BOARD OF WATER SUPPLY

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April 25, 2016

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and

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and

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Dear Messrs. Pallarino, Chang and Miyamoto:

Subject: Board of Water Supply (BWS) Recommendations for Inclusion into the Red Hill Bulk Storage Fuel Facility Administrative Order on Consent (AOC) Work Plans

Thank you for inviting us to meet with you from May 10-12, 2016 to discuss development of the AOC work plans. The BWS and its consultants reviewed the meeting minutes, presentations, and scope of work outlines posted on the United States Environmental Protection Agency's (EPA) website resulting from the Parties' meetings in late 2015 and 2016 related to developing the work plans required under the AOC.

The BWS offers the following recommendations and discussion for inclusion into the work plans that are being developed for each of the Statement of Work (SOW) tasks. These recommendations will produce defensible scientific and engineering results that will ensure our drinking water supplies are protected.

The BWS looks forward to working with the Parties to incorporate these following suggestions, proposed procedures, and action items into the applicable Work Plans:

Section 2 – Tank Inspection, Repair, and Maintenance (TIRM)

At this time, the only document available for review is an outline for the TIRM report. The BWS looks forward to reviewing the Navy's TIRM Report when completed: learning more about TIRM practices used for Tank 5 and the implementation of tank-specific plans and specifications for all cleaning and repair operations. The BWS is also hopeful that Section 3 (Lessons Learned from Tank 5...) will provide a detailed description of the Tank 5 failure, including the extent to which original construction/corrosion/corrosion fatigue/subsequent repairs led to the leak.

Further to our letter of December 3, 2015, the BWS also appreciates that the Draft Report Outline acknowledges (in Section 2-2.1.2) that probability of detection curves were not included in Wilbros or TesTex reports. It is important that probability of detection data is provided for all non-destructive examination (NDE) techniques used in order to accurately assess tank integrity. It is also an important consideration when performing the Risk/Vulnerability Assessment (Section 8).

Section 3 – Tank Upgrade Alternatives (TUA)

The BWS has noted that Navy's Draft TUA Report Outline covers the "Tank within a Tank (Duplex Stainless Steel and Carbon Steel)" upgrade alternatives and states that they have been selected for further investigation. This upgrade alternative is consistent with our previous recommendations. The BWS offers the following comments about the alternatives outlined in the Draft Outline:

- The single wall alternatives are challenging because the lack of containment redundancy makes these solutions sensitive to workmanship, quality control and long-term durability in a corrosive environment. Alternative 1A appears to be the status quo, perhaps with some additional quality control. Based on the history of leakage and the continued deterioration, it is unlikely that this solution will satisfy the risk mitigation requirements to be determined in Task 8. Alternative 1B could reduce the risk of leakage by an amount dependent on the quality and reliability of the coating, preferably based on a proven history of good performance in similar applications. Alternative 1D is questionable, given the recent poor performance of a refurbished Tank 5, presumably due to workmanship and weld quality issues.
- The double wall provides containment redundancy that improves reliability to a degree not possible with single-wall solutions. The probability of a significant leak escaping both the primary and secondary tanks without early detection and mitigation is remote with respect to the same risk associated with a single-wall tank, even after improvements outlined in Alternative 1A, 1B and 1D are conducted.
- The interstitial space between the primary and secondary tank walls provides an opportunity for a new telltale leak detection system. Such a system would likely be far more sensitive to leaks than systems associated with a single wall (where any leaked fuel would be in direct contact with cracked concrete and the surrounding rock). Absent a telltale system, the immense size of the tanks precludes sensitive leak detection based on fuel levels, and may need to incorporate sophisticated detection algorithms.
- The composite systems, as described (Alternative 2B), include filling the interstitial space between the tank shells with concrete grout, and providing intermittent channels as a telltale system to direct leaks to a central manifold. However, it is unclear how fuel

leaking through the primary wall away from the channel could make it through the filled interstitial space to the channels. Has this method been shown to work on other tanks or similar tank systems? An open interstitial space, as described in the tank-within-a-tank system, would not have this limitation.

- The order(s)-of-magnitude increase in reliability and leak detection associated with secondary containment systems versus the single wall alternatives may not be apparent in a matrix evaluation/scoring selection method as presented. The degree of risk mitigation achieved with these methods, perhaps as determined in Task 8, needs to be a primary consideration. For instance, if the risk assessment, considering the costs to the community should the aquifer be contaminated, concludes a very low tolerance for leaked fuel, then the composite or tank-within-a-tank solutions may be the only feasible alternatives.

