BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843
www.boardofwatersupply.com

September 27, 2016

Mr. Bob Pallarino
EPA Red Hill Project Coordinator
United States Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

and

Mr. Steven Chang, P.E.
DOH Red Hill Project Coordinator
State of Hawaii
Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801-3378

and

Mr. Jimmy Miyamoto
Deputy Operations Officer
NAVFAC Hawaii
400 Marshall Road
JBPHH, Hawaii 96860

Dear Messrs. Pallarino, Chang and Miyamoto:

Subject: Board of Water Supply (BWS) Comments on the Section 8 Red Hill Bulk Fuel Storage (RHBFSF) Facility Administrative Order on Consent (AOC) Work Plan and Associated Scoping Meetings Conducted on August 31 – September 1, 2016

Thank you for inviting us to meet with you on August 31 – September 1, 2016 to discuss development of the Administrative Order on Consent (AOC) Section 8 Risk and Vulnerability Assessment Work Plan (Work Plan). Below is a recap of our comments and recommendations shared at the meeting.

The Board of Water Supply (BWS) continues to be concerned about the petroleum contamination that is still present in the rocks and groundwater underneath and near the Red Hill fuel tanks and the risk for potential future, perhaps catastrophic leaks. The Navy has been diligently testing the groundwater since 2005. However, tests conducted by the Navy from 2014 to 2016 indicate the amount of petroleum contamination in the groundwater underneath Tank 5 is rising.

Navy studies and reports on the condition of the tanks also show many holes forming from corrosion of the steel tanks which is requiring the Navy to hire contractors to weld patch plates to cover the holes. The Navy is doing all it can to keep the steel tanks from corroding but progress is being complicated by the inability to reach and treat the outside of the steel plates of the 250-feet tall tanks. Maintaining the inside of the tank but not the outside which cannot be reached is not reducing the risk of more leaks.

The BWS would like to remind the signatories of the Red Hill Bulk Fuel Storage Facility Administrative Order on Consent (AOC) of their respective mission statements and Article XI of the Hawaii State Constitution that holds all public natural resources in trust and protected for the benefit of the people of Hawaii.

In keeping with the Hawaii State Constitution, the BWS firmly maintains its position of:

1. Accepting no more fuel leaks from the Red Hill tanks and to restore the groundwater to its original pristine condition by cleaning up the fuel contamination that exists there now and preventing future leaks regardless of amount.
2. Zero risk of fuel leaks to the environment.
3. Relocating the fuel to a different facility at a different location or locations, or retrofitting all Red Hill Bulk Fuel Storage Facility (RHBFSF) active tanks with double walls (tank-within-a-tank).
4. Maintaining public transparency and not sign any non-disclosure statement.
5. Finding the 2014 fuel leak by installing more groundwater monitoring wells to get the information needed to completely understand the groundwater contamination underneath and near the tanks.

To date, the BWS has fully participated in AOC scoping discussions and shared its knowledge by submitting pages and pages of comments and recommendations to the AOC parties. So far the comments appear to be ignored and unused.

At the AOC Section 8 risk and vulnerability assessment scoping meetings held August 31 – September 1, 2016 at the EPA Region IX office in San Francisco, the Navy provided an update of Navy personnel undergoing the three-year rotation in and out of the Red Hill AOC assignment. The BWS is extremely concerned about the complete change of Navy leadership every two or three years. It does not foster strong continuity of institutional knowledge and commitment despite the best debriefing and orientation efforts. Each new Commander, Captain, and Admiral would have to repeat the learning process to become familiar with the very complex issues involved in this situation. This has been a major challenge to other communities in the United States dealing with similar groundwater contamination issues caused by the military.

We feel that there are two alternatives to address this critical issue of continuity of leadership:

1. Delegate full authority to the highest ranking civilian engineer at NAVFAC Hawaii on all matters related to this facility and the AOC, including funding priorities to implement actions needed. The civilian Navy employees are not rotated and offer the best level of continuity and should be given full authority to make the decisions, take the necessary actions and approve the funding needed to implement the AOC work to its logical conclusion.

2. If the Department of Navy and its officers in charge are unwilling to delegate authority to the ranking civilian administrators or engineers, then the responsibility and authority for decisions stay with the Navy Commander, Captain, and Admiral currently in command of Navy Region Hawaii now, regardless of their assignment to another command or base.

During the scoping meetings, the Navy officers also appeared to imply that obtaining the funds to improve the Red Hill tanks under the AOC is not an issue given the Navy's seriousness to protect the environment, preserving the drinking water and the facility's strategic importance in the Pacific. If so, cost should not be factor nor reason for not implementing the highest environmentally protective solutions at Red Hill.

The Honolulu Board of Water Supply (BWS) offers the following general and specific comments concerning the AOC Section 8 Work Plan and the associated scoping meetings. We also include a list of requested documents that the BWS would like for the parties to provide us copies for our review.

General Comments

The meetings did not change BWS's position that significant risk reduction can only be achieved in two ways:

1) Relocating the fuel to a different facility at a different location or locations that are not over drinking water quality groundwater aquifers, or

2) Retrofitting all Red Hill Bulk Fuel Storage Facility (RHBFSF) active tanks with double walls (tank-in-tank).

Enormous volume of fuel in close proximity to sole source aquifer and existing contamination

The RHBFSF tanks put an enormous volume of fuel in close proximity to groundwater. The RHBFSF holds about 180 million gallons of fuel in 15 tanks (Lau, 2015a). The bottom elevation of the Red Hill tanks is approximately 100 feet (ft) above the State-designated Waimalu and Moanalua Oahu's sole source drinking water aquifers (TEC, 2007; FR, 1987).

