

# **DRAFT REMOVAL ACTION REPORT**

## **Former Pepekeo Sugar Company Property Hakalau, Hawaii**

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The logo for Integral Consulting Inc. features the word "integral" in a blue, lowercase, sans-serif font. A thin, curved line starts from the bottom of the letter 'i' and sweeps upwards and to the right, ending under the letter 'l'. To the right of the word "integral", the words "consulting inc." are written in a smaller, blue, lowercase, sans-serif font.  
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## CONTENTS

<b>LIST OF FIGURES .....</b>	<b>iv</b>
<b>LIST OF TABLES .....</b>	<b>v</b>
<b>ACRONYMS AND ABBREVIATIONS.....</b>	<b>vi</b>
<b>1 INTRODUCTION .....</b>	<b>1-1</b>
1.1 PURPOSE OF REPORT.....	1-1
1.2 LOCATION AND SITE DESCRIPTION .....	1-1
1.3 PREVIOUS INVESTIGATIONS.....	1-1
<b>2 FIELD METHODOLOGY.....</b>	<b>2-1</b>
2.1 PHASE 1 – XRF SOIL SCREENING FOR ARSENIC, LEAD AND MERCURY .....	2-1
2.2 PHASE 3 – TRENCHING AND VERTICAL PROFILING OF SOIL ARSENIC .....	2-2
2.3 PHASE 3 – DECISION UNIT MULTI-INCREMENT SAMPLING AND ANALYSIS.....	2-2
2.4 BIOACCESSIBLE ARSENIC ANALYSIS .....	2-3
<b>3 SAMPLING AND ANALYSIS RESULTS .....</b>	<b>3-1</b>
3.1 PHASE 1 – XRF SOIL SCREENING FOR ARSENIC, LEAD AND MERCURY .....	3-1
3.2 PHASE 2 – TRENCHING AND VERTICAL PROFILING OF SOIL ARSENIC .....	3-1
3.3 PHASE 3 – DECISION UNIT MULTI-INCREMENT SAMPLING RESULTS .....	3-2
3.4 BIOACCESSIBLE ARSENIC ANALYSIS .....	3-3
3.5 EVALUATION OF HAZARDOUS WASTE POTENTIAL .....	3-4
3.6 ESTIMATED VOLUMES OF ARSENIC CATEGORY C AND D SOILS.....	3-5
<b>4 CONCEPTUAL SITE MODEL and ENVIRONMENTAL HAZARDS.....</b>	<b>4-1</b>
4.1 CONCEPTUAL SITE MODEL.....	4-1
4.2 ENVIRONMENTAL HAZARD EVALUATION .....	4-1
4.3 SUMMARY OF POTENTIAL ENVIRONMENTAL HAZARDS.....	4-2
<b>5 REMOVAL ACTION SUMMARY.....</b>	<b>5-1</b>
5.1 REMOVAL ACTION OBJECTIVES.....	5-1
5.2 REMOVAL ACTION LEVEL.....	5-1
5.3 SUMMARY OF REMOVAL OPTIONS .....	5-1
5.4 REMOVAL ALTERNATIVES EVALUATION CRITERIA.....	5-2
<b>6 REMOVAL ALTERNATIVES EVALUATION.....</b>	<b>6-1</b>
6.1 ALTERNATIVE 1 – NO ACTION .....	6-1

6.1.1	Effectiveness.....	6-1
6.1.2	Implementability .....	6-1
6.1.3	Cost.....	6-1
6.2	ALTERNATIVE 2 – EXCAVATION AND OFFSITE LANDFILL DISPOSAL.....	6-1
6.2.1	Effectiveness.....	6-2
6.2.2	Implementability .....	6-2
6.2.3	Cost.....	6-3
6.3	ALTERNATIVE 3 – ONSITE CONTAINMENT CELL FOR CATEGORY C AND D SOILS .....	6-3
6.3.1	Effectiveness.....	6-4
6.3.2	Implementability .....	6-4
6.3.3	Cost.....	6-5
6.4	ALTERNATIVE 4 – ONSITE CONTAINMENT CELL FOR ARSENIC CATEGORY C SOILS, OFFSITE LANDFILL DISPOSAL OF ARSENIC CATEGORY D SOILS .....	6-5
6.4.1	Effectiveness.....	6-5
6.4.2	Implementability .....	6-6
6.4.3	Cost.....	6-6
6.5	ALTERNATIVE 5 – CONSOLIDATION AND CAPPING OF ARSENIC CATEGORY C AND D SOILS AT SOURCE AREA .....	6-6
6.5.1	Effectiveness.....	6-7
6.5.2	Implementability .....	6-8
6.5.3	Cost.....	6-8
6.6	COMPARISON OF ALTERNATIVES AND RECOMMENDATION .....	6-8
<b>7</b>	<b>CONCEPTUAL DESIGN AND IMPLEMENTATION .....</b>	<b>7-1</b>
7.1	SUPPLEMENTAL INVESTIGATION AND REMOVAL ACTION WORK PLAN.....	7-1
7.2	SOIL REMOVAL AND CONFIRMATION TESTING USING MI SAMPLING.....	7-1
7.3	CONTAINMENT CELL DESIGN AND IMPLEMENTATION .....	7-1
<b>8</b>	<b>CONCLUSIONS AND RECOMMENDATIONS .....</b>	<b>8-1</b>
<b>9</b>	<b>REFERENCES.....</b>	<b>9-1</b>

