TETRA TECH

# Draft
# Response Action Memorandum (RAM)

## Hickam Communities Remedial Action Site
**Joint Base Pearl Harbor-Hickam**
**Oʻahu, Hawaiʻi**

**June 7, 2012**

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# Draft
# Response Action Memorandum (RAM)

## Hickam Communities Remedial Action Site
Joint Base Pearl Harbor-Hickam
Oʻahu, Hawaiʻi

*Prepared for:*

**Hawaiʻi Department of Health**
Office of Hazard Evaluation and Emergency Response

*Prepared by:*
**Hickam Communities LLC**
*211 Mercury Street*
Honolulu, Hawaiʻi 96818

**Tetra Tech**
*737 Bishop Street, Suite 3020*
*Honolulu, Hawaiʻi 96813*
*(808) 533-3366*
*Fax (808) 533-3306*

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## Statement of Approval

This Draft Response Action Memorandum (RAM) presents the remedy selected by the State of Hawai'i Department of Health (HDOH), Hazard Evaluation and Emergency Response Branch (HEER) for the Hickam Communities LLC (HC) Remedial Action Site at Joint Base Pearl Harbor-Hickam (JBPHH), O'ahu, Hawai'i (hereinafter the "Site"). The HC Remedial Action Site consists the neighborhoods Hale Na Koa I-1, Earhart I-2, Earhart I-3, and Onizuka II-1. The remedy for the Site was selected as part of the Remedial Action process that was conducted under the *Voluntary Agreement for Environmental Response Actions* (*Voluntary Agreement*) between HDOH and HC dated February 18, 2011. This Draft RAM was prepared on behalf of HDOH HEER by HC and Tetra Tech.

As part of the Department of Defense Military Family Housing Privatization Initiative, the US Air Force (USAF) selected Lend Lease Americas LLC (Lend Lease; legacy Actus Lend Lease LLC) to develop, design, and construct 1,182 new homes and to renovate 1,260 homes at JBPHH under a 50-year ground lease with the USAF. The project company, Hickam Community Housing LLC (HCH) was created in 2005 to manage the residential property under the 50-year ground lease. The project company is an affiliate of Lend Lease, and leases property at JBPHH from the USAF through the contract of the ground lease. The project company serves as the lessee and has certain responsibilities under the lease (development, property management and maintenance). As the lessee, the project company has overall responsibility for the project sites. The USAF, as lessor, maintains a review and coordination role for all activities conducted at the project sites. The dates of the ground lease are February 1, 2005 through July 31, 2057 for Construction Phase I housing and August 1, 2007 through July 31, 2057 for Construction Phase II housing. The project company HCH changed its name to HC in 2010.

The Site consists of Construction Phase I and Construction Phase II residential housing that has undergone redevelopment (demolition of older homes followed by construction of new replacement homes) and/or renovation in subphases. The four subphases included in the Site are:

- The Hale Na Koa I-1 neighborhood, which as redeveloped for 170 multiplex units with minor renovations to 354 existing units and completed in April 2007;

- Two neighborhoods within the boundary of the Earhart Village housing area which are the Earhart I-2 neighborhood in the easternmost portion of the Earhart Village, and Earhart I-3 neighborhood in the east-central portion of Earhart Village. The Earhart I-2 neighborhood was redeveloped for 252 multiplex units that were completed in June 2008. The Earhart I-3 neighborhood was redeveloped for 222 multiplex units that were completed in June 2009; and

- The Onizuka II-1 neighborhood which is located in the Onizuka Village housing area. The Onizuka II-1 neighborhood in in the southwestern portion of the Onizuka Village, and was redeveloped for 104 multiplex units that was completed in August 2009. Also within the boundary of Onizuka II-1, are the redeveloped HC Housing Office and Maintenance Facility (HOMF), which was completed in February 2010.

This Draft RAM summarizes Site history (including operations, investigations, hazard evaluation, and remediation), outlines the remedial alternatives analysis process for selecting a preferred alternative, and presents the final remedy chosen for the Site. Additional information may be found in the following documents:

- *Removal Action Report, Hickam Communities Remedial Action Site, Joint Base Pearl Harbor-Hickam, Oʻahu, Hawaiʻi (RAR)* (Tetra Tech 2012d);
- *Remedial Investigation Report, Hickam Communities Remedial Action Site, Joint Base Pearl Harbor-Hickam, Oʻahu, Hawaiʻi (RI Report)* (the Environmental Hazard Evaluation is included as Appendix E) (Tetra Tech 2012c);
- *Remedial Alternatives Analysis, Hickam Communities Remedial Action Site, Joint Base Pearl Harbor-Hickam, Oʻahu, Hawaiʻi (RAA)* (Tetra Tech 2012e);
- *Environmental Hazard Management Plan: Hickam Communities Property, Joint Base Pearl Harbor-Hickam, Oʻahu, Hawaiʻi (EHMP)* (Tetra Tech 2012b).
- *Pesticide-Impacted Soil Investigation and Management Program Manual, Hickam Communities Property, Joint Base Pearl Harbor-Hickam, Oʻahu, Hawaiʻi (Program Manual)* (Tetra Tech 2011d); and
- *Land Use Controls Inventory Document, Hickam Communities Property, Joint Base Pearl Harbor-Hickam, Oʻahu, Hawaiʻi (LUCID)* (Tetra Tech 2012a).
- *Hickam Communities Resident Guide and Community Standards Handbook (Resident Guide)*, (provided to HC residents as attachment A to the Tenant Lease) (HC 2010).

## Assessment of Property

Soil at the Site has been impacted with residual organochlorine pesticides, specifically aldrin, technical chlordane (chlordane)[1], and dieldrin. In buildings constructed from the 1940s to the 1980s at military installations, organochlorine pesticides were routinely applied to soil under and around the perimeter of building foundations to control termites. Although use of organochlorine pesticides was cancelled by the US Environmental Protection Agency by the late-1980s, because these pesticides are persistent in the environment residual concentrations can still be present in the soil beneath building foundations, and subsequently exposed when the buildings are demolished to prepare for construction of new housing, or during renovation of existing homes. The remedial action process was initiated at the Site in 2010 to address exposed pesticide-impacted soil identified at the Site; the remedial action included a Site Investigation, Environmental Hazard Evaluation, and implementation of three removal actions starting in September 2010 and completed in August 2011. Following completion of the removal actions, the residual pesticide-impacted soil remaining at the Site does not present a current hazard to human health or the environment.

## Description of Selected Remedy

The following remedy has been selected for the Site: no further remedial action and implementation of institutional controls. As part of the remedial action process at the Site, the remedial alternative analysis process focused on a developing a proposed remedy to address the residual pesticide-impacted soil remaining at the Site following completion of the removal actions. In accordance with the *Program Manual*, to prevent exposure to pesticide-impacted soil by HC workers, residents, and guests, pesticide-impacted soil is placed under hardscapes (new building foundations, roads, parking areas), and/or by capping the soil using a 9-inch (minimum)

[1] Technical chlordane (referred to as “chlordane”) is a mixture of more than 140 related compounds. Major

to 2-foot (maximum) cap of clean soil. This also includes areas where pesticide-impacted soil is managed in engineered locations; these locations consist of the soil berm located at the Earhart I-2 neighborhood at the Site, and burial pits located outside the Site boundary on HC property. In areas where pesticide-impacted soil was placed in the soil berm or burial pits, the pesticide-impacted soil is covered with a marker layer of orange geotextile fabric followed by a 2-foot clean soil cap. In the areas where soil was managed during the three removal actions at the Site, and in these engineered management areas, the marker layer of orange geotextile fabric is used to indicate the presence of, and create a barrier to pesticide-impacted soil below the geotextile.

Institutional controls. For all HC property, the primary institutional control already in place to protect HC workers, residents and guests from potential exposure to pesticide-impacted soil is a "no dig" policy. For HC residents, this policy is clearly presented in the *Resident Guide* which is provided to residents when they enter into a lease with HC. As a condition of their lease agreements, all residents are restricted from digging or gardening on property leased from HC, including their yards and the open areas surrounding their property. For HC construction workers, the *Program Manual* presents specific standard operating procedures for working with, and effectively managing pesticide-impacted soil. These procedures are intended to provide workers with clear guidance to prevent exposure to themselves or HC residents and guests, to pesticide-impacted soil at the Site.

Institutional controls were presented in the *RAA* as part of a preferred remedy for the Site, which are the remedial action documents, the *LUCID* and the *EHMP*. The overall scope of *LUCID* and the *EHMP* encompass all of HC property. The *LUCID* contains detailed maps indicating where pesticide-impacted soil remains on HC property, and is targeted at HC maintenance workers. The *LUCID* provides clear standard operating procedures for planning and conducting work in areas where pesticide-impacted soil is known or presumed to be present, and includes procedures for emergency response and repairs at HC. The *EHMP* provides a detailed description of where pesticide-impacted soil is present at HC and what potential hazards are associated with this soil, and presents the long-term monitoring procedures for HC property.

An important aspect of institutional controls presented in these plans includes HC's commitment to monitoring these controls ensure their effectiveness over the 50-year lease. By adherence to the *Program Manual, Resident Guide, LUCID,* and the *EHMP,* HC can ensure that the soil management procedures (e.g. hardscapes, clean soil caps, geotextile) are implemented during construction/renovation activities, and remain intact following routine maintenance or emergency repairs.

## Declaration

The chosen remedy has been judged by the HDOH HEER Office to be protective of the human health and the environment, to comply with federal and state requirements that are legally applicable or relevant and appropriate to the Remedial Action, and to be cost-effective. Subject to the soil management and institutional controls described above, the chosen remedial alternative meets the remedial objectives established for the property and ensures that risk to the human health and the environment will be avoided.

6-8-12

Keith E. Kawaoka, D. Env. Program Manager
Hazard Evaluation and Emergency Response Branch
Hawai'i Department of Health

Date

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| APRA | Analysis of Potential Removal Alternatives |
| ARAR | Applicable or Relevant and Appropriate Requirement |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| COPC | chemical of potential concern |
| CY | cubic yards |
| DDD | dichlorodiphenyldichloroethane |
| DDE | dichlorodiphenyldichloroethene |
| DDT | dichlorodiphenyltrichloroethane |
| DEAL | Direct Exposure Action Level |
| DU | decision unit |
| EAL | environmental action level |
| EHE | Environmental Hazard Evaluation |
| *EHMP* | *Environmental Hazard Management Plan, Hickam Communities Remedial Action Site* |
| EPA | US Environmental Protection Agency |
| HAFB | Hickam Air Force Base |
| HAR | Hawai‘i Administrative Rules |
| HC | Hickam Communities LLC (the project company) |
| HDOH | Hawai‘i Department of Health |
| HEER | Hazard Evaluation and Emergency Response Branch |
| HHD | Historic Homes District |
| HI | hazard index |
| HHRE | human health risk evaluation |
| *HHRE WP* | *Preliminary Human Health Risk Evaluation Work Plan for Hickam Communities* |
| HOMF | HC Housing Office and Maintenance Facility |
| HQ | hazard quotient |
| HRS | Hawai‘i Revised Statute |
| JBPHH | Joint Base Pearl Harbor-Hickam |
| *LUCID* | *Land Use Controls Inventory Document, Hickam Communities LLC Property* |
| LS | lump sum |
| mg/kg | milligram per kilogram |
| MI | multi-incremental |
| O&M | operations and maintenance |
| open areas | Open areas are defined as undeveloped land outside of the former building footprints and 3-foot building zones. |

| | |
|---|---|
| *Program Manual* | *Pesticide-Impacted Soil Investigation and Management Program Manual* |
| *RAA* | *Remedial Alternatives Analysis, Hickam Communities Remedial Action Site* |
| *RAM* | *Response Action Memorandum* |
| *RAR* | *Removal Action Report, Hickam Communities Remedial Action Site* |
| RCRA | Resource Conservation and Recovery Act |
| *RI Report* | *Remedial Investigation Report, Hickam Communities Remedial Action Site* |
| RO | removal action |
| technical chlordane | Technical chlordane (referred to as "chlordane") is a mixture of more than 140 related compounds. Major constituents of technical chlordane include alpha- and gamma-chlordane, chlordane, and heptachlor. |
| *TGM* | *Hawai'i Department of Health Interim Final Technical Guidance Manual for Implementation of the Hawai'i State Contingency Plan* |
| TBC | to be considered |
| USAF | US Air Force |
| *Voluntary Agreement* | *Voluntary Agreement for Environmental Response Actions.* |

# 1.0 INTRODUCTION AND PURPOSE

This Draft Response Action Memorandum (RAM) presents the remedy selected by the State of Hawai'i Department of Health (HDOH) Hazard Evaluation and Emergency Response Branch (HEER) for the Hickam Communities LLC (HC) Remedial Action Site at Joint Base Pearl Harbor-Hickam (JBPHH), O'ahu, Hawai'i (hereinafter the "Site"). The HC Remedial Action Site consists of the neighborhoods Hale Na Koa I-1, Earhart I-2, Earhart I-3, and Onizuka II-1. The remedy for the Site was selected as part of the remedial action process that was conducted under the *Voluntary Agreement for Environmental Response Actions* (*Voluntary Agreement*) between HDOH and HC.[1] The Site is shown in Figure 1-1.

