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In reply, please refer to:
File:
210969 AH

August 12, 2024

Ms. Jocelyn Tamashiro
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Environmental Restoration, Department of the Navy
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400 Marshall Road, Building X-11
Pearl Harbor, Hawaii 96860
Sent via e-mail to: jocelyn.tamashiro.civ@us.navy.mil

Facility/Site: Red Hill Bulk Fuel Storage Facility

Subject: Review of Draft Remedial Investigation Work Plan, Per- and Polyfluoroalkyl Substances Release, Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, Oahu, HI, Pearl Harbor HI FISC Site 30; dated June 2024

Dear Ms. Tamashiro:

The Hawaii Department of Health (HDOH) Hazard Evaluation and Emergency Response (HEER) Office has reviewed the above-referenced document for the Red Hill Bulk Fuel Storage Facility (RHBFSF) site and has the following comments:

General Comments:

1. Throughout the work plan where there are discussions of previous sampling data, concentrations of PFAS compounds are not consistently compared to HDOH Tier 1 (unrestricted) Environmental Action Levels (EALs). Concentrations of PFAS compounds from soil confirmation samples, routine groundwater monitoring, and the September 2023 Baseline Sampling Event had exceedances of HDOH Tier 1 EALs. Thus, please revise the document to ensure consistency in comparison of concentrations of PFAS compounds from past sampling events to current HDOH Tier 1 EALs. Please also note in the text that where "grab" or "discrete" soil sampling methods were conducted rather than Decision Unit Multi-Increment Sampling (DU-MIS) methods required by HDOH, the data may be considered in determining presence of chemicals of potential concern (COPCs), but the data may not be used for final decision-making.

2. HDOH is of the understanding that a formal Preliminary Assessment (PA) and Site Inspection (SI) for PFAS have not occurred at the RHBFSF, and the Navy instead intends to proceed immediately to the Remedial Investigation (RI) phase. This report begins by stating that the intent of the RI is solely to investigate for PFAS associated with known and potential undocumented

AFFF releases at the site. HDOH requests, however, that locations that stored and/or transferred AFFF be included as potential sources, and facilities known to be associated with PFAS contamination, such as wastewater treatment facilities, landfills, plating operations, etc. be included as potential sources as well. Two additional potential sources of PFAS within the RHBFSF that should be investigated include the Oily Waste Disposal Facility (OWDF) site and the Collection, Holding, and Transfer (CHT) Tank. In lieu of a formal PA, the Navy should, at a minimum, conduct a historical review to identify any additional potential PFAS sources within the RHBFSF and include those sites in for further evaluation in the RI.

Groundwater Monitoring

3. HDOH requests that initial sampling of groundwater adhere to the minimum requirements, as agreed upon by the Navy, the EPA, and HDOH during meetings that occurred on July 3, 9, 12, and 17, 2024. Revise all areas of the report detailing groundwater sampling activities to reflect the following requirements:

    a. Wells to be sampled include RHMW-2254, RHP01, RHP02, RHP03, RHP-06, RHP-07, RHP-08, RHMW-06, RHMW-17, RHMW-17S, RHMW-17D, RHP04A, RHP04B, RHP04C, RHP-05, OWDPMW01, RHMW-18, RHMW-20, RHMW-07, RHMW-08, RHMW-21, RHMW-04, RHP-08B, RHP-08C, RHMW01R, RHMW-02, RHMW-03, RHMW-05, OWDFMW03A, OWDFMW03B, OWDFMW08A, and OWDFMW08B.

    b. Sampling of the above groundwater monitoring wells will begin in September and will occur quarterly for at least one year, after which wells to be sampled, and frequency and duration of sampling will be re-evaluated by the Navy, the EPA, and HDOH.

    c. Laboratory analysis of samples obtained from the above groundwater monitoring wells will be EPA method 1633 for 40 PFAS compounds.

4. In addition to analysis via EPA method 1633, HDOH requests that soil and groundwater samples are processed and analyzed for Total Oxidizable Precursors (TOPs) and Total Organic Fluorine (TOF) to calculate a cumulative Hazard Index for PFAS and determine Total PFAS Risk per HDOH HEER Office's updated *Interim Soil and Water Environmental Action Levels (EALs) for Perfluoroalkyl and Polyfluoroalkyl Substances (PFASs)* (2024 HDOH PFAS Guidance) (HDOH, 2024): https://health.hawaii.gov/heer/files/2024/07/PFASEALGuidanceHIDOHApril2024Rev070524.pdf. Further, please require that the laboratory take an MI subsample size of 10 grams for soil analysis. Revise all areas of the work plan that discuss laboratory analysis of soil, sediment, and groundwater samples to include TOPs and TOF analysis in addition to EPA method 1633, and a laboratory subsample size of 10 grams.

5. During the aforementioned meetings, the EPA also requested sampling of groundwater monitoring wells NMW-32, NMW-30, and NMW-12A. The request was made to evaluate PFAS concentrations and provide delineation in the area near Adit 3, and provide delineation of concentrations potentially downgradient of Adit 6 due to concentrations of PFAS exceeding the EPA's maximum contaminant levels (MCLs) during the Navy's September 2023 Baseline Sampling Event. HDOH concurs with EPA's requests and rationale, and notes that concentrations of PFAS also exceeded HDOH Tier 1 (unrestricted) EALs and generated a Total PFAS Risk Hazard Index of >1 during this event. Thus, HDOH also requests that NMW-32, NMW-30, and NMW-12A be included in initial groundwater sampling.

6. Please reconfirm that groundwater monitoring well RHMW2254-01 will be sampled bi-monthly in order to monitor the source water at the Red Hill Shaft as previously confirmed by the Navy in a letter to EPA and HDOH dated June 21, 2024.

Soil Sampling and Analysis

7. HDOH does not accept discrete, or grab, soil sampling as a representative method of sampling that can be used for final decision-making because grab soil sampling has been demonstrated to be unreliable. Thus, HDOH requires that DU-MIS collection of soil samples be conducted in accordance with HDOH guidance. HDOH guidance on DU-MIS can be found in our HDOH HEER Office *Technical Guidance Manual* (TGM) (HDOH, 2008 Interim Final last updated 2024): https://health.hawaii.gov/heer/tgm/. Enclosed is HDOH letter 177334 MR, dated October 28, 2020, which discusses HDOH's position on DU-MIS sampling of soil versus grab soil sampling and the use of HDOH guidance.

Specific Comments:

8. Worksheet #5 (PDF pg. 29): Please revise to depict lines of communication between HDOH and the Navy in an equal position as EPA and delete the "line of authority" from EPA to HDOH. Please also delete the line of communication between HDOH and the Navy's contractor. HDOH should be able to deal directly with the Navy when necessary.

9. Worksheet #8 (PDF pg. 35): Please revise to include the 2024 HDOH PFAS Guidance as guidance that will be used during soil and groundwater sampling and analysis.

10. Worksheet #10, Table 10-1 (PDF pg. 50): For all future reports, all concentrations of PFAS compounds should be compared to EPA MCLs and HDOH Tier 1 (unrestricted) EALs in addition to EPA RSLs. Further, all future reports should include Pre-TOPs, Post-TOPs, and Excess Fluorine hazard indices with a final Total PFAS Risk Hazard Index per sample.

11. Worksheet #10, Section 10.2.8.3 (PDF pg. 51) only includes groundwater monitoring wells RHP01, RHP02, RHP03, RHP06, and RHP07 as wells with concentrations of 6:2 FTS as non-detect with PFOS exceeding screening criteria, leaving out NMW32. Does the omission of NMW32 imply that concentrations of PFAS compounds in this well could be related to the AFFF concentrate release of November 2022 and/or a release of modern formulations of AFFF?

12. Table 10-2 (PDF pg. 52): Revise the table to include concentrations of PFAS obtained during the September 2023 Baseline PFAS Sampling Event.

13. Worksheet #10, Section 10.2.8.4 (PDF pg. 53): Please state that HDOH rescinded the No Further Action status of the Oily Waste Disposal Facility (OWDF) on April 8, 2024, due to information provided via power point presentation during a Navy briefing to HDOH and EPA in February 2024, lessons learned from the November 2021 petroleum release from the RHBFSF, and the requirement for institutional controls documented in an environmental hazard management plan.

14. Worksheet #10, Section 10.4.1 (PDF pg. 55): This section states that the former slop tank was in use from approximately 1963 to the mid to late 1960s. Please revise to reflect the date at which use of the slop tank actually ceased.

15. Worksheet #10, Section 10.4.3 (PDF pg. 58): What is the basis for the conclusion that there are not any ecological receptors associated with Halawa Stream? Include more details on the conclusions gathered from the referenced report, *Red Hill Bulk Fuel Storage Facility Final Technical Report, Pearl Harbor, Hawaii* (DON, 2007).

16. Worksheet #11, Section 11.3 (PDF pg. 60): Project screening levels (PSLs) must include HDOH Tier 1 (unrestricted) EALs and Total PFAS Risk per the 2024 HDOH PFAS Guidance. Revise all sections of the document referring to PSLs to include Total PFAS Risk.

17. Worksheet #11, Section 11.3 (PDF pg. 60): Revise to include PFAS analytical results from the September 2023 Baseline PFAS Sampling Event as a primary decision input.

18. Worksheet #11, Section 11.3 (PDF pg. 60): Revise to include an environmental hazard evaluation per the HDOH HEER Office TGM in addition to a human health risk assessment and ecological risk assessment to be developed from soil, sediment, and groundwater analytical results.

19. Worksheet #11, Section 11.4 (PDF pg. 61): Revise Area B to include the OWDF site and the CHT tank.

20. Worksheet #11, Section 11.6.2 (PDF pg. 62): Include the HDOH HEER Office TGM and HDOH PFAS Guidance to the list of methodologies which will minimize decision errors.

21. Worksheet #12 (PDF pg. 65): Revise collection frequency of equipment rinsate blanks to one per sampling team per day in addition to per matrix.

22. Worksheet #12 (PDF pg. 65) lists relative percent differences (RPDs) of ≤50% for water and ≤100% for soil and sediment under measurement performance criteria, with Section 10.6.1.2 of the HDOH HEER Office TGM as a source for those criteria, which is an incorrect reference. Section 10.6.1 of the HDOH HEER Office TGM discusses field replicates, or duplicates, which states that a field replicate precision of approximately 10-35% is generally established as a data quality objective (DQO) for discrete, or grab, sampling. For DU-MIS methodology, a relative standard deviation (RSD) of <35% is the recommended DQO. Thus, the proposed RPDs must be revised to reflect a maximum RPD of 35% for water, and for soil and sediment, two sets of DU-MIS replicates must be collected to establish an RSD of <35%.

23. Worksheet #13 (PDF pg. 67): A Data Source and Data Generator for the Release Report section cites a document from the HDOH "Hansen's Disease Branch." Please revise to HDOH "HEER Office."

24. Worksheet #14, Section 14.4 (PDF pg. 71): HDOH does not allow for final decision making to be based on discrete, or grab, soil sampling methodology as grab sampling has been demonstrated to be unreliable. HDOH instead requires that soil samples be collected via DU-MIS methodology in accordance with the HDOH HEER Office TGM. Revise all sections discussing soil and sediment sampling to the requirements in Comments 24a and 24b below.

    a. Area A: All soil samples must be obtained via DU-MIS methodology. Source DUs should include the Former AFFF 200 Gallon tank area and slope to the below pavement, the drainage swale, and surge rock/drainage area at the end of the drainage swale. The remainder of the grassy areas within Area A should be perimeter DUs (area west of Building 313, south of Building 313, east of the Former 200-gallon tank with slope DU, and the grassy areas south of the excavated areas alongside the road). The depths of the

surface DUs should be 0-6 inches, and a second vertical DU should be under the surface DUs from 6-12 inches. All locations of borings as proposed within this report for the purpose of determining the vertical extent of residual contamination are acceptable to HDOH. However, these borings should be treated as exploratory borings per the HDOH HEER Office TGM which designate DU intervals along the soil core which are then sampled via MIS methodology. HDOH requires a minimum of 50 increments collected per MI sample, and DU size must not exceed 5,000 sq. ft. (or 100 cubic yards in volume).

b. Area B: All soil samples should be obtained via DU-MIS methodology. All locations of borings as proposed within this report are acceptable to HDOH. However, these borings must be treated as exploratory borings per the HDOH HEER Office TGM which designate DU intervals along the soil core which are then sampled via MIS methodology. Further, each proposed boring location can serve as the center of a surface soil DU, and a separate DU for the CHT tank is required. HDOH requires a minimum of 50 increments collected per MI sample, and DU size must not exceed 5,000 sq. ft. (or 100 cubic yards).

25. Worksheet #14, Section 14.5 (PDF pg. 71): HDOH suggests that the groundwater monitoring wells to be installed into the perched aquifer be 2 inches in size, or large enough to be able to install transducers and/or bail groundwater for sampling purposes, versus a 4 inch well as suggested by HDOH and the Department of Land and Natural Resources for installation of RHMW17 and 17S/17D.

26. Worksheet #14, Section 14.5.2 (PDF pg. 73): Provide dates of logging to HDOH at least 2 weeks prior to allow for attendance at drilling, logging, installation, etc. activities regardless of any scenarios. Please arrange military escorts and/or NAVFAC representatives during such visits.

27. Worksheet #14, Section 14.5.5 (PDF pg. 76): In addition to an elevated PID reading, any olfactory and/or visual indications of free product or gross contamination should be included in the rationales for determining depth to set conductor casing.

28. Worksheet #14, Section 14.5.5 (PDF pg. 76): Please clarify that a conductor casing will be required for all contaminated perched groundwater at any depth where significant inflow to the borehole cannot be prevented by grouting.

29. Worksheet #14, Section 14.5.5 (PDF pg. 76): Revise to reflect one of the following methods of grouting, and ensure all details are included: 1) Ensure that the driller will grout the annular space all around the maximum dimension of the conductor casing with cement-bentonite grout, either by pressure grouting through the conductor casing using a steel tremie pipe placed through a packer assembly, or by pumping through a steel tremie pipe placed on the outside of the conductor casing, or 2) If tremie grouting is conducted, it will be performed in a two-step process; first, the base of the conductor casing will be grouted in place with a 3- to 5-ft-thick cement-bentonite grout plug, then the grout plug will be left undisturbed for a minimum of 24 hours for curing before emplacing grout above the plug to the surface with a steel tremie pipe. Placing the grout in the annular space may be done in stages or lifts with time allowed for the grout to set so as to prevent distortion or collapse of the casing by heat and/or pressure. Following the grouting procedure, the grout will be left undisturbed for a minimum of 24 hours curing.

30. Worksheet #14, Sections 14.6.1.1, 14.6.1.2, and 14.6.1.3 (PDF pgs. 79-80): Provide the rationale behind choosing the flow rate and determining the criteria for the conductor casing. Also, how will inflow and outflow be measured?

31. Worksheet #14, Section 14.6.1.4 (PDF pg. 80): If contaminated soil is encountered, samples must be collected and analyzed for petroleum constituents and PFAS compounds per the HDOH HEER Office TGM and the 2024 HDOH PFAS Guidance. Ensure that the following are also included for analysis: 2-2-methoxyethoxyethanol (EPA method 8270), 2-2-butoxyethoxyethanol (EPA method SW8015C), High resolution GC/FID fingerprint with n-alkanes and isoprenoids (EPA method 8015M), and SVOCs (EPA Method 8270E). In addition to SVOC priority pollutant data, ensure non-target analysis is performed (surfactants, polars, etc.).

32. Worksheet #15 (PDF pg. 89): HDOH does not agree in that analytes without currently available screening values will not be further evaluated. Revise to state that all PFAS compounds, plus TOPs and TOF should be analyzed during all future events to continue gathering data for future use.

33. Worksheet #15 (PDF pg. 89): The 1994 FFA states that state standards must be taken into account at the RI phase and should be addressed as early as possible within the CERCLA process. HDOH does not accept state standards beginning with the feasibility study phase as adequate data would not have been gathered in order to determine potential alternatives. Thus, revise to state that state standards will be used during this RI phase.

34. Worksheet #16 (PDF pg. 97): Revise to include submittal of a Draft Final RI workplan for HDOH and EPA review before proceeding to the Final version of the document. Further, ensure a regulatory review period of 60 days is granted to both EPA and HDOH.

35. Worksheet #16 (PDF pg. 97): HDOH requests that laboratory reports be submitted to both EPA and HDOH as soon as they are received. Further, ensure that raw data from laboratory analysis of samples is included (i.e. EDD files, chromatograms in ASCII files and text files, etc.).

