

Project Title: Draft Deep SVE Pilot Study Work Plan
 Red Hill Bulk Fuel Storage Facility
 Joint Base Pearl Harbor-Hickam, Pearl Harbor Oahu, Hawaii
 Reviewer: USEPA and HDOH
 Date: May 15, 2024

Comment No.	Comment Type & Section No.	Comment
1	General	Reference the applicable Quality Assurance Project Plan and Sampling and Analysis Plan. Include relevant details about sampling protocols and analytical methods.
Response: In an effort to accelerate the production and submittal of the Deep SVE Pilot Study Work Plan (Work Plan), the Navy opted to forego production of a QAPP specific to this scope of work. Sampling protocols and analytical methods will be described in the revised Work Plan. This is consistent with the Shallow SVE Pilot Study Work Plan.		
2	General	Baseline sampling is first discussed in Section 7. Describe baseline sampling throughout the Work Plan. Include the collection of vapor samples to be analyzed via methods, TO-15 (including total petroleum hydrocarbon [TPH] fractions) and TO-17. Provide details on the locations, number, and frequency of analytical samples. Explain how the baseline results will be compared with the study results.
Response: The revised Work Plan will elaborate on the baseline sampling procedures.		
3	General	Describe how testing individual soil vapor extraction (SVE) wells will be sequenced to maximize use of the available soil vapor monitoring points (SVMPs) and calculation of radiuses of influence.
Response: The revised Work Plan will elaborate on the description of these activities.		
4	Section 1, page 1	<p>a. Item 1 states Phase 1 sampling will occur “on two pilot study extraction wells with pre-determined locations[,]” while two additional deep SVE wells will be installed during Phase 2 “[a]ssuming that the outcome of the first test phase is favorable...” We are concerned that limiting the evaluation to two deep SVE wells during the initial phase of the study may limit the chances for a successful pilot test. We recommend adding one additional SVE extraction well to Phase 1 of the study based on expected fuel mass location(s).</p> <p>b. The second paragraph indicates that locations for the proposed SVE wells and nested, deep soil vapor monitoring points (DSVMPs) were identified based on site characterization activities completed between November 2021 and October 2022, and may be altered based on additional characterization and field observations. Given that additional work has occurred since the Work Plan was submitted, please clarify whether new locations were selected, provide the basis for the selection(s), and update the figures and Table 3 accordingly.</p> <p>c. Provide an additional figure that estimates the potential distribution of fuel mass based on these investigation results.</p>
<p>Response: a. To have a better understanding of the subsurface, the Navy plans to proceed with the installation of the first two deep SVE wells during the first phase and the two additional deep SVE wells in the second phase. This approach will allow for more informed placement of the two deep wells in the second phase based on information gained during the first phase. The Navy is committed to installing the two additional deep wells in Phase 2. The work plan text will be revised for clarification.</p> <p>b. The additional work performed since submittal of the Work Plan has not altered the planned activities. The figures and Table 3 will be updated to reflect the current status in the revised Work Plan.</p> <p>c. The revised Work Plan will include a figure(s) showing the distribution of observed subsurface impacts, including soil vapor data from existing DSVMPs.</p>		
5	Section 3.7, Pages 4-9	<p>a. The first paragraph on page 4 notes that, “[i]nvestigation activities to determine the nature and extent of JP-5 impacts in the Adit 3 study area are ongoing.” Page 9 discusses the extent of light non-aqueous-phase liquid (LNAPL). Describe additional investigation activities that have occurred since the Work Plan was submitted and update the discussions of the extent of LNAPL to reflect current knowledge.</p> <p>b. Figure 1 on page 5, add dashed blue, green, and orange lines to the figure legend (also applies to Section 6, Figure 3, Page 15). Clarify which is the Hume Line and describe in the Section 3 text whether there is any drainage from the orange or green lines into Red Hill Shaft (RHS).</p> <p>c. While the title of this section is Conceptual Site Model, the content appears to align more with a physical description. Revise the title accordingly.</p>
<p>Response: a. The revised Work Plan will include an updated summary of investigation activities and results reported to date.</p> <p>b. The requested changes will be included in the revised Work Plan.</p>		