The BWS also notes that the Navy/DLA has not referenced the 22-year period included in the AOC (not even in the contract task order documentation for the risk/vulnerability assessment). The BWS remains interested in obtaining the data/analyses that show continued operation of the tanks will not result in future fuel releases over the next 22 years.

Section 4 – Release Detection/Tank Tightness Testing

The BWS has several comments with respect to the content of the Fuel Release Monitoring Systems Report released on April 4, 2016:

- Section 5 (of Section 4.3) currently fails to clearly explain which of the technologies in use at the Red Hill Bulk Fuel Storage Facility constitute dynamic versus static release detection systems. For instance, the Mass Technology Corporation (MTC) Mass Technology Precision Mass Measurement System (MTPMMS) is first discussed under Section 5-2 (Static Release Detection Systems). It is subsequently mentioned in the context of research into applicable dynamic release detection systems (Section 5-3). The BWS believes the latter reference unintentionally implies that the MTPMMS is capable of assessing tank fuel content at all times, to include when fuel is being added or removed from a tank.
- Section 6-2 (of Section 4.3) does not indicate the extent to which the static and dynamic warning/critical alarms are tested and/or validated.
- Although some information regarding leak detection sensitivity is given in Section 6-3 (of Section 4.3), the BWS wants to reiterate our previous recommendation concerning additional testing to determine the probability of detection of the minimum leak rate. Currently the probability of leak detection appears to be based on tests done on non-Red Hill tanks. In fact, Ref. [3] (Evaluation of the Mass Technology Precision Mass Measurement System on Bulk Field-Constructed Tanks) refers to testing performed in 1998 at the Defense Energy Support Center (DESC) in San Pedro, California. In 2002, the DESC Fact Book reported that 7 of the 26 50,000 barrel tanks were out of service due to previous tracer test failures (Defense Energy Support Center Fact Book, 2002).
- A series of tests could be designed and implemented using controlled releases of a certain low rate (not to the environment) made when an operator does not know a test is occurring to determine if the leak detection system in place can reliably detect leaks within a given time period. This would provide leak detection probability not provided in Section 6-3.1, but necessary to consider in the risk/vulnerability assessment (Section 8).

Section 5 – Corrosion and Metal Fatigue Practices

The Corrosion and Metal Fatigue Practices Report released on April 4, 2016 does an adequate job of outlining the modes of internal and external corrosion that may affect the Red Hill Bulk Fuel Storage Facility tanks. The BWS was interested to learn from the Draft TIRM Report Outline (Section 2) that a section of shell plate exhibiting backside corrosion was removed from Tank 16 in May 2006 and resides in the TesTex facility in Pittsburgh, Pennsylvania. This section of shell reportedly has an average remaining thickness of 0.153-inch and a thickness ranging from 0.000-inch (two holes) to 0.200-inches. This clearly indicates outside corrosion of the steel tank to the extent that two through-wall holes were found in 2006.

Corrosion Rate

As early as 1978, Military Construction Program Projects have recommended cutting coupons from the tank plates to assess the extent of external corrosion and measure actual plate thickness (Corrosion and Metal Fatigue Practices Report Final, 2016). As previously mentioned, pages 23 – 24 of the Corrosion and Metal Fatigue Report outline a theoretical construct for determining the external corrosion rate of the steel tank liner, which concludes 0.003488 inch/year (based on twice 0.15 inches per 86 years; where 2 is a "safety factor") as "a conservative engineering assumption". Given that the minimum thickness of the Tank 16 sample removed in May 2006 was 0.000-inches (it contained two holes), the BWS suggests that "real" not "theoretical" information can be used to estimate the corrosion rate. Using the Tank 16 plate at TesTex's facility as an example, the input values for wall loss and tank age would be 0.250 inches and 64 years, respectively. The resulting calculated corrosion rate is 0.00391 inch/year, which is greater than the "conservative assumption" made in the Report. The BWS continues to recommend that actual corrosion rates can be obtained from the extracted tank liner sample. We also recommend that additional steel liner wall be removed from out-of-service tanks in order to more fully characterize the corrosion rate and weld defect size distribution, as discussed below.