Also made clear during the meetings is that protection of the underlying, sole-source aquifer is not given a sufficiently high priority in the proposed assessment of risk at the RHBFSF; otherwise alternate fuel storage locations, continuing corrosion, and double-walled tanks would be more closely considered. In short, the risk assessment work plan is almost entirely limited to issues that support continuation of the status quo and lacks the rigor and breadth necessary to evaluate the risk posed by the RHBFSF to our drinking water supply. The BWS, therefore, is providing a summary of our concerns and suggestions for improving the Section 8.0 Work Plan for Qualitative Risk and Vulnerability Assessment (QRVA).

Parties' Mission Statements

Based on our observations of the comments made at the meeting, the BWS feels it is important to remind the parties of their mission statements:

- The Environmental Protection Agency (EPA) mission is to "protect human health and the environment."
- The Hawaii Department of Health (DOH) mission is to "protect and improve the health and environment for all people of Hawaii." Further, Article 11 Section 7 of the Hawaii State Constitution states: "The State has an obligation to protect, control, and regulate the use of Hawaii water resources for the benefit of its people."
- The Navy mission, as it pertains to the environment, states, "the Navy has a responsibility to serve as a good steward of the environment. The Navy demonstrates that commitment by investing in programs that minimize, and in some cases eliminate, the effects of Navy operations on the environment."

BWS recommends that the parties remember and carefully reflect often on their own mission statements as they execute the work associated with Section 8 and all other sections of the AOC.

Section 8 Meeting Comments

The BWS reiterated in the AOC Section 8 meetings at the EPA Region IX office in San Francisco at multiple times and in multiple ways that our position regarding acceptable risk is zero, to clean up the contamination that is present at the facility and in the groundwater per our 2015 Board resolution, and that the facility be upgraded sufficiently so that no more leaks occur (double wall tanks) or the fuel be moved to another location or locations.

Containment boundary for Level 2 Risk Analysis

During the meeting, Dr. James Liming of the American Bureau of Shipping (ABS) suggested that the boundary used to differentiate a Level 1 from a Level 2 risk assessment should be associated with the point at which the Navy loses control of spilled product. We agree with this fundamental notion. As such we propose the following:

1. Tanks: There is evidence of communication between the steel liner-to-concrete interface and the surrounding rock. As such, there is no engineered containment to

prevent product that escapes the steel liner from reaching the aquifer. For the tanks, we recommend that the containment boundary be the steel liner itself.

2. Piping: Fuel pipelines connecting the tanks to the harbor run through both concrete-lined and unlined tunnels. While we agree that the tunnels/drains/doors may contain product that escapes the pipe, it is not an engineered containment, and some unknown fraction of the spilled product will escape to the environment. Absent a reliable containment system, we recommend that the containment boundary be the pipelines (pipe sections, joints, valves, T's, pumps, surge tanks, etc.) themselves.
3. Given the confinement boundary coincides with the equipment (tanks and pipelines), the differentiation between Level 1 and Level 2 risk assessment is no longer meaningful.

Poisson Model for risk will not model aging and corrosion failure modes properly

The ABS Phase I description of the risk assessment states that the initiating incidents will be modeled with a Poisson distribution. Such a model would not capture conditions in which initiating incident rates increase, perhaps due to corrosion or other degradation mechanisms. Dr. Liming suggested he would address this issue; but we are concerned that corrosion and other wear-out failure mechanisms may not be incorporated into the QRVA model.

Phase 2 QRVA should include quantification of alternative risk mitigation methods

As currently described in the ABS work plan, the Phase 2 QRVA will be performed on the state of the facility and operational procedures frozen at the time of the notice to proceed. The AOC stated that the Risk/Vulnerability assessment may include a study of the effectiveness of risk mitigation and protection procedures in order to inform any such decisions. There was some discussion of the possibility of doing this at the meeting, but BWS would like to see this aspect of the work described in the Phase 2 work plan.

BWS strongly recommends that the QRVA risk model be sufficiently robust that it can readily determine the change in frequency in leaks and amount leaked associated with a tank-in-tank option, as well as with the option of moving the tanks to another location on the island. Dr. Liming indicated that his model, as currently contemplated, would have this capability. A tank-in-tank (i.e., composite tank) option has the potential to significantly change the facility performance because 1) it significantly lowers the probability of product release, and 2) it significantly increases the leak detection capability. BWS also strongly recommends that an engineering feasibility study be conducted now for the tank-in-tank option; such a study could yield information that could improve the risk assessment.

The BWS also believes that a thorough risk assessment cannot be completed without evaluating the tank relocation option, with the Navy storing fuel at another or multiple locations on Navy properties within Oahu. During the AOC meeting on September 1, 2016, the Navy disclosed that such an evaluation of tank relocation was completed in 2009, but the report was classified.

BWS recommends that the QRVA Phase 2 be expanded to include all of the aspects anticipated in the AOC. These include a risk matrix, hydrology studies (Level 3), evaluation of risk mitigation measures, and comparison of the risks and benefits of storing fuel at the current facility versus alternate storage sites.

Level required for QRVA Risk Assessment

The BWS strongly recommends that the QRVA be done to Level 3; that is, failure should be based on how the aquifer water quality is affected. This will require that fate and transport models be included in the QRVA.