As part of the Department of Defense Military Family Housing Privatization Initiative, the US Air Force (USAF) selected Lend Lease Americas LLC (Lend Lease; legacy Actus Lend Lease LLC) to develop, design, and construct 1,182 new homes and to renovate 1,260 homes at JBPHH under a 50-year ground lease with the USAF. A project company, Hickam Community Housing LLC (HCH), was created in 2005 to manage the residential property under the 50-year ground lease. The project company is an affiliate of Lend Lease, and leases property at JBPHH from the USAF through the contract of the ground lease. The project company serves as the lessee and has certain responsibilities under the lease (development, property management and maintenance). As the lessee, the project company has overall responsibility for the project sites. The USAF, as lessor, maintains a review and coordination role for all activities conducted at the project sites. The dates of the ground lease are February 1, 2005 through July 31, 2057 for Construction Phase I housing and August 1, 2007 through July 31, 2057 for Construction Phase II housing. The project company HCH changed its name to HC in 2010.

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- *Remedial Alternatives Analysis, Hickam Communities Remedial Action Site, Joint Base Pearl Harbor-Hickam, O'ahu, Hawai'i (RAA)*;[4]
- *Environmental Hazard Management Plan: Hickam Communities Property, Joint Base Pearl Harbor-Hickam, O'ahu, Hawai'i, (EHMP)*;[5]
- *Pesticide-Impacted Soil Investigation and Management Program Manual, Hickam Communities Property, Joint Base Pearl Harbor-Hickam, O'ahu, Hawai'i (Program Manual)*;[6]

[1] (HC 2011)
[2] (Tetra Tech 2012d)
[3] (Tetra Tech 2012c)
[4] (Tetra Tech 2012e)
[5] (Tetra Tech 2012b)

- *Land Use Controls Inventory Document, Hickam Communities Property, Joint Base Pearl Harbor-Hickam, Oʻahu, Hawaiʻi (LUCID)*;[7] and

- *Hickam Communities Resident Guide and Community Standards Handbook (Resident Guide)*, (provided to HC residents as attachment A to the Tenant Lease).[8]

A Site Investigation was conducted a *RI Report* has been completed for the Site (as part of the *Voluntary Agreement*) and is scheduled to be approved by HDOH.[9] This document characterizes the nature and extent of organochlorine pesticide impact to Site soil and makes recommendations for further remediation of pesticide impacted soil based on the Environmental Hazard Evaluation (EHE), which is included as an appendix to the *RI Report.* Three removal actions (ROs) were implemented at the Site from September 2010 to August 2011 to address pesticide-impacted soil presenting an immediate risk to HC workers, residents, and guests. The ROs are documented in the *RAR*, which is scheduled to be approved by HDOH.[10] Site-specific factors including the implementation of the RO process and the results of the EHE were used to develop the *RAA* for the Site. The *RAA* has been completed and is scheduled to be approved by HDOH.[11] The *RAA* identified potentially applicable remediation technologies and process options, combined the various technologies into remedial alternatives that satisfy the remedial action objectives, presented a detailed comparative analysis of remedial alternatives and recommended a final remedy for the Site.

## 1.1 Response Action Memorandum Process

A Draft RAM is a summary of the SI results and the corresponding EHE, the *RAA*, and presents the proposed remedy selected for the Site. This document is intended for review and public comment over a 30-day period. A public notice will be posted regarding availability of the Draft RAM and other key documents, a fact sheet, solicitation of verbal or written comments, and information on the public meeting, which will be held during the middle of the comment period.

A Final RAM will document the selected remedy for the Site as approved by HDOH HEER. Public comments will be addressed in a responsiveness summary in the Final RAM, and incorporated as changes to the selected remedy as appropriate.

## 1.2 Document Organization

This document generally follows the RAM format recommended in the HDOH *Interim Final Technical Guidance Manual for Implementation of the Hawaiʻi State Contingency Plan (TGM)*,[12] with revisions and additions to accommodate unique aspects of this analysis. The report is organized into the following sections:

**Section 1:** Introduction and Purpose. Describes the purpose of the report and outlines the RAM process.

[6] (Tetra Tech 2011d)
[7] (Tetra Tech 2012a)
[8] (HC 2010)
[9] (Tetra Tech 2012c)
[10] (Tetra Tech 2012d)
[11] (Tetra Tech 2012e)
[12] (HDOH 2009)

**Section 2:** Site Location and Description. Describes the Site characteristics, setting, history, and existing conditions. The Site history includes a summary the events surrounding the release and the remedial action implemented at the Site.

**Section 3:** Environmental Hazard Evaluation. Describes the Site conceptual site model (CSM) and potential hazards identified in the environmental hazard evaluation (EHE).

**Section 4:** Remedial Strategy. Outlines the remedial action objectives, remedial action levels, and areas at the Site that require treatment.

**Section 5:** Proposed Remedy. Describes the RAA process including identification of potentially applicable technologies; screening of technologies; assembly of remedial alternatives; and a comparison of the remedial alternatives against the threshold criteria of effectiveness, implementability, and cost. Presents the proposed remedy for the Site and basis for selection, and provides an overview of the "next steps" for a Final RAM, including the public comment period, responsiveness, and final acceptance of remedy.

**Section 6:** Responsiveness Summary. This is a placeholder section in the Draft RAM. Documentation of public comments received and HDOH responses to those comments will be provided in this section of the Final RAM.

**Section 7:** References. This Section provides complete references for all documents, communications, and maps cited in the draft RAM.

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# 2.0 SITE LOCATION AND DESCRIPTION

## 2.1 Site Location

The Site is located within the Hickam Air Force Base (HAFB) section of JBPHH on the island of O‘ahu, approximately 8 miles west of downtown Honolulu, and adjacent to the Honolulu International Airport. Joint Base Pearl Harbor-Hickam is situated on approximately 2,700 acres of the Pearl Harbor coastal plain on the southern coast of O‘ahu.

## 2.2 Site Description

### *2.2.1 Climate*

The climate in the Honolulu area is mild to very warm, with dry to moderate humidity and northeasterly trade winds approximately 90 percent of the summer and 50 percent of the winter. There is very little diurnal or seasonal variation in temperature on O‘ahu because of its tropical latitude, marine influence, and the prevailing northeasterly trade winds. The average daytime temperatures range between 22 and 27 degrees Celsius or 72 and 81 degrees Fahrenheit. The humidity varies between 58 and 90 percent. [1]

The average annual precipitation on HAFB is approximately 56 centimeters (22 inches). December is typically the wettest month of the year, and June is the driest.[2]

### *2.2.2 Soils/Geology*

The JBPHH lies within on the coastal plain on the leeward side of the Ko‘olau Range, immediately east of Pearl Harbor. The Pearl Harbor coastal plain is underlain by a succession of terrestrial alluvial and marine sedimentary layers. As the island subsided over thousands of years, alluvial sediments interspersed with volcanic flows and volcanic ash were deposited on the margin of the island, building a reef platform. During periods of lower sea levels, the reef was exposed. This so-called caprock (because it caps the underlying volcanic rock, which contains the basal aquifer) contains strata of alluvium, lagoonal mud, beach sands, volcanic tuff, and corals. At depth, these strata overlay volcanic bedrock of the Honolulu volcanic series.

Most of JBPHH soils are mapped as fill, comprising material dredged from the ocean or hauled in from elsewhere. In addition to the fill, there are five naturally occurring soil types present (Māmala stony silt clay loam, Makalapa clay, Kea‘au stony clay, Jaucus sand, and coral outcrop) that are associated with the coastal plain and coral reef substratum over which the base lies. The fill and naturally occurring soil types are considered poor for vegetation growth, and high-maintenance landscaping areas usually contain topsoil fill from off-base sources. The erosion potential for the JBPHH soils is generally slight to moderate, with the exception of Jaucus sand, which is highly erodible.[3]

### *2.2.3 Surface Water*

There are no natural lakes, rivers, or streams in the Earhart Village housing areas, but Manuwai Canal, which provides storm drainage for the eastern third of JBPHH, flows next to the southern

[1] (USACE 1997)
[2] (HAFB 2006)
[3] (USAF 2002)

boundary of the Earhart Village housing area. The Manuwai Canal empties into Māmala Bay to the south.

The housing areas are not in the area on JBPHH designated as a potential flood inundation zone. The housing areas use a storm drainage system that collects surface water and sends it to a series of canals that eventually empty to Māmala Bay. The sedimentary deposits are intermittent with the volcanic basalts that make up the land mass of the Hawaiian Islands.

No wetlands are present on the Earhart Village housing area properties. The Manuwai Canal, which flows next to the southern boundary of the Earhart Village housing area, has been classified by the National Wetland Inventory as an estuarine, open water, subtidal inundation, and excavated wetland.[4]

### *2.2.4 Groundwater*

There are two groundwater aquifers below JBPHH. Most of the installation is underlain by a brackish aquifer that is not suitable for commercial or residential use or for recreation. General groundwater flow in the area is toward the Pacific Ocean to the south. A small portion of the base is underlain by a protected freshwater aquifer and has stringent requirements for water quality protection. Potable water is supplied to the HAFB part of JBPHH from Navy storage tanks outside the base.[5]

## 2.3 Site Setting

The topographic relief of the area is generally flat, with elevations ranging from 0 to 20 feet above mean sea level.[6] Most of the soils on JBPHH are mapped as fill, which consists of dredge material from Pearl Harbor and other sources. Placement of the fill changed the topography of JBPHH from an uneven series of low lying coastal ridges and swales to a level plateau. The Site consists of military residential housing located within the Hickam Air Force Base (HAFB) section of JBPHH, which is an active military installation. Joint Base Pearl Harbor-Hickam is situated on approximately 2,700 acres of the Pearl Harbor coastal plain on the southern coast of O‘ahu, approximately 8 miles west of downtown Honolulu, and adjacent to the Honolulu International Airport.

Hale Na Koa. The Hale Na Koa Village (Hale Na Koa) housing area (formerly known as “Capehart”) encompasses approximately 85 acres on the central part of JBPHH, northwest of Earhart Village.[7] Hale Na Koa is Construction Phase I housing that consists of two project areas: the Hale Na Koa I-1 subphase of new multiplex units, and the other is Hale Na Koa Minor Renovations consisting of minor renovations of existing multiplex units,

Earhart Village. The Earhart Village (Earhart) housing area encompasses approximately 130 acres on the eastern portion of JBPHH.[8] Earhart consists of Construction Phase I housing in four subphases of new multiplex units, which are the Earhart I-1, Earhart I-2, Earhart I-3, and Earhart I-4 subphases. Earhart Village is the location for two of the neighborhoods at the Site, Earhart I-2 and Earhart I-3. These two neighborhoods are mostly delineated by Ohana Nui Circle, which is the outermost street that loops through Earhart Village.

[4] (USAF 2002)
[5] (USAF1998)
[6] (USAF 2002)
[7] (Tetra Tech 2005)
[8] (Waller 2005)

Onizuka Village. The Onizuka Village (Onizuka) housing area encompasses approximately 74 acres in the central portion of JBPHH, west of Earhart Village. Onizuka consists of Construction Phase II housing in three subphases of new multiplex units, which are the Onizuka II-1, Onizuka II-2, and Onizuka II-3 subphases. The Onizuka II-1 neighborhood is the only one of these three that is part of the Site, and is located in the southwestern portion of Onizuka. The Onizuka II-1 neighborhood also includes the HC Office and Maintenance Facility (HOMF).

The location of these housing areas at JBPHH is shown in Figure 1-1.

