3 TANK PREVENTIVE MAINTENANCE AND LEAK MONITORING PROGRAM

The Facility overlies a very valuable groundwater resource that produces between 4.5 and 16 mgd of potable water for the PHWS and its military consumers via U.S. Navy well 2254-01. This water resource is virtually irreplaceable, considering the present limitations of the sustainable yield of the Pearl Harbor and Honolulu Aquifer Sectors, the available water, land, as well as construction costs for new sources.

A large release of petroleum LNAPL to groundwater from the Facility can eliminate the Red Hill sub-basin as a water resource to PHWS via U.S. Navy well 2254-01. Currently there is no effective way to quickly determine whether a release is occurring. Groundwater samples are collected quarterly; a chronic release of 8 gallons per hour over a period of 90 days is approximately 17,280 gallons. Groundwater model simulations indicate that a release of this size has the potential to allow contaminated water to enter the infiltration gallery and contaminate the U.S. Navy well 2254-01 at concentrations greater than the MCL for benzene (TEC 2007). Such contamination would require the well to be withdrawn from domestic service until a treatment plant and associated by-pass water transmission system were put in place.

The age of the Facility and the mission-critical requirements for its storage capacity combine to present a significant future risk of a moderate to large release of fuel to the underlying groundwater. In order to mitigate the risk associated with future releases, the U.S. Navy will:

1. Implement a rigorous tank maintenance program, and
2. Continue to research and investigate a viable leak detection system for the Facility. Deployment of a leak detection system is dependent on the suitability of available technologies and budget constraints.

Although the Facility USTs are deferred from many of the State and Federal regulations, including the requirement for release detection (HAR, Title 11, Chapter 281, Subchapter 5, "Release Detection") deployment of a reliable leak detection system would reduce the potential for a chronic release to the Red Hill sub-basin. The impact of a future chronic release of fuel over a prolonged period of time would:

1. Eliminate 4.5 mgd to 16 mgd of potable water from the PHWS, which would severely impact the U.S. Navy mission in the Pacific;
2. Be extremely difficult and costly to remediate in accordance with the HDOH UST regulations (HAR, Title 11, Chapter 281, Subchapter 7, "Release Response"); and
3. Remove the Red Hill sub-basin as a source of potable water for an undetermined period of time.

Although there is currently a network of three groundwater monitoring wells within the Facility, these wells are only sampled every three months, and each monitors approximately 200,000 square feet of the water table beneath the Facility. A release from Tank 12 could potentially

impact an area of the water table of 150,000 square feet before being intercepted at RHMW02 at Tank 6. For these reasons, it is clear that every effort must be made to ensure that these releases do not occur, and this will be accomplished by instituting a rigorous maintenance schedule, and continuing the effort to identify and implement state of the art release detection procedures.

3.1 Tank Maintenance and Repair Program

3.1.1 Tank Maintenance and Repair Histories

Data from modified API 653 Inspection Reports and existing written site histories (see Appendix B) are summarized here. In addition to actual leaks from the tanks, it should be noted that in some cases, reported leaks in histories were leaks into the tell-tale system piping itself (which are internal to the tank) and were not external tank leaks.

Dates	Tank 1 Activity
August 1953	Leak found on tell-tale no. 7 and crack found in tank during cleaning; no indication given of leakage rates.
8/64 to 9/67	Various leaks from tell-tale; unknown quantity of leakage.
8/70 to 4/72	Unexplained fuel drops amounting to 31,294 gallons.
5/75 to 8/78	Unexplained fuel drops amounting to 32,765 gallons.
10/81	Tank modernization repair project starts.
7/82 to 1/83	Leak tests result in fuel drops amounting to 5517 gallons.
9/99	End of history.
Dates	**Tank 2 Activity**
10/47	Tell-tale leak noted, unknown amount; tank emptied.
12/81	Tank removed from service for repair and lining.
4/83	End of history.
Dates	**Tank 3 Activity**
3/53 to 12/81	No leaks reported.
Dates	**Tank 4 Activity**
1/53 to 4/83	No leaks reported.

