ENVIRONMENTAL HAZARD MANAGEMENT PLAN

Building Exterior Soils, Framework for Schools Statewide

Prepared for

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January 4, 2019

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

COPC	chemical of potential concern
EAL	environmental action level
EHMP	environmental hazard management plan
EPA	U.S. Environmental Protection Agency
HDOE	Hawaii Department of Education
HDOH	Hawaii Department of Health
HEER	Hazard Evaluation and Emergency Response
Integral	Integral Consulting Inc.
OCP	organochlorine pesticide
RCRA	Resource Conservation and Recovery Act
SAP	sampling and analysis plan
SOP	standard operating procedure
TCLP	toxicity characteristic leaching procedure
TGM	*Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan*
XRF	x-ray fluorescence

1 INTRODUCTION AND PURPOSE

Integral Consulting Inc. (Integral) was retained by the Hawaii Department of Education (HDOE) to perform an assessment of potential human health hazards in building exterior soils at various schools, and to develop an environmental hazard management plan (EHMP) to support the management of soils containing hazardous substances. Soils with hazardous substances at concentrations above Hawaii Department of Health (HDOH) environmental action levels (EALs) could present a human health hazard if direct exposure through ingestion or inhalation[1] with soil were to occur.

This EHMP "framework" document provides guidance on managing soils with hazardous substances at concentrations above action levels at schools statewide. This document does not provide school-specific guidance, but instead provides a general framework for managing contaminated soils at all schools. The framework is based on a current understanding of building exterior soil contamination at schools, developed from recent soil investigations at 23 schools in the Hilo, Waiakea, Kau, Keaau, Pahoa, and Laupahoehoe complexes (eastern portion of the Hawaii District, island of Hawaii). At these schools, soils were identified with arsenic, lead, and chlordane at concentrations above HDOH action level. As additional soil assessments are conducted at other schools, this EHMP framework document is expected to evolve and become more comprehensive with respect to the variation of soil contaminants and the range of soil management tools to be employed.

[1] Direct exposure with soil may occur by incidental ingestion, inhalation of soil dust, or dermal exposure (soil touching the skin. The dermal exposure route presents less risk than incidental ingestion of soil and inhalation of soil dust for the chemical compounds identified in this study.

2 BACKGROUND

This EHMP framework document has been developed in parallel with building exterior soil assessments (initial assessments) at 23 schools in the eastern portion of the Hawaii District. The schools studied are listed on Table 2-1.

2.1 SUMMARY OF SOIL SAMPLING ACTIVITIES

Two phases of soil assessment were performed at the subject schools. First, a reconnaissance soil assessment (screening assessment) was conducted for arsenic and lead (and other metals if present) using a field portable x-ray fluorescence (XRF) instrument, with a subset of samples analyzed by laboratory methods to confirm XRF results. Surface soils (0–6 in. depth) in open space areas, garden plots, and along building perimeters were evaluated by XRF.

Following the screening assessment, a set of decision units was laid out at each school for multi-increment soil sampling and laboratory analysis of arsenic, lead, and organochlorine pesticides (OCPs). Decision units are logical sampling areas, such as a playground, courtyard, or a building perimeter, in which the average concentration of chemicals of potential concern[2] (COPCs) is sought. Multi-increment soil samples are large (1 to 2 kg mass) samples composed of a number (30 to 50) of small sample increments collected from locations distributed across the decision unit. Multi-increment sampling of decision units is the preferred sampling technique for soil assessments recommended by HDOH in its *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan* (TGM; HDOH 2008).

Soil assessment work at the schools was conducted under a sampling and analysis plan (SAP; Integral 2016), reviewed and approved by HDOE and HDOH. Soil with arsenic, lead, chlordane (or other compounds) at concentrations greater than the HDOH direct-exposure action levels for unrestricted land use could present a human health hazard if direct exposure to soil were to occur. The results of the assessment are provided in a report of findings (Integral 2017).

2.2 EXTENT OF SOIL WITH COPCS ABOVE EALS

The initial soil assessment program consisted of reconnaissance XRF soil screening and limited multi-increment soil sampling of an average of four to five decision units (open spaces, building perimeters, or garden plots) per school. More comprehensive multi-increment soil sampling was conducted at DeSilva Elementary based on the identification of elevated arsenic in building perimeter soils. The main findings of the initial soil assessment project (Integral 2017),

[2] COPCs are elements (such as metals) or chemical compounds that may present a human health hazard by direct exposure if present at concentrations exceeding Hawaii EALs.

consisting of XRF screening and multi-increment soil sampling and analysis program, were as follows:

- Five schools did not have any COPCs in soils above unrestricted land use action levels.
- Four schools had COPCs above unrestricted land use action levels but below commercial/industrial land use action levels.
- Fourteen schools had COPCs above commercial/industrial land use action levels.
- Only three COPCs were identified: arsenic, lead, and chlordane (an OCP).
- Some arsenic and lead was discovered above action levels in open space and garden plot samples, however
- The most prevalent and highest concentrations of COPCs were present in building perimeter soils.
- Soil along perimeters of older buildings (pre-1970) had the highest occurrence of COPCs above action levels. No exceedances of action levels was observed for buildings built after 1980.

3 POTENTIAL ENVIRONMENTAL HAZARDS

This section discusses EALs for the COPCs identified at various schools. EALs are concentrations of contaminants in soil (or other media) above which the contaminants could pose a potential adverse threat[3] to human health and the environment (HDOH 2017a). Concentrations of COPCs above EALs indicate a potential for an adverse threat, but do not by themselves indicate an actual threat is present. EALs are designed to be conservative for screening sites for potential hazards; an exceedance of an EAL typically indicates the need for further assessment considering land use, receptors, and other factors.

HDOH publishes EALs for several land use scenarios, for example "unrestricted land use" (applicable to residential or other high-use scenarios) and "commercial/industrial land use." EALs specifically designed for school scenarios have not been developed, and therefore the unrestricted and commercial/industrial EALs are used in this EHMP to identify potential hazards and the need for mitigation actions. HDOH is considering the use of human health risk assessment to further evaluate potential hazards or to develop school-specific EALs. If such risk assessment is performed, this framework EHMP will be updated accordingly.

3.1 CHEMICALS OF POTENTIAL CONCERN

Prior to conducting sampling and analysis of soil, preliminary COPCs were defined by their likelihood of presence based on historical site activities and operations (e.g., use of lead-based paint, termite treatment of building foundations, etc.). Based on these considerations, arsenic, lead, and OCPs were identified as COPCs. Once sampling and analysis was conducted, any chemical compound that was present in soils at a concentration above certain HDOH EALs was retained as a COPC for this project. Based on the recent soil assessment work conducted at 23 schools in the eastern portion of the Hawaii District, three COPCs exceeded screening action levels[4]: arsenic, lead, and technical chlordane[5] (chlordane).

The EALs (compound-specific concentrations) used for screening soil sample chemical concentrations for this EHMP are provided in Tables 3-1, 3-2, and 3-3, along with the basis for selection as appropriate action levels. For the purposes of this EHMP, these action levels are referred to as "screening action levels," to indicate that they are used to screen results to determine whether soil concentrations of a particular compound could present a potential

[3] The terms "risk" and "hazard" are also commonly used to describe an adverse threat.
[4] One of the 119 soil samples analyzed exceeded, by a small margin, the primary action level for 4,4′-DDD (a degradation product of 4,4′-DDT). Based on this single occurrence, 4,4′-DDD is not considered a COPC at this time.
[5] The term "technical chlordane" is used to describe a mixture of closely related chemicals including chlordane, *cis*-chlordane, *trans*-chlordane, heptachlor, and others. In this EHMP, the term "chlordane" refers to the technical chlordane mixture.

hazard. Additional action levels to define contaminated soil categories and associated mitigation actions (remedies) are identified below in Section 3.2.

3.2 ACTION LEVELS FOR COPCS AT SCHOOLS

For most compounds, the screening action levels are based on HDOH direct-exposure action levels for an unrestricted land use scenario (HDOH 2017a, Table I-1). For example, the lead screening level is set at a value of 200 mg/kg total lead. The two exceptions to these action levels are arsenic and chromium. Arsenic is an exception, where the screening level is based on a value of 23 mg/kg bioaccessible arsenic.[6] In practice, soils are first analyzed for total arsenic; if soils exhibit concentrations of total arsenic greater than 100 mg/kg, then they are considered to have the potential to contain >23 mg/kg bioaccessible arsenic.[7] One may assume soils with >100 mg/kg total arsenic contain >23 mg/kg bioaccessible arsenic, or one may run the *in vitro* laboratory test to measure the actual bioaccessible arsenic content. Arsenic action levels are further described below. The total chromium action level is set at 1100 mg/kg, based on naturally occurring background levels in Hawaii soils (HDOH 2017a, Table K). The hexavalent form of chromium, which is typically formed by man-made processes and is more toxic than other forms, has a lower direct-exposure action level of 30 mg/kg.

The following Sections 3.2.1 through 3.2.3 and related Tables 3-1 through 3-3 describe applicable action levels and soil categories for the COPCs in this study, which are arsenic, lead, and chlordane. Integral, in consultation with the HDOH Hazard Evaluation and Emergency Response (HEER) Office, has developed soil management recommendations based on arsenic, lead, and chlordane soil categories that are specific to school facilities in Hawaii. Tables 3-1 through 3-3 provide an overview of soil categories in both high activity and low activity areas at a school facility. "High Activity Areas" include play areas, picnic areas, athletic fields, garden plots, unpaved parking areas, drop-off and loading areas and any other area where students congregate on a regular basis. "Low Activity Areas" include open spaces not commonly used by students, building perimeters with landscaping that impedes regular access, building maintenance and storage areas, and any other areas where students are not expected to visit or congregate on a regular basis.

[6] Bioaccessible arsenic is the fraction of total arsenic that is extracted from soil using an *in vitro* laboratory test designed to simulate conditions within the human gastrointestinal tract (Drexler and Brattin 2007; Brattin et al. 2013). Only the bioaccessible fraction of arsenic is considered to present a human health risk, not the total amount of arsenic.

[7] This applies to iron-rich volcanic soils where bioaccessible arsenic rarely exceeds 25 percent of total arsenic. For other soil types, or such materials as cinder fill, a lower total arsenic screening value may be more appropriate.

3.2.1 Action Levels for Arsenic-Contaminated Soils

Arsenic is a common soil contaminant in Hawaii, often related to its former use as an herbicide in sugarcane production and as an all-purpose pesticide and herbicide at residential and commercial/industrial locations, and is also naturally occurring at “background” levels in Hawaii’s volcanic soils. In the eastern portion of the Island of Hawaii, arsenic above background levels in soil is widespread on former sugar plantation lands (Cutler et al. 2013). At schools in the eastern portion of the Hawaii District, arsenic was observed above background levels (>24 mg/kg total arsenic) in open spaces, in several garden plots, and along building perimeters. The arsenic in soils of open spaces and garden plots is believed to be due to the presence of former sugarcane field soils at these schools. The highest levels of arsenic observed in soils were along school building perimeters, and are believed to be the result of application of arsenic compounds for either weed or pest control, or both.

HDOH recommends the management of arsenic by evaluation of total and bioaccessible arsenic. Bioaccessible arsenic is the fraction of total arsenic that is extracted from soil using an *in vitro* laboratory test designed to simulate conditions within the human gastrointestinal tract (Drexler and Brattin 2007; Brattin et al. 2013). Only the bioaccessible fraction of arsenic is considered to present a human health risk, not the total amount of arsenic. HDOH (2012) has developed guidance for managing arsenic by formulating four soil categories based on total arsenic (to define background) and bioaccessible arsenic levels (to define relative human health risk): Category A (natural background levels, ≤24 mg/kg total arsenic), Category B (minimally impacted, >24 mg/total arsenic but ≤23 mg/kg bioaccessible arsenic), Category C (moderately impacted, >23 and ≤95 mg/kg bioaccessible arsenic), and Category D (heavily impacted, >95 mg/kg bioaccessible arsenic). The lower concentration thresholds for Category C and D soils are equivalent to the direct-exposure action levels for unrestricted and commercial/industrial land use, respectively (HDOH 2017a, Tables I-1 and I-2).

The HDOH (2012) arsenic soil guidance provides general recommendations for management of soils based on soil category. In Table 3-1, Categories A through D[8] are defined based on total and bioaccessible arsenic concentrations as per the HDOH (2012) guidance described above.

3.2.2 Action Levels for Lead-Contaminated Soils

Soil categories for lead, and general mitigation actions for schools, are provided in Table 3-2. This matrix is a parallel construct to the one prepared for arsenic, with Categories A through D and recommended actions for high and low activity areas. Lead soil categories are defined by various HDOH action levels. Category A (background) soils exhibit lead levels less than or equal to 73 mg/kg. Low risk Category B soils are above background levels, but below the

[8] HDOE and HDOH have agreed on a naming convention for soil Categories A through D as: A) background or negligible risk, B) low risk, C) moderate risk, and D) high risk.

HDOH direct-exposure action level of 200 mg/kg for an unrestricted land use scenario. This action level is applicable to residential settings, and also appropriate for a school setting with young children. Moderate risk Category C soils are above 200 mg/kg lead but less than or equal to 800 mg/kg lead. The 800 mg/kg concentration is the HDOH direct-exposure action level for a commercial/industrial land use scenario, and is applicable to adult school workers and contractors. High risk Category D soils have lead concentrations above the 800 mg/kg action levels for school workers and contractors.

3.2.3 Action Levels for Chlordane-Contaminated Soils

Soil categories for chlordane, and general mitigation actions for schools, are provided in Table 3-3. This matrix is a parallel construct to the matrices prepared for arsenic and lead. Chlordane soil categories are defined by various HDOH action levels, and are slightly different than arsenic and lead. Because chlordane is not a naturally occurring compound, there is no natural background level. Category A soils exhibit chlordane levels less than or equal to 7.0 mg/kg, and are considered to have negligible risk. The action level of 7.0 mg/kg is based on a conservative (highly protective) noncancer hazard quotient of 0.2 (one fifth the concentration where health effects might occur due to direct exposure). Low risk Category B soils have chlordane above the 7.0 mg/kg action level but less than or equal to the HDOH direct-exposure action level of 17 mg/kg for an unrestricted land use scenario. This action level is applicable to residential settings, and also appropriate for a school setting with young children. Moderate risk Category C soils are above 17 mg/kg but less than or equal to 77 mg/kg chlordane. The 77 mg/kg concentration is the HDOH direct-exposure action level for a commercial/industrial land use scenario, and is applicable to adult school workers and contractors. High risk Category D soils have chlordane concentrations above the 77 mg/kg action levels for school workers and contractors.

3.3 SUMMARY OF ENVIRONMENTAL HAZARDS

The building exterior soil testing program, conducted at 23 schools in the eastern portion of the Hawaii District, was designed to screen soils for potential COPCs and determine the likely locations of COPC soil concentrations exceeding actions levels. The sampling and analysis program consisted of reconnaissance XRF soil screening and limited multi-increment soil sampling of an average of four to five decision units (open spaces, building perimeters, or garden plots) per school. The sampling and analysis program was sufficient to allow determination of the presence or absence of COPC action level exceedances, and whether further analysis or potential mitigation might be required.

Integral identified arsenic, lead, and chlordane as COPCs at concentrations above screening action levels. Table 3-4 shows a summary of findings at each school, with shading to indicate the presence of Category C and D soils that will require mitigation action. At most schools, additional soil investigation will be required to fully delineate the extent of Category C and D soils in order to design a comprehensive mitigation program.

In open space areas, arsenic was observed above the screening action level of 23 mg/kg bioaccessible arsenic only at Keaau Middle School. While not identified in surface soils of open space areas at other schools, bioaccessible arsenic above the screening level could be present in subsurface soils covered by fill soils, and not yet identified. For most open space areas, arsenic above natural background concentrations is believed to be primarily the result of historical arsenical herbicide applications to former sugar cane plantings. At several schools, lead was observed in open space areas at Category C concentrations. These open spaces were either adjacent to roadways where historical lead emission from vehicles may have deposited, or near buildings where lead-based paint may have migrated to open space soils. Chlordane, which was used as a termiticide at or beneath building foundations, was not analyzed in open space soil samples.

Along building perimeters, all three COPCs were observed at many schools at Category C and D concentrations. Lead, likely derived from lead-based paint spalling from buildings onto adjacent soils, was the most ubiquitous COPC. Arsenic and chlordane were present along some building perimeters at several schools. The presence of high concentrations (Category D levels) of arsenic along building perimeters at four schools is believed to be the result of historical application of arsenical chemicals for weed or pest (rats or termites) control. The presence of chlordane along building perimeters is believed to be the result of historical termiticide application.

Garden plot soils were analyzed for arsenic and lead. Arsenic was identified at Category D levels in the former garden area of Keaau Middle School[9], which is currently vegetated and not actively used for gardening. Lead was identified above screening action levels, at Category C concentrations, in garden plots at three schools.

The current COPCs in building exterior soils, based on testing at 23 schools in the eastern portion of the Hawaii District, consist of arsenic, lead, and chlordane. It is possible that additional COPCs will be identified at other schools during testing in future hazard assessment phases. Based on soil sampling and analysis experience at various residential, commercial/industrial, and military facilities throughout Hawaii, other OCPs beyond chlordane (such as aldrin and dieldrin) are the most likely additional COPCs to be discovered. It is recommended for additional school soil testing around buildings (pre-1988 construction[10]) that the full analytical suite of OCPs be analyzed in order to detect other OCPs than chlordane, if present.

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[9] The HDOH HEER Office informed Keaau Middle School of the elevated arsenic in the garden upon receipt of 2004 sampling results. The garden area has been revegetated and is not in use.
[10] The U.S. Environmental Protection Agency (EPA) banned all uses of chlordane in 1988.

4 SHORT-TERM SOIL MANAGEMENT ACTIONS

During reconnaissance XRF screening at DeSilva and Kapiolani Elementary schools, very high (total arsenic >1000 mg/kg) arsenic levels were observed along several building perimeters, and multi-increment sampling and analysis was expedited, which confirmed the XRF findings. Bioaccessible arsenic results determined soils were in Category D (high risk). Based on these findings, interim actions (as will be described below) were implemented to cover high arsenic soils. In addition, DeSilva Elementary was more intensely investigated during the follow-on multi-increment sampling program, such that the campus has been fully characterized (i.e., full characterization of surface soils across all areas, not full vertical characterization of COPCs soils at depth).

