources and the regulatory drinking water distribution point for Navy Drinking Water Well RH2254-01, all samples have been non-detect for petroleum contamination since the January release. Analytical results from the drinking water samples data were within applicable safe drinking water standards or below any Federal maximum contaminant levels (MCLs). Refer to **Table 1 of Appendix B** for a comparison table.

The Task Force finds that the BWS and the Navy have undertaken significant efforts to assess the effects of the reported fuel leak on the environment and to protect drinking water resources. The Task Force acknowledges that the BWS has accelerated sampling at nearby drinking water sources. In addition, the Navy has performed extensive sampling and analysis of the groundwater, drinking water, and soil vapor at or near the Red Hill Fuel Storage Facility. The Navy has reported that their drinking water source remains safe based on analytical monitoring from certified laboratories that have been reviewed by DOH. The BWS has reported that 5 BWS drinking water wells in close proximity to Red Hill to date show no detections of petroleum chemical contaminants.

Long-term effects

According to the most recent groundwater monitoring results dated, July, 21, 2014, levels of TPH(d) still persist in the groundwater beneath Tank 5, above DOH Environmental Action Levels (EALs), but are below the SSRBLs approved by DOH for this facility. The monthly soil vapor results also remain elevated, in the range of 100,000 – 200,000 ppbv, according to the latest report dated September 25, 2014. However, soil vapor results remain below the SSRBL of 280,000 ppbv approved by DOH.

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Refer to **Appendix B** for a more details on the soil vapor and groundwater monitoring results and **Appendix C** for the Navy's current monitoring plan and **Appendix F** is an explanation of EALs and SSRBLs provided by the DOH. Additional cumulative groundwater sampling results are posted online at: http://health.hawaii.gov/shwb/underground-storage-tanks/.

BWS will continue periodic monitoring of its drinking water sources for petroleum contamination. The Navy will also continue periodic monitoring of the groundwater, drinking water, and soil vapor at the Red Hill Fuel Storage Facility, in accordance with the Groundwater Protection Plan. The Task Force expects the BWS and the Navy to continue providing reports on those efforts to the DOH and the EPA. The reports are available to the public from the DOH.

DOH and BWS Comments & Recommendations

- Navy must comply with state requirements for investigation of release points within Tank 5 and characterization and delineation of contamination released, including the active remediation of free product to "the maximum extent practicable" to prevent any contamination from extending beyond the current location. The Navy has taken steps to determine where free product, if any, may be located. To date no free product has been found. The Navy is continuing efforts to investigate and recover retrievable free product.
- Request Navy to continue to provide to DOH all water quality data collected at the Facility by monitoring well location and contaminant.
- Continue groundwater modeling studies by the Navy and the BWS. The studies are critical to understanding the rate and direction of groundwater movement in the area to assess potential impacts to neighboring potable water wells. The studies will also complement groundwater monitoring well contaminant data collection to assess the overall condition of the aquifer and validate earlier studies that evaluate the direction of groundwater flow in the area including a northwesterly component towards the BWS Halawa Shaft drinking water source cited in an April 15, 2010 TEC Inc. Tier 3 letter report. The full report is available online: http://health.hawaii.gov/shwb/underground-storage-tanks/. According to the TEC report:

  "In the vicinity of the USTs, as before, the gradient indicates a regional component of groundwater flow to the west northwest and a local component to the southwest."

  "The northwest regional flow places the HBWS Halawa Shaft, a major drinking water source for south Oahu, down gradient from the USTs."

  "The northwest regional component of the groundwater flow may be transporting a petroleum plume or dissolved hydrocarbons in a direction that is not currently being monitored. Currently there are no compliance wells between the Halawa Shaft and the Facility to evaluate this possibility. For the HBWS Halawa Shaft to be threatened by contamination from the Facility a free product plume would have to be present within approximately 1200 ft. of this drinking water source."

- Navy to drill and install additional groundwater monitoring wells north and south of the facility to enable the collection of groundwater data and provide information for the updated area-wide groundwater modeling. This will increase and improve the scientific understanding of the present and long-term quality and condition of the aquifer beneath the Red Hill tanks and beyond its boundaries. Select sites for additional monitoring wells after sampling results are obtained from the two monitoring wells installed in September and October 2014. Obtain relative groundwater elevation data in the Halawa/Red Hill/Moanalua area for proper characterization.
- Devise a financial mechanism in which the Department of Health, the Honolulu Board of Water Supply, and the U.S. EPA may be reimbursed for site investigation activities needed to initiate (e.g. installation of additional monitoring wells, any increased groundwater and drinking water sampling, and any water treatment to remove contamination) within the area, to ensure that contamination is not migrating from the Red Hill facility into neighboring drinking water pump stations.
- Strengthen Hawaii's groundwater protection program by increasing surveillance and identification of potentially contaminating activities from other field constructed tanks to protect and mitigate impacts to groundwater aquifers. At this time there are 46 such facilities statewide with Red Hill being the largest in the State and the United States. See **Appendix E** for a full listing of these tanks, their location and current status and whether the tanks are located over a drinking water source.
- Navy and Department of Health, Safe Drinking Water Branch should monitor the drinking water by collecting and testing duplicate samples for the parameters identified in the existing groundwater and drinking water sampling schedules and others identified by the Honolulu Board of Water Supply. The Groundwater Protection Plan should be updated to include a Quality Assurance Project Plan that specifically identifies sampling methodology, data acceptance criteria and laboratory selection criteria to ensure that all sampling is consistent and replicable. The results should be shared with all interested parties to assure that all Quality Assurance/Quality Control procedures were followed.
- Request Navy to develop a system to continuously monitor the soil vapor probes as a form of leak detection, with alarm set points to alert operator(s) of organic vapors rising above pre-determined concentrations.

BWS Comments

- Mitigate existing contamination beneath the tanks starting with the area adjacent to Red Hill groundwater monitoring well #2, to contain and prevent contamination from extending beyond the current location. The Task Force deems prevention is less expensive than clean up and water treatment of all releases – large and small.
- Graph the Navy monitor well data and analyze for water quality data trends, correlation with past fuel release, interrelationships between wells and groundwater flow. Graphing data provides a pictorial view of trends over time. Comparing the data with other information is standard scientific practice in conducting a thorough analysis of the information collected. The comparisons can show any correlations between data points when compared with past fuel releases and contaminant presence or other monitoring wells.

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All of this data analysis enables a better understanding of the "short and long term effects of the leak." in accordance with SCR 73.

- Fund and conduct a health effects study to assess the health significance of low level concentrations of petroleum chemicals in ground water and sources of drinking water in accordance with SCR 73 which requested the Task Force to "consider the short- and long-term effects of the leak at the Red Hill Fuel Storage Facility, including effects relating to the health of residents, safe drinking water, and the environment." Presently there are no drinking water standards that define whether the amounts of petroleum contaminants and frequency being detected are safe to be in groundwater that is used as a source of drinking water. This study will scientifically assess and determine the maximum amount of petroleum contaminants that is safe to be in drinking water and provide the documentation to respond to any questions and concerns about the petroleum contaminants detected to date.

  According to the DOH document, **Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater (Interim Final, May 2005 and updates),** EALs were developed to help assess the risks of environmental contamination and make decisions regarding the need for additional site investigation, remedial action or a more detailed risk assessment. The EALs were developed, among others, to help protect drinking water resources and aquatic habitats (discharges to surface water). The DOH document indicates that "while the presence of chemicals at concentrations above the EALs does not necessarily indicate that a significant risk exists at the site. It does, however, generally indicate that additional investigation and evaluation of potential environmental concerns is warranted." According to DOH, EALs for Total Petroleum Hydrocarbon (TPH) and many non-carcinogenic, petroleum related compounds (e.g., xylenes) are driven by the protection of groundwater quality. EALs therefore appear to be protective of the environment but is not a limit that when exceeded requires remedial action and clean up. This appears to infer an allowance of contamination to exist in the environment possibly for long periods as monitoring and testing continues without any mitigation. The BWS favors mitigating contamination before it travels and affects parts of the aquifer that are not contaminated. Maintaining drinking water quality criteria to the whole aquifer is favored over establishing a "risk based" level that appears to allow contamination at points in the aquifer in contact with a contaminating activity.

- Conduct a scientific peer review and evaluation of the sampling and test methods and detection limits used by the Navy to develop a uniform monitoring protocol. Understanding the short and long term effects of Red Hill leaks needs reliable peer-reviewed and vetted scientific data in order to accurately understand the issues and make sound decisions on those issues. Professional scientific peer-review and auditing is standard practice in all good testing and research studies undertaken to insure data validity, quality and transparency.

- A Red Hill Task Force Technical Subcommittee should be created to evaluate, comprehend and explain all of the complex and voluminous scientific information in support of the Task Force's discussion of issues and decision-making and to provide the Task Force and public with easily understandable technical information on Red Hill.

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Navy Comments:

- The Navy will continue to ensure the safety of drinking water resources through implementation of the Groundwater Protection Plan. The Plan was published and approved by DOH in 2008 and has been updated in 2009 and 2010. A 2014 interim update was recently reviewed by DOH. The Plan will continue to be updated as additional information becomes available. The Groundwater Protection Plan and its 2009 and 2010 updates are available online at: http://health.hawaii.gov/shwb/underground-storage-tanks/.