Dates	Tank 5 Activity
3/65	Tell-tale leak at 1 gallon per 1.25 hours; tank worked on intermittently for 6 months but no leak found; suspect leak in tell-tale system.
2/72	Tell-tale leak at 2 quarts per day; response uncertain.
4/83	End of history.
Dates	**Tank 6 Activity**
6/63	Problems with tell-tale system; no clear indication of external leaks.
3/83	End of history.
Dates	**Tank 7 Activity**
11/73	Tell-tale leakage, tank emptied; leak may have been internal only.
5/78	Significant tell-tale leakage, tank emptied.
2/80	After filling leak rates measured and approx. 6505 gallons leakage measured until rate dropped to < 13 gallons per day (gpd) below 207' fill level.
4-5/81	Tank removed from service for repairs and put back in service; end of history.
Dates	**Tank 8 Activity**
3/52 to 4/83	No leaks reported.
Dates	**Tank 9 Activity**
4/58 to 5/58	Approximately 1500 gallons leaked from tell-tale.
4/96	Report of a hole found under middle pipe support for 18" line; no details provided.
7/78 to 2/81	Tank repair project and installation of telemetering system; leak test rates after project range from 4.5 to 17.9 gpd; no documentation of any actions
Dates	**Tank 10 Activity**
1/73	Suspected leak; tank emptied.
4/76	Tell-tale leak; tank emptied and removed from service.
10/78 to 4/80	Tank repair project and installation of telemetering system.
1/81	During refill a severe leak detected somewhere near top of tank; fuel ran out on concrete near first platform on stairway to top of dome; tank emptied.
10/81	Started refilling tank after repair.
4/83	End of history.

Dates	Tank 11 Activity
8-9/80	Leak testing after repair and upgrade; rates from 165 to 2412 gpd over 1 month; based on these valued estimated fuel loss between 10,000 and 20,000 gallons.
9/80	Tank emptied and repaired.
1/81	End of history.
Dates	**Tank 12 Activity**
1/64	Reported that there is a known leak in the dome section; no other information
3/73	Tank emptied, suspected leak; no additional information given.
2/81	Leak testing after repair and upgrade showed leak rate of 1,400 gpd; Unknown amount of leakage.
5/81	Tank was removed from service for a second time for leak repairs; end of history.
Dates	**Tank 13 Activity**
5/76	Leak reported, no details.
9/81	Tank returned to service after lining and repairs; leaks found above 188 foot level; repaired.
2/82	End of history.
Dates	**Tank 14 Activity**
3/49 to 2/82	No leaks reported.
Dates	**Tank 15 Activity**
7/81	Tank leaked badly upon refilling after tank repair and lining, no details.
8/81 to 10/81	Removed from service, repaired; leak test still showed leak and repaired again.
1/82	End of history.
Dates	**Tank 16 Activity**
7/48	Leak reported, no details; emptied tank.
7/49	Tell-tale leak, lost 2.25" in 11 days (approx. 11,000 gallons); no additional information.
12/49	Tank refilled, lost 3.63" in 4 days (approx. 18,000 gallons); no information on when leakage was stopped.
5/73	Tell-tale leakage at 1 drop per 20 seconds; no additional information.
1/75	Emptied tank.

Dates	Tank 16 Activity (continued)
10/81	Tank refilled after repairs and lining and found to leak badly.
11/81	Tank removed from service.
12/81	Tank reworked and returned to service; end of history.
Dates	**Tank 17 Activity**
6/69	Leak reported by gauger; tell-tale leaking at 1 gallon per 1.5 minutes; fuel transferred.
1/75	Tell-tale started leaking; no additional information.
5/79	End of history.
Dates	**Tank 18 Activity**
12/50 to 9/75	No leaks reported.
Dates	**Tank 19 Activity**
6/64	Leak discovered around weld in tank bottom, 5 mL per hour (mL/hr); other small holes discovered during inspection; rewelded.
1998	"Back seepage" was observed from holes in steel liner during a tank maintenance project.
Dates	**Tank 20 Activity**
8/60 to 3/79	No leaks reported.

Based on various types of leak tests conducted since 1997, other releases may have occurred that are not reflected in the histories above. However, the accuracies of these tests are not known and in some cases leakage through gate valves has been determined as the cause of unexplained changes in fuel levels. In 2004, gate valves on fuel lines were replaced with twin seal plug valves (double block bleed valves). These replacements are believed to have eliminated leaky valves as a factor to explain unexpected changes in fuel levels.

3.1.2 Tank Inspections and Repairs

To date, five tanks (Tanks 7, 8, 10, 15 and 16) have been inspected and repaired in accordance with a modified protocol for USTs based on the API 653. API 653, *Tank Inspection, Repair, Alteration and Reconstruction*, is a maintenance and inspection program developed by the API to provide for an ongoing assessment of a facility's above ground storage tanks. This protocol was modified to be appropriate for USTs. API 653 provides minimum requirements for maintaining the integrity of welded steel storage tanks. It applies specifically to aboveground tanks, but the principles also apply to field-constructed underground tanks. Tanks 7, 8, and 10 underwent the

modified API 653 process and were completed in 1998. Tanks 15 and 16 underwent the modified API 653 process and were completed early in 2007. The modified API 653 reports are provided in Appendix B.