Sabotage

BWS understands that risk associated with sabotage or malicious acts must be assessed in the context of secrecy associated with national defense interests. However, BWS recommends that the QRVA report describe, in general terms, how such risks will be incorporated into the overall facility risk assessment.

Independent review of QRVA

The QRVA process and methodology typically involves substantial engineering judgment regarding fragilities of equipment and components and methods for addressing human factors. The BWS strongly recommends that the EPA and DOH retain the services of a consultant with a demonstrated record of performing QRVA for major facilities. The objective of this consultant would be to ensure to the Regulators that the assumptions and methodology inherent in the ABS's QRVA is consistent with state-of-the-practice risk assessments. The scope would be to audit the ABS consultant at several milestones (to be determined) and the final report. The ABS schedule and budget should include time to meet with this reviewer regularly (perhaps quarterly) and to respond to comments from the reviewer. A log of peer reviewer comments and how they were resolved should be an appendix of the final report.

Leak, repairs, and inspection history and results

The tanks have been in service for nearly 75 years, and there is a documented history of leaks, repairs and inspections. The BWS strongly recommends that the Navy provide all such documentation to the ABS risk assessor, and that this information be weighted heavily in the risk model development. For instance, the detailed API tank inspection reports and appendixes that provides the pit and weld defect depth and locations on a defect-by-defect basis would be helpful in generating a distribution of pre-existing flaws upon which the effect of corrosion and other degradation mechanisms could be modeled. The audit of this facility completed by the Naval Audit Service in 2010 is also of interest to those trying to understand the history of leaks, repairs and inspections.

Tank integrity evaluation

The Navy needs to provide all previously performed API 653 and API 570 integrity evaluations, as well as any other tank integrity evaluations that may have been performed that are within the scope of these API standards.

The Navy 2010 Audit found extended intervals between internal UST tank integrity inspections for most of the tanks at Red Hill. Many had extended internal inspection interval periods, and the longest time frame was 47 years. There is a significant potential for corrosion to occur unobserved, and the minimum recommended inspection interval in API 653 is 20 years. It is less if there is no baseline corrosion evaluation to determine tank shell and dome corrosion rates. It is strongly recommended that API 653 evaluations be performed immediately on every tank that is outside of the 20-year time inspection period.

It is recommended that an independent and experienced API 653 expert evaluate all of the reports and make recommendations accordingly. The BWS can offer recommendations for professionals to perform these services, and believes that EPA and/or DOH should contract for this work.

Release detection

The Navy should provide all release detection records that are available as well as any monthly visual inspections or checklists for the underground storage tanks (USTs) and the UST system components. The Navy has been using the Mass Technology release detection system since 2009, and a review of the records would be useful. Any additional inventory records that are available would also be helpful, regardless of the age of the records. The data should include any mechanically or electronically gauged product liquid level inventory records, all delivery receipts, all product withdrawals, any water-level readings (when water in the fuel settles to the bottom of the tank, corrosion can occur), and any other recorded data related to inventory.

Single-wall methods of leak detection are inherently flawed. This fact needs to be emphasized frequently in the record. There are two types of release detection for single-wall UST systems – internal and external. External systems only detect releases after the damage is done and are not preventative. Internal systems, particularly on large USTs, are inherently and historically inaccurate and ineffective because of the larger volumes and throughputs. They are only effective in finding large volume releases, and are not reliable or effective for small or low volume releases, as pointed out in the 2010 audit by the Naval Audit Service (Navy, 2010).

There is a need for more accurate methods of inventory, particularly given the reality that any changes in tank upgrades or relocation are going to take time. Consideration should be given to completing a pilot study on one tank using a radar gauging system and comparing the results to the Mass Technology system. In addition, it would be beneficial to have a third-party expert like Warren Rogers or Marcel Moreau be retained to perform an independent evaluation and a trend analysis of inventory records provided by the Navy. BWS believes that EPA and/or the DOH should contract for this work.

The Navy should provide any release detection or inventory records that exist for the tanks that contained leaded aviation gas.

Release prevention options

Given the inherent weaknesses of the effectiveness of release detection and prevention with single-wall UST systems, the BWS expressed concerns about retaining the existing USTs with internal repairs and putting them back into single-wall service. The BWS fears that this approach will not protect the aquifer and will only delay a permanent resolution to a present and significant risk. Given the mission of EPA, the importance of protecting essential groundwater resources, and the requirements in the federal UST rule, the BWS requests a response from EPA to explain the priorities for establishing a prevention-based alternative to single-wall systems.

The value of secondary containment for release prevention was discussed at the meeting by the BWS. Secondary containment allows for expedient response to potential releases and minimizes any potential for groundwater contamination. The proven track record of secondary containment was mentioned, particularly in regard to the Florida Leak Autopsy Study. In addition, a number of states have more stringent requirements for their well-field protection areas, have accelerated schedules for tank upgrades, and more stringent release detection and operation and maintenance requirements. BWS strongly recommends secondary containment as a solution for release prevention. The BWS also supports any temporary or permanent relocation of tank storage off-site in Oahu. This will provide a lower cost and practical solution, particularly during tank upgrade activities at Red Hill and during the military construction procurement process.

Many private and government storage tank facilities evaluate and develop protocols after operational near-miss release events (e.g. – a suspected release that was avoided through prompt actions by operators). The BWS would like to request that the Navy provide any such records or documents if they exist, and that all parties review the information to help prepare appropriate safeguards for release prevention.