## 2.4 Site History and Previous Investigations

The Site is part of HC leased property located within the boundary of JBPHH, formerly Hickam Air Force Base (HAFB). The Site has been used for military purposes for more than 50 years. Development of the base began in 1928, when the War Department identified the area to improve air defenses for Hawaiian territories.[9] Prior to acquisition by the War Department, the area that now contains HAFB was used for agriculture and fish ponds.[10] In 1935, approximately 2,225 acres of brush and sugar cane fields were developed into Hickam Field and the Base was activated in 1938. Hickam Field became HAFB in 1948, which merged with Naval Base Pearl Harbor in 2010 to form JBPHH. The Hickam Field Officer Quarters (part of the Historic Homes District [HHD]) were constructed between 1939 and 1947.[11]

The property currently occupied by the Hale Na Koa and Earhart Village housing areas was utilized for agricultural purposes, primarily the cultivation of sugarcane. The property occupied by the Hale Na Koa housing area was acquired in 1935 and developed for residential purposes and as an open area to support aviation activity. The open area was later developed for residential purposes. A former motor pool also was been situated on the northern portion of the former Capehart housing area; the specific dates of its operation are not known.[12] The Fort Kamehameha housing area (part of the HHD) was acquired by USAF in March of 1993. Constructed in 1917, they are the oldest units at JBPHH. In addition to their historical significance as the earliest remaining military family housing units established on the island, Fort Kamehameha is archaeologically significant as pre and post-contact remains have been recovered within the area. With the exception of the HHD, most of the original housing at the Site was constructed in the 1950s through the 1970s. The Earhart Village housing property was acquired in two phases (1942 and 1968) and developed for residential purposes. Onizuka Village was originally constructed in 1975, overlaying what was once part of the airfield.[13]

### *2.4.1 Pesticide-Impacted Soil Management*

In buildings constructed at military installations from the 1940s to the 1980s, organochlorine pesticides were routinely applied to soil under and around the perimeter of building foundations to control subterranean termites. Although use of organochlorine pesticides was banned by the US Environmental Protection Agency (EPA) by the late-1980s, because these pesticides are persistent in the environment residual concentrations can still be present in the soil beneath building foundations, and subsequently exposed when the buildings are demolished to prepare for construction of new housing, or during renovation of existing homes. Since any pesticide-impacted soil detected at HC would require management during demolition, renovation, and/or construction of military housing, a series of management practices were implemented at HC to

[9] (Waller 2005)
[10] (KJC 1991)
[11] (Tetra Tech 2007a)
[12] (Tetra Tech 2005; USAF 2002)
[13] (Waller 2005)

manage soil impacted by organochlorine pesticides, referred to as "pesticide-impacted soil"[14]. The practices for managing this pesticide-impacted soil are presented in a HC-specific soil management plan, which was developed for use during construction and renovation activities. This management plan is periodically updated to capture changes in risk criteria, and/or procedures being used to investigate and manage pesticide-impacted soil during construction and renovation activities at HC. Thus, this plan presents the site-specific criteria and procedures used to assess pesticide-impacted soil at HC.

The first plan version of the plan developed for HC was the *MPPIS* which was finalized for HC in 2006.[15] The *MPPIS* was updated and renamed the *Pesticide-Impacted Soils Investigation and Management Program Manual* in 2009.[16] Under the most recent version of the *Program Manual*, dated August 31, 2011[17], the procedures call for excavation of pesticide-impacted soil to a depth of at least 1-foot below final grade in areas that would not be covered by hardscapes after new construction is completed. The excavated areas are then capped by at least 1-foot of clean soil to bring the HC project site to final grade. Any pesticide-impacted soil under hardscapes (e.g. roads, building foundations, sidewalks, driveways, and parking lots), would not need to be removed because the hardscapes provide a long-term barrier to exposure. Placement of excavated pesticide-impacted soil under new hardscapes is also used as a method to permanently manage pesticide-impacted soil and prevent the exposure pathways of direct contact, inhalation, and ingestion that may be associated with exposed pesticide-impacted soil.

Additional controls are provided in the *Program Manual* pertaining to management and export of soil and materials from HC for off-site disposal. The *Program Manual* specifies that pesticide-impacted soil must not be exported off-site for disposal or management; all pesticide-impacted soil must be managed within the HC property boundary. In addition, any pesticide-impacted soil or any soil exceeding the Tier 1 EALs that is not considered pesticide-impacted, would not be managed or placed in any areas identified as ecological habitats or wetlands at HC.

Any soil/material exported off of HC property is profiled and cannot have detected COPCs with concentrations that exceed the respective environmental screening levels: (1) the HDOH Tier 1 EALs for unrestricted use for sites where groundwater is a potential drinking water resource and a surface water body is located within 150 meters of a release site (Table A-2),[18] and (2) the Toxicity Characteristic, Leaching Procedure (TCLP).[19] For landfill disposal, the soil cannot have detected COPCs with concentrations that exceed HDOH (1) Tier 1 EALs where groundwater is not potential drinking water resource and a surface water body is located greater than 150 meters of a release site (Table B-1); (2) the Direct Exposure Action Levels (DEALs), Commercial / Industrial Land Use Scenario (Table I-2);[20] and (3) TCLP.[21, 22]

### *2.4.2 Description of Release*

The release at the Site occurred during redevelopment when pesticide-impacted soil that originated from excavating footprints of former buildings was improperly placed or graded into

[14] Pesticide-impacted soil is defined as soil having organochlorine pesticide concentrations, specifically aldrin, chlordane, and dieldrin, exceeding the applicable site-specific risk criteria established for HC.
[15] (Tetra Tech 2006c)
[16] (Tetra Tech 2009a)
[17] (Tetra Tech 2011d),
[18] (HDOH 2009)
[19] (CFR 2010)
[20] (HDOH 2009)
[21] (CFR 2010)
[22] (Tetra Tech 2011d)

open areas, and not subsequently covered by hardscapes. This pesticide-impacted soil was not detected until after construction at the Site was completed or nearing completion. The pesticide-impacted soil at the Hale Na Koa I-1 neighborhood was detected and mitigated in 2007. Based on the results of confirmation soil sampling conducted in 2010,[23] the Hale Na Koa I-1 neighborhood was included in the *Voluntary Agreement* in February 2011,[24] and subsequently evaluated as a part of the remedial action.[25] Further evaluation by HC and HDOH of the analytical results from 2010 confirmation soil sampling at the Hale Na Koa I-1 determined that this neighborhood did not a require a removal action.[26] The pesticide-impacted soil at the Earhart I-4 neighborhood was detected and mitigated in 2010. Based on the results of the confirmation soil sampling conducted 2010, the pesticide-impacted soil at Earhart I-4 neighborhood was considered to have been addressed prior to the initiation of the *Voluntary Agreement; h*owever, due to the pesticide-impacted soil detected at Earhart I-4, confirmation soil sampling was conducted at the remaining three Site neighborhoods Earhart I-2, Earhart I-3, and Onizuka II-1. These results of this confirmation soil sampling indicated that pesticide-impacted soil was present in some of the DUs sampled at these neighborhoods; the detection of this pesticide-impacted soil initiated the remedial action process implemented by HC and HDOH in July 2010, and the inclusion of these neighborhoods into the scope of the *Voluntary Agreement.*[27] As part of the remedial action, a SI was conducted at these three neighborhoods. Based on the preliminary results of the SI, HC implemented three ROs to address the immediate risk posed by exposed pesticide-impacted soil at the Earhart I-2 and Earhart I-3 neighborhoods. The results of the previous investigations including the SI are summarized below, and the results of the SI are provided in their entirety in the *RI Report*.[28] The ROs are summarized in Section 2.4.6 and detailed in the *RAR*.[29]

### *2.4.3 Investigations at the Hale Na Koa I-1 Neighborhood (2004 through 2010)*

Based on the preliminary findings of the Phase I ESA conducted in 2004 (and finalized in January 2005),[30] and the known application methods used to treat building foundations with organochlorine pesticides, a discrete soil sampling investigation was conducted at Hale Na Koa I-1 (the former Capehart neighborhood) in 2004.[31] For this investigation, discrete soil samples were collected within the building driplines and close to the foundations of the existing buildings prior to demolition.

The results of the 2004 discrete soil sampling investigation indicated that organochlorine pesticides were present in Hale Na Koa I-1 soil at concentrations exceeding the HDOH EALs.[32] In 2006, a soil investigation to characterize the extent of the pesticide-impacted soil at the Hale Na Koa I-1 was performed, whereby decision units (DUs) were delineated to distinguish a 10-foot zone of soil around the buildings.[33] It is important to note that the entire Site was characterized during this investigation; that is, some of the DUs included this 10-foot zone around the buildings, while others were located in open areas between the buildings and backyards. The results of this investigation indicated that nineteen of the sampled DUs were identified as having exposed pesticide-impacted soil. The soil in these nineteen DUs was

[23] (Tetra Tech 2010f)
[24] (HC 2011)
[25] (HDOH 2011a)
[26] (HDOH 2011d)
[27] (HC 2011)
[28] (Tetra Tech 2012c)
[29] (Tetra Tech 2012d)
[30] (Tetra Tech 2005)
[31] (Tetra Tech 2004)
[32] (HDOH 2005)
[33] (Tetra Tech 2006a)

managed by excavation of the soil to 1-foot below planned final grade, and placement of a 1-foot thick clean soil cap which was completed in 2007.

Confirmation soil sampling of Hale Na Koa I-1 was performed in 2010. For this confirmation soil sampling investigation, the Hale Na Koa I-1 neighborhood was divided into eleven DUs and sampled using multi-incremental (MI) soil sampling methodology.[34] Five of these DUs included the nineteen DUs where pesticide-impacted soil was previously identified and managed; these DUs were sampled at the 0 to 6 and 6 to 12-inch depth intervals. The remaining six DUs for the areas that had previously tested as not being pesticide-impacted were sampled from the 0 to 6-inch depth interval only. The results of the confirmation soil sampling investigation indicated that organochlorine pesticide detections in the MI soil samples do not exceed the applicable risk criteria,[35] and concludes that there is no exposed pesticide-impacted soil at Hale Na Koa I-1.

### *2.4.4 Investigations at the Earhart I-2, Earhart I-3, Earhart I-4, and Onizuka II-1 Neighborhoods (2006 through 2010)*

Prior to demolition, open area soil sampling around the existing buildings was conducted at the Earhart I-2, Earhart I-3, and Earhart I-4 neighborhoods, and limited open area sampling was conducted at the Onizuka II-1 neighborhood.[36] The results of the soil sampling indicated that pesticide-impacted soil was not present in the upper 6 inches of soil in these neighborhoods. Demolition and redevelopment of Earhart I-2 was conducted between March 2007 and August 2008, Earhart I-3 from March 2008 and August 2009, and Onizuka II-1 from February 2008 to June 2009. Demolition of the Earhart I-4 neighborhood began in June 2008. Since demolition and soil management at the Earhart I-4 neighborhood was underway when environmental oversight was implemented, HC decided to conduct verification soil sampling during ongoing construction in areas at Earhart I-4 where PI soil had already been managed. Based on previous oversight, Tetra Tech performed confirmation soil sampling in open areas at Earhart I-4 between August and December 2009.[37] The confirmation soil sampling identified that organochlorine pesticides were present in surface soil. Based on these results, the upper 1-foot of open area soil at Earhart I-4 was removed and placed into burial pits at the Onizuka II-2 neighborhood. Clean soil removed from Onizuka II-2 to create the burial pits was used to install a 1-foot clean soil cap at Earhart I-4. Confirmation soil sampling was performed at Earhart I-4 after the cap was installed which indicated that no pesticide-impacted soil remained in surface soil at Earhart I-4.[38]

Confirmation soil sampling was also conducted following completion of new housing construction at the Earhart I-2, Earhart I-3, and Onizuka I-1 neighborhoods.[39] Ten open area DUs were sampled at Earhart I-2, six open area DUs were sampled at Earhart I-3, and five open area DUs were sampled at Onizuka II-1. The results of the confirmation soil sampling indicated that organochlorine pesticides were present in soil at all ten open area DUs at Earhart I-2, all six open area DUs at Earhart I-3, and two of five open area DUs at Onizuka II-1.[40]

### *2.4.5 Site Investigation (SI) (2010)*

As a result of the confirmation soil sampling at the Earhart I-2, Earhart I-3, and Onizuka II-1 neighborhoods, meetings between HDOH and HC were conducted in July 2010, and the SI was

[34] (Tetra Tech 2010b)
[35] (Tetra Tech 2009a)
[36] (Tetra Tech 2006b and 2007b)
[37] (Tetra Tech 2009c)
[38] (Tetra Tech 2010a, 2010c, 2010d, 2010i, 2010L, and 2010m)
[39] (Tetra Tech 2010b)
[40] (Tetra Tech 2010e, 2010g, and 2010h)

planned. Two Sampling and Analysis Plans (SAPs) were developed. The entire exposed ground surfaces within the Earhart I-2, Earhart I-3, and Onizuka II-1 neighborhoods were subdivided into DUs of up to 5,500 sq ft in size.[41] The area of each DU only included the exposed surface area, including landscaped areas, but excluded the measured areas of hardscapes. The DUs were also defined by the nature of the land use, so that they corresponded to front yards, back yards, play areas, or common areas (such as pedestrian corridors) used by residents and guests. The soil in each DU was sampled using MI sampling methodology, which involves collecting 30 to 50 individual soil samples (or "increments") from points spread out across the DU. These increments are combined into a single composite sample; and mixing and processing the composite sample is conducted during laboratory preparation to ensure that a representative subsample of the composite sample is analyzed. The MI soil samples are a means of directly estimating the average concentration of pesticides within the DU. For the SI, the Earhart I-2 neighborhood was divided into a total of 330 DUs, the Earhart I-3 neighborhood was divided into 180 DUs, and the Onizuka II-1 neighborhood was divided into 21 DUs. The MI soil samples were collected from the 0 to 6 and 6 to 12-inch depth intervals, resulting in samples representing the average concentrations of pesticides within these depth intervals for each DU.

