Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater

Volume 1: User's Guide

Hawai‘i Edition

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DISCLAIMER

This document, *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater* (Fall 2017), is a technical report prepared by staff of the Hawai'i Department of Health (HDOH), Environmental Management Division. The document updates and replaces the Summer 2016 edition of the same document. A summary of 2017 updates is provided in Appendix 9.

The document provides guidance for identification and evaluation of environmental hazards associated with contaminated soil and groundwater. The Environmental Action Levels (EALs) presented in this document and the accompanying text are specifically *not* intended to serve as: 1) a stand-alone decision making tool, 2) guidance for the preparation of a baseline environmental risk assessment, 3) a rule to determine if a waste is hazardous under the state or federal regulations, or 4) a rule to determine when the release of hazardous substances must be reported to the HDOH.

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Executive Summary

This document presents guidance for the expedited identification of environmental hazards associated with contaminated soil and groundwater and the preparation of *Environmental Hazard Evaluation* (EHE) reports. This guidance should be used in conjunction with the Hawai‘i Department of Health (HDOH) HEER Office *Technical Guidance Manual* (HDOH 2016 and updates). The use of *Decision Unit* (DU) and *Multiple-Increment Sample* (MIS) investigation approaches is required for comparison of site data to *Environmental Action Levels* (EALs) and final decision making presented in this guidance. A companion,“Tropical Pacific” edition of this guidance has been prepared for use in the Commonwealth of the Northern Mariana Islands and Guam (TPEHE 2017 and updates; check with the local, overseeing regulatory agency for concurrence to use the guidance).

Refer to the HDOH *Technical Guidance Manual* (TGM) for guidance on the collection and analysis of samples for comparison to EALs (HDOH 2016). The EALs apply to the *mean* concentration of the contaminant for the targeted “Decision Unit (DU)” area and volume of media investigated, in the same manner as if the entire DU could be submitted to the laboratory and tested as a single sample. The EALs are not intended for direct comparison to individual, “discrete” sample data collected within a subarea or volume of a targeted DU beyond simple screening purposes. This is a fundamental principal of sampling theory. This approach is well developed for soil, as discussed in Sections 3, 4 and 5 of the TGM, with final decisions to be based on Multi Increment sample rather than discrete sample data. Development of methods to better apply the concept of DUs to soil vapor are currently underway. The concept is already well developed for testing of indoor air (refer to Section 7 of the HDOH TGM).

An EHE should be carried out at all sites where contaminated soil or groundwater is identified. A brief but properly prepared EHE will in most cases replace what is traditionally referred to as an environmental “risk assessment.” An important part of the EHE is the use of pre-approved EALs included in the lookup tables and *EAL Surfer* included with the EHE guidance (referred to as *Environmental Screening Levels* or *ESLs* in the Tropical Pacific edition of the guidance). The EALs are used to rapidly screen soil, soil vapor, and groundwater data collected for a site and identify potential environmental hazards. Under most circumstances, and within the limitations described, the presence of a chemical in soil, soil vapor, or groundwater at concentrations below the corresponding Tier 1 EAL can be assumed to not pose a significant threat to human health and the environment. This allows sites or portions of sites with minimal or no contamination to be quickly cleared for potential environmental concerns, a task which could easily take months or even years using a traditional, environmental risk assessment approach.

Site-specific risk assessments for contaminants in soil were reasonable in the 1980s when only a small number of cases were being investigated. The caseload exploded in the late 1980s and early 1990s, however, and agencies were overwhelmed with case work. This was highly detrimental to the regulated community from a legal and financial perspective, with the average time required to prepare, review and accept a risk assessment exceeding a year. This spurred the publication of conservative, but usually optional, soil action (screening) levels in the early 1990s by the U.S. Environmental Protection Agency (USEPA) and a progressively increasing number of states, with HDOH publishing the first edition of action levels in 1995.

The EALs incorporate an enormous amount of technical expertise across fields as diverse as toxicology, geology, chemistry, physics, ecology, engineering and even economics. Much like driving a car, however, it is not necessarily to understand the technical intricacies of the EALs in order to use them. As potential environmental hazards are identified, additional expertise can be brought in as deemed necessary and cost-beneficial for remediation of the contamination.

Exceeding the Tier 1 EAL for a specific chemical does not necessarily indicate that the contamination poses significant environmental concerns, only that additional evaluation is warranted. A detailed review of specific hazards and preparation of alternative action levels can be carried out at the discretion of the responsible party if time- and cost-beneficial (or as otherwise required by the HEER Office). This can include the preparation of a detailed, human health or ecological risk assessment, although this level of effort will rarely be required for typical sites.