3.1.3 Current Status of the USTs

At the date of this report, 17 of the 20 tanks at the Facility are in operation. Three tanks (1, 6 and 19) are currently out of service (Table 3-1). Tanks 1 and 19 have been taken out of service permanently (Appendix B). Tank 6 is presently undergoing modified API 653 tank inspection procedure (Appendix B).

3.2 Current Petroleum Release Monitoring Systems

3.2.1 Soil Vapor Monitoring System

The soil vapor monitoring system (SVMS) is not an ATG system. As implemented in the pilot study, the SVMS consists of two or more probes located at various points in existing boreholes beneath seven of the Facility tanks (2, 6, 10, 11, 12, 14 and 16). Each probe is used to draw vapor from isolated segments of the borehole associated with the front, middle, and back of the tanks. Vapors are withdrawn from each probe via a pump and sampled in the field using a hand-held organic compound detector. Total volatile organic vapors are measured down to 1 part per billion and compared to baseline measurements from the same location. Increasing concentrations over time are an indication of fuel leaks at the tested tank. The SVMPs can be monitored periodically (quarterly) or when data from the ATG leak detection system indicates a potentially leaking tank. All 20 tanks have horizontal borings underneath them from earlier investigations, therefore full scale implementation would require removal of the existing casing and SVMP installation in eleven additional boreholes (Tank 1 and Tank 19 are out of service indefinitely). Limitations of the SVMPs as currently designed are described below.

- Currently only one boring exists under each UST. Additional borings under each UST would increase the probability of detection by increasing the coverage.
- In the case of multiple releases from a single UST, vapors from a previous release may mask any new releases to some extent, especially if the releases affected the same SVMP. This limitation may be overcome by evaluating concentration trends, versus the positive detections of petroleum as an indication of a new release. Additional borings and multiple vapor monitoring points per borehole would increase the probability of detection of multiple releases from different locations in a UST.
- The remaining borings that have not been fitted are smaller in diameter and present technical difficulties in installation of the SVMPs with multiple monitoring points (MPs). Alternative installation procedures will be required.

3.2.2 Groundwater Monitoring at the Facility

Although a groundwater monitoring program is currently in place at the Facility, this program is not a viable leak detection method, since leaks can occur that are not observed at the monitoring wells. Its purpose is to evaluate groundwater quality under the Facility to determine whether contamination presents a risk to consumers of the water within the Red Hill sub-basin. In addition, the groundwater monitoring program will also provide "triggers" to the groundwater protection responses presented in Table 4-2. Petroleum in groundwater from each well can be inferred to have come from upgradient sections of the Facility; however, the objective of the leak detection program is to verify and correct any leakage before the drinking water resource is impacted in order to minimize the chance that the responses presented in Table 4-2 are required.

In the current configuration, three groundwater monitoring wells are in place within the lower access tunnel of the Facility.

- RHMW01 is at the southwest edge of the Facility, between Tank 1 and the U.S. Navy well 2254-01. RHMW01 is considered to be hydraulically downgradient from the USTs and is the last sentry well before the U.S. Navy well 2254-01 infiltration gallery. RHMW01 will be the first point of detection for releases from Tanks 1 through 6.
- RHMW02 is upgradient of Tank 6, approximately 600 feet upgradient of RHMW01. It will be the first point of detection for Tanks 7 through 14.
- RHMW03 is upgradient of Tank 14, approximately 800 feet upgradient from RHMW02 and 600 feet downgradient from Tanks 19 and 20. It is the first point of detection for Tanks 15 through 20.

The current groundwater monitoring program consists of quarterly sampling events, and results generally take two to three weeks from the time of sample collection. While this is a very important part of the confirmation process, it does not provide timely information required for protection of the groundwater resource. A detailed groundwater monitoring program has been developed for the Facility. This program is described in Section 4 of this report and in Appendix C (Groundwater Monitoring Field Sampling and Analysis Plan).

3.3 Ongoing Groundwater Protection Activities

1. Continue to conduct modified API 653 tank inspections and repairs for USTs (see proposed schedule in Table 3-1). This process is an extension of previous tank inspection and repair procedures that have been conducted to date. Tanks will continue to be inspected periodically at time intervals based on the results of the latest inspection (no greater than 20 years).
2. Expand vapor monitoring program to all active Red Hill tanks. Currently seven active tanks are fitted with SVMPs. Install SVMPs in existing borings in the eleven remaining tanks as part of the overall fuel management program. The estimated cost to equip each tank with SVMPs is approximately $15,000, for a total cost of $165,000. An additional