36. Worksheet #21 (PDF pg. 115): Revise to include both the HDOH PFAS Guidance and HDOH HEER Office TGM as sampling references.

37. Worksheet #23 (PDF pg. 119): Revise to include TOPs and TOF as methods for analysis of samples. Further, provide information for the laboratory (name, address, and point of contact) that will be used to analyze obtained samples.

38. Figure 7 (PDF pg. 165): Include On-Site Construction Workers as potential human receptors for Area B.

39. Figure 8 (PDF pg. 167): What was the standard or guidance used to make the “Insignificant” determination for multiple pathways of the conceptual site model? HDOH considers a pathway as Incomplete, Potentially Complete, or Complete, thus revise all “Insignificant” determinations to “Potentially Complete” until data collected through the RI can provide information as to a more appropriate determination.

If you have any questions or should you need a hardcopy of this letter, please feel free to contact me at 808-586-4249 or by email at allison.hutto@doh.hawaii.gov.

Sincerely,

Allison Hutto

Allison Hutto
Remedial Project Manager
Hazard Evaluation and Emergency Response Office
Hawaii Department of Health

cc: Mr. Chris Lichens, EPA, via email.

Enclosure: HDOH Comment Letter 177334 MR (with attachments)

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In reply, please refer to:
File:
177334 MR

October 28, 2020

Jan Kotoshirodo
Remedial Project Manager
Environmental Restoration
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Hawaii 400 Marshall Road, Building x-11
Pearl Harbor, HI 96860

Subject: Response to Navy email dated September 9, 2020 regarding the use of discrete sample data for PFAS investigations

Dear Ms. Kotoshirodo:

This letter is in response to your email dated September 9, 2020, requesting clarification of the Hawai′i Department of Health (HDOH), Hazard Evaluation and Emergency Response (HEER) Office acceptance of discrete data as part of a Preliminary Assessment (PA) or Site Investigation (SI) for PFAS, to be carried out by the Navy. In summary, HDOH does not accept the use of discrete sample data for final decision-making as part of an environmental investigation, including under the following circumstances:

1) Establishing the presence or absence of a contaminant above levels of potential concern,
2) Characterizing the extent and magnitude of contamination, or
3) Estimating a mean, contaminant concentration for a targeted exposure area as part of a risk assessment.

The general basis of this position is summarized below. A more in-depth discussion of this issue is provided in the attached letter to the US Environmental Protection Agency dated August 19, 2019 (Attachment 1). Your email was specific to the investigation of soil and sediment contaminated with perfluoroalkyl substances (PFASs). The general unreliability and unacceptability of discrete sample data apply to all contaminants, however, as does the following discussion.

As used in the environmental industry, a “discrete sample” is a small amount of soil or sediment, typically 100 to 300 grams, collected from a single point with an area targeted for investigation. The sample is submitted to a laboratory for analysis, where an attempt to “homogenize” the material might or might not be undertaken. A small subsample of the material, typically one to ten grams, is then collected from a single location and analyzed for targeted contaminants of concern. The resulting data are used to approximate the lateral and vertical extent of contamination above levels of potential concern

and/or used to estimate the mean concentration of the contaminant within a designated, exposure area for assessment of risk.

Although widely used as an integral part of environmental investigations since the 1980s, the consistent reliability of discrete sample data for either site characterization or risk assessment purposes have never been demonstrated in the field. Quite the opposite, as cautioned by field workers as early as the late 1980s and as demonstrated in field research more recently carried out by our office; discrete sample data can be highly unreliable for both aspects of a site investigation (Brewer et al, 2017a,b). This is due to multiple factors, including:

- Inherent, random variability of contaminant concentrations (i.e., contaminant distribution) in soil and sediment between closely located, discrete points,

- Similar random (and unresolvable) variability of contaminant concentration within individual, discrete masses of soil and sediment submitted to a laboratory for analysis, and

- Inadequate number of sample collection points and total sample mass for estimation of a mean contaminant concentration for a targeted area and volume of material.

The implications of these deceptively simple observations are significant – data provided by the laboratory cannot be reliably considered to be representative of the sample provided and the sample provided cannot reliably be assumed to be representative of the immediate area where it was collected. Site characterization errors, reflected in the need for multiple remobilizations with no clear end point and the unexpected discovery of additional contamination outside of areas initially targeted for remediation, are directly tied to these unavoidable attributes of contaminants in soil and sediment. Such errors in sample collection routinely result in significant increases in the time and cost to complete a site investigation, failed remedial actions and, in some cases, considerable overestimation or underestimation of risk and uncertainty in the appropriateness of final decisions.

The science is very clear as fortunately is the solution. Consistently reliable data for particulate media such as soil or sediment are obtained by following a three-step process:

1) Designation of site-specific, risk-based or remediation-based areas and volumes of soil for testing, referred to as "Decision Units (DUs);"

2) Preparation of a single, representative sample for each DU by combining a minimum of 1 to 2 kilograms soil or sediment from a large number of points (default 50) within each DU, referred to in HDOH guidance as a "Multi Increment" sample (MIS); and

3) Proper processing the sample at the laboratory (e.g., air drying and sieving to target particle size) to ensure that a representative subsample that meets minimum mass requirements (e.g., 10g) is collected and tested. The basis and implementation of such "DU-MIS" investigation approaches is discussed in Section 3, 4 and 5 of the HDOH *Technical Guidance Manual* (TGM; HDOH 2016). Links to in-depth, recorded, DU-MIS training webinars on are posted to the HEER Office webpage.

HEER Office staff began raising concerns with the Navy (and USEPA) about reliance on discrete sample data for final decision making as early as 2005. We documented our initial concerns regarding

site characterization in a letter to NAVFAC Hawai′i in 2011 (included as an attachment to Attachment 1; USEPA Region 9 cc'd). HEER Office staff began to raise concerns regarding the reliability of discrete sample data for use in risk assessments soon afterwards. Our field study of discrete sample data variability and reliability documented that the mean contaminant concentration estimated for a targeted area could vary dramatically between independent, replicate sets of data (refer to Brewer et al. 2017a, b). This highlighted unseen but potentially significant error in risk assessments that relied on a single set of discrete sample data for final decision-making. We highlighted this concern in a follow-up letter to risk assessors with USEPA Region 9 who assist in NAVFAC-Hawai′i projects dated August 19, 2019 (see Attachment 1; NAVFAC-Hawai′i cc'd). These issues, and an introduction to DU-MIS investigation methods, are summarized in a Fact Sheet published by our office in March 2020 (Attachment 2).

The HDOH Solid and Hazardous Waste Branch (SHWB) informally required the use of DU-MIS data at sites overseen by that office since the publication of initial HEER Office guidance in 2009 and formally adopted a requirement for the use of DU-MIS data in final decision-making in a technical memorandum dated September 23, 2019 (Attachment 3). The HDOH Clean Water Branch (CWB), working in conjunction with the SHWB requires the collection and use of DU-MIS data for all dredged material that is proposed for reuse in upland areas. The CWB also requires the collection of Multi Increment type samples for monitoring of turbidity in surface water during dredging projects (HDOH 2015a, b). The collection of DU-MIS data is also required for disposal of soil by several landfill operators in Hawai′i and is being formally incorporated into landfill permits as those permits come up for renewal.

In conclusion, it has been the position of the HEER Office and HDOH in general for some time that, while discrete sample data can be useful for initial, gross characterization of contaminated soil and sediment and initial assessment of risk (discussed in Section 4 of the HEER TGM), DU-MIS data are required for final decision-making. HDOH guidance allows the use of discrete sample data for initial site characterization and risk assessment purposes, but final decisions should be based on DU-MIS data collected in accordance with the HEER Office TGM. While possible in theory, proposals to rely on discrete sample data for final decisions by a Navy project manager must address the concerns raised above. Note that HDOH has historically not required retesting of sites where discrete sample data were used for final decision-making purposes, although this might be prudent for a small subset of sensitive cases where data variability is suspected to be especially high.

We would welcome the opportunity to discuss the continued use and reliability of discrete soil and sediment sample data and the need for DU-MIS data for confirmation purposes with Navy staff and mutually develop ways to move forward. Please let us know if you would like to schedule a call to discuss this further. You may contact me at maria.reyes@doh.hawaii.gov and Dr. Roger Brewer at roger.brewer@doh.hawaii.gov. Thank you very much for your time and consideration in this matter.

Sincerely,

Ma. Eloisa Q. Reyes

Maria Eloisa Q. Reyes, Ph.D.
Remedial Project Manager
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Attachments:

1. HDOH letter to USEPA Region 9: Update to 2011 HDOH Memo Regarding Representative Sample Data, dated August 19, 2019
2. HDOH DU-MIS Fact Sheet, April 2020
3. HDOH Solid Hazardous Waste Branch memorandum requiring use of HEER Office *Technical Guidance Manual* for SHWB projects, September 23, 2019

References:

Brewer, R., Peard, J., and Heskett, M. 2017a. A critical review of discrete soil sample reliability: Part 1 – Field study results. *Soil and Sediment Contamination*. Vol 26, No 1. Available from: http://dx.doi.org/10.1080/15320383.2017.1244171

Brewer, R., Peard, J., and Heskett, M. 2017b. A critical review of discrete soil sample reliability: Part 2 – Implications. *Soil and Sediment Contamination*. Vol 26, No 1. Available from: http://dx.doi.org/10.1080/15320383.2017.1244172

HDOH, 2015a, Applicable Monitoring and Assessment Plan Guidelines: Hawai‘i Department of Health, Clean Water Branch, August 14, 2015, Version 1.

HDOH. 2015b, Applicable Monitoring and Assessment Plan - Helpful Hints and Supporting Information: Hawai‘i Department of Health, Clean Water Branch.

HDOH, 2016, *Technical Guidance Manual*: Hawai‘i Department of Health, Office of Hazard Evaluation and Emergency Response, http://www.hawaiidoh.org/

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In reply, please refer to:
File: 2019-387 RB

August 19, 2019

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Subject: Update to 2011 HDOH Memo Regarding Representative Sample Data

Dear Dr Stralka and Dr Black,

This letter addresses questions you raised in a meeting with staff from the Hawaii Department of Health (HDOH), Hazard Evaluation and Emergency Response (HEER) Office earlier this year regarding the acceptance of discrete soil and sediment sample data at contaminated sites in Hawaii. I was unfortunately unable to attend that meeting.

You asked if HDOH accepts discrete soil and sediment sample data for final decision making as part of a human health or ecological risk assessment. A detailed discussion of this issue is provided in Attachment 1. The short answer is "Yes." This is caveated, however, with a condition that individual, discrete samples be collected, processed and tested in accordance with Gy's sampling theory. The total mass and number of samples collected must also meet sampling theory requirements for "infinite particle" media such as soil and sediment. This typically requires the collection and testing of 1-2 kilograms of soil from at least 50 points within a targeted area. Independent, replicate sets of discrete sample data (minimum two) must be collected and tested to demonstrate total sampling precision and the reproducibility of an estimated exposure point (area) concentration. I am unaware of any discrete sample data project in Hawaii that fully meets these conditions.

We left this question open in a June 27, 2011, HDOH technical memorandum that I prepared following a meeting between our staff earlier that year (Attachment 2). In that meeting, we discussed and I think in general agreed on the high potential for error in determining the extent of contamination based on testing of small, individual masses of soil and sediment from "discrete" points. This is due to the inherent, heterogenous nature of contaminants in soil and sediment and the randomness of the concentration reported for a sample collected at a single point. We demonstrated the range of possible error in the use of discrete sample data to estimate

the extent of contamination in a field study of that we carried out in 2014 (see Attachment 1). The results were alarming but not necessarily surprising, given the common recognized disparity between "co-located" discrete samples collected as part of a site investigation.

The potential for significant error associated with estimation of an exposure point concentration based on a single set of discrete sample data was less well understood, since replicate sets of samples are rarely if ever collected to test data reproducibility. Our 2014 field study demonstrated, however, that the error can indeed be very large and that 95% UCLs based on replicate sets of discrete sample data collected from the same exposure area can vary significantly. This occurs in part because the mass of soil tested and/or the number of points considered in the sample data are inadequate to represent the targeted area and volume of soil.

These types of potential errors in the use of discrete sample data to characterize sites and assess risk motivated our office to begin transitioning to the use of "Decision Unit" and "Multi Increment Sample" investigation methods in 2004 and fully implement the use of "DU-MIS" methods in 2009. The science is very clear - DU-MIS sampling methods are far more reliable and efficient for final decision making than discrete sampling methods. This includes both initial site characterization and assessment of risk. The only question in the case of the latter is whether the degree of hidden error inherent in discrete sample data is tolerable in comparison to safety margins built into toxicity factors and estimates of exposure. This would be a useful topic to explore and discuss in more detail for both soil and sediment investigations.

We would be glad to discuss these issues with you and your group in more detail. Please feel free to contact me at your convenience. Perhaps we could begin by reviewing examples of projects where you feel that discrete sample data were adequate for final decision making to initiate discussions? I would be glad to set up a meeting at our office during your next visit to Hawaii. Please contact me at your convenience (roger.brewer@doh.hawaii.gov).

Sincerely,

Roger C. Brewer, PhD
Senior Environmental Scientist

Cc: Keith Kawaoka, Fenix Grange, Maria Reyes (HDOH); Angeles Herrera, John Chesnutt (USEPA 9), Aaron Poentis, Jan Kotoshirodo, Janice Fukumoto (Navy)

Attachment 1: Discrete Sample Data Reliability (August 19, 2019)

Attachment 2: Multi-Increment versus Discrete Soil Samples (HDOH June 27, 2011)

Attachment 1

Discrete Sample Data Reliability

(HDOH August 19, 2019)

Discrete Sample Data Reliability for Use in Site Characterization and Risk Assessment

2011 Technical Memorandum

In the 2011 meeting between USEPA and HDOH staff documented in the 2011 memorandum (Attachment 2), we discussed concerns regarding the reliability of discrete sample data to estimate the lateral and vertical extent of contamination above potential levels of concern as well as the use of the data in human health and ecological risk assessments.

There was general agreement on the potential for error in the use of discrete sample data for general, site characterization purposes. We tentatively concurred with the continued use of discrete sample data to estimate mean, exposure area concentrations in risk assessments pending further research but we questioned the adequacy of small numbers of samples, for example eight or ten, purported in USEPA guidance to be adequate to represent large areas of contaminated soil.

Post-2011 Research and Experience

Our office carried out a detailed field study of discrete sample data variability in soil in 2015 (HDOH 2015; Brewer et al. 2017a,b). The results of that study as well as with additional experience at sites in Hawaii and discussions with international sampling experts are clear – Data provided by laboratories for a discrete soil sample are not reliably representative of the sample provided, and the sample provided is not reliably representative of the immediate area where it was collected. The only question is the degree of potential error in the data and in final, decision making.

Site Characterization

Our field study suggested that the concentration of a contaminant in soil can randomly vary around a single point by a factor of two under relatively ideal circumstances (e.g., arsenic-contaminated wastewater released to fine-grained soils) and as much as several orders of magnitude under scenarios where tiny "nuggets" of the contaminant are present in the soil (e.g., nuggets of PCB-infused tar from waste dielectric oils). The inherent randomness of discrete sample data is predicted in sampling theory for "infinite particulate media" such as soil and sediment and has been known by the mining and agriculture industries for decades. This phenomenon has only been recently "discovered" by the environmental industry, however. This is in large part due to the fact that the repercussions of erroneous data – failed mining ventures and failed crops in the former, are less obvious in assessments of chronic health risk.

Even so, the unreliability of discrete sample data in environmental work is well known to field workers, where completion of a site investigation can take years only for later data to indicate that the extent and mass of contamination present was much greater than initially thought. This has obvious implications on the continued acceptance of discrete sample data by regulatory agencies to assess the final adequacy of remedial actions.

Risk Assessment

The HDOH field study documented similar concerns with the use of a single set of discrete sample data to estimate the true mean for a targeted exposure area of contaminated soil and

subsequent assessment of risk. In one case (Study Site A – Arsenic), the 95% UCL estimated for random sets of 10, discrete samples collected from the area was consistently *higher* than the more reliable mean estimated by triplicate Multi Increment samples collected from the same area. While this might be used to support a conclusion that a 95% UCL based on discrete sample data is "conservative," it has obvious, negative implications for people concerned about potential impacts to their health as well as for parties required to remediate properties that in reality do not pose a significant risk to human health or the environment.