This section of the EHMP discusses the short-term (near-term) actions that should be taken when evidence of COPCs in soils above action levels is discovered at a school. These include: 1) interim actions to prevent direct exposure to any Category C and D soils; 2) supplemental soil assessment (sampling and analysis) to fully characterize the extent of COPC exceedances of action levels; and 3) the development of school-specific interim EHMPs to guide management of Category C and D soils on school campuses.

School-specific interim EHMPs should be prepared at schools with Category C or D soils, to provide guidance to school staff and contractors on safe practices for contaminated soil management until permanent mitigation remedies are implemented.

Figure 4-1 provides a generalized process flowchart for the assessment and mitigation of building exterior soil hazards. Please refer to this flowchart during discussions of short-term and long-term soil management actions (Sections 4 and 5).

4.1 INTERIM ACTIONS

Interim actions are recommended for soils where COPCs have been identified at higher concentrations—what are described as Category C and D soils. An interim action consists of a short-term remedy to prevent direct exposure through ingestion or inhalation with soil. Table 4-1 provides a summary of acceptable minimum interim actions for Category C or D bare soils that may be immediately implemented.

Of most concern are bare (un-vegetated or otherwise covered) soils with higher COPC concentrations (Category D soils) within high activity areas. For these situations, immediate action is recommended to cover the bare soils with an engineered cap (further discussed in Section 5.2.3). This type of cap is the same design as suitable for a long-term mitigation action. General specifications for the design and construction of interim action caps are provided in

Appendix A. These specifications represent minimum requirements for use by HDOE or its contractors in constructing interim action caps.

For Category C soils in high activity areas, maintaining a landscape cover (such as thick grass, wood chips, cinder, gravel, or stone) is the recommended interim action. For Category C and D soils in low activity areas, interim actions may include either maintaining a landscape cover, or restricting access with fencing. If a landscape cover cannot be implemented at a certain location, a cap (geotextile and clean soil, stone aggregate, or cinder) is the recommended action.

In implementing the interim actions, the highest priority will be generally given to elementary schools, and any other school with daycare or preschool, where young children are present meeting the U.S. Environmental Protection Agency (EPA) definition of child-occupied facilities (as defined in 40 CFR 745, Subpart E), and Category D soil in high activity areas.

4.2 SUPPLEMENTAL SOIL SAMPLING AND ANALYSIS TO FULLY DELINEATE EXTENT OF CATEGORY C AND D SOILS

The initial building exterior soil assessments at 23 schools in the eastern portion of the Hawaii District did not attempt to fully characterize (by multi-increment soil sampling and analysis) all open spaces or buildings perimeters[11], except at DeSilva Elementary where high arsenic levels (total arsenic >1000 mg/kg) were observed. An average of four to five multi-increment soil samples were collected per school for the purpose of identifying the potential for soils with COPCs above action levels.

For most schools, supplemental soil sampling and analysis is recommended to fully delineate the extent of the COPCs. This supplemental work would entail developing a school-specific addendum to the SAP (Integral 2016), which would describe the decision units for multi-increment soil sampling and COPCs for analysis for the soil samples within each decision unit. Upon completion of the supplemental soil assessment work, a soil assessment findings report for each school would be prepared. Based on the findings, a school-specific mitigation action plan can be developed. If any Category D soils are identified during the supplemental soil assessment work, interim actions (per Section 4.1) should be instituted.

If new gardening activities are being considered at any schools, the soil shall be tested by a competent environmental professional to ensure no COPCs are present above action levels. In addition, subsurface excavation work such as conducted for utility upgrades, plumbing, or new building construction should also include an evaluation of the need for testing by a competent environmental professional to ensure COPCs are not above action levels (see Section 6).

[11] All observed garden plots were assessed.

4.3 SCHOOL-SPECIFIC INTERIM EHMP

An EHMP provides an overall framework for managing soils at schools with Category C and D soils. Schools with soils in Categories C or D that are not completely removed and disposed of will require a school-specific EHMP to support short-term and long-term onsite management of these soils. The school-specific EHMP will include descriptions of the extent of Category C and D soils on the property, including a summary of the investigation findings and map(s) depicting the extent and magnitude of Category C and D soils. An "interim" EHMP should be prepared once Category C and/or D soils are identified, after completing the supplemental soil assessment and interim actions (see Figure 4-1).

HDOH provides an outline for the components of an EHMP in the TGM (HDOH 2008, Section 19.6). The EHMP must include:

- Brief summary of the site background and history of contaminant releases
- Identification of the COPCs
- Clear depiction of the extent and magnitude of remaining impacts above EALs in soil (or other environmental media[12]), presented on easily readable, to-scale maps with north arrow
- Identification and discussion of all potential environmental hazards
- Requirements for long-term monitoring of contaminants in soil (or other environmental media)
- Discussion of engineering and/or institutional controls needed to address identified environmental hazards to eliminate exposure pathways
- Guidance on proper handling, reuse, and disposal of soil (or other environmental media) that is encountered during future site activities
- Specific description of construction worker protections and required notifications
- Use restrictions to protect students, staff, workers, guests, and others
- Measures for repair or replacement of engineering controls that are disturbed or breached during future site activities
- Any other information required to adequately mitigate and manage remaining environmental concerns at the site.

[12] Environmental media include soil, soil vapor, sediment, groundwater, surface water, and air.

For large, complex sites where significant public review is anticipated, HDOH recommends preparing a brief fact sheet that summarizes key elements of the EHMP in simple, non-technical terms.

5 LONG-TERM SOIL MANAGEMENT ACTIONS

Short-term actions include fully characterizing Category C and D soils at schools, performing interim actions on Category D (high risk) soils to prevent direct exposure, and preparing school-specific interim EHMPs to manage soils until permanent mitigation actions (remedies) are implemented. Long-term actions consist of the implementation of permanent mitigation actions for Category C and D soils, to manage potential soil hazards over a longer time horizon. These actions include the implementation of engineering remedies (such as soil removal or capping) and placement of institutional controls (administrative actions) to manage contaminated soil remaining onsite. Upon implementation of mitigation actions, a final school-specific EHMP will be prepared if any Category C and D soils remain on campus.

5.1 SCHOOL-SPECIFIC MITIGATION ACTION PLANS

Once the extent of soil impacts above action levels has been delineated in accordance with procedures in the TGM, a school-specific mitigation action plan can be developed for each school. The school-specific mitigation action plans will describe the areas (open spaces, building perimeters, or garden plots) that require mitigation actions, and will provide specific actions to be taken to address the impacted areas.

5.2 MITIGATION ACTIONS

The goal of mitigation actions (also called “response actions”) for soils with COPCs above action levels is to minimize human health risks by reducing the potential for direct exposure with soils. The TGM states that appropriate response actions are required “if a hazardous substance release substantially endangers public health or the environment.” The type of mitigation action depends on the degree of hazard (see tiered soil categories in Section 3), the specific physical characteristics of the impacted area, and current and future planned uses of the impacted area. For example, a low activity area with Category C soils only requires maintaining good landscape cover (no bare soil); however, the same soil condition in a high activity area requires soil removal or capping.

The specific mitigation actions for various soil categories are provided in Table 5-1. As previously described, “High Activity Areas” include play areas, picnic areas, athletic fields, garden plots, unpaved parking areas, drop-off and loading areas, and any other area where students congregate on a regular basis. “Low Activity Areas” include open spaces not commonly used by students, building perimeters with landscaping that impedes regular access, building maintenance and storage areas, and any other areas where students are not expected to visit or congregate on a regular basis.

For Category A soils (background or negligible risk), no action is required. Soils in Category B (low risk) require no action if in low activity areas; whereas no bare soil is recommended for high activity areas.[13] Category C (moderate risk) soils may be managed with landscape cover or restricting access in low activity areas; however, in high activity areas these soils must either be removed and disposed of (at a permitted landfill) or capped. Capping options are provided below in Section 5.2.3. Category D (high risk) soils must be removed or capped regardless of whether in a low or high activity area.

5.2.1 Maintaining Landscape Cover

In order to prevent exposure to soils with COPCs above action levels, a landscape cover may be sufficient in certain situations. As described above, a landscape cover or limiting access with fencing is sufficiently protective for Category B soils in low activity areas, and is recommended to the extent practical for Category C soil in high activity areas.

A landscape cover such as grass serves as a properly functioning protective barrier when it prevents soil from being contacted by a person, such as someone pressing their hands to the ground surface. At some schools in Hawaii where heavy rainfall occurs, soils become saturated with water and the underlying soil is mobilized as mud. In these conditions, soil (mud) will move up through the grass and can come in contact with a person. In these wet/muddy situations, landscape cover may not be sufficient to prevent exposure with soils containing COPCs above action levels, and soil removal or capping may be required as indicated in a school-specific EHMP. Guidance for maintaining landscape cover is provided in Appendix B, standard operating procedure (SOP) 1—Routine Maintenance for Grass Cover or Landscaping.

5.2.2 Soil Removal

Soil removal is a permanent solution to mitigate risks from exposure to soils with COPCs. Removal typically involves excavation (e.g., by shovel or backhoe) and backfilling of the excavated area with "clean" (Category A or B) soils. Clean soils should be imported from a known clean source, or tested to confirm they do not contain COPCs above action levels (the upper concentration limit for Category B soils). Testing of soils for import as clean fill is further described in HDOH's specific guidance on evaluation of imported and exported fill material (HDOH 2017b).

Confirmation sampling and analysis of the soil excavation area is required to confirm that remaining soils have COPCs below action levels (e.g., below Category C concentrations). This sampling and analysis should be performed using decision units and multi-increment sampling similar to the program employed during the investigation (assessment) phase. Further details

[13] This recommendation should be particularly considered when concentrations of COPCs are at the high end of the Category B range, approaching Category C concentrations.

on removal actions and confirmation sampling are provided in the HDOH TGM (HDOH 2008, Section 14).

Category C and D soils that are excavated should be properly disposed of at a permitted landfill. The soils will need to be sampled and analyzed for waste characterization parameters as directed by the landfill, and an approved waste profile will need to be provided by the landfill prior to disposal. Further information on waste characterization is provided below in Section 7.2.3. No landfills in Hawaii are currently permitted for the disposal of hazardous waste. Some Category D soils for arsenic, lead, or chlordane (or potentially other COPCs) could be considered hazardous waste based on the toxicity characteristic leaching procedure (TCLP) test, typically required by the landfill as part of waste characterization. Based on our experience with soils from schools in the eastern portion of the Hawaii District, failing TCLP and classification as a hazardous waste is highly unlikely (see further discussion in Section 7.2.3).

Further guidance on the management of contaminated soils is provided in the following SOPs attached in Appendix B:

- SOP 2—Onsite Management and Reuse of Contaminated Soil
- SOP 3—Characterization and Landfill Disposal of Contaminated Soil.

5.2.3 Soil Capping

If Category C and D soils are not removed, a cap may be used to prevent direct exposure. Capping materials vary based on site conditions, future uses of the area, and cost constraints. Such onsite mitigation actions, where Category C and D soils are managed onsite, are considered "engineering controls." Detailed engineering specification for capping mitigation actions are provided in Appendix A.

5.2.3.1 Clean Soil Cap

Clean soil may be placed over Category C and D soils, typically with a geotextile fabric (permeable separator) placed over the soils to prevent intrusion (e.g., digging into impacted soils) and to prevent mixing between Category C or D soils and overlying clean soils. Various geotextile fabrics are available, from simple garden "weed block" fabrics to robust fabrics used in road construction. If the soil cap is being constructed as a long-term (permanent) remedy, then a construction-grade geotextile is recommended (see specification in Appendix A). Geotextile materials should be permeable to water, so that rainwater infiltrates into the ground and does not cause ponding or unwanted runoff.

HDOH HEER, consistent with U.S. EPA guidance (USEPA 2003), recommends a minimum 12-in.-thick clean soil cap for covering Category C or D soils, and a minimum 24-in.-thick clean soil cap for garden plots.[14] In some situations where the ground cannot be built up substantially above existing grade, such as along a building wall or foundation, some soil may need to be removed to accommodate the minimum clean soil thickness. In these situations, a combination of soil removal and clean soil capping may be appropriate. A warning tape indicating contaminated soils are below shall be placed above geotextile before clean soil is placed (see specifications in Appendix A).

5.2.3.2 Stone Aggregate Cap

A stone aggregate (crushed rock) cap may be considered as an alternative to a clean soil cap in certain situations. A minimum stone thickness of 4 in. over geotextile fabric is recommended for Category C and D soils. The stone aggregate cap is thinner than a clean soil cap, and is more applicable in areas where no vegetation is desired. A typical material used is 1/2-in. minus washed drain rock, which is compact and easy to place. Larger stone may be considered for some situations; however, larger stone may present a safety risk if children play with the stone improperly (i.e., throwing the stones). As an alternative, 3/4-in. minus cinder may be considered instead of rock aggregate, however the application should be carefully considered as cinder is lighter and more prone to be eroded by stormwater. Similar to soil cap, a warning tape will be placed on geotextile before stone or cinder bed is constructed.

5.2.3.3 Hard Cap (Asphalt or Concrete)

While typically more expensive than clean soil or stone aggregate caps, hard caps of asphalt or concrete provide the most robust protection against unwanted intrusion into underlying soils. As per roadway and walkway construction, an underlying geotextile and base course of aggregate is recommended under the asphalt or concrete surface. An advantage of a hard cap is minimal buildup of the ground surface, typically 6 in. in total (e.g., 2-in. aggregate base course and 4-in. asphalt or concrete). A potential negative aspect of a hard cap is stormwater runoff; these surfaces will not allow rain water to infiltrate in place, and will therefore cause unwanted runoff in some situations. Artificial grass turf or other surface materials may be used over hard caps to allow improved uses of the area (e.g., as a playground or athletic field).

5.2.3.4 Permeable Pavers or Elevated Walkway

Permeable pavers are manufactured materials, such as bricks, that can be placed on the ground to prevent direct exposure through ingestion or inhalation of underlying Category C and D soils. Unlike hard cap materials, permeable pavers allow rain water to infiltrate, preventing unwanted runoff. Similar to a hard cap, permeable pavers are typically placed over geotextile

[14] EPA indicates that 12-in. soil cap is typically adequate for capping lead-impacted soils in residential settings, whereas 24-in.-thick soil cap is needed in potential garden areas (USEPA 2003).

and a base course of aggregate. In some situations, a wooden (or other construction material) walkway may be used above Category C and D soils to prevent direct exposure.

5.3 INSTITUTIONAL AND ENGINEERING CONTROLS

For sites with Category C or D soils remaining onsite, institutional and engineering controls are required. Institutional controls are legal or administrative (procedural) methods of ensuring that contaminated soils are properly managed to prevent direct exposure. In a school campus setting, these controls could include rules or warning signs to restrict site activities and use for areas with contaminated soils. For example, a low activity area with Category C soils being managed by landscape cover should not be used for high level activities such as play or athletics. Institutional controls will be described in the school-specific EHMP.

Engineering controls are physical controls to prevent exposure to contaminated soils such as maintaining landscape cover, or a cap. Fencing of other physical barriers to prevent or minimize exposure are also considered engineering controls. Like institutional controls, engineering controls are described in a school-specific EHMP.

5.4 ADMINISTRATIVE CONTROLS

Administrative controls are procedural methods ensuring that the EHMP is implemented and enforced. A set of administrative procedures will document the chain of command, roles and responsibilities, and communications within HDOE with respect to the implementation of the short- and long-term actions outlined in the EHMP. These procedures will also document communications with outside parties such as easement holders and contractors that may perform earth work on HDOE properties.

The HDOE is currently developing procedures to implement administrative controls pursuant to the EHMP. This section will be amended once as the administrative procedures are established by HDOE.

5.5 SCHOOL-SPECIFIC FINAL EHMP

This document provides an overall framework for managing soils at schools where Category C and D soils remain onsite. The contents of an EHMP are provided above in Section 4.3 (interim EHMP). Once mitigation actions are complete, the interim EHMP should be updated to reflect conditions after soil mitigation. If all Category C and D soils were removed during mitigation actions, then no EHMP is required. If some Category C and D soils remain on the campus, a final EHMP should be prepared and followed.

Along with any institutional and engineering controls implemented to address Category C or D soils remaining on site (Section 5.3), the final EHMP shall include a clear map to-scale depicting the location of all known contaminated areas and the controls in place for these soils (e.g., landscape cover, clean soils (and depth), gravel, hard material caps, fences, or other. Existing hard surfaces (e.g., buildings, paved lots/walkways) on the property under which contaminants have not been characterized (i.e., are unknown) shall also be included and labeled on the site Environmental Hazard Map.

6 INSPECTION, MAINTENANCE, AND REPORTING

6.1 MONITORING AND MAINTENANCE

For school areas with Category C or D soils, some type of mitigation action is required (see Table 5-1). Long-term monitoring (periodic inspections and reporting) and maintenance (repair of engineering controls [caps] and grass-covered areas) may be required for mitigations where Category C or D soils remain in place. An engineered cap or landscape cover inspection and maintenance form is provided in Appendix C. If complete removal of Category C and D soils is performed, and the removal is validated with confirmation sampling and analysis, no further monitoring or maintenance is required.

Long-term monitoring and maintenance is required for all mitigation actions in which Category C or D soils remain onsite. The mitigation actions (remedies) for these situations range from maintaining landscape cover to installing an engineered cap. For these non-permanent remedies, the condition of the landscape cover or cap needs to be inspected on a periodic basis to ensure that the cover material (grass or cap) remains in place and has not degraded. For cap remedies, the condition of the cap components must also be inspected and maintained. The frequency of inspections will be described in the school-specific EHMP, as mentioned in Section 5.5. Quarterly inspections (4 times per year) or semiannual would be the typical inspection frequency for a non-permanent remedy.

If any degradation of the landscape cover or engineered cap is identified during a periodic inspection (or by any other observation), maintenance to repair the cover or cap should be scheduled. Refer to SOP 1 in Appendix B for further discussion of inspection and maintenance of landscape cover.

6.2 COMMUNICATIONS AND REPORTING

Internal HDOE and external communications regarding the assessment and mitigation of Category C and D soils is critical to create appropriate awareness and minimize hazards.

6.2.1 HDOE Internal Communications

The presence of Category C and D soils on school campuses shall be communicated to school points of contact by way of a copy of the soil assessment findings reports(s), and the framework and school-specific EHMPs. Training on management of Category C and D soils consistent with the EHMP will be conducted so that school staff can ensure that institutional controls are implemented and engineering controls maintained in place. School staff may also perform periodic inspections to ensure engineering control have not degraded.