## **LIST OF FIGURES**

- Figure 1. Project Location Map
- Figure 2. Aerial Photograph circa 2006
- Figure 3. Aerial Photograph circa 1993
- Figure 4. Aerial Photograph circa 1978/79
- Figure 5. 1966 Sanborn Fire Insurance Map
- Figure 6. HDOH Study – Decision Unit Locations
- Figure 7. Soil Arsenic Screening by XRF – Data Posting
- Figure 8. Soil Arsenic Screening by XRF – Concentration Contours
- Figure 9. Current Study – Decision Unit Locations
- Figure 10. Environmental Hazard Map
- Figure 11. Alternatives 3 and 4 – Containment Cell
- Figure 12. Alternative 5 – Consolidation Area

## **LIST OF TABLES**

Table 1.	HDOH Study – Surface Soil Sampling Results
Table 2.	Current Study – Sampling Decision Units
Table 3.	Current Study – Surface Soil Sampling Results
Table 4.	Predicted Total Arsenic by XRF for HDOH Soil Arsenic Categories
Table 5.	Summary of Soil Environmental Hazards
Table 6.	Cost Estimate for Alternative 2
Table 7.	Cost Estimate for Alternative 3
Table 8.	Cost Estimate for Alternative 4
Table 9.	Cost Estimate for Alternative 5
Table 10.	Comparison of Removal Action Alternatives

## ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
cy	cubic yards
DU	decision unit
EAL	environmental action level
EHMP	Environmental Hazard Management Plan
EPA	U.S. Environmental Protection Agency
ERM	Environmental Resources Management
ESA	environmental site assessment
HDOH	Hawaii Department of Health
Integral	Integral Consulting Inc.
MI	multi-increment
NIST	National Institute of Standards and Testing
PCB	polychlorinated biphenyl
PPE	personal protective equipment
RAL	removal action level
RAO	removal action objective
RCRA	Resource Conservation and Recovery Act
SMA	Special Management Area
SRM	standard reference material
SVOC	semivolatile organic compound
TCLP	toxicity characteristic leaching procedure
TPH	total petroleum hydrocarbons
UC Boulder	University of Colorado, Boulder
XRF	X-ray fluorescence

# **1 INTRODUCTION**

## **1.1 PURPOSE OF REPORT**

This Draft Removal Action Report presents alternative remedies to address elevated soil arsenic at the former Pepeekeo Sugar Company property in Hakalau, Hawaii. Each alternative is described in detail and evaluated in terms of effectiveness, implementability and cost. A recommendation is made on the preferred remedy to address the soil arsenic problem.

## **1.2 LOCATION AND SITE DESCRIPTION**

The subject property (site) consists of approximately 8.7 acres of land along the coastline at Hakalau, Hawaii, which formerly housed Pepeekeo Sugar Company facilities (Figures 1 and 2). The parcel TMKs are 03-2-9-02: 79 and 81; the property is owned by Shropshire Group LLC. The site previously housed operations related to the Pepeekeo Sugar Company, supporting the plantation fields and the mill facility located north at lower elevation within the river floodplain. Historic aerial photographs (Figures 3 and 4) and a 1966 Sanborn Fire Insurance Map (Figure 5) provide information on facilities and operations that have existed on the subject property. Historic operations on the subject property included offices; warehousing; maintenance shops; storage for gasoline, oil, fertilizer and pesticides; seed dipping; and pesticide storage and mixing.

## **1.3 PREVIOUS INVESTIGATIONS**

The Hawaii Department of Health (HDOH) performed soil sampling and analysis at the site during September 2007 and January 2008, focusing on former plantation company facilities most likely to have been contaminated by historical chemical releases. These included the pesticide mixing area, seed dipping vats, and a low-lying drainage area to the east of most operations.

The initial HDOH sampling was conducted in September 2007, with follow-up work in January 2008. In September 2007, HDOH collected six multi-increment (MI) surface soil samples from four decision units (DUs): two from DUs at the former pesticide mixing area (labeled "Poison Mixing" on the Sanborn Fire Insurance Map [Figure 5]), three replicate samples from a DU at the drainage area at the eastern portion of the site, and a single sample from a DU along the southern flank of the former seed dipping vats. Locations of DUs are shown in Figure 6 with the historic Sanborn Fire Insurance Map as a reference.

Samples were analyzed for total metals, dioxins/furans, semivolatile organic compounds (SVOCs), organophosphorus pesticides, and organochlorine pesticides. Results of laboratory

analyses are shown on Table 1, with only those compounds detected in one or more samples listed. Copies of the original laboratory reports are provided in Integral/ERM (2009, Appendix 1). For metals, arsenic was observed in the pesticide mixing area and drainage area at levels exceeding the HDOH environmental action level (EAL) (HDOH 2011b). Antimony was reported at concentrations above its EAL in pesticide mixing area soils. Cadmium was also reported slightly above its EAL in one of six samples. Pesticides, SVOCs and dioxins were reported at levels below EALs developed for unrestricted (residential) exposure scenarios by HDOH.