Non-Destructive Examination and Destructive Testing

While the BWS is in general agreement with the conclusions in Section 3-3.2.2, we still strongly recommend the Parties immediately plan and perform additional non-destructive examination (NDE) and destructive testing (DT) analysis on Tanks #1 and #19 since:

1. Defective welds were noted as early as 1949.
2. Many of the leaks that have occurred have been associated with welds and, likely, weld defects that have resulted in leaks from corrosion and/or corrosion-fatigue.
3. There is no reliable data regarding the initial distribution (frequency, size) of weld defects from the original construction welds or from the repair welds that have been made over the years. Both the initial construction welds and repair welds are likely to contain a variety of weld defects including hydrogen-induced cracking, porosity, lack of fusion, etc.
4. Both surface-connected and nonsurface-connected defects pose risks: the former can grow from corrosion and/or corrosion fatigue whereas the latter can grow from fatigue to become surface-connected (and leak) or grow faster by corrosion-fatigue.

It is our understanding that Tanks #1 and #19 have been taken out of service (with no current plans for placing them back into service) and are therefore potentially available for quantification of:

1. The probability of detection of the various corrosion and weld flaws using the Red Hill NDE techniques. NDE testing of the Red Hill tanks using API 653-quanlified inspectors followed by DT of plate sections found to contain large and small defects should be used as a means of characterizing the probability of detecting corrosion and weld flaws.
2. Repair weld procedures and the NDE techniques used to evaluate the repair welds. Test repair welds can be made on the tank walls followed by NDE and DT to determine the size distribution of weld defects on repair welds made on the old steel with current weld parameters.
3. The frequency and size distribution of corrosion depth on the outer and inner surfaces of the steel tanks liner.
4. The frequency and size distribution of the remaining original construction weld defects.
5. The frequency and size distribution of repair weld defects.

Tank Steel Liner Plate Characterization

The BWS finds Report Section 3-3.2.1, which states that metallurgical analysis of the tank shell plate is the only method of verifying the shell plate chemical composition, to be consistent with our previous comments. Metallurgical analysis of the plate is also needed to determine the ultimate tensile strength (UTS), yield strength, elongation, and fracture toughness of the liner. Similarly thorough characterization can be performed on the steel liner welds.

It is likely that various heat lots of steel were used in the construction of the tanks. For this reason, sufficient steel tank samples should be tested to determine the range of chemistries and mechanical properties.

Metal Fatigue Design Considerations

Further to our comments on tank steel characterization, Section 3-2.4 suggests that the primary mode of fatigue would be crack initiation (stress-life or S-N type of analysis), while the BWS believes crack growth is equally, if not more, critical to consider. Despite the claim that there is no evidence of metal fatigue, many of the leaks to date have been associated with welds/weld defects. Some of these may have grown as a result of corrosion and/or corrosion fatigue since the tanks were constructed. This highlights the need for detailed examination of the weld material on tanks taken out of service to get an estimate of the current weld defect size distribution (i.e., the original defect size distribution that would include any growth of these defects through corrosion or corrosion-fatigue) that can be coupled with a fatigue analysis based on crack growth.

Piping

The TIRM plans still omit mention of inspecting the piping for the Red Hill Bulk Fuel Storage Facility Tanks. There is no indication that the tank-related piping has been systematically inspected, despite indications of hydrostatic failures, weld cracks, and metal loss locations as recent as 2008. For example, when a 32-inch pipeline (F-76 line) running from the Red Hill Complex to the Pearl Harbor pump house was examined using in-line inspection in 2005-2006 (Regin, et al., 2008), "a critical leak was discovered that likely would have resulted in a catastrophic failure if left undetected" (Under Secretary of Defense, 2007). The Department of Defense (DOD) has previously acknowledged that water leaking into the tunnels at the Facility has led to "major" external corrosion of 16-, 18-, and 32-inch piping. The BWS has not been provided with records to indicate that the coating survey, pipeline integrity program, or tunnel integrity survey recommended by the DOD in 2007 to address pipeline and tunnel integrity concerns were performed. The inspection of all Red Hill piping will be an important contribution to the Risk/Vulnerability Assessment (Section 8).