- The Navy is actively investigating for the presence of free product and will remove free product to the maximum extent practicable. The Navy will continue soil vapor and ground water monitoring in accordance with the approved Groundwater Protection Plan.

Recommendations Agreed Upon By Task Force:

- Additional groundwater monitoring wells are warranted to adequately assess groundwater hydrology and to support fate and transport models for a facility of this size and unique geology. The number of additional wells will be based upon a technical discussion using available data, as well as any current and future studies.

- BWS will continue periodic monitoring of its drinking water sources for petroleum contamination. The Navy will also continue periodic monitoring of the groundwater, drinking water, and soil vapor at the Red Hill Fuel Storage Facility, in accordance with the Groundwater Protection Plan. The Task Force expects the BWS and the Navy to continue providing reports on those efforts to the DOH and the EPA. The reports are available to the public from the DOH.

2. Response strategies to mitigate the effects of future leaks at the Red Hill Underground Fuel Storage Facility

Finding of Facts

REGULAR MAINTENANCE

The Red Hill facility consists of field constructed USTs that are currently deferred from Federal and State UST regulations that require other regulated non-field constructed USTs to have secondary containment for all new tanks and piping. It also requires corrosion protection and leak detection for all existing tanks and piping. **Appendix D** shows a summary of regulatory requirements for all other underground storage systems and those provisions for which field constructed tanks (FCTs) are exempt from.

The Navy performs periodic inspection of all petroleum, oil, and lubricant tanks and pipelines to ensure that the Red Hill Bulk Fuel Storage Tank system is properly maintained. Other protective measures include a Mass Technology Measurement System used by the Navy to assess tank tightness for all active Red Hill tanks. The tank tightness testing is performed every two years. In addition, the Navy employs an Automated Fuel Handling System to detect

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unscheduled fuel movements which alerts the operators of any potential fuel loss. Inventory levels are also assessed on a regular basis for trends that might reveal any potential fuel losses. Soil vapor monitoring equipment is also installed at the Facility to monitor hydrocarbon levels in the subsurface.

Recent maintenance cycles performed on tanks within Red Hill utilize a modified American Petroleum Institute (API) 653 procedure developed by the Navy, for determining integrity of steel plates and welds. According to the Navy, a general corrosion rate is used to estimate how much of the original steel will be thinned out from corrosion at the end of a 20 year operational cycle. The goal of tank maintenance is to have at least 0.1 inches of steel plate remaining from the original 0.25 inch steel. Regarding Tank 5, the Navy reported over 600 areas where tank thickness did not meet the appropriate standards. The required thickness was restored through additional weld patch plating within Tank 5 during its maintenance cycle that ended December 2013.

SECONDARY CONTAINMENT EVALUATION

In addition to the procedures mentioned above which monitor inventory levels to reveal potential fuel losses, the Navy uses soil vapor monitoring equipment to monitor hydrocarbon levels in the subsurface. However, these systems do not prevent leaks and fuel loss into the environment. A previous study conducted by the Navy in 2008 evaluated secondary containment options for the fuel tanks at Red Hill. The study included two options – a "tank within a tank" and a composite tank system. A redacted version of this report is available to the Legislature upon request. The Navy plans to continue studying secondary containment options as well as advanced leak detection technologies in collaboration with DOH and EPA.

At the October 7, 2014 Task Force meeting, the Navy stated the importance of the Facility and its need to continually maintain the capacity at Red Hill to support its fuel needs. The Task Force finds that the Navy plans to study secondary containment options and advanced leak detection technologies in collaboration with the DOH and EPA.

SITE ASSESSMENT & CONTINGENCY PLANS

In continuing efforts to monitor the groundwater for contamination and to better assess the fate-transport model, the seven (7) groundwater monitoring wells that were previously installed in and around the Facility will continued to be monitored on a regular basis, including the Navy's one drinking water well and the multiple drinking water wells maintained by the BWS. Monitoring of the CWRM Halawa Deep Monitoring Well and the Tripler Army Medical Center Monitoring Well could serve as sentinel well monitoring for any contaminant movement to the south towards BWS' Moanalua Wells.

Subsequent to the January 2014 release, the Navy, in coordination with the DOH and EPA, installed two additional groundwater monitoring wells in October 2014 (RHMW06 and RHMW07). Preliminary results from these two new wells have shown low levels of petroleum contamination 300 feet north of the facility. Refer to **Diagram 1** for locations of all wells.

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When available, samplings results will be submitted to the DOH and EPA. DOH will make the data available to the public.

Additional wells may be necessary to adequately determine groundwater hydrology and support contaminant fate and transport models that are underway. **Diagram 1** maps the location of existing wells and the two new wells installed since the reported release from Tank 5.

The Navy has developed contingency plans with other federal agencies to address potential consequences from releases. These plans are periodically reviewed, updated and appropriate actions are taken by the Navy in response to these reviews and updates.

DOH Comments

- All current methods of release detection that the Navy implements at the Facility are reactionary. There is no 'alarm' until contamination has left the steel containment and then enters the environment. Secondary containment would capture fuel released from the inner wall into an interstitial space and alert Navy operators of releases. It could also be designed to allow for product recovery.

- As of December 24, 2014, DOH has not been able to verify the accuracy and precision of any Automatic Tank Gauging (ATG) system, any Automated Fuel Handling System or the "highly sophisticated inventory system" that the Navy is using.

- The Legislature should issue a resolution to encourage Navy to consider enhanced containment and improved leak detection at Red Hill.
- DOH should amend the State's UST regulations to require secondary containment and leak detection for all of Hawaii's field constructed USTs. Refer to **Appendix E** for a listing and maps of these FCTs.

DOH and EPA Comments

- The Navy should evaluate current release detection methods, tank tightness testing protocol, tank inspection and repair procedures, and corrosion and metal fatigue control practices at Red Hill and institute best available technology where feasible and appropriate.

BWS Comments

- Support proposed EPA regulatory changes to cancel the deferral of field constructed USTs from 40 CFR Parts 280 and 281. The changes will regulate field constructed tanks (FCTs) and require compliance with existing release detection, spill and overfill control protection, and cathodic corrosion protection requirements.
- The Legislature is urged to issue a resolution encouraging the President of the United States to pass the proposed changes out of the Office of Management and Budget as originally published.
- Revise the DOH UST leak response requirements to specify the Resource Conservation and Recovery Act (RCRA) methodology for characterizing the nature and extent of

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contamination. The RCRA site characterization approach is a comprehensive data collection method for producing a clear understanding of the current contamination problem and its extent in the environment. From there, targeted measures can be developed to mitigate the situation that can lead to developing strategies to mitigate the effects of future leaks at Red Hill.

The major elements of the RCRA methodology are:

- Identify and determine the velocity of contaminant movement in the groundwater (saturated zone), amounts present, factors influencing plume movement and extrapolation of future movement (modeling).
- Examine the contamination in vadose zone (unsaturated zone), amounts present, factors influencing plume movement and extrapolation of future movement (modeling).
- Employ contaminant characterization presentation tools to create three-dimensional data plots to show lateral and vertical extent of contaminant plumes.
- Examine impacts to potential receptors such as potentially affected human populations, environmental systems, ecology, biota and endangered/threatened species.

- Release and use EPA Drinking Water State Revolving Fund (DWSRF) set-aside grants to fund the drilling and installation of additional monitor wells in the Red Hill area. The use of DWSRF set asides describes a specific funding source and strategy to mitigate the effects of future leaks at Red Hill. The installation of additional sentinel wells provides long range surveillance and advance planning information to mitigate the effects of past and future leaks. The number of additional monitor wells to drill should be based on sound science data generated through the RCRA site characterization process.

The Board of Water Supply believes the Hawaii State Legislature will expect the Task Force's report to contain specific targeted action steps, strategies and recommendations that are based on sound science and the most state-of-the-art technical approaches for characterizing and mitigating the short and long term effects of leaking Red Hill underground fuel tanks.

Department of Land and Natural Resources Comments & Recommendations

- Provide an update on the wells which have been surveyed by US Geological Survey.
- Provide the date of distribution of the final USGS survey data.
- To effectively monitor the groundwater beneath a facility as large as Red Hill, with the complexities inherent in the fractured and porous basalts that underlie the facility, monitoring wells must be placed based upon a careful and thorough evaluation of the groundwater flow regime under and around the facility. Groundwater modeling will provide some insight and flow direction predictions, however, modeling and any other groundwater flow evaluation is dependent upon accurate water level data collected from monitoring wells with screened casings across the water table, and in locations that allow flow directions to be calculated. The linear locations of wells RH MW01, 02, 03, and 05, along the ridge, are too linear and too closely spaced to evaluate groundwater gradients.
- At this time, the CWRM recommends that two additional monitoring wells be installed and sampled: one monitoring well on the south side of the Facility (e.g. near the west end of Ala

Iolani Street), and one monitoring well on Icarus Way, west/northwest of RHMW01, near the entrance of the upper tunnel. These new wells, and all others associated with the Facility, should be surveyed to a common benchmark. A water level survey of all wells should then be conducted. Based on upon water levels, and sampling results, groundwater gradient/flow direction can be evaluated, and then if needed, additional monitoring well(s) can be installed and sampled.

