BOARD OF WATER SUPPLY

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

March 13, 2018

Mr. Omer Shalev
United States Environmental Protection Agency
Region IX
Underground Storage Tank Program Office
75 Hawthorne Street
San Francisco, California 94105

and

Ms. Roxanne Kwan
Solid and Hazardous Waste Branch
State of Hawaii
Department of Health
2827 Waimano Home Road
Pearl City, Hawaii 96782

Dear Mr. Shalev and Ms. Kwan:

Subject: Review Comments – Sentinel Well Network Development Plan, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility, dated December 11, 2017

The Honolulu Board of Water Supply (BWS) offers the following comments to the Navy's Sentinel Well Network Development Plan, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility (Navy, 2017) submitted to the United States Environmental Protection Agency (EPA) and Hawaii Department of Health (DOH) on December 11, 2017.

General Comments

Our review found that implementation of the Sentinel Well Network Development Plan (SWND Plan) (Navy, 2017) as proposed by the Navy will not protect our drinking water supply from existing or future Red Hill Bulk Fuel Storage Facility (RHBFSF) contamination. As written, the SWND Plan does not include a sufficient number of sentinel wells and a sufficiently long monitoring period. The SWND Plan proposes to use risk-based action levels at sentinel wells located in Halawa and Moanalua Valleys outside the RHBFSF instead of the more protective existing drinking water standards

and guidelines. Our review found that there are serious flaws, both conceptual and numerical, in the proposed method for calculating risk-based contaminant levels. Our review also identified fallacious reasoning in the sentinel well selection criteria. The SWND Plan should be rewritten to provide monitoring at an adequate number of locations over the entire duration of the tank upgrade period, follow existing regulatory standards, and use sound science so that our drinking water resources will have the protections they require.

Given the high degree of heterogeneity in hydraulic properties that can be expected in the basalt aquifer due to a'a clinker zones and pahoehoe lava tubes and the preferential transport pathways associated with each, the expectation that the proposed sentinel wells will detect contaminant migration is a major concern. Unless sentinel wells are spaced closely enough to intersect flow through all of the potential preferential transport pathways, they will not be able to detect the contaminants that may be transported between (our greatest concern), above, or beneath the sentinel wells' screened intervals. Either the sentinel wells must be demonstrated to be spaced as closely together as the scale of the preferential flow paths (e.g., a single lava tube) or they will provide no guarantee that contaminant migration could go undetected and, therefore, provide no protection to Halawa Shaft and Moanalua Wells.

We are concerned that the SWND Plan will yield insufficient monitoring of Halawa and Moanalua Valleys, whether from a lack of sentinel well density, insufficient length of monitoring period, or both. The Navy proposes to select and evaluate sentinel wells based on a set of criteria and modeling results that are not conservative and do not incorporate uncertainty about the hydrogeologic framework, aquifer properties, and groundwater flow system. Given the enormous amounts of fuel stored at Red Hill and the continuing external corrosion of the tank steel liners that are more than 70 years in age, shouldn't the Navy focus on monitoring an appropriately large number of locations for the entire duration of the tank upgrade process in order to protect our Sole Source aquifer? The SWND Plan should focus on the steps to be taken to create a comprehensive sentinel well network, especially if the Navy does not either relocate the fuel facility or select double-walled tanks with interstitial monitoring as the upgrade alternative. The cost to effectively monitor our drinking water aquifer is much, much smaller than the cost of replacing our drinking water supply. This is a Sole-Source aquifer and the BWS is duty-bound to its stakeholders to protect our groundwater resource.

Specific Comments

1. Section 1.2 Objective, page 2 of 24, lines 2 to 4 state the overall objective:

"The overall objective of the Sentinel Well Network Program is to establish a network of monitoring wells that provides an early warning system of potential impacts from the Facility to protect drinking water and other receptors."

The BWS agrees that the sentinel well network should monitor groundwater heads and chemistry as an "early warning system". We believe that the volume of fuel stored at the RHBFSF, the continued fuel release through leaks whether reported (like the January 2014 leak) or not reported (like the leak that caused fuel to reach groundwater at monitoring well RHMW02 in 2005 and 2006), and the fuel's proximity to our Sole-Source Aquifer and water supplies all require a much larger monitoring well network than exists or is planned to be put in place. What is lacking is the duration for operating the sentinel well network. How long does the Navy propose to operate the network, two years, ten years, indefinitely? External corrosion of the tank steel liners that are more than 70 years in age will continue, so the risk of future releases will continue to increase. This highlights a critical need for long-term monitoring at a comprehensive sentinel well network for the duration of tank upgrades and beyond. Monitoring duration and intensity could be reduced if the facility is moved to a new location or if the selected tank upgrade alternative (TUA) is double-lined tanks with monitoring of the interstitial volume. The SWND Plan should also ensure that monitoring results from the sentinel wells are shared immediately with the BWS as well as the Regulatory Agencies.