The federal spill prevention, control, and countermeasure (SPCC) regulations do not cover the existing tanks at the RHBFSF. Nevertheless, an SPCC-type approach with a comprehensive Emergency Response Plan is recommended. The BWS would like to review any existing Emergency Response Plan documents, and would recommend a revised plan if any problems are discovered in the existing plan.

The BWS has serious concerns about the Tank 5 release, and would recommend that Tank 5 remain out of service to evaluate the release and to develop remedies for the other storage tanks. Alternatively, as recommended by the Enterprise Engineering Reports completed in 1998 and 2008, Tanks 1 and 19 could be used to evaluate remediation options (Enterprise Engineering Inc., 1998 and 2008a).

Regulations

Although it was not discussed at the August 31 meeting, the current version of 40 CFR 280 now includes requirements for previously deferred field constructed tanks. The BWS reading of this rule is clear that the Red Hill USTs are subject to 40 CFR 280. They meet the definition of field-constructed tanks; and, like fiberglass tanks, the cathodic protection requirements of the rule are not pertinent. The BWS would like to clarify this issue and believes that it is a salient issue in developing strategies for protecting the aquifer beneath the Red Hill facility.

Section 8 Work Plan Comments

ABS has provided a draft document titled "U.S. Navy Red Hill Bulk Fuel Storage Facility Quantitative Risk and Vulnerability Assessment (QRVA) Work Plan," dated August 11, 2016.

BWS has reviewed the above-referenced document and provides the following comments, criticisms, and suggestions for its improvement.

1. There is relatively little in the subject document that is Red Hill-specific. Much appears to be a "cut & paste" from previous ABS Group (ABS) nuclear probabilistic risk assessment (PRA) boilerplate or reports. For instance, the term "radioactive" is found 175 times in the 445-page document whereas "hydrocarbon" is found once, "leak" is found 17 times, and "corrosion" is found five times.

2. The proposed analysis is only going to include Level 1 (probability of failure of structures, systems or components associated with containment within the system) and Level 2 (probability of loss outside of RHFSF) analyses. Level 3 (probability of exceeding public WQ limits) and Level 4 (Probability of injuries or illness) analyses will not be considered.

    - The probability of Level 1 is much higher than is acceptable, as the Red Hill Bulk Fuel Storage Facility (RHBFSF) has had several large fuel releases within the last 73 years.
    - The probability of Level 2 is similar as there is no effective containment system and the presence of contaminants in groundwater is known.
    - ABS should indicate that when the report discusses "outside of RHBFSF" boundaries, ABS does not mean "off the RHBFSF property," as ABS also states that a Level 2 risk would affect the "Red Hill Groundwater Shaft Water Quality." The point being that a release to the groundwater either within or outside the RHBFSF boundary constitutes a Level 2 release.

3. The ABS draft indicates that rates may be higher during the facility's first few years (i.e., infant mortality issues), but appears to dismiss the increasing rate of failures with age:

    > "However, data on events that occur more frequently indicate that the rate of occurrence may be higher during the facility's first years than during subsequent years. There are insufficient data to predict whether or not the frequency of these initiators might increase in later life. For purposes of this chapter it is

assumed that the model for initiating events will be based on a constant rate of occurrence (the Poisson model)."

The QRVA also states that Level 1 and Level 2 event and fault tree models do not correctly account for time-dependent component failures, component dependences, etc. This appears to indicate that corrosion and corrosion-fatigue will not be modeled correctly. ABS gives no basis for modeling wear out type failure probabilities with a Poisson model.

4. The risk analysis will be based on a design that is "frozen" prior to proceeding to the Phase 2 risk analysis. A comparison of risks and benefits between the current facility and alternative fuel storage facilities is **not included** within the scope of this QRVA work plan.

    a. "The design basis will be the as-built, as-operated facility as of the NTP date**, to include design, operation, maintenance, and testing changes that have been approved and funded as of the NTP date**."

    b. This means that the design modifications must be selected prior to knowing anything about the risk of the current design, how the other design alternatives may substantially reduce the risk, or how the design modifications compare to the option of relocating the tanks.

    c. If the Phase 2 analysis of the frozen design risk is found to be too high, other design modification will need to be considered and the analysis redone for these new modifications.

5. The Level 3 analysis (hydrology, fate, and transport) that the Navy/EPA seemed to be agreeable to perform during the last meeting (May 2016) is not included in ABS's work scope, except for a statement that they will work with AOC Section 6 & 7 technical teams to "help" them address, evaluate, and report potential impacts on the Red Hill Water Shaft. It seems to BWS that it would make more sense for ABS to work with the AOC Section 6 and 7 teams to evaluate the Level 3 risk portion and to incorporate the Section 6 and 7 risks in their Section 8 report.

6. Level 4 analysis (dosage/toxicity/health impact) is not proposed to be included in the ABS analysis. The BWS believes that the QRVA should include a Level 4 analysis because of the presence of impact of petroleum hydrocarbons to groundwater. The closest current drinking water extraction point, the Navy's Red Hill Shaft, has been impacted and therefore, the potential exposure of receptors (consumers of the drinking water) should be considered.

7. The QRVA outline seems to consider that leaks less than 13,000 gallons are not deemed critical. "In this case, a hypothetical bin boundary of 13,000 gallons was selected, because AOC Sections 6 and 7 preliminary task results have indicated that this potential fuel release volume may be critical in predicting important fuel contamination levels for the Red Hill Water Shaft." If this is the position of ABS or the Navy/EPA, this conclusion and its basis need to be clearly stated.