Navy Comments

- The Navy will continue a service life extension program for the 12 remaining tanks.

- The Navy will explore additional containment protection solutions and seek funds to implement those that are likely to be effective in providing additional protection to the drinking water resources.

DOH, BWS and DLNR Comment

- Although the Navy has done, and continues to do, extensive repair work and improvements to this Facility, the best solution is some type of secondary containment. More research needs to be completed in regards to what technologies are available and if and how it can be successfully integrated.

3. **Improve communications between the United States Navy, the State, and the public in the event of future leaks at the Red Hill Underground Fuel Storage Facility**

Finding of Facts

The technical information on Red Hill is primarily communicated between the Navy and the DOH and EPA as required by state and federal regulations. Regulatory monitoring data is available to the public and other agencies through DOH.

DOH and BWS Comments

- DOH continue to maintain a public website containing all information from the Task Force, Navy, DOH, BWS, and other agencies (e.g., meeting notices, notes of meetings, reports, data, trend graphs, laboratory analysis, etc.) to provide easy access to information and improve transparency.
- Continue the work of the Red Hill Task Force to ensure the long-term management, information access and decision making on issues related to leaks at Red Hill and the protection of Oahu's ground water aquifer, environment and public health.
- Continue to utilize notification systems to communicate future leaks and incidences at Red Hill or other underground storage tanks located above or in the vicinity of drinking water aquifers. The alert system should be targeted to specific persons for first response action.

Department of Land and Natural Resources Comments

- To share a timeline for the distribution of any sampling results to the Task Force and/or involved parties (e.g. distribute results within 2 weeks of receipts of results).

Comments Agreed Upon by the Task Force

- The Task Force also finds that all parties have demonstrated and continue to be fully committed to communicating with the public for any matters of public interest regarding the Red Hill Fuel Storage Facility. The Task Force acknowledges that the DOH, EPA, BWS and the Navy have made significant efforts to keep the public informed on the reported fuel leak. This began with a joint press conference by the DOH, BWS and Navy immediately following the January 2014 release, and continued with participation in community outreach events, publication of numerous media releases, and active coordination between and among appropriate State and Federal agencies to remediate any potential contamination and prevent future leaks at the Facility. The Task Force expects that all parties will continue to keep the public informed of any events at the Red Hill Storage Facility that would impact the public or the environment.

4. Implications of Closing the Red Hill Underground Fuel Storage Facility

Finding of Facts

The Task Force finds that the Navy operates and maintains the Red Hill Fuel Storage Facility as a strategic petroleum facility that provides critical fuel to operating forces in the Pacific region. The Task Force acknowledges that the Navy has no plans to close the Facility. The Task Force expects that the Navy will inform the public should those plans change.

The Navy indicated at the October 7, 2014 meeting that assessments are underway to explore alternative fuel storage solutions in lieu of either continued full or partial use of the Red Hill Facility.

DOH & BWS Comments

- The Department of Health does not have information regarding implications of shutting down this facility. DOH's priority is the protection of the environment and it views the storage of up to 187 million gallons of fuel, 100 feet above a drinking water resource, is inherently dangerous. Therefore, the operation of this facility should only exist on the condition that the facility be upgraded with secondary containment and state-of-the-art leak detection to ensure safe operations and prevent adverse impact to the environment.

- Any secondary containment feasibility study should include a comparison with the creation of a new fuel farm consisting of above ground tanks (ASTs) or the use of other available fuel storage options (i.e. closed refineries, fuel tankers, etc…) that already have secondary containment.

- The Navy should have facility-wide implementation of secondary containment by December 31, 2024. DOH recommendations on this point may be altered through the negotiation of an enforceable agreement with the Navy.

- In the interim, while the Navy studies available technologies increased protection and monitoring must be applied until secondary containment can be implemented.

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BWS Comments

- Given the age and condition of the Red Hill Fuel Storage Facility, and with its history of leaks dating back to 1947 to the present, the Navy should disclose all studies or reports conducted including possible catastrophic release scenarios (e.g. seismic related, accidents, etc.).

Navy Recommendations and Opinions

- The Navy has above described the actions taken to continually upgrade and modernize the Red Hill Bulk Fuel Storage Facility and intends to continue to implement a sound systematic phased approach using continual improvement processes to continue those upgrades. The initial phase consists of ongoing evaluation of additional containment protection solutions. The second phase would involve planning, programming and implementing those solutions that are likely to be effective in providing additional protection to drinking water resources.

- The Navy will continue a service life extension program for the 12 remaining tanks.

Legislative Recommendations from the DOH

- Passage of a resolution that would request owners and operators of the 46 field constructed tanks (FCTs) in Hawaii to update the Legislature and the Department of Health on the status and condition of each of their 70+ year old tanks (e.g. construction and operational history, past leaks, monitoring and water quality test data, leak detection and liner upgrades, visual inspections, maintenance procedures, etc…). This is currently not required of FCTs in the current UST rules. Refer to **Appendix E** for a listing and maps of the field constructed tanks in Hawaii.

- To increase DOH's portion of the current allocation of the Environmental Response, Energy, and Food Security Tax ("Barrel Tax"). The Barrel Tax places $1.05 levy on every barrel of oil imported into the State. Five cents of that tax goes to DOH's Environmental Response Revolving Fund (ERRF), which has not increased since the tax was created in 1993. As Hawaii undergoes its forward-looking transition to renewable energy and imports fewer barrels of oil, this also means that there is reduced funding available for the ERRF. An increase from 5 cents to 15 cents out of the $1.05 is needed to support current personnel and increase resources to the Solid & Hazardous Waste Branch, the Safe Drinking Water Branch, among other branches, to regulate Red Hill and manage other complex environmental issues. DOH recommends that an additional 10 cent contribution into the ERRF come from the 60 cents that currently goes into the general fund.

- Support adoption of revisions to existing DOH UST rules requiring increased protection from Hawaii's 46 field constructed tanks (FCTs), of which Red Hill tanks make up 24 (4 of Red Hill's surge tanks are also FCTs). All of these tanks are 70 years or older.

Legislative Recommendations from the BWS

- Provide additional resources to DOH to adequately monitor, study and regulate this Facility.

- Legislature issue resolution continuing the work of the Task Force until DOH is satisfied with progress and outcome on issues related to this Facility and will recommend suspension of the Task Force.

Task Force Recommendations to the Legislature

- Encourage the DOH, EPA, BWS, and the Navy to continue efforts to protect Hawaii's groundwater and drinking water sources.

- Encourage the DOH, EPA, BWS, and the Navy to keep the public informed on matters of public interest regarding the Red Hill Fuel Storage Facility.

- The Task Force further recommends that the Legislature encourage the DOH, EPA, and Navy to finalize a negotiated agreement for the Red Hill Fuel Storage Facility that protects drinking water resources, appropriately responds to the reported release of petroleum, and minimizes the threat of potential future releases.

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Appendices, Tables and Diagram

Glossary
Appendix A: List of Red Hill Task Force Members and Alternates
Appendix B: DOH and BWS Summary of Releases at Red Hill Facility
Table 1: Petroleum Contaminants Detected in Navy Red Hill Groundwater Monitoring Wells 2005-2014
Table 2: Soil Vapor Results from SV05
Figure 1: Soil Vapor Measurements SV05
Appendix C: Navy Data, including Monitoring Plan, Laboratory Numerical Levels, Groundwater Data Beyond Tank 5, Soil Vapor Results, Free Product Floating on the Surface of the Groundwater
Table 1: Data on Other Wells For Petroleum Contaminants of Concern
Appendix D: Hawaii UST Regulations and Exemptions for Field Constructed Tanks
Appendix E: List of Field Constructed Tanks in Hawaii and Maps
Appendix F: How Red Hill Facility Site-Specific Risk-Based Levels Were Established
Diagram 1: Location of the seven monitoring wells routinely tested by the Navy in green, and the two new sentinel wells north installed in Sept/Oct 2014