Between August and October 2010, the SI was performed with MI soil samples collected from the 0 to 6 and 6 to 12-inch depth intervals at each DU. These MI soil samples were submitted for analysis of organochlorine pesticides by EPA Method 8081. The results of the SI indicated that the soil was impacted with residual organochlorine pesticides, specifically aldrin, chlordane, and dieldrin at the three neighborhoods sampled for the SI. At the request of HDOH, following review by Tetra Tech and HC, the preliminary analytical results for organochlorine pesticides from the soil samples collected for the SI were tabulated and transmitted to HDOH on a daily basis. The complete analytical results for the SI are provided in the *RI Report*.[42]

### *2.4.6 Removal Action (RO) (2010 through 2011)*

The daily review of the preliminary SI analytical results by HC, Tetra Tech, and HDOH indicated that organochlorine pesticides detected in soil at some of the sampled DUs were present at concentrations that posed an immediate human health risk to HC workers, residents, and guests. Based on meetings between HC, HDOH, and Tetra Tech risk assessors, it was agreed that the immediate risk was posed by the non-carcinogenic risk from organochlorine pesticide concentrations in soil. As a result, the decision making process for ROs was developed based on calculation of the Hazard Index (HI) for each MI soil sample. Hickam Communities, in consultation with HDOH, used interim site-specific EALs to further screen the soil sample results. Based on the results of this screening, the RO was initiated in September 2010 to address the pesticide-impacted soil detected at the three neighborhoods. These removal actions were identified for specific DUs at the Earhart I-2 and Earhart I-3 neighborhoods; no DUs were identified at Onizuka II-1 neighborhood for action under the RO process.

The RO process consisted of three ROs, Removal Action No. 1 (RO #1), Removal Action No. 2 (RO #2), and Removal Action No. 3 (RO #3). These ROs were implemented in sequential order between October 2010 and August 2011. RO #1 and RO #2 were implemented to address soil with organochlorine pesticide concentrations that presented the highest health risks at the Site. The RO #1 and RO #2 were conducted based on immediate human health concerns, while HC

[41] (Tetra Tech 2010j and 2010k)
[42] (Tetra Tech 2012c)

conducted the RO #3 voluntarily, as described below. The ROs are summarized here, and presented in detail in the *RAR*.[43]

### *2.4.6.1 Removal Action No. 1*

The RO #1 was implemented starting in October 15, 2010 and completed by early January 2011. For RO #1, two actions (RO-1A and RO-1B) were taken based on the risk criteria under the provided in the 2009 *Program Manual*[44], referred to as the "2006 HHRA Standard". Under RO-1A, soil that contained concentrations associated with a combined non-carcinogenic risk described by an HI >10 were targeted for excavation of the upper 1-foot of soil, placement of a marker layer of orange geotextile fabric, and capping with 1-foot of soil with clean soil.[45] A total of four DUs in Earhart I-2, and one DU in Earhart I-3 met this criterion and were selected for action under RO-1A. At the same time, a second response action was initiated under RO-1B to ensure that turf grass in areas with soil presenting an intermediate level of risk was maintained so that the grass cover would act as an effective barrier to exposure. Under RO-1B, one DU in the Earhart I-2 neighborhood was identified where a large enough area of grass cover was inadequate and the DU was selected for excavation and replacement of the upper 1-foot of soil.

During planning of RO #1, HC decided to excavate and replace soil in three additional DUs in the Earhart I-2 area that were adjacent to the selected DUs, and to remove soil from small parts of three other adjacent DUs. All PI soil removed during RO-1A and RO-1B was stockpiled at a temporary pesticide-impacted soil management area, and subsequently placed into Burial Pit No. 6b constructed in the Onizuka II-3 neighborhood on April 22, 2011.[46]

### *2.4.6.2 Removal Action No. 2*

The RO #2 was implemented starting on January 4, 2011 and completed by the end of April 2011. Following completion of RO #1, RO #2 was designed to address DUs in which organochlorine pesticide concentrations with an HI >1, based on modified exposure assumptions that were presented in the memorandum entitled *Revised Analysis of Potential Removal Alternatives, Earhart I-2, Earhart I-3, and Onizuka II-1 Neighborhoods* and referred to as the "2010 Analysis of Potential Removal Alternatives (APRA) Standard".[47]

On the basis of this analysis, for RO #2, three actions were implemented. Under RO-2A, one additional DU in the Earhart I-2 area was selected for excavation of the upper 1-foot of soil, placement of a marker layer of orange geotextile fabric, and capping with 1-foot of soil with clean soil. A second response action was undertaken under RO-2B (RO-2B1 and RO-2B2) to inspect landscaping strips adjacent to homes in 41 DU and identify specific landscaping strip DUs requiring installation geotextile barriers in landscape strips. Under RO-2B1 and RO-2B2, actions were implemented at a total of 29 landscaping strip DUs. For the third response action, which was undertaken under RO-2C, a total of 195 DUs with intermediate pesticide concentrations were identified for inspection. The inspection was to evaluate if bare areas were present in the DUs that required hydroseeding to improve grass cover. Under RO-2C, actions were implemented at a total of 23 bare area DUs. All PI soil removed during RO #2 was

[43] (Tetra Tech 2012d)
[44] (Tetra Tech 2009a)
[45] (Tetra Tech 2010n)
[46] (Tetra Tech 2012d)
[47] (Tetra Tech 2010p and 2010q)

stockpiled at a temporary pesticide-impacted soil management area, and placed into a PI soil Burial Pit No. 6b constructed in the Onizuka II-3 neighborhood on April 22, 2011.[48]

#### *2.4.6.3 Removal Action No. 3*

The RO #3 was implemented starting on January 5, 2011 and completed August 4, 2011. The RO #3 was developed based on reevaluation of the human health risks associated with dieldrin and aldrin presented in the *Preliminary Human Health Risk Evaluation Work Plan for Hickam Communities* (*HHRE WP*)[49] and referred to as the "2011 HHRE Standard". Based on these modified EALs, one action (RO-3) was conducted to address DUs with an HI >1.[50] Under RO-3, ten DUs in Earhart I-2 and four DUs in Earhart I-3, which identified with combined pesticide concentrations representing an HI >1, were excavated to a depth of 9 inches below final grade, a marker layer of orange geotextile fabric installed, and the soil replaced with clean fill and reseeded (a depth of 6-inch below final grade for this excavation was presented in the work plan for RO #3, which was approved by the HDOH in its letter dated June 9, 2011.[51] The final depth of 9-inches for the excavations was based on geotechnical concerns for the clean fill soil. The pesticide-impacted soil excavated during RO-3 was placed into a pesticide-impacted soil berm constructed at the Earhart I-2 neighborhood in February 2012.[52]

## 2.5 Current/Future Land Use

The Site currently consists of new multi-unit residential housing that is managed by HC. The residential homes at the Site are occupied, and primarily leased by military personnel. Since HC holds a 50-year ground lease of the Site property, this property is expected to remain used for residential housing until at least 2057.

## 2.6 Chemicals of Potential Concern (COPCs)

Chemicals of Potential Concern are chemicals that have been detected in the environment that may adversely impact human or ecological receptors. These COPCs were identified based on the most recent soil sampling data collected from August 12 through October 12, 2010 to characterize the DUs identified in accordance with HDOH guidelines within the Earhart I-2, Earhart I-3, and Onizuka II-1 neighborhoods. All soil samples were analyzed by EPA Method 8081 for organochlorine pesticides. For this evaluation, all pesticides detected in at least one soil sample were identified as COPCs and evaluated further in the *EHE*. Chemicals detected at the Site are summarized in Table 2-1 and include aldrin, chlordane, dieldrin, dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyltrichloroethane (DDT), endrin, endrin ketone, endosulfan sulfate, delta-BHC, and methoxychlor. The primary chemicals of concern identified at the site are organochlorine pesticides, including chlordane, aldrin, dieldrin, DDD, DDE, and DDT. Other organochlorine pesticides, such as endosulfan sulfate, endrin, endrin ketone, delta-BHC, and methoxychlor, have been detected sporadically at concentrations close to their detection limits. These compounds do not contribute significantly to the cumulative risk from organochlorine pesticides at the Site.

[48] (Tetra Tech 2012d)
[49] (Tetra Tech 2011a)
[50] (Tetra Tech 2011b)
[51] (HDOH 2011d)
[52] (Tetra Tech 2012d)

**Table 2-1. Chemicals of Potential Concern in Soil**

| Chemical [(a)] |
|---|
| Aldrin |
| Chlordane [(b)] |
| Dieldrin |
| DDD |
| DDE |
| DDT |
| Endrin |
| Endrin ketone |
| Endosulfan sulfate [(c)] |
| delta-BHC [c] |
| Methoxychlor[c] |

(a) All organochlorine pesticides detected in soil as part of site investigation activities conducted at the Site in 2010 are included in this table.
(b) Chlordane is representative of technical chlordane which consists of chlordane isomers, heptachlor, and heptachlor epoxide. For this reason, other chlordane isomers, heptachlor, and heptachlor epoxide are evaluated as chlordane and are not listed individually in this table.
(c) Listed chemical detected at low levels in one sample.

## 2.7 Magnitude and Extent of Contamination

This section describes the contamination or presumed contamination remaining at the Site based on previous investigations and ROs implemented at the Site. As a result of these actions, there are no current hazards posed by pesticide-impacted soil at the Site; however, residual pesticide-impacted soil is known or presumed to be present beneath clean soil caps and hardscapes, and known to be present in on-site management areas.

### *2.7.1 Contaminated media*

The contaminated media at the Site consists of soil impacted by COPCs, primarily, the organochlorine pesticides aldrin, technical chlordane (chlordane),[53] and dieldrin. The primary means by which these pesticides were introduced into Site soil is through termiticide application. The application method was likely a combination of spraying soil surfaces prior to the construction of concrete slab foundations, and subsequent injection through utility openings in the foundations, and along foundation perimeters following construction of the homes. For this type of application, the intended application depths are not expected to have exceeded 2 to 3 feet below grade. Although some downward migration may have occurred immediately after the initial application (when the organochlorine pesticides were still dissolved in carrier solvents), any subsequent movement of organochlorine pesticides sorbed to soil particles due to leaching is expected to be minimal.[54]

Pesticide-impacted soil was placed at greater depths during HC construction activities due to:

[53] Technical chlordane (referred to as “chlordane”) is a mixture of more than 140 related compounds. Major constituents of technical chlordane include alpha- and gamma-chlordane, chlordane, and heptachlor.
[54] (Tetra Tech 2009b)

1. Known use of pesticide-impacted soil as backfill for some utility trenches;

2. Intentional burial of pesticide-impacted soil in the Onizuka Village neighborhood burial pits (Figure 3-1); and

3. Other potential (and unverified) burial of pesticide-impacted soil.

These locations are summarized below, and presented in detail in maps provided in the *EHMP* and the *LUCID*.

### *2.7.2 Removal Action at the Earhart I-2 and Earhart I-3 Neighborhoods*

As a result of the ROs, DUs with combined organochlorine pesticide concentrations representing HI >1 were identified based on results of the SI were excavated to at least 9-inches below final grade, and a marker layer of orange geotextile fabric installed followed by clean fill soil. Following the completion of the RO, calculated HIs for those remaining DUs at the Site are considered acceptable for current use.

### *2.7.3 Hale Na Koa I-1 and Onizuka II-1 Neighborhoods*

At the remaining areas of the Site, consisting of the Hale Na Koa I-1 and Onizuka II-1 neighborhoods, pesticide-impacted soil was remediated (Hale Na Koa I-1), or has been managed under hardscapes, and/or under at least 1-foot of clean soil (Hale Na Koa I-1 and Onizuka II-1). At Onizuka II-1, no excavations were conducted under the RO and pesticide-impacted soil is assumed to be present at depths greater than at 1-foot below final grade. There is no marker layer of orange geotextile fabric installed at Hale Na Koa I-1 or Onizuka II-1.

### *2.7.4 Utility Trenches*

Pesticide-impacted soil was used to backfill utility trenches in some areas at the Earhart I-2, Earhart I-3 and Onizuka II-1 neighborhoods. The depths of utility trenches range from approximately 1-foot (irrigation lines) to approximately 10 feet below final grade (water mains and sewer lines). The use of pesticide-impacted soil as trench backfill was discontinued in 2010, but pesticide-impacted soil could be present in utility trenches at the Site. The *LUCID* provides maps indicating the locations where pesticide-impacted soil is known or assumed to be present in utility trenches.