In the second case (Study Site B – Lead), the 95% UCL predicted from random sets of 10, discrete samples collected from the area fell both below and above the "true" mean concentration of lead in the soil based on DU-MIS data. This highlights the fact that a 95% UCL calculated from a single set of discrete samples is, like data for single points, *random within a largely unknown range of possibilities.*

The randomness and unreliability of 95% UCLs based on discrete sample data was particularly highlighted at the third study site (Study Site C – PCBs), where 95% UCLs based on random, 10-sample data sets varied from as low as 4 mg/kg to over 1,000,000 mg/kg. Such error in the estimation of the mean contaminant concentration for a targeted exposure area could only be reliably identified by the collection and comparison of independent, replicate sets of discrete sample data.

Collection of Representative Sample Data

As I discussed in a February 2019 webinar and again in July 2019 (links posted to the HEER Office webinar webpage), risk assessors "almost got it right" in the 1990s. Risk is of course based on the "mean" or "true" concentration of a contaminant within a designated, exposure area, rather than concentrations reported for individual, small masses of soil within the targeted area. These are referred to as "Exposure Area Decision Units" in Section 3 and Section 4 of the HDOH TGM.

The true mean can only be determined by testing of the entire volume of soil in the exposure area. This is of course not feasible. The mean is instead estimated by collecting and testing soil from a number of points within the exposure area. On this point we still agree.

The objective from an analytical standpoint is to estimate the concentration of the targeted contaminant in the total mass of soil collected. Data for individual points have no meaning in terms of assessing risk. The individual points do not reflect the mean for the exposure area, nor does the mass tested by the laboratory, typically one or ten grams, reflect the default mass of soil assumed to be ingested by young children (200 mg/day) or adults (100 mg/day). The concentration of a contaminant reported by a laboratory will vary with respect to the mass of the soil subsample specifically tested by the laboratory. The range of contaminant concentrations reported therefore also has no meaning in terms of risk.

The use of statistical tests to estimate the mean concentration of a contaminant based on a single set of discrete sample data could in theory provide an acceptably accurate answer, with the limitations noted above. The number of points included and the total mass of soil represented by

the data would also need to meet minimum requirements under sampling theory for testing of "infinite particle media." This is discussed in Section 4 of the HEER TGM.

It makes far more sense and allows for far better data precision to simply combine the individual masses of soil collected within a targeted exposure into a single sample, have the laboratory properly process the sample, collect a representative subsample for analysis and report a single concentration. This is the essence of "Decision Unit" and "Multi Increment Sample" investigation methods, which could be more properly described as "Risk Based Site Characterization." Sampling theory and decades of research by field workers and statisticians in the mining and agriculture industries tells us that for typical, environmental investigations, a sample must be collected from a minimum of 50 points or "increments" (to address distributional heterogeneity) and have a minimum mass of 1-2 kilograms (to address compositional heterogeneity). The total precision of the resulting data is assessed through the collection and testing of independent, replicate samples, as discussed in Section 4 of our TGM. In some cases, the collection of a smaller sample from fewer points might yield accurate data, but this would need to be demonstrated on a site-specific basis. Larger samples comprised of more than 50 increments and having a greater, bulk mass might be required in other instances, as seems to routinely be the case for PCBs and soil contaminated with small fragments of lead.

Environmental professionals well experienced in discrete sampling methods but new to sampling theory and DU-MIS methods typically reach a "compromise" point where they conclude that DU-MIS investigation methods are appropriate for some situations and discrete sample investigation methods are appropriate for others. This is usually due to a premature assumption that discrete samples are required to determine the initial extent of contamination. As demonstrated in our field study as well as in thirty years of "failed" confirmation samples, however, discrete sample data are highly prone to "false negatives," that is, underestimation of the actual extent of contamination present. The extent of contamination is far more reliably determined through the designation of well-placed Decision Units and the collection of Multi Increment samples from each DU. We dedicated an entire webinar to this topic in our 2017, six-part training series on DU-MIS investigation methods (recordings posted to HEER YouTube channel).

Risk assessors sometimes retort that they want to know the "range" of contaminant concentrations in soil collected from individual points as part of their decision making. As discussed in our training workshops and publications, however, the concentration reported for a contaminant in soil is entirely dependent on the mass of soil actually extracted by the laboratory. Greater variability and higher concentrations will be reported for smaller and smaller subsamples. At some scale, the "maximum" concentration of a contaminant in soil, if present, will always be "100%" (Brewer et al. 2017b). The concentration of a contaminant reported for a random subsample collected from a single, random, discrete field sample in turn has no bearing whatsoever on risk. It is a random artifact of the mass of soil tested.

Sediment Research

The majority of past research by our office and other entities have focused on improved sampling methods for soil, but it is rational to assume that similar concerns apply to sediment. The only question is again the relative degree of error in the data and in decision making.

Informal studies in Hawaii and discussions with sediment experts in the US and other countries suggests that data for co-located, discrete samples in sediment that was contaminated prior to being deposited are unlikely to vary to the extreme observed at the HDOH PCB study site but could easily vary by an order of magnitude under some scenarios. This seems to be particularly true for PCBs, similar to our findings for soil.

A detailed field study of discrete sample data variability similar in scope to the soil study carried out in 2015 by HDOH is sorely needed. We propose that such a study be jointly carried out with staff from USEPA Region 9 and other government agencies or research institutions to better understand the reliability of discrete sample data for characterization and assessment of contaminated sediment. The HDOH TGM provides a few examples of DU-MIS investigation methods for sediment but more field research in sample collection methods is also needed. The study could explore more efficient ways to collect representative sediment samples in different aquatic environments, including for example the recent advent of "mini Vibracore" sampling tools.

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Attachment 2

Use of Multi-Increment versus Discrete Soil Samples in DoD sites in Hawaii (HDOH June 27, 2011)

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

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In reply, please refer to:
File:
2011-390 MR

July 15, 2011

Ms. Janice Fukumoto
Environmental Restoration
Product Line Supervisor
Department of the Navy
Naval Facilities Engineering Command, Hawaii
400 Marshall Road, Building X-11
Pearl Harbor, Hawaii 96860

Facility/Site: **Department of Defense (DoD) Sites in Hawaii**

Subject: **Use of Multi-Increment versus Discrete Soil Samples in DoD sites in Hawaii**

Dear Ms. Fukumoto:

In recent years, the multi-increment sampling method has been developed to provide another tool to help in environmental investigations. There still seems to be a lot of questions on when and where multi-increment sampling is appropriate to use. Attached is a memorandum from Dr. Roger Brewer summarizing the key points and recommendations on the use of multi-increment versus discrete sampling methods in investigations of DoD sites in Hawaii. In addition to the HDOH Technical Guidance Manual, these recommendations, resulting from the May 18, 2011 meeting with NAVFAC-HI, NAVFAC-PAC, USEPA Region IX, and HDOH, serve as HDOH guidance on how sites are to be investigated using multi-increment samples. Please advise your contractors and other Navy reviewers who need to know how multi-increment sampling is done, of this guidance.

Should there be any questions, please do not hesitate to contact me at 586-7576. Thank you very much for your time and consideration in this matter.

Sincerely,

Ma. Eloisa Q. Reyes

Maria Eloisa Q. Reyes, Ph.D.
Remedial Project Manager
Hazard Evaluation and Emergency Response Office

Attachment

c: John Chesnutt, U.S. EPA Region 9
Christopher Lichens, U.S. EPA Region 9
Daniel Stralka, U.S. EPA Region 9
Ned Black, U.S. EPA Region 9
Rich Howard, TechLaw, Inc.

NEIL ABERCROMBIE
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In reply, please refer to:
File: EHA/HEER Office

TO: Fenix Grange, Steven Mow and Maria Reyes
Site Discovery, Assessment and Remediation Section
HEER Office

2011-344-RB

FROM: Roger Brewer RCB
Environmental Hazard Evaluation
HEER Office

DATE: June 27, 2011

SUBJECT: Use of Multi-Increment versus Discrete Soil Samples at Department of Defense (DoD) Sites in Hawai'i

This memo summarizes key points and recommendations on the use of multi-increment (MI) samples (MIS) versus discrete soil samples at DoD sites in Hawai'i, following our May 18, 2011, meeting at Pearl Harbor Navy Base with Janice Fukumoto of NAVFAC and Dan Stralka (human health risk assessor), Ned Black (eco risk assessor), John Chestnut (Federal Facilities manager), Chris Lichens (project manager) of USEPA Region IX. The meeting focused on the use of MIS vs discrete samples for risk assessment purposes as well as the use of MIS vs discrete soil samples for site investigation purposes. This memo reflects similar comments regarding the use of discrete soil samples by USEPA contactors for investigation of a former pesticide mixing site within Pearl Harbor Naval Reservation (HDOH 2011a).

The discussion focused on two main points:

A. Use of the 95% UCL of soil data in human health, risk assessments at DoD sites, and
B. Use of data for a small number of discrete soil samples (e.g., <8) for final decision making purposes during the site investigation stage of a project.

HDOH and USEPA Region IX staff agreed on the first point and further agreed that either discrete or MI samples can be used to accomplish this goal during the Risk Assessment stage of a project. USEPA staff pointed out that the concept of Exposure Area Decision Units (DUs) described in the HEER office *Technical Guidance Manual* (TGM) is identical to the concept of exposure areas described in USEPA risk assessment guidance. Both HDOH and USEPA staff emphasized that an adequate number of discrete soil samples must be collected to calculate a viable 95% UCL. USEPA staff pointed out that a minimum of eight samples is required and usually more, depending on the number and variability of discrete sample data points. HDOH staff suggested that MI samples generally provide higher quality data, given the large number of sample ("increment") points incorporated into the final data and enhanced coverage of the targeted DU.

HDOH and USEPA staff disagreed on the use of a small number of discrete soil samples (e.g., less than eight) to initially screen a site for potential soil contamination concerns during the Site Investigation stage of a project. USEPA staff suggested that the maximum concentration of targeted contaminants reported for a small number of samples could be compared to risk-based screening (action) levels and combined with general knowledge of the site history to determine the need for additional actions. HDOH staff pointed out that, based on their experience with both discrete and MI sample data, this approach is prone to "false negatives" and the risk of declaring a contaminated site to be clean. HDOH staff insisted that high quality data be collected for final, decision making purposes in both the Site Investigation and Risk Assessment stages of a project, regardless of whether discrete or MI samples are used. Additional discussion of this issue is provided below.

Use of Discrete vs MI Soil Sample Data in Risk Assessments

USEPA and HEER staff concurred that either discrete or MI soil samples can be used to characterize targeted Exposure Area DUs as part of a risk assessment. This is also discussed in the HEER office Technical Guidance Manual (TGM; HDOH 2009). USEPA staff noted that the concept of a "Decision Units (DU)" to specify a targeted exposure area in the field is consistent with USEPA risk assessment guidance. The targeted Exposure Area DU should be designated at the beginning of the investigation and either discrete or MI samples then collected to characterize the DU.

If discrete soil sample data are used then a 95% UCL be calculated for estimation of Exposure Area ("Point") Concentrations (EAC). This is done in part because the number of available, discrete sample data points is often inadequate to calculate a reliable Exposure Area Concentration based only on the arithmetic mean. Use of the 95% UCL is intended to help address this issue and estimate a more conservative but still reasonable EAC.

If the maximum-reported concentration exceeds the calculated 95% UCL calculated for the DU, the maximum concentration should not be used for final, decision making purposes. Additional discrete samples (or alternative MI samples) should instead be collected to improve the quality of the data and provide a more representative estimate of the 95% UCL. Although this is rarely done for risk assessments, USEPA staff suggested that is it adequate for initial, Site Investigation purposes. As discussed in the following section, this conflicts with guidance in the HEER office TGM and is not recommended for use in either risk assessments or site investigations.

USEPA staff also recommended that a 95% UCL be calculated for estimation of the Exposure Area Concentration if an MIS approach is used to characterize a DU for risk assessment purposes. This is conservative but reasonable for DoD sites. As discussed in our Technical Guidance Manual, this will require the collect of at least three, replicate MI samples in the targeted DU. USEPA staff agreed that replicate samples do not need to be collected in *every* DU to be evaluated in the risk assessment. Statistical evaluation of replicate data for a DU can be applied to other DUs where replicate samples were not collected, provided that the DUs have a similar contaminant history. This is also discussed in our TGM. In some cases it may be prudent to increase the number or increments included in an MI sample and/or increase the number of replicates collected in order to improve the calculation of a 95% UCL.

Use of MIS vs Discrete Soil Samples in Site Investigations

Both USEPA and HEER staff also agreed that either discrete or MI soil samples can be used during the Site Investigation stage of a project. In either case, however, **Decision Units must be designated to specifically denote the area (and volume) of the soil that the samples are intended to represent as part of the initial stage of a Site Investigation.** This is generally not done as part of traditional, discrete sampling approaches.

Much of the discussion with USEPA staff centered on the use of a small number of discrete samples during the Site Investigation stage of a project and use of the data to determine whether or not the project should continue on to the Remedial Investigation stage. Although this was common practice in the past, **the absence of well-thought-out DUs and reliance on a small number of discrete sample points for final, decision making purposes at the Site Investigation stage of a project can lead to multiple problems** (see attached figure; HDOH 2011b), including:

1. Risk of "false negatives" and erroneous declaration of contaminated sites to be clean;
2. Underestimation of the lateral and vertical extent of contaminated soil surrounding significant spill areas;
3. Confusion over sample-size "hot spots" in areas that are otherwise not significantly contaminated ("false positives");
4. Underestimation of contaminant mass for evaluation of soil treatment options.

These problems occur due to the inherent heterogeneity of contaminant concentrations in soil at the scale of a discrete sample or more specifically the discrete sample aliquot actually analyzed by the laboratory (typically one to thirty grams). Attempting to do so opens the potential for "false negatives" ("A" in attached figure) and the erroneous determination of "clean" boundaries within areas of otherwise contaminated soil (i.e., mean fails screening level but individual sample points may fall below this level; see HDOH 2011b).

Focusing on individual, discrete soil samples can also lead to confusion over "false positives" and outlier "hot spots" ("B" in attached figure) within an otherwise area of clean soil (i.e., mean passes screening level but individual sample points may exceed this level). These problems are expressed in the field by the need for multiple, over-excavations of contaminated soil that had initially been identified based on discrete samples data or misguided attempts to excavate isolated, sample-size "hot spots" of contaminated soil in otherwise clean areas (see HDOH 2009, 2011b).

If discrete samples are to be used during the Site Investigation stage of a project, then an adequate number of samples should be collected from designated DUs to calculate a representative, 95% UCL for all targeted contaminants. The 95% UCL should then be used for final, decision making purposes, including the need to carry the advance the DU into the Remedial Investigation stage of the project. If the maximum-reported concentration exceeds the calculated 95% UCL calculated for the DU, then additional discrete samples should be collected until such time that a viable, 95% UCL can be calculated. Use of the maximum-reported concentration of a contaminant from a small number of discrete samples to screen the site is not acceptable. Subsampling of discrete soil samples to be used to calculate a 95% UCL for risk assessment purposes is not necessary, however, although this may decrease inter-sample variability and help generate a more representative UCL.

In some cases it may be necessary to make preliminary decisions for site investigation, risk assessment and/or remedial actions based on a small number of discrete soil samples (e.g., sites with existing, discrete soil data). **In order to ensure that the potential errors outlined above are adequately addressed, recommendations based on discrete sample data should be confirmed by the collection of followup, Multi-Increment (MI) samples in accordance with HEER office guidance** (HEER 2009, 2011b).

As an alternative, and as recommended in our TGM, an MI sample can be collected and used to characterize targeted DUs at the beginning of a site investigation (HDOH 2009). MIS-investigation approaches help to minimize these types of problems by first designating a specific area/volume of soil that the soil sample(s) is intended to represent and then ensuring that an adequate number of sampling points, or "increments," are collected within that area to estimate a representative mean. Multi-increment samples by definition require that a relatively large number of sample points ("increments") be incorporated into the sample in order to provide a better estimation of mean contaminant concentrations up front. The collection of replicate samples within the same DU (or similar DUs) is intended to help verify that the data reported for targeted contaminants is indeed representative of the true mean. If the replicate data are adequately similar (e.g., Relative Percent Difference +/- 35%) then adjustment of data for individual DUs (e.g., calculation of 95% UCLs) isn't strictly necessary.