An EHE serves as the link between site investigation activities and the selection of final response actions. The site investigation can be modified to ensure that adequate types and amounts of data are collected as potential environmental hazards are identified. For example, soil vapor should be collected if a comparison of initial soil or groundwater data to action levels indicates a potential vapor intrusion hazard. Once the site investigation and EHE are completed, *Environmental Hazard Maps* can be prepared to summarize the findings of the investigations and serve as a tool to help guide and design subsequent remedial efforts. The type of remedial actions required at the site will vary, depending on the nature of the environmental hazards identified (e.g., soil removal or capping to address direct exposure or leaching hazards versus soil vapor extraction to address vapor intrusion hazards).

The following information should be included in an EHE (or included in a report that contains the EHE):

1. **Site History:** Brief summary of the site history and operations that lead to the release of hazardous chemicals.
2. **Past Investigations and Remedial Actions:** Overview of past investigations and remedial actions.
3. **Extent and Magnitude of Contamination:** Summary of the extent and magnitude of contamination in soil, soil vapor and/or groundwater above Tier 1 EALs, clearly depicted on to-scale maps of the site.
4. **Identification of Potential Environmental Hazards:** Identification of potential environmental hazards by comparison of site soil, soil vapor and/or groundwater data to Tier 1 EALs as well as action levels for specific hazards (latter especially important at sites where full cleanup to the Tier 1 EALs will not take place or alternative action levels will be considered).
5. **Detailed Evaluation of Specific Environmental Hazards (optional):** Detailed evaluation of specific environmental hazards using approaches described in this document or alternative approaches approved by HDOH.
6. **Conclusions and Recommendations:** Provides a summary of EHE findings and recommendations for follow-up actions.

The level of detail needed in the EHE will vary depending on the nature of the contamination and anticipated cleanup actions. A basic EHE should be used to screen for potential environmental hazards, identify data gaps and complete the site investigation. The completed EHE should conclude with recommendations for follow-up actions, such as no further action, collection of additional data to better evaluate a specific environmental hazard, or evaluation of remedial alternatives. At sites where full cleanup is not possible, an “as-built” EHE should be used to document the extent and magnitude of remaining contamination as well as potential environmental hazards posed by the contamination in the absence of institutional or engineered controls. This “as built” EHE serves as the basis for an *Environmental Hazard Management Plan* (EHMP) that describes ongoing measures to be taken to ensure that the contamination is properly managed in the future.

The Tier 1 EALs presented in the lookup tables are NOT regulatory "cleanup standards". Site-specific action levels and cleanup levels are, however, subject to the approval of HDOH. EALs presented for chemicals that are known to be highly biodegradable in the environment may be excessively conservative

for use as final cleanup levels (e.g., many petroleum-related compounds). Stand-alone use of the Tier 1 EALs may be inadequate in some cases. Examples include sites with a high public profile that cannot be fully cleaned up and require a detailed discussion of potential risks to human health. Other examples include sites where physical conditions differ drastically from those assumed in development of the EALs (e.g., mine sites, landfills, etc., with excessively high or low pH) and sites where impacts pose heightened threats to sensitive ecological habitats. Use of the EALs as stand-alone screening criteria or final cleanup levels should be evaluated in terms of overall site conditions and potential environmental hazards, the cost/benefit of developing site-specific cleanup levels as well as the pros and cons of full site cleanup versus long-term management.

The EHE approach described in this guidance is applicable to any site where contaminated soil and groundwater are identified, including sites that fall under the purview of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The guidance will be of particular benefit to small-business owners and property owners with limited financial resources, for whom the preparation of traditional, Superfund-type risk assessments is generally not feasible or even necessary. The guidance is particularly useful as a rapid and cost-effective tool for the evaluation of brownfield or potential brownfield properties. This guidance will be updated as needed, in order to incorporate changes in the referenced sources as well as lessons gained from site investigation and response actions. Comments and suggestions are welcome at any time and should be submitted to the contacts noted at the beginning of this document.

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Introduction

1.1 Environmental Hazard Evaluation

Environmental Hazard Evaluation (EHE) is the link between the discovery of contaminated soil or groundwater during the *site investigation* and *response actions* taken to address this contamination (Figure 1-1). During this step of the overall environmental response process, the significance of potential environmental hazards associated with the contamination is determined. This is carried out initially by comparison of soil, groundwater and/or soil vapor data to pre-approved, Environmental Action Levels (EALs) presented in Tables A through E at the end of this volume. If potential concerns are confirmed, then the specific hazards posed by the contamination are identified, the need for additional data to complete the site investigation is determined and the preparation of appropriate remedial actions is recommended.