6.2.2 Department of Health Communications and Reporting

HDOE staff will communicate regularly with HDOH (HEER Office) staff on the status of soil assessment work (findings reports) and the framework and school-specific EHMPs by providing inspection reports to HDOH on an annual basis. HDOE staff will address HDOH comments on documents and approaches to manage Category C and D soils, and will incorporate HDOH's comments into documents and procedures. Periodic inspection reports, a component of a school-specific EHMP, will be retained by HDOE and provided to HDOH upon request.

6.2.3 External (Public) Communications

HDOE will conduct public communications on the status of school assessments, mitigation actions, and long-term soil management by way of public meetings and fact sheets. HDOE will consult with HDOH in preparation of fact sheets, and will seek support from HDOH for public meetings and risk communication services. HDOH issued fact sheets on arsenic, lead, and OCPs that are geared towards the public and may aid communications with school staff and parents. These fact sheets are included in Appendix C.

7 SOIL MANAGEMENT FOR FUTURE SITE ACTIVITIES

Future site activities, such as new facility construction or subsurface utility repairs and upgrades, may encounter Category C and D soils. The soil assessment programs, both screening and full delineation, will focus on surface (0–6 in. depth) soils where immediate direct exposure hazards may be present. Deeper soils may contain COPCs above action levels, especially in certain settings. There are two primary situations where deeper soils might have COPCs above action levels: 1) in soils beneath Category C and D surface soils, and 2) in soils below clean fill materials.

The first situation occurs where Category C or D soils are present at the surface (0–6 in. depth). In this situation, Category C and D soils could also be present at depth. The second situation occurs where clean fill soils have been placed over Category C and D soils. A common occurrence is where clean soil or cinder was placed over former sugar plantation soils during facility construction, where former plantation soils are still present beneath fill soils or along property perimeters not covered by fill soils, and could be either Category C or D for arsenic. Another potential situation occurs where landscaping materials (soils, mulch, or other cover material) have been placed along building perimeters over Category C and D soils.

As described above, deeper soils may contain COPCs above action levels, especially in certain settings. Actions should be taken as described below to identify and manage these soils prior to and during ground-intrusive activities, such as construction projects and intensive landscaping (especially along building perimeters).

7.1 SOIL ASSESSMENT PRIOR TO EXCAVATION

Prior to conducting soil-intrusive activities, such as excavation, the potential for encountering Category C and D soils should be assessed. A decision on the potential to encounter Category C and D soils at the project site is a matter of professional judgment and should be made by HDOE environmental or engineering staff or its environmental consultants, or by the contractor (with support from HDOE's environmental consultants) if authorized by HDOE. Prior soil assessment findings and school-specific EHMPs should be reviewed, along with information such as building age and geographical location (e.g., whether built over former plantation land).

When there is potential for encountering Category C and D soils, or if the school has not been assessed in a prior study, an *in situ* soil assessment[15] prior to conducting intrusive activities is recommended. The soil assessment should include collection of soil samples at various depths and screening for metals (arsenic and lead at a minimum) plus OCPs for pre-1988 structures. (Chlordane was banned in 1988. Other OCPs were banned prior to this date.) Discrete or

[15] An *in situ* soil assessment consists of sampling and analysis of soils in place before they are excavated.

composite samples can be collected and analyzed for screening purposes[16] only; multi-increment samples can be collected and analyzed to determine approximate concentrations of COPCs in the soil. If screening indicates the presence of COPCs, soils should be considered above action levels unless more comprehensive multi-increment sampling and analysis indicates concentrations are below Category C levels. For some projects, comprehensive *in situ* soil sampling and analysis prior to excavation may not be necessary; soils may be excavated and characterized after excavation in soil piles prior to determining disposal method.

For either screening or for more comprehensive multi-increment sampling and analysis of soils prior to excavation, a SAP should be prepared that describes sample locations, sampling methods, analytical parameters, and the goals of the sampling program. In all cases, the SAP should be consistent with the Hawaii TGM.

7.2 SOIL EXCAVATION, HANDLING, REUSE, AND DISPOSAL

Intrusive work in soils, except for soil tilling or grading, typically results in removing (excavating) some soils. Excavation work is typically performed for building foundations, underground utilities, stormwater drainage projects, etc. Some common procedures for excavation, handling, and disposal of Category C and D soils are provided below.

7.2.1 Erosion and Dust Control

Excavated Category C and D soils shall be managed to prevent unwanted migration via stormwater erosion or dust generation. Soils shall either be loaded directly into trucks for transport to the landfill or placed in temporary covered stockpiles onsite until determination is made on reuse or landfill disposal. If stockpiled, the soils should be placed in a designated land area with best management practices to prevent migration by stormwater sediment runoff or dust generation. The stockpile area may be lined to prevent contamination of the underlying surface; if not lined, sampling and analysis (and further excavation as necessary to meet action levels) may be required of the land surface after stockpile removal.

Fugitive dust migration may be controlled by applying water to the excavation and stockpiled soils, by covering with tarps, or by applying soil stabilizers or tackifiers. For certain projects, a dust fence around the excavation and/or soil stockpiling areas may be deemed necessary. No visible dust should be generated without taking reasonable precautions, and no visible dust should leave the project property line, in compliance with Hawaii Administrative Rules, Section 11-60.1-33 (Fugitive Dust). A fact sheet on fugitive dust is provided in Appendix C.

[16] Screening in this context is intended to determine presence or absence of COPCs, not a precise concentration within a decision unit. HDOH generally required multi-increment sampling for final decision-making.

Depending on the size of the excavation project, HDOE may require the contractor to prepare an environmental control plan to include erosion and sediment control and dust control components. For certain projects where concentrations of COPCs in soils may present a health risk by exposure to contaminated dust, a health and safety plan may be required, with guidance from a certified industrial hygienist, to ensure compliance with 29 CFR 1926 (Occupational Safety and Health Administration Construction Standards) including 29 CFR 1926.62 (Lead in Construction) for soils with lead levels in Category D.

While there are no specific requirements for air monitoring (ambient and/or personal) based on concentrations of COPCs in soils, as general guidance it is recommended that an air monitoring program be considered when disturbing Category D (high risk) soils and visible dust cannot be completely eliminated by dust control measures.

7.2.2 Onsite Reuse of Contaminated Soils

For many projects, Category C or D soil may be suitable for onsite reuse as backfill material, as long as it is placed in a condition where it will not present a direct exposure hazard (e.g., in deeper portions of an excavation or under structures or pavement). Refer to SOP 2 in Appendix B for further discussion of onsite reuse of soil.

7.2.3 Characterization and Disposal of Contaminated Soils

Excavated soil must be characterized for waste disposal, as either a non-hazardous solid waste or a hazardous waste. This process involves sampling and analysis of the soil for waste characterization parameters. It is the responsibility of the party that "generates"[17] the waste (soil) to determine its characteristics prior to disposal. Federal regulations regarding solid and hazardous waste are contained in Resource Conservation and Recovery Act (RCRA) regulations at 40 CFR Parts 239 through 282. Federal RCRA regulations are largely adopted by the state of Hawaii.

First, the generator must determine whether the waste soil is a hazardous waste. For soil at schools containing arsenic, lead, and OCPs, the soil could be considered hazardous by characteristics, in particular by the toxicity characteristics for arsenic, lead, or chlordane. A representative sample of soil is evaluated by the TCLP test (EPA SW-846 method 1311) to determine the leachable concentrations of various compounds. If the TCLP test results for a compound are above defined regulatory levels, then the waste soil is considered a hazardous waste. If results are below regulatory levels, then the soil is a non-hazardous solid waste.

[17] The act of excavating contaminated soil triggers waste generation. Although an HDOE contractor may perform the excavation, it is typical that the land owner or operator is the formal generator of the waste. For most school campuses, HDOE would be considered the generator and responsible party for managing the waste soil. Certain responsibilities can be transferred to a contractor by contract.

No landfills in Hawaii are currently permitted for the disposal of hazardous waste, and hazardous waste is typically shipped to the mainland for treatment and disposal. Some soils with high concentrations of arsenic, lead, or chlordane (or potentially other COPCs) could be considered hazardous waste based on the TCLP (i.e., the soils could potentially fail the TCLP test and be identified as hazardous waste). Because the costs for managing the disposal of hazardous waste are high, an approach often considered is to test soil *in situ* (before generated by excavation) to allow careful planning before hazardous waste generation.

Non-hazardous soil (solid waste) can be disposed of at the permitted West Hawaii Sanitary Landfill about 10 miles southwest of Waikoloa Village. Further information on characterization and landfill disposal of contaminated soil is provided in SOP 3 (Appendix B).

To assess the potential for contaminated sites at schools to fail TCLP[18] and be classified as RCRA hazardous waste, Integral re-sampled[19] and analyzed six decision units that contained some of the highest concentrations of arsenic, lead, or chlordane based on the multi-increment sampling and analysis performed for the schools in the eastern portion of the Hawaii District. Table 6-1 provides the results of this analysis, and includes the TCLP regulatory limits at which the soil would be considered a hazardous waste.

Only one soil sample failed TCLP for lead; that sample had total lead of 8100 mg/kg (higher concentrations than observed in any samples from the comprehensive multi-increment sampling program). Samples with arsenic up to 1800 mg/kg were well below the regulatory limit. A sample with chlordane at 88 mg/kg showed TCLP chlordane at 0.19 mg/L, which is about 63 percent of the regulatory limit. In summary, soils with high concentrations of COPCs could potentially fail TCLP, but most soils are expected to be considered non-hazardous.

[18] "Failing" TCLP means the test result concentration for a compound is equal to or greater than the regulatory level.
[19] The re-sampling consisted of collection of multi-increment samples with approximately 15 increments; the sampling and analysis results were not designed to replicate the prior, more comprehensive, multi-increment sampling that utilized approximately 45 increments per sample.

8 LIMITATIONS

Integral has prepared this report for HDOE under contract No. C1101049, Job No. Q61001-11, Project: Various Schools Statewide, Hazardous Materials Assessment. The conclusions presented in this report are based on Integral's observations during field investigations and on chemical analytical data. The findings of this assessment should be considered as a professional opinion based on Integral's evaluation of limited data.

Integral's services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. Integral makes neither express nor implied representations, warranties, guarantees or certifications regarding the results of this limited investigation.

Integral does not purport to give legal advice. Any reference to legal issues or terms is provided as part of the general environmental assessment and is not a substitute for the advice of competent legal counsel.

9 REFERENCES

Brattin, W., J. Drexler, Y. Lowney, S. Griffin, G. Diamond, and L. Woodbury. 2013. An *in vitro* method for estimation of arsenic relative bioavailability in soil. *J. Toxicol. Environ. Health*. 76(7):458–478.

Cutler, W., R. Brewer, A. El-Kadi, N. Hue, P. Niemeyer, J. Peard, and C. Ray. 2013. Bioaccessible arsenic in soils of former sugar cane plantations, Island of Hawaii. *Sci. Total Environ.* 442:177-188.

Drexler, J.W., and W.J. Brattin. 2007. An *in vitro* procedure for estimation of lead bioavailability: With validation. *Hum. Ecol. Risk Assess.* 13:383–401.

ERM. 2009. Combined phase I & II environmental site assessment, Keaau Middle School, Keaau, Hawaii. Prepared for County of Hawaii, Department of Environmental Management. Environmental Resources Management, Honolulu, HI. February.

HDOH. 2008. Technical guidance manual for the implementation of the Hawai'i state contingency plan. Interim final (November 12, 2008), as periodically updated online at http://www.hawaiidoh.org/tgm.aspx. Hawai'i Department of Health, Office of Hazard Evaluation and Emergency Response, Honolulu, HI.

HDOH. 2012. Update to soil action levels for inorganic arsenic and recommended soil management practices. http://www.hawaiidoh.org/. Hawai'i Department of Health, Office of Hazard Evaluation and Emergency Response, Honolulu, HI. November 25, 2011; updated September 2012.

HDOH. 2017a. Evaluation of environmental hazard at sites with contaminated soil and groundwater. Hawaii Edition. Hawai'i Department of Health, Environmental Management Division, Honolulu, HI. Fall.

HDOH. 2017b. Guidance for the evaluation of imported and exported fill material, including contaminant characterization of stockpiles. http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/technical-guidance-and-fact-sheets. Hawai'i Department of Health, Office of Hazard Evaluation and Emergency Response, Honolulu, HI. Fall.

HDOH and AMEC. 2007. Soil arsenic assessment study, Keaau, Hawaii. Honolulu. Hawaii Department of Health, Hazard Evaluation and Emergency Response Office, and Earth and Environmental, Inc. December.

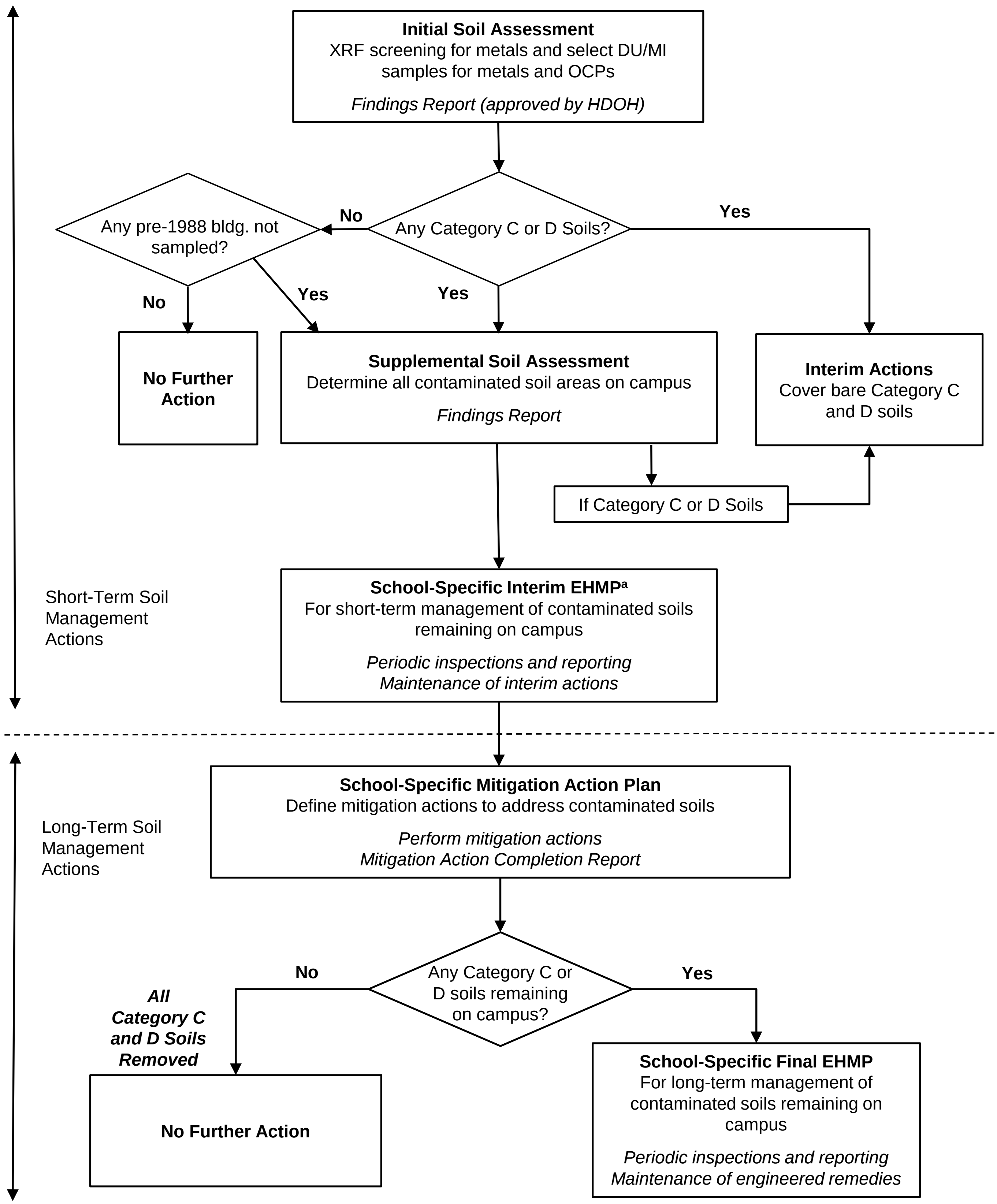
Integral. 2016. Sampling and analysis plan, hazardous material assessments, various schools statewide, DOE Job No. Q61001-11. Prepared for Hawaii Department of Education, Honolulu, HI. Integral Consulting Inc., Waipahu, HI. October 28.

Integral. 2017. Soil assessment findings, hazardous material assessments, various schools statewide, HDOE Job No. Q61001-11. Prepared for Hawaii Department of Education, Honolulu, HI. Integral Consulting Inc., Waipahu, HI. December 26.

KJC. 2014. Soil testing report, Keaau Middle School, Building B, D, E, and G demolition, Honolulu. Kennedy/Jenks Consultants. April 22.

USEPA. 2003. Superfund lead-contaminated residential sites handbook. OSWER 9285.7-50. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. August.

FIGURE



Notes:
[a] Environmental Hazard Management Plan
Applies to surface soils at school campuses, refer to Framework EHMP Section 6 for subsurface soils

Figure 4-1.
Soil Assessment and Mitigation Flowchart

TABLES

Table 2-1. Schools Assessed for Building Exterior Soil Hazards

HAWAII DISTRICT	
Hilo-Laupahoehoe-Waiakea	
HILO COMPLEX	
1	Hilo High
2	Hilo Intermediate
3	Kalanianaole Elementary & Intermediate
4	DeSilva Elementary
5	Haaheo Elementary
6	Hilo Union Elementary
7	Kapiolani Elementary
8	Kaumana Elementary
9	Keaukaha Elementary
LAUPAHOEHOE COMPLEX	
10	Laupahoehoe High & Elementary
WAIAKEA COMPLEX	
11	Waiakea High
12	Waiakea Intermediate
13	Waiakea Elementary
14	Waiakeawaena Elementary
Kau-Keaau-Pahoa	
KAU COMPLEX	
15	Kau High & Pahala Elementary
16	Naalehu Elementary & Intermediate
KEAAU COMPLEX	
17	Keaau High
18	Keaau Middle
19	Keaau Elementary
20	Mountain View Elementary
PAHOA COMPLEX	
21	Pahoa High & Intermediate
22	Keonepoko Elementary
23	Pahoa Elementary

Table 3-1. Soil Categories for Arsenic

Soil Category	Action Level (mg/kg)[a]	Notes
A (Background)	≤24 (total As)	HDOH natural background action level for arsenic in soil is 24 mg/kg.
B (Low Risk)	>24 (total As) and ≤23 (BA As)	This category considers soils with arsenic above background levels, but below the 23 mg/kg bioaccessible arsenic soil action level for residences and young children (HDOH 2017a, Table I-1).
C (Moderate Risk)	>23 to ≤95 (BA As)	This category considers soils with bioaccessible arsenic above the 23 mg/kg action level, but below the 95 mg/kg soil action level for school workers and contractors (HDOH 2017a, Table I-2).
D (High Risk)	>95 (BA As)	Category D soils pose a potential risk to school workers and contractors, even in low activity areas where work may potentially occur.