Subsurface Investigations

Decision Units must be designated for subsurface investigations. This would ideally involve the designation and characterization of individual, subsurface DU layers, with thirty or more increments collected from each layers. **This will require the installation of thirty or more borings for typical, tabular-shaped DUs (i.e., vs DUs that are thicker than they are wide or long).** If this is not practical, for example due to access or budget constraints, then the limitations of the data should be discussed in the investigation report. As discussed in the HEER office TGM, increments are collected and combined from subsurface DU layers in the same manner as done for surface soils. The mass of increments collected from individual cores may require subsampling in the field in order to reduce the final, bulk MI sample to a manageable size (see HDOH 2009, 2011b). This approach can also be used for the investigation of subsurface soils contaminated with volatile chemicals (HDOH 2011c).

For screening level purposes, it may be useful or even necessary to designate targeted layers *within individual borings* as Decision Units. This is commonly done to initially estimate the lateral and/or vertical extent subsurface contamination. As discussed in the HEER office TGM, the *entire core* from the targeted DU layer should be submitted to the lab for subsampling and analysis. In essence this is a "discrete" sample since the core is not subsampled prior to submittal to the lab for processing and analysis. If the cores are too long or otherwise too bulky then they should be subsampled in the field (refer to HEER office TGM). The reduced confidence in the resulting data should be noted and taken into consideration along with the history of the targeted area and the potential for significant contamination to be present. As discussed above, **preliminary decisions based on based on limited discrete sample data should be confirmed by the collection of followup, Multi-Increment (MI) samples and/or additional, more focused borings in areas of particular concern.** Examples include the collection of MI confirmation samples from sidewalls and floors of excavation initially established based on discrete sample data from borings.

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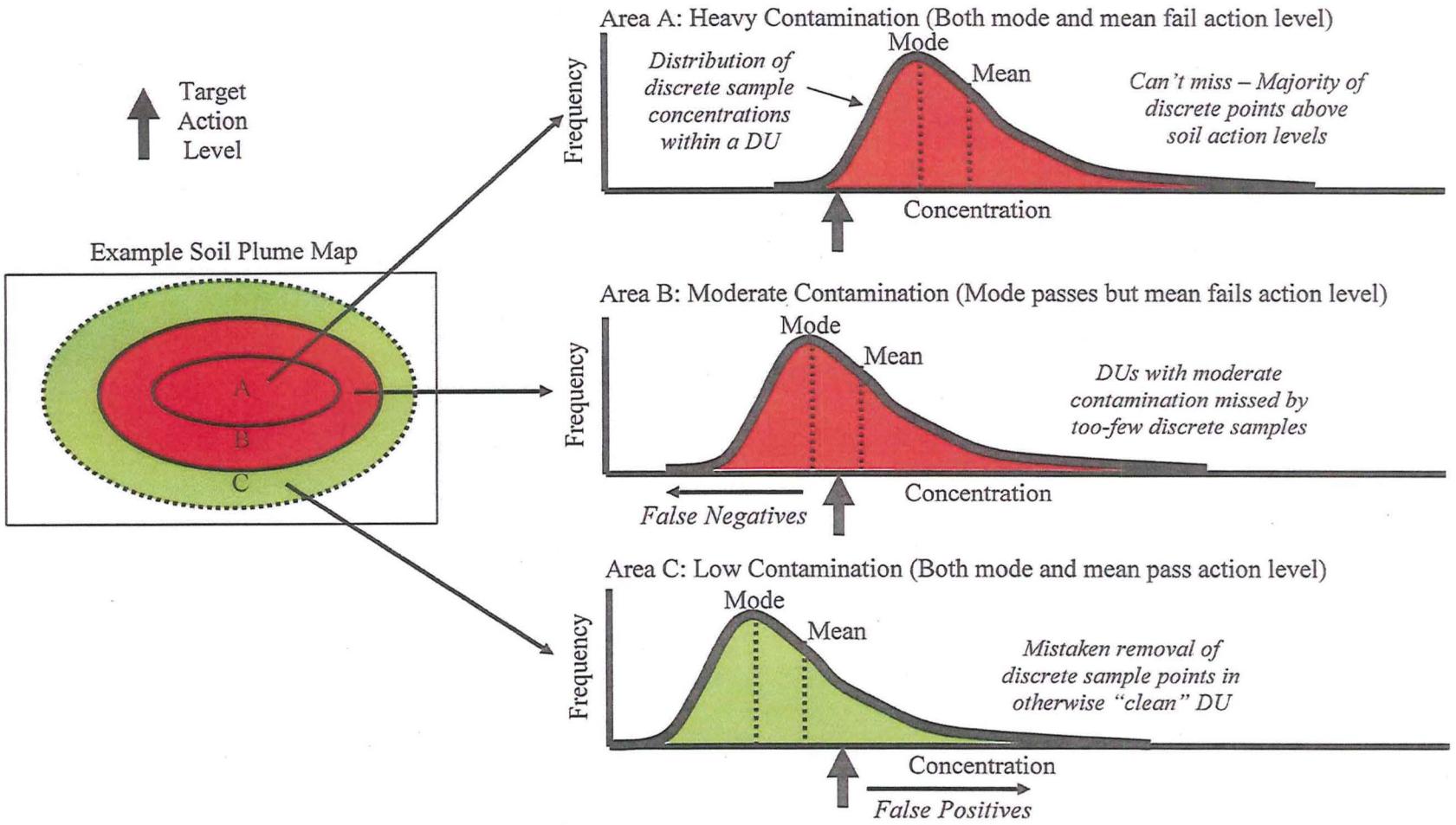


Figure 1 (see also HDOH 2011). Effect of contaminant heterogeneity at the scale of a discrete laboratory subsample on decision making when using a non-representative number of discrete samples or MI increment points. Initial samples likely to fall around the mode. A minimum of thirty to fifty sampling points (discrete or MI) is required to adequately capture the heterogeneity of contaminant distribution within the DU and estimate a representative contaminant mean (and mass). A small number of discrete samples will identify areas of heavy contamination in Scenario A but could underestimate mean concentration and total mass, leading to failed *in situ* remediation. False negatives in Scenario B can lead to an underestimation of contamination extent and failed excavations or *in situ* treatment. False positives in Scenario C lead to unnecessary soil treatment/removal associated with discrete sample points or borings in otherwise clean DUs.

HAWAII STATE DEPARTMENT OF HEALTH

The **Hawai'i Department of Health (HDOH), Hazard Evaluation and Emergency Response Office (HEER Office)** is a state environmental health division whose mission is to protect human health and the environment. The HEER Office provides leadership, support, and partnership in preventing, planning for, responding to, and enforcing environmental laws relating to releases or threats of releases of hazardous substances.

Use of DU-MIS Sampling Methods for Risk-Based Investigation of Contaminated Soil and Sediment

This fact sheet provides government regulators, consultants, property owners and other interested parties with a brief overview of Decision Unit and Multi Increment® Sample (DU-MIS) investigation methods for contaminated soil. (Multi Increment® is registered trademarked of EnviroStat, Inc.) The Fact Sheet focuses on soil, but similar approaches are applied to testing of sediment.

What is DU-MIS?

"Decision Unit" and "Multi Increment Sample" (DU-MIS) investigation methods are a risk-based strategy to test soil and determine if contamination poses a potential threat to human health and the environment. The methods were specifically designed to address concerns related to the unreliability of traditional, discrete sample data. The approach can require additional time and effort at the beginning of a project but will ultimately help to:

- Reduce total project duration and cost;
- Ensure sample data collected are reliable and reproducible;
- Provide a higher degree of confidence that potential risks have been identified and addressed;
- Provide confidence that cleanup actions are only conducted where warranted; and
- Avoid unanticipated delays or even abandonment of projects due to time and cost overruns and lack of a clear endpoint.

DU-MIS investigation methods provide greater confidence in decision making and help to complete environmental projects in a reliable time- and cost-effective manner.

The methods apply to both nonvolatile and volatile contaminants as well as surface and subsurface soils. Similar sampling methods have been used for decades by the mineral exploration and agriculture industries but are relatively new to the environmental industry, where the effects of erroneous data are less evident. Hawai'i first published guidance in 2009.

How is DU-MIS Implemented in the Field?

DU-MIS investigation methods are carried out in a very methodical, step-by-step manner to ensure that the resulting sample data directly answer the questions being asked and are reliably representative of site

conditions. The science behind DU-MIS methods might seem very complex, but implementation in the field is relatively straightforward with some experience.

Step 1: Review the Site History

The first step in "risk-based" investigation is to gain a thorough understanding of the site before samples are collected. This step-by-step process, which includes inspecting the site, talking to people familiar with the site history and compiling existing data, is referred to as "Systematic Planning." The information is summarized in a preliminary "Conceptual Site Model" or "CSM." The CSM is used to design the site investigation.

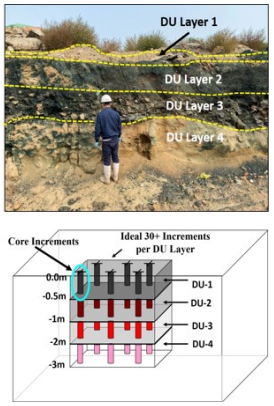
Step 2: Select Areas for Individual Testing

The second step is to designate well-thought-out areas of the site to be individually tested for contamination, referred to as "Decision Units." A DU can be thought of as an area *and volume* of soil that would ideally be sent to a laboratory for testing as a single sample. Each DU is designated to address a specific site investigation question regarding risk assessment or optimization of potential remedial actions. The objective of sample collection is always to determine the mean or "true" concentration of the contaminant for the DU volume of soil *as a whole*.

DUs are designated to answer specific risk or remediation questions. The entire property is often tested.

Risk-based DUs should be selected based on site history and current potential exposure pathways. "Exposure Area" DUs include unpaved areas where children and adults frequently play or work, such as playgrounds, schoolyards, gardens, open areas of commercial and industrial sites and exposed soil at construction sites. These are a very common component of human health risk assessments. The exact size of an Exposure Area DU is necessarily site-specific but normally ranges from a few hundred to a few thousand square meters in area and one hundred to several hundred cubic meters of soil in volume. Assessment of current exposure risk typically focuses on establishing the mean concentration of a contaminant in the upper 10 to 20 centimeters of soil (i.e., surface soil). Assessment of future risk might include the designation and testing of subsurface soil DUs of similar size, assuming the soil could be excavated and spread out at the surface or encountered by workers during construction or utility activities.

Areas of known or suspected, heavily contaminated soil that are almost certain to pose a risk if exposed at the surface should be isolated for separate testing. These are referred to as "Source Area" or "Spill Area" DUs. Source Area DUs are surrounded by anticipated clean, "Boundary DUs" in order to isolate areas of relatively higher contamination and optimize remediation efforts. Successful remediation of contamination can be verified by designation and testing of Exposure Areas DUs in the same locations.



DU Layers are also designated to test subsurface soils.

DUs are designated to characterize both surface soil and, as needed, subsurface soil. Subsurface soil is characterized in terms of stacked, DU Layers. Suspect layers of subsurface soil, identified by site history, initial surface soil data or other observations, should be designated for separate testing in order to bound the vertical extent of the contamination.

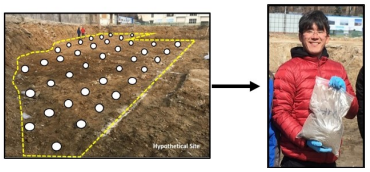
The size and number of DUs designated to characterize a site reflects the "resolution" of the investigation necessary to answer the questions being asked, much like the pixels of a digital photograph.

Five to ten DUs are normally adequate to characterize a simple site. Twenty or more DUs might be required to characterize a complex site.

A very specific, "Decision Statement" that explains the action to be taken when sample data are received is prepared in advance for each DU. This provides a clear pathway forward for subsequent stages of the investigation and helps to expedite overall completion of the project.

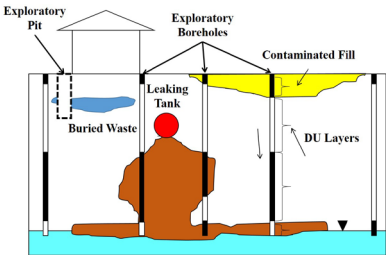
Step 3: Collect a Representative Sample from Each DU Area

Because the collection of the entire volume of soil from a DU and submittal to a laboratory is rarely possible, a representative sample of the soil must instead be collected. The science and statistics behind the collection of a representative sample of soil is complex and involves the need to address both variability between individual particles ("compositional heterogeneity") and variability within the targeted DU ("distributional heterogeneity"). The procedure to collect a sample in the field is, however, relatively straightforward.



A single sample is prepared for each DU by combining small amounts of soil from a large number of points.

A single sample is prepared for each designated DU by collecting and combining small, core-shaped masses of soil from a large number of points within the targeted area. The soil from each point is referred to as an "increment" and the combined increments are referred to as a "Multi Increment (MI)" sample. The sample should be collected from 30 to 75+ points in a systematic, random fashion within the DU area, depending on the nature of the contamination. A default of 50 increments per sample is recommended. Fewer increments might be acceptable for testing of liquid releases (e.g., pesticides). A larger number of increments is required for contaminants present in the soil as clumps or chips (e.g., lead or PCBs). The final mass of the sample must be at least 1 to 3 kilograms or around one liter. Increments are combined in a bottle containing a pre-measured volume of methanol if the sample is to be tested for volatile chemicals.



MI samples can be collected from targeted, DU layers in single, Exploratory Borings for initial investigation of subsurface conditions.

This sample collection method provides a high degree of confidence that that the resulting data will be representative of the targeted area of soil and pertinent to the investigation questions being asked. Just to be certain, however, two additional, independent samples are collected from at least one of the DU areas. These are referred to as "replicate" samples and are used to evaluate the overall precision of the sampling method and reproducibility of the sample data.

Direct-push rigs or excavators can be used to collect increments and prepare MI samples from subsurface DU Layers. If the collection of 50-increment MI samples is not possible due to drilling obstructions or other challenges, then this should be discussed with the overseeing, regulatory agency and the limitations of the resulting data noted. MI sample testing of targeted, DU Layers in individual, "Exploratory Borings" can be useful for very general estimation of the extent and magnitude of subsurface contamination, especially in the case of subsurface petroleum and solvent releases. Be aware, however, that there is a risk of "false negative" results when using this approach and underestimation of contamination and risk. Full, DU-MIS testing of the soil is required for confirmation.

Step 4: Sample Processing and Analysis

Contact the laboratory during the planning phase to ensure the correct sample containers are used and that the laboratory can achieve desired reporting limits and data quality objectives. Select analysis that achieve the desired risk concerns and goals. Avoid testing for unneeded unknowns to keep costs in control. Lead, arsenic, petroleum, PCBs and pesticides like Technical Chlordane and DDT are common contaminants of potential concern.

MI samples to be tested for nonvolatile chemicals are dried, sieved and then carefully subsampled.

Once collected, the sample is sent to a laboratory for processing and testing. The laboratory will not be able to test the entire, 1-2 kg sample. Strict protocols must be followed in order to collect a representative subsample for testing. The sample is normally air dried for 24 to 48 hours and then passed through a sieve to remove large rocks and other debris. A sectoral splitter is then used to collect a representative subsample (third photo in figure). Although more prone to error, the sample can also be spread into a thin layer and a subsample manually collected from a large number of points, similar to how the original sample was collected in the field.

These steps help to ensure that the laboratory data are representative of the sample submitted and that the sample submitted is representative of the targeted DU area. The laboratory is also instructed to collect and test independent, triplicate subsamples from 10% of the samples submitted in order to verify that the subsampling method utilized is reliable and the data generated are reproducible. (Note that this is not necessary for samples preserved in methanol for VOC analysis.)

Step 5: Data Review and Decision Making

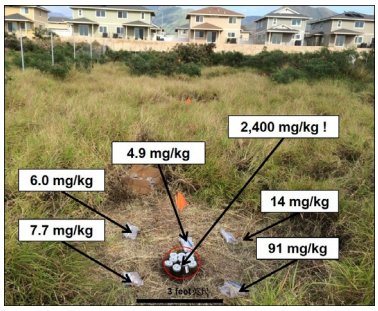
When the laboratory data are received, a review of the overall reliability of the data is made based on field and laboratory replicate samples and other quality control measures. If the replicate data are very different and the problem is determined to be at the laboratory, then determination of the source of error and retesting of the samples might be required. If the problem is determined to be related to the method used to collect the samples in the field, then the sampling process will be reviewed and the collection of new samples might be required. Error associated with sample collection and laboratory testing decreases as experience is gained.

Once the data are determined to be usable, then data for each DU can be directly compared to risk-based screening levels and decisions can be made on the need for cleanup or other soil management actions. The need to collect additional samples should be minimal, assuming that DUs were properly designated at the beginning of the project and DU questions and decision statements were properly prepared ahead of time.

Why are DU-MIS Sampling Methods Necessary?