### *2.7.5 Soil Management Areas at Hickam Communities*

As a result of construction, redevelopment, and renovation at HC project sites, including ROs, no pesticide-impacted soil is transported off-site for disposal. Although soil generated by these activities is commonly managed within the HC project boundary by placement under hardscapes and/or a 1-foot clean soil cap, two other management methods are used at HC, which are described below.

#### *2.7.5.1 Burial Pits*

To manage pesticide-impacted soil, burial pits are constructed within the HC property boundary. To construct these burial pits, soil is excavated in open areas to a maximum depth of 5-feet above mean sea level (approximately 8 to 12 feet below final grade), which is deeper than the expected depth of pesticide application. These burial pits are then backfilled with pesticide-impacted soil, a marker layer of orange geotextile fabric installed, followed by a minimum 1-foot clean soil cap. There are currently no burial pits located at the neighborhoods within the Site. The burial pits at HC were installed in the Onizuka II-2 and Onizuka II-3 neighborhoods starting

in 2009; the last available pit was closed in the Fall of 2011 (Figure 2-1). Approximately 1,318 cubic yards (CY) of soil from RO #1 and 245 CY of soil from RO #2 is managed in Burial Pit No. 6b located in the Onizuka II-3 neighborhood.[55]

*2.7.5.2 Soil Berms*

With the pending closure of the burial pits at the Onizuka Village neighborhood, soil berming was identified as a new management option for pesticide-impacted soil at HC. Soil berms are an above-ground management method where pesticide-impacted soil is placed into an elongated berm, compacted, covered with a marker layer of orange geotextile fabric, and then capped with 2-feet of clean soil. This clean cap is subsequently landscaped with a groundcover.

To manage the soil generated from the Historic Homes District, and the soil from generated from RO #3, construction of a soil berm was proposed at the Earhart I-2 neighborhood to manage this pesticide-impacted soil (Figure 2-2). The berm was engineered and constructed based on plans and procedures presented in the *Soil Management Plan for Pesticide-Impacted Soil Berms, Earhart I-2 Neighborhood, DCN: 2626001.0002.F01,*[56] which was approved by HDOH in its letter dated August 22, 2011.[57] The total capacity of the Earhart I-2 soil berm is approximately 15,500 CY,[58] including approximately 1,390 CY of pesticide-impacted soil from RO #3, which was transported to the berm in February 2012.[59]

[55] (Tetra Tech 2012d)
[56] (Tetra Tech 2011c)
[57] (HDOH 2011e)
[58] (Tetra Tech 2011c)
[59] (Tetra Tech 2012d)

# 3.0 ENVIRONMENTAL HAZARD EVALUATION (EHE)

An *EHE* was prepared for the Site and included as Appendix E of the *RI Report*.[1] The purpose of the *EHE* was to recommend alternative EALs and provide corresponding support documentation to support soil management and cleanup at HC. The proposed alternative EALs were derived to incorporate the most up-to-date scientific practices and to reflect current recommended risk assessment guidelines. The alternative residential EALs provided in the *EHE* and used in this evaluation are considered to be protective of human health, particularly when coupled with strict soil management controls at JBPHH, such as restrictions on digging associated with the residential leases, maintaining good lawn cover, and other restrictions to be instituted as part of the long-term management of the Site. The land use restrictions will be detailed in the *LUCID* for HC.

The alternative EALs in the *EHE* have been used to evaluate potential human health risks in the four neighborhoods, in accordance with HDOH risk assessment guidelines in order to evaluate the need for, or scope of, potential remediation/mitigation efforts in the Hickam neighborhoods.

As described in the *EHE*, the soil within each DU sampled during the SI was evaluated using the 2011 HHRE Standard presented draft *HHRE WP* dated May 13, 2011[2], and approved by HDOH in its letter dated June 7, 2011[3]. As per the HDOH-approved 2011 HHRE Standard, a DU is not considered to pose a threat to human health and the environment due to organochlorine pesticides if all of the following criteria are met:

1. The cumulative excess cancer risk (ECR) for aldrin plus dieldrin must not exceed $1 \times 10^{-4}$;

2. The cumulative ECR for all other organochlorine pesticides must not exceed $1 \times 10^{-5}$;

3. The cumulative ECR for all COPCs must not exceed $1 \times 10^{-4}$; and

4. The hazard index for all COPCs must not exceed 1. If any of these criteria are not met, then the soil within the DU is considered to pose a threat to human health and the environment and must be treated accordingly.

Although aldrin and dieldrin are the primary chemicals of concern at the Site, alternative EALs are also provided for both child and adult residents for all organochlorine pesticides detected in soil during the 2010 Site investigation. The full list of residential EALs approved for the Site are summarized in Table 3-1 (child resident) and in Table 3-2 (adult resident). These values were developed as part of the final *HHRE WP* dated October 7, 2011[4] and approved by HDOH in its letter dated October 31, 2012,[5] with final approval provided by HDOH in its letter dated February 27, 2012.[6]

[1] (Tetra Tech 2012c)
[2] (Tetra Tech 2011a)
[3] (HDOH 2011c).
[4] (Tetra Tech 2011e)
[5] (HDOH 2011f)
[6] (HDOH 2012b)

**Table 3-1. 2012 Residential EALs – Child Resident**

| Chemical | HC Site-Specific Soil Screening Levels (mg/kg) | |
|---|---|---|
| | Cancer | Noncancer |
| | Target Risk [(a)] | Target HQ = 1 |
| Aldrin | 42.1 | 12.2 |
| Chlordane | 42.6 | 38.3 |
| Dieldrin | 20.4 | 9.8 |
| DDD | 48.7 | - |
| DDE | 34.4 | - |
| DDT | 46 | 67 |
| Endrin | - | 30.1 |
| Endrin Ketone | - | 30.1 |
| Endosulfan Sulfate | - | 601.6 |
| delta-BHC | - | 38.3 |
| Methoxychlor | - | 501.4 |

[(a)] Target risk of $1 \times 10^{-4}$ applies only to aldrin and dieldrin; the cancer EALs for all other compounds were derived based on a target risk of $1 \times 10^{-5}$.
mg/kg: milligrams per kilogram
HQ: hazard quotient

**Table 3-2. 2012 Recommended Alternative Residential EALs – Adult Resident**

| Chemical | HC Site-Specific Soil Screening Levels (mg/kg) | |
|---|---|---|
| | Cancer | Noncancer |
| | Target Risk [(a)] | Target HQ = 1 |
| Aldrin | 209.4 | 60.9 |
| Chlordane | 219.8 | 188.8 |
| Dieldrin | 101.4 | 48.7 |
| DDD | 253.6 | - |
| DDE | 179 | - |
| DDT | 223.7 | 326 |
| Endrin | - | 156.5 |
| Endrin Ketone | - | 156.5 |
| Endosulfan Sulfate | - | 3,130.5 |
| delta-BHC | - | 188.9 |
| Methoxychlor | - | 2,609 |

[(a)] Target risk of $1 \times 10^{-4}$ applies only to aldrin and dieldrin; the cancer EALs for all other compounds were derived based on a target risk of $1 \times 10^{-5}$.

The Site has been thoroughly investigated, and, as part of the *EHE*, specific portions of the Site have been identified where either remediation or the implementation of soil management or

institutional controls were required during the three ROs to mitigate direct exposures to contaminants in soil that could pose an environmental hazard.

## 3.1 Conceptual Site Model (CSM)

As indicated by HDOH guidance provided in *Screening for Environmental Hazards at Sites with Contaminated Soil and Groundwater*[7], a basic understanding of environmental hazards associated with contaminated soil and groundwater is a critical component in the overall environmental response process. The potential environmental hazards and targeted environmental hazards that were evaluated as part of the *EHE* are summarized in the following sections.

### *3.1.1 Potential Environmental Hazards*

Common environmental hazards that should be evaluated at release sites include:

**Soil**

- Direct exposure risks to human health;
- Intrusion of subsurface vapors in buildings;
- Leaching and subsequent impacts to groundwater resources;
- Impacts to terrestrial habitats; and
- Gross contamination and general resource degradation.

**Groundwater**

- Impacts to drinking water resources;
- Impacts to aquatic habitats;
- Intrusion of subsurface vapors in to buildings; and
- Gross contamination and general resource degradation.

Potential environmental hazards were evaluated for their applicability to the Site. Potential environmental hazards that were considered to be insignificant at the Site based on available information were eliminated from further consideration and are not evaluated further. Potential environmental hazards identified as posing a potential threat to human health and/or the environment were evaluated further in the *EHE*.

### *3.1.2 Targeted Environmental Hazards*

A summary of potential environmental hazards and their significance at the Site is provided below in Table 3-3.

[7] (HDOH 2011a)

**Table 3-3. Potential Environmental Hazards**

| Medium | Potential Environmental Hazard | Potentially Significant? |
|---|---|---|
| Soil | Direct exposure threats to human health | Yes |
| | Intrusion of subsurface vapors in buildings | No |
| | Leaching and subsequent impacts to groundwater | No |
| | Impacts to terrestrial habitats | No |
| | Gross contamination and general resource degradation | No |
| Groundwater | Impacts to drinking water sources | No |
| | Impacts to aquatic habitats | No |
| | Intrusion of subsurface vapors into buildings | No |
| | Gross contamination and general resource degradation | No |

Direct Exposure. As described in more detail in the *EHE*, direct exposure to soil was retained and evaluated in the *EHE*.

Vapor Intrusion. Vapor intrusion was eliminated as a potential environmental hazard because none of the COPCs are classified as volatile compounds by EPA or HDOH.

Leaching/Groundwater Impacts. The chlorinated pesticides detected at the Site have low solubilities and bind tightly to soils (i.e., have very limited mobility) and therefore, are not considered to pose a significant soil leaching hazard in regard to contamination of groundwater.

Drinking Water Resource Impacts. Contamination of drinking water supplies was eliminated due to the following: the limited mobility of the COPCs, groundwater beneath the study area is brackish and is not suitable for commercial, residential, or recreational use, and because potable water is supplied to JBPHH from US Navy storage tanks outside the base.

Ecotoxicity. As discussed in the *EHE*, terrestrial and aquatic ecotoxicity was eliminated from consideration due to the low mobility of the COPCs and due to a lack of sensitive habitat/receptors within the Site and immediately adjacent to the Site.

Gross Contamination. Gross contamination was eliminated because the maximum detected levels of pesticides within the Site are well below the corresponding HDOH screening levels for gross contamination.

## 3.2 Exposed Populations and Exposure Pathways

The identification of potentially exposed populations and exposure pathways is a critical component of developing health protective environmental action levels. An exposure pathway describes the course a chemical takes from a source to an exposed individual. Based on current and anticipated future conditions at the Site, the chemical exposures that could potentially be associated with the three neighborhoods were identified considering the following four factors:

1. Sources of COPCs;

2. Environmental media in which COPCs have been detected (i.e. soil);

3. Exposure of contact points with the environmental media (e.g. direct contact with soil); and

4. Exposure routes for chemical intake by a receptor (e.g. soil ingestion).

The exposure pathways identified for the Site are based on evaluations of the likelihood of receptors directly contacting COPCs and the mechanisms governing the fate and transport of the COPCs.

### *3.2.1 Potential Receptors*

Potentially exposed human populations (receptors) were identified for current and expected future land-use scenarios. The Site is currently developed for residential land use and it is anticipated that it will remain in its current use over the course of the 50-year lease between HC and the USAF, which does not expire until 2057. Human populations that could potentially be exposed to pesticide-impacted soil within the Site under current and expected future conditions, include residential receptors (adults and children), landscaping/maintenance workers, and construction workers.

For the *EHE*, residential, landscape/maintenance worker, and construction worker receptors were evaluated. For landscape/maintenance workers and construction worker receptors, a reasonably anticipated future exposure scenario includes exposure to previously buried pesticide-impacted soil due to excavation or erosion. Similarly, if pesticide-impacted soil remaining at the Site is brought to the surface in the future, residents could also be potentially exposed.

Thus, for CSM development, the potentially affected human populations include:

- Residential receptors (adults and children)
- Landscape/maintenance workers, and
- Construction workers.

### *3.2.2 Exposure Media and Exposure Pathways*

As indicated above, direct exposure to pesticide-impacted soil by residents and future workers is the potential environmental hazard evaluated in the *EHE*. The complete exposure pathways for potentially affected populations identified above include: 1) incidental ingestion of soil; 2) dermal contact with soil; and 3) inhalation of airborne particulates.

Potential receptors and exposure pathways are summarized in Table 3-4. The CSM summarizing the potential and retained environmental hazards for pesticide-impacted soil at the Site is presented in Table 3-5.