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c. The section title will be revised as requested to "Physical Description of Adit 3 Tunnel – Investigation Locations, Hume Line, and Discharge Lines".		
6	Table 2, Page 11	a. Add study question "What are baseline concentrations of xxx..." at the beginning of Step 2. Later, the mass removal study questions should include, "Compare concentrations over time with the baseline concentrations." b. Provide additional details of the analytical approach for achieving the study goal, "Determine design and optimal operating parameters for long-term SVE system." i. Use mass recovery rate instead of mass loading rate as the basis for evaluating system effectiveness and specify the mass recovery rate at which the U.S. Department of the Navy (Navy) will decide that the system has reached diminishing returns and whether to shut the system down.
Response: a. The study questions will be revised as requested. b. Additional details on the analytical approach will be added to the revised Work Plan. Table 2 indicates that the Navy will assess "initial petroleum hydrocarbon mass removal rate" in the initial evaluation of SVE efficacy. At this time, it is premature to specify the mass recovery rate that will be used as shut down criteria for the pilot study. If SVE is determined to be an appropriate remedy for full-scale operation during the pilot study, additional discussion and coordination with the RAs will occur, which will include shut down criteria.		
7	Section 6, Page 14	Add a step to collect baseline samples to determine pre-operational concentrations of constituents in SVMPs.
Response: Baseline sampling using field screening methods is included and discussed in Section 7.1 of the Work Plan. The collection of samples for laboratory analysis will be added to the baseline sampling and included in the revised Work Plan.		
8	Section 6.1, Page 14	The first sentence indicates that the deep SVE construction is scheduled to begin after the evaluation of the shallow SVE field activities. Please confirm whether this is still the proposed timeline.
Response: The deep SVE well installations are tentatively scheduled to begin during operation of the shallow SVE system. The text will be revised for clarity in the revised Work Plan. Any revision to the installation schedule will be communicated to the RAs weekly.		
9	Section 6.4, Page 17	The second-to-last section indicates that SVE-2 is located in a region with known perched water. Figure 2 seems to show that one of the DSVMPs is also constructed below the water table. The Hawaii Department of Health (DOH) and U.S. Environmental Protection Agency (EPA), collectively the Regulatory Agencies, acknowledge that the purpose of this placement is to compare an SVE location with known LNAPL impacts to an SVE location where LNAPL was not identified, but we question the effectiveness of SVE in an area with perched water. Add text to this section describing how close the saturated soil is to the screened intervals of the SVE wells and whether the DSVMP is placed in saturated soil. Include a figure showing the saturated zone in relation to the SVE-2 intake.
Response: The perched water occurs within a weathered A'a clinker unit found immediately below the Adit 3 tunnel floor. The weathered clinker unit and the associated perched water are generally constrained to the first ten to twelve feet below the tunnel floor based on boring logs of DSVMPs and other points installed within the Adit 3 area. Beneath this clinker unit is a series of unsaturated units, beginning with a massive A'a unit immediately below the weathered clinker. The lack of saturation in the underlying units has been repeatedly confirmed during the installation of the DSVMP's and through collection of soil gas from the DSVMPs following their construction. The screened intervals for all DSVMPs and SVEs are targeted for the unsaturated units below this shallow, saturated perched zone. The revised Work Plan will include a description of this relationship.		
10	Section 6.4.1, Page 19	a. It is stated that the hole will be reamed to 4.9 inches outer diameter to a depth of two feet from the bottom of the grout plug. It then states that a 5-inch inner diameter casing will be installed in the reamed hole. Describe how this casing will be installed into the hole. b. Given the history of contamination in and near Adit 3, sample any LNAPL that is encountered during drilling or that has accumulated on perched groundwater, and analyze it for: i. Saturated Hydrocarbons (EPA Method 8015M via GC/FID), including analysis for alkanes C9-C40, pristane, phytane, and other selected isoprenoids.

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		ii. Alkylated polycyclic aromatic hydrocarbons (PAHs) (EPA Method 8270M via GC/MS-SIM), including analysis for parent and alkyl PAHs including naphthalenes. iii. Semi-volatile organic compounds (Method SW8270 via GC/MS), including analysis for 2-(2-methoxyethoxy)-ethanol and phenol. iv. Volatile organic compounds with methylbenzenes (Method SW8260 via GC/MS), including analysis for tri- and tetra-methylbenzenes.

Response: a. The initial drilling using PQ coring tooling produces an approximately 4.9-inch diameter borehole. Where shallow perched water is identified, this perched zone will be isolated using a 5-inch diameter isolation casing before deeper drilling continues. This will be accomplished by reaming the borehole to a diameter of 6.5 inches to allow placement and grouting of the 5-inch isolation casing. Once the isolation casing is set, PQ coring (using a 4.9-inch OD bit) will continue through the 5-inch isolation casing. The text and related Figure 4 will be updated in the revised Work Plan to better clarify this procedure.

b. Any LNAPL encountered during drilling activities will be sampled, consistent with sampling previously conducted during Adit 3 site characterization activities and include saturated Hydrocarbons (EPA 8015M via GC/FID), alkylated PAHs (EPA 8270M via GC/MS-SIM), PIANO (EPA 8260 via GC/MS) to include tri and tetra-methylbenzenes, and semi-volatile organic compound testing for phenols and 2-(2-methoxyethoxy)-ethanol (EPA 8270 via GC/MS). These procedures and analytes will be articulated in the revised Work Plan.