Notes:

Table applies to surface (0–6 in. depth) soils at school campuses.

As = arsenic

BA = bioaccessible

HDOH = Hawaii Department of Health

mg/kg = milligrams of contaminant per kilogram of (< 2mm particle size) soil.

[a] Action levels are based on natural background concentrations and residential and commercial/industrial direct-exposure levels presented in HDOH (2017a).

Table 3-2. Soil Categories for Lead

Soil Category	Action Level (mg/kg)[a]	Notes
A (Background)	≤73	HDOH natural background action level for lead is 73 mg/kg.
B (Low Risk)	>73 to ≤200	This category considers soils with lead above background levels, but below the 200 mg/kg soil action level for residences and young children (HDOH 2017a, Table I-1).
C (Moderate Risk)	>200 to ≤800	This category considers soils with lead above the 200 mg/kg action level, but below the 800 mg/kg soil action level for school workers and contractors (HDOH 2017a, Table I-2).
D (High Risk)	>800	Category D soils pose a potential risk to school workers and contractors, even in low activity areas where work may potentially occur.

Notes:

Table applies to surface (0–6 in. depth) soils at school campuses.

HDOH = Hawaii Department of Health

mg/kg = milligrams of contaminant per kilogram of (< 2mm particle size) soil.

[a] Action levels are based on natural background concentrations and residential and commercial/industrial direct-exposure levels presented in HDOH (2017a).

Table 3-3. Soil Categories for Chlordane

Soil Category	Action Level (mg/kg)[a]	Notes
A (Negligible Risk)	≤7.0	This category considers soils with technical chlordane up to an action level of 7.0 mg/kg, based on a conservative target hazard quotient of 0.2 for young children (HDOH 2017a, Table I-1).
B (Low Risk)	>7.0 to ≤17	This category considers soils with technical chlordane above 7.0 mg/kg but below the 17 mg/kg action level for residences and young children, based on a target hazard quotient of 1.0 for young children (HDOH 2017a, Table I-1).
C (Moderate Risk)	>17 to ≤77	This category considers soils with chlordane above the 17 mg/kg action level, but below the 77 mg/kg action soil level for school workers and contractors (HDOH 2017a, Table I-2).
D (High Risk)	>77	Category D soils pose a potential risk to school workers and contractors, even in low activity areas where work may potentially occur.

Notes:

Table applies to surface (0–6 in. depth) soils at school campuses.

HDOH = Hawaii Department of Health

mg/kg = milligrams of contaminant per kilogram of (< 2mm particle size) soil.

[a] Action levels are based on residential and commercial/industrial direct-exposure levels presented in HDOH (2017a).

Table 3-4. Multi-Increment Soil Sampling Results—Summary of Findings and Recommendations—23 Schools in Eastern Portion of Hawaii District

		Open Space Areas			Building Perimeters			Garden Plots		
No.	School Name	Arsenic	Lead	OCPs	Arsenic	Lead	OCPs	Arsenic	Lead	OCPs
1	Hilo High	OK	OK	- -	OK	>AL	OK		No Garden Plots	
2	Hilo Intermediate	OK	>AL	- -	OK	>AL	OK	OK	OK	- -
3	Kalanianaole Elementary & Intermediate	OK	>AL	- -	OK	>AL	OK	OK	>AL	- -
4	DeSilva Elementary	OK	OK	- -	>AL	>AL	OK	OK	OK	- -
5	Haaheo Elementary	OK	OK	- -	OK	>AL	OK	OK	OK	- -
6	Hilo Union Elementary	OK	OK	- -	OK	>AL	>AL	OK	>AL	- -
7	Kapiolani Elementary	OK	>AL	- -	>AL	>AL	>AL	OK	>AL	- -
8	Kaumana Elementary	- -	- -	- -	OK	>AL	OK		No Garden Plots	
9	Keaukaha Elementary	- -	- -	- -	OK	>AL	OK	OK	OK	- -
10	Laupahoehoe High & Elementary	OK	OK	- -	OK	>AL	OK	OK	OK	- -
11	Waiakea High	OK	OK	- -	OK	OK	OK	OK	OK	- -
12	Waiakea Intermediate	- -	- -	- -	>AL	OK	OK	OK	OK	- -
13	Waiakea Elementary	OK	OK	- -	OK	OK	OK		No Garden Plots	
14	Waiakeawaena Elementary	OK	OK	- -	OK	>AL	>AL	OK	OK	- -
15	Kau High & Pahala Elementary	OK	OK	- -	OK	>AL	>AL	OK	OK	- -
16	Naalehu Elementary & Intermediate	- -	- -	- -	OK	>AL	OK	OK	OK	- -
17	Keaau High	- -	- -	- -	OK	OK	OK	OK	OK	- -
18	Keaau Middle[a]	>AL	>AL	OK	>AL	>AL	OK	>AL[b]	OK	OK
19	Keaau Elementary	OK	OK	- -	OK	OK	OK	OK	OK	- -
20	Mountain View Elementary	OK	OK	- -	OK	>AL	OK	OK	OK	- -
21	Pahoa High & Intermediate	- -	- -	- -	>AL	>AL	>AL	OK	OK	- -
22	Keonepoko Elementary	OK	OK	- -	OK	OK	OK	OK	OK	- -
23	Pahoa Elementary	- -	- -	- -	OK	>AL	>AL	OK	OK	- -

Notes:

Results are for decision units with highest observed concentrations. Approx. 4 to 5 sampling decision units per school (except DeSilva and Keaau Middle where more sampling occurred).

Shaded cells correspond to Category C soils.

Outlined cells correspond to Category D soils.

- - = not analyzed

>AL = concentrations above action levels

HDOH = Hawaii Department of Health

OK = concentrations below action levels

[a] Based on previous investigations at Keaau Middle School conducted by HDOH and AMEC (2007), ERM (2009), and KJC (2014).

[b] Former garden plot at Keaau Middle School was taken out of service in 2005, based on HDOH advice to school. Currently in highly vegetated state with no bare soils.

Table 4-1. Interim Actions for Bare Soils based on Soil Category

Soil Category	Interim Action Options[a]	
	High Activity Areas[b]	Low Activity Areas[c]
A	No action required	No action required
B (Low Risk)	No action required	No action required
C (Moderate Risk)	Install and maintain landscape cover (such as thick grass, wood chips, cinder, gravel, stone)	Install and maintain landscape cover; or Limit access with fencing
D (High Risk)	See options for Category D high activity areas in Table 5-1 Immediate action needed: install landscape cover or limit access with fencing	Install and maintain landscape cover; or Limit access with fencing

Notes:

[a] These are minimum requirements for short-term soil management actions. Schools may choose to immediately implement long-term mitigation actions without first implementing interim actions. Options for long-term mitigation actions are provided in Table 5-1.

[b] High Activity Areas include play areas, picnic areas, athletic fields, garden plots, unpaved parking areas, drop-off and loading areas, and any other area where students congregate on a regular basis.

[c] Low Activity Areas include open spaces not commonly used by students, building perimeters with landscaping that impedes regular access, building maintenance and storage areas, and any other areas where students are not expected to visit or congregate on a regular basis.

Table 5-1. Long-Term Mitigation Actions based on Soil Category

Soil Category	Long-Term Mitigation Action Options[a]	
	High Activity Areas[b]	Low Activity Areas[c]
A	No action required	No action required
B (Low Risk)	Maintain thick grass cover with minimal bare soil, as a best management practice[d]	No action required
C (Moderate Risk)	Remove and properly dispose of impacted soil Geotextile fabric with minimum 12-in.-thick clean soil cap[e] Geotextile fabric with minimum 4-in.-thick stone aggregate or cinder bed Permeable pavers Hard-cap pavement (e.g., asphalt, concrete)	Maintain landscape cover Limit access with fencing
D (High Risk)	As above per Category C, High Activity Areas	As above per Category C, High Activity Areas

Notes:

[a] Example mitigation actions to reduce exposure and/or limit access to impacted soil areas. Alternative caps to clean soil include stone beds, permeable pavement, artificial turf or “hard caps” (asphalt or concrete, minimum 4-in. thick), or other types of permanent cover that inhibit digging and disturbance of underlying impacted soil.

[b] High Activity Areas include play areas, picnic areas, athletic fields, garden plots, unpaved parking areas, drop-off and loading areas, and any other area where students congregate on a regular basis.

[c] Low Activity Areas include open spaces not commonly used by students, building perimeters with landscaping that impedes regular access, building maintenance and storage areas, and any other areas where students are not expected to visit or congregate on a regular basis.

[d] Applies to Category B soils where total arsenic is >100 mg/kg.

[e] Soil cap thicknesses are from USEPA (2003) guidance. Garden plots require minimum 24-in.-thick clean soil cap.

Table 6.1. TCLP Analysis Results

	Lead		Arsenic		Technical Chlordane	
Decision Unit	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)
S6-03	8100	14				
S6-05	2100	0.27			88	0.019
S7-02			1800	0.055	49	0.0053
S7-04			1400	0.049		
S7-09	1500	0.89			30	0.0022
S12-02			1300	0.46		

Notes:
TCLP Regulatory Levels:
Arsenic = 5 mg/L
Chlordane = 0.03 mg/L
Lead = 5 mg/L

Shaded cells exceed TCLP levels.

TCLP = toxicity characteristic leaching procedure

APPENDIX A

GENERAL SPECIFICATIONS FOR MITIGATION ACTION SOIL CAPS

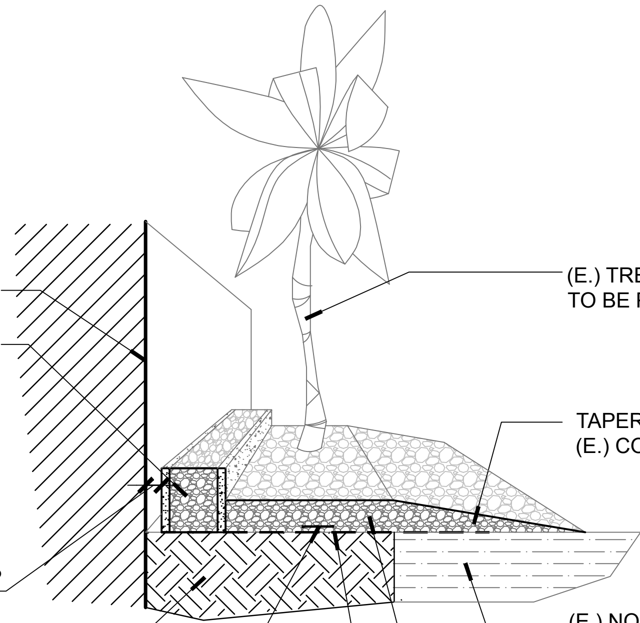


FIGURE 1A: SECTION OF CONTAMINATED SOILS ALONG BUILDING PERIMETERS - AGGREGATE CAP

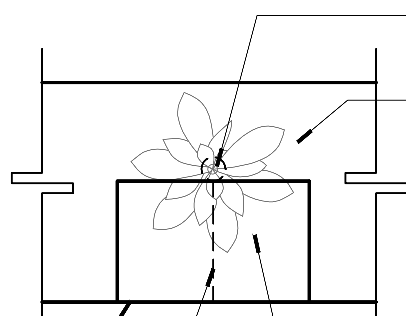


FIGURE 1B CONTAMINATED SOILS AT EXISTING FOLIAGE

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CONTAMINATED SOILS MITIGATION ACTIONS

Figure 1
CONTAMINATED SOILS ALONG BUILDING PERIMETERS

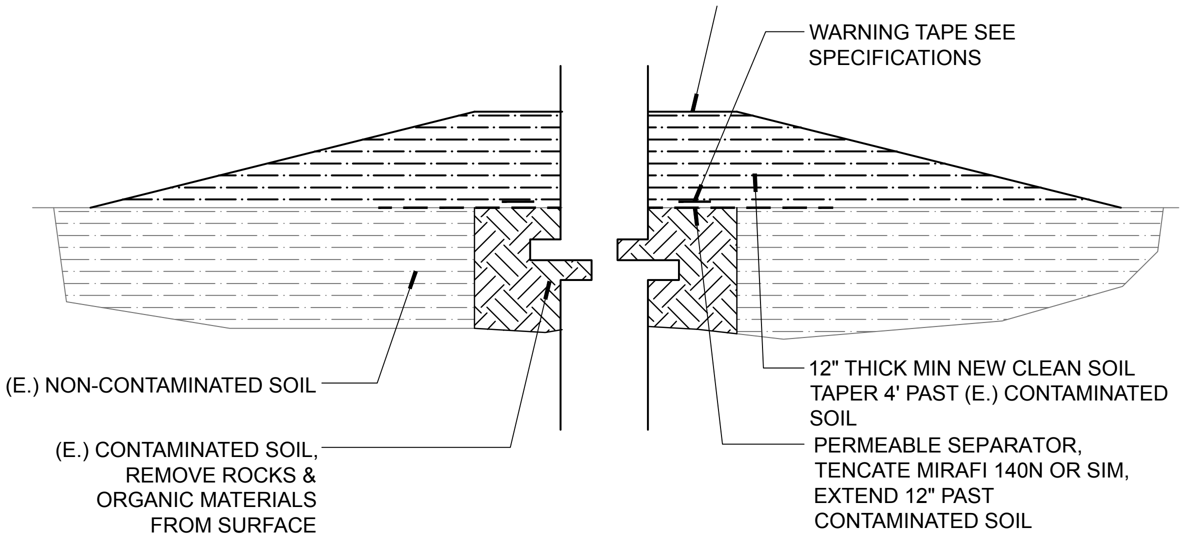

FIGURE 2A: CONTAMINATED SOILS IN OPEN SPACE AREAS - CLEAN SOIL CAP

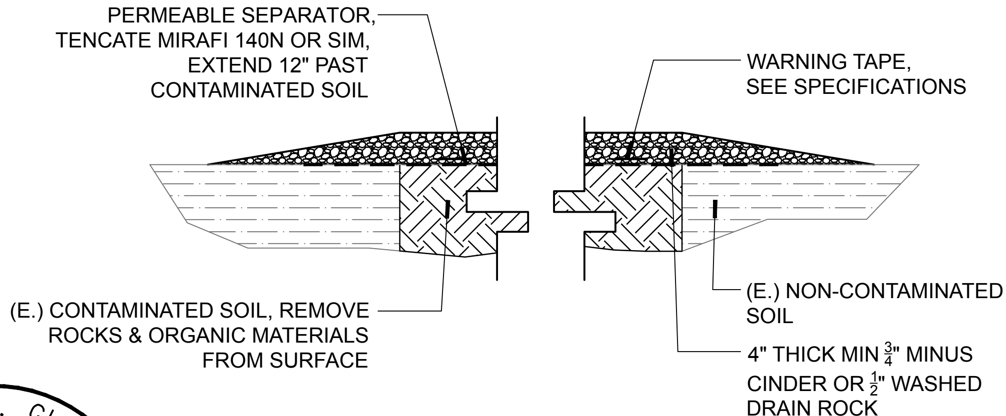

FIGURE 2B: CONTAMINATED SOILS IN OPEN SPACE AREAS - AGGREGATE CAP

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CONTAMINATED SOILS MITIGATION ACTIONS

Figure 2
CONTAMINATED SOILS IN OPEN SPACE AREAS

DIVISION 2—SITE WORK

SECTION 02055—REMOVE ROCKS AND DELETERIOUS MATERIALS

PART 1—GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, tools, and equipment necessary to complete all removal work and surface preparation work as specified herein. The work includes selective removal of all surface materials (e.g., rocks and other deleterious materials located on or above the ground surface) as indicated or specified. Submit a detailed description of methods and equipment to be used for each operation, and sequence of operations. All materials resulting from removal work, except as indicated or specified otherwise, shall become the property of the Contractor and shall be removed from the limits of State property.

1.02 DUST CONTROL

A. Take appropriate action to prevent the generation and spread of dust to occupied portions of the building and to avoid the creation of a nuisance in the surrounding area. Water may be used if it does not result in hazardous or objectionable conditions, such as flooding or pollution. Dust fencing may be used to help contain potential fugitive dust migration. Comply with all dust regulations imposed by local air pollution agencies.

1.03 PROTECTION

A. Safety: Where and when deemed necessary by the Contracting Officer, removal work area shall be cordoned off. Contractor shall be responsible to verbally notify all personnel of impending health and safety hazards that may occur during the removal work.

PART 3—EXECUTION

3.01 GENERAL

A. The Contractor shall visit the project site, examine the premises, and note all existing conditions and the extent involved for the completion and proper execution of all work as called for on the plans and as herein after specified.

B. All work shall be executed in an orderly and careful manner with due consideration for the existing facilities, as the Contractor shall be responsible for all damages to State property.

C. Every precaution shall be taken at all times for the protection and safety of the Contracting Officer, school employees, students and public.

3.02 EXISTING ITEMS TO BE REMOVED

A. All work shall be executed in an orderly and careful manner with due consideration for all items to remain. All work shall be as indicated and as required to complete the removal work.

B. Remove all rocks greater than two inches diameter. Remove all vegetation to one inch or less above the ground surface. Remove all other organic and deleterious materials as necessary to prepare a relatively smooth ground surface.

C. Do not disturb existing contaminated soils. Grasses and roots to remain in place.

D. Use of motorized equipment shall be approved by the Contracting Officer. All damages to any part of the building or grounds by use of motorized equipment shall be the Contractor's responsibility regardless of permission granted for use of such equipment. All damages shall be repaired at no cost to the State.