Based on the elevated arsenic identified in the September 2007 sampling, HDOH performed additional sampling and analysis of soils along the northern site perimeter in the area of the former pesticide mixing facility in January 2008. Three MI samples were analyzed for total arsenic and lead, and the sample with highest reported arsenic was analyzed for bioaccessible arsenic. Total arsenic was reported above EALs, whereas lead was below EALs. The sample with highest total arsenic concentration reported bioaccessible arsenic at 102 mg/kg. Based on this level of bioaccessible arsenic, the soil would be placed in the HDOH arsenic soil Category D (HDOH 2011a), which would typically require some form of remedial action (excavation, capping w/ clean soil, relocating under roadway or parking lot, etc.) in order to obtain a No Further Action letter from HDOH prior to residential or unrestricted land use.

A Phase II environmental site assessment (ESA) report (Integral/ERM 2009) was prepared by Integral Consulting Inc. (Integral) with the support of Environmental Resources Management (ERM), on behalf of the current owner of the subject property. The owner intends to redevelop the property for residential use and/or other uses. The ESA built upon the body of information including previous site investigation work performed by HDOH, historic aerial photographs, Sanborn Fire Insurance Maps, and additional soil sampling and analysis performed by Integral/ERM. The primary objective of the ESA was to determine the presence and extent of chemical contaminants in soil at the site.

The ESA was performed in conformance with a July 2008 soil sampling and analysis plan (ERM 2008a), a September 2008 sampling and analysis plan amendment (ERM 2008b), and dialog with HDOH on October 7, 2008. The intent of the assessment was to complete the soil evaluation and support the evaluation of a remedy for arsenic-impacted soil. The findings of Integral/ERM are included in the following Sections 2 through 4.



## 2 FIELD METHODOLOGY

For the ESA (Integral/ERM 2009), predominantly surface soil samples were collected, since contaminant impacts were probably introduced to the top of the soil column (as opposed to subsurface releases, e.g., underground storage tanks). Subsurface soil samples (vertical contaminant profiles) were collected from a series of trench excavations in areas that showed elevated arsenic based on surface soil X-ray fluorescence (XRF) mapping.

### 2.1 PHASE 1 – XRF SOIL SCREENING FOR ARSENIC, LEAD AND MERCURY

Comprehensive XRF soil screening was conducted across the 8.7-acre property on 22–24 July 2008, with infill sampling and analysis on August 27–28, 2008. An initial grid with 50-ft spacing was laid out by measuring tape and pin flags, and surface soils from 0 to 6 in. depth were collected at each sample location in zip-top plastic bags. An east-west oriented baseline transect was laid along the southern property boundary and labeled Transect A. Samples were collected at 50-ft intervals along this transect and labeled A50, A100, A150, etc. Successive parallel transects were laid out parallel to Transect A, at 50-ft spacing (see Figure 7).

Samples were analyzed using an Innov-X (Alpha series) field portable XRF instrument for arsenic, lead and mercury. Arsenic was the principal target of the investigation, with lead being a secondary concern because other sugar facilities have shown lead in soils around older buildings (apparently from lead paint weathering and incorporation into soils). Mercury was added to the target metal list for XRF screening to help resolve the issue of potential release from an on-site seed dipping facility. Detection levels for arsenic, lead and mercury were approximately 10 mg/kg.

Standard reference materials (SRMs) for arsenic were created using native soil from the Island of Hawaii that was known to contain less than 10 mg/kg arsenic. Site-specific SRMs at a range of arsenic concentrations were prepared by spiking these reference soils with known quantities of arsenic. SRMs at 50, 200, 800, 3,000, and 10,000 mg/kg were prepared. SRMs were analyzed by XRF before, during, and after analysis of field samples, and reported arsenic concentrations were corrected based on SRM calibration curves. For lead and mercury, commercial SRMs from the National Institute for Standards and Technology (NIST) were utilized, since they had certified lead and mercury content. (Note: NIST SRMs also had certified arsenic content; however, the presence of lead in these SRMs interferes with accurate XRF analysis for arsenic.)

The initial sampling and XRF analysis of soils was performed on the 50-ft grid. Soil arsenic levels were mapped and an area of elevated soil arsenic was observed near the location of the former pesticide mixing facility (Figure 8). Infill sample locations at 25-ft spacing were placed across this arsenic anomaly to improve delineation of the feature. During initial field screening,

samples were analyzed in field-moist condition; later, samples were dried in the laboratory and re-analyzed to provide more precise elemental composition.<sup>1</sup>

## **2.2 PHASE 3 – TRENCHING AND VERTICAL PROFILING OF SOIL ARSENIC**

Eight trenches were excavated at locations recommended by Integral, within the arsenic soil anomaly near the northern property boundary. The locations of test trenches are shown on Figures 7 and 8. Composite soil samples were collected at 4-in. (10-cm) intervals from the surface to the bottom of the trenches (from 3- to 7-ft depth). Samples were analyzed by portable XRF as per surface soil samples.