11	Section 6.4.1.2, Page 19	Add text stating that the recordings of the down-hole images will be provided to the Regulatory Agencies in a format that can easily be viewed on a standard PC.
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Response: Downhole imagery from planned boreholes will be provided to the Regulatory Agencies (RAs) via EDMS upload, and the revised Work Plan will include text stating such.

12	Table 4, Page 21	a. Clarify whether the "AOC POC Call" is the weekly Closure Technical Working Group meeting. b. Update the Regulatory Agency point of contact information: <ul style="list-style-type: none"> i. EPA – Lynn Brockway and Matthew Cohen ii. DOH – Remove Fenix Grange and replace with Kelly Ann Lee and Gracelda Simmons
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Response: The "AOC POC Call" was, at the time of this plan's original submittal, ongoing weekly. This call is no longer scheduled. As such, the reference to "AOC POC Call" will be removed and Table 4 will be updated to reflect the current communications channels in the revised Work Plan. The points of contact will be updated to show the main contacts for each Regulatory Agency.

13	Section 6.5.1, Page 22	Add text to Scenario 3, Bullet 2 documenting that the Navy will also notify EPA.
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Response: The Scenario 3 text will be updated with "RAs" instead of "DOH" in the revised Work Plan.

14	Section 6.8.1, Page 30	a. Paragraph 1 indicates the helium tracer test will only be performed on one of the SVE wells. Consider doing a helium tracer on all SVE wells and DSVMPs to characterize the interconnectivity of geologic units laterally and vertically. b. Extend the soil vapor tracer testing to include point-to-point continuity testing and recovery evaluations, along with mass balances. Provide an explanation of the gas volumes and logistics of the proposed injection into RHS and how that feature will be sealed to prevent gas loss.
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Response: a. Monitoring more than one deep SVE well for transmittance of helium from the planned injection into RHS and the water development tunnel will be considered. However, please note that only two of the four proposed SVE wells (SVE-2 and SVE-4) closely overlie the alignment of the water development tunnel (see Figure 3 of the Work Plan). Geological interconnectivity is also evidenced by vacuum transmittance, which will be monitored and measured during the SVE Step Test and Constant Rate Test.

b. Vacuum transmittance is conclusive evidence of continuity between DSVMPs and SVE wells. A helium tracer test was proposed because we cannot assess RHS continuity using vacuum given the large volume of the RHS and associated water development tunnel. A point-to-point helium tracer study will be added to the work plan to evaluate gas flow velocity and preferential flow between DSVMPs and SVE extraction wells. The point-to-point helium tracer testing will be conducted following the step and constant rate tests. The data evaluation will be based on the tracer concentration profile in the extracted soil gas. The revised Work Plan will include a more detailed discussion of the planned gas volumes and logistics