3.04 DISPOSITION OF MATERIALS

A. All materials resulting from removal work shall become the property of the Contractor and shall be removed from the limits of the State property and shall be disposed of at the Contractor's expense.

3.05 CLEAN UP

A. Remove and transport debris and rubbish in a manner that will prevent spillage on streets or adjacent areas. Clean up spillage from streets and adjacent areas. Comply with Federal, State, and local hauling and disposal regulations.

END OF SECTION

SECTION 02060—PERMEABLE SEPARATOR

PART 1—GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, tools, and equipment for the installation of geotextile permeable separator as indicated on the drawings and as specified herein.

B. Related Section include the following: Section 02055—Removal of Rocks and Deleterious Materials

PART 2—PRODUCTS

2.01 MATERIALS

A. Material for permeable separator shall be in accordance with the below listed sections of the Hawaii Department of Transportation “2005 STANDARD SPECIFICATIONS", 716.02 Geotextiles For Permeable Separator Applications.[1]

B. Warning Tape—Six (6) inch wide detectable metallic underground warning tape with markings as follow: “STOP DIGGING! Soil below contains “NAME OF CONTAMINANT” (site specific). Black fonts on yellow film tape and a minimum of 5.0 mil overall thickness with 0.35 mil solid aluminum foil core.

PART 3—EXECUTION

3.01 CONSTRUCTION

A. Site Preparation. Prepare surface in accordance with Section 02055—Remove Rocks and Deleterious Materials.

B. Installation. Unroll geotextiles smoothly on prepared surface in longitudinal direction. Do not drag geotextiles. Remove wrinkles and folds by stretching and anchoring. Overlap geotextiles a minimum of 3 feet at longitudinal and transverse joints.

C. Geotextile Placement. Hold geotextiles in place by pins, staples, or piles of permeable material. On curves, fold or cut geotextiles to conform to curve, with appropriate overlap or seam. Install fold or overlap in direction of permeable material placement.

D. Geotextile Exposure Following Placement. Limit time exposure of geotextiles to natural elements, between placement and cover, to a maximum of five days. Construction equipment and vehicular traffic will not be allowed directly on geotextiles.

1 Consider using a high visibility geotextile material (such as orange color), if available.

E. Warning tape shall be placed on the geotextile fabric in a cross-hatch pattern with 10-foot spacing between parallel tapes. Tapes will be pinned in place to prevent moving prior to and during soil placement.

F. Narrow cover applications along building perimeter or other locations less than 10 feet wide shall require a single continuous line of warning tape longitudinally along the at the middle of the cover application site.

G. Cover Material Placement. Place cover material in accordance with Section 02210—Cover Material.

H. Damage Repair. Geotextile will be considered damaged if it is torn or punctured, or if overlaps or sewn joints are disturbed. Repair damaged geotextile by removing permeable cover material around damaged or displaced area and by replacing damaged geotextile with a patch of same type of geotextile. Overlap existing geotextile a minimum of 3 feet from edge of damaged area, or repair damaged sheets by sewing. Replace and compact removed permeable cover material.

END OF SECTION

SECTION 02210—PLACE COVER MATERIAL

PART 1—GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, tools, and equipment necessary to place permeable cover material, consisting of drain rock, cinder, or clean soil (or other materials approved by Contracting Officer).

PART 2—PRODUCTS

2.01 MATERIALS

A. **Drain Rock**: Drain rock shall be select imported non-expansive granular material with 80 to 100% of material by weight passing the 3/4" sieve, 0-40% passing the 3/8" sieve, and 0-4% passing the No. 4 sieve.

B. **Cinder**: Crushed red or black cinder with 100% passing the 3/4" sieve.

D. **Topsoil**: Topsoil shall be imported, screened, natural, fertile, friable soil free from rocks, gravel, debris, noxious seed, weeds, roots, and subsoil. Topsoil must be certified "clean" (not containing contaminants above the Hawaii Department of Health environmental action levels for unrestricted land use). The certification may be provided by the source entity (seller) or by laboratory testing of the imported materials by the Contractor.

PART 3—EXECUTION

3.01 PROTECTIVE MEASURES

A. Existing contaminated soils shall not be disturbed. Contractor shall keep said contaminated soil in place and guard against development of dust or tracking of material outside of the contaminated areas as shown in plans.

C. The Contractor shall protect from damage all surrounding structures, landscaping, walks, pavements, etc. Any damage will be repaired or replaced to the satisfaction of the Contracting Officer and at no additional cost to the State.

D. Work site shall be kept free from standing water. Grading shall be controlled so that the ground surface is properly sloped to provide positive drainage away from buildings and consistent with existing or intended drainage patterns.

E. The Contractor shall conduct operations with minimum interferences to normal school operations, streets, driveways, sidewalks, passageways, traffic, etc.

F. The Contractor shall confine all work, materials, equipment, and personnel as much as to possible to the work area (Contract Zone Limits) as indicated so as not to interfere with the normal functions of the School. The Contractor shall schedule all work that involves excessive noise, dust, dirt, or any other nuisances created by the work of this Section in order to minimize disruptions to normal school functions.

G. When necessary and when directed by the Contracting Officer and/or Governmental Official, the Contractor shall provide and erect barriers, etc. with special attention given to the protection of personnel.

3.02 SITE PREPARATION

A. Prior to placement of cover material surface shall be prepared as per Section 02055 and Permeable Separator shall be placed as per Section 02060 and approved for placement of cover material by the Contracting Officer.

3.03 DRAIN ROCK AND CINDER PLACEMENT

A. Drain Rock and/or Cinder shall be placed in horizontal lifts restricted to 4 inches in loose thickness and shall not be compacted. Rake to a consistent depth.

3.04 TOPSOIL

A. Topsoil shall be placed in 8-inch thick lifts maximum and shall be compacted in place. Top 4 inches shall not be compacted.

B. Moisture Content. Do not work soil when air is so moist that excessive compaction occurs, or so dry that dust forms and clods do not break up readily.

C. Grading and Drainage. Grade soil to smooth and even finish without abrupt changes or pockets. Verify that surface drainage is adequate. Notify the Engineer of discrepancies, obstructions, and other impediments to proper execution of work.

D. Vegetation. Final vegetation on clean topsoil cover shall be performed as described in Section 02920—Lawns and Grasses.

3.05 CLEAN-UP

A. Clean up and remove all debris accumulated from construction operations from time to time and as directed by the Contracting Officer. Upon completion of the construction work and before final acceptance of the work, remove all surplus materials, equipment, etc., and leave the project site(s) neat and clean.

END OF SECTION

SECTION 02920—LAWNS AND GRASS

PART 1—GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment, and tools for grass planting as specified herein. Grass shall be planted in areas listed below.

1. All existing grassed areas (both inside and outside the Contract Zone Limits) that are damaged by construction activities.

2. All areas where new clean topsoil is placed over the geotextile permeable separator at the project site.

PART 2—PRODUCTS

2.01 MATERIALS

A. Grass shall match existing unless otherwise directed by the Contracting Officer. At the option of the Contractor, grass planting may be by seeds (plain seeding or by hydro-mulching) or by sprigs.

1. Grass seeds shall be fresh, hulled, and meet the following requirements:
   Pure Seed 95.0% minimum
   Crop Seed 1.0% maximum
   Weed 0.5% maximum
   Inert Material 5.0% maximum
   Germination 85.0% minimum

   Grass seeds shall be delivered to the site in unopened, sealed containers, labeled with the brand name and percent purity. Labeling shall indicate that the seeds passed a certified germination test no more than 12 months prior to use.

2. Grass sprigs shall be healthy living runners and stolons, a minimum of 6 inches long with at least 3 nodes. After they are dug, they shall be covered and kept moist until planted.

B. Fertilizer shall be pelleted and shall consist of the following percentages by weight of active ingredient:

1. For First Application:
   Nitrogen 16%
   Phosphate 16%
   Potash 16%

2. For Second Application:
   Nitrogen 16%
   Phosphate 16%
   Potash 16%

C. Mulch Materials
   1. Mulch shall be specially processed fiber containing no growth or germination-inhibiting factors. It shall be such that any addition and agitation in the hydraulic equipment with seed, fertilizer, water and other additives are not detrimental to plant growth, and the fibers will form a homogeneous slurry. When hydraulically sprayed on the soil, the fibers will form a blotter-like ground cover that readily absorbs water and allows infiltration to the underlying soil.

   2. Stabilizing and water-retaining agent for hydro-mulching option shall be "Verdyol Super," "Ecology Control M-Binder," or approved equal. Rate of application of "Verdyol Super" shall be 50 lb/acre and that for "Ecology Control M-Binder" shall be 60 lb/acre.

D. Organic Soil Conditioners: Organic amendments shall be brown, gray, or black in color. They shall be free of live seeds, cuttings, fungus, spores, and foul odor. They shall also not contain resins, tannin, or other materials in quantities that would be detrimental to plant life.

   Soil conditioner shall be one, or a combination of the following:
   1. Burnt Bagasse Mix shall be a mixture of sugar cane ash, aged sugar cane trash, and milled forest waste products.

   2. Redwood shavings shall be a nitrogen-stabilized compost of redwood material passing through a 1/2-inch screen.

   3. Peat Moss.

   4. Shredded Hapuu shall be finely shredded hapuu fern.

   5. Macadamia nut husks shall be air classified fine husk, sifted through a 1/4-inch screen and free of shells.

   6. Composted green waste shall be stabilized compost of recycled green waste material passing through a 1/2-inch screen. The material shall not contain any treated or painted woods.

E. Topsoil for repair work shall be as specified in Section 02210. See Paragraph 3.01.D.5. for application.

F. Water shall be potable.

PART 3—EXECUTION

3.01 INSTALLATION AND WORKMANSHIP

A. Site Preparation:
   1. Placement of clean topsoil cover as specified in Section 02210—Place Cover Material.

B. Planting: The Contractor shall notify the Contracting Officer 1 day before planting of grass.
   1. Immediately prior to planting operations, all planting areas shall be cleared of weeds, debris, rocks over 1 inch in diameter and clumps of earth that not break up.

   2. Option by Grass Seeding: If grass seeds are used, the following procedure shall be used. (NOTE: Contractor should exercise caution in seeding slopes where seeds may be washed away.):
      a. The grass seeds shall be broadcast uniformly by hand or by sowing equipment at the rate of 100 lb/acre. Half of the seeds shall be sown with the sower moving in one direction and the remainder shall be sown at right angles to the first direction.

      b. The surface shall then be raked to a smooth even plane while the seeds are simultaneously worked into the soil to a depth of about 1/2 inch.

      c. The surface shall then be smoothed and compacted by means of a culti-packer, roller, or other similar equipment weighing 60 to 90 pounds per lineal foot of roller.

      d. The planted area shall then be watered sufficiently to provide water penetration to a depth of at least 2 inches and shall then be kept moist until roots are established.

   3. Option by Grass Sprigging
      a. Furrows shall be placed perpendicular to drainage aisles and parallel to contours on slopes and shall be spaced no more than 4 inches apart.

      b. Fresh sprigs shall be planted in each furrow a maximum of 6 inches apart and covered with soil to a minimum depth of 2 inches.

      c. The surface shall then be smoothed and compacted by means of a culti-packer, roller, or other similar equipment weighing 60 to 90 pounds per lineal foot of roller.

      d. The planted areas shall be watered immediately after rolling in sufficient quantity to provide water penetration to a depth of at least 2 inches and shall then be kept moist until roots are established.

      e. The area shall then be overseeded with annual rye grass seeds at the rate of 25 lb/acre.

   4. Option by Hydro-Mulching of Grass Seed: This work shall consist of furnishing and applying hulled Bermuda seed, fertilizer, mulch and stabilizing and water retaining agent by hydro-mulching
      a. The seeds shall be applied at the rate of 100 lb/acre minimum. Mulch shall be applied at a rate of 500 lb/acre minimum (31 lb per 900 sq ft).

In every application, complete and uniform coverage of the soil shall be attained.

b. First application of fertilizer shall be included with mulch and seed.

c. The hydro-mulch equipment shall be capable of mixing all the necessary ingredients to a uniform mixture and to apply the slurry to provide uniform coverage. Seed, fertilizer, mulch mix, and stabilizing water retaining agent shall be applied in one operation by hydraulic equipment made specifically for this use. The equipment shall have a built-in agitation system with an operating capacity sufficient to keep the mix in uniform distribution until pumped from the tank. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with hydraulic discharge spray nozzles that provide a uniform distribution of the slurry.

d. Areas inaccessible to hydro-mulching application shall be seeded or hand sprigged and fertilized by approved hand methods.

e. Water shall be applied immediately following mulching and the planted area shall be kept moist until roots are established.

C. Application of Fertilizer: the Contractor shall notify the Contracting Officer 1 day before application of fertilizer.

1. Fertilizer shall be fertilized uniformly over the planted area.

2. The first application of fertilizer shall be applied at the rate of 300 lb/ acre about 2 weeks after grassing and shall be followed by watering. (First application of fertilizer if using hydro-mulching option shall be mixed with seeded mulch.)

3. The second application of fertilizer shall be applied at the rate of 300 lb/acre about 1 week before the end of the maintenance period and shall be followed by watering.

D. Maintenance:

1. General: The Contractor shall be responsible for the proper care of the grassed areas. Maintenance shall include watering, weeding, moving, repairing, regrassing, and protection, and shall be required until the entire project is accepted, but in any event for a period not less than 45 days after the planting of grass.

2. Watering: After planting of seeds or grass sprigs or mulching the ground shall be watered as deemed necessary by the Contractor to establish a healthy growth. Watering shall be done in a manner that will prevent erosion due to the application of excessive quantities of water, and the watering equipment shall be of a type that will prevent damage to the finished surface.

3. Weeding: Weeds shall be uprooted and removed completely and in no case shall be allowed to grow and propagate more seeds. Large holes caused by weeding shall be filled with screened soil and raked level.

4. Mowing: Grass shall be mowed to a height of 1 inch whenever the height of grass becomes 1–1/2 inches.

5. Repairing and Regrassing: When any portion of the surface becomes gullied or otherwise damaged and grass has failed to grow, such areas shall be repaired with grass. Any area of 1 foot square or more in which grass has failed to grow after 30 days of maintenance shall be regrassed.

6. Protection: The grassed areas shall be protected against traffic so that the grass establishes a healthy growth. Grassed areas damaged by traffic shall be replanted.

3.02 ACCEPTANCE OF GRASSING

A. At the time of acceptance, the grass shall have been well-established and shall be given a final weeding and a final mowing to a height of 1 inch. If the maintenance period has expired before acceptance of the entire project, the Contractor shall continue to maintain the grass until acceptance of the entire project. If the maintenance should extend beyond acceptance of the entire project, the Contractor shall continue to maintain the grass until the end of the specified period of time required for maintenance.

B. At the end of the maintenance period, should there appear areas where grass has failed to grow, such areas shall be replanted with grass, refertilized, and maintained beyond the maintenance period until a healthy growth is established.

END OF SECTION

SECTION 04825—CONCRETE MASONRY UNITS

PART 1—GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, tools, and equipment for the installation hand placement of concrete masonry units (CMU) as indicated on the drawings and as specified herein.

1.04 QUALITY ASSURANCE

A. Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer.
   1. Block plant shall maintain a quality control program to monitor and control block chloride ion content.

PART 2—PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. Concrete Masonry Units: ASTM C-90 and as follows:
   1. Unit Compressive Strength: Provide load-bearing units with minimum average net-area compressive strength of 1000 psi.

   2. Nominal size as indicated in the plans.

PART 3—EXECUTION

3.02 INSTALLATION, GENERAL

A. General: All masonry units shall be handled to protect and minimize chipping, spalling, and cracking.

B. Masonry units shall be placed directly on top of the geotextile permeable separator. Units shall be straight, level, and parallel to the existing buildings as indicated on the plans. Units shall abut one another end to end.

B. Masonry units shall be placed with a 2-inch gap maintained between the face of the building foundation wall and the units.

C. Fill masonry unit cells with Drain Rock or Cinder cover material as specified in Section 02210.

END OF SECTION

APPENDIX B

STANDARD OPERATING PROCEDURES (SOPS)

- SOP 1—ROUTINE MAINTENANCE FOR GRASS COVER OR LANDSCAPING
- SOP 2—ONSITE MANAGEMENT AND REUSE OF CONTAMINATED SOIL
- SOP 3—CHARACTERIZATION AND LANDFILL DISPOSAL OF CONTAMINATED SOIL

STANDARD OPERATING PROCEDURE (SOP 1)

ROUTINE MAINTENANCE FOR GRASS COVER OR LANDSCAPING

SCOPE AND APPLICATION

This standard operating procedure (SOP) has been developed for use by Hawaii schools to ensure thick grass cover or landscaping over areas with soil in the Hawaii Department of Health soil Category C for low activity areas. Maintaining thick grass cover is one of the mitigation options for this soil condition (see Integral 2017, Table 5-1).

DEFINITION OF ADEQUATE GRASS COVER

A thick grass cover is defined as a densely vegetated area of turf grass where no bare soil is visible. Landscaping is defined as a vegetated or sparsely vegetated area where the ground is covered with garden fabric with a layer of either mulch, wood chips, cinders, or crushed stones, and where no bare soils is visible.

Thick grass cover serves as a properly functioning protective barrier when it prevents soil from being contacted by a person, such as someone pressing their hands to the ground surface. At some schools in Hawaii where heavy rainfall occurs, soils become saturated with water and the underlying soil is mobilized as mud. In these conditions, soil (mud) will move up through the grass and can come in contact with a person. In these wet/muddy situations, thick grass cover may not be sufficient to prevent contact with soils containing chemicals of potential concern above action levels, and soil removal or capping may be required.

INSPECTION AND MAINTENANCE PROCEDURES

Inspection and maintenance will occur on a regular basis, with minimum inspections conducted approximately once per quarter (4 times per year), consistent with the schedule provided in the school-specific environmental hazard management plan (EHMP). Maintenance personnel will be trained in the inspection and maintenance of grass cover and landscaping. Inspection forms as well as maintenance forms, included in the school-specific EHMP, will be completed by the personnel conducting the inspection and the maintenance, and will be kept at the school and made available for inspection by Hawaii Department of Education personnel upon request.