8. Section 3.9 is referenced in Table 2-12, but there is no QRVA Procedures Guide Section 3.9.
9. BWS provided a letter dated May 27, 2016 with many suggestions for improving the contemplated risk assessment of Section 8. Most of those recommendations have not been addressed in this QRVA draft (Lau, 2016a).

Data Supporting the Importance of Rigorous Evaluation

The potential for catastrophic environmental loss is high

The potential for catastrophic environmental and economic damages caused by fuel releases from one or more of the field-constructed tanks at Red Hill is quite high, given:

1) the large (fuel) volume and age of the tanks, 2) acknowledged instances of through-wall, corrosion-induced holes (Enterprise Engineering Inc., 2008a; Whitacre, 2005; Weston, 2007a; WillBros, 2012), 3) general uncertainty about the structural integrity of the tanks and piping, and 4) the documented history of leaks at the site.

The cost of immediate action to rehabilitate the Facility tanks and characterize and remediate the subsurface contamination will be far less than the cost required to remediate another large fuel release as well as rehabilitate the tanks. EPA has argued that upgrading large field-constructed tanks (including those at Red Hill) can lead to "substantial reductions in remediation costs and public exposure" caused by large-scale fuel releases from these previously deferred large field-constructed tanks (Industrial Economics, 2015).

Groundwater underneath the tanks is contaminated

Groundwater in Oahu's Sole Source Aquifer has already been contaminated by documented Red Hill fuel leaks since 1947. It will continue to be at risk from contamination caused by future fuel leaks (Lau, 2015a). As shown in the photos below, fuel staining of the basalt rock beneath the tanks demonstrates that the steel liners are breached and that the concrete around the tanks is cracked, allowing fuel contaminants to migrate beyond the control of the Navy toward our Sole Source Aquifer. Known fuel contamination exists surrounding and below the tanks and has caused significant impacts to groundwater, as shown in the plot for monitoring well RHMW02 below. Fuel contaminant concentrations in that monitoring well far exceed DOH Environmental Action Levels (EAL) and are increasing steadily in time. Contamination from leaked fuel has been detected at the Navy's Red Hill Shaft drinking water supply since 2005. The Parties must take action now to prevent any additional contamination of our aquifer and all current contamination should be remediated. Please see the BWS City and County of Honolulu Resolution No. 860.2015 "No More Fuel Contamination of O'ahu's Groundwater Aquifers" (BWS, 2015).

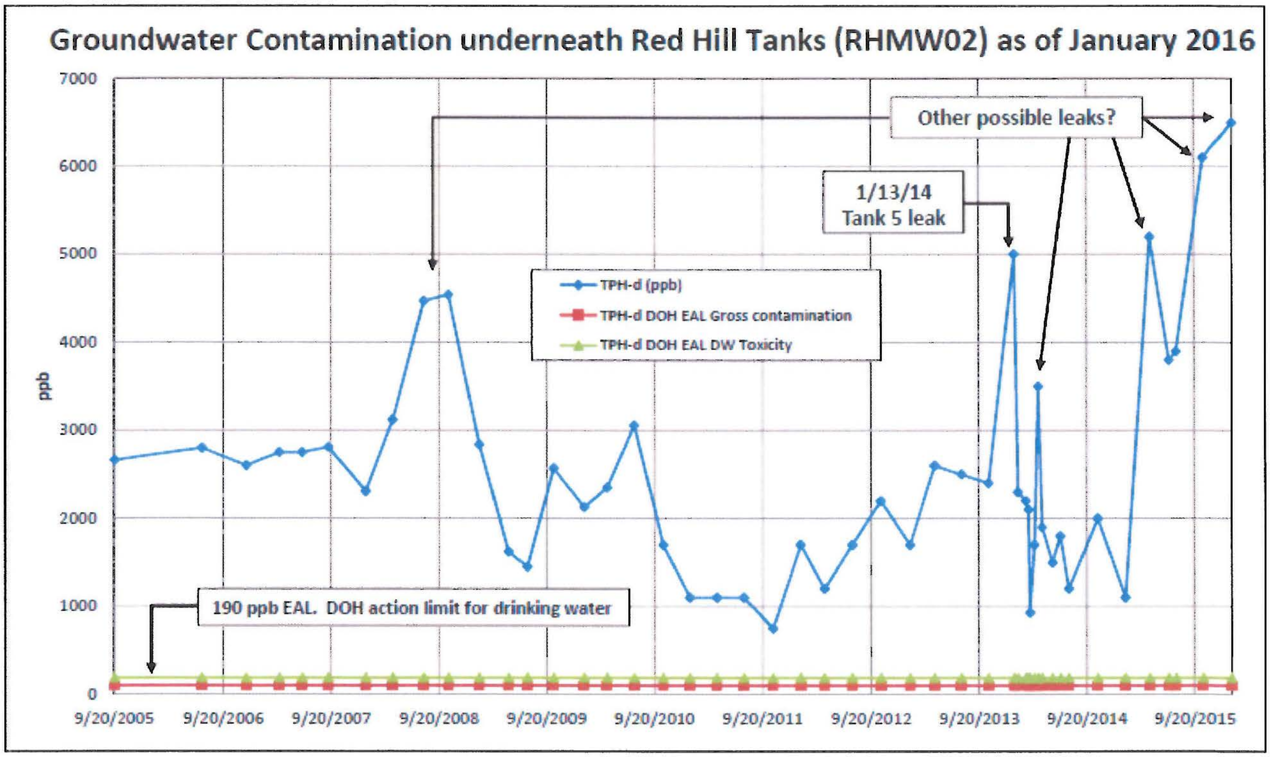
Fuel Contamination Under Red Hill Tanks

- 1998-2002 Investigations.
- Basalt rock core samples taken from underneath **19 out of 20 tanks show petroleum stains**.