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<p>for the proposed helium injections into RHS. Please note that implementation of a helium tracer study in the RHS is subject to internal Navy review and approvals.</p>		
15	Section 7.0, Page 30	<p>While it appears that transient biorespirometry testing will be conducted, it's unclear how the data will be used to determine the potential utility of aeration. Conduct transient biorespirometry testing to determine the rates of oxygen utilization and carbon dioxide production by soil microbes and determine the associated rates of hydrocarbon degradation using stoichiometric relationships.</p>
<p>Response: The requested testing will be performed and added to the revised Work Plan. Note that this testing will require shutdown of the SVE system during the biorespirometry testing periods, which may affect the overall schedule of the deep pilot study.</p>		
16	Section 7.1 and Table 6, Pages 30 and 31	<p>Include sample collection and laboratory analysis in the initial baseline testing.</p>
<p>Response: The collection of samples for laboratory analysis will be added to the baseline sampling and included in the revised Work Plan.</p>		
17	Section 8.0, Page 33	<p>a. Describe the partitioning characteristics of the vadose zone contamination and compare it to bench testing conducted for the shallow SVE pilot study. Estimate the phase distribution of the fuel mass in the formation to predict reductions in contaminant mass and changes in TPH composition resulting from SVE.</p> <p>b. Based on the data, assess the applicability of SVE for achieving specific remedial objectives. If the technology is deemed viable, quantify the likely outcomes and in-situ endpoints of SVE. These may include the estimated percentage of mass recovered relative to the total fuel mass in-place, time to achieve endpoints, character of the residual mass, necessary operational facets (number of wells, flow rates, treatment, etc.), and other factors related to the net benefit of applying this remedial technology in the Adit 3 area. Comment on whether the results of these evaluations can be applied to other areas of the Red Hill Bulk Fuel Storage Facility.</p> <p>c. The data should also be assessed to identify any vertical aspects of vapor flow and leakage. This can be accomplished by using data collection and evaluation methods outlined in Falta, 1996; Benson et al, 1993; and Beckett & Huntley, 1994. The associated air flow parameters should be derived from the transient vacuum propagation at each location. Vapor pressure transducers can greatly assist in the quality of these field measurements.</p>
<p>Response: a. The composition of the extracted vapor will be compared to NAPL and vapor composition data acquired during the bench-scale evaporation study to assess the degree of JP-5 volatilization that has occurred, as described in the Bench-Scale JP-5 Evaporation Study Report (DON 2024).</p> <p>b. The proposed evaluations are more relevant to a full-scale remedy and related remedial objectives rather than a pilot study. If, at the completion of the SVE pilot study the use of SVE is determined to be the appropriate remedy for the site, proposed remedial objectives and a narrative on how SVE will satisfy those remedial objectives will be presented to the RAs for discussion and concurrence. It will be premature to specify and quantify likely remedial outcomes at the end of the pilot study.</p> <p>c. The SVE pilot test data will be assessed to identify vertical aspects of flow and potential leakage from the ground surface, Adit 3 tunnel, and the water development tunnel based on vacuum distribution and data collected during the helium tracer test. The Navy will review the referenced literature and will include any modifications that will add additional value to the planned activities in the revised Work Plan.</p>		
18	Section 9, Page 35	<p>The third paragraph indicates that the proposed additional SVE well and DSVMP locations will be communicated to the Regulatory Agencies prior to installation. Add that, "DOH and EPA shall have the opportunity to comment on the additional SVE well and DSVMP locations prior to installation."</p>
<p>Response: The Navy intends to present data collected during the initial testing (Phase 1) of SVE-1 and SVE-2 to the RAs prior to moving forward with the installation of the Phase 2 SVE wells (SVE-3 and SVE-4) as scoped in this Work Plan. As stated in Section 8.1 of the Work Plan, additional SVE locations (beyond the four planned deep SVE wells in this Work Plan) will only be considered if there is no measurable vacuum response and no change in oxygen content in soil gas. At that time, the Navy will provide recommendations on future SVE well locations and SVMPs to the RAs for discussion and concurrence.</p>		

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19	Section 11, Page 36	In addition to the technical memorandum that will be submitted four weeks after the conclusion of the study, include interim reporting (e.g., a letter report after Phase 1 is completed, verbal updates during weekly meetings, field change requests, etc.).
Response: The Navy will continue to provide the RAs with updates on work progress weekly or more frequent as needed.		
20	Appendix A	This SVE Operations and Maintenance (O&M) Manual was written for Onizuka Village in 2016. Many components that were used in Onizuka Village and the site-specific parameters do not apply to the current SVE operation and maintenance at Red Hill. Please provide an updated SVE Manual for Red Hill in 2024. Use the data from the shallow SVE system to set site-specific parameters and then update the O&M manual after the deep SVE system has been in operation. Consider providing the Regulatory Agencies with the table of contents prior to resubmitting the plan so we can ensure all the required, site-specific, components are included.
Response: The Navy will provide an updated SVE Manual to the RAs under separate cover as an informational document.		
21	Appendix D	a. Table D.2-1 – Include TPH–gasoline range for soil gas and Per- and Polyfluorinated Substances for groundwater. Add LNAPL sampling, should it be encountered. b. Table D.2-2 – Update with current Environmental Action Levels and Regional Screening Levels.
Response: a. Gasoline range will be added to the TPH analysis for soil gas and LNAPL sampling will be added to Table D.2.1.		
Regarding the request to analyze soil gas for Per- and Polyfluorinated Substances (PFAS), the work described in the Work Plan is being conducted in accordance with the federal Resource Conservation and Recovery Act (RCRA) and the State of Hawai'i Department of Health (DOH) Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan (DOH 2023) in order to address the JP-5 petroleum release in November 2021. This pilot study is not being conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as it falls within CERCLA's petroleum exclusion.		
Pursuant to the letter from VADM Wade, samples can be collected and held for PFAS analysis. However, based on the CERCLA designation and DoD requirements for PFAS investigations (as stated above), the samples will not be analyzed under this Work Plan. If the Regulatory Agencies would like to analyze the held soil gas samples for PFAS, the Navy respectfully requests that information regarding transportation to their selected laboratory is provided.		
b. Table D.2-2 will be updated and included in the revised Work Plan.		