Inspections

Inspection and maintenance will be conducted by school personnel consistent with the SOP and the school-specific EHMP. The typical inspection items that are required in order to maintain an adequate grass cover are as follows:

- *Sparse vegetation*—Identify all bare areas and schedule for maintenance.
- *Presence of erosion or damage*—Identify all areas showing signs of soil or landscaping erosion as well as damage to the ground cover. Schedule these areas for maintenance to prevent further damage.

Maintenance

The maintenance items to ensure adequate grass cover or landscaping are as follows:

- *Sparse vegetation*—Replace grass that is dying or damaged. Reseed or patch all bare areas. Identify and remedy the causes of the sparse vegetation. The causes could include lack of irrigation, pedestrian or vehicular traffic, weeds, or stormwater flow.
- *Presence of erosion*—Reseed or patch all bare areas. Repair all areas showing damaged landscaping so that bare soil is no longer exposed. Identify and remedy the causes of the erosion. The causes for erosion may include insufficient (sparse) vegetation, excessive stormwater, pedestrian or vehicular traffic, or improper grade.
- *Irrigation*—Perform routine maintenance on irrigation systems to ensure that adequate water is supplied to the grass cover or landscaping, and that the system provides adequate water coverage to all vegetated areas.

REFERENCES

Integral. 2017. Environmental hazard management plan, building exterior soils, framework for schools statewide. Prepared for Hawaii Department of Education, Honolulu, HI. Integral Consulting Inc., Waipahu, HI. December 19.

STANDARD OPERATING PROCEDURE (SOP 2)

ONSITE MANAGEMENT AND REUSE OF CONTAMINATED SOIL

SCOPE AND APPLICATION

This standard operating procedure (SOP) has been developed for use by Hawaii schools to ensure proper onsite management and reuse of impacted soils during construction and maintenance activities. For many projects, contaminated soil may be suitable for onsite reuse as backfill material, as long as the soil is placed in a condition where it will not present a direct contact hazard (e.g., in deeper portions of an excavation or under structures or pavement).

DEFINITIONS

Maintenance and Construction Activities

Maintenance and construction activities are defined as any activities related to ongoing school maintenance or construction projects that may disturb surface (0–6 in. depth) or subsurface (>6 in. depth) soils.

Contaminated Soil

Contaminated soils are defined as soils with arsenic, lead, or chlordane (or other compounds) at concentrations greater than the Hawaii Department of Health (HDOH) direct-exposure action levels for unrestricted land use. For arsenic, lead, and chlordane, these soils would be considered Category C or D soils.

Hazardous Waste Determination

Soil with elevated concentrations of arsenic, lead, or chlordane (or other compounds) may be considered a hazardous waste upon generation (i.e., upon excavation) if the soil fails the toxicity characteristic leaching procedure (TCLP) in accordance with the Resource Conservation and Recovery Act and its regulations. The TCLP laboratory test evaluates the potential for chemicals to be leached from the waste material (soil). If leached concentration of chemicals are above specific regulatory levels, the excavated soil would be considered a hazardous waste and could not be reused onsite or disposed of at a municipal landfill. Hazardous waste materials are typically shipped to the mainland U.S. for treatment and disposal at permitted hazardous waste facilities.

GENERAL PROCEDURES

This SOP applies when maintenance or construction activities are planned that may result in disturbance (excavation or grading) of contaminated soils. Prior to any intrusive work, evaluate all affected portions of the project area to determine the potential for encountering contaminated soil. The school-specific EHMP should provide maps of prior soil assessment work showing the locations of any known contaminated soils. If there is uncertainty regarding the potential to encounter contaminated soil, prepare and implement a soil sampling and analysis plan to determine soil contaminant concentrations within the planned work area(s), and to ensure the soil is not a hazardous waste upon generation (when excavated). If there is the potential to generate a hazardous waste soil, contact the HDOH to provide additional guidance to the Hawaii Department of Education (HDOE) personnel and their contractors.

Onsite Management of Excavated Soil

Observe the following precautions when temporarily stockpiling excavated soils onsite:

- Use best management practice erosion control measures, such as filter socks, to surround the soil stockpile.
- Place the stockpile on heavy-duty plastic sheeting to prevent contamination of clean soil.
- Place heavy-duty plastic sheeting over the stockpile as a cover to prevent dust generation and erosion of the stockpile.
- Tag and label the stockpile with information such as source location, date of excavation, date of sampling, estimated soil volume, and designated HDOE contact.

Onsite Reuse of Excavated Soil

Excavated soil may be reused onsite if certain criteria are met. Characterize the soil stockpile by way of sampling, following the HDOH procedures outlined in the guidance for the evaluation or imported and exported fill material (HDOH 2017). For soils to be reused at schools, the HDOH recommends a default stockpile sampling volume of 400 cubic yards for contaminants such as metals and chlordane. If the excavated soil is determined to be contaminated (e.g., Category C or D soils), the soil should be used as general backfill or engineered fill in deeper portions of an excavation (minimum 2 ft below final grade), and covered with clean soil, or be placed beneath permanent structures or a cap (landscaped cap or hard cap [e.g., asphalt or concrete]).

Amend or update the school-specific EHMP to document the location and contaminant characteristics of the contaminated soils reused onsite.

In summary, contaminated soil reuse is prohibited for soils that are determined to be a hazardous waste upon generation. The final disposal of contaminated soil reused onsite should be consistent with an approved mitigation action such as capping with clean soil, landscaping, or hard cap (see Integral 2017, Table 5-1).

Offsite Soil Disposal

Dispose of excavated contaminated soils that will not be reused onsite at a permitted municipal landfill. These soils should not be transported to other sites or construction projects for disposal or alternative reuse. Waste characterization data are required in order for the landfill to provide an approved waste profile and accept the soil for disposal. Work with the landfill company and an environmental consultant to ensure proper waste characterization and profile approval. Soil stockpiled for landfill disposal may be characterized by way of sampling, following HDOH guidance for the evaluation of imported and exported fill material (HDOH 2017).

REFERENCES

HDOH. 2017. Guidance for the evaluation of imported and exported fill material, including contaminant characterization of stockpiles. http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/technical-guidance-and-fact-sheets. Hawaii Department of Health, Office of Hazard Evaluation and Emergency Response, Honolulu, HI. Fall.

Integral. 2017. Environmental hazard management plan, building exterior soils, framework for schools statewide. Prepared for Hawaii Department of Education, Honolulu, HI. Integral Consulting Inc., Waipahu, HI. December 19.

STANDARD OPERATING PROCEDURE (SOP 3)

CHARACTERIZATION AND LANDFILL DISPOSAL OF CONTAMINATED SOIL

SCOPE AND APPLICATION

This standard operating procedure (SOP) has been developed for use by Hawaii schools to characterize contaminated soils planned for offsite disposal at a permitted landfill.

DEFINITIONS

Contaminated Soil

Contaminated soils are defined as soils with arsenic, lead, or chlordane (or other compounds) at concentrations greater than the Hawaii Department of Health (HDOH) direct-exposure action levels for unrestricted land use. For arsenic, lead, and chlordane, these soils would be considered Category C or D soils.

Hazardous Waste Determination

Soil with elevated concentrations of arsenic, lead, or chlordane (or other compounds) may be considered a hazardous waste upon generation (i.e., upon excavation) if the soil fails the toxicity characteristic leaching procedure (TCLP; U.S. Environmental Protection Agency [EPA] SW-846 Method 1311) in accordance with the Resource Conservation and Recovery Act (RCRA) and its regulations. The TCLP laboratory test evaluates the potential for chemicals to be leached from the waste material (soil). If leached concentration of chemicals are above specific regulatory levels, the excavated soil would be considered a hazardous waste and could not be reused onsite or disposed of at a municipal landfill. Hazardous waste materials are typically shipped to the mainland U.S. for treatment and disposal at permitted hazardous waste facilities.

GENERAL PROCEDURES

Contaminated soils that are excavated and will not be reused onsite (see SOP 2) must be disposed of at a permitted landfill. Waste characterization is required in order for the landfill to provide an approved waste profile and accept the soil for disposal. Work with the landfill company and an environmental consultant to ensure proper waste characterization and profile approval. Soil stockpiled for landfill disposal may be characterized by way of sampling and laboratory analysis, following EPA waste sampling guidance (USEPA 2002) and HDOH guidance for the evaluation of imported and exported fill material (HDOH 2017).

First, the generator (Hawaii Department of Education or its contractor if delegated) must determine whether the waste soil is a hazardous waste. For soil at schools containing arsenic, lead, and organochlorine pesticides (OCPs), the soil could be considered hazardous by characteristics, in particular by the toxicity characteristics for arsenic, lead, or chlordane. A representative sample of soil is evaluated by the TCLP test (EPA SW-846 Method 1311) to determine the leachable concentrations of various compounds. If the TCLP test results for a compound are above defined regulatory levels, then the waste soil is considered a hazardous waste. If results are below regulatory levels, then the soil is a non-hazardous solid waste.

No landfills in Hawaii are currently permitted for the disposal of hazardous waste, and hazardous waste is typically shipped to the mainland for treatment and disposal. Some soils with high concentrations of arsenic, lead, or chlordane (or potentially other chemicals of potential concern) could be considered hazardous waste based on the TCLP (i.e., the soils could potentially fail the TCLP test and be identified as hazardous waste). Because the costs for managing the disposal of hazardous waste are high, an approach often considered is to test soil *in situ* (before generated by excavation) to allow careful planning before hazardous waste generation. Once generated, a hazardous waste soil cannot be returned to the excavation.

Most contaminated soil in Hawaii, and most of the contaminated soil anticipated to be discovered on school campuses, will be determine to be non-hazardous solid waste upon generation, and can be disposed of at several permitted sanitary landfill facilities (such as the West Hawaii Sanitary Landfill in Waikoloa).

Identification of Chemicals for Testing

Waste characterization is a process of describing the characteristics of a waste material prior to reuse, treatment, or disposal. Information for the waste characterization may include process knowledge, along with historical and current chemical analysis. The list of chemicals to be analyzed may be streamlined based on process knowledge of prior site activities that may have resulted in soil contamination. For most soils at school campuses, metals and OCP compounds are the minimum suite of chemical analytes necessary for waste characterization.

Typically, for a waste soil be approved by the landfill facility for disposal, waste characterization laboratory chemistry data must be submitted along with other information such as the source of the soil and its physical properties. Based on the information provided to the landfill, a list of chemicals will be determined for testing. The landfill may require certain chemical testing regardless of process knowledge.

Sampling of Soil Stockpiles

Soil samples shall be collected and analyzed following procedures outlined in HDOH (2017) in order to provide chemical information on the soil stockpile to be disposed. HDOH recommends multi-increment soil sampling of stockpiles to generate characterization data that is representative of the entire volume of stockpiled soil. Depending on the size of the stockpile, a minimum number of multi-increment samples is recommended. Depending on the size of the stockpile, heavy equipment such as backhoes or excavators may be needed to reach all areas of the stockpile during the sampling process. Individuals performing the sampling must be qualified environmental professionals.

In Situ Characterization

In some situations, a soil can be characterized for reuse or landfill disposal prior to being excavated, by *in situ* sampling and analysis of soil in place. Representative samples of the volume of waste material planned for excavation should be collected, by way of multi-increment samples if possible. Soils should be analyzed for likely chemical contaminants as total compounds by applicable EPA-approved methods and for leachable analytes by the TCLP test.

Once the soil has been pre-characterized, it may be excavated and directly reused (e.g., as construction backfill) or loaded, transported, and disposed of at a landfill under an approved waste profile. The process of pre-characterizing waste soil can often reduce project costs by eliminating stockpiling and re-handling processes.

REFERENCES

HDOH. 2017. Guidance for the evaluation of imported and exported fill material, including contaminant characterization of stockpiles. http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/technical-guidance-and-fact-sheets. Hawaii Department of Health, Office of Hazard Evaluation and Emergency Response, Honolulu, HI. Fall.

USEPA. 2002. RCRA waste sampling draft technical guidance, planning, implementation, and assessment. U.S. Environmental Protection Agency, Solid Waste and Emergency Response. EPA530-D-02-002. August.

APPENDIX C

GENERAL GUIDANCE DOCUMENTS

Engineered Cap or Grass Cover
Inspection and Maintenance Form

Location: ____ Inspector(s): ___________________________

Mitigation Action No.: ___________ Date of Inspection: __________ Type of Inspection: ☐ Quarterly ☐ Yearly ☐ Every 6 months ☐ Other:____________

Type of Mitigation Action: ☐Grass cover ☐ Stone/cindercap

Area Activity Level: ☐ High activity ☐Low activity

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Results Expected When Maintenance Is Performed**
1. Erosion	Treatment measure has channels, ruts or holes, and/or soil is exposed because of erosion.			No evidence of erosion or soil exposure.
2. Sediment/soil accumulation	Sediment or soil accumulating that covers vegetation or cap area.			Remove accumulated sediment or soil deposits. Dispose of sediment/soil properly. Examine why accumulation is occurring on this area.
3. Grass health (for grass areas only)	Grass is either dead or diseased. Plant growth is poor because either there isn't enough sunlight or irrigation is not working properly.			Grass is healthy and receives proper amount of sunlight. Dying or diseased vegetation have been properly removed and replaced. Irrigation system supplies adequate water coverage.
4. Grass/Stone Ccoverage	Sparse grass or stone cover with patches in more than 10% of the area.			Grass or stone coverage in more than 90% of the area. For grass: determine why growth of planted vegetation is poor and correct that condition. Replant with plugs of grass, or reseed into loosened, fertile soil. Stones, cinders and/or soil meet design specifications.
5. Trash and debris accumulation	Trash and debris accumulated on the mitigation action area.			Trash and debris removed from area. Dispose of trash and debris properly.
6. Activity level	Note any changes in area activity level (from high to low activity or vice versa)			Report any changes in activity level.
7. Miscellaneous	Any condition not covered above that needs attention in order for the cap to function as designed.			Meet the design specifications.

Fugitive Dust Fact Sheet

Prepared by the Department of Health, Clean Air Branch
Rev October 2014

Hawaii Administrative-Rules, Section 11-60.1-33, Fugitive Dust-states, in part:

11-60.1-33(a): No person shall cause or permit visible fugitive dust to become airborne without taking reasonable precautions.

11-60.1-33(b): ...no person shall cause or permit the discharge of visible fugitive dust beyond the property lot line on which the fugitive dust originates.

An air permit for a facility may contain additional or more stringent fugitive dust requirements. Failure to comply with the fugitive dust requirements may result in civil and administrative fines of not more than $25,000 per day per violation.

Examples of Reasonable Precautions

The following are examples only, this list is not exclusive nor comprehensive. Reasonable precautions to control fugitive dust are determined on a case-by-case basis. The site topography and surroundings, soil conditions, meteorological conditions, site activities, site equipment, and types of material processed must be considered. The use of any or all of the example measures does not automatically mean compliance with the fugitive dust requirements. The owner, project manager or operator should assess the project activities and conditions daily and make adjustments so that reasonable precautions are taken to prevent fugitive dust from becoming airborne and crossing the property line. Generally, dry and windy conditions will require more control measures than rainy and calm periods.

General Measures

- Design, develop and implement a dust control plan.
- Use water or suitable chemical compounds in the demolition of existing structures, construction operations, and grading or clearing of land.
- Apply water, dust suppressants, or suitable compounds on roads and material stockpiles.
- Pave ingress and egress points to the site.
- Establish and monitor speed limits for on - site vehicles.
- Cover all moving, open-bodied trucks transporting dusty materials.
- Install and use enclosures, screens, hoods, vacuums, and filters to control the handling, sanding or finishing of dusty materials.
- Use trash chutes to direct waste downwards to the ground from upper levels
- Clean up material spills as soon as possible.
- Promptly remove soil or other “carry out“materials from roads adjacent to the site.
- Install dust screens or wind barriers around construction site.
- Where practical, provide a buffer zone between fugitive dust activities and residential areas.

Agricultural Activities

- Keep fallow land to a minimum.
- Use cover crops to minimize exposed soil.
- Limit vehicular speed during plowing activities and while traveling onsite.

Crushing and Screening

- Pre-wet material.
- Monitor crusher's visible dust emissions.
- Apply water to crushed material.
- Apply water at material transfer points.
- Stabilize material immediately after screening.
- Drop material through the screen slowly and minimize drop height.
- Install wind barrier upwind of screen.

Earth-moving activities

- Pre-apply and re-apply water as necessary to maintain soils in a damp condition.
- Limit the amount of exposed areas through planning and timing of project phases.
- Cover temporarily exposed areas with mulch.

Stockpiles

- Stabilize stockpile materials.
- Keep stockpiles wet or damp as needed
- Cover stockpile when not in use. Use mulch or synthetic cover based on usage of stockpile.
- Keep drop or pile height as low as possible.
- Install wind barriers
- Add or remove material from downwind portion of stockpile
- Maintain storage piles to avoid steep sides or faces.

Trucking

- Provide water while loading and unloading to prevent fugitive dust.
- Maintain at least six inches of freeboard on haul vehicles. Level the height of load.
- Limit vehicular speed while traveling onsite.
- Cover your load while travelling.
- Install a gravel pad and grizzly at exit.
- Reduce carry out with a tire wash or spray system.