Guidance for the investigation of contaminated sites published by the USEPA in the 1980s focused on the collection and testing of individual, small masses of soil from single points referred to as “discrete” samples. The authors noted that this method would only be reliable if the concentration of a contaminant in soil was very uniform both within a sample and between closely spaced samples.

Scientists and field workers began to warn in the early 1990s that this was not the case. Data for co-located samples often varied widely and randomly, as did data for duplicate subsamples tested by the laboratory. This caused confusion in the field regarding the extent of contamination above levels of potential concern and in the assessment of risk. The need to repeatedly remobilize field teams for sample collection and the discovery of additional contamination after remediation was thought to be completed caused some projects to drag on for years and in some cases to be abandoned due to the lack of a clear endpoint.



Contaminant concentrations can vary dramatically between co-located, discrete samples and even within the same sample.

A thorough field study of the reliability of discrete sample data for testing of environmental sites was, surprisingly, not carried out until 2015 – thirty years after the first USEPA site investigation guidance was published (Brewer et al. 2017). The field study verified contaminant concentrations can vary dramatically and randomly between samples collected just a few centimeters from each other and even within an individual sample. Statistical analysis of replicate sets of discrete samples can predict very different risks associated with mean contaminant concentrations for targeted exposure areas.

These factors are the primary cause of failed remediation attempts, project delays and cost overruns, and the later discovery of significant contamination in areas earlier declared to be "clean." The mineral exploration and agricultural industries recognized the same problems many years ago. Gold exploration companies often went bankrupt when the amount of gold present in a discovery turned out to be far less than predicted by the samples collected or more commonly when large accumulations of gold were overlooked due to erroneous sample data. Farmers realized the unreliability of discrete sample data very quickly, as crop yields failed to meet expectations or large sums of money were unnecessarily spent on fertilizer or other field amendments.

The result was the development in the 1950s of the Theory of Sampling by Pierre Gy, which serves as the basis of the DU-MIS methods described in this fact sheet. Errors in sample data and decision making are less obvious in the environmental industry, but DU-MIS methods are being continually improved in order to make the investigation, assessment and remediation of contaminated soil as efficient and reliable as possible.

Where can I get more information on DU-MIS methods and Gy's Theory of Sampling?

Refer to the HEER Office website and *Technical Guidance Manual* (https://health.hawaii.gov/heer/) for further information about this fact sheet and the basis and implementation of Decision Unit and Multi Increment Sample investigation methods or contact:

Hawai'i Department of Health, Hazard Evaluation and Emergency Response Office
2385 Waimano Home Road, Pearl City, HI 96782
Telephone: (808) 586-4249

Field study of the nature and reliability of discrete sample data:

Brewer, R., Peard, J. and M. Heskett. 2017a. A critical review of discrete soil sample reliability, Part 1 – Field study results: Soil and Sediment Contamination, Vol. 26 (1).

Brewer, R., Peard, J. and M. Heskett. 2017b. A critical review of discrete soil sample reliability, Part 2 – Implications: Soil and Sediment Contamination, Vol. 26 (1).

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In reply, please refer to:
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TO: Interested Parties

THROUGH: Elizabeth Galvez, Acting Program Manager
Hazard Evaluation and Emergency Response (HEER) Office

FROM: Lene Inchinotsubo, Acting Chief
Solid and Hazardous Waste Branch (SHWB)

DATE: September 23, 2019

SUBJECT: **Use of HEER Office Environmental Action Level Guidance and HEER Office *Technical Guidance Manual* for Characterization and Remediation of Contaminated Properties Overseen by the SHWB**

This memorandum supersedes and takes precedence over a July 15, 2005, SHWB memorandum titled, *Use of May 2005 Environmental Action Levels ("EALs") at Leaking Underground* Storage *Tank sites* (Attachment I). The 2005 memorandum recommended reference to soil and groundwater EALs published by the HEER Office earlier that year for use at underground storage tank (UST) sites overseen by the SHWB but also allowed reference to action levels published in 1995 by the SHWB. In August 2013, SHWB adopted HEER Office EALs as "alternative site-specific action levels" as referenced in state UST regulations. The HEER Office EALs and subsequent updates have since been fully adopted by the SHWB for use at contaminated properties overseen by the SHWB, including, but not limited to, UST sites, and use of the 1995 action levels is no longer permitted (HDOH 2017a).

Parties involved in soil and groundwater investigation projects overseen by the SHWB are furthermore, advised to refer to the HEER Office *Technical Guidance Manual* (TGM) for the design and implementation of filed activities (HDOH 2016). The HEER Office TGM incorporates updates and takes precedence over information published in the UST *Technical Guidance Manual* prepared by the SHWB (HDOH 2000). In particular, guidance for testing of soil, groundwater, and soil vapor presented in the HEER Office TGM replaces guidance in Section 7 (Sampling and Analysis) of the 2000 SHWB UST TGM. Guidance specific to the installation of groundwater monitoring wells at UST sites presented in Appendix 7-E of the 2000 SHWB TGM can, however, be referred to in coordination with the overseeing project manager from the SHWB (Attachment 2). Note that the HEER Office EAL guidance similarly supersedes and takes precedence over guidance specific to the preparation of risk assessments presented in Section 5 of the 2000 SHWB-UST TGM, which was also adopted in August 2013.

Reference to the HEER Office guidance documents must take into account updates to SHWB regulations. Related technical documents published by both the SHWB and HEER Office should also

be referred to as appropriate and approved by SHWB project managers. This includes the "Clean Fill" guidance prepared jointly by the SHWB and HEER Office and used for testing of imported and exported fill material as well as soil stockpiles (HDOH 2017b, and updates).

The HEER Office TGM does not serve as a replacement for testing requirements presented in other SHWB guidance and regulations. The HEER Office TGM in particular does not discuss requirements for testing and disposal of non-soil wastes overseen by the SHWB. Explicit guidance on management of active UST facilities is also not provided in the HEER Office TGM.

The SHWB intends to prepare addendums to the HEER Office TGM that addresses these and related subjects in the future. In the interim, the SHWB has prepared the attached, Question & Answer section to discuss use of the HEER Office TGM in projects overseen by this office.

References

HDOH, 2000, Hawaii Underground Storage Tank Technical Guidance Manual: Hawai'i Department of Health (March 2000):): Hawai'i Department of Health, Solid and Hazardous Waste Branch. http://health.hawaii.gov/shwb/ust-tgm/.

HDOH, 2005, *Use of May 2005 Environmental Action Levels ("EALs") at Leaking Underground Storage Tank sites* (July 2005): Hawai'i Department of Health, Solid and Hazardous Waste Branch.

HDOH, 2016, *Technical Guidance Manual* (Fall 2016, and updates): Hawai'i Department of Health, Office of Hazard Evaluation and Emergency Response, http://www.hawaiidoh.org/.

HIDOH, 2017a, *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater – Hawaii Edition* (Fall 2017, and updates): Hawai'i Department of Health, Office of Hazard Evaluation and Emergency Response. http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/EALs.

HDOH, 2017b, *Guidance for Soil Stockpile Characterization and Evaluation of Imported and Exported Fill Material,* (October 2017 and updates): Hawai'i Department of Health, Office of Hazard Evaluation and Emergency Response, http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/technical-guidance-and-fact-sheets.

PVT, 2016, *Landfill Policies and Procedures for All Users*: PVT Land Company, Limited, August 2016.

SUBJECT: Use of HEER Office *Environmental Action Level* guidance and HEER Office *Technical Guidance Manual* for Characterization and Remediation of Contaminated Properties Overseen by the Solid and Hazardous Waste Branch – Common Questions and Answers

Q-1: How is the HEER Office TGM different from the 2000 SHWB UST TGM?

The HEER Office TGM provides an extensive update to sample collection and test methods for soil and sediment, as well as expanded guidance on the testing of indoor air and soil vapors for volatile chemicals. Updates to the guidance are coordinated with and reviewed by SHWB staff.

Guidance for testing of soil, groundwater, and soil vapor presented in the HEER TGM (HDOH 2016), in particular, updates guidance presented in Section 7 (Sampling and Analysis) of the 2000 SHWB UST TGM. Guidance presented for the installation of groundwater monitoring wells at UST sites included in Section 7 of the 2000 SHWB TGM can still be referred to, however. This information will be incorporated into future updates of the HEER TGM.

Q-2. Are discrete soil sampling methods described in the original SHWB TGM still acceptable for final decision making at contaminated sites overseen by the SHWB?

No. Data based on advanced and more reliable, Decision Unit-Multi Increment Sample (DU-MIS) investigation methods should be collected and used for final decision making at contaminated sites overseen by the SHWB. Existing discrete sample data can be used to design initial remediation plans, if desired. DU-MIS data collected in accordance with the HEER Office TGM should then be collected and used to confirm the adequacy of remedial actions.

Q-3. Do SHWB sites that were characterized and granted a No Further Action Status based on discrete sample data need to be reopened and retested?

No. Experience at sites where both discrete and Multi Increment sample data have been collected primarily highlights the inefficiency and unreliability of discrete sample data for site characterization. This led to significant, unnecessary delays and expenditures for completion of many projects. Additional confirmation testing using more reliable, DU-MIS methods could, however, be beneficial as part of property transactions or redevelopment at complex sites where localized areas of contaminated soil might have been inadvertently overlooked. This can help avoid delays in proposals for offsite reuse or disposal of soil after a project has already been initiated.

Q-4. The collection of Multi Increment subsurface soil samples from thirty or more borings at active gas stations and similar facilities will not be practical in some cases, due to limited access, underground tanks and utilities, and other difficulties. Can traditional, discrete soil samples be collected instead?

No. The collection of traditional discrete soil samples has been demonstrated to be unreliable for the characterization of both surface and subsurface soils. This is due to the heterogenous nature of contaminants in soil at the scale of a discrete sample and the mass tested by the laboratory. As discussed in Section 4 of the HEER TGM, data will not be reliably representative unless "Decision Unit" areas and volumes of soil are specified and a 1-2kg sample of soil is collected from at least 30 to 50 points within the targeted DU. This cannot be avoided.

Consider the use of "Single Borehole DU" investigation methods described in Sections 3.3.4 and 4.2.8.2 of the HEER Office TGM for cases where the collection of proper DU-MIS sample data from subsurface soils is not feasible. Under this method, single boreholes are used to approximate the lateral and vertical extent of subsurface contamination, in a similar manner as typically done in the past at active gas stations. A continuous core of soil is extracted from each borehole, and the core is divided into continuous depth intervals for testing. A single 1-2kg sample is then collected from multiple points within each targeted interval. In some cases, the entire targeted core interval can be collected and submitted to the laboratory for MIS processing and testing.

This approach works well for the general approximation of the extent and magnitude of subsurface petroleum contamination, which can be easily identified in single cores, although the representative concentration and mass of contamination present will be difficult to reliably estimate. A more detailed investigation might be required for in situ treatment of contamination once high-risk areas have been identified. For testing of volatile chemicals, small plugs of soil are collected from the entire length of the targeted core interval and either combined in methanol in the field for submittal to the laboratory or encapsulated and immediately frozen for extraction in methanol at the laboratory.

Q-5. Are DU-MIS data required for reuse or disposal of soil (or sediment) at municipal landfills in Hawaii or hazardous waste landfills on the mainland?

Requirements for the use of DU-MIS data for soil and similar material will be progressively incorporated into landfill disposal permits as those permits are renewed. Be aware that some municipal landfills, and the PVT Construction and Demolition Waste landfill on the island of O'ahu, already require that the collection of soil sample data follow methods described in the HEER Office TGM (Attachment 3; PVT 2016). This is in part to ensure that landfill workers are not inadvertently exposed to high levels of contaminants in soil that is brought to the landfill for disposal or for use as cover material.

If soil is designated for disposal to a landfill or reuse at another off-site location, then the generator must make a hazardous waste determination in accordance with 40 CFR §262.11, as incorporated and amended in §11-262.1-1, Hawai'i Administrative Rules (HAR). Refer also to Section 2 of the joint SHWB-HEER Office "Clean Fill" guidance for additional information (HDOH 2017b).

Q-6. Are default, Decision Unit (DU) areas and volumes presented in the HEER Office TGM and the joint, HEER-SHWB "Clean Fill Guidance" (HDOH 2017b) strict requirements or can alternative DU volumes be applied to sites overseen by the SHWB?

The default DU areas and volumes of soil presented in the HEER Office TGM and joint HEER-SHWB *Clean Fill Guidance* are intended to expedite testing and clearing of soil for unrestricted reuse in residential neighborhoods, schools, medical facilities and other sensitive locations or reuse at commercial/industrial properties. This will help to avoid potential fines for offsite transportation and placement of contaminated soil. The SHWB considers soil that exceeds the most stringent (Tier 1) Environmental Action Levels (EALs) for unrestricted use to be a "waste," as defined in Hawaii Revised Statutes, Chapter 342H. Proposal of alternative DU volumes for testing and reuse of soil is allowed on a site-by-site basis, provided that adequate justification is presented in a workplan to the SHWB for review and approval.

Q-7. Are DU-MIS data required for characterization of non-soil material, including municipal or industrial waste or recyclable material not related to soil?

The collection of DU-MIS data for reuse or disposal of non-soil material is encouraged to the extent practicable. This is because data related to past, "discrete" sampling methods has been demonstrated to be unreliable and can lead to concerns regarding landfill worker exposure and offsite migration of contaminants in surface runoff or leachate.

DU-MIS data are now routinely collected for waste incinerator ash, for example. Reliable, Multi Increment samples for solids (e.g., waste sandblast grit) can often be collected from containerized waste by simply transferring the waste to another container and periodically collecting individual sample increments during this process. Sampling tubes and other tools can be used to collect representative samples of containerized, liquid waste.

Additional SHWB guidance on the use of DU-MIS methods for characterization of non-soil waste is anticipated in the future.

Attachment 1

Use of May 2005 Environmental Action Levels ("EALs") at Leaking Underground Storage Tank sites (July 2005)

(includes subsequent updates to EALs and use for characterization and disposal of soil and sediment under all SHWB programs)

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In reply, please refer to:
File: EHAITEER Office

TO: Interested Parties

FROM: Steven Chang, Chief
Solid & Hazardous Waste Branch

DATE: July 15, 2005

SUBJECT: Use of May 2005 Environmental Action Levels ("EALs") at Leaking Underground Storage Tank sites

The Hazard Evaluation and Emergency Response (HEER) office has recently published a technical document entitled, *Screening For* ***Environmental Concerns at Sites With Contaminated Soil and Groundwater*** **(Interim Final - May 2005). Environmental Action Levels (EALs) presented** in this document represent an update to action levels presented in the 1995 document, *Risk-Based Corrective Action and Decision Making at Sites With Contaminated Soil and Groundwater,* prepared by the Solid and Hazardous Waste Branch (December 1995, revised June 1996). Formal revision of the 1995 action levels as presented in Hawai'i Administrative Rules (HAR) Section 11-281-78 (UST Site Cleanup Requirements) is currently underway. It is anticipated that this process will be completed in early 2006.

In the interim, the Solid and Hazardous Waste Branch has prepared this Question & Answer sheet to discuss use of the May 2005 EALs at Leaking Underground Storage Tank sites.

Q: How are the May 2005 EALs different from the 1995 Action Levels?

A: The May 2005 EALs reflect more recent toxicological data and take into account additional exposure pathways and environmental concerns. Action levels for petroleum-related chemicals are not significantly different from those presented in the 1995 RBCA document with the exception of ethylbenzene and Total Petroleum Hydrocarbons (TPH). In the case of ethylbenzene, groundwater action levels were updated to reflect more recent data for the protection of aquatic habitats. For sites that do not threaten a source of drinking water, the groundwater action level for ethylbenzene increased from 140 ug/L to 290 ug/L (sites within 150m of a surface water body) and 300 ug/L (sites not within 150m of a surface water body). This change, coupled with use of an alternative model for leaching of chemicals from soil, increased soil action levels for ethylbenzene by up to one order of magnitude.

The 1995 soil action levels for Total Petroleum Hydrocarbons (TPH) were retained for use in the May 2005 EALs. Action levels for nuisance concerns (odors, staining, etc.) were also added, however. This issue was not specifically addressed in the 1995 document. The

additional action levels will be most useful at sites being redeveloped for residential purposes. For example, soil impacted with TPH-gasoline at a concentration of 2,000 mg/kg (1995 action level) could pose potential odor concerns if exposed at the ground surface or encountered during landscaping or utility work. An action level of 100 mg/kg is incorporated into the May 2005 EAL document to address this concern. An additional, nuisance-based action level of 500 mg/kg is presented for both TPH-diesel ("middle distillates") and heavier oils ("residual fuels"). Exceeding these concentrations of TPH in exposed or shallow soils indicates that nuisance concerns may exist and a more site-specific, field-based assessment of this issue should be carried out.