Red Hill Bulk Fuel Storage Facility, Initial Phase II Site Characterization Report   Section: 4
Date: March 1999   Page: 11 of 12

Figure 4-7 Petroleum Stained Core – B16C, 49' to 60'

Figure 4-8 Petroleum Stained Core – B16C, 60' to 69'



Tanks have had a history of leaking in the past

There have been more than 41 fuel leak events from the tanks over the last 72 years (DOH Presentation, 2016).

The steel liners have corroded from both the inside and outside

The 0.25-inch-thick steel liner that prevents fuel from reaching groundwater is over 73 years old and has been breached in the past as a result of corrosion. The steel liners in the 20 RHBFSF tanks are and have been corroding from both the inside and the outside since their construction in the early 1940s (Weston, 2007a; Weston, 2007). The corrosion will continue to worsen in the future because corrosion damage accumulates over time, is irreversible, and the corrosion cannot be stopped without complete rehabilitation.

It has been suggested that since the steel liner is embedded in concrete and it is therefore protected from corrosion. This is clearly not the case since the steel liner has been documented to have suffered significant external corrosion on the steel surface that is supposedly in contact with concrete. It is apparent that in many places the concrete is either no longer in direct contact with the steel and the concrete has cracked and therefore significant external corrosion has occurred.

Corrosion rates have been high enough to penetrate the steel in the past

The predicted corrosion rates used to establish remaining tank life do not appear to consistently consider internal corrosion processes or appropriate safety factors (Lau, 2015a). Estimated corrosion rates of 0.0017 inch per year (Enterprise Engineering Inc., 2008a; Enterprise Engineering Inc., 2008b) appear to significantly underestimate actual corrosion rates; a rate as high as 0.0045 inch per year was reported for a through-wall hole in Tank #15 (Weston, 2007a). Such corrosion rates, at least in certain areas on the other tanks (not an unreasonable assumption), could explain why there have been so many leaks in the past. That is, 0.0045 inch per year times 72 years is 0.328 inch, which is greater than the 0.25-inch wall thickness of the tanks. Likewise, pit depths of 0.300 inch found on the 0.5-inch thick tank bottoms (Weston, 2007b) do not appear to have been considered in the setting of repair and re-inspection intervals.

Past repairs to the steel liner are of questionable quality

In January 2014 approximately 27,000 gallons (or more) of fuel was released from Tank #5 at Red Hill after the steel liner had been repaired welded (Lau, 2015a). The currently disclosed cause appears to have been related to poor repair weld quality and inspection (US EPA and Hawaii DOH, 2015a). This leak occurred after repair patches have been applied to the liner. The leak, the questionable steel chemistry of early 1940 vintage steel, and welding procedures cause us to be concerned with the size distribution of defects in the original welds as well as with the defect size distribution or the repair welds.

Navy Audit Report indicates deferred maintenance

An audit of the RHBFSF by the Navy in 2010 indicated that several of the tanks had not been inspected for over 20 years (Naval Audit Service, 2010):

Exhibit F:

Tank Inspection and Record of Maintenance Intervals

Tank #	Status	Fuel Type	Last Inspection or Record of Maintenance	Approximate years since last Inspection of ANY kind (as of 2009)	Next API 653 Inspection Scheduled (per MTMP Apr 09 or Inspection Report)	Approximate years between last and next scheduled inspection
1	Out-of-service	N/A	2007	2	N/A	N/A
2	Active	JP8	2008	1	2028	20
3	Active	JP8	1982	27	2012	30
4	Active	JP8	1982	27	2011	29
5	Active	JP8	1982	27	2009	27
6	Active	JP8	2007	2	2027	20
7	Active	JP5	1998	11	2014	16
8	Active	JP5	1998	11	2014	16
9	Active	JP5	1996	13	2012	16
10	Active	JP5	1998	11	2015	17
11	Active	JP5	1980	29	2011	31
12	Active	JP5	1995	14	2012	17
13	Active	F76	1995	14	2013	18
14	Active	F76	1995	14	2010	15
15	Active	F76	2005	4	2026	21
16	Active	F76	2006	3	2026	20
17	Active	JP5	1974	35	2009	35
18	Active	JP5	1963	46	2010	47
19	Out-of-service	JP5	1989	20	2009	20
20	Active	JP5	2008	1	2028	20

* Yellow shading indicates tanks with longest intervals since last recorded inspection/maintenance event.

There are limited groundwater monitoring wells

The Red Hill Facility holds about 180 million gallons of fuel in 15 tanks, yet has less than 10 groundwater monitoring wells (Lau, 2015a). Other fuel facilities on Oahu, such as the Navy's Upper Tank Farm fuel release site, hold much less fuel but have dozens more monitoring wells. Given the greater risk posed by the RHBFSF tanks to Oahu's drinking water supply because of its large fuel volume and proximity to the aquifer, a more extensive subsurface monitoring network is required. Quite simply, the number of monitoring wells does not match the risk posed by the volume of fuel stored at the RHBFSF.