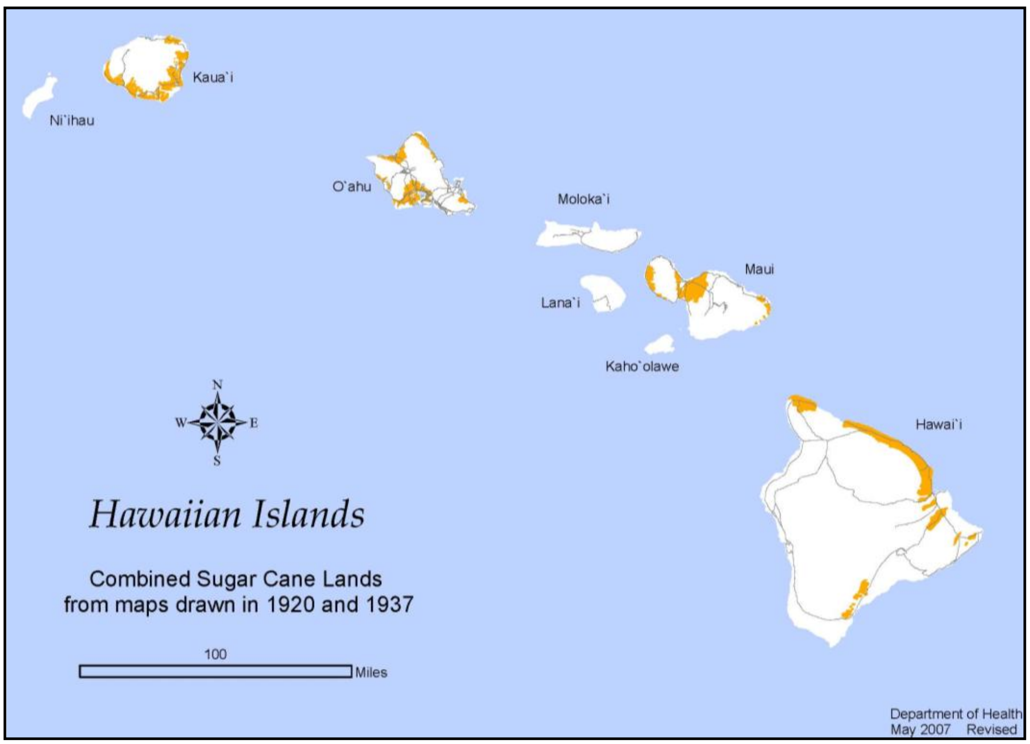
HAWAII STATE DEPARTMENT OF HEALTH

The **Hazard Evaluation and Emergency Response (HEER) Office** is part of the Hawaiʻi Department of Health Environmental Health Administration 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.

Arsenic in Hawaiian Soils: Questions and Answers on Health Concerns

This fact sheet provides landowners, private citizens, farmers, developers, construction contractors, realtors, and others with an overview of the potential human health concerns associated with arsenic-contaminated soils in Hawaiʻi. Additionally, this fact sheet discusses methods for reducing exposure to soil arsenic and provides resources for further information.

What is arsenic and where is it found in Hawaiʻi?



This map estimates extent of former lands in sugar cane cultivation in Hawaiʻi, 1920-1937 (orange areas). Elevated levels of arsenic may be found in soils within some of these areas, related to the use of arsenic-based herbicides in and around cane fields in the 1920s through 1940s.

Arsenic is a naturally occurring element in the earth's crust. In Hawaiʻi, low levels of arsenic are found naturally in native soils. However, significantly elevated levels of arsenic have been identified in soils at former sugar cane fields, former pesticide storage or mixing areas, former sugar plantation camps, a former canec production plant, wood-treatment plants, and at least one former golf course. The presence of elevated levels of soil arsenic at some historic sugar plantation areas is believed to be related to the widespread use of sodium arsenite (an inorganic arsenic compound) or other arsenic-based herbicides/pesticides in and around the cane fields in the 1920s through 1940s. Because inorganic arsenic is stable in the environment, it remains in the soil many years after use. Another possible source of arsenic exposure is past use of inorganic arsenic as an insecticide in "canec" board. Canec board was made out of waste sugar cane fiber and widely used for ceilings or walls in home or commercial construction in Hawaiʻi during the 1930s through the 1950s (see Arsenic in Canec Ceilings and Wallboard in Hawaiʻi fact sheet). Arsenic was also a common ingredient in wood preservatives for many years (e.g. copper-chromium-arsenic ["CCA"] pressure-treated lumber). Certain types of fertilizers that contained arsenic may be a source of contamination as well.

How are people exposed to arsenic?

TOP: Children are at risk of arsenic exposure from unintentional ingestion of soil through normal play activities.

BOTTOM: Local produce grown in soil with elevated arsenic is considered safe to eat provided it is washed to remove soil and dust. Low but significant levels of inorganic arsenic are found in foods such as rice, fish, chicken and seaweed that are common in diets of Hawai'i, but adverse health effects from arsenic in these foods has not been reported.

- **Unintentional ingestion of soil** - If arsenic is in the soil, ingesting the soil is the primary source of exposure. The main concern is that on a regular or periodic basis some people may unintentionally swallow very small amounts of contaminated soil - especially young children who are unaware of the hazards and may be exposed to contaminated soil through normal play activities. Most children put their hands, toys, or other objects in their mouths, and these often have small amounts of soil and dust on them that the child swallows. Residual dirt on produce grown in arsenic-contaminated soil and on hands after gardening or outside work may also contribute to arsenic exposure through accidental ingestion of soil particles. In most cases the amount of inorganic arsenic that a person could be exposed to from contaminated soils is estimated to be less than inorganic arsenic in their diet. It is important to minimize additional exposure to inorganic arsenic from non-food sources, however, in order to minimize potential health risks. Inhalation of arsenic in dust is possible, but in most circumstances this is a very minor source of exposure compared to unintentional soil ingestion. Arsenic in soil is not believed to be absorbed through bare skin in significant amounts.

- **Food** - Arsenic is found in shellfish and fish from many areas of the world. Arsenic in seafood is primarily organic arsenic, a different chemical form than inorganic arsenic used in the past on sugar plantations, in canec board products, and for wood treatment. Organic arsenic compounds are generally not considered toxic or harmful. Common island diets contain trace amounts of inorganic arsenic in foods such as rice, fish, chicken, and seaweed although no adverse health effects have been reported from arsenic in these foods. HDOH tested produce from community gardens with elevated soil arsenic and found arsenic levels were similar to levels in produce from grocery stores across the mainland U.S. Produce grown in soil with elevated arsenic is considered safe to eat provided it is washed to remove soil and dust.

- **Water -** In some parts of the world, arsenic in drinking water is a concern. In Hawai'i, this is not the case. HDOH has implemented a water quality-testing program for all public water systems in the state, including testing for arsenic and other chemicals. Results of these tests have not detected arsenic in any of the State's public drinking water.

- **Factors limiting exposure to arsenic in soil -** Arsenic binds to other chemicals like iron and aluminum oxides that are abundant in many of the soils in Hawai'i. This characteristic significantly reduces the arsenic soil hazard for humans. Also, arsenic bound very tightly in soils is typically not taken up by plants.

What are the human health concerns of arsenic exposure?

People who have been exposed to high levels of arsenic over long periods of time have had health symptoms that include changes in skin pigmentation (dark spots), thickening or warts on the palms of the hands and soles of the feet, damage to heart and blood vessels, and inflammation of the liver. In addition, long-term exposure to high levels of arsenic has been associated with an increased risk of cancer.

These types of health effects have been identified in some countries where drinking water is contaminated with high amounts of arsenic. These health effects have not been documented from soil arsenic exposure in Hawaiʻi. However, very small increases in the risk of cancer are also extremely hard to associate with past chemical exposures and to examine in relatively small population sizes that occur in many regions of the Hawaiian Islands. Consequently, limiting exposure to elevated levels of arsenic wherever possible is generally recommended. Arsenic does not accumulate in the body (bioaccumulate). Stopping exposure will reduce arsenic levels in the body.

This picture shows soil sample collection from a small garden located on the island of Hawaiʻi. The garden is on former sugar cane land and therefore has the potential for elevated soil arsenic concentrations. Soil testing for arsenic will confirm if arsenic levels are elevated.

When should testing for soil arsenic be conducted?

The potential to encounter elevated soil arsenic exists for farmers, residents, construction contractors, or others that live or work on former sugar cane lands (see map, page 1), and on lands known to have had facilities associated with arsenic use. Many of the former sugar cane lands have not yet been tested, and testing has been limited in those areas where studies have been conducted (e.g. the former Olaʻa/Puna Sugar Mill plantation area). Soil arsenic levels can also vary considerably from site to site, even for sites in close proximity. Consequently, soil testing is the only option to know for certain if levels are elevated, and to what extent. If initial testing shows arsenic above natural background levels (up to 24 milligrams per kilogram [mg/kg]), additional soil arsenic bioaccessibility testing is generally recommended by HDOH. For new residential or commercial developments, testing may be conducted by environmental consultants as part of the environmental site assessment process required by the owner, buyer, or lending institution. A guide to assist homeowners in how to test for soil arsenic is available from the HEER Office. Once land is tested, HDOH has guidance to help interpret the soil arsenic levels, and determine what action, if any, may be warranted to reduce exposure to the arsenic. In some specific areas, HDOH may have limited information about other land tested in the same general vicinity.

How can I test to see if I have been exposed to arsenic?

Any arsenic exposure testing should be recommended and conducted by a doctor or trained medical professional. Tests are available to measure arsenic in your urine, blood, or hair and fingernails. HDOH has not generally recommended human exposure testing in former sugar cane plantation areas. The urine arsenic test is considered the most reliable, but is expensive, and determines exposure only within the last few days. The testing can determine if the level of arsenic in the body is higher or lower than the average person. The testing cannot determine the origin of the arsenic (e.g. soil or food) or whether the arsenic levels in the body will affect the individual's health. Limited urine arsenic testing (by HDOH and the federal Agency for Toxic Substances Disease Registry [ATSDR]) of people living by two Hawaiʻi Island garden areas with elevated soil arsenic found normal arsenic levels in most individuals tested. The tests could not determine if higher inorganic arsenic exposures measured in some older individuals was from soil ingestion or the rice and seafood diets they ate.

What can I do to prevent exposure to contaminated soil?

If testing reveals elevated levels of soil arsenic on your land, or you have not tested but live or work in an area that may have elevated soil arsenic levels, the potential for exposure can be minimized through a variety of means. Some options for limiting exposure to contaminated soil include:

- If you work with contaminated soil, old arsenic-treated wood, or canec, you should use common protective gear to reduce exposure. This may include use of gloves, long-sleeve clothing, safety glasses, or a dust mask. Additionally, working with these materials may result in arsenic-containing dirt or dust on your clothing. Be sure to change clothes and shower right after working with these materials, and avoid spreading dirt from clothes or shoes into your vehicle or house.
- If you have bare soil on your property, maintain grass, other vegetative cover, or some kind of surface material over the soil. This acts as a barrier to prevent soil exposure. Cover dog runs with old rugs or other materials to eliminate bare dirt areas.
- Keep children from playing in bare dirt and keep toys, pacifiers, and other items that go into children's mouths clean.
- Wash hands and face thoroughly after working or playing in the soil, especially before meals and snacks.
- Wash fruits and vegetables from the garden with water before bringing them in the house, then wash again inside with a brush to remove any remaining soil particles. Pare root and tuber vegetables before eating.
- Bring in clean sand for sandboxes and add soil known to be free of contamination to food garden areas. You could also make raised garden beds with clean soils.
- Avoid tracking soil into the home and clean up right away if soil is tracked in. Remove work and play shoes before entering the house. Keep pets from tracking soil into your home.

Further Information

For questions about this fact sheet or further information on HEER Office guidance related to soil arsenic, contact:

Hawaiʻi Department of Health,
Hazard Evaluation and Emergency Response Office
919 Ala Moana Boulevard, Room 206
Honolulu, Hawaiʻi 96814, Telephone: (808) 586-4249

To access more detailed information regarding soil arsenic, including detailed reports of studies conducted in Hawaiʻi and elsewhere, please visit the HEER Office website: http://hawaii.gov/health/environmental/hazard/index.html

Additional references located on HEER Office website:

HDOH, 2008. *Homeowner's Guide to Soil Testing for Arsenic*

HDOH, 2010. *Arsenic in Canec Ceilings and Wallboard in Hawaiʻi* (Fact Sheet)

Federal Government

To learn about recommendations from the Federal Government regarding arsenic, you can also contact the Agency for Toxic Substances and Disease Registry, ToxFAQs internet address http://www.atsdr.cdc.gov/toxfaq.html

This fact sheet was created with assistance and funding from USEPA's Region 9 Superfund Division.

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Lead in Hawaiian Soils: Questions and Answers

This fact sheet provides landowners, private citizens, farmers, developers, realtors, and others with an overview of the potential human health concerns associated with lead in soils in Hawaiʻi. Additionally, this fact sheet discusses methods for reducing exposure to lead and provides resources for further information.

What is lead and how does it get in the soil?

Lead is a naturally occurring element that occurs in all soils, including Hawaiian soils, at low levels. Natural background levels of lead in soils are typically 10 to 75 mg/kg (milligrams of lead per kilogram of soil) but elevations in the range of 100-200 mg/kg, levels still considered below a significant long-term health hazard risk, can be found in isolated cases due to additional inputs from historic human activity. Higher lead levels in soils (e.g. >200 mg/kg) may be present from a variety of pollution sources related to historic or current human activities. Exposure to very high levels of lead can be toxic to humans and animals, causing serious health effects. Most childhood exposures to lead can be traced to lead-based paint or lead in batteries, jewelry, and other household items. Exposure to lead in soil can also be important, however.

Lead shot at a firing range. There are several sources of human-caused lead contamination that affect Hawaiʻi's soil and groundwater.

There are two main human-caused sources of lead in soils: the past use of lead-based paint in homes and the past use of leaded gasoline. Although lead in gasoline was phased out starting in the 1970s, years of leaded gasoline use means the soils adjacent to highways and roads have elevated lead levels. Studies in urban areas have shown that soil lead levels are highest around building foundations and within a few feet of busy streets. Lead from leaded gasoline is also found in soils affected by past releases from storage tanks and pipelines at gas station sites. Other human-caused sources of lead in soil include pipes and plumbing materials, roofing nails, and batteries. Some industrial sources of lead contaminate the soil as well. Lead shot at former and active firing ranges, scrap metal yards, and ash from burning lead-bearing wastes like painted wood and batteries can all contribute to lead contamination in soils. When lead is released to the air from industrial sources or vehicles, it may travel long distances attached to fine particles before settling to the ground, where it mixes with soil particles. Lead does not biodegrade in soils, but can be dispersed through natural or human soil disturbances over time or could be transported by erosion to adjacent areas.

The State of Hawaiʻi Department of Health's (HDOH) Hazard Evaluation and Emergency Response Office (HEER Office) is responsible for responding to releases of lead and other hazardous substances into the soil or groundwater, and overseeing cleanup efforts. Other state and federal agencies have complementary roles in helping to prevent and address lead contamination and exposure. Additional information for these other resources are included at the end of this fact sheet.

How are people exposed to lead in the soil?

Ingesting the soil is the primary source of exposure to lead in soil. Lead can also be inhaled with very fine soil particles during outdoor tasks (e.g. dust from yard work or construction work) or carried into houses as airborne dust, or on shoes, clothing, and pets where it gets on floors or other objects that residents then come in contact with.

Children are at risk of lead exposure from unintentional ingestion of soil through normal play activities.

Lead was added to paint as early as the Medieval ages to speed up drying and increase durability. The use of lead in house paint was banned by 1978 but it still exists in the interior and/or exterior paint of many older homes in Hawaiʻi. As a result, real estate sales must disclose the potential presence of lead based paint on buildings built before 1978. As the paint chips off, it falls to the ground where the lead-contaminated chips persist in the soil near the foundation. In addition, some older type roofing nails contain lead. Roofing nails have wide, flat heads and short shanks. Similar to the paint chips, as the roofing nails fall off and land adjacent to the foundation, lead can be leached from the nails and mix with soil.

Lead-based paint is still present in many homes in Hawaiʻi. Children are at risk from eating paint chips and flakes. The paint chips can also fall off the house exterior and get in the soil adjacent to the foundation where children may play.

People, and especially young children, may unintentionally swallow very small amounts of lead-contaminated soil through gardening or other normal outdoor work or play activities. Children frequently put their hands, toys, or other objects in their mouths, and these can often have small amounts of soil and dust on them that the child then swallows.

Exposure to lead can also result from eating produce grown in gardens with elevated soil lead levels, such as gardens near building foundations where deteriorated lead-paint may be present or gardens adjacent to busy roadways. In general, plants do not absorb or accumulate lead. A greater concern is the accidental ingestion of lead in soil or dust particles found on unwashed produce. Thorough washing of produce is especially important for root crops such as taro, carrots or sweet potatoes and leafy vegetables like fern heads, kale and lettuce due to the tendency of soil particles or dust to adhere to the surface of this produce.

What are the human health concerns of lead exposure?

Lead can be particularly harmful to pregnant women and young children. According to the U.S. Centers for Disease Control (CDC) lead poisoning is the most common and serious “environmental” disease affecting children. Children’s bodies absorb more lead than adults do and their brains and nervous systems are more sensitive to the damaging effects of lead.

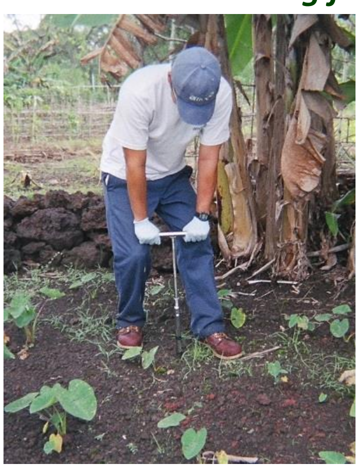
Lead can affect most every organ and system in the human body. Ingestion of large amounts of lead can cause seizures, coma and even death. Adults exposed to high levels of lead have had health symptoms that include: cardiovascular problems, increased blood pressure and incidence of hypertension; decreased kidney function; and reproductive problems (in both men and women).

Significant lead exposure to young children is typically traced to lead-based paint, batteries, jewelry, or other household articles rather than lead in soil. Exposure of children to even low levels of lead has been shown to result in behavior and learning problems, lower IQ and hyperactivity, slowed growth, hearing problems, insomnia, and anemia. Once absorbed by the human body, lead is difficult to remove. Consequently, limiting exposure to lead wherever possible is recommended.

How can I test to see if I have been exposed to lead?

If you have evidence or documentation of lead contaminated soils on your property (i.e. soils that exceed the state lead action levels) or if you think you or a family member may be experiencing symptoms of lead poisoning, you can contact your physician or local health department for information on blood lead testing. Any lead exposure testing should be recommended and conducted by a doctor or trained medical professional. A simple blood test is available to measure lead levels. Testing can determine if the level of lead in the body is higher or lower than the average person. The U.S. Center for Disease Control has updated its recommendations on children’s blood lead level of concern for young children to 5 micrograms per deciliter of lead in the blood. The testing cannot determine the origin of the lead (for example soil or food) or whether the lead levels in the body will affect the person’s health.

When should testing for soil lead be conducted?



This picture shows soil sample collection from a small garden. Gardens grown near house foundations or near busy roadways have the potential for elevated soil lead concentrations.

Residential or commercial buildings that were built before 1978 or are located near busy roadways may potentially have elevated lead in soil surrounding the foundation area or in soil near the busy roadway due to former use of lead-based paint on the structures or the former use of lead-containing gasoline by vehicles. If you suspect elevated levels of lead in your soil, you may want to have the soil tested. You can hire an environmental professional to conduct testing, or call the HEER Office for advice on sampling and laboratory analysis of any samples collected.