Section 6 – Investigation and Remediation of Releases

According to the meeting outline and the final SOW, the objective of SOW Section 6 is to "Determine the feasibility of alternatives for investigating and remediating releases from the Facility". There have been numerous identified significant releases even prior to the January 2014 release, so the SOW Section 6 work plan should determine the disposition of the hydrocarbon masses in the vadose zone and characterize the pathways for contaminants to reach groundwater. This will require that the work plans for Sections 6 and 7 of the SOW should include characterization of the geologic and hydrogeologic framework at a site-specific scale to enable appropriate assessment of contaminant migration in the vadose zone, the saturated zone, and in potential perched groundwater zones.

The Parties' meeting outline listed four tasks for the SOW Section 6 work plan: Evaluate Vadose Zone Geology (designated Task 6.1), Investigate LNAPL (designated Task 6.2), Identify COPCs (designated Task 6.3), and Monitoring Well Network (designated Task 6.4). We note that some of the decisions listed in the meeting summary for these tasks are consistent with our previous comments and recommendations, whereas other decisions threaten successful achievement of the overall objective of investigating and remediating releases.

According to the Parties' meeting summary, the Parties made the following decisions regarding the SOW Section 6 work plan:

- Geological mapping will be performed using existing site data and previous investigations to refine the existing conceptual site model and to focus future work.
- Additional drilling and intrusive work for the purposes of locating NAPL at the tank farm is not proposed at this time. None of the methods discussed for investigating NAPL are currently recommended due to the complexity of the subsurface geology, site constraints, and the low likelihood of producing actionable data.
- No new soil vapor data collection for the current investigation is proposed. At this time, no changes to the existing soil vapor monitoring program are proposed.
- Four new monitoring wells will be installed as part of the current investigations, and their continued use and a determination of their adequacy as sentinel wells will be evaluated in the final report.
- The proposed wells will be installed prior to the refinement of the groundwater model. The final report will evaluate whether additional wells are needed to fill data gaps.
- Continuous core logging will be performed for all newly proposed monitoring wells.

Understanding the geology of the vadose zone (Task 6.1) is important, and so it will be improved and refined by the decisions to include geologic mapping and continuous coring of the new groundwater wells in the work plan. However, we are very concerned that vital aspects of the vadose zone, specifically the location of NAPL and fuel vapors around the tanks, have been ignored by the decisions against drilling to characterize the vadose zone and against installing new vapor monitoring wells.

These decisions by the Parties ignore the likelihood that released fuel has migrated laterally and semi-laterally away from the tanks along lower permeability horizons at different elevations. The low permeability of some of the basalt horizons were mentioned several times in the meeting presentations. Mention was also made of recharge through the same basalt, which is estimated to be on the order of 10 inches per year. If the infiltrating water can move through the low-permeability horizons, so too can the fuel. Infiltrating water likely contacts fuel perched on these horizons and eventually transports it to the aquifer. It is possible that the fuel from the January 2014 release is moving slowly through the same fractures used by the infiltrating water, and so will become a source driving future groundwater contamination.

As we requested in our December 2015 letter, site-specific coring studies are needed for the areas around the tanks to determine the basalt characteristics and assess which depth intervals are likely to retain and/or provide preferential pathways for leaked fuel. These studies are critical for understanding the fate of future releases, especially larger releases. Once the Parties know where the January 2014 fuel release is located in the vadose zone, then they will be better able to predict the potential impacts for different size fuel releases from the facility's tanks. We request that the Parties provide data or case studies that support the Parties' contention that properly designed and implemented drilling programs are highly likely to mobilize fuel located in the vadose zone. Years of experience on Oahu and in other basalt environments have demonstrated that the risk of re-mobilizing fuel is minimal from well planned, implemented, and monitored drilling and well installation programs.

The present soil vapor monitoring points are located beneath the thick concrete pads underlying each tank. These monitoring points provide no information about the presence of vadose zone contamination around the tank perimeters. We strongly recommend that the Parties remedy this data gap by installing vapor monitoring points around tank 5 and others that have leaked at several elevations along the tank height. The existing soil vapor data from the existing monitoring points are completely inadequate for understanding the threat to groundwater contamination from fuel contamination located alongside the tanks. This data gap can only be remedied by installation of soil vapor monitoring points along the tank perimeters at appropriate vertical intervals.