A third update to the 1995 RBCA document that may affect leaking underground tank sites is the inclusion of EALs for additional polynuclear aromatic hydrocarbon compounds (PAHs). A list of targeted PAHs that should be tested for at petroleum releases is provided in Chapter 2 of the May 2005 document. These compounds are often found in waste oil and to a lesser extent in diesel-range fuels. The addition of the compounds to the lookup tables reflects updates to the USEPA Preliminary Remediation Goals (PRGs) as well as other USEPA guidance.

Reference to the additional PAHs is not likely to affect the scope of cleanup required for contaminated soils. Many of the EALs for PAHs in groundwater are very low, however, and may even be below normal laboratory method reporting limits. (In cases where the EAL is below the laboratory method reporting limit, the reporting limit should be used for screening purposes.) This is primarily because these PAHs are highly toxic to aquatic organisms. At a "Tier 1" screening level, the EAL document assumes that contaminated groundwater at a site could migrate to a body of surface water and impact sensitive aquatic habitats. This is especially a concern for highly mobile chemicals (e.g., chlorinated solvents). PAHs are not significantly mobile in groundwater, however, and unlikely to migrate more than a few tens of meters from the original release area. Once it can be established that PAH-contaminated groundwater is not likely to migrate to a body of surface water, consideration of the EALs for PAHs in groundwater cleanup plans is no longer needed (e.g., based on groundwater monitoring data and length versus age and length of plume). Proper management of contaminated groundwater (and soil) during site future redevelopment activities will be required, however.

Q: Am I now required to use May 2005 EALs at Leaking Underground Storage Tank sites?

A: No. Use of the May 2005 EALs is entirely optional on the part of the party responsible for investigating, assessing and cleaning up contaminated sites.

Q: Can I use the May 2005 EALs at Leaking Underground Storage Tank sites if I so desire?

A: Yes. The May 2005 EALs are primarily a compilation of published information that would be normally accessible for use in a "site-specific" environmental risk assessment. HAR Section 11-281-78 (UST Site Cleanup Requirements) allows for the use of approved, "site-specific" action levels at leaking underground storage tank sites provided that all potential environmental concerns are addressed. The updated EALs meet this requirement. Action levels from the 1995 document and the 2005 document should not be mixed, however.

Either one document or the other should be referred to unless otherwise approved by the Solid and Hazardous Waste Branch.

Q: **Should I use the May 2005 EALs at Leaking Underground Storage Tank sites, even if this is not required?**

A: This depends on the nature and status of the site. A review of cleanup levels at sites that have already been closed or at sites where cleanup levels have already been approved is not necessary.

As indicated above, the May 2005 EALs may be used at sites where investigation and cleanup actions are still underway via a "site-specific" environmental risk assessment. Updated EALs for ethylbenzene may reduce the scope of cleanup needed at many sites, especially where cleanup is being driven by groundwater protection concerns. At sites being redeveloped for residential purposes, additional screening of TPH levels in shallow soils for potential nuisance concerns (odors, staining, etc.) is prudent. This allows the property owner and developer to identify areas where potential cleanup of contaminated soils beyond typical toxicity and leaching concerns may be needed and helps avoid unexpected delays and disposal costs during redevelopment. Although final action levels for petroleum-related releases are not significantly affected, the updated EALs also take into account potential vapor intrusion concerns and subsequent impacts to indoor air.

Q: Can I still use the 1995 Action Levels?

A: Yes. The 1995 action levels (and 1996 updates) can be used until such time that HAR Chapter 11-281 ("Underground Storage Tanks"), including HAR Section 11-281-78 (UST Site Cleanup Requirements), is formally revised (anticipated early 2006). As discussed above, action levels from the two documents should not be mixed except as discussed in the May 2005 document (e.g., soil action levels for high rainfall areas).

The May 2005 EAL document will be revised and updated on a regular basis. Comments and suggestions from the general public are welcome at any time. Updates will be posted to this website and notification sent to persons on the EAL mailing list. Workshops to present and discuss the EALs will also be held periodically. To provide comments or be included on the mailing list for updates and workshop announcements, please contact:

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Telephone: 1-808-586-4328
E-mail: rbrewer@eha.health.state.hi.us

Attachment 2

Hawaii Underground Storage Tank Technical Guidance Manual (March 2000), Appendix 7-e: Recommended Sampling and Analysis Procedures (water)

[redacted]

WATER SAMPLING

Surface Water Sampling

Representative concentrations of the contaminants of interest in water samples should be assured by taking the following precautions in obtaining field samples.

1. Prior to the initial sampling, decontamination procedures should be followed on all equipment [redacted] to prevent the introduction of contaminants by outside sources.

2. Samples from shallow depths can be readily collected by merely submerging the sample container. The container's mouth should be positioned so that it faces upstream, while the sampling personnel are standing downstream so as not to stir up any sediment that may contaminate the sample.

3. To avoid aeration of the sample, the sample container should be held at an angle so that the stream of water flows down the side. The sample container should be filled until it overflows and the lid carefully screwed on. Zero headspace in the sample container should be ensured by inverting the vial and carefully tapping on the cap. If air bubbles appear, remove the cap and add enough sample water to produce an inverted meniscus. Cap and repeat the check for air bubbles.

4. Collecting a representative sample at depth or from a larger body of surface water is difficult but not impossible. Samples should be collected near the shore if possible. If boats are used, the body of water should be cross-sectioned, and samples should be collected at various depths across the water in accordance with the specified sample location plan. For this type of sampling, a weighted-bottle sampler is used to collect samples at any predetermined depth. The sampler consists of a glass bottle, a weighted sinker, a bottle stopper,

and a line that is used to open the bottle and to lower and raise the bottle during sampling. The procedure for use is as follows:

a. Gently lower the sampler to the desired depth so as not to remove the stopper prematurely.

b. Pull out the stopper with a sharp jerk of the sampler line.

c. Allow the bottle to fill completely, as evidenced by the cessation of air bubbles.

d. Raise the sampler and cap the bottle.

e. Wipe the bottle clean. The bottle can also be used as the sample container.

5. Samples for volatiles should be placed in three 40 mL volatile organic analysis (VOA) bottles provided by the analytical laboratory. These sample bottles are screw-top vials with Teflon-lined silicone septa. Sample bottles should not be rinsed prior to sampling, and should be placed in the ice chest immediately after labeling.

6. Duplicate samples, when collected, should be taken immediately after the field sample. Decontamination procedures are not necessary between sampling for the field sample and the duplicate.

7. Field samples, field duplicates, and trip blanks should be labeled in sequence and individually placed in plastic bags to prevent cross-contamination. Chain of custody and sample analysis request forms should accompany each shipment of samples to the laboratory, listing the analyses to be performed and the QA/QC criteria for laboratory duplicates and matrix spikes. All samples should be packed in a cooler on blue ice (at 4°C) in such a way as to prevent breakage. A thermometer should be placed in the cooler during transport.

Groundwater Sampling. Groundwater samples should be obtained from monitoring wells in accordance with the procedures set forth in this section. All monitoring wells intended for use in groundwater sampling programs are required to be designed and constructed in accordance with Department of Health (DOH) guidelines set forth in this section and the HIDOH document titled draft *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan* dated December 1996. An example groundwater monitoring well construction design is provided in Figure 7E.2. DOH does not set restrictions on the minimum

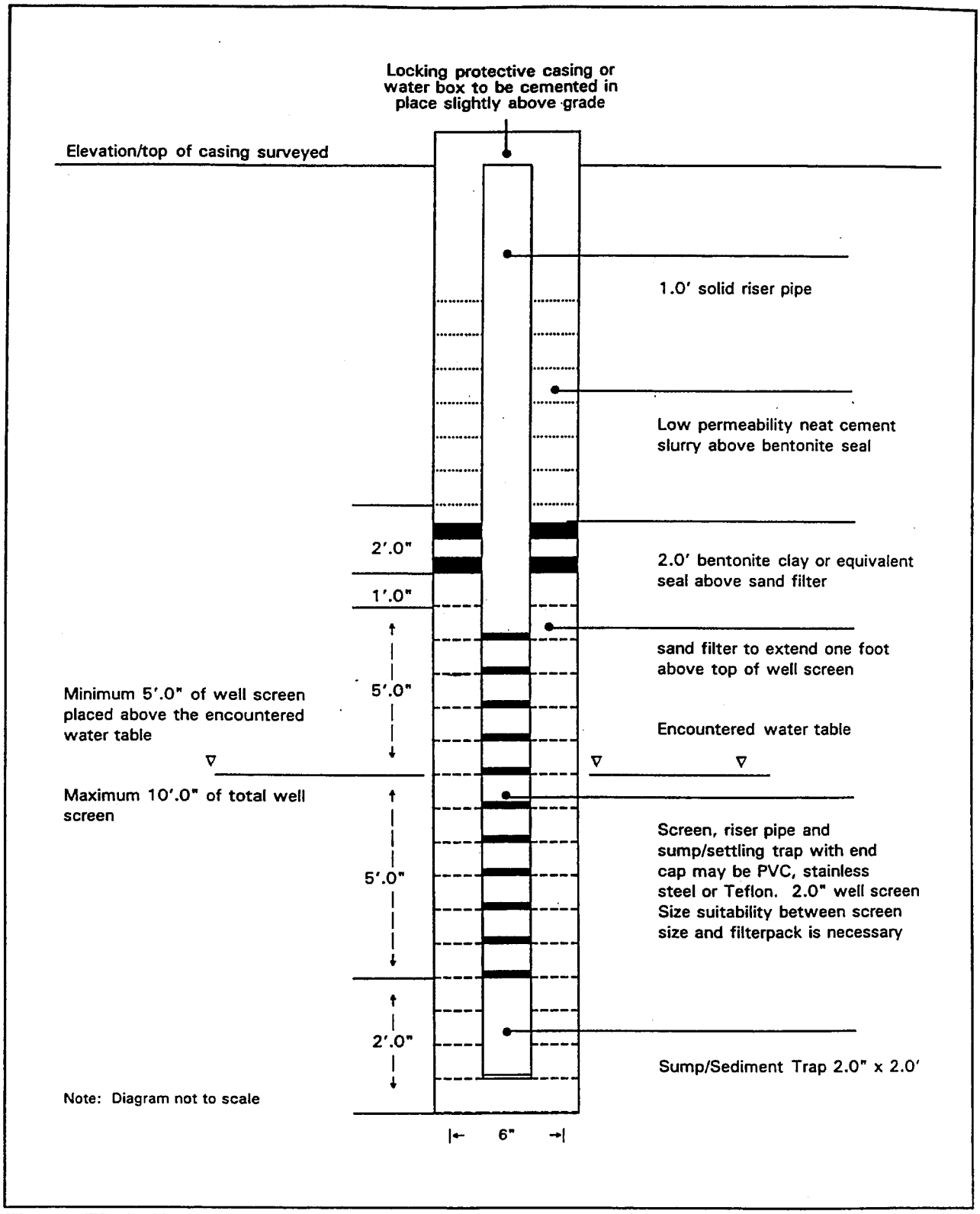

Figure 7E.2 Example Ground-water Monitoring Well Construction Detail

allowable diameter of a monitoring well provided that the well is constructed in accordance with the above-stated guidelines. While the diameter of a monitoring well strongly effects the present and future **utility** and **efficiency** of the well, DOH does not consider well diameter to cause a significant negative bias on the **quality** of groundwater samples extracted from the well, provided that standard sampling procedures are adhered to. DOH also does not place restrictions on the use of push-type devices (e.g., Geoprobe, Stratoprobe, etc.) to install small-diameter monitoring wells, again provided that the wells are designed and constructed in accordance with DOH-recommended guidelines.

As noted, small-diameter wells have distinct advantages but site-specific considerations must be taken into account before deciding on the well diameter most appropriate for a given site. Problems reported to DOH regarding the use of small-diameter wells include difficulties in installing wells in soils or sediments with intermixed, consolidated rock; difficulties in obtaining adequate sample volumes in low permeability soils or sediments; clogging of wells over time; and difficulties in locating the vadose-zone/groundwater interface so that well screens can be properly positioned.

Monitoring wells should be constructed in accordance with the specifications provided in Figure 7E.2. Wells should be developed (bailed, pumped, surged) until a constant minimum turbidity is achieved. Excessive turbidity of water removed from a well may affect sample integrity and may indicate improper well installation. Monitoring well placement should be specified in the sample location plan.

Filtering of Groundwater Samples

Unless otherwise directed by DOH, groundwater samples that are to be tested for non-volatile constituents (Henry's Law Constant $\leq 10^{-5}$ atm-m^3/mol and a molecular weight $\geq$ 200 grams/mol) should be filtered if there is any evidence of turbidity in the samples (e.g., turbidity > 5 NTU), refer to Table 7E.1. Turbidity should be measured in the field during sampling as needed. Filtering of the samples should take place prior to the addition of a preservative in order to prevent leaching of otherwise sorbed-phase contaminants from suspended sediment. Filter pore sizes should be no smaller than 0.45 microns. The methods and equipment used to filter groundwater samples should be clearly described in the text of the groundwater sampling report presented to DOH for review and incorporation into the public file for the facility.

Filtering of samples that are to be tested for volatile contaminants (Henry's Law Constant > 10^{-5} atm-m^3/mol and a molecular weight < 200 gm/mol) should be avoided in order to minimize the loss of contaminants due to volatization during sampling. Based on published partitioning data for low molecular weight, non-surface reactive contaminants (e.g., volatile compounds), the contribution of

Contaminant	[2]Volatile?	[3]OK to Composite Soil Samples?	[4]OK to Filter Groundwater Samples?	OK to Collect Sample With Vacuum-Type Pump?
[1]COMMON UST-RELATED CONTAMINANTS				
Benzene	yes	NO	NO	[5]YES(see note)
Toluene	yes	NO	NO	[5]YES(see note)
Ethylbenzene	yes	NO	NO	[5]YES(see note)
Xylene (mixed)	yes	NO	NO	[5]YES(see note)
Benzo(a)pyrene	no	YES	YES	YES
Acenaphthene	yes	NO	NO	[5]YES(see note)
Fluoranthene	no	YES	YES	YES
Naphthalene	yes	NO	NO	[5]YES(see note)
PCE	yes	NO	NO	[5]YES(see note)
1,1 DCE	yes	NO	NO	NO
Vinyl Chloride	yes	NO	NO	NO
TCE	yes	NO	NO	[5]YES(see note)
1,1,1 TCA	yes	NO	NO	[5]YES(see note)
PCBs (1260 Arochlor)	no	YES	YES	YES
TPH-residual fuels	no	YES	YES	YES
TPH-middle distillates	yes	[6]NO (see note)	[6]NO (see note)	YES
TPH-gasolines	yes	[6]NO (see note)	[6]NO (see note)	YES
[7]OTHER CONTAMINANTS				
Acetone	yes	NO	NO	[5]YES(see note)
Chlorobenzene	yes	NO	NO	[5]YES(see note)
Chloroform	yes	NO	NO	[5]YES(see note)
4,4 DDD	no	YES	YES	YES
4,4 DDE	no	YES	YES	YES
4,4 DDT	no	YES	YES	YES
Di-n-octyl phthalate	no	YES	YES	YES
Ethylene glycol	no	YES	YES	YES
Methylene chloride	yes	NO	NO	[5]YES(see note)
2,3,7,8 TCDD (Dioxin)	no	YES	YES	YES
Chlordane	no	YES	YES	YES
Carbon tetrachloride	yes	NO	NO	[5]YES(see note)

1. Refer to recommended chemical analysis for UST closure and release response (Table 7.2, DOH Technical Guidance Manual - August 1992).
2. Defined as Henry's Law Constant > 0.00001 m^3-atm/mole and molecular weight < 200 gm/mol.
3. For biased-sampling actions, analytical results from composited samples should be multiplied by the number of samples composited to determine the maximum possible contaminant concentration in any one sample. This adjusted value should be used for comparison to applicable DOH action levels.
4. Minimum filter size 0.45μ.
5. Multiply laboratory analytical results by a factor of two for volatile contaminants.
6. Soil and groundwater samples to be tested for TPH may be composited or filtered for release verification purposes only. Any detection of TPH in the samples constitutes a release and requires followup action.
7. Contact DOH for information on contaminants not listed.