**Table 3-4. Potential Receptors and Exposure Pathways**

| Receptor | Medium | Exposure Pathway |
|---|---|---|
| On-Site Resident (Adult and Child) | Soil | Incidental Ingestion |
| | | Dermal Contact |
| | | Dust Inhalation |
| Landscape/Maintenance Worker | Soil | Incidental Ingestion |
| | | Dermal Contact |
| | | Dust Inhalation |
| Construction Worker | Soil | Incidental Ingestion |
| | | Dermal Contact |
| | | Dust Inhalation |

## Table 3-5. Conceptual Site Model for Organochlorine Pesticides [a]

| Primary Sources | Primary Release Mechanism | Secondary Sources | Potential Environmental Hazards | | Hazards Present Under Current or Future Conditions? | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Current | | Future | |
| | | | | | Residents | Construction/ Maintenance Workers | Residents | Construction/ Maintenance Workers |
| Historical Maintenance Activities for Residential Units (Application of pesticides under and around building foundations for termite control) | Soil moving activities associated with recent construction work | Soil | Risk to Human Health | Direct Exposure [b] - ingestion - dermal contact - dust inhalation | No [i] | No [i] | Yes | Yes |
| | | | | Vapor Intrusion into Buildings | ---- | ---- | ---- | ---- |
| | | | Risk to Terrestrial Ecological Habitats [c] | | No | | No | |
| | | | Leaching [d] | | No | | No | |
| | | | Gross Contamination [e] | | No | | No | |
| | | Groundwater | Risk to Human Health [f] | Direct Exposure | ---- | | ---- | |
| | | | | Vapor Intrusion into Buildings | ---- | | ---- | |
| | | | Risk to Aquatic Ecological Habitats [g] | | ---- | | ---- | |
| | | | Gross Contamination [h] | | ---- | | ---- | |

[a] Conceptual Site Model is based on EAL Surfer Summary Reports for organochlorine pesticides (HDOH 2011b). It is assumed that the Site is not located within 150 meters of a surface water body or sensitive aquatic habitat, and groundwater is not a current drinking water resource.
[b] Human health hazards include direct exposure to contaminated soil or inhalation of airborne dust.
[c] Assumes significant terrestrial ecological habitat is impacted due to contamination with resulting toxicity to flora/fauna.
[d] Assumes potential leaching of soil contaminants resulting in impacts to underlying groundwater.
[e] Gross contamination hazards for soil include potential explosive hazards, odors and general nuisance concerns, and general resource degradation.
[f] Human health hazards include ingestion of contaminated groundwater and potential dermal and inhalation exposures during showering.
[g] Assumes contaminated groundwater discharges/migrates to an aquatic habitat. Contaminants in groundwater screened using chronic aquatic toxicity action levels for sites < 150 meters from a surface water body.
[h] Gross contamination hazards for groundwater include taste and odor concerns for drinking water, presence of free product, odors, and general resource degradation.
[i] Due to remediation activities completed at the Site, current hazards are not likely to exist for current residents. Similarly, for current landscape/maintenance and construction workers who may engage in intrusive soil activities, institutional controls are currently in place to ensure that Occupational Safety and Health Administration safe practices are followed by maintenance and construction workers in areas of the Site associated with remaining pesticide-impacted soil.

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# 4.0 REMEDIAL STRATEGY

## 4.1 Evaluation of Remedial Alternatives

The RAA presented the development and screening of remedial alternatives, which is summarized in this Section. The RAA process identifies and evaluates alternatives that will "eliminate, reduce, prevent, minimize, mitigate or control risks to the public health or welfare, the environment, or natural resources"[80], with the goal of selecting the alternative that best meets the evaluation criteria. The guiding principles for developing appropriate response actions are described in the State Contingency Plan (SCP) Hawai'i Administrative Rules (HAR) §11-451-15[81].[82] These guiding principles are incorporated into Section 2 of the *TGM* (HDOH 2009), which provides an approach to identify and analyze response actions intended to be protective of human health and the environment.

### *4.1.1 Identification and Screening Technologies*

The Remedial Action Objectives (RAOs) and General Response Actions (GRAs) are defined in the following sections. This section also includes a screening of technology types and process options.

#### *4.1.1.1 Development of Remedial Action Objectives (RAOs)*

The RAOs are goals that are developed to protect the human health and environment. The RAOs developed in the RAA address the environmental hazards posed by residual pesticide-impacted soil remaining at the Site.[83] The remedial action selected (institutional controls) and ultimately implemented will be designed to achieve the RAOs based on the anticipated future use of the property, which will for residential purposes over a least the next 50 years under HC's lease with the USAF.

The primary remedial action objective is to reduce the remaining risk from residual pesticide-impacted soil at the Site to acceptable levels. The RAOs developed for the Site consist of: (1) reduction of contaminant concentrations in Site soil; (2) removal of the direct exposure pathways between contaminants and receptors; (3) preventing contaminant migration; (4) minimizing potential adverse impacts to the surrounding communities and the environment; and (5) compliance with the Applicable or Relevant and Appropriate Requirements (ARARs) pertaining to the Site and the specific remedial action.

#### *4.1.1.2 General Response Actions (GRAs)*

General response actions are selected to satisfy the remedial action objectives for each area of concern. The GRAs for soil include excavation, soil vapor extraction, containment, and institutional controls. The applicable treatment technologies or process options for the Site include excavation with on-site management or off-site disposal, incineration, ex-situ or in-situ bioremediation, and thermal desorption. Applicable treatment technologies for containment include the installation of horizontal or vertical barriers to control the migration of contamination.

[80] (HDOH 1995)
[81] *Hawai'i Administrative Rules (HAR) Title 11 Department of Health, Chapter 451 State Contingency Plan*. August 2, 1995.
[82] (HDOH 1995)
[83] (Tetra Tech 2012e)

Applicable institutional controls to protect HC workers residents and guests include the adherence to project plans including the *Resident Guide*, *EHMP*, *Program Manual* and *LUCID*.

### *4.1.2 Development of Remedial Alternatives*

To develop remedial alternatives, GRAs are combined using various technologies applicable to the residual pesticide-impacted soil remaining at the Site to meet all RAOs. For the Site, four remedial alternatives were developed based on no action, implementation of institutional controls, to a cleanup to unrestricted use scenario.

#### *4.1.2.1 No Action Alternative (Alternative 1)*

The "no action" alternative does not require any further remedial actions at the Site. Inclusion of the no action alternative is recommended in order to establish a baseline for the evaluation of other alternatives.[84] For the baseline condition of the Site, a scenario is applied where no actions have yet been conducted in response to the initial discovery of pesticide-impacted soil at the Site. Although existing administrative and soil management controls may be implemented under this alternative, they would not be required, nor would any additional controls or long-term monitoring of the Site. Alternative 1 evaluates site conditions in the absence of the three ROs (RO #1, RO #2, and RO #3), and is the only alternative in the RAA where this baseline scenario is applied.

#### *4.1.2.2 Cleanup to Unrestricted Use (Alternative 2 and 3)*

Based on where residual pesticide-impacted soil is known or presumed to be present at the Site both Alternative 2 and 3 would allow for unrestricted future use of the Site, regardless of construction activities, through the removal of all pesticide-impacted soil at the Site. For unrestricted use to apply, no soil at the Site would have organochlorine pesticide concentrations exceeding the respective HDOH Tier 1 EALs (for unrestricted land use in areas that are greater than 150 meters from the nearest surface water body and where groundwater is not considered a current or potential drinking water source).[85] For unrestricted use, no further remedial actions would be required, nor the implementation of land use controls or long-term monitoring.

For Alternative 2, the removed soil would either be managed on-site, outside the Site boundary (but within HC property), and for Alternative 3 the removed pesticide-impacted soil would be transported off-site for disposal at a local landfill on O'ahu.

#### *4.1.2.3 Institutional Controls (Alternative 4)*

This alternative consists of no further remedial actions and implementation of institutional controls at the Site. Administrative and soil management controls for pesticide-impacted soil have been implemented at HC since 2006. Additional institutional controls would include the preparation of the *LUCID* and a comprehensive *EHMP*, including proactive inspections and long-term monitoring of the Site to ensure that all administrative and soil management controls are being consistently and effectively implemented at the Site.

[84] (HDOH 2009)
[85] (HDOH 2011b)

## 4.2 Detailed Screening of Remedial Alternatives

Each remedial alternative was evaluated based on the criteria of effectiveness, implementability, and cost. The effectiveness of each alternative was evaluated based on the potential to minimize residual risks, provide long-term, reliable protection to HC workers, residents and guests, and to comply with applicable requirements. The implementability of each alternative was evaluated based on the availability of the technology required and the alternative's administrative feasibility including permitting and logistical matters. The cost of each alternative was evaluated based on the capital costs for implementation of the alternative, as well as long-term costs for operation and maintenance over the 50-year term of HC's lease with the USAF. This evaluation is discussed below, and summarized in Table 4-1. A breakdown of the costs for each alternative is presented in Table 4-2.

### *4.2.1 Alternative 1: No Action*

Since Alternative 1 assumes a baseline condition for the Site where no removal or remedial actions have been implemented, this alternative has low effectiveness in the short and long-term. This is due to the potential for current and future exposures to pesticide-impacted soil present in surface soil at the Site.

The advantages of Alternative 1 are: (1) implementation of this alternative would have no impact on the military mission and JBPHH, the surrounding communities, or environment; (2) there are currently soil management controls provided by *Program Manual,* and the *Resident Guide,* in place at the Site; and (3) there is no cost for implementing and maintaining Alternative 1.

The disadvantages of Alternative 1 are: (1) The COPC concentrations would not be reduced at the Site since residual pesticide-impacted soil would remain at the Site; (2) there are short and long-term exposure pathways for HC workers, residents, and guests to pesticide-impacted soil. There is also and increased long-term potential exposure hazard to construction and maintenance workers from insufficient controls that could result in disturbance and exposure to pesticide-impacted soil; and; (3) existing institutional controls will be under long-term monitoring by HC over the 50-year ground lease; however, there would no additional institutional controls or an *EHMP* developed to further restrict or prevent the potential for future exposure to residual pesticide-impacted soil.

### *4.2.2 Alternative 2: Cleanup to Unrestricted Use (On-Site Placement)*

Alternative 2 would only be moderately effective for the Site. Even though it would remove all of the pesticide-impacted soil from the Site, in the short term this alternative has low effectiveness since the excavation and removal of currently capped pesticide-impacted soil would present a potential exposure hazard to residents from dust emissions, or spillage of soil during transport.

The advantages of Alternative 2 are: (1) The COPC concentrations would be reduced at the Site since all of the pesticide-impacted soil would be removed; and (2) no further land-use controls would be required since the Site would be suitable for unrestricted use.

The disadvantages of Alternative 2 are: (1) The overall volume of pesticide-impacted soil is not eliminated by this alternative since it would not be destroyed or detoxified, only be moved for long-term management at other neighborhoods within HC; (2) pesticide-impacted soil managed in other areas at HC would require long-term management and controls; (3) there is limited available space for on-site management of pesticide-impacted soil at HC; (4) there is the potential of migration of pesticide-impacted soil during excavation and removal through dust emissions and spills; (5) it would be difficult to implement since removal of pesticide-impacted

soil from beneath homes and structures could only be conducted following removal or renovation of these homes and structures; (6) possible relocation of military personnel has potential negative impacts on the military mission at JBPHH, and implementation of this alternative could meet resistance by the USAF and US Navy; and (7) the costs for implementing and maintaining Alternative 2 would be extremely high.

### *4.2.3 Alterative 3: Cleanup to Unrestricted Use: (Off-Site Disposal)*

Alternative 3 would only be moderately effective for the Site. Even though it would remove all of the pesticide-impacted soil from the Site, in the short-term this alternative has low effectiveness since the excavation and removal of currently capped pesticide-impacted soil would present a potential exposure hazard to residents from dust emissions, or spillage of soil during transport.

The advantages of Alternative 3 are: (1) The COPC concentrations would be reduced at the Site since all of the pesticide-impacted soil would be removed; (2) no further land-use controls would be required since the Site would be suitable for unrestricted use; and (3) since soil would be disposed off-site, there would be not additional management or controls at HC for the removed pesticide-impacted soil.

The disadvantages of Alternative 3 are: (1) The overall volume of pesticide-impacted soil is not eliminated by this alternative since it would not be destroyed or detoxified, only be transported to a landfill on O‘ahu for disposal; (2) pesticide-impacted soil managed in other areas at HC would require long-term management and controls; (3) there is limited capacity in local landfills, and no guarantee that they would accept such large volumes of pesticide-impacted soil; (4) There is the potential of migration of pesticide-impacted soil during excavation and removal through dust emissions and spills; (5) it would be difficult to implement since removal of pesticide-impacted soil from beneath homes and structures could only be conducted following removal or renovation of these homes and structures; (6) possible relocation of military personnel has potential negative impacts on the military mission at JBPHH, and implementation of this alternative could meet resistance by the USAF and US Navy; and (7) the costs for implementing and maintaining Alternative 3 would be extremely high.