The decision to install additional groundwater monitoring wells is consistent with our previous comments and recommendations, but can only be considered as a step along the right direction. More monitoring wells will be needed and we look to the Parties to continue discussions about the number and location of additional wells as data gaps are identified. It is important that the work plan describe the specific processes for identifying and acknowledging such data gaps. The decision to first install the wells before updating the groundwater flow model matches our previous recommendation, but we must remind you that all of the existing and new wells must be accurately surveyed. USGS and others have established that there are significant errors in the elevation measurements for the tops of casings for the wells in the current Red Hill monitoring well network. These errors are large enough to create significant errors in groundwater heads used for model calibration, likely leading to model bias and larger than necessary uncertainty. The erroneous elevation for tops of casings must be addressed promptly so that groundwater heads can be recalculated with the necessary accuracy prior to conducting model calibration.

Furthermore, monitoring well RHMW07 shows head values that are several feet higher than all other groundwater monitoring wells. Preliminary data from the USGS 2015 pump test showed head changes in the other monitoring wells but not in RHMW07. These facts demonstrate this well is screened in a groundwater system that is separate from the regional aquifer system and so this well should be replaced.

According to the Red Hill data available to us, the concentration of TPH-D measured in monitoring well RHMW02 was about 5,000 micrograms per liter (μg/L) shortly after about 30,000 gallons of fuel leaked from tank #5 on January 13, 2014. Prior to the January 2014 fuel leak, TPH-D concentrations from the Navy's reported data for this well only exceeded 5,000 μg/L in one sample collected in 2008 (see data tables on DOH website and Figure 1). During 2015, four of the eight TPH-D samples collected at RHMWO2 had concentrations above 5,000 mg/L: two in April 2015 and two in October 2015. These values exceed the 5,000 μg/L TPH-D concentration measured at this well after fuel leaked from tank #5. TPH-D at monitoring well RHMW02 appears to be steadily increasing since mid-2014 (Figure 1). The BWS requests that the Parties explain the cause for the increasing TPH-D concentration at well RHMW02 and provide justification that these high concentrations are not from new fuel leaks.

Section 7 – Groundwater Protection and Evaluation

According to the meeting outline and the final SOW, the major objective of the SOW, Section 7 is to "Monitor and characterize the flow of groundwater around the Facility". The Parties' meeting outline listed three tasks for the SOW Section 7 work plan: Update the Existing Groundwater Model (Task 7.1), Evaluate Whether to Perform a Tracer Study (Task 7.2), and Evaluate Potential Remedial Alternatives (Task 7.3). According to the Parties' meeting summary, the Parties made the following decisions regarding the SOW Section 7 work plan:

- The existing groundwater flow model prepared in 2007 will be updated utilizing the same software platform (i.e., MODFLOW) incorporating historic, current, and future data. As part of the update, a sensitivity analysis will include evaluating the potential effects of hydraulic barriers associated with the caprock formation and other lower permeability volcanics (i.e., Honolulu Volcanic Series, saprolite, valley fill), and various hypothetical pumping rate scenarios.
- Preliminary remedial alternatives will be identified in the Work Plan/SOW, and discussed and evaluated in the final report. Future potential releases will also be considered (e.g., response to catastrophic releases). Final report will include an initial screening of alternatives followed by a more detailed evaluation of select remedial alternatives.
- Contaminant fate and transport modeling to be performed as presented during the scoping meeting (e.g., based on the existing fate and transport model).
- Conceptual site model to evaluate potential vadose zone flow mechanisms and degradation.
- An evaluation of whether to perform a tracer study will be included in a progress report deliverable following monitoring well installation and receipt of initial groundwater gradient and chemical data.

Achieving the stated objective of "Monitor and characterize the flow of groundwater around the Facility" will require tasks beyond updating the existing model (Task 7.1) and conducting a tracer test (Task 7.2). The Parties should first collect and analyze groundwater elevations over time at locations appropriate for determining the groundwater flow direction and rate from the Red Hill Bulk Fuel Storage Facility, especially in the Halawa and Moanalua valleys.

To do this, the Parties must also install and monitor wells in Halawa valley. There are too few wells to understand the groundwater flow pattern in the valley, which precludes a defensible conceptualization flow direction and rates between the Red Hill Bulk Fuel Storage Facility, Halawa Shaft, and other wells to the west.

We have previously mentioned the large errors in elevation measurements for different groundwater monitoring wells. These errors must be corrected before the existing wells can be used to discern groundwater flow patterns or to calibrate the updated groundwater flow model.