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GLOSSARY

API – American Petroleum Institute
API 653- American Petroleum Institute 653 repair standard for above ground tanks that was modified to be applied to the Red Hill underground storage tanks.
AST- above ground tanks
ATG- Automatic Tank Gauging system
BWS – Honolulu Board of Water Supply
CWRM- Commission for Water Resource Management, a division of the Department of Land and Natural Resources
DLNR- Department of Land and Natural Resources
DOH – State of Hawaii Department of Health
DWSRF- EPA Drinking Water State Revolving Fund
EALs – Tier 1 Environmental Action Levels
EPA – United States Environmental Protection Agency
ERRF- Environmental Response Revolving Fund
FCT – field constructed tank
GWPP- Groundwater Protection Plan 2008, updates in 2009 and 2010. An interim 2014 update is being reviewed by DOH at this time. This plan is available online at: http://health.hawaii.gov/shwb/underground-storage-tanks/,
HEER- DOH's Hazard Evaluation & Emergency Response Office
JP-8- Jet Propulsion fuel, type 8
MCL – maximum contaminant levels, federal drinking water standards
MTG – Multi-function Tank Gauge
PID- photo ionization detector
POU- permanently out of use
ppb- parts per billion
ppbv- parts per billion by volume (as a measure of soil vapor)
ppm- parts per million
RH2254-01 – The Navy's drinking water well, also known as the Red Hill Shaft
RHMW02 – Groundwater monitoring well No.2, which is located closest to Tank 5 and has the highest groundwater contamination concentrations
RHMW06 and RHMW07- two additional monitoring wells installed north of the Facility after the January release
RCRA- Resource Conservation and Recovery Act
SCR – Senate Concurrent Resolution
SSRBLs- Site-Specific Risk-Based Levels
TOU- temporarily out of use
TPH(d) – Total Petroleum Hydrocarbons, diesel range
ug/L – micrograms per Liter (also parts per billion)
USGS – United States Geological Survey
UST – underground storage tanks
VOC- volatile organic compound

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APPENDIX A

Red Hill Task Force Members

1. Gary Gill, Deputy Director, Department of Health
2. Aaron Poentis, NAVFAC Hawaii
    a. Capt. Mike Williamson
3. Senator Mike Gabbard, Chair, Energy/Environment Committee
4. Representative Chris Lee, Energy/Environmental Committee
5. Steven Linder, EPA Region IX
    a. Dean Higuchi, Hawaii EPA representative
6. Ernest Y.W. Lau, P.E., Honolulu Board of Water Supply (HBWS)
    a. Erwin Kawata, - HBWS
7. Patrick N. Casey, P.G., CHG, Geologist, Commission on Water Resource Management
    a. Robert Chenet, alternate
8. Steven Y. Onoue, President, Moanalua Valley Community Association
9. David Yomes, Chair Aliamanu/Salt Lake Neighborhood Board

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APPENDIX B

DOH and BWS Summary of Releases at Red Hill Facility

Navy studies and test reports show the Red Hill tanks have a history of fuel releases dating back to 1947 and the presence of fuel contaminants in groundwater and fractured rock beneath the tanks. Soil vapor and groundwater monitoring well data consistently show petroleum detections from 2005 to the present.

Samples from Red Hill groundwater monitoring well 2 (RHMW02), located in the tunnel near Tank 5 and Tank 6, contain the highest levels of total petroleum hydrocarbons as diesel (TPH-d) at 12 to 50 times above the DOH environmental action levels (EALs) of 100 µg/L (parts per billion) from 2005 to the present. The latest groundwater sampling event occurred on July 21, 2014 with 1,300 ppb of TPH-d (1.3 ppm). Based on Navy monitoring well test results submitted to DOH, the range of petroleum chemical contaminants detected and EPA health advisories, DOH Hazard Evaluation & Emergency Response Office Environmental Action Levels (DOH HEER EALs) and EPA safe drinking water Maximum Contaminant Levels (MCLs) are summarized in **Table 1.**

Soil Vapor sampling points were installed by the Navy beneath each of the 18 operational tanks at Red Hill. Tank 1 & Tank 19 were removed from service in the 1980s and lack soil vapor sampling points. The Navy has collected and reported monthly soil vapor for volatile organic compounds (VOCs) by photo ionization detector (PID) beneath each tank from 2008 to present.

Soil vapor VOCs spiked to 225,000 ppbv (parts per billion by volume) beneath Tank 5 in the sampling event of January 15, 2014. The prior event on December 23, 2013 showed 794 ppbv. The Navy increased SV monitoring to a weekly basis from Feb 2014 to July 2014. Maximum SV VOCs beneath Tank 5 increased to 450,000 ppbv on May 1, 2014 and have since declined to 208,000 ppbv on September 25, 2014.

Soil vapor sampling beneath the adjacent Tank 6 showed maximum VOCs of 43,600 ppbv on May 21, 2014 and 18,700 ppbv on September 25, 2014. Similar results were seen in the direction of Tanks 6-10 and sporadic high readings beneath Tanks 2, 3, 4 indicating air pathways thru the fractured basalt surrounding the tanks within the complex.

Monthly data from the Navy's soil vapor sampling report for Tank 5 is shown in **Table 2**. **Figure 1** illustrates this information in graphical form (Navy report, Oct 2014).

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Table 1 of Appendix B Petroleum Contaminants Detected in Navy Red Hill Groundwater Monitoring Wells 2005 to 2014
(values that exceed DOH/EPA levels in Bold)

#	Contaminant	DOH EAL drinking water threatened > 150 m to surface water (ppb)	EPA drinking water MCL** (ppb)	EPA health advisory (ppb)	Minimum value reported (ppb)	Maximum value reported (ppb)
1	TPH-d (diesel)	100	None	None	<20	**6,300**
2	TPH-g (gasoline)	100	None	None	13.2	**660**
3	Xylene	20	10,000	None	0.37	1.1
4	Benzene	5	5	None	0.14	0.92
5	Toluene	40	1,000	None	0.5	2.5
6	Acenaphthene	20	None	None	0.02	0.86
7	Fluorene	240	None	None	0.03	16
8	1-methylnaphthalene	4.7	None	None	0.02	**109**
9	2-methylnaphthalene	10	None	None	0.007	**88.5**
10	Naphthalene	17	None	100	0.03	**180**
11	Ethyl benzene	300	700	None	0.15	1.3
12	Lead (dissolved)	15	15	None	0.14	11.9
13	Pyrene	68	None	None	0.03	0.11
14	Chrysene	1	None	None	0.0159	0.062
15	Phenanthrene	240	None	None	0.02	0.14
16	Fluoranthene	130	None	None	0.026	0.24
17	Benzo[k]fluoranthene	0.4	None	None	0.0068	0.051
18	Benzo[a]anthracene	0.092	None	None	0.077	0.071
19	Indeno[1,2,3-c,d]pyrene	0.092	None	None	0.0075	0.037
20	Benzo[a]pyrene	0.2	0.2	None	0.0086	0.045
21	Benzo[g,h,i]perylene	0.13	None	None	0.0057	0.034
22	1,2-dibromoethane (EDB)	0.04	None	0.05	ND*	ND*
23	1,2-dichloroethane (1,2 DCA)	0.15	None	5	ND*	ND*

ppb = parts per billion or micrograms per liter
MCL = maximum contaminant level (EPA safe drinking water standard)
*Non-Detectable however, minimum detection limits were higher than DOH HEER EALs
NOTE: Additional constituents have been analyzed but have not shown significant detections

Table 2 of Appendix B
Soil Vapor Results from SV05
Soil Vapor Monitoring Letter Report
Red Hill Bulk Fuel Storage Facility

Date	SV05S	SV05M	SV05D
3/24/2008	1295	716	697
5/6/2008	5441	4214	4012
5/29/2008	6523	4638	3984
7/3/2008	5195	4218	3957
7/31/2008	5190	3785	2894
9/2/2008	6905	5581	3681
9/29/2008	7149	6405	3960
10/23/2008	3497	3690	2518
11/25/2008	3750	5221	3741
1/14/2009	9519	20567	12473
2/5/2009	1744	1824	1638
2/26/2009	7015	2820	1616
4/1/2009	1178	996	1179
4/20/2009	1209	1146	1326
5/27/2009	1120	1054	1123
6/29/2009	1055	1061	1131
7/20/2009	1237	1296	1582
8/28/2009	1776	1314	1457
9/24/2009	1901	1722	1906
10/29/2009	1430	1507	1724
11/19/2009	780	2100	2715
12/16/2009	210	2068	3418
1/28/2010	818	976	1227
2/22/2010	487	1453	2234
3/25/2010	1028	1473	1484
4/28/2010	398	1417	1532
5/26/2010	1002	980	1147
6/28/2010	64900	42100	25600
7/28/2010	38167	45633	59433
9/29/2010	NC[1]	NC[1]	NC[1]
10/18/2010	NC[1]	NC[1]	NC[1]
11/16/2010	NC[1]	NC[1]	NC[1]
12/14/2010	NC[1]	NC[1]	NC[1]
1/13/2011	NC[1]	NC[1]	NC[1]
2/15/2011	NC1	NC1	NC1
3/15/2011	NC[1]	NC[1]	NC[1]
4/18/2011	NC[1]	NC[1]	NC[1]
5/18/2011	NC[1]	NC[1]	NC[1]
6/22/2011	NC[1]	NC[1]	NC[1]
7/27/2011	NC[1]	NC[1]	NC[1]
8/26/2011	NC[1]	NC[1]	NC[1]
9/22/2011	NC[1]	NC[1]	NC[1]
10/27/2011	NC[1]	NC[1]	NC[1]
11/22/2011	NC[1]	NC[1]	NC[1]
12/16/2011	NC[1]	NC[1]	NC[1]
1/20/2012	NC[1]	NC[1]	NC[1]