## **2.3 PHASE 3 – DECISION UNIT MULTI-INCREMENT SAMPLING AND ANALYSIS**

After the XRF soil screening phase and review of soil screening results, DUs were established, in consultation with HDOH staff, based on a combination of screening results and prior facility operations as determined from review of the Sanborn Fire Insurance Map. A sampling and analysis plan amendment was prepared for HDOH review, showing the proposed DU layout and proposed analytical suites. Based on dialog with HDOH on October 7, 2008, the sampling plan was slightly modified to include chlordane in several DUs around older building footprints and mercury in a DU downgradient from the former seed dipping operation. The DUs sampled are shown on Figure 9, and described in Table 2.

Each DU was sampled using a MI sampling technique. Approximately 30–40 discrete sample increments of surface soil were collected from each DU based on a random and distributed pattern of sample locations. At each sample location, a surface soil sample increment was collected from a depth of 0 to 6 in. below ground surface (bgs) using a pick and stainless steel trowel. Each collected sample increment, of consistent volume, was placed along with other previously collected increments into a clean glass bowl and homogenized with a stainless steel trowel. Large rocks, sticks and other debris were selectively removed from the sample. The 30+ sample increments were composited and homogenized in the field to create a single representative “average” MI sample. The MI sample was itself split into smaller containers for various laboratory analyses (metals, polychlorinated biphenyls [PCBs], etc.) using an MI subsampling technique where 30 or more small subsamples were taken from the master sample to create the subsample.

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<sup>1</sup> Moisture will reduce the XRF response for all elements. Site-specific SRMs created for use in this project used air dried soils and, therefore, analysis of air-dried field samples provided the most accurate assessment of elemental composition when calibrating with SRMs.

## **2.4 BIOACCESSIBLE ARSENIC ANALYSIS**

A subset of 12 soil samples was selected for analysis of total and bioaccessible arsenic at the University of Colorado, Boulder (UC Boulder). Samples were chosen across a range of total arsenic concentrations, as determined by XRF, to determine the correlation between total and bioaccessible arsenic. Seven samples were selected from the surface soils (generally fill soils), whereas five samples were selected from a vertical sequence of Hilo Series soils from within excavation test pit TP2.

Prior to shipment UC Boulder, MI samples were pre-processed by air drying, sieving to <0.25 mm and splitting at the University of Hawaii, Manoa. Samples were analyzed at UC Boulder for total and bioaccessible arsenic. Total arsenic was determined by extracting soil with a combination of nitric, hydrochloric, and hydrofluoric acids (Farrell et al. 1980) in order to obtain total arsenic data more consistent with XRF measurements than would be obtained from U.S. Environmental Protection Agency (EPA) extraction method 3050B. Bioaccessible arsenic extraction and analysis was performed in accordance with the method described in Drexler and Brattin (2007).

### **3 SAMPLING AND ANALYSIS RESULTS**

For the ESA (Integral/ERM 2009), predominantly surface soil samples were collected, since contaminant impacts were probably introduced to the top of the soil column (as opposed to subsurface releases, e.g. underground storage tanks). Subsurface soil samples were collected from a series of trench excavations in areas that showed elevated arsenic based on surface soil XRF mapping.

#### **3.1 PHASE 1 – XRF SOIL SCREENING FOR ARSENIC, LEAD AND MERCURY**

The initial sampling and XRF analysis of arsenic, lead and mercury in surface soils was performed on the 50-ft grid. Infill sample locations at 25-ft spacing were placed across an observed higher concentration arsenic anomaly near the former pesticide mixing area to improve delineation of the feature. Soils were tested by XRF in field-moist condition within zip-top plastic bags, and calibrated using site-specific and NIST SRMs. It should be noted that total metals measured by XRF is typically higher than that measured using the standard EPA chemical extraction and analysis method (EPA 3050B/6010). This may in part be due to less than complete removal of all metals from soils using the EPA 3050B extraction procedure. Maps showing the location of XRF soil screening sample locations and a contour map of surface soil arsenic concentrations are provided as Figures 7 and 8. Arsenic soil levels greater than 100 mg/kg are generally confined to the area surrounding the former pesticide mixing area and the soils to the east—or downhill of the pesticide mixing area. Two other area areas showed arsenic above 100 mg/kg: 1) an isolated finding at the east of the property at location F600, and 2) around the northwestern warehouse at locations I0 and H100. Maximum concentrations of arsenic in surface soils were observed at sample location K300, at a level of greater than 10,000 mg/kg (1 percent arsenic by weight).

Lead and mercury were also measured using the Innov-X portable XRF. Concentrations of these two metals did not appear to be elevated above background soil levels, and were generally below the HDOH EALs for unrestricted land use exposure. Only a few samples had lead and mercury concentrations as measured by XRF above EALs; these samples were not significantly above EALs and were not spatially clustered (see Integral/ERM [2009] for further details).

#### **3.2 PHASE 2 – TRENCHING AND VERTICAL PROFILING OF SOIL ARSENIC**

Eight trenches, or “test pits” were excavated in site soils at locations within the dominant arsenic anomaly sourced from the former pesticide mixing area. Figures 7 and 8 show the

locations of the trenches, labeled TP1 through TP8. Once trenches were dug, soils were examined and logged by a geologist. The soil profile consisted of organic-rich, mixed sandy to gravelly loam (mixture of native soils and fill materials) overlying silty clay loams of the Hilo Series.