Leak detection sensitivity on Red Hill tanks is such that large volumes of fuel can be released without detection

An audit by the Navy indicated the inability of the current RHBFSF leak detection system to detect slow, chronic fuel leaks, which could result in many thousands of gallons being released but undetected until the ground water is adversely affected (Naval Audit Service, 2010).

The Red Hill area has seismic concerns

The Red Hill tanks were shown to be vulnerable to seismic loading when they leaked after a moderate earthquake in 1948 and ongoing corrosion since then has likely made the tanks and associated utilities (including connections) even more vulnerable. Seismic design principles and methodologies have improved tremendously since the design and construction of the RHBFSF, and it is unlikely that the tanks and associated piping systems meet current seismic requirements.

Groundwater Model – Source Term

The contaminant transport model proposed by the Navy is designed to simulate dissolved constituents of the non-aqueous phase liquid (NAPL) in the groundwater and does not simulate flow of the NAPL itself. As a result, the "source term' for the transport model is in the form of dissolved groundwater concentrations distributed spatially and in time for the constituent being simulated (e.g., naphthalene, TPH-d). What is the method of determining the NAPL distribution in the aquifer as a dissolved-phase source term? This is important for both transport simulations of NAPL currently in the subsurface and for transport simulations linked to the risk model.

The full risk model related to the RHBFSF entails development of three separate models: The Qualitative Risk and Vulnerability Assessment (QRVA) model, the groundwater Flow and Transport model, and an intermediate model that specifies dissolved constituent sources (e.g., dissolved naphthalene and TPH-d) needed by the transport model which arise from leaked fuel specified from the QRVA model. This intermediate model is critical in specifying how the leaked fuel is interacting with the groundwater.

The method briefly described by AECOM at the September 1, 2016 meeting was that the leaks from the QRVA will be applied as a 'pancake' on the water table for delineating the source for the transport model. The so-called 'pancake' model is an overly simplistic approach and it is clear that the method of distributing the volume of leaked fuel, in both time and space, has not yet been determined. Also, applying the leaked fuel on the water table does not agree with the Navy's notion that fuel is bound up in the vadose zone and that it does not migrate directly to the water table. The 'pancake', or any other configuration of fuel on the water table will also likely migrate laterally in the direction of the hydraulic gradient necessitating a model to simulate flow of the NAPL itself.

Extensive additional site characterization is needed by the Navy to properly characterize the hydrogeology and the nature and extent of the fuel contamination in the subsurface (vadose zone and basal aquifer) in the vicinity of the tanks and surrounding Halawa Valley area. In addition, a code capable of simulating NAPL flow in the subsurface may be required. Only after proper characterization of the hydrogeology and nature and extent of the fuel contamination can model source terms be more accurately defined and the uncertainty associated with simulation of NAPL and its dissolved constituents in the subsurface be reduced to an acceptable risk level.

Consider the presence of free product

The current presence of NAPL in groundwater should be considered during the performance of the QRVA. The solubility of JP-5 is reported to be 4,500 µg/L by TEC (TEC, 2007) and is used by the Navy as the site-specific risk based level (SSRBL). As stated in the EPA website Contaminated Site Clean-up Information (https://clu-in.org/): ***As a rule of thumb, if dissolved concentrations are at or above 1 percent of effective solubility, it is likely that the well is***

completed in the vicinity of a NAPL zone. Based on the discussion, it appears that the Navy considers TPH-d concentrations to represent concentrations of JP-5. Several wells at the Red Hill facility site have TPH-d concentrations above 1 percent of the JP-5 solubility. Monitoring well RHMW02 has TPH-d concentrations that have been consistently close to, or in some cases, above the stated JP-5 solubility value. As discussed by INTERA during the September 1, 2016 meeting, TPH-d concentrations exceed the JP-5 solubility, which likely indicate that monitoring well RHMW02 has been directly impacted by JP-5 free product since the groundwater samples taken from that monitoring well would contain small quantities of the fuel phase. Small quantities of JP-5 may be present attached to colloids or other particles present in the well, or may be present due to some other process. Other wells (RHMW01, RHMW03, OWDFMW01, Halawa Deep Monitor (CWRM Well) have had, at times, TPH-d concentrations well above 1 percent of the JP-5 solubility, indicating they are also being impacted by dissolution of nearby NAPL.

Construction of a Groundwater Treatment Facility

Given that there is currently contamination in the groundwater and that until the QVRA is completed, we will not know the risk of future releases, the BWS recommends that the Navy proceed with the design, construction, and operation of a groundwater treatment facility at the RHBFSF. This will allow the treatment of current contaminants and provide the ability to clean up continuing or future releases. Because of the time involved to implement all sections of the AOC, the underlying aquifer is currently at risk of additional impact. An active treatment system is the only reasonable action that the Navy could take to help ensure that potential receptors are not exposed to contaminated groundwater. The design of such a system should include additional Site characterization and pilot study work to ensure that an adequate groundwater treatment facility is constructed.

Groundwater resource use

The BWS would like to reiterate our position that alternative sources of drinking water are needed for the City and County of Honolulu and that the BWS intends to assess all areas of Oahu for groundwater extraction. The Halawa valley area is particularly valuable because of BWS owned properties in the area along with significant BWS infrastructure. The BWS is currently developing a Water Master Plan in order to meet its objective to provide safe, dependable, and affordable water to the people of Oahu now and into the future (BWS, 2016). New production wells at Moanalua Reservoir 405/Halawa 372/Halawa booster station are just a few of the sites currently being considered by the BWS.