Date	SV05S	SV05M	SV05D
2/23/2012	NC[1]	NC[1]	NC[1]
3/13/2012	NC[1]	NC[1]	NC[1]
4/16/2012	NC[1]	NC[1]	NC[1]
5/15/2012	NC[1]	NC[1]	NC[1]
6/19/2012	NC[1]	NC[1]	NC[1]
7/10/2012	NC[1]	NC[1]	NC[1]
8/14/2012	NC[1]	NC[1]	NC[1]
10/24/2012	NC[1]	NC[1]	NC[1]
11/26/2012	NC[1]	NC[1]	NC[1]
12/18/2012	NC[1]	NC[1]	NC[1]
1/31/2013	NC[1]	NC[1]	NC[1]
2/28/2013	NC[1]	NC[1]	NC[1]
3/28/2013	NC[1]	NC[1]	NC[1]
4/25/2013	NC[1]	NC[1]	NC[1]
5/30/2013	215	221	184
6/27/2013	115	233	232
7/25/2013	208	218	322
8/29/2013	63	68	161
9/26/2013	14	29	114
10/24/2013	229	250	201
11/21/2013	94	120	109
12/23/2013	50	622	794
1/15/2014	96	225000	204000
1/30/2014	818	150000	176000
2/24/2014	597	68200	100000
3/5/2014	492	96600	217000
3/10/2014	308	111000	204000
3/21/2014	593	99600	182000
3/25/2014	3144	271000	209000
4/3/2014	43700	384000	426000
4/7/2014	76100	413000	401000
4/16/2014	106000	437000	398000
4/22/2014	105000	383000	381000
5/1/2014	159000	450000	426000
5/8/2014	130000	377000	327000
5/15/2014	165000	401000	337000
5/21/2014	131000	415000	380000
5/27/2014	125000	369000	349000
6/3/2014	134000	341000	359000
6/11/2014	105000	288000	279000
6/19/2014	173000	284000	309000
6/23/2014	34500	45600	78700
7/9/2014	39700	277000	287000
7/21/2014	111000	234000	237000
8/27/2014	148000	205000	222000
9/25/2014	94500	208000	195000

ppbv: parts per billion by volume
NC[1]: Not collected due to maintenance work

Date	SV05S	SV05M	SV05D
3/24/2008	1295	716	697
5/6/2008	5441	4214	4012
5/29/2008	5523	4636	3984
7/3/2008	5195	4218	3957
7/31/2008	5190	3785	2894
9/2/2008	6905	5581	3681
9/29/2008	7149	5405	3960
10/23/2008	3497	3690	2518
11/26/2008	3760	5221	3741
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5/27/2009	1120	1054	1123
6/29/2009	1055	1061	1131
7/20/2009	1237	1296	1582
8/28/2009	1778	1314	1457
9/24/2009	1901	1722	1906
10/29/2009	1430	1507	1724
11/19/2009	780	2100	2715
12/16/2009	210	2068	3418
1/28/2010	818	976	1227
2/22/2010	487	1453	2234
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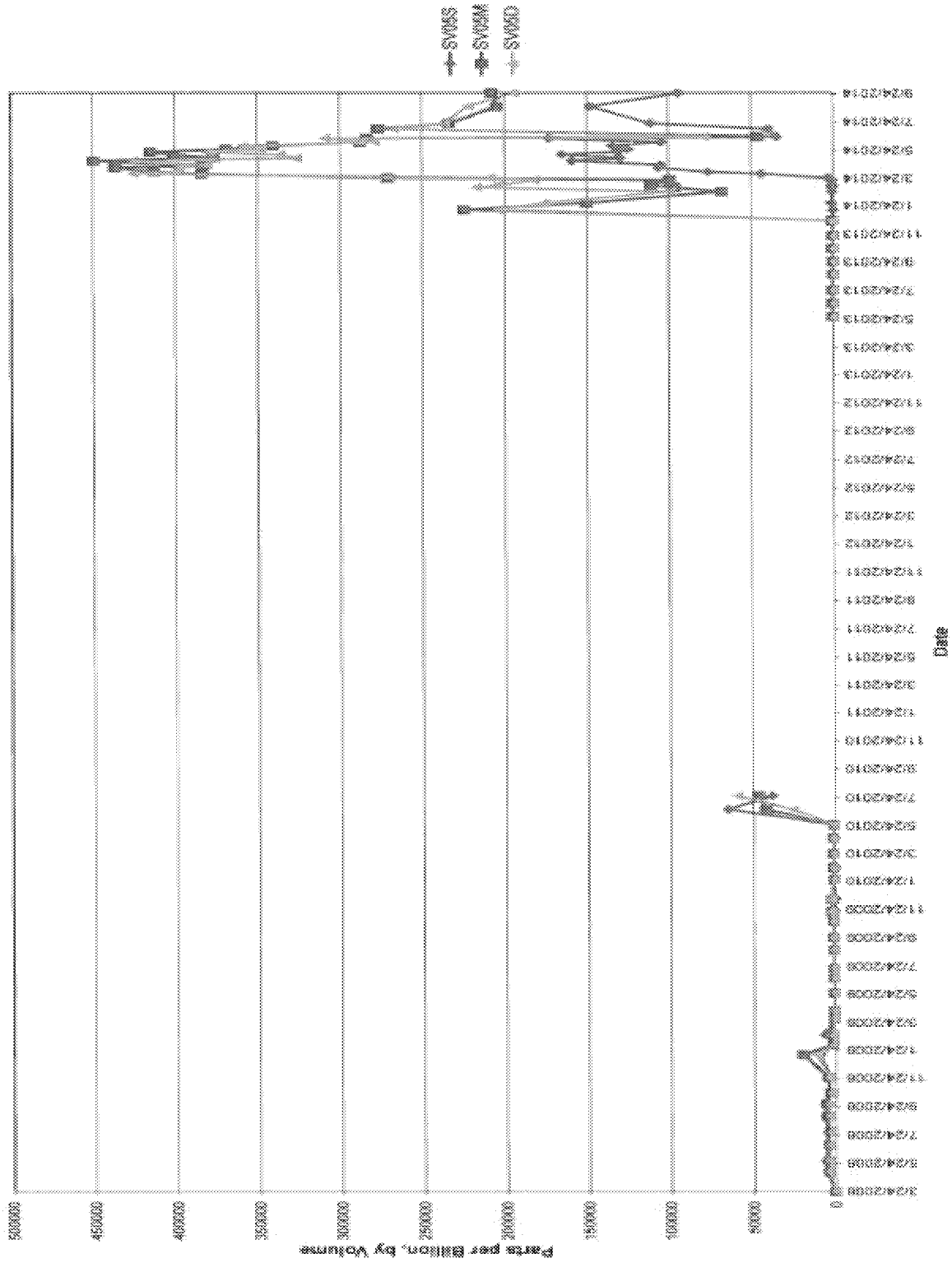
5/26/2010	1002	980	1147
6/28/2010	64900	42100	25600
7/28/2010	38167	46633	59433
9/29/2010	NC[1]	NC[1]	NC[1]
10/18/2010	NC[1]	NC[1]	NC[1]
11/16/2010	NC[1]	NC[1]	NC[1]
12/14/2010	NC[1]	NC[1]	NC[1]
1/13/2011	NC[1]	NC[1]	NC[1]
2/15/2011	NC1	NC1	NC1
3/15/2011	NC[1]	NC[1]	NC[1]
4/18/2011	NC[1]	NC[1]	NC[1]
5/16/2011	NC[1]	NC[1]	NC[1]
6/22/2011	NC[1]	NC[1]	NC[1]
7/27/2011	NC[1]	NC[1]	NC[1]
8/26/2011	NC[1]	NC[1]	NC[1]
9/22/2011	NC[1]	NC[1]	NC[1]
10/27/2011	NC[1]	NC[1]	NC[1]
11/22/2011	NC[1]	NC[1]	NC[1]
12/16/2011	NC[1]	NC[1]	NC[1]
1/20/2012	NC[1]	NC[1]	NC[1]

Date	SV05S	SV05M	SV05D
2/23/2012	NC[1]	NC[1]	NC[1]
3/13/2012	NC[1]	NC[1]	NC[1]
4/16/2012	NC[1]	NC[1]	NC[1]
5/15/2012	NC[1]	NC[1]	NC[1]
6/19/2012	NC[1]	NC[1]	NC[1]
7/10/2012	NC[1]	NC[1]	NC[1]
8/14/2012	NC[1]	NC[1]	NC[1]
10/24/2012	NC[1]	NC[1]	NC[1]
11/26/2012	NC[1]	NC[1]	NC[1]
12/18/2012	NC[1]	NC[1]	NC[1]
1/31/2013	NC[1]	NC[1]	NC[1]
2/28/2013	NC[1]	NC[1]	NC[1]
3/28/2013	NC[1]	NC[1]	NC[1]
4/25/2013	NC[1]	NC[1]	NC[1]
5/30/2013	215	221	184
6/27/2013	115	233	232
7/25/2013	208	218	322
8/29/2013	63	68	161
9/26/2013	14	29	114
10/24/2013	229	260	201
11/21/2013	94	120	109
12/23/2013	50	622	794
1/15/2014	96	225000	204000
1/30/2014	818	150000	176000
2/24/2014	597	68200	100000
3/5/2014	492	98600	217000
3/10/2014	308	111000	204000
3/21/2014	593	99600	182000
3/25/2014	3144	271000	209000
4/3/2014	43700	364000	426000
4/7/2014	76100	413000	401000
4/16/2014	106000	437000	398000
4/22/2014	105000	383000	381000
5/1/2014	159000	450000	426000
5/8/2014	130000	377000	327000
5/15/2014	165000	401000	337000
5/21/2014	131000	415000	380000
5/27/2014	125000	389000	349000
6/3/2014	134000	341000	359000
6/11/2014	105000	288000	279000
6/19/2014	173000	284000	309000
6/23/2014	34500	45600	78700
7/9/2014	39700	277000	267000
7/21/2014	111000	234000	237000
8/27/2014	148000	205000	222000
9/25/2014	94500	208000	195000

ppbv: parts per billion by volume

NC[1]: Not collected due to maintenance work

Figure 1 of Appendix B
Soil Vapor Measurements
SV05



APPENDIX C

Navy Data

Current Red Hill Monitoring Plan

This data is provided in addition to the information provided by DOH and BWS in Appendix B. The Navy monitors at many wells and tanks. The current regulatory approved monitoring plan includes:

- 50 soil vapor monitoring points (2 to 3 monitors beneath the 18 tanks) –measures volatile organic compounds (VOC) vapors in the soil/rock beneath the tanks. The data is collected monthly.
- 7 groundwater monitoring wells and 2 new wells – groundwater samples are analyzed for chemical contaminants at least quarterly and the groundwater is also monitored for free product monthly.
- Drinking water monitoring at Red Hill Water Shaft – samples are routinely analyzed according to Safe Drinking Water standards. Additional analyses are performed to check for petroleum products.

All monitoring plans and sampling results are provided to the Department of Health.

Laboratory Numerical Levels

The results from the drinking water wells are compared against ***Maximum Contaminant Levels (MCLs)*** under the Safe Drinking Water Act. These MCLs were established considering human health risk, technology for testing and treatment and several other factors. The MCLs are the specified standard appropriate for source wells used for drinking water distribution.

The results from the ground water monitoring wells are compared against the ***Environmental Action Levels (EALs)*** and ***Site Specific Risk Based Levels (SSRBLs)***. The EALs were established by the DOH based on the most conservative risk-based exposure assumptions to the environment (including humans and aquatic life) as well as other factors such as taste, color, etc (that may not necessarily be harmful to humans). EALs can be used as screening levels and evaluation starting points to be put into context of the specific site and other contamination found.

The Department of Health's guidance, "Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater" describes how to use and interpret EALs:

- ***"Exceeding the Tier 1 EAL for a specific chemical does not necessarily indicate that the contamination poses significant environmental concerns, only that additional evaluation is warranted."***
- ***"The Tier 1 EALs presented in the lookup tables are NOT regulatory "cleanup standards"."***

When additional evaluation is warranted as specified above, the risks at the specific site are studied and Site Specific Risk Based Levels (SSRBLs) developed and submitted to the regulators. Data from a

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particular site should also be compared against the SSRBLs approved for the site. For Red Hill, the following SSRBLs were approved:

- SSRBL for TPH-d = 4,500 ug/l in groundwater
- SSRBL for benzene = 750 ug/l in groundwater
- SSRBL for JP8/5 = 280,000 ppb per volume in soil vapors
- SSRBL for diesel = 14,000 ppb per volume in soil vapors

As the derivation of EALs did not incorporate technology and are the most conservative levels based on numerical assessments, a consistent detection level can be a challenge for laboratories. When testing for drinking water consumption, there is normally an expectation of the range of results (usually near the MCL.) However when testing for groundwater for possible contamination, the range of concentration is less defined and, due to the exploratory nature of the investigation, could be very wide.

Groundwater Data Beyond Tank 5

Contaminant concentrations detected in wells RHMW01 and RHMW05, which are down-gradient of Tank 5 and up-gradient of the Red Hill Shaft, are below the SSRBLs for TPH-d and below the DOH EALs for other chemicals. Similarly, the data from the well between Tank 5 and the Halawa Shaft are below the DOH EALs. The data for the contaminants marked as a concern in the BWS table in Appendix B are summarized for the other relevant wells below. (60+ other low level chemical results are not listed in table.) Values are displayed in in parts per billion (ppb).

Table 1 of Appendix C – Data on Other Wells
For Petroleum Contaminants of Concern in Listed Appendix B
Navy Red Hill Groundwater Monitoring Wells 2005 to 2014
(values that exceed SSRBLs or DOH EALs in Bold)

#	Contaminant	DOH EAL (ppb)	EPA drinking water MCL (ppb)	EPA health advisory (ppb)	Min. value reported (ppb)	Max value reported (ppb)	SSRBL (ppb)
RHMW02 (nearest to Tank 5)							
1	TPH-d (diesel)	100	None	None	<20	**6,300**	4,500
2	TPH-g (gasoline)	100	None	None	13.2	**660**	
8	1-methylnaphthalene	4.7	None	None	0.02	**109**	
9	2-methylnaphthalene	10	None	None	0.007	**88.5**	
10	Naphthalene	17	None	100	0.03	**180**	
RHMW01 (down-gradient of Tank 5)							
1	TPH-d (diesel)	100	None	None	<80.8	**1500**	4500
2	TPH-g (gasoline)	100	None	None	<13	16.6	
8	1-methylnaphthalene	4.7	None	None	<.05	0.101[a]	
9	2-methylnaphthalene	10	None	None	<0.015	3.07	
10	Naphthalene	17	None	100	<.050	5.61	

RHMW05 (down-gradient of Tank 5, up-gradient of Red Hill Shaft)							
1	TPH-d (diesel)	100	None	None	<10	**673**[b]	4500
2	TPH-g (gasoline)	100	None	None	<30	13.2	
8	1-methylnaphthalene	4.7	None	None	<0.0158*	0.0335*	
9	2-methylnaphthalene	10	None	None	<0.0158*	0.0246*	
10	Naphthalene	17	None	100	<0.0326*	0.17*	
****RHMW04** (between Tank 5 and Halawa Shaft)							
1	TPH-d (diesel)	100	None	None	new	17	
2	TPH-g (gasoline)	100	None	None	new	<60	
8	1-methylnaphthalene	4.7	None	None	<0.0162 *	<0.052*	
9	2-methylnaphthalene	10	None	None	<0.0162 *	<0.052*	
10	Naphthalene	17	None	100	<0.0335 *	<0.073*	

* Concentration is below the DOH EAL

** Data for RHMW04 represents the re-start of testing in July 2014. HDMW2253-03 tested and levels also below DOH EALs and SSRBLs, but well suitability for groundwater testing is questionable. Data from new monitoring wells are not yet available.

a – The max value reported was 9.44 ppb; however, previous and subsequent analytical results were non-detect and the consultant indicated that the outlier is likely not representative of the true groundwater condition at the site. The next highest value reported was 0.101 ppb.

b – The max value reported was 2060 ppb; however, the laboratory indicated that this value may have included compounds unrelated to Facility stored fuels (specifically, caprolactam and DEET). The analytical method quantifies the total concentration of all compounds within the diesel fuel range. The next highest value reported was 673 ppb.

Soil Vapor Results

Soil vapor results at Tank 5 are represented in the graph in Appendix B. The comparison to the SSRBL of 280,000 ppbv prompted more frequent monitoring. Increases at neighboring tanks were also detected.

Free Product Floating on the Surface of the Groundwater

Monthly monitoring using an oil/water interface probe has not detected any measurable product at the well nearest to Tank 5 or any of the other groundwater monitoring wells.

APPENDIX D

Hawaii UST Regulations and Exemptions for Field Constructed Tanks

1. Design, construction, and installation
2. Notification, permits, and variances
3. General operating requirements (i.e. spill & overfill protection, repairs, recordkeeping)
4. Release detection
5. **Release reporting, investigation & confirmation***
6. **Release response action***
7. **Closure***
8. Financial Responsibility
9. **Enforcement***

*Hawaii UST regulations require Field Constructed USTs to comply with only 5, 6, 7 and 9.