Table 7E.1 Allowance for Compositing Soil Samples

sorbed or colloidal phases of these contaminants to total contaminant concentration can be expected to be insignificant. If the collection of highly turbid groundwater samples cannot be avoided at a site (e.g., due to the placement of the monitoring well in clayey, oversaturated lagoonal sediments), then an in-line filter should be used to minimize sample disturbance. Again, this should be clearly described and justified in the text of the report.

Water Level Measurements. Water level measurements are routinely required as part of the sampling program. Collection of water elevations on a continuing basis is important for determining if horizontal and vertical flow gradients have changed since the initial site characterization. A change in hydrologic conditions may necessitate modifications in the design of the ground-water monitoring system or of the corrective action technology being implemented.

The field measurements should include depth to standing water and total depth of the well. This information is required to calculate the volume of stagnant water in the well and to provide a check on the integrity of the well (e.g., identify siltation problems). Each well should have a permanent, easily identified reference point from which its water level measurement is taken. The reference points should be established by an accurate survey and typically located and marked at the north side and top of the well casing with the locking cap removed or on the apron, and, where applicable, the protective casing.

Measure the static water level before removing water from the well for purging or sampling. The well should be allowed to stabilize for a minimum of 24 hours after development of the well or any other withdrawal procedures before a water level measurement is taken. The device used to detect the water level surface must be sufficiently sensitive so that a measurement to $\pm$0.01 foot can be reliably obtained. The water level reading should be recorded on the ground-water sampling data sheet in Figure 7E.3. Three methods of measuring the water level in a well are described below:

1. Electric tape

   Note: The electric tape method should not be used in wells containing free product unless electrical connections are intrinsically safe (explosion proof).

   a. Turn on the switch. Check the batteries by inserting the probe (the tip) into water and noting if the contact between the probe and the water surface is registering clearly.

   b. Rinse the probe with distilled water.

SITE INFORMATION:

Site Name, Date:

Location: _____

UST Facility ID Number: ___ -- ___ ___ ___ ___ ___ ___ Owner/Operator: _____

SAMPLER INFORMATION:

Name: _____ Phone Number: _____

Organization: _____

WELL INFORMATION:

Well Number: _____ Well Location: _____

Depth to Water: _____ ft. Depth of Well: _____ ft. Water Column Height: _____ ft.

Well Diameter: _____ in.

VOLUME OF WATER TO BE REMOVED DURING PURGING:

V = * (D) 2 * 0.041
V = one well volume (gal)
H = height of water column (ft)
D = inside diameter of well (in.)

Well volume, V = _____ gal

V * 3 well volumes = _____ gal V * 5 well volumes = _____ gal

COLLECT SPECIFIC CONDUCTIVITY, TEMPERATURE AND pH MEASUREMENTS INITIALLY AND AFTER EVERY WELL VOLUME IS PURGED

TIME	SPEC. COND.	TEMP	pH	COMMENTS

SAMPLE INFORMATION:

Sample numbers:	Time of Collection:	Total Pre-Sampling Time:

Figure 7E.3 Ground-water Sampling Data Sheet

c. Slowly lower the probe into the well by pulling cable from the hand-held reel.

d. Continue lowering until the bulb lights up, the beeper beeps, or the ammeter needle deflects, indicating that the water table has been reached.

e. Measure the length of cable in the well from a datum point (the top of the casing) or other reference point (look for a mark on or in the casing or some type of "v" etched into the casing) to the nearest 0.01 foot. Subtract this length (depth to the water table) from the reference elevation to determine the water level elevation.

f. Raise the probe until contact with the water has been broken. Lower the probe once again in order to check the measurement reading.

g. Rinse the cable and probe with distilled water.

Note: Multiphase probes are available which audibly indicate the relative position of both nonaqueous phase liquids and aqueous phase liquids. Operation is similar to that of the single phase electric tape probe discussed above.

2. Popper

a. Measure the length of the popper.

b. Rinse the line and popper with distilled water.

c. Lower the popper into the well.

d. Listen for the "pop." You may have to raise and lower the popper several times to make sure you have found the water level.

e. Read the tape measurement from a datum point (the top of the casing) or other prescribed point (look for a mark on or in the casing or some type of "v" etched into the casing) to the nearest 0.01 foot. Add the length of the popper to arrive at the depth to water.

f. Raise the tape approximately 1 foot. Lower the tape once again and repeat steps "d" and "e" in order to check the reading.

g. Subtract the depth to water from the reference point elevation to obtain the water level elevation.

h. Rinse the line and popper with distilled water.

3. Coated tape

Note: The coated tape usually has a weight attached to the end, and it may be necessary to add or subtract the length of the weight from the total water level elevation. Know which type of tape measuring device you intend to use before going into the field.

a. Rinse the lower few feet of the tape with distilled water and dry.

b. Chalk the lower few feet of the tape by drawing the tape across a piece of colored carpenter's chalk.

c. Lower the tape into the well until you hear or feel the tape reach the water surface. Lower the tape a few inches into the water.

d. Read the tape measurement from a datum point (the top of the casing) or other prescribed reference point (look for a mark on or in the casing or some type of "v" etched into the casing) to the nearest 0.01 foot. Record the reading.

e. Withdraw the tape from the well and observe the lower end of the tape. The demarcation between the wetted and unwetted portions of the chalked tape should be apparent.

f. Subtract this value (item d) from the elevation of the top of the casing (from reading item c). This difference is the depth to the water surface.

g. Subtract the depth to water from the elevation at the top of the casing to obtain the water level elevation.

h. Record the well location and number, depth to groundwater, depth to bottom of the monitoring well, reference point used, and other pertinent data on the groundwater sampling data sheet.

i. Rinse the tape with distilled water.

If the presence of free product is indicated, the thickness of the free product layer can be determined using a tape coated with water and hydrocarbon indicator pastes or an intrinsically safe electronic interface probe. In the case of the former,

a steel tape coated with water indicator paste on one side and hydrocarbon indicator paste on the other is lowered into the monitoring well. This should be done so there is as little disturbance of the water surface as possible. The hydrocarbon indicator paste should coat a length of the steel tape that is 2 to 4 inches greater than the estimated thickness of the product. The thickness of the product is measured to the nearest 0.01 foot. As for the interface probe, this instrument is operated similarly to the electric tape device explained above except a different signal should result when product is encountered.

All equipment should be constructed of inert materials and should be decontaminated prior to use at another well to avoid cross- contamination.

Well Purging. The goal in sampling ground-water monitoring wells is to obtain samples that are representative of the aquifer or ground water in question. A representative sample is a volume of water taken from a well whose physical and chemical properties are accurately interpreted to be indicative of conditions in the ground water. Water that stands within a monitoring well for a long period of time may become unrepresentative of the ground water because chemical change may cause water quality alterations. Even if the stored water in the monitoring well may be unchanged from the time it entered the well, the stored water may not be representative of ground water at the time of sampling. In order to obtain a representative sample, the stored water must be removed, or purged, from the monitoring well before samples are collected. The following procedures should be followed for purging monitoring wells.

1. Wells screened in low permeability formations (wells that can be purged dry):

    a. Pump or bail the well dry.

    b. Allow the well to recover after purging.

    c. Purge the well a second time, if time permits.

    d. Collect the sample as soon as there is a sufficient volume of water for the intended analyses; the well does not need to fully recover.

2. Wells screened in high permeability formations:

    a. Pump or bail three to five well volumes.

    b. Do not pump a well dry if the recharge rate causes the formation water to vigorously cascade down the sides of the screen and

causes an accelerated loss of volatiles. Purge the well volumes at a rate that does not cause recharge water to be excessively agitated.

c. Test the ground water for pH, temperature, and specific conductance (see the Field Measurements section below for sampling procedures) after every well volume, or after every 10 minutes, whichever comes first. The pH, temperature, and specific conductance should stabilize with time. This stabilization indicates that water is now being drawn from the aquifer and not from the vincity of the casing. If stabilization occurs before pumping or bailing three to five well volumes, continue to pump or bail until three to five complete well volumes have been purged.

d. Introduce as little air and turbulence into the formation as possible in order to prevent alteration of the samples.

Calculation of the well volume is accomplished by using the following formula:

$$V = (H)(D^2)(C)$$

where:
- V = one well volume, gallons
- H = height of water column, feet
- D = inside diameter of well, inches
- C = 0.041 gallons/(inches)^2 (feet)

The volume in gallons calculated by the above equation must be multiplied by the number of well volumes necessary to adequately purge the well.

Purging of monitoring wells can be accomplished with Teflon or stainless steel PVC bailers or with bladder, peristaltic, gas-lift, centrifugal, or venturi pumps. All pump components that may be exposed to the water, including the discharge tubing, should be constructed of Teflon, stainless steel, or PVC. Some of these pumps cause volatilization and produce high pressure differentials, which result in variability in the analysis of pH, specific conductance, metals, and volatile organic samples. They are, however, acceptable for purging the wells if sufficient time is allowed to let the water stabilize prior to sampling. Do not use purged water for samples since the water is aerated in the purging process.

When purging equipment must be reused, it should be decontaminated, following the same procedures as those required for the sampling equipment. Steps should be taken to prevent surface soils from coming into contact with the purging equipment and lines, which could introduce contaminants into the well. The purged ground water must be stored in a specified waste drum until the water

samples are analyzed and appropriate disposal procedures are determined. The purged water may NOT be dumped on the ground.

Field Measurement Procedures

Several water quality parameters are subject to rapid change when the groundwater is removed from its natural environment and exposed to the atmosphere. Therefore, temperature, specific conductance, and pH must be measured on an unfiltered sample at the time of sample collection.

Field personnel should familiarize themselves with the manufacturer's instructions for use of the pH, temperature, and/or specific conductance meter(s) before going to the field and collecting samples. Calibration of any field-test probes or kits should be done at the beginning of each use according to the manufacturer's specifications.

Temperature.

1. Rinse the thermometer or temperature meter probe with distilled water.

2. Immerse the thermometer or probe into the sample. The thermometer or probe must not be placed in sample containers containing groundwater samples for laboratory analysis.

3. Wait for the temperature reading to stabilize (this may take about a minute).

4. Read and record the temperature to the nearest 0.5°C (or °F). Read the thermometer while it is immersed in the sample.

5. Rinse the thermometer or probe with distilled water.

Specific Conductance.

1. Set up and calibrate the conductivity meter according to the manufacturer's instructions.

2. The specific conductance cell can become coated with oil and other materials. It is essential that the cell be thoroughly rinsed and, if necessary, cleaned between samples.

3. Set the range selector to the desired range for measurement.

4. Measure the temperature of the sample with a thermometer (as above) and set the temperature selector on the conductivity meter to the measured temperature (if required). Whenever possible, samples should be analyzed at 25°C. If samples are analyzed at different temperatures, temperature corrections must be made and resulting specific conductance reading reported at 25°C.

5. Rinse the probe with distilled water.

6. Place the probe into the sample and move it up and down several times to remove the air bubbles inside the cell casing. Rotate the cell slowly in the sample until the reading stabilizes (some meters may require different procedures).

7. Read and record the conductivity measurement. Remember to multiply the reading by the range the dial is set to (see No. 2).

8. Rinse the probe with distilled water.

9. If necessary, correct the measurement to the standardized 25°C.

pH.

1. Set up and calibrate the pH meter with the proper buffer solution according to the manufacturer's instructions.

2. Rinse the electrode thoroughly with distilled water. Coatings of oily material or particulate matter can impair electrode response. These coatings can usually be removed by gentle wiping or detergent washing, followed by rinsing with distilled water. An additional treatment with hydrochloric acid (1:9) may be necessary to remove any remaining film.

3. Immerse the electrode into the sample and if possible gently swirl.

4. Wait for the reading to stabilize.

5. Read and record the pH to the nearest 0.1 unit.

6. Remove the electrode from the sample and rinse the electrode with distilled water.

7. Store the electrode in the buffer solution (following the manufacturer's recommended storage procedure). The electrode should never be allowed to dry out, since it could damage the electrode.

Sampling Procedures. Special care must be taken in order to prevent cross-contamination when carrying sampling equipment from one well to another. The sampling equipment must be cleaned thoroughly prior to sampling each monitoring well. The effects of cross contamination can be minimized by sampling the least contaminated wells first and progressing to the more contaminated ones. Dedicated sampling devices for each well may be desirable in certain cases where the potential for cross-contamination is extremely high.

The decontamination procedure is as follows:

1. Steam clean or scrub equipment with a nonphosphate detergent.

2. Rinse twice with distilled water.

Equipment and procedures that minimize sample agitation and reduce or eliminate contact with the atmosphere during sample transfer must be used in order to eliminate the loss of volatile constituents from the sample. For collecting samples, a Teflon or stainless steel bailer is acceptable as is a gas-actuated positive displacement pump or a submersible pump. Airlift pumps should not be used. Sampling equipment should be constructed of inert materials. Equipment with neoprene fittings, PVC bailers, tygon tubing, silicon rubber bladders, neoprene impellers, polyethylene, and viton are not acceptable. If bailers are used, an inert line, cable, or chain should be used to raise and lower the bailer.

Vacuum-type (e.g., peristaltic) pumps may be used to collect groundwater samples with the following constraints: 1) the pump is operated at a low flow rate (generally < 200ml/minute); 2) contaminants of concern must have a Henry's Law Constant of less than or equal to 0.03 atm-m^3/mol (refer to Table 7E.2); and 3) a 50% sampling loss is assumed for volatile contaminants. Unless otherwise directed or approved by DOH, concentrations of volatile contaminants should be reported as the laboratory analytical results for the contaminant multiplied by two (i.e., following the assumption that 50% of the contaminant was lost during the sample collection).

When sampling for volatile organics, evaluate the area around the sampling point prior to sample collection for possible contamination from air routes. Products that may contaminate the ground-water samples include perfumes, cosmetics, suntan lotions, and automotive products such as gasoline, starting fluids, and carburetor cleaners. Avoid contact of sampling equipment with surface soils surrounding the monitoring wells. Sampling equipment may be laid on polyethylene sheeting.

Before collecting the water sample, mark the sample bottles to be used for the ground-water sample with a waterproof pen. Label the bottle with the name, or identification, of the monitoring well, the date, time the sample was collected, and the sampler's name.

Samples for volatiles should be placed in three 40 mL VOA bottles provided by the analytical laboratory. These sample bottles are screw-top vials with Teflon-lined silicone septa. Sample bottles should not be rinsed prior to sampling.

Procedures for sampling using bailers:

1. Put on latex or surgical gloves.

2. Rinse the bailer and line with distilled water. Use of a disposable bailer and new line at each sampling interval is preferred.

3. Lower the bailer slowly into the monitoring well. Once the bailer has contacted and entered the ground water, allow the bailer to fill with the ground-water sample.

4. Gently raise the bailer out of the monitoring well (do not allow the bailer rope to touch the ground--use plastic sheeting).

5. Empty the bailer into the sample bottles, using a slow, steady stream. Open, or uncap, one volatile organics analyses vial at a time. Fill the VOA vial so that it is slightly overflowing and a positive, or convex, meniscus is formed. Cap immediately. Turn the VOA vial upside down and tap the vial gently. Check for air bubbles. If air bubbles are found, uncap bottle and allow gas to escape, then create a positive meniscus. The bottle should be emptied and refilled as the preservative would be lost. Keep trying until no air bubbles are found in the VOA vial. Any air bubbles in the VOA vial could aerate the sample and void the analysis.

6. Duplicate samples, when collected, should be taken immediately after the field sample.

7. Record all pertinent sampling data on the ground-water sampling data sheet (Figure 7E.3).

8. Decontaminate the bailer. Cut off and discard any of the line that came in contact with the ground water. Decontaminate the remaining line.

9. Place the sample bottles in baggies to prevent cross contamination. If the sample is highly contaminated, wrap the sample bottle in aluminum foil before placing in a baggie.

10. Place the samples in a 4°C cooler with ice. VOA vials may get too cold when they are placed against the ice, and may freeze and crack. Therefore, care should be taken when placing the VOA vials inside the cooler. A thermometer should be placed in the cooler during transport.

11. Carefully remove gloves. Do not touch the outside of the gloves where they may have been contaminated by the ground water. Place the gloves in a designated garbage bag, or a baggie, for proper disposal. Gloves should be changed for each sampling site.

The procedure for sampling using bladder pumps is the same as the procedure for bailers with the exception of the following steps:

1. Positive gas displacement bladder pumps should be operated in a continuous manner so that they do not produce pulsating samples that are aerated in the return tube or upon discharge.