Within each trench, composite soils samples were collected at 10 cm bgs, 20 cm bgs, and then at successive 20-cm depth intervals bgs to the bottom of the test pit. The composite samples were individually packaged in zip-top plastic bags and measured for arsenic content by XRF. Data results are provided in Integral/ERM (2009, Table 3 and Figures 11 and 12).

Test pit 2 (TP2) showed the highest concentrations of arsenic, at a maximum of 12,000 mg/kg at a depth of 80 cm. TP3, 55 ft south of TP2, showed nearly similar high arsenic concentrations. In both of these two test pits, arsenic levels over 100 mg/kg extended to the base of the excavation; however, concentrations showed significant decline deeper than 100 cm. The high concentrations in the subsurface at TP3 were not observed in the surface soils, probably because of more recent grading and fill placed at this location. Concentrations were significantly lower than those observed at TP2 and TP3 at all other test pit locations, but concentrations above 100 mg/kg were still prevalent.

While the subsurface extent of soil arsenic can be generally understood from profiles in eight test pits, the subsurface extent is not as well defined as for the surface soils. For example, the area of the soil arsenic anomaly surrounding and downgradient from the former pesticide mixing area has been mapped in surface soils with approximately 30–40 sample locations, whereas only 8 locations have been excavated to allow vertical profiles. During future removal action efforts, additional subsurface characterization will be required to confirm that all subsurface arsenic impacts have been addressed.

### **3.3 PHASE 3 – DECISION UNIT MULTI-INCREMENT SAMPLING RESULTS**

MI surface soil samples were collected from five DUs on October 7, 2008, as shown on Figure 9. Samples were analyzed for metals, total petroleum hydrocarbons (TPH), PCBs, chlordane, or mercury depending on the DU and prior activities in that area. Table 3 shows the analytical results for the soil samples, and a comparison to HDOH Tier 1 EALs.

Mercury in soils from DU01, collected downgradient from the former seed dipping area was reported at 2.48 mg/kg, below the EAL of 4.7 mg/kg. This finding is consistent with the HDOH soil mercury finding of 1.06 mg/kg in their sample (HSDV-DU-1) collected adjacent to the former seed dipping tank area (see Table 1).

For DU02 through DU05, Resource Conservation and Recovery Act (RCRA) eight metals and petroleum hydrocarbons were analyzed. Arsenic was, as expected, present at concentrations above the Tier 1 EAL. All other metals were reported at concentrations below EALs. Gasoline-

and oil-range hydrocarbons were not detected; however, diesel-range hydrocarbons were present, but at concentrations below the EAL. PCBs and chlordane were analyzed for DU02 and DU03, the locations of former plantation buildings now removed, and were not detected.

In summary, there is no evidence of significant site impacts at concentrations above EALs from chemical compounds from former or current operations, other than arsenic. HDOH reported cadmium in one DU just at the EAL concentration (Table 1). This level is not believed to represent a human health or environmental hazard.

### **3.4 BIOACCESSIBLE ARSENIC ANALYSIS**

A subset of 12 soil samples was selected for analysis of total and bioaccessible arsenic. Samples were chosen across a range of total arsenic concentrations, as determined by XRF, to determine the correlation between total and bioaccessible arsenic. Seven samples were selected from the surface soils (mixed native and fill soils), and five samples were selected from a vertical sequence of Hilo Series soils from within TP2.

Prior to shipment to UC Boulder, MI samples were pre-processed by air drying, sieving to <0.25 mm and splitting at the University of Hawaii, Manoa. Samples were analyzed at UC Boulder for total and bioaccessible arsenic. Total arsenic was determined by extracting soil with a combination of nitric, hydrochloric, and hydrofluoric acids, in order to obtain total arsenic data more consistent with XRF measurements. Bioaccessible arsenic extraction and analysis was performed in accordance with the method described by Drexler and Brattin (2007).

Results of total and bioaccessible arsenic analysis for the fine fraction (<0.25-mm fraction) soils are provided in Integral/ERM (2009, Table 5). Bioaccessible arsenic in soils ranges from as low as 0.7 mg/kg to nearly 7,000 mg/kg (at K300 surface location). The percentage of total arsenic that is bioaccessible ranges from as low as 1 percent in samples with low total arsenic to as high as 37 percent in the highest arsenic contaminated soils.

HDOH evaluates human health hazards from soil arsenic using the bioaccessible fraction (HDOH 2011a). Soils with bioaccessible arsenic below 23 mg/kg are considered minimally impacted, and are “within acceptable health risks for long-term exposure”. Site with soils in this so called Category B are suitable for unrestricted land use. Category C soils (moderately impacted) have bioaccessible arsenic levels from 23 to 95 mg/kg, and sites with these soils are not suitable for unrestricted land use. Sites with Category C soils may be suitable for certain commercial or industrial land uses, but would require remediation for unrestricted (i.e., residential) uses. Category D soils with bioaccessible arsenic above 95 mg/kg (heavily impacted) require remedial action irrespective of future land use.