2. Section 2.3 Risk-Based Decision Criteria Development (RBDC) Plan, pages 9 and 10 of 24 describes the process for establishing site-specific risk-based levels (SSRBLs) for the sentinel wells:

   "The RBDC will be used along with mass flux of "Chemicals of Potential Concern (COPC) in groundwater to tap water receptors to establish SSRBLs for sentry wells to ensure that drinking water is protected at the tap. Individual SSRBLs will be established for each sentry well."

   This entire section of the SWND Plan requires significant revision because it proposes to use SSRBLs at wells in Halawa and Moanalua Valleys instead of the applicable drinking water standards and Environmental Action Levels (EALs). To "ensure that drinking water is protected at the tap", BWS advocates that contaminant concentrations in sentinel wells be compared against drinking water standards to make decisions about "additional contingency action (e.g., further evaluation, more frequent monitoring, treatment)", not SSRBLs that are defined using the pumping rate at Red Hill Shaft that may not pump into perpetuity (see Section 2.7 in Navy, 2017 and comment 6 below). The AOC does not regulate

how groundwater contaminant concentrations should be evaluated in our Sole Source aquifer. The SWND Plan should be revised so that it no longer provides less protection than existing state laws and regulations but instead provides equal or greater protection. BWS recommends that decisions about mitigation and remediation should be determined using by comparing contaminant concentrations at sentinel wells to drinking water standards and EALs as appropriate, as the aquifer is the source of drinking water.

3. Section 2.4 Potential Exposure Analysis, pages 10 to 13 of 24. The exposure analysis ignores fuel discharge to the ground surface and surface water bodies via migration through the vadose zone without justification. The RHBFSF stores so much fuel that a release could comprise many tens or hundreds of thousands of gallons of fuel to more than a million gallons of fuel into the vadose zone at elevations that lie above the nearby Halawa and Moanalua Valleys. Fuel can rapidly migrate laterally through clinker zones and lava tubes and discharge above the valley floors. This section should be revised to describe and evaluate this exposure pathway.

4. Section 2.5 Comprehensive CSM, pages 13 and 14 of 24. The section title should be revised to read "CSM" not "Comprehensive CSM". Line 31 of page 13 states that the CSM is still under development, and, to the best of our knowledge, the CSM has not been released for review. The list of CSM processes listed on pages 13 and 14 do not include uncertainty in driving forces, hydrogeologic framework, and aquifer properties. This section should be revised to include these uncertainties. It should be revised to more completely explain the hydrogeologic processes responsible for the anomalously high groundwater levels observed at monitoring wells RHMW07 and RHMW11. The CSM has yet to explain the interaction between groundwater in the valley sediments and groundwater in the basalt aquifer. This section should also be revised to address our comments on the Navy's CSM Development and Update Plan (Lau, 2017). From our perspective the Navy's CSM still lacks very important elements and so it is premature to call it "comprehensive".

5. Section 2.6 Groundwater Model, page 14 of 24. This section states that the "groundwater flow and CF&T models and the CSM play a critical role in evaluating proposed sentinel monitoring wells". BWS is seriously concerned that the Navy's conceptual basis that it proposes to use to select sentinel well locations does not match several years of groundwater head observations. As an example, the Navy's conceptual explanation of groundwater flow depicted in Figure 5 does not match 2015 and 2016 groundwater levels reported by the United States Geological Survey. Attachments A and B to this letter overlay the

observed groundwater levels for 2015 and 2016, respectively, on the Navy's Figure 5. The Navy's hypothetical flow direction (blue arrows) directly contradicts the northwest flow direction indicated by the observed groundwater levels. The Navy's "hypothetical" flow arrows should at least reflect the observed groundwater levels from data sets that have long been available to the Navy. If the actual flow direction is from southeast to northwest, then the hypothetical capture zone from pumping at Red Hill Shaft will have a very different orientation and extent. Consequently, the BWS asks that the Regulatory Agencies to direct the Navy to honor the observed data in selecting sentinel well locations rather than using conceptual and numerical models that contradict these observations.