### *4.2.4 Alterative 4: Institutional Controls*

Alternative 4 is highly effective for the Site. Since no current hazards are present at the Site, and soil management controls are already provided by the current project plans (*Program Manual* and *Resident Guide)*, with the additional institutional controls provided by the *LUCID* and the *EHMP* developed under the remedial action process, it has high effectiveness in both the short term and long-term.

The advantages of Alternative 4 are: (1) implementation of this alternative would have no impact on the military mission and JBPHH, the surrounding communities, or environment; (2) there are currently soil management controls provided by *Program Manual,* and *the Resident Guide,* in place at the Site; (3) there would be additional institutional controls consisting of the *LUCID and the EHMP* developed under the remedial action process to further restrict or prevent the potential for future exposure to residual pesticide-impacted soil; (4) the existing and additional institutional controls will be under long-term monitoring by HC over the 50-year ground lease; and (5) There are only moderate costs for implementing Alternative 4 over the 50-year lease.

The disadvantages of Alternative 4 are: (1) The COPC concentrations would not be reduced at the Site since residual pesticide-impacted soil would remain at the Site; (2) although there is no short-term exposure pathway for HC workers, residents, and guests from pesticide-impacted

soil, there is a long-term potential exposure hazard to construction and maintenance workers from residual pesticide-impacted soil; and (3) even though capping provides a barrier preventing short-term mobilization of pesticide-impacted soil, the soil could potentially be disturbed in the future.

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**Table 4-1. Remedial Alternatives Analysis.**

| Criteria | Remedial Alternative | | | |
|---|---|---|---|---|
| | **1**<br>**No Action** | **2**<br>**Unrestricted Use (On-Site Management)** | **3**<br>**Unrestricted Use (Off-Site Management)** | **4**<br>**Institutional Controls** |
| **Effectiveness:**<br>**Overall Protection of Human Health and the Environment** | **Low Effectiveness.**<br>--Short-term: Low effectiveness since pesticide-impacted soil would still be present at the Site<br>--Long-term: Low since all pesticide-impacted soil would still be present at the site. It does not allow for additional mandated long-term institutional controls. There are existing plans to address pesticide-impacted soil management; however, these soil management plans are not an EHMP developed under the remedial action process. | **Moderate Effectiveness**.<br>--Short-term: Low effectiveness since there is no need to conduct excavation since there are current hazards. Excavation of residual PI soil may present a risk to residents by exposing capped PI soil. Excavation of contaminated soil has the potential of creating dust emissions and the possibility of distribution of contaminated soil outside of work areas during excavation and transport.<br>--Long-term: High effectiveness since removes all of the contamination and leaves site in "unrestricted use" condition. | **Moderate Effectiveness.**<br>--Short-term: Low effectiveness since there is no need to conduct excavation since there are current hazards. Excavation of residual PI soil may present a risk to residents by exposing capped PI soil. Excavation of contaminated soil has the potential of creating dust emissions and the possibility of distribution of contaminated soil outside of work areas during excavation and transport.<br>--Long-term: High effectiveness since removes all of the contamination and leaves site in "unrestricted use" condition. | **High Effectiveness.**<br>--Short-term: High effectiveness because there is no existing hazard. Also, since HC has already has ICs in place for PI soil since 2004. These ICs are presented in PI soil Management Program Manual. HC staff is already familiar with PI soil management procedures.<br>--Long- term: Over-protective for long-term because of the IC's and the EHMP (which is a remedial action document). In addition, the Site will be managed by HC for the next 50 years under the 50 year ground lease, and the adherence to ICs can be monitored by HC. |
| **Effectiveness:**<br>**Compliance with ARARs** | **Moderate Effectiveness**<br>--Complies with ARARs; however, would not comply with protectiveness measures identified in HAR §11-451. | **High Effectiveness.**<br>--Complies with ARARs | **High Effectiveness.**<br>--Complies with ARARs | **High Effectiveness.**<br>--Complies with ARARs |
| **Effectiveness:**<br>**Reduction of Toxicity, Mobility, and Volume** | **Low Effectiveness.**<br>--Short and long- term: There is no reduction in volume, and pesticide-impacted surface soil has the potential to be distributed within and outside the Site. Low effectiveness since it does not remove or reduce the toxicity | **Low Effectiveness.**<br>--The intent of this criterion is to evaluate actual reduction of contaminant. In the case of excavation, the toxicity is not being reduced since the PI soil is being removed and placed in another location at HC.<br>--Since PI soil is being transported, there is the potential for distributing the soil during excavation by dust emission, and during loading, transport and off-loading by both dust emissions and spills. | **Moderate Effectiveness.**<br>--The intent of this criterion is to evaluate actual reduction of contaminant. In the case of excavation, the toxicity is not being reduced since the PI soil is being removed and placed at another location on O'ahu.<br>--Since PI soil is being transported, there is the potential for distributing the soil during excavation by dust emission, and during loading, transport and off-loading by both dust emissions and spills. | **Low Effectiveness.**<br>--Short term: Since residual PI soil is capped, there is no current need to reduce toxicity; reduction of toxicity is not really applicable.<br>--Long term: Low effectiveness since it does not remove or reduce the toxicity. |
| **Implementability:**<br>**Technical Feasibility** | **High Implementability.**<br>--Does not require any additional work to implement. | **Low Implementability.**<br>--Would require the demolition and rebuilding of the neighborhoods. Removal of soil in areas not currently occupied, but that soil removal from backyards and under foundations would only happen if/when a house was demolished.<br>--Contaminated soil could not be managed on the Site and would require management in other areas at HC. | **Low Implementability.**<br>--Would require the demolition and rebuilding of the neighborhoods. Removal of soil in areas not currently occupied, but that soil removal from backyards and under foundations would only happen if/when a house was demolished.<br>--Soil transported off-site for Landfill disposal would create a significant disruption to occupied neighborhoods and would require extensive planning to implement.<br>--Availability of landfill space on O'ahu is limited.<br>--there is a high carbon footprint associated with truck transport of large quantities of soil. . | **High Implementability.**<br>--Institutional controls already adopted at HC. Any additional ICs would be fairly easy to implement.<br>--Project plans already developed for management of contaminated soil.<br>--High degree of familiarity on soil management procedures at HC. |
| **Implementability:**<br>**Administrative Feasibility** | **High Implementability.**<br>--No administration of this alternative is required. | **Low Implementability.**<br>--Would require extensive coordination with the USAF, and HC residents.<br>--Possible relocation of HC residents who are active military personnel during excavation may interfere with military directives. | **Low Implementability.**<br>--Would require extensive coordination with the USAF, and HC residents.<br>--Possible relocation of HC residents who are active military personnel during excavation may interfere with military directives. | **High Implementability.**<br>--Easy to implement since PI soil ICs are already adopted at HC. Comprehensive management plan in the EHMP will integrate easily into the existing management and monitoring strategies.<br>--High degree of familiarity on soil management procedures at HC. |
| **Cost:**<br>**Overall Costs** | **No Cost.**<br>--No cost in implementation of this alternative.<br>--No annual O&M Costs. | **High Cost.**<br>--Highly expensive to implement<br>--Long-term O&M costs for managing contaminated soil at HC. | **High Cost.**<br>--highly expensive to implement<br>--No O&M costs | **Low to Moderate Cost.**<br>--HC-specific project plans have already been developed no cost incurred in the implementation. There will be a cost associated with the EHMP.<br>--O&M costs would be incurred for updates to existing plans and EHMP. |

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**Table 4-2. Comparison of Estimated Costs**

| Description | Alternative | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Project Management and Planning | $0 | $587,920 | $801,243 | $2,850 |
| Implementation of Remedy | $0 | $63,275,409 | $55,505,056 | $57,000 |
| Waste Management | $0 | $50,923,530 | $167,951,750 | $0 |
| Documentation / Reporting | $0 | $151,000 | $151,000 | $0 |
| *Estimated Total Capital Costs* [(a)] | ***$0*** | ***$114,937,859*** | ***$224,409,050*** | ***$59,850*** |
| *Estimated Cost Over for the Duration of the 50-year Ground Lease* [(b)] | ***$0*** | ***$11,457,794*** | ***$0*** | ***$7,793,249*** |
| ***Grand Total*** | ***$0*** | ***$126,395,653*** | ***$224,409,050*** | ***$7,853,099*** |

(a) Capital costs for implementation of Alternatives 2 and 3 are assumed over a 6 month period
(b) Calculated for the remaining time on the ground lease (2057 – 2012 = 45 years)

## 4.3 Summary of Comparative Analysis of Remedial Alternatives

The comparative analysis of remedial alternatives with respect to the screening criteria is summarized using numerical values in Table 4-3. The alternative with the highest ranking for a specific criterion was given a score of 5 and the alternative with the lowest ranking for a specific criterion was given a score of 1. Therefore, the alternative with the highest total numerical value would rank the highest in this scoring system. It should be noted that the rankings were based on an "equal-weight" scoring system, where all criteria were considered to be of equal importance. This is often not the case, particularly in situations where funding is limited or in the presence of other constraints.

**Table 4-3. Ranking of Remedial Alternatives**

| Criteria | Alternative | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Effectiveness: Overall protection of human health and the environment | 1 | 2 | 3 | 5 |
| Effectiveness: Short-term effectiveness | 1 | 1 | 1 | 5 |
| Effectiveness: Long-term effectiveness | 1 | 4 | 4 | 5 |
| Effectiveness: Reduction of toxicity, mobility, and volume | 1 | 1 | 2 | 2 |
| Effectiveness: Compliance with ARARs | 2 | 5 | 5 | 5 |
| Implementability: Technical feasibility | 5 | 1 | 1 | 5 |
| Implementability: Administrative feasibility | 5 | 3 | 3 | 5 |
| Cost: Overall Costs | 5 | 1 | 1 | 4 |
| ***Total Score*** | ***21*** | ***18*** | ***20*** | ***36*** |

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# 5.0 PROPOSED REMEDY

A remedy for a remedial action site can consist of more than one remedial alternative; however, Alternative 4 was selected as the most effective, implementable, and cost effective for addressing environmental hazards at the Site. Alternative 4 consists of no further remedial action and the implementation institutional controls.

This proposed remedy was selected based on the following:

- There are no current hazards for HC workers, residents, and guests from pesticide-impacted soil at the Site.
- There are currently institutional controls provided by *Program Manual* and *Resident Guide* in place at the Site.
- There are additional institutional controls provided by the *LUCID* and the *EHMP* developed under the remedial action process to further restrict or prevent the potential for future exposure to residual pesticide-impacted soil.
- All institutional controls will be under long-term monitoring by HC over their 50-year lease.
- This remedy will have minimal impacts on the military mission at JBPHH, or the surrounding communities and the environment.
- Reasonable costs to implement and maintain this remedy over HC's 50-year ground lease.

Successful implementation of the proposed remedy is contingent upon:

- A commitment by HC for the continued implementation and maintenance of the institutional controls, which are provided by the *Program Manual, EHMP, LUCID*, and the *Resident Guide*; and
- Long-term monitoring and reporting to ensure all institutional controls are in place and consistently implemented at the Site by HC.

## 5.1 Process for Acceptance of the Final Remedy

As discussed in Section 1.1, this proposed remedy will be presented to the public for review and comment over a 30-day period. A public notice will be posted regarding availability for review of the Draft RAM and other key documents, a fact sheet, solicitation of verbal or written comments, and information on the public meeting, which will be held during the middle of the comment period.

The Final RAM will document the selected remedy for the Site as approved by HDOH HEER. Public comments will be addressed in a responsiveness summary in the Final RAM, and incorporated as changes to the selected remedy as appropriate.

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# 6.0 RESPONSIVENESS SUMMARY

The Final RAM will be prepared after the completion of the public comment period, receipt of public comments, and selection of the final remedy by HDOH. Documentation of public comments received and HDOH responses to those comments will be provided in this section of the Final RAM.