2. When collecting samples where volatile constituents or gases are of interest using a positive gas displacement bladder pump (or a submersible pump), pumping rates should not exceed 100 mL/minute. Higher rates can increase the loss of volatile constituents and can cause fluctuation in pH and pH-sensitive analytes. Samples should be placed in an ice chest maintained at 4°C with blue ice. A thermometer with a protected bulb should be carried in each ice chest.

Attachment 3

Landfill Policies and Procedures for All Users: PVT Land Company, Limited, August 2016

PVT LAND COMPANY LIMITED
87-2020 Farrington Highway • Waianae, Hawaii 96792 • Tel: 808 668-4561 • FAX:808 668-1368 • www.pvtland.com

LANDFILL POLICIES AND PROCEDURES FOR ALL USERS

Enforcement of Policies. Compliance with PVT's policies and procedures is mandatory. PVT reserves the right to deny access to the landfill to any customer, user, transporter or driver who is not in good standing.

Landfill Hours. Landfill hours of operation on Monday through Friday are from 7:00 am to 4:00 pm. The last load of the day must be on the scale by 3:00 pm and scaled out no later than 3:30 pm; no exceptions. Landfill hours of operation on Saturday are 7:00 am to 1:30 pm. The last load of the day must be on the scale by 1:00 pm. and scaled out no later than 1:30 pm; no exceptions. Unless otherwise notified, landfill hours shall not include Sundays and holidays (see PVT website (www.pvtland.com) for Holiday Schedule). Landfill hours of operation are subject to change without notice; PVT reserves the right to close the landfill at any time for any purpose, including but not limited to rain, high winds, and repair and maintenance.

Permitted Materials. User may only dispose at the landfill: (1) materials which originate from construction or demolition sites, including concrete, hollow tile, bituminous concrete, asphaltic pavement, wood, glass, masonry, roofing, siding, plaster, dirt, rock, stumps, boulders and brush, as defined in Chapter 342H, Hawaii Revised Statutes, and Title 11, Administrative Rules Chapter 58.1, Solid Waste Management Control, as may be amended, (2) petroleum-contaminated soil with required Agreement and pre-approval, (3) contaminated soil from construction and demolition operations with required Agreement and pre-approval, (4) petroleum-based liquids for solidification and (5) asbestos waste. Permitted materials will only be accepted with the required Agreements and pre-approvals

Prohibited Materials. User shall not dispose at the landfill: (1) household waste, garbage, commercial solid waste or industrial solid waste as defined in HAR 11-58.1-03, (2) regulated hazardous wastes and TSCA-regulated PCB contaminated materials, (3) pesticide containers, (4) bulk green waste (grass, leaves, tree trimmings, etc.), loads of land clearing debris or C&D waste containing more than 10 percent green waste, (5) whole tires or car parts, (6) free liquids and liquids products, including paints, solvents, sealers or adhesives (except liquids accepted for solidification), (7) white goods, (8) contaminated C&D loads, and (9) lead-acid batteries.

As stated, household wastes, including household hazard wastes are prohibited. For information on the proper disposal of household wastes, please call the City and County of Honolulu Refuse Division at 808-523-4774. THESE WASTES WILL NOT BE ACCEPTED AT PVT:

Living Room	**Kitchen**	**Bathroom**	**Storage Shed**
glass cleaner rug	oven cleaner	toilet bowl cleaner	oil based paint
shampoo	ammonia drain	disinfectant	paint thinners
insecticides flea	cleaner floor	mildew remover	lacquer, varnish
collar flea bomb	stripper metal	home perm.	adhesives
furniture polish	polish insect spray	medicine	epoxies
rubber cement	rodent killer roach	nail polish remover	paint stripper
mothballs	poison	lice/flea shampoo	photographic chemicals
		bleach	herbicides
			pesticides
			insect repellent

Garage:
Motor oil, antifreeze, car batteries, brake/transmission fluid, engine degreasers, carburetor cleaners, gasoline, gunk remover, cleaning solvents of any type are all deemed unacceptable.

User Responsibilities. User is responsible for screening, examining and inspecting all of User's loads to verify that no load contains any prohibited materials. PVT assumes no responsibility for screening, examining or inspecting any loads delivered by User, except that PVT reserves the right to examine, screen and/or inspect any load at any time. If any load contains any prohibited materials, User is responsible for the removal of such loads or prohibited materials, and any additional fees for the processing and removal of such loads and prohibited materials, as determined by PVT.

Pre-approval of all Permitted Materials. All materials to be landfilled must be approved by PVT prior to acceptance. User shall submit to PVT the completed and executed Request for Clearance form (available on PVT's website (www.pvtland.com) or at PVT's office) no less than seven (7) business days prior to commencement of the demolition or scheduled hauling of Permitted Materials to the landfill. Failure to comply with this paragraph may result in the denial of acceptance for disposal at the landfill. PVT reserves the right to inspect all demolition sites and contaminated soil sites prior to the acceptance of Permitted Materials.

PVT's Right of Rejection. PVT reserves the right to reject any load where PVT believes, for any reason, said load may contain Prohibited Materials. PVT reserves the right to reject any load which may be a violation of its solid waste permit or any laws, rules or regulations (federal, state or local) now or hereafter in effect, or any load which would adversely impact the landfill.

POLICIES AND PROCEDURES FOR DRIVERS WHILE AT THE LANDFILL

Speed Limits. The speed limit at the landfill is 15 miles per hour. This speed limit will be strictly enforced.

PVT Instructions. Drivers of all vehicles must follow the instructions of PVT spotters and other PVT employees.

Vehicle noise. All customer-owned vehicles must be operating with fully functional mufflers and be in a good state of repair while on the landfill. Quiet operating techniques and practices must be followed. There shall be no engine braking. Vehicle horns may not be used except in the event of an emergency. Drivers must turn-off their engines while queuing for the scale house or while parked at the landfill.

Cover Loads. Drivers of non-household vehicles must cover their loads.

Lualualei Naval Road. Lualualei Naval Road is owned by the United States Navy. The Navy has posted no parking signs along the road. Drivers and operators of all vehicles should obey the posted signs and should refrain from stopping and/or parking along the shoulders of Lualualei Naval Road.

Landfill parking. Drivers are not permitted to park at the landfill except in the area designated for drivers to make phone calls to dispatchers, finish paperwork or wait for the next job. All vehicles must leave the landfill at the close of operating hours; there is no overnight parking. In the event that a customer's vehicle breaks down and cannot be driven from the landfill, PVT may in its discretion allow the vehicle to remain at the landfill for up to 24 hours subject to the terms and conditions of an executed Temporary Parking Agreement. Under no circumstances shall a vehicle remain for more than 24 hours; if the vehicle is not removed, PVT will have the vehicle removed from the landfill at the owner's expense.

Unloading at the landfill. Drivers are required to unload their loads at the landfill as directed by spotters or other PVT employees. If a driver is unable to unload debris from the truck, trailer or bin, PVT may in its discretion assist with the removal of debris from the truck, trailer or bin subject to the terms and conditions of an executed Additional Services Agreement.

POLICIES AND PROCEDURES FOR ASBESTOS DISPOSAL

Landfill hours. The landfill will only accept asbestos on Tuesdays and Thursdays from 7:00 am to 1:30 pm. All asbestos loads must be scheduled twenty-four (24) hours before delivery. Last asbestos loads must be on the scale by 1:30 pm. Last hand unloads for asbestos loads must be on the scale by 1:30 pm. Scheduled loads that are not received by the required time will require re-scheduling for future delivery and acceptance. Landfill hours of operation are subject to change without notice; PVT reserves the right to close the landfill at any time for any purpose, including but not limited to rain, high winds, and repair and maintenance.

Permitted Asbestos Materials. User may dispose non-friable and friable asbestos, such as roofing, ceiling and insulating materials, and fixed asbestos, with required Agreements and pre-approvals.

Asbestos Containment and Labelling. All asbestos containing material ("ACM") that is brought into landfill is required to be prepared for disposal as though the ACM were friable, even if it has been determined to be non-friable. All ACM must be thoroughly wet down or encapsulated prior to containment by the operator preparing the debris for disposal. All ACM must be double bagged or double wrapped in plastic with a minimum thickness of six (6) millimeters, or contained in sealed drums or barrels. All bagged, wrapped, or contained ACM must display asbestos hazard warning labels, as well as labels that have the owner's name, address and telephone number. Any chemical (e.g., solvent used to remove VAT mastic) added to the ACM waste must be pre-approved by the landfill's Operation Manager prior to acceptance for disposal.

Asbestos Pre-approval. PVT will accept ACM on a prearranged basis only. A Request for Clearance Number form and an Asbestos Notification of Demolition and Renovation form must be completed and submitted to the PVT Office in advance of any ACM being accepted for disposal. All asbestos loads must be scheduled twenty-four (24) hours before delivery and accompanied by a properly executed Asbestos Waste Shipment Record. Each Asbestos Waste Shipment Record must be signed by both the operator and transporter hauling the ACM to the landfill. No disposal will be allowed without a complete Asbestos Waste Shipment Record. All other applicable State and Federal Regulations concerning this waste stream must be met prior to acceptance of this waste stream for disposal. It is the responsibility of the User to know and comply with these regulations.

Asbestos Contractors and Transporters. All asbestos contractors and transporters must have an active account with PVT. All contractors and transporters must provide a local telephone number for emergency purposes.

Asbestos Disposal. Each asbestos load accepted for disposal will be escorted and directed where to unload. The PVT escort will stand a safe distance away from the unloading area and truck, while viewing the load disposal. The transporter must make every reasonable effort to avoid the release of any ACM at the landfill. A qualified individual must accompany the load and observe disposal. If the asbestos load breaks open upon disposal and ACM is exposed, the qualified individual must cover the exposed area promptly. All asbestos will be covered at the end of the day. No bags will be left exposed.

Asbestos Records. The Weigh Master for PVT will be responsible for signing the Asbestos Waste Shipment Record, printing a tag and returning copies to the driver.

PVT's Right of Rejection. PVT reserves the right to reject any load where PVT believes, for any reason, said load may contain Prohibited Materials. PVT reserves the right to reject any load which may be a violation of its solid waste permit or any laws, rules or regulations (federal, state or local) now or hereafter in effect, or any load which would adversely impact the landfill.

POLICIES AND PROCEDURES FOR CONTAMINATED SOIL

Landfill hours. The landfill will only accept contaminated soil from 7:00 am to 3:00 pm, Monday through Saturday. All contaminated soil loads must be scheduled twenty-four (24) hours before delivery. The last contaminated soil load must be on the scale by 3:00 pm. Monday through Friday, and by 1:00 pm Saturday. Scheduled loads that are not received by the required time will require re-scheduling for future delivery and acceptance. Landfill hours of operation are subject to change without notice; PVT reserves the right to close the landfill at any time for any purpose, including but not limited to rain, high winds, and repair and maintenance.

Permitted Contaminated Soil. User may dispose petroleum-contaminated soil and contaminated soil from construction and demolition operations with required Agreements and pre-approvals.

Contaminated Soil Pre-approval. PVT will accept contaminated soil on a prearranged basis only. Only contaminated soil from known sources will be accepted for disposal. Generators must provide reliable documentation describing the nature and source of the contamination. The following forms must be completed and submitted to the PVT Office in advance of any contaminated soil being accepted for disposal: Request for Clearance Number and Soil Profile Sheet. The Soil Profile Sheet must be signed by both the generator and the transporter hauling the contaminated soil to the landfill. All contaminated soil loads must be scheduled twenty-four (24) hours before delivery. All other applicable State and Federal Regulations concerning this waste stream must be met prior to acceptance of this waste stream for disposal. It is the responsibility of the generator to know and comply with these regulations.

Contaminated Soil Testing Requirements. All potentially contaminated soil must be tested prior to acceptance for disposal. All soil that may have been impacted by contamination or that was generated as a result of a remedial activity for contamination must be tested. Testing must be designed to screen for potential constituents and their concentrations in the soil. Sampling and analysis of contaminated soil shall be performed in accordance with the Department of Health, Office of Hazard Evaluation and Emergency Response ("HEER") Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan, as updated ("TGM"). Persons conducting the sampling must be qualified and experienced environmental professionals. Soil samples must be collected so as to be representative of the soil to be disposed. *See, e.g.,* TGM Section 4, Soil Sample Collection Approaches; *see also* "Guidance for the Evaluation of Imported and Exported Fill Material, Including Contaminant Characterization of Stockpiles," HEER, October 2011. Soil samples must be collected and analyzed so as to provide accurate information on the soil to be disposed. *See, e.g.,* TGM Section 11, Handling and Analysis of Samples. The following chemical testing is required where appropriate to the potential source of contamination:

- Toxicity Characteristic Leaching Procedure (TCLP) for Resource Conservation and Recovery Act (RCRA) metals, including arsenic, cadmium, chromium and lead
- Ignitability
- Total metals for RCRA metals, including arsenic, cadmium, chromium and lead.
- Total petroleum hydrocarbons (TPH), including TPH as gasoline, TPH as diesel, and/or -TPH as oil as appropriate
- Benzene, toluene, ethylbenzene, xylenes (BTEX)
- Polynuclear aromatic hydrocarbons (PAHs)
- Polychlorinated biphenyl's (PCBs)
- Halogenated volatile organic compounds (HVOCs)
- Toxic Equivalent (TEQ) dioxins
- Technical chlordane and other organochlorinetermiticides
- Other contaminants for which HEER has set Environmental Action Levels (EALs)

Additional testing and/or supplemental information on the soil may be requested on a case-by case basis.

Contaminated Soil Documentation Requirements. Documentation of the sampling methods and analytical results must be submitted with the Request for Clearance Number and the Soil Profile Sheet.

PVT's Right of Rejection. PVT reserves the right to reject any load where PVT believes, for any reason, said load may contain Prohibited Materials. PVT reserves the right to reject any load which may be a violation of its solid waste permit or any laws, rules or regulations (federal, state or local) now or hereafter in effect, or any load which would adversely impact the landfill.

POLICIES AND PROCEDURES FOR PETROLEUM-BASED LIQUIDS FOR SOLIDIFICATION

Landfill hours. The landfill will only accept petroleum-based liquids from 7:00 am to 2:00 pm, Monday through Friday. All petroleum-based liquid loads must be scheduled twenty-four (24) hours before delivery. The last petroleum-based liquid load must be on the scale by 2:00 pm. Scheduled loads that are not received by the required time will require re-scheduling for future delivery and acceptance. Landfill hours of operation are subject to change without notice; PVT reserves the right to close the landfill at any time for any purpose, including but not limited to rain, high winds, and repair and maintenance.

Permitted Petroleum-Based Liquids. User may dispose liquid wastes containing only known sources of petroleum products for solidification ("petroleum-based liquids") with required Agreements and pre-approvals.

Petroleum-Based Liquids Pre-approval. PVT will accept petroleum-based liquids on a prearranged basis only. Only petroleum-based liquids from known sources will be accepted for solidification. Generators must provide reliable documentation describing the origin and contaminant anticipated in the petroleum-based liquids. The following forms must be completed and submitted to the PVT Office in advance of any petroleum-based liquids being accepted for solidification: Request for Clearance Number and Solidification Profile Sheet. All petroleum-based liquids must be scheduled twenty- four (24) hours before delivery. All other applicable State and Federal Regulations concerning this waste stream must be met prior to acceptance of this waste stream for solidification and disposal. It is the responsibility of the generator to know and comply with these regulations.

Petroleum-Based Liquids Testing Requirements. All petroleum-based liquids must be tested prior to acceptance for solidification. Sampling and analysis of petroleum-based liquids shall be performed in accordance with the Department of Health, Office of Hazard Evaluation and Emergency Response ("HEER") Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan, as updated ("TGM"). Persons conducting the sampling must be qualified and experienced environmental professionals. Samples must be collected and analyzed so as to provide accurate information on the petroleum-based liquids for solidification. *See, e.g.,* TGM Section 11, Handling and Analysis of Samples. The following chemical testing is required where appropriate to the potential source of contamination:

- TCLP for RCRA 8 metals
- Volatile organic compounds
- Semivolatile organic compounds
- PCBs
- Pesticides
- Herbicides
- TPH

Additional testing and/or supplemental information on the petroleum-based liquids may be requested on a case-by case basis.

Petroleum-Based Liquids Documentation Requirements. Documentation of the sampling methods and analytical results must be submitted with the Request for Clearance Number and the PVT Solidification Profile Sheet.

PVT's Right of Rejection. PVT reserves the right to reject any load where PVT believes, for any reason, said load may contain Prohibited Materials. PVT reserves the right to reject any load which may be a violation of its solid waste permit or any laws, rules or regulations (federal, state or local) now or hereafter in effect, or any load which would adversely impact the landfill.