6. Section 2.7 Capture Zone Analysis, pages 14 and 15 of 24. This section requires significant revision because it does not address the risks to water supplies in Halawa and Moanalua Valleys from Red Hill contamination and contains conceptual and numerical errors.

   The approach described in this section is neither conservative nor defensible. It unjustifiably assumes that pumping at Red Hill Shaft will maintain a completely effective capture zone without fail into the future. The BWS questions the validity of estimating risk-based levels for contaminant levels at the sentinel wells without directly addressing important uncertainty about the subsurface environment and flow system in Halawa and Moanalua Valleys. For example, the hypothetical capture zone and groundwater flow directions shown in Figure 5 are not defensible if valley fill or saprolite do not form a continuous and low-permeability presence below the water table. Yet there is no evidence that such features are actually present below the water table and prevent contamination migration from Red Hill to our Halawa Shaft and Moanalua Wells. SSRBLs should be determined using an approach that incorporates important uncertainties, not the proposed approach which, as described, ignores important uncertainties.

   This section states that SSRBLs will be calculated as a function of pumping at the Red Hill Shaft but does not explain how such a calculation is applicable to receptors other than Red Hill Shaft. Where is the approach for calculating the SSRBLs for Halawa Shaft and Moanalua Wells? On what basis should the SSRBL for a sentinel well in Halawa Valley (or Moanalua Valley) be calculated as a function of Red Hill pumping?

   The equation for calculating SSRBL values for each sentinel well that is shown in lines 8 to 15 on page 15 contains conceptual and numerical errors. SSRBL concentration is defined as the ratio of some mass flux and pumping at Red Hill Shaft. If the pumping rate is kept very low, this equation could yield SSRBLs with

dangerously high concentrations that will allow extensive contamination, instead of protecting our aquifer. This section must be revised because there is no explanation about how mass flux will be estimated and how the mass flux estimate will be affected by the important uncertainties. Also missing are the units for the pumping rate at Red Hill Shaft. These are needed to ensure the correct conversion factor. Furthermore, lines 14 and 15 appear to contain several errors. The conversion factor of "184 micrograms per gallon per day [µg-gal-day] / grams per liter per day [g-L-day]" is either numerically incorrect or the equation itself is in error. We note that "micrograms per gallon per day" and "grams per liter per day" are incorrectly denoted as "[µg-gal-day]" and "[g-L-day]", respectively; they should be denoted instead as "[µg/gal/day]" and "[g/L/day]", respectively.

This section, which focuses only on the Red Hill Shaft as a receptor, contradicts Section 2.4.1, which states that Halawa Shaft, Moanalua Wells, and Red Hill Shaft are the water supply receptors nearest to the RHBFSF. SSRBLs are only defined as a function of pumping at Red Hill Shaft, which ignores the risks to Halawa Shaft and Moanalua Wells.

7. Section 3.2.1 Primary Criteria, pages 16 to 21 of 24. We have serious concerns about all of the primary criteria. Sentinel well screens should intersect multiple vertical intervals because the Navy has little to no data about the vertical distribution of contaminants below the water table (Section 3.2.1.1). Choosing sentinel well locations should focus on locations between contaminant sources at Red Hill and pumping centers in Halawa and Moanalua Valleys first and groundwater head gradients should be a secondary concern (Section 3.2.1.2). Fuel released from the RHBFSF tanks can migrate over long distances within the vadose zone, so there are a large number of contamination starting points that must be considered. The gradients themselves vary over time in direction and magnitude as pumping rates vary, so choosing locations using gradients based on recent pumping rates may or may not be relevant for future pumping conditions. Using plume capture analysis to select sentinel well locations should only be done within an analytical framework that directly evaluates the impacts of important uncertainties on the capture zone (Section 3.2.1.3). Using the past history of COPC detections to select sentinel well locations is logically fallacious (Section 3.2.1.4). Future releases may occur at different tanks, or at different locations on tanks with prior releases, thus reducing the probability that wells with past detections will intersect the new releases. Furthermore, future releases may put much larger fuel volumes into the vadose zone, leading to migration pathways that differ significantly from past releases. Concentrations should be compared against drinking water standards and EALs, especially for sentinel

wells in Halawa and Moanalua Valleys, not the SSRBLs proposed in Section 3.2.1.5 (see comment 6 above).