Once the site has been adequately characterized, the most appropriate remedial action is determined. For sites where the extent of contamination is minimal or time is of the essence, the most cost-beneficial response may be the immediate removal of the contaminated media. In other cases, the potential cost of remediation or difficulty in accessing the contamination could preclude a complete cleanup. An advanced evaluation of specific environmental hazards is usually warranted at such sites. This may involve the development of site-specific cleanup levels and remedial actions to address the most pressing hazards (e.g., discharges of free product into storm sewers or vapor intrusion into overlying buildings). The extent and magnitude of the remaining contamination and the specific environmental hazards posed by the contamination is then documented in final site investigation and environmental hazard evaluation report. This is then used to prepare an *Environmental Hazard Management Plan* (EHMP) that presents guidelines for long-term management of the contamination and associated institutional and engineered controls.

Environmental Hazard Evaluations are therefore an integral part of site investigations and remedial actions. Site investigations and remedial actions

carried out in the absence of a basic understanding of the environmental hazards posed by contaminated soil or groundwater run the risk of being incomplete. This can result in later, unanticipated requirements for additional actions and unnecessary delays and costs needed to bring the property back into productive use. The guidance presented in this document is intended to help avoid such surprises and make the investigation, evaluation and remedial action process as effective and efficient as possible.

1.2 Targeted Environmental Hazards

A basic understanding of environmental hazards associated with contaminated soil and groundwater is critical in the overall environmental response process (see Figure 1-1). Common environmental hazards that should be initially screened for at all contaminated sites include:

Soil:
- Direct-exposure threats to human health
- Intrusion of subsurface vapors into buildings
- Leaching and subsequent threats to groundwater resources
- Threats to terrestrial habitats
- Gross contamination and general resource degradation concerns

Groundwater:
- Threats to drinking water resources
- Threats to aquatic habitats
- Intrusion of subsurface vapors into buildings
- Gross contamination and general resource degradation concerns

For use in this document, the term "soil" refers to any unconsolidated material found in the subsurface, including actual soil, saprolite, sediment, fill material, etc. Soil data should be reported on dry-weight basis (see Appendix 1, Section 7.3). Tier 1 Environmental Action Levels (EALs for soil presented in this guidance are *not* directly applicable to soil that is situated within the capillary fringe zone or below the water table. This is because the leaching models assume that the soil is not in direct contact with groundwater and the direct-exposure models assume the soils are or could be exposed at the ground surface and are relatively dry (latter increases assumed vapor emissions; refer to following section and Section 2.4).

The soil screening levels are also not applicable to samples of rock or other solid media. If little to no soil is present within a targeted area then no further action

with regards to soil contamination is required (e.g., contaminated soil removed down to bedrock to the extent practicable, with less than a few cubic yards/meters of soil left in place in isolated low areas or fractures).

For comparison, the minimum Decision Unit volume of soil recommended for characterization is 20 cubic yards (HDOH 2016). Although proper management might still be required, for example disposal of grossly contaminated soil disturbed during construction projects, smaller volumes of contaminated soil are not anticipated to pose a significant, long-term risk to human health and the environment under typical site scenarios and no further action under direct, HDOH oversight is warranted. Potential exceptions include the use of contaminated soil in small play areas used by young children. This does not necessarily imply that small volumes of heavily impacted soil do not pose a potential environmental concern, since the presence of isolated "hot areas" within a larger DU can cause the DU as a whole to fail EALs.

A brief description of each hazard is provided in Figure 1-2a. A schematic of common, potential environmental hazards associated with contaminated soil and groundwater is depicted in Figure 1-2b. Detailed discussions of each hazard are provided in Chapters 4 and 5 and in Appendix 1. Additional site-specific environmental hazards that may need to be reviewed on a site-specific basis include the uptake of contaminants in garden produce and the erosion and runoff of contaminated soil into nearby surface water bodies.

Note that several of the environmental hazards listed above are not necessarily "risk-based," at least in the traditional regulatory use of this term. For example, soil that is grossly contaminated with petroleum may not pose a toxicological risk to future residents, but it could pose significant odor and nuisance concerns and in some cases even result in explosive levels of vapors in soil vapor. Although it may seem counterintuitive, it is quite possible (and unfortunately common) for traditional, human health risk assessments to conclude that soil is "nontoxic," even though the soil would ignite if a match was dropped on it. Nevertheless, the fact that the soil is flammable is clearly important to identify and discuss in the Environmental Hazard Evaluation. Gross contamination can also complicate future construction or subsurface utility activities that require disturbance of heavily contaminated soil or groundwater. Leaching of contaminants from soil into groundwater is also important to consider, even though this is often neglected in traditional risk assessments. Discharges of contaminated groundwater or free product into surface water bodies, either naturally or via seepage into storm

sewers or via discharge during construction-related dewatering activities, can likewise pose significant environmental hazards to aquatic habitats.