A comparison has been made between total arsenic as measured by XRF with bioaccessible arsenic (Integral/ERM 2009). This correlation allows one to predict the areas and soil volumes

mapped by XRF at certain bioaccessible arsenic thresholds. For a given total arsenic concentration, surface soils have a higher percentage of bioaccessible arsenic than subsurface soils. Therefore, surface soil and subsurface soils (Hilo Series) are evaluated separately. Surface soils show that about 8 percent of total arsenic (measured by XRF) is bioaccessible, whereas subsurface soils show that about 4 percent of XRF-measured arsenic is bioaccessible. Using these correlations, we can predict the XRF-measured arsenic levels that would correspond to the HDOH Tier 2 EAL thresholds (HDOH 2011a) for bioaccessible arsenic, as shown in Table 4.

By this analysis, surface soils with total arsenic by XRF between 288 and 1,188 mg/kg are likely Category C soils, and with total arsenic by XRF above 1,188 mg/kg are likely Category D soils. For subsurface soils with half the percentage total arsenic as bioaccessible, the thresholds for Category C and D soils are twice as high as for surface soils. Reviewing the XRF soil arsenic contour mapping on Figure 8, the soils shaded dark pink to red likely contain Category C and D soils. Category D soils are confined to dark red areas contiguous with the former pesticide mixing area.

### **3.5 EVALUATION OF HAZARDOUS WASTE POTENTIAL**

Because of the high concentrations of arsenic observed in soil at the former pesticide mixing area, and the potential for future excavation and relocation or landfill disposal of arsenic-impacted soils, a composite sample was collected to evaluate the hazardous waste characteristic by the toxicity characteristic leaching procedure (TCLP).

The composite sample (ID: OG-TP2) was collected from the walls of excavation TP-2, which showed the highest concentrations of soil arsenic in vertical profiles. The composite sample consisted of equal amounts of sample collected every 20 cm from surface (0 cm) to 120 cm depth. This sample location is expected to represent the most highly arsenic-impacted soil that might be excavated in a future remediation project.

The sample was prepared and analyzed at Test America laboratory in Aiea, Hawaii. The field-moist sample was sieved to <2-mm particle size, and subsampled for a 10-g aliquot for total arsenic analysis by EPA Methods 3050B/6010B (larger sample size than required by EPA); a separate subsample was utilized for TCLP extraction and analysis (EPA Methods 1311/6010B). The laboratory reported 1,820 mg/kg total arsenic in the sample (not dry-weight corrected), but no detection of arsenic in the TCLP extract (at a reporting limit of 0.5 mg/L). Based on these findings, it is highly unlikely that excavated soils would be considered a hazardous waste under federal solid and hazardous waste regulations (RCRA).

### **3.6 ESTIMATED VOLUMES OF ARSENIC CATEGORY C AND D SOILS**

Based on XRF analysis and mapping of surface soils, XRF analysis of subsurface soils from trenches, and correlation of total arsenic by XRF to bioaccessible arsenic, we have estimated the volume of soil exceeding the Category C lower limit of 23 mg/kg bioaccessible arsenic and the Category D lower limit of 95 mg/kg bioaccessible arsenic.

It is estimated that approximately 6,100 cubic yards (cy) of soil exceed the Category C lower limit, and 800 cy of soil exceed the Category D lower limit. By difference, approximately 5,300 cy of soil are Category C.



## **4 CONCEPTUAL SITE MODEL AND ENVIRONMENTAL HAZARDS**

### **4.1 CONCEPTUAL SITE MODEL**

Former facilities and operational areas at the site, related to the former sugar plantation, are potential locations for the release of chemical contaminants. Sampling of soils was performed at and around those facilities/operations to identify potential soil impacts. Prior studies by HDOH and the current ESA (Integral/ERM 2009) evaluated a suite of chemicals likely to have been handled onsite based on known or suspected operations. Soils samples were collected around former facilities/operations using a DU/MI sampling approach, coupled with site-wide XRF screening of discrete surface soil samples and test pits for arsenic and several other metals. Concentrations of detected contaminants were compared to HDOH EALs under the following conditions: current and future land use was considered to be unrestricted; the aquifer below the site was not considered as a drinking water source; and the distance to the nearest surface water body was less than 150 m.

Arsenic in soil represents the predominant contamination issue. Soils in the vicinity of the former pesticide mixing area ("source area") show high arsenic concentrations in surface soils, and impacts extend to a depth of 1.5 to 2 m below grade in the source area. Elevated soil arsenic is also present at topographically lower levels (downhill) from the source area, however only in the shallow soils (typically <0.5-m depth). This pattern is consistent with downhill migration of surface soils from the source area over time, possibly the result of stormwater transport when surface vegetation was not adequate to prevent soil migration and/or grading and relocation of surface soils. Several isolated areas of soil arsenic that were observed during the site-wide XRF screening work do not appear to be connected to the predominant source area at the former pesticide mixing area. These isolated soil arsenic areas may be the result of secondary releases or translocation of soils from the primary source area during site operations or by subsequent landscaping efforts.

### **4.2 ENVIRONMENTAL HAZARD EVALUATION**

Chemicals detected in soil were evaluated using the HDOH EAL "Surfer" tool. Maximum values observed in decision unit sampling and laboratory analyses from either the previous HDOH study or in this study were used for screening. Table 5 presents a summary of soil environmental hazards as calculated using the EAL "Surfer" tool. There is evidence of significant soil impact from arsenic at concentrations well above Tier 1 EALs. Antimony and cadmium were also reported in site soils at concentrations slightly above EALs in one or more samples.