8. Section 3.2.1.5 Integration with Risk-Based Decision Criteria, Page 21 of 24, Lines 24 – 31. The ability to predict whether COPC concentrations at the drinking water tap could exceed the Risk-Based Decision Criteria (RBDC)", based on concentrations measured in a sentinel monitoring well is very questionable. It cannot be assumed that the highest COPC concentrations in the aquifer will be detected in a sentinel monitoring well. Higher concentrations than those measured in a sentinel monitoring well could easily be in the aquifer elsewhere. Furthermore, the transport pathways to potential receptors cannot be predicted with much certainty. The BWS believes that only conservative assumptions should be made when COPCs are detected (or not detected) in sentinel monitoring wells.

9. Section 3.2.2, Secondary Criteria, Page 21 of 24, Lines 1 – 6. This criterion is logically fallacious because there is no guarantee that future releases will occur at the same locations and rates as past releases. See Comment No. 7 above.

10. Section 3.2.2, Secondary Criteria, Page 21 of 24, Lines 33 – 37. There are no "known groundwater barriers". There are only inferred groundwater barriers based on one borehole (RHMW11) with observed saprolite and no hydraulic testing of the saprolite to estimate its hydraulic properties. Assumed barriers should not be included as Secondary Criteria in deeming monitoring wells unimportant.

Thank you for the opportunity to comment. If you have any questions, please feel free to call Erwin Kawata at 808-748-5080.

Very truly yours,

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

cc: Mr. Steve Linder
United States Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

Mr. Mark Manfredi
Red Hill Regional Program Director/Project Coordinator
NAVFAC Hawaii
850 Ticonderoga Street, Suite 110
JBPHH, Hawaii 96860

References

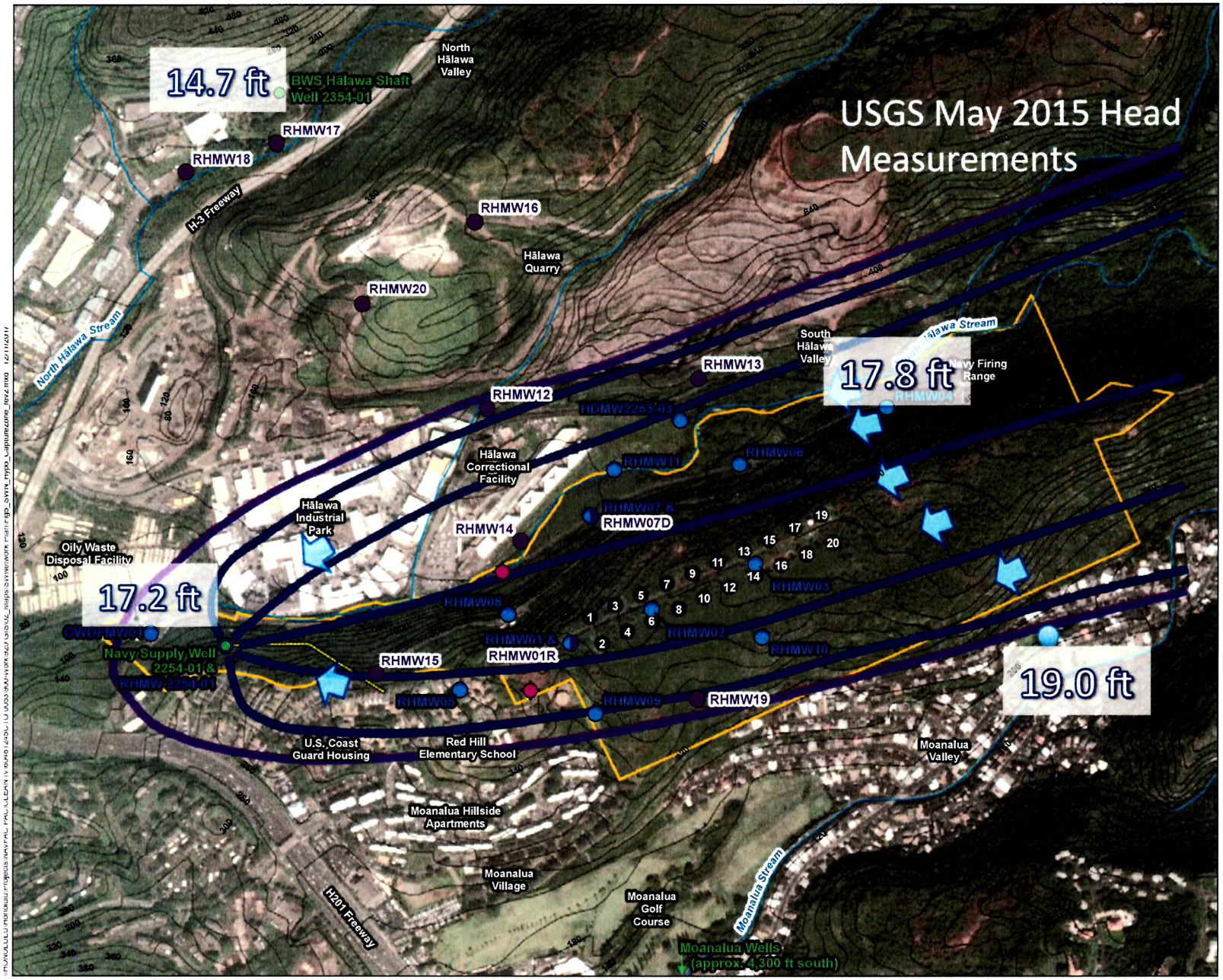
Lau, E. 2017. Letter to Mr. Bob Pallarino, EPA, and Mr. Steven Chang, Hawaii Department of Health: Board of Water Supply (BWS) Review Comments – Conceptual Site Model Development and Update Plan, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility, dated September 1, 2017. Letter dated November 13, 2017.