The environmental hazard that drives the potential need for remedial action at a contaminated site depends on the toxicity and mobility of the targeted contaminants (refer to Appendix 1). Soil contaminated with chemicals that are that are highly toxic to humans and relatively immobile (e.g., arsenic, lead, polychlorinated biphenyls [PCBs], etc.) will usually be flagged for potential direct exposure hazards. Soil contaminated with chlorinated, volatile chemicals that are potential carcinogens (e.g., tetrachloroethylene [PCE] or TCE) or soil contaminated with gasoline or diesel fuel is typically flagged for potential vapor intrusion hazards. Soil contaminated with petroleum, solvents or highly mobile pesticides (e.g., total petroleum hydrocarbon [TPH] gasoline or diesel, benzene, toluene, ethylbenzene and xylenes [BTEX], PCE, atrazine, etc.) will often be flagged for potential leaching hazards. Soil contaminated with pesticides or metals that are relatively non-toxic to humans (e.g., barium, copper, nickel, etc.) can pose significant toxicity hazards to terrestrial flora and fauna and an ecological risk assessment might be require is sensitive habitat have been impacted.

Drinking water toxicity hazards are almost always identified for aquifers contaminated with hazardous chemicals. As is the case for soil, vapor intrusion hazards will often be identified for groundwater contaminated with carcinogenic, volatile chemicals. A number of chemicals pose potential aquatic toxicity hazards at relatively low concentrations, if the groundwater were to discharge into a sensitive aquatic habitat. Free product on groundwater poses gross contamination hazards that could lead to sheens or odor in surface water if allowed to migrate offsite (as well as vapor hazards). Gross contamination hazards could also be identified for drinking water contaminated with chemicals that have a low taste and odor threshold (e.g., TPH, ethylbenzene, toluene, xylenes, methyl tertiary butyl ether [MTBE]).

1.3 Tier 1 Environmental Action levels

Tier 1 *Environmental Action levels* (Tier 1 EALs are concentrations of contaminants in soil, soil vapor and groundwater above which the contaminants could pose a potential adverse threat to human health and the environmental. Figure 1-3 summarizes the use of the Tier 1 EALs. Exceeding the Tier 1 EAL does not necessarily indicate that contamination at the site poses environmental hazards. It does, however, indicate that additional evaluation is warranted. This can include additional site investigation and a more detailed evaluation of the

specific, tentatively identified hazards. The action levels, or approved alternatives, can be used to delineate specific areas of the site that require remedial actions. These actions can vary, depending on the hazard present and site conditions. An overview of the development of the Tier 1 EALs is provided in Chapter 2. A detailed discussion of the compilation and development of the EALs is provided in Appendix 1.

1.3.1 EAL Surfer

The EAL Surfer, an Excel-based version of the lookup up tables, makes use of the EALs and the identification of potential environmental hazards at contaminated sites especially easy. The EALs should be rounded to two significant digits for comparison to site data. The EAL Surfer is available for download from the HDOH web page (refer to contact information at beginning of guidance). Use of the EAL Surfer in EHE reports is recommended. Guidance on use of the Surfer and example printouts are provided in Chapter 3.

1.3.2 Use of EALs in Site Investigations

One of the most basic uses of the EALs is to identify potential contaminant of concern (COPCs) and guide completion of the site investigation. The initial list of COPCs established during a review of past site operations can be quickly narrowed down by direct comparison of soil and groundwater data to the Tier 1 EALs. Further consideration of contaminants that do not exceed Tier 1 EALs is not necessary. This assumes of course that existing data are representative of overall site conditions.

The EALs presented in Tables A and B reflect unrestricted land use (e.g., residential allowed) under four scenario where underlying groundwater is or is not a potential source of drinking water and the site is situated >150m or <150m from a surface water body (originally developed for petroleum plumes; Shih et al. 2004). These scenarios are discussed in Section 2.4. The EAL Surfer allows for modification of land use from unrestricted to commercial/industrial only. The resulting EALs are no longer considered Tier 1, however, since a restriction on use of the property might then be required. This can include a restriction on the excavation and offsite reuse of soil impacted the most stringent, Tier 1 EALs (i.e., unrestricted landuse, situated over groundwater that is a source of drinking water and <150 meter from surface water). Refer to the HDOH document *Guidance for Soil Stockpile Characterization and Evaluation of Imported and Exported Fill Materia*l (HDOH 2017) for additional information.