Groundwater is not considered to be at risk from the elevated soil arsenic levels observed onsite. In test pits, the highest arsenic levels were within the upper 1.5 m of the soil profile in the former pesticide mixing area. Concentrations decreased at depth, indicating that they had only penetrated several meters through the dense, clay-rich Hilo Series soil profile. Surface water is not considered to be at risk, as long as soils are not disturbed and not allowed to migrate to the adjacent Pacific Ocean via stormwater runoff. The site is currently highly vegetated, and the owner is managing site activities to ensure no disruption of impacted soils occurs.

Human direct contact with arsenic-impacted soils presents the dominant potential risk pathway. To prevent such exposure, the arsenic-impacted soil areas are being managed in a highly vegetated state, and no excavation is being allowed in impacted areas. A map showing the Environmental Hazards at the site is provided in Figure 10. The pink and red shaded areas on the map are surface soils with soil arsenic concentrations greater than 50 mg/kg, as determined by XRF.

### **4.3 SUMMARY OF POTENTIAL ENVIRONMENTAL HAZARDS**

During the course of the ESA, Integral/ERM: 1) reviewed historic aerial photographs and fire insurance maps, 2) evaluated previous soil investigations by HDOH, 3) performed comprehensive surface soil mapping of arsenic, lead and mercury, 4) conducted vertical soil arsenic profiling in a series of test pits at the dominant soil arsenic anomaly, and 5) conducted MI surface soil sampling at five DUs to evaluate soils for a range of chemical compounds.

Based on the body of information, the only significant environmental condition identified that is likely to represent a human health or environmental hazard is arsenic in surface and subsurface soils. The dominant soil arsenic anomaly as observed in surface soils is in the vicinity of the former pesticide mixing area, and contiguous soils downgradient (east) of this arsenic source area. Several other lower concentration but relative isolated soil arsenic anomalies were also observed.

Test pits were excavated to determine the vertical extent of soil arsenic impacts within the dominant arsenic anomaly observed in surface soils. At the two test pits closest to the former pesticide mixing facility, arsenic exceeding 100 mg/kg extended to the full depth of the test pits (6–7 ft below grade). At other locations, the soil arsenic impacts only extended several feet deep or less. In each test pit, the deepest sample showed concentrations of total arsenic by XRF less than 1,000 mg/kg. Remedial measures are recommended to address the recognized soil arsenic condition.

Based on the elevated soil arsenic levels, a general precaution is advised for persons working on or visiting the property. Until a removal action is performed to address the elevated arsenic, persons should avoid contact with and removal of contaminated soil. The land owner will

exercise general oversight of the site, preventing contact with and removal of soil by others. The site will also be maintained in a vegetated state to prevent soil erosion and consequent downgradient movement of contaminated sediment.

In discussions with HDOH, former plantation workers mentioned the possibility of seed dipping effluent being directed to a sump along the eastern slope of the site. Prior to implementing the selected remedy for site soils, HDOH recommends a focused soil sampling in the vicinity of the former seed effluent sump and analysis for mercury and Benlate (benomyl) used as fungicides in seed treatment. Any soils impacted by these compounds will be excavated and properly managed along with arsenic-impacted soils.

## **5 REMOVAL ACTION SUMMARY**

Soils containing arsenic at the former Pepeekeo Sugar Company property present a potential direct exposure risk to humans and may present terrestrial ecotoxicity hazards. Based on these findings a removal action is recommended. In order to determine the most appropriate removal action approach, an evaluation of removal action alternatives was performed. The goal of this process is to screen and evaluate options that would be effective, technically and administratively feasible, and cost effective at addressing the soil arsenic issue at the subject property.

### **5.1 REMOVAL ACTION OBJECTIVES**

The primary focus of the removal action is to address elevated arsenic in the soils at the site to provide protection of human and ecological health by preventing exposures to arsenic-impacted soils. The removal action objectives (RAOs) are as follows:

1. Remediate portions of the property anticipated for future unrestricted (residential) land use to appropriate bioaccessible arsenic soil concentrations, herein defined as removal action levels (RALs)
2. Prevent migration of contaminants to surface or groundwater
3. Minimize potential risk to human health or ecological receptors from exposure to arsenic impacted soil, during and after the removal action.

### **5.2 REMOVAL ACTION LEVEL**

The RAL is the target concentration of bioaccessible arsenic that will be achieved by the removal action to allow appropriate site land use. Considering the planned unrestricted (residential) land use for the majority of planned parcels on the subject property, a RAL of less than or equal to 23 mg/kg bioaccessible arsenic is recommended for areas of the site considered for future residential use. Areas meeting this RAL will have all soils in Category C and D removed.

