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April 17, 2017

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Dear Messrs. Pallarino and Chang:

Subject: Board of Water Supply (BWS) Comments to the Existing Data Summary and Evaluation (EDSE) Report for Groundwater Flow and Contaminant Fate and Transport Modeling, Red Hill Bulk Fuel Storage Facility Joint Base Pearl Harbor-Hickam, O'ahu, Hawai'i dated March 5, 2017

We have reviewed the subject document and offer the following comments and recommendations.

The BWS finds that the EDSE report is a good first step in compiling data of sufficient quality and quantity. Much of the data evaluation section (Section 3) contains interpretations of conditions, some of which are unsupported by data or need further explanation, rather than evaluating whether the data are of sufficient quantity and quality to develop the Red Hill Bulk Fuel Storage Facility (RHBFSF) conceptual site model (CSM). All such interpretations should be removed from the EDSE report.

The following section provides our most important comments together with supporting examples. Given the amount of data, our review is not meant to be comprehensive, but instead demonstrate that the report needs to be revised. The last section lists the references cited.

1. Confused or Misrepresented Objective

According to statements made by the United States Environmental Protection Agency (EPA) during the February 16, 2017 Red Hill Administrative Order on Consent (AOC) meeting, the EDSE report is to describe the “universe of data” for the RHBFSF including the “usability of the data” and the “accuracy of the data” (Lau, 2017). The EDSE report presented data but needs to do more to address the usability and accuracy of the data.

Per line 1 of the Introduction, the “*report presents currently compiled existing data and other relevant information pertaining to the groundwater flow modeling area*”. The EDSE report does not discuss the usability of the data for the CSM that the numerical model is supposed to represent in quantitative manner. The EDSE report text only focuses on the numerical model, which is based on an outdated CSM developed in 2007. The amount of data collected since then should be evaluated for usability in updating the CSM, otherwise the Navy is moving forward with a numerical model that may not adequately represent all the features, events, and processes that are most important to conceptually understanding flow and transport in the vadose zone and saturated zones beneath and around the RHBFSF.

Our review noted that the compiled data are not properly evaluated regarding usability. The compiled data do not appear to include information about the time-varying inflows and outflows from the CSM’s area of interest. For example, pumping data are given for the year 2007 only; however, 1) the text states that other pumping data are available, and, 2) nor are there data on the time-varying outflows to springs (such data are readily available from the USGS). The many bore logs included are not evaluated with regard to establishing depth of the valley fill. Of what value to the RHBFSF CSM are these bore logs if they only provide confirmation of the well-known surface geology maps? Are there any bore logs beyond Halawa deep monitoring well (2253-03) that provide some information about the depth of saprolite or valley fill in both North and South Halawa Valleys?

2. Interpretation Should be Eliminated

The report contains interpretations of conditions at the RHBFSF rather than focusing on the data and their usability and accuracy. All interpretations should be removed from the EDSE report and placed instead in reports where such interpretation is appropriate. Examples include:

- Figure 8 shows no data beyond ground surface elevation and wells yet depicts the Navy’s interpretations of valley fill in Moanalua and Halawa valleys that are not supported by the available data and contradict the references cited (Izuka, 1992 and Wentworth, 1942). This figure should be removed because it does not show subsurface data and only depicts the Navy’s long-held interpretation that lack supporting data. Cross-section A-A’ in Izuka (1992) shows valley fill extends to only a few feet below the water table near Halawa shaft, not many tens of feet. Similarly, Figure 25 in Wentworth (1942) shows two equally valid interpretations of valley fill thickness, one with shallow valley fill (similar to the A-A’ cross-section in Izuka, 1992) and one with deep valley fill. Citing this author in defense of Figure 8 is incorrect.

- Section 3.1.1 of the EDSE report discusses the numerical model boundaries instead of discussing the Navy's assessment of whether the available data are applicable or sufficient in number or quality to support defining the area of interest. Instead, the text in this section should be revised to describe the available data and data usability.
- Much of Sections 3.1.1 and 3.1.2 discuss parameter values used in selected previous numerical models rather than actual measurements or the ranges of values used in all previous numerical models. An example is the focus in lines 2 through 18 of Page 3-2 on the Rotzoll (2012) parameter values rather than actual measurements in the area of interest or discussing the applicability of values used in other numerical models, such as Oki (2005). This is not defensible because the model in Oki (2005) is a calibrated model containing the area of interest whereas the Rotzoll (2012) is a study of deep borehole behavior and not of groundwater flow across the area of interest. Thus, the applicability of the findings and parameter values from the Oki (2005) model is likely much greater than those from Rotzoll (2012). The entire report should be revised to carefully distinguish between actual measurements and values used in numerical models and to ensure that all model parameter values are assessed equally for applicability to the RHBFSF and its vicinity.
- All text that is solely interpretation or speculation lacking in any actual data support and should be removed from the EDSE report. These include lines 31 through 43 on page 3-1, lines 8 to 16 on page 3-4, and lines 15 to 21 on page 3-6.