The lateral and vertical extent of contamination should be determined for COPCs that exceed the Tier 1 EALs (or approved, alternative action levels). Delineation of the extent of contamination to laboratory reporting or detection limits is often impracticable and, from a hazard evaluation standpoint, unnecessary. The investigation can be considered complete once the extent of contamination in excess of Tier 1 EALs (or approved alternatives) is accomplished. The use of field screening methods, mobile labs and quick turnarounds in laboratory analyses will help expedite the completion of site investigation activities.

The identification of potential environmental hazards should begin as soon as the first data are received. This will help identify the need for alternative types of data that will be required for more detailed evaluations of specific hazards and completion of the site investigation. For example, if arsenic is reported in soil at concentrations above 24 mg/kg then laboratory bioaccessibility tests should be run on the same sample (refer to Chapter 4). If the reported concentrations of volatile contaminants exceed action levels for vapor intrusion concerns then soil vapor data should be collected. Incorporating these decision rules in the sampling and analysis plan will help expedite completion of the site investigation as well identify potentially significant environmental hazards at the site that could require immediate action.

1.3.3 Use of EALs in Environmental Hazard Evaluations

The most important use of the Tier 1 EALs is the rapid identification of potential environmental hazards associated with contaminated soil and groundwater (refer to Section 2.1). With the exception of gross contamination, most of the environmental hazards noted earlier are not obvious in the field. An initial comparison of site data to the Tier 1 EALs provided in Tables A through E will only indicate if a potential hazard is present (i.e., “yes” or “no”). If the Tier 1 EAL is exceeded, site data should be compared to the detailed action levels used to develop the Tier 1 EAL. The specific, potential environmental hazard(s) associated with the contaminant can then be identified. This process is described in more detail in Chapter 3. As discussed above, use of the EAL Surfer will significantly expedite this process.

Potential environmental hazards identified in a Tier 1, action level EHE can be evaluated on a more site-specific basis as needed (refer to Chapters 3 and 4). The information gained can be used to better define the need for additional site investigation as well as to help develop appropriate remedial options. The level of effort required for advanced evaluations can vary greatly. For example, only a minimal level of effort may be needed to rule out potential hazards to terrestrial

ecological habitats at a highly developed commercial or industrial site that does not contain significant natural habitat. Vapor intrusion is typically a potential hazard at volatile organic chemicals (VOCs) contaminated sites where occupied structures are present (or proposed). The collection of soil vapor data at these sites can be highly useful and in some cases required. A detailed review of groundwater data can replace soil action levels for leaching hazards at sites that have remained uncapped for a sufficiently long period of time for worst-case groundwater impacts to take place.

1.3.4 Use of EALs in Remedial Actions

In cases where contamination is limited, easily accessible and time is of the essence, it can be more cost-effective to aggressively remediate the impacted soil or groundwater to the Tier 1 EALs. The Tier 1 EALs are not strict cleanup standards, however, and should not be used as such. In cases where cleanup costs could be significant or complete cleanup is not practicable, the choice is not so clear and a more advanced evaluation of specific environmental hazards is usually warranted (refer to Chapters 3 and 4). Use of the detailed EALs presented in Appendix 1 of this guidance and, in particular, use of the accompanying *EAL Surfer*, makes the identification of specific, potential environmental hazards relatively quick and easy. The information gained can then be used to evaluate specific environmental hazards in more detail and develop more efficient remedial actions.

Long-term management will be required for sites where contaminated soil and groundwater cannot be remediated in a relatively short time frame. In such cases, the detailed action levels presented in this guidance (or acceptable alternatives) should be used to delineate areas of contaminated soil and groundwater that will require long-term management as well as identify the specific environmental hazards posed by the contamination under uncontrolled site conditions. Specific actions required to address these hazards should then be described in an *Environmental Hazard Management Plan* (EHMP). An overview of EHMPs is presented in Chapter 5 and in the HEER office *Technical Guidance Manual* (HDOH 2016).

1.4 Decision Unit and Multi Increment Investigation Strategies

The use of *Decision Unit (DU)* and *Multi Increment (MI) sampling* methods is strongly recommended for the investigation of contaminated sites. Refer to the Sections 3-5 of the HEER Office *Technical Guidance Manual* for a detailed