Lead in soil may be very unevenly distributed and therefore, a “Multi Increment” sampling approach for soil lead testing is advised. Multi Increment samples are typically large (weighing between 500-2,000 grams, or filling at least one-half of a gallon-size plastic bag) as each sample is made by combining many small soil increments that are collected from the area of interest. Lead tends to accumulate in the upper few inches of soil and does not move to any great extent in soils unless the soil has been disturbed by activities such as excavation for building or tillage for landscaping and gardening (a low soil pH may also enhance the mobility of lead). Surface soil samples are typically collected using a small diameter (approximately 1 inch) hand-coring tool from the ground surface down to about 2 to 6 inches in depth, targeting the surface soil depth where exposure may be most likely for you or your family.

Soil testing is the only option to know for certain if levels are elevated, to what extent, and to what depth. Laboratories in Hawaiʻi that have facilities to analyze soils for lead content can be found in internet directories or in the phone book under "Environmental Analysis Laboratories" or "Analytical Laboratories". Laboratories should be contacted to confirm the services provided and to coordinate on sample collection and delivery details. Laboratories should dry and sieve the Multi Increment sample(s) they receive to analyze the $\leq$ 2 millimeter (mm) particle size soil fraction for total lead content.

How are soil lead testing data evaluated?

A professional environmental consultant can be hired or the HEER Office can be consulted for questions regarding the evaluation of your data and to provide recommendations. The HEER Office has established environmental action levels or standards for lead in soil. Total lead in soil concentrations should not exceed 200 mg/kg for residential properties and 800 mg/kg for commercial and industrial properties. The HEER Office environmental action levels were developed taking into consideration potential health risk determinations based on predicted bioaccessible lead levels. Bioaccessible lead levels take into account only the estimated proportion of total lead that will be absorbed in the digestive system and potentially contribute to human health risks (a portion of the lead stays tightly bound to soil particles and will not be absorbed).

If soil results show estimated total lead levels are above 200 mg/kg, young children and pregnant women should avoid contact with the bare soil. Cleanup actions may be warranted for residential properties where soil lead levels exceed 200 mg/kg. Total lead levels above 800 mg/kg are considered a potential concern even for commercial or industrial uses of a property, and warrants action to further evaluate lead levels in soil or evaluate and pursue cleanup options. Contact the HDOH HEER Office if testing indicates soil lead levels are above the applicable environmental action levels, and for specific advice on lead control or removal measures that should be taken.

How can I remove lead from the soil?

Currently, the best ways of dealing with high lead soils are to (1) if feasible, eliminate the lead exposure risk by physically removing the contaminated soil to an approved landfill, or (2) covering the lead-containing soils with clean soils. An additional potential method of reducing the hazard of lead in soils is geochemical fixation. Geochemical fixation uses a non-toxic chemical mixed into the contaminated soil to convert the potentially toxic form of lead into a compound less likely to be absorbed by the body if accidentally ingested or inhaled. Soil removal or remediation actions at sites where lead in soil exceeds HEER Office environmental action levels should be conducted by qualified individuals such as professional environmental consultants.

What can I do to prevent exposure to lead-contaminated soil?

If testing reveals elevated soil lead levels on your property, or you live or work in an area that may have elevated soil lead levels, the potential for exposure can be minimized through the following actions:

- Wash hands and face thoroughly after working or playing in the soil, especially before meals and snacks.

- Keep dense groundcover or permanent cover close to the house, roads, and driveways to prevent children from playing in soil where higher lead levels may be found.
- Keep children from playing in bare dirt. Keep toys, pacifiers, and other items that go into children's mouths clean.
- Plant gardens away from house foundations, roads, and driveways where lead levels in the soil may be higher. Have your garden soil tested for lead before you plant. Lime soils as recommended by a soils test; a soil pH of 6.5 to 7.0 will minimize lead mobility.
- Bring in clean sand for sandboxes and add soil known to be free of contamination to food garden areas. Raised garden beds with clean soils should be used if you know your soil has elevated lead concentrations.
- Wash fruits and vegetables from the garden with water before bringing them in the house. Wash again carefully with a 1% vinegar solution or soapy water to remove any remaining soil particles. Discard outer leaves before eating leafy vegetables. Pare root and tuber vegetables before eating. Do not compost the produce peelings and unused plant parts for use back in the vegetable garden.
- Avoid tracking soil into the home and clean up right away if soil is tracked in. Leave shoes at the door or use door mats. Keep pets from tracking soil into your home.

Further Information

For questions related to lead in soils and groundwater, lead sampling, lab analysis and lead testing reports, contact:

Hawaiʻi Department of Health,
Hazard Evaluation and Emergency Response Office
919 Ala Moana Boulevard, Room 206
Honolulu, Hawaiʻi 96814

Telephone: (808) 586-4249
Website: http://hawaii.gov/doh/heer

On Hawaiʻi Island: call the Hilo HEER Office at 808-933-9921

State of Hawaiʻi Indoor and Radiological Health Branch's lead program helps: (1) prevent exposure to lead and lead-based paint, and (2) maintains the State of Hawaii lead abatement accreditation, certification, and registration systems for lead abatement entities and individuals: http://health.hawaii.gov/irhb/lead/

State of Hawaiʻi Solid and Hazardous Waste Branch provides guidance on disposal of lead based paint waste and how to manage used lead acid batteries: http://health.hawaii.gov/shwb/files/2013/06/lbpwaste.pdf and http://health.hawaii.gov/shwb/files/2013/06/oldcbats1.pdf

State of Hawaiʻi Children with Special Health Needs Branch has a Childhood Lead Poisoning Prevention Program: http://health.hawaii.gov/cshcn/home/leadpp/

State of Hawaiʻi, Safe Drinking Water Branch provides subsidized lead and copper testing for individual homes served by catchment systems: http://health.hawaii.gov/sdwb/raincatchment/

Workplace exposures to Lead

Preventing lead exposures for workers such as those in construction, manufacturing, or other businesses is the responsibility of the employer through compliance with applicable workplace safety and health regulations.

U.S. Environmental Protection Agency's (EPA) Lead Renovation, Repair and Painting Certification requires that companies performing projects that disturb lead-based paint in homes, child care facilities and pre-schools built before 1978 have their company certified by EPA or the State of Hawaiʻi, use certified renovators who are trained by EPA-approved training providers, and follow lead-safe work practice: http://www2.epa.gov/lead/renovation-repair-and-painting-program

State of Hawaiʻi Occupational Safety and Health Division (HIOSH) oversees safe and healthful working conditions for workers in Hawaiʻi. This includes inspecting workplaces to ensure workers are protected: http://labor.hawaii.gov/hiosh/ . For construction workers, see the guidance on OSHA's Lead in Construction Standard: https://www.osha.gov/Publications/osha3142.pdf

Other Resources for Lead Exposure:
Agency for Toxic Substances and Disease Registry's ToxFAQs website is a federal government website providing information and recommendations regarding lead: http://www.atsdr.cdc.gov/toxfaqs/index.asp

Centers for Disease Control (CDC) Lead Poisoning Prevention Program has information to help eliminate childhood lead poisoning in the United States: https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=93&tid=22

This fact sheet was created with assistance and funding from USEPA's Region 9 Superfund Division.

The **Hazard Evaluation and Emergency Response Office (HEER Office)** is part of the Hawai'i Department of Health (HDOH) Environmental Health Administration, 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.

Past Use of Chlordane, Dieldrin, and other Organochlorine Pesticides for Termite Control in Hawai'i: Safe Management Practices around Treated Foundations or during Building Demolition

This fact sheet provides building owners, demolition and construction contractors, developers, realtors, and others with an overview of the potential environmental concerns associated with the past use of organochlorine termiticides (pesticides used to control termites) in Hawai'i. In addition, this fact sheet discusses methods for reducing exposure to organochlorine termiticides during building demolition or around the foundations of treated buildings and identifies resources for further information.

What are organochlorine termiticides?

Organochlorine termiticides are a group of pesticides that were used for termite control in and around wooden buildings and homes from the mid-1940s to the late 1980s. These organochlorine pesticides included chlordane, aldrin, dieldrin, heptachlor, and dichlorodiphenyltrichloroethane (DDT). They were used primarily by pest control operators in Hawaii's urban areas, but also by homeowners, the military, the state, and counties to protect buildings against termite damage. In the 1970s and 1980s, the U.S. Environmental Protection Agency (EPA) banned all uses of these organochlorine pesticides except for heptachlor, which can be used today only for control of fire ants in underground power transformers. Chlordane was the most widely used organochlorine pesticide against termites in Hawai'i. Termiticides were commonly applied directly to soil beneath buildings or beneath slab foundations and around the foundation perimeter for new construction. They may also have been periodically applied underneath the building (if accessible) at occupied structures, around the perimeter of the foundation, or in trenches excavated around the foundation, or by injection through holes drilled next to the foundation or in the flooring at the periphery of walls. These pesticides break down slowly in the environment, application rates were relatively high, and applications may have been repeated over time. As a result, these organochlorine termiticides may sometimes still be found in treated soils at concentrations detrimental to human health.

At least seven species of termites are found in Hawai'i. The most destructive are the Formosan subterranean termite (shown here) and the West Indian drywood termite, both of which arrived during the past 100 years and are now common throughout the state.

How do I identify if organochlorine termiticides are present at levels that may be a concern?

Some organochlorine termiticide contamination may be found below wooden structures, building slabs, or adjacent to foundations built in Hawaiʻi before 1989. The highest concentration of termiticides in soil is typically found beneath the house or around the perimeter of the building foundation (extending away from the building a distance of up to 1 to 3 feet). Highest concentrations are believed to be contained in the top 1 to 2 feet of soil because termiticides are persistent chemicals that stick to soil particles. Most, however, are likely within the top 6 inches or top 12 inches of treated soil depending on soil type and if the termiticides had been applied on the surface, in shallow trenches, or injected a little deeper underground during application. If soils in the areas treated were subsequently covered or scraped off, that could also affect the depth where any residues may be found. Termiticides applied more than two decades ago are not detectable by smell or sight, so generally they are assumed to be present at levels that may be a concern, or soil testing is recommended to confirm the presence and level of these toxic substances. The Department of Health (HDOH) HEER Office has established specific soil action levels for each of the organochlorine termiticides that, if exceeded, represents a potential hazard that would warrant further evaluation or cleanup.

When organochlorine termiticides are assumed to be present underneath or around the foundation perimeter (or both) of wooden structures built before 1989, the HEER Office recommends following practices that will help avoid or greatly reduce the potential for exposure in the (presumed) treated areas. See the section below on *What can I do to limit or avoid exposure to soil or foods contaminated with organochlorine termiticides?*

The HEER Office recommends testing soils (at wooden structures built before 1989) when: (1) the homeowner plans to grow produce within 5 feet of the building foundation, (2) the soils adjacent to the foundation cannot be covered or landscaped with non-edible plants and children or others playing or working in this area may periodically come in contact with bare soil, (3) the home or other structures are going to be demolished and the soil underneath the structure and from around the foundation will be reused either on or off site, and (4) there is reason to believe soil in areas of the yard away from the foundation were treated with organochlorine termiticides in the past, or that treated soil from underneath the structure or from the foundation perimeter may have been spread out in the yard.

In the case where structures will be demolished, the demolition and redevelopment process could spread termiticide-contaminated soil about the property in the process of grading or site preparation. Spreading the soil could put the demolition and construction contractors at risk of exposure as well as future site inhabitants. Consequently, testing before grading is conducted is important to evaluate the potential for soil contamination. Alternatively, the soil from under the structure and around the foundation perimeter (to a depth of at least 1 foot) can be assumed to be contaminated, excavated, and disposed of in an approved landfill. If soil is disposed of at a landfill, any specific landfill testing or disposal requirements would apply.

A knowledgeable contractor can collect soil samples, arrange for laboratory testing, and help interpret testing data. A guide to assist contractors in soil testing for organochlorine termiticides is available on the HEER Office website (see <u>Further Information</u> below). Once the soil has been tested, the HEER Office also offers guidance to assess the termiticide levels (if present) and help decide what actions may be appropriate to reduce or eliminate exposures.

What can I do to limit or avoid exposure to soil or foods contaminated with organochlorine termiticides?

Residents or owners of homes or buildings treated with organochlorine termiticides have a higher potential risk of exposure, primarily through direct contact with contaminated soil or eating foods grown in contaminated soil. If you have or suspect organochlorine termiticide-contaminated soil on your property, the Department of Health HEER Office recommends these actions to limit or avoid exposure:

Limiting Exposures

- Plant grass or other non-edible vegetation, or cover contaminated soil with some kind of surface material such as gravel (within several feet of the foundation) to act as a barrier to prevent soil exposure.
- Keep children from playing in dirt near the foundation and keep toys, pacifiers, and other items that go into children's mouths clean.
- Locate pet enclosures away from the perimeter of the building foundation.
- Do not grow edible produce such as fruits and vegetables in potentially contaminated soils next to the building foundation. Cover the soil next to the foundation, or add clean soil and landscape with non-edible plants.
- Do not relocate soils from underneath the building or from the foundation perimeter to other areas of the property.
- To reduce exposure to soil, cover bare soil underneath the house with a barrier material such as gravel or plastic before you work or store materials underneath the house.

Practices for Exposure Prevention

- Wash hands and face thoroughly after you work or play in soil near the building foundation, especially before meals and snacks.
- Avoid tracking soil from near the foundation perimeter into the home and clean it up right away if soil is tracked in. Remove work and play shoes before you enter the house. Keep pets from tracking contaminated soil into your home.
- If you work with contaminated soil or soil that may be contaminated, you should wear gloves and protective clothing (long-sleeve shirt and pants) to reduce exposure. A protective paper mask (N-95 type with two elastic straps) should be worn if airborne dust is present (such as when you are operating a weed-eater in contaminated or potentially contaminated areas). Working with contaminated soil may leave residues on your clothing, so change clothes and shower after you work with the soil and avoid spreading dirt from clothes or shoes into your vehicle or house.

What are the hazards of organochlorine termiticides?

The organochlorine termiticides used in Hawaiʻi before 1989 are persistent synthetic chemicals that stick to soil particles, do not dissolve easily in water, remain in the environment for many years, and may bioaccumulate up food chains. Exposure to the organochlorine termiticides can occur through ingestion, absorption through the skin, or inhalation; however, the primary exposure to these chemicals long after application is from unintentional ingestion of contaminated soil or through contaminated foods (plants can take up residues from the soil). The greatest exposure to these chemicals is expected in areas where they were applied at homes or building sites for termite control, but the potential for exposure would depend on how and where they were applied in the past, the frequency residents may come into contact with contaminated soil or foods grown in contaminated soil, and any actions after applications that may have disturbed or spread contaminated soil. Following is general information for each of these pesticides, as published by the U.S. Department of Health and Human Services and EPA.

CHLORDANE (Technical Chlordane)

Chlordane was the most common organochlorine termiticide used in Hawaiʻi. The amount of chlordane used was more than twice that of the termiticides aldrin, dieldrin, or heptachlor. Exposure to high levels of chlordane can harm the human endocrine system, nervous system, digestive system, and liver. EPA has also concluded that chlordane is a probable human carcinogen and may cause liver cancer. Chlordane can persist in the soil for more than 20 years. Technical chlordane does not occur naturally in the environment. It is not a single chemical, but a mixture of pure chlordane (50 to 75 percent) and more than 100 related compounds, including heptachlor and heptachlor epoxide. Chlordane was used widely throughout the U.S. from 1948 to 1983 for control of termites as well as pests in some agricultural crops and in lawns. EPA banned all uses of chlordane in 1983 except to control termites, and banned all uses in 1988, because of concern about damage to the environment and harm to human health.

ALDRIN and DIELDRIN

Aldrin and dieldrin are often considered together because they are chemically similar compounds. These chemicals were used as insecticides in agriculture and as termiticides to protect buildings after they were commercially available in the early 1950s. EPA banned all uses of aldrin and dieldrin in 1987. Exposures of animals to high levels of aldrin or dieldrin have caused nervous system effects. Based on animal studies, EPA has also concluded that aldrin and dieldrin are probable human carcinogens. Aldrin breaks down to dieldrin in the body and in the environment. Dieldrin breaks down very slowly in soil.

DDT, DDD, and DDE

Since the mid-1940s, dichlorodiphenyltrichloroethane (DDT) had been used widely as an insecticide in agriculture, for control of mosquitoes that may carry disease, and as a termiticide. EPA banned DDT in 1972. Dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE) are chemicals similar to DDT that occur as manufacturing byproducts and breakdown products or metabolites of commercial DDT. DDD also had been produced and sold as an insecticide, but its use was banned along with DDT. Exposure to high levels of DDT affects the nervous system. EPA has concluded that DDT, DDD, and DDE are probable human carcinogens. DDT, DDD, and DDE are long-lived in the environment, though current levels found in soils of agricultural fields are typically quite low. However, higher DDT levels may occur around or beneath wooden building foundations where it was used as a termiticide because the application rates for termite control were higher than the application rates for agricultural insect control.

HEPTACHLOR and HEPTACHLOR EPOXIDE

Heptachlor is a manufactured chemical that was commercially available from 1953 through 1987, when EPA banned virtually all uses. Little is known about the health effects of heptachlor in humans, but high levels may damage the liver and nervous system. EPA considers heptachlor epoxide a possible human carcinogen. Heptachlor was used as an insecticide in agriculture, as well as a termiticide for homes. Currently, it can be used only for fire ant control in underground power transformers. Bacteria and animals break down heptachlor to form heptachlor epoxide; therefore, heptachlor epoxide is more likely to be found in the environment over time than is heptachlor.

For questions about this fact sheet of further information, contact:

- *Hawaiʻi Department of Health, Hazard Evaluation and Emergency Response Office, Telephone: (808) 586 – 4249, Website: http://hawaii.gov/health/environmental/hazard/index.html*

Additional references located on the HEER Office website:

- HDOH, 2011. *A Guide to Soil Testing for Organochlorine Termiticides at Residential Sites in Hawaiʻi*

Access information from the federal government on termiticides:

- (U.S.) Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine ToxFAQs Website: http://www.atsdr.cdc.gov/toxfaq.html.
- U. S. Environmental Protection Agency Website: http://www.epa.gov/pbt/pubs/cheminfo.htm

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