3. Assessment of Usability and Quality is Inadequate

Section 3 of the EDSE report contains discussion of the numerical model or unsupported interpretations that should be removed and replaced with a more complete discussion of how the Navy assessed the applicability of the data and their findings. In some cases, there is little or no assessment (such as whether any of the numerous shallow bores in stream valleys add information about sub-surface characteristics), in other cases the assessment is founded on technically resolvable issues like access to data.

Important examples of the poor usability assessment are found in the discussions of the 2015 pump test data and the 2016 synoptic water level data. The Navy cites problems with securing access to the data and the fact that one well (RHMW07) had a very small response to the pump test (Section 3.1.2); however, the pump test data are the most complete to date for the Moanalua and Halawa valleys and provide the best available picture of heads before, during, and after the pump test. Moreover, RHMW07's small to negligible response should not be a reason for ignoring the far larger pump test responses at other wells. Similarly, Section 3.1.4 appears to dismiss the water level values from the 2016 synoptic survey from being included in the flow model calibration. This is unwarranted exclusion of the best available data for recent groundwater conditions in the area of interest. The Navy should work to ensure that all site-specific

data, and especially the most recent data, are used to develop the CSM and groundwater flow numerical model for the RHBFSF and its vicinity.

4. Errors in Data or Text

Our review has identified several errors that require correction. A non-exhaustive list of examples includes:

- The locations of the borings plotted on Figure 5 need to be confirmed, e.g., RH-B01(MW-01) through RH-B06 (MW-06) and Stearns (1943) bore locations (or is the correct citation Macdonald, 1941).
- Some of the borings are misrepresented so the elevation of contacts (e.g., basalt) are inaccurate in AppA1-Geology (Excel file). For example, core was not collected from the top 190 feet (ft) at Hole 2-B (Stearns, 1943 [Macdonald, 1941]). App-A1 GEO-4 states that the depth to bedrock at Hole 2-B is ~200 feet (ft) and calculates the top of the bedrock elevation as 339.5 ft mean sea level. Since core was not collected from the top 200 ft, it is inaccurate to correlate the core collection start depth to the top of bedrock.
- The data sets contain many groundwater samples with negative oxidation-reduction potential values but have high dissolved oxygen concentrations. This is not possible, so one or both measurements are incorrect and should be validated.
- No location coordinates for wells, borings, or other features.
- No citations for hydraulic properties other than DON (2007) for valley fill in Table HYDRO-2 even though there are other important sources.
- Navy apparently considers Halawa shaft as one of the Red Hill Storage Facility pumping locations because it is included in Table Well-5.
- The average pumping rate at Red Hill shaft in Table Well-5 is much lower than and not consistent with pumping rates reported to CWRM.

5. Important Data Missing from the EDSE Report

Our review found the following (non-exhaustive) examples of important data sets that are missing from the EDSE report and should be added:

- No data on effective solubility of fuel constituents and applicability of those data to identifying observations of NAPL in or near monitoring wells.
- Head and salinity data from long-term monitoring wells in the study area such as all the Waimalu and Moanalua valley calibration data in Oki (2005) that are important for understanding the changes in groundwater levels, freshwater lens storage, and transition zone depth as well as acting as calibration targets.
- Long term records of pumping at all pumping centers in the study area.
- Long-term discharge rates from Pearl Harbor springs in the study area that are available from USGS website.
- Water supply well table (WELL-4) does not include Fort Shafter wells, numerous BWS supplies (Kalihi shaft and the Moanalua, Kaonohi, Kaamilo, Aiea, and Aiea Gulch wells), or the Honolulu International Country Club well; yet some or all of

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these appear to be include in Table WELL-6. Table WELL-6 does not include Red Hill shaft or Halawa shaft, even though it is a table of pumping locations in the groundwater numerical model area.

- In Table 2-1, please include the date ranges and locations where measurements of natural attenuation parameters (NAP) exist.
- Valley fill not included in Table HYDRO-1.

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,



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