Navy. 2017. Sentinel Well Network Development Plan, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility. AOC Statement of Work Sections 6.2, 7.1.2, 7.2.2, and 7.3.2. Revision 00. December 11.

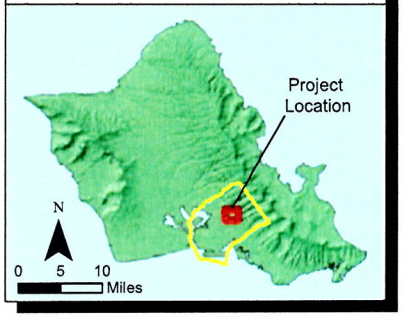
Attachments

Attachment A – USGS May 2015 Head Measurements
Attachment B – USGS November 2016 Head Measurements

Attachment A



Location Map



Legend

- Existing Monitoring Well Location
- Proposed Monitoring Well Location
- Adjacent Existing and Proposed Monitoring Well Locations
- Potential New Sentinel Monitoring Well
- Existing Water Supply Well
- 2254-01 Infiltration Gallery
- Red Hill Fuel Storage Tank
- Flow Direction
- Particle Flow Path in Groundwater (to be estimated during interim modeling)
- Hypothetical Capture Zone (will be determined based on particle flow paths)
- Stream
- Topographic Contour (feet above mean sea level)
- Red Hill Installation Boundary
- Groundwater Model Area