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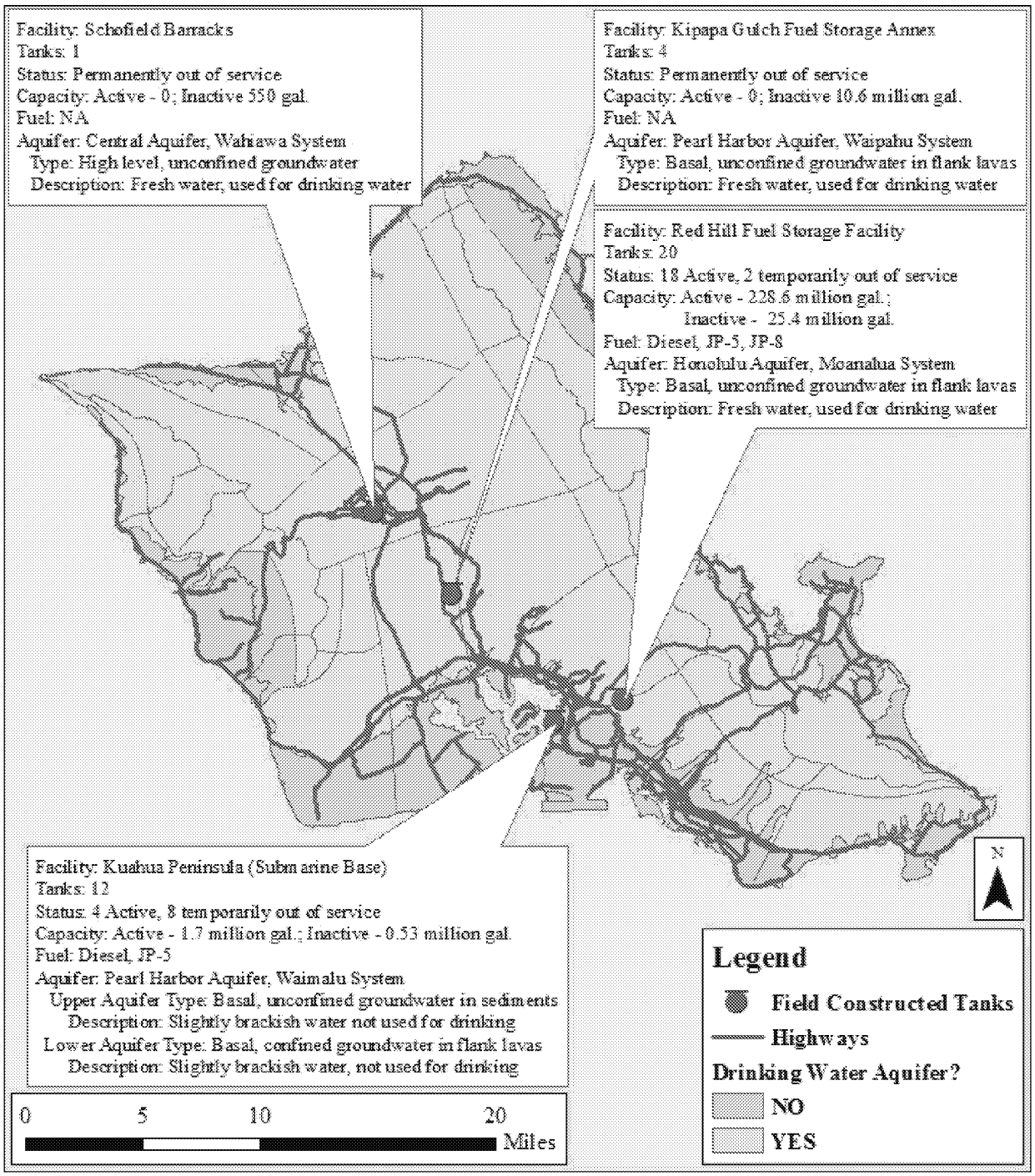
APPENDIX E

List of Field Constructed Tanks in Hawaii

Location	Status	Qty	Capacity of each tank (gallons)	Composition	Installation Date	Over Drinking Water Resource	NOTES
Kipapa Gulch Fuel Storage Annex	**POU*** In 2002	**4**	**2,650,000**	Bare Steel	May 1941	Yes	DOH Office of Hazard Evaluation & Emergency Response is overseeing remediation (bioventing) for a release
Red Hill Facility	**TOU*** Tank 19 in 1986 Tank 1 in 1997	**2**	**12,700,000**	Bare Steel, encased in concrete	May 1941	Yes	
Red Hill Facility	**In use**	**18**	**12,700,000**	Bare Steel, encased in concrete	May 1941-1943	Yes	DOH Office of Solid & Hazardous Waste Branch is responding to a release from Tank 5
Kuahua Pennisula – Submarine Base Pearl Harbor	**TOU*** In 1990	**3**	**20,000**	Concrete	May 1943	No	
Kuahua Pennisula – Submarine Base Pearl Harbor	**TOU*** In 1990	**5**	**94,000**	Concrete	May 1943	No	
Kuahua Pennisula – Submarine Base Pearl Harbor	**In use**	**4**	**425,000**	Bare Steel	May 1941	No	Surge tanks used at Red Hill Facility
Pacific Missile Range	**In use**	**9**	**50,000**	Cathodically Protected Steel	April 1942	No	
Schofield Barracks	**POU*** In 1996	**1**	**550**	Concrete	Unk	Yes	
TOTAL	**In use**	**31**					
	TOU/POU*	**15**					
		46					

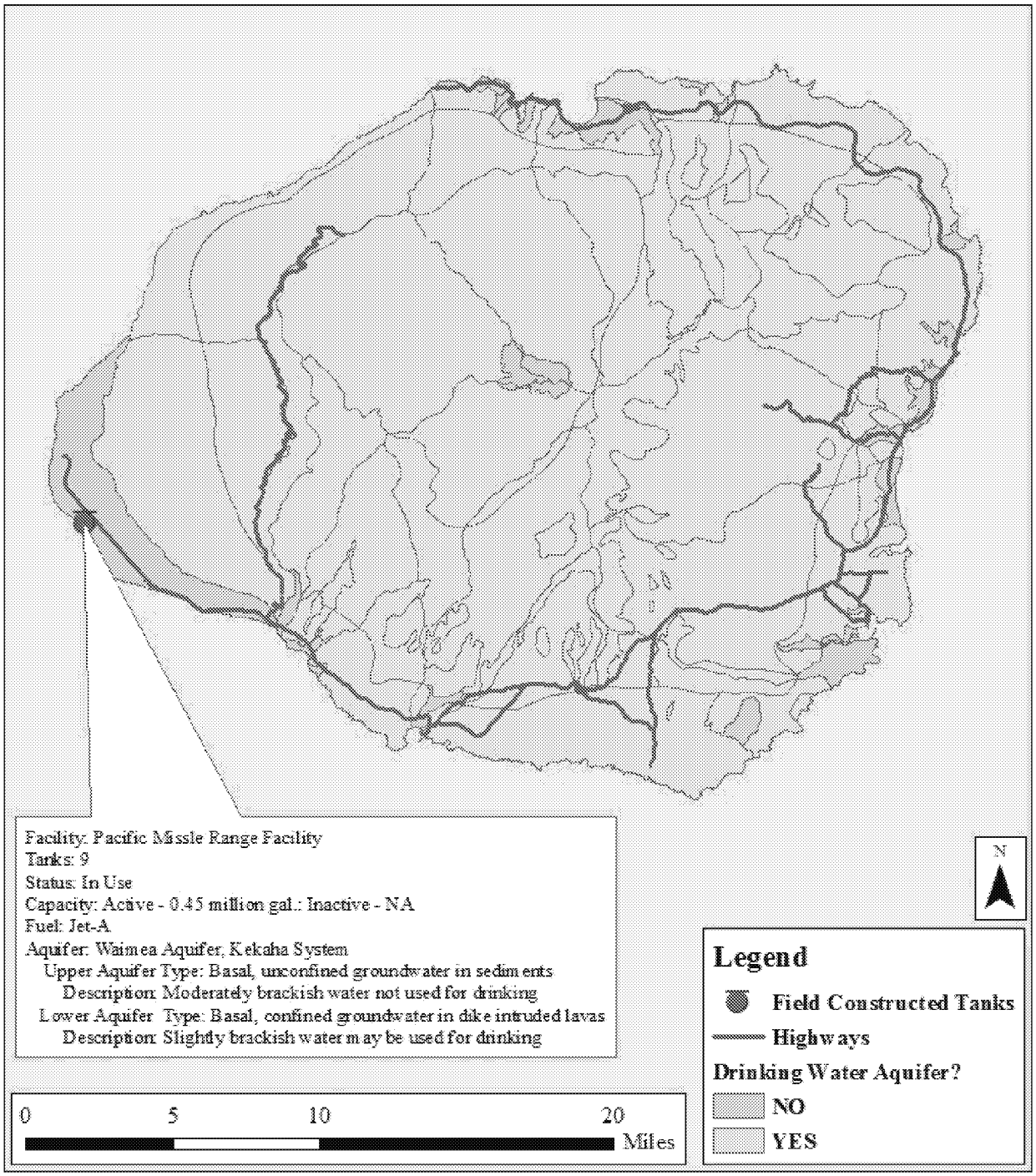
*TOU – temporarily out of use, subject to additional information from the tank owners
*POU – permanently out of use/closed

NOTE: Safe Drinking Water Branch has mapped out these tanks on the following pages.



There are 5 fuel storage facilities that utilize field constructed tanks. Four of these facilities are located on Oahu and shown in the map above. Labels for the each facility list the name, number of tanks, fuel capacity, fuel type, and describe the aquifer below the tanks. The map also shows those aquifers that are sources of fresh drinking water. In most areas of Oahu, freshwater resides in single aquifer. However, in areas with extensive caprock such as the Kuahua Peninsula (Submarine Base, Pearl Harbor), groundwater in the sedimentary formations overlies groundwater in the lava formations

below. The sediments confine the groundwater in the lava formations providing it with protection from contamination. Where the layered aquifers do not exist there is no natural hydraulic protection from fuel leaks.