The decision to use only sensitivity analysis to evaluate the potential effects of hydraulic barriers on groundwater and contaminant migration from the Red Hill Fuel Facility is not defensible. The presence or absence of the barriers should not be simply assumed, but determined from a drilling and hydraulic testing program. The location and thickness of valley-fill materials in the Halawa valleys remain an important data gap that must be resolved before model updates. Previous USGS groundwater modeling (Oki, 2005) showed that predicted groundwater levels in the Red Hill – Halawa area were essentially unchanged whether valley fill was present or absent in the model simulations: "Simulated water levels in the absence of valley-fill barriers generally were lower, by a few tenths of a foot or less, than simulated water levels using the base-case valley-fill barriers..." (page 53 in Oki, 2005). Examination of the actual USGS model results shows that groundwater flows from the Red Hill Fuel Facility toward the Halawa Shaft in the absence of valley fill in the saturated zone below North Halawa stream. Given the importance of such an assumption in determining the risk to an important water supply, the Parties should ensure that the SOW Section 7 work plan thoroughly investigates the extent and hydraulic properties of valley fill units.

The Rotzoll and El-Kadi (2007) groundwater flow model constrains regional groundwater flow directions and rates through its choice of specified head boundary conditions. This is not acceptable given the unknown groundwater flow directions and rates in Halawa valley and the area surrounding the facility. The work plan should include alternate conceptualizations of the regional driving forces for groundwater flow. The work plan should also include changing the boundary condition types and locations (e.g., pushing the boundary conditions farther away from the area of concern) so that errors in their conceptualization have negligible impact on the flow pattern in the area of concern. We also request that the Parties should ensure that the groundwater model files and draft report will be peer-reviewed by the BWS and an independent third-party expert.

We ask that the Parties provide a more complete description of the proposed remediation alternative screening (Task 7.2) that will be conducted under the work plan for SOW Section 7. At present it appears to us that such a screening will hold little value in the absence of adequate determination of the nature and extent of contamination in the aquifer and the vadose zone. This concern also applies to the proposed fate and transport modeling work. Please explain how the existing fate and transport model will provide useful and defensible information for protecting our drinking water supply if the Parties have not yet identified the location of the released fuel.

Similarly, we are concerned about the value of the proposed evaluation of potential vadose zone flow mechanisms and degradation without site-specific data from the vadose zone near the tanks. A defensible evaluation should be founded upon and tested against site-specific data for the vadose zone. These should include but are not limited to NAPL location, vapor and gas (e.g., O_2 and CO_2) concentrations surrounding the tanks (not just below the very low permeability concrete plugs beneath the tanks), water content, NAPL saturation, and mapping of geologic features such as a'a clinker zones, dikes, lava tubes, etc.

We welcome the tracer study, but recommend that it be designed and implemented only after the conceptual model has been adequately updated with site-specific data. The tracer test should be designed to fill in specific data gaps about groundwater flow and migration rates and directions. As we have noted above, data gaps about flow directions and rates should first be resolved with site-specific data and only then should the tracer test be discussed.

Section 8 – Risk/Vulnerability Assessment

The Contract Task Order (CTO) for the Risk/Vulnerability Assessment (RVA) includes much of the scope we outlined in the BWS letter of December 3, 2015 and includes two significant phases: 1) evaluate candidate probabilistic risk assessment methodologies and choose most appropriate, and 2) perform the risk assessment.

The BWS recognizes that choosing a methodology for the RVA is not trivial, as it will need to be general enough to address multi-hazards such as fire, seismic, equipment failures, etc., and their possible interaction. It is critical that the methodology be adaptive so as to incorporate information learned from the concurrent AOC task that involve corrosion and metal fatigue characterization, leak detection studies, tanks inspections/analyses, and retrofit options. As the chosen method needs to be completed in a timely fashion, a comprehensive, rigorous treatment of all possible hazards may not be a realistic option.

The CTO provides a bullet item list of the minimum scope of the risk assessment. This suggests that other hazards could be added to the list upon further consideration. The BWS offers the following observations about the scope of the risk assessment:

- One issue that appears to be missing from the scope is downstream evaluation of the risk of groundwater contamination. It is likely that different failure modes will have different leak rates, and different thresholds of leak detection. As such, some leak modes will pose a greater threat to the drinking water, and there would therefore be less tolerance for risk of those failure modes. The risks from a range of released fuel volumes should be evaluated, such as the risk from releases of 50,000, 100,000, and 1,000,000 gallons, as well as catastrophic failure of one or more tanks.
- At a basic level, risk is a probability multiplied by a consequence. Risk in this context is not the probability of leaking some volume of fuel, but the risk of contaminating the drinking water supply. The BWS recommends that the scope of the risk assessment be expanded to assess the costs associated with a contaminated aquifer. Such costs may include decontamination wells, equipment and materials; infrastructure required to accessing alternate water supplies, if available and halting the transport of underground plumes of leaked fuel. How those costs are affected by volume of leaked fuel and location of the leak (e.g., a leak at an uphill tanks versus a downstream leak associated with pipes or equipment) should be considered.
- It is not clear whether this risk assessment is only for the tanks in their as-is condition, or whether this assessment is meant to incorporate planned upgrades or other leak mitigation actions. It should be clearly stated for which of these conditions (or both) the evaluation is intended. If the latter, then completion of other AOC tasks may be required before this task can be complete, and the calculated risks may change as additional inspections, analysis or mitigation measures are completed. The risk assessment schedule should take into account that it will need to be modified or revised as additional data becomes available with regard to additional information regarding, for instance, weld crack size and corrosion depth distribution data from additional NDT and destructive testing and analysis.

- The BWS recommends consideration of adding an additional bullet that would require a sensitivity analysis identifying those mitigation actions that would result in the largest decreases in aquifer contamination risk.

BWS recommends that SOW Section 8 be modified to evaluate tank relocation alternatives and their costs pursuant to paragraphs 8 (a), 8 (b) and 8 (c) of the AOC. This work would provide a comparison of the trade-offs between upgrading the tanks versus relocating them, which would eliminate the risk of future leaks by removing the presence of the fuel in totality above the groundwater table. This cost will provide context and perspective to the TUA work presently underway and affords a thorough and holistic examination of all best available practicable technologies.

Risk to Human Health

Finally, BWS recommends and urges a modification of the work as provided under paragraphs 8 (a), 8 (b) and 8 (c) of the AOC. Specifically, paragraph 8 (c) in part states that the Regulatory Agencies may determine that certain tasks or activities are necessary in addition to or in lieu of the Work when such additional performance is necessary for protection of human health and the environment. BWS is of the view that additional work to conduct a contaminant health effects study is necessary for and in keeping with protection of human health and the environment.

Groundwater monitor well data collected since 2005, show measureable levels of various petroleum based chemicals in the groundwater under and surrounding the Red Hill tanks. Some of these chemicals have maximum allowable limits that define what is safe under federal drinking water standards, while many do not. The absence of a maximum allowable limit does not mean that a contaminant's presence is safe. On the contrary, it is the maximum allowable limit that defines what is safe. Given many of the chemicals being detected have no safe limit or standard, understanding the health effects of low level petroleum contaminants in groundwater is paramount to ensuring safety of human health.

Some opine that the monitoring well data are measuring groundwater quality which is not the same as drinking water. We disagree. The groundwater data are measurements of the contaminants in that part of the aquifer where the monitoring wells are located. This groundwater is part of an aquifer that is hydraulically connected to parts of the aquifer that are currently being used for drinking water. Since groundwater is always moving, contaminants in the vicinity of the monitor wells can migrate to those parts of the aquifer that are currently not contaminated. Furthermore, data from the Navy drinking water source, Red Hill Shaft, has recorded detections for petroleum related chemicals. Users of this water was/are receiving drinking water that contains measurable levels of contaminants for that period of time the contaminant was being detected. Understanding the health effects of these chemicals is therefore essential and necessary to protect human health.

As we stated in our letter of 29 March 2016, the BWS does not support the agencies' decision to approve the Navy's request to reduce the number of COPCs analyzed in the quarterly groundwater samples. Limitation of COPCs to only 10 analytes is premature and is not defensible given the increasing concentrations of fuel constituents at monitoring well RHMW02. Until the Navy demonstrates that the magnitude and extent of contamination in the vadose zone and groundwater have been fully characterized (nature and extent), all compounds associated with the current and historic contents of the tank system, as well as chemicals used for cleaning and repair of the tanks should be considered COPCs. The detection of over 30 analytes in groundwater samples collected from the RHBFSF site is an indicator that these compounds are present in the subsurface. Reducing the number of COPCs compromises the work to understand the disposition and migration of the leaked fuel, especially now that contaminant concentrations have been increasing in monitoring well RHMW02.

Thank you for the opportunity to comment. If you have any questions, please feel free to call me at (808)748-5061.