Notes

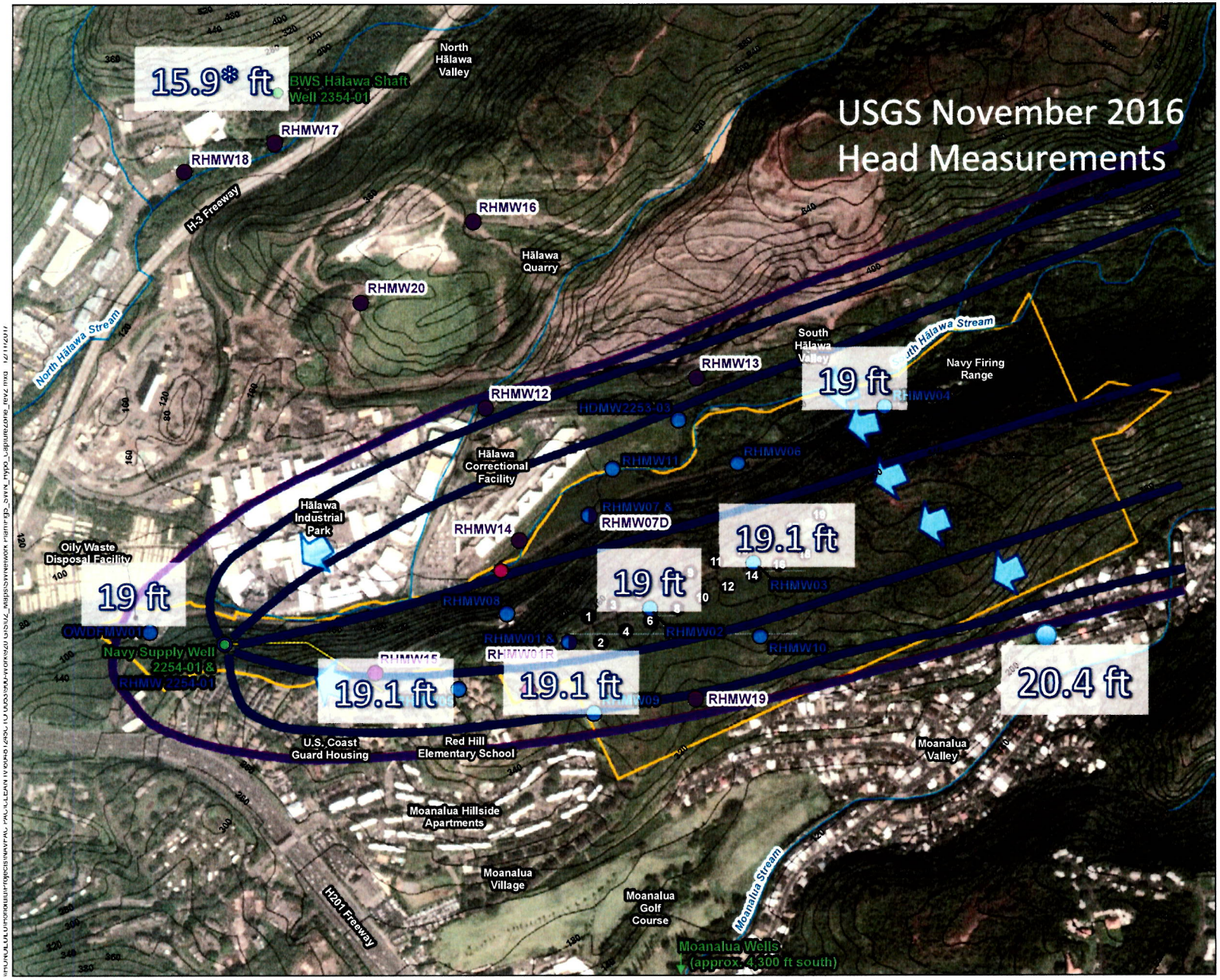
1. Map projection: NAD 1983 UTM Zone 4N
2. Base Map: DigitalGlobe, Inc. (DG) and NRCS. Publication_Date: 2015
3. Coordinates: NAD 1983 UTM Zone 4N
4. A sentinel monitoring well could be identified as an existing well or as a newly proposed monitoring well contingent on results of modeling efforts.

N

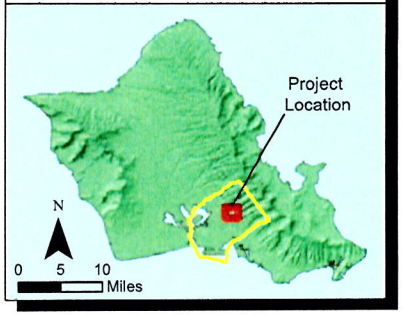
0 500 1,000 2,000 Feet

Figure 5
Hypothetical Capture Zone
Near Red Hill Bulk Fuel Storage Facility
Sentinel Well Network Development Plan
Red Hill Bulk Fuel Storage Facility
JBPHH, O'ahu, Hawai'i

Attachment B



Location Map



Legend

- Existing Monitoring Well Location
- Proposed Monitoring Well Location
- Adjacent Existing and Proposed Monitoring Well Locations
- Potential New Sentinel Monitoring Well
- Existing Water Supply Well
- 2254-01 Infiltration Gallery
- Red Hill Fuel Storage Tank
- Flow Direction
- Particle Flow Path in Groundwater (to be estimated during interim modeling)
- Hypothetical Capture Zone (will be determined based on particle flow paths)
- Stream
- Topographic Contour (feet above mean sea level)
- Red Hill Installation Boundary
- Groundwater Model Area

Notes

1. Map projection: NAD 1983 UTM Zone 4N
2. Base Map: DigitalGlobe, Inc. (DG) and NRCS. Publication_Date: 2015
3. Coordinates: NAD 1983 UTM Zone 4N
4. A sentinel monitoring well could be identified as an existing well or as a newly proposed monitoring well contingent on results of modeling efforts.

N

0 500 1,000 2,000 Feet

Figure 5
Hypothetical Capture Zone
Near Red Hill Bulk Fuel Storage Facility
Sentinel Well Network Development Plan
Red Hill Bulk Fuel Storage Facility
JBPHH, O'ahu, Hawai'i

* Not measured in 2016 but scaled using the 1.2 ft difference in RHMW04 heads between 2015 and 2016.