The Pacific Missile Range Facility is the only Hawaii location outside of Oahu where field constructed tanks are in service. The 9 tanks for this facility are located over a sedimentary aquifer that is not used for drinking water due to excessive salinity and low productivity. Below this sedimentary aquifer is confined groundwater that could potentially be used for drinking water. The potential drinking water aquifer is protected from contamination by the overlying sedimentary aquifer.

APPENDIX F

How Red Hill Facility Site-Specific Risk-Based Levels Were Established

In setting Tier 1 Environmental Action Levels (EALs), DOH assumes that components of each TPH mixture consist of the most toxic fraction. These levels then serve as a screening method or an indicator that a health or environmental threat may exist and should be addressed or evaluated further.

In the case of Red Hill, after Tier 1 levels were exceeded, indicating that groundwater under the facility did not meet criteria for potable water need, a Tier 2 assessment was completed. The Tier 2 evaluation looks at migration pathways for contaminants. It determined that no seepage of leachate was occurring to the water table and that soil vapor pathways were not a significant concern. A Tier 3 assessment was then conducted to evaluate the future risk to the potable water production well, the Navy's drinking water pump station (Red Hill Shaft) that is the nearest and most vulnerable to contamination from Red Hill.

During the Tier 3 assessment, Site-Specific Risk-Based Levels (SSRBLs) were established for TPH, benzene and soil vapor at the Red Hill facility, the basis of which were made through modeling efforts, groundwater elevation studies and pump tests. In these models, certain assumptions were made.

- Concentrations of dissolved hydrocarbons measured with EPA Method 8015 is limited to 4500 ug/L – the computed maximum solubility of JP-5 in direct contact with the aquifer.
- Groundwater flows "mauka to makai" and updated with a slight northwesterly component, but assumes that Red Hill Shaft is still down-gradient and the most vulnerable receptor
- The dissolved fuel hydrocarbons will degrade at a Bulk Degradation Rate of 0.009% per day. In other words, half-life = 0.693/[rate constant] = 0.693/0.009 = 77 days. The initial concentration of TPH in groundwater is assumed to be reduced by half every 77 days due to biodegradation and attenuation as groundwater migrates away from the release area. This allows down-gradient concentrations of TPH in groundwater to be predicted based on the concentration in groundwater immediately under the tank and the estimated groundwater flow rate.
- It also looked at the maximum pumping rate at the Red Hill Shaft that could be sustained for five days (approximately 4.6 million gallons per day).

The Tier 3 assessment also recommended that groundwater samples be treated to remove petroleum-related breakdown products using "silica gel" prior to analysis. This would reduce the reported amount of contamination in the samples. The DOH recently clarified that this method is not acceptable for sample data that will be used to evaluate the threat to human health or the environment. Data from untreated samples are still required to make this evaluation.

It is estimated that the Navy's drinking water well, 2254-01, is approximately 3,000 feet down-gradient from the Red Hill facility. The upper entrance of the infiltration gallery is located approximately 1,600 feet from Tank 1 and 2. According to the Navy's 2007 petroleum fate and transport model, releases from the tank farm would be unlikely to migrate more than approximately 1,100 feet away from the release location above levels of potential concern for impacts to drinking water.

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Using this data, SSRBLs were established based on distance of the Facility to the eastern end of the infiltration to the Navy's drinking water well, 2254-01. These SSRBLs were based upon the assumption that free product would be present in the groundwater at the Facility monitoring wells and correspond to the solubility limit of TPH from JP-5 and benzene. Soil Vapor SSRBL was also set.

TPH is the risk driver because modeling indicates that it would be the first contaminant of concern to reach unacceptable concentrations in this scenario. Other, individual compounds, including benzene, naphthalene and methylnaphthalene, have also been reported in groundwater samples collected beneath the Red Hill tanks but are less likely to reach the infiltration gallery and drinking water well above drinking water action levels due to their initially very low concentration.

Action Level Table

	Drinking Water EAL	Tank Farm SSRBL	Soil Vapor
TPH(d)	100 (µg/L)	4,500 (µg/L)	280,000 µg/m^3
Benzene	5 (µg/L)	750 (µg/L)	NA

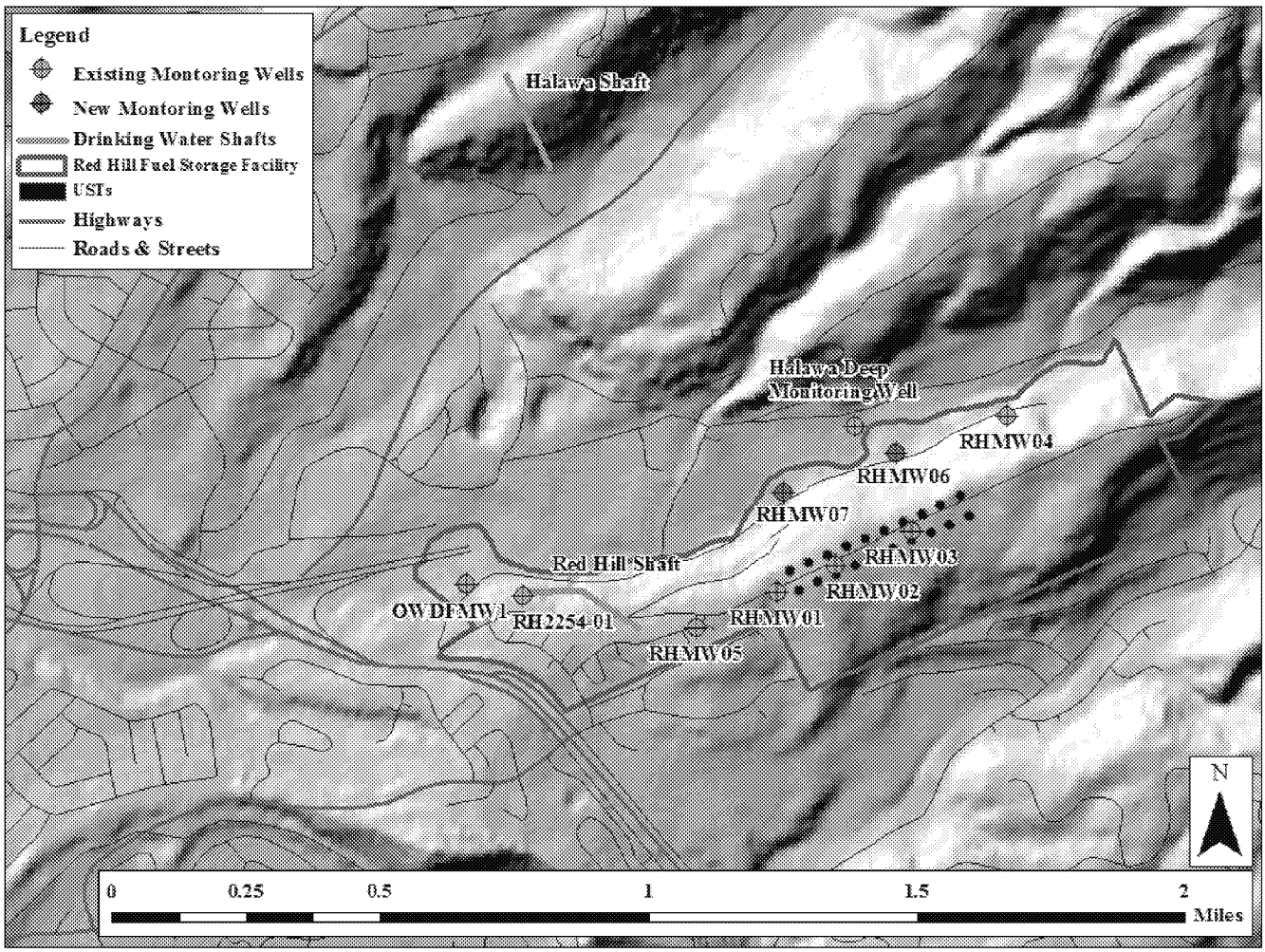
DOH has examined these studies and accepts appropriateness and applicability of these SSRBLs, provided that they be reviewed as additional data are collected from the site.

The SSRBLs were incorporated into the Red Hill Groundwater Protection Plan. This plan was developed to mitigate the risk associated with inadvertent releases of fuel from Red Hill and to provide an overview of actions (or contingency plans) that would be required for detections below but approaching the SSRBLs as well as actions to mitigate large releases if they were to migrate to the water table. For instance if RHMW02 exceeds 1/2x SSRBL or 2,250 ppb then reporting, monitoring and immediate evaluation of tanks for leaks would be required.

It also includes quality assurance project plans for sampling and analysis.

This plan is updated periodically and submitted to DOH for approval.
These plans are available online at: http://health.hawaii.gov/shwb/underground-storage-tanks/.

- 2008 Red Hill Groundwater Protection Plan: 2008GWprot.pdf
- 2010 Re-evaluation of the Tier III Risk Assessment: 2010RedHillTierIII

Diagram 1

Locations of the seven monitoring wells routinely tested by the Navy in green, and the two new sentinel wells north installed in Sep/Oct 2014 in blue.