Navy Tier 3 Risk Assessment Comments

BWS has reviewed the Navy Tier 3 Risk assessment documents to identify and comment on any issues related to the risk assessments that have been conducted for groundwater. Particular emphasis was devoted to the basis of the 4.5 mg/L (4,500 µg/L) site-specific risk based level (SSRBL) for total petroleum hydrocarbons (TPH) and any required actions for exceeding this level.

The first Tier 3 risk assessment of the Red Hill site was conducted by TEC, Inc. for the Navy in August 2007 and was re-evaluated in April and May 2010. The initial Tier 3 risk assessment proposed SSRBLs for benzene and TPH. TPHs are generally divided into three fractions: TPH-g (gasoline), TPH-d (diesel), and TPH-o (oil). Although these fractions have specific definitions and analytical methods to detect and determine the concentration of these complex mixture, the Navy's use of term TPH is not always clear. In some cases, "TPH" appears to be used as a synonym for the complex mixtures being evaluated at Red Hill and in others it represents a specific fraction of TPHs.

In the initial Navy Tier 3 risk assessment a framework for assessing groundwater monitoring sampling data was developed. This framework relies on the Hawaii DOH Exposure Action Limits (EALs) as the first criterion for evaluation of the monitoring well water samples. These EALs are often health-based. The health-based (non-cancer) risk-based action level for TPH-g is 100 µg/L and for TPH-d, 190 µg/L; however, in setting the EAL for TPH, the taste and odor threshold was taken into consideration and therefore, set at 100 µg/L. The SSRBLs are a subsequent criterion for taking action. Only when 1/10 of the SSRBL for benzene and 1/2 the SSRBL for TPH are exceeded in these wells does any significant response begin. The SSRBL for TPH is 4.5 mg/L (4,500 µg/L) and is based on solubility of JP-5; understood to represent TPH-d. This is not a health-based criterion. The action limit of 1/2 the SSRBL for TPH is over 10 times higher than the Hawaii DOH risk based action level for two of the TPH fractions. Therefore, use of the JP-5 solubility limit as the SSRBL is not protective of human health or water quality because the SSRBL is set too high.

As part of the 2010 re-evaluation of the Navy Risk Assessment, an analysis was conducted to characterize the TPH-d fraction to determine if contained non-fuel components. The premise being that the analytical method captures the presence of non-fuel compounds and therefore, the total TPH concentration could be adjusted to a "corrected" TPH concentration. The analysis of only four samples showed that between 0% and 73.7% of the TPH concentration was non-fuel compounds. Despite the variability seen in these few samples, it was concluded that an average contribution of 35% of non-fuel compounds supports the validity of the SSRBL for TPH-d at 4,500 µg/L. It is unclear how this analysis supports this conclusion. The wide variability seen in these samples cannot be represented by an average concentration of non-fuel compounds. This is highlighted by the one sample (i.e., 0%) that was determined to contain 100% TPH and no non-fuel compounds were detected – adjustment of the concentration of TPH in this sample would result in false representation of TPH in the ground water in this sample.

In the 2010 re-evaluation, a report by Zemo & Associates is provided as Attachment E. This report states that the polar degradation products are not persistent in groundwater containing oxygen or in surface water. However, no evidence was provided to show that the groundwater at the Red Hill site contains sufficient levels of oxygen to allow for degradation of these polar compounds; thus, the claim that these compounds will not persist is speculation. In addition, it is claimed by Zemo & Associates that the reliance on TPH fractions is "unjustifiably conservative" is not supported. The overall framework for addressing the potential toxicity of TPHs is designed to be conservative in order to account for the uncertainties associated with the unknown toxicity of some individual compounds and the potential for the toxicity to be cumulative for the compounds in the complex mixture.

Information Requests

Finally, below is a list of information that were discussed at the August 31 and September 1, 2016 AOC meetings that BWS would like to receive copies.

1. Please provide all historical fuel storage/additive information (it is our understanding that the Navy will request this from DLA and then provide the information to the Parties)
2. Bechtel Corporation (Bechtel). 1949. Report on Engineering Survey of U.S. Navy Petroleum Facilities at Pearl Harbor.
3. Navy Rebuttal of Bechtel Report (complete citation unknown)
4. All RHBFSF API 653 Tank Upgrade Reports
5. 2014 Tank Alternative Location Documents (Two DLA Reports). These are 2014 Tank Alternative Location Documents mentioned by Captain Tim Daniels in the AOC Working Group Meeting on September 1, 2016.
6. Burns and McDonald Report with complete appendices
7. RHBFSF Tank Management Plan
8. Tank 5 Investigation Report to be submitted by the Navy to DOH in October 2016
9. Navy Release Detection Records
10. API 653 and API 570 Integrity Evaluations
11. All RHBFSF Navy "Near-Miss" Records
12. RHBFSF Emergency Response Plans or Annexes

Thank you for your assistance with this matter. If you have any questions, please call me at 748-5061.

Very truly yours,

ERNEST Y. W. LAU, P.E.
Manager and Chief Engineer

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Lau, E. Y. W. (2015c). Board of Water Supply Recommendations to Consider in the Development of the Red Hill Administrative Order on Consent (AOC) Work Plans, To: United States Environmental Protection Agency (EPA), State of Hawaii Department of Health (DOH), Department of Navy (Navy) and the Defense Logistics Agency (DLA), Board of Water Supply, Honolulu, Hawaii, December 3.

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