Very truly yours,

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

Enclosure

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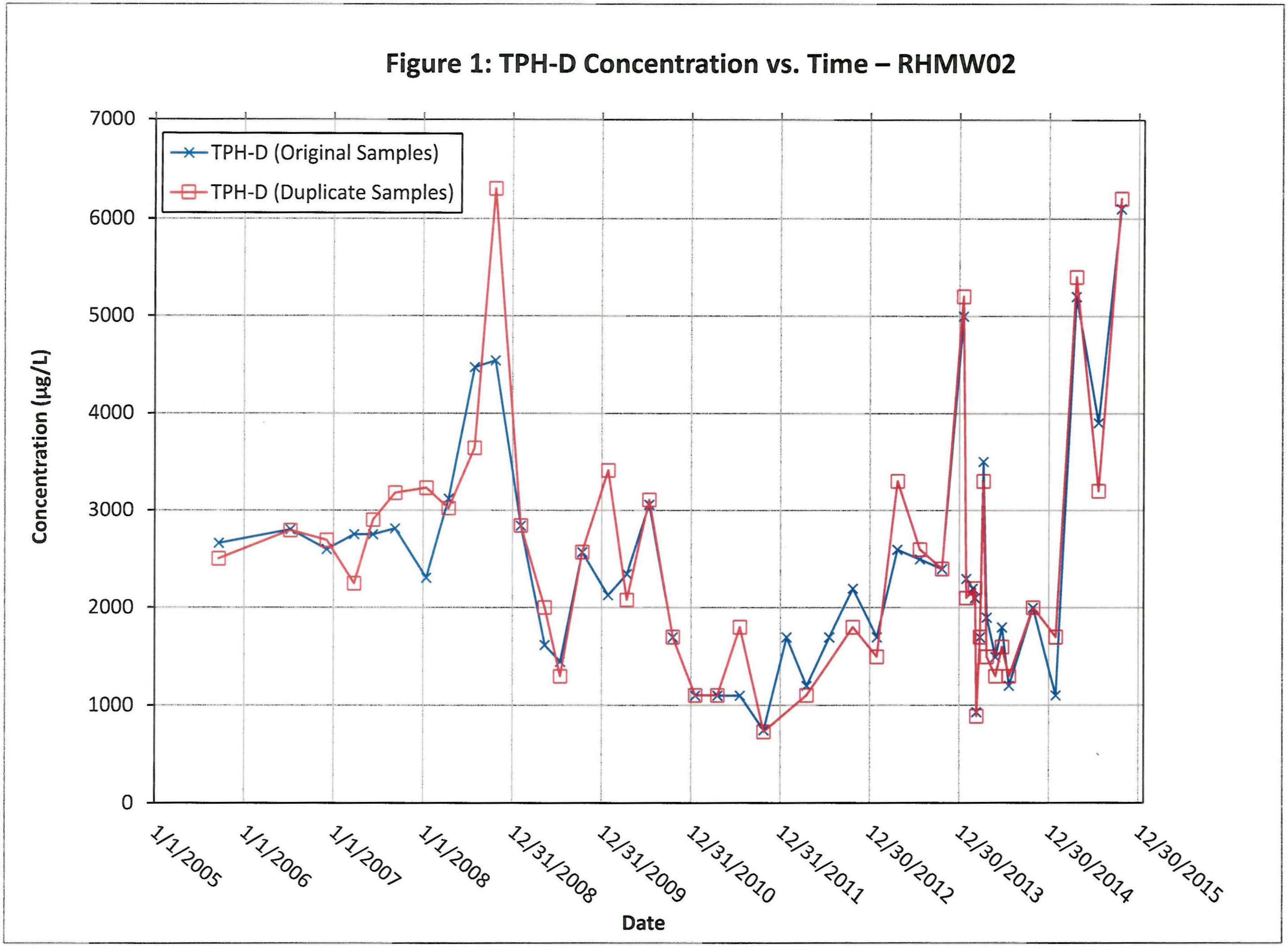

Figure 1: TPH-D Concentration vs. Time – RHMW02
TPH-D (Original Samples)
TPH-D (Duplicate Samples)
Concentration (µg/L)
7000
6000
5000
4000
3000
2000
1000
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
12/31/2008
12/31/2009
12/31/2010
12/31/2011
12/30/2012
12/30/2013
12/30/2014
12/30/2015
Date