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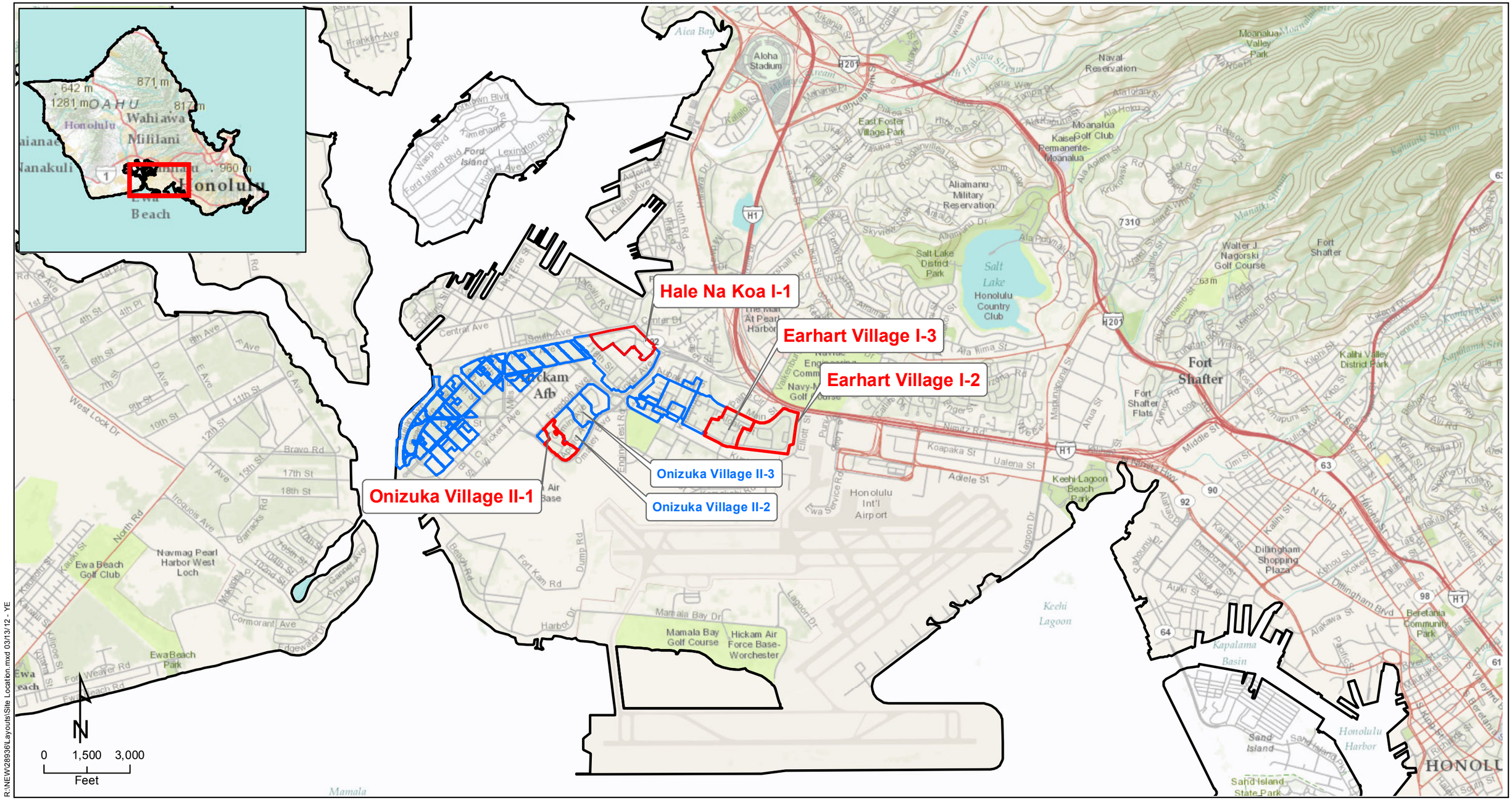
# FIGURES

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Site Boundary

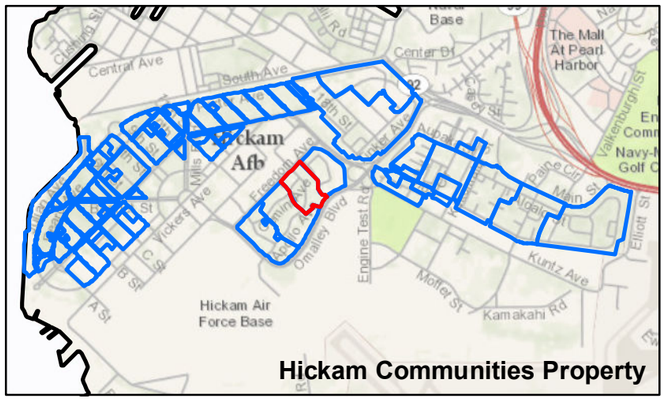
Hickam Communities Project Boundary

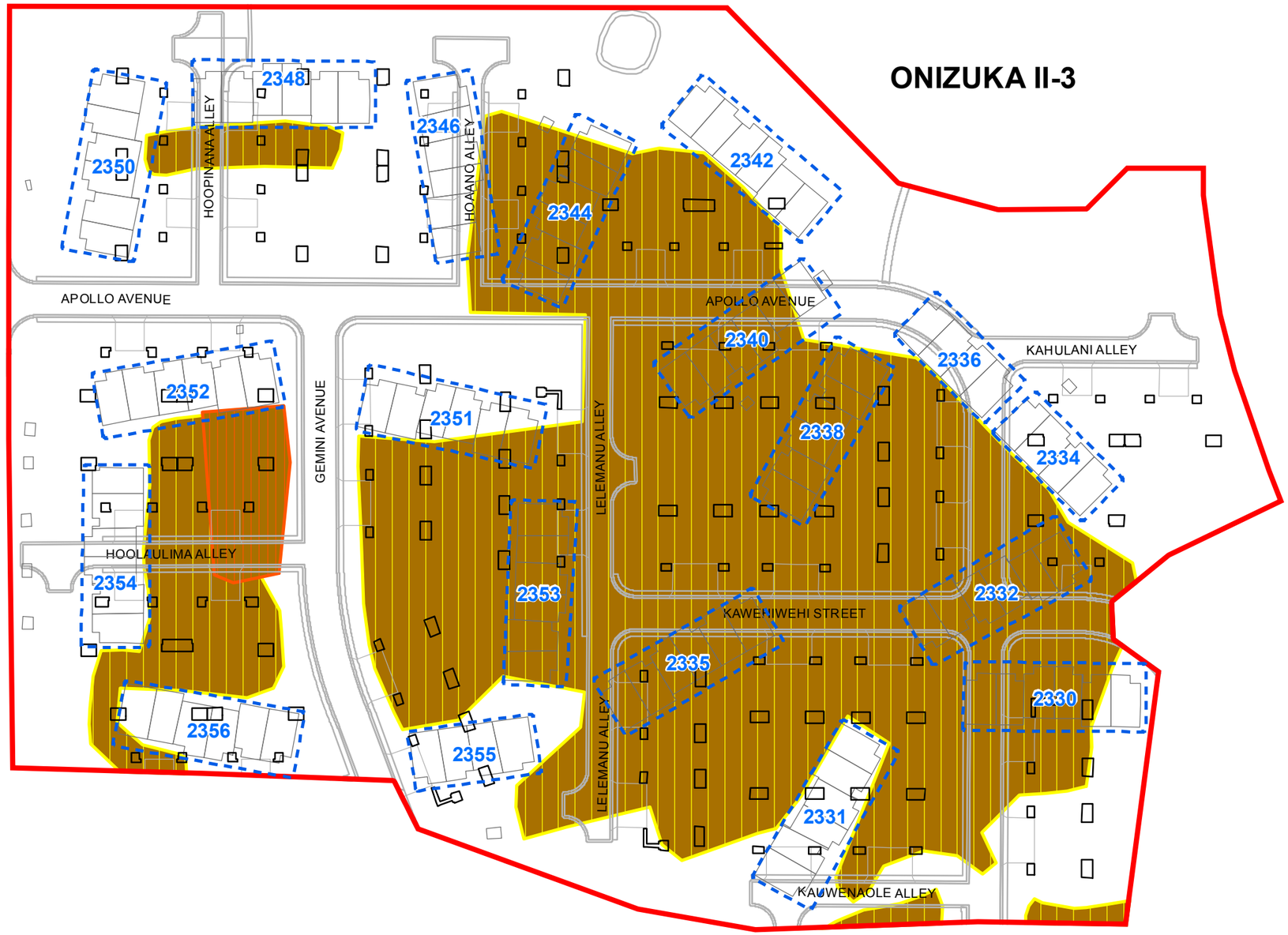
***Remedial Action Site***
***Response Action Memorandum - 2012***

Joint Base Pearl Harbor-Hickam, O'ahu, Hawai'i

TETRA TECH

**Figure 1-1**




0 50 100
Feet

*This is a draft map. The final topographic map for the burial pits is still outstanding.*

Onizuka II-3 Boundary
New Building Footprints
Roads
Burial Pits
Old Building Footprints
Burial Pit #6b

**Notes:**

- **Inset map shows Hickam Communities Property Boun dary Line.**
- **Within the burial pits, PI soil is expected under building foundations and in utility trenches**
- **An orange geotextile marker layer has been installed between the clean soil cap and the PI soil**
- **Within burial pits, all soil removed from deeper than 1 foot has to be assumed pesticide-impacted unless tested**
- **Within burial pits, PI soil has been placed up to an elevation of 5 feet amsl**

# *Onizuka II-3 Burial Pits*
# *Response Action Memorandum - 2012*

Joint Base Pearl Harbor-Hickam, O'ahu, Hawai'i

**Figure 2-1**

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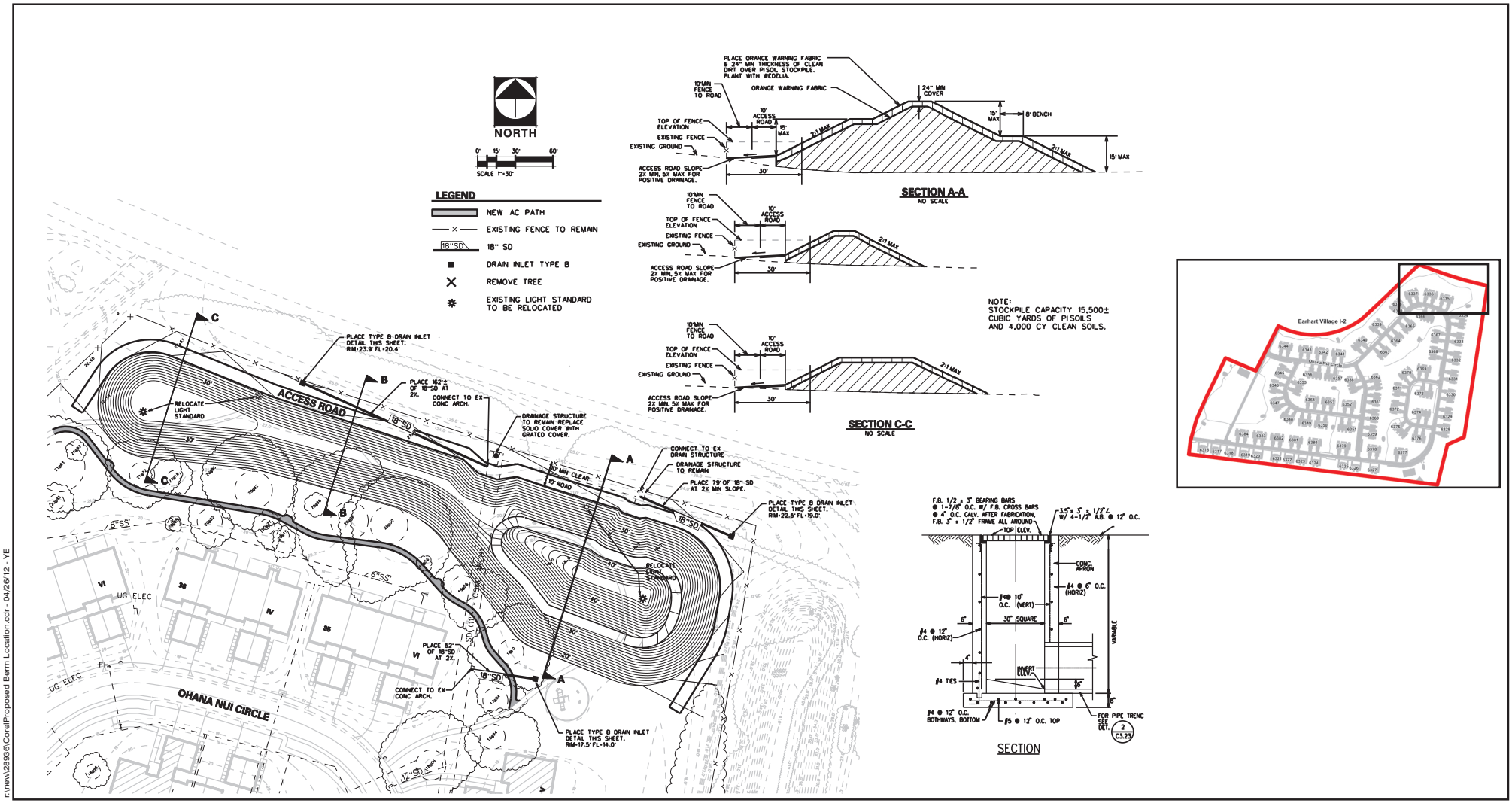


Earhart Village I-2

Hardscapes

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Source: KASL March 2011

# *Earhart I-2 Soil Berm*

## *Response Action Memorandum - 2012*

Joint Base Pearl Harbor-Hickam O'ahu, Hawai'i

**Figure 2-2**

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