### **5.3 SUMMARY OF REMOVAL OPTIONS**

Based on the above-stated RAOs and RAL, we provide the following removal alternatives for consideration. Since leaching of site contaminants and impact to groundwater do not represent a site risk, the removal alternatives considered consist of proven methods for eliminating human direct contact risk and terrestrial ecological risk. There are several alternatives or options that have the potential to meet the RAOs for the site, including the following:

1. No Action (does not meet RAOs, included for comparative baseline)
2. Excavation and Offsite Landfill Disposal of Arsenic Category C and D Soils
3. Onsite Containment Cell for Arsenic Category C and D Soils
4. Onsite Containment Cell for Arsenic Category C Soils, Offsite Landfill Disposal of Arsenic Category D Soils
5. Onsite Consolidation and Capping of Arsenic Category C and D Soils at Source Area.

## 5.4 REMOVAL ALTERNATIVES EVALUATION CRITERIA

Each alternative was evaluated against the following three performance criteria:

1. Effectiveness
2. Implementability
3. Cost

The *effectiveness* criterion addresses the ability of the remedial alternative to provide:

- Overall protection of human health and the environment
- Achievement of RAOs
- Short-term effectiveness
- Reduction of toxicity, mobility, and volume of contaminants by treatment
- Long-term effectiveness and permanence
- Compliance with regulatory requirements

The *implementability* criterion addresses:

- Technical feasibility (i.e., technology, reliability, and implementation limitations, e.g., terrain, logistics)
- Amount of time to implement
- Complexity (e.g., number of steps to complete)
- Administrative feasibility (local land management, permits, right-of-ways, zoning)
- Suitability of land for future uses
- Availability of equipment, materials and services

The *cost* criterion addresses:

- Overall cost to implement the removal action

## **6 REMOVAL ALTERNATIVES EVALUATION**

The four alternatives carried forward are evaluated herein. Supporting cost estimates for each alternative is provided in Tables 6 through 9.

### **6.1 ALTERNATIVE 1 – NO ACTION**

The No Action alternative, included as a comparative baseline, consists of no removal actions and leaving the site in its current condition. Under this alternative, no engineering features or institutional controls (signage, deed notices, etc.) are employed to prevent potential human or ecological risks from exposure to arsenic-impacted soils.

#### **6.1.1 Effectiveness**

The No Action alternative would not achieve RAOs and, most importantly, would not protect against incidental human direct contact with arsenic-contaminated soil.

#### **6.1.2 Implementability**

There are no issues of implementability for the No Action alternative, since by definition no action is planned.

#### **6.1.3 Cost**

There is no cost associated with the No Action alternative.

### **6.2 ALTERNATIVE 2 – EXCAVATION AND OFFSITE LANDFILL DISPOSAL**

Excavation and landfill disposal of arsenic-contaminated soils exceeding the RAL constitutes the second remedial alternative for evaluation. The general tasks under this option include delineating soil removal boundaries, characterizing soil for disposal, excavating and transporting soil to a local landfill, conducting post-excavation confirmation sampling, backfilling excavations with clean soil, and restoring the site with vegetative ground cover. This alternative is based on the assumption that all the soil meets regulatory levels and is not considered hazardous waste requiring offsite landfill disposal.

TCLP was conducted on the composite soil sample (OG-TP2) collected from the walls of excavation TP-2, which had the highest concentration of soil arsenic in vertical profiles. Total arsenic in the sample was 1,820 mg/kg, but there was no detection of arsenic in the TCLP extract (refer to Section 3.5). Based on these findings, it is highly unlikely that that excavated soils

would be considered a hazardous waste under federal solid and hazardous waste regulations (RCRA).

The only solid waste landfill on the Island of Hawaii that is permitted to accept contaminated soil is the West Hawaii Landfill near Waikoloa, managed by Waste Management, Inc. This facility is located approximately 65 miles from Hakalau via the Hawaii Belt Road through the town of Waimea.

Soils exceeding the unrestricted land use RAL (Category C and D soil with bioaccessible arsenic above 23 mg/kg) are shown as dark pink and red shaded areas on Figure 10. Approximately 6,100 cy of soil is estimated to require removal and disposal under this alternative. Considering 1.755 tons of soil per in-place cubic yard (130 lb/ft<sup>3</sup>, average for moist clay soil), some 10,700 tons would require excavation and disposal. Further detail on scope elements for this alternative is provided in Table 6.

### **6.2.1 Effectiveness**

Excavation and offsite disposal of soils exceeding the unrestricted land use RAL would be an effective long-term remedy to meet RAOs. It would eliminate the potential for human direct contact risks associated with arsenic-contaminated soils and minimize risk to potential environmental receptors at the site. This alternative would remove arsenic to the acceptable RAL, and thereby reducing the toxicity, mobility, and volume of contamination at the property; however, the impacted soil would still exist to be disposed at a permitted landfill facility. Short-term effectiveness, during and immediately after the removal action, is only moderate since there is potential exposure to site workers and the community during implementation of the soil excavation, transport and disposal. Short-term effectiveness can be improved by strong engineering and management controls, such as personal protective equipment (PPE) for workers and air monitoring and mitigations for dust suppression, dust barriers, etc. This alternative would be in compliance with regulatory requirements.

### **6.2.2 Implementability**

The excavation and offsite disposal of soil can be implemented using traditional construction techniques. This alternative is simple in approach, i.e., “dig and haul.” Dust control and soil erosion control measures must be implemented during excavation and loading activities to ensure community and worker health and safety. Large volumes of soil, approximately 10,700 tons or 535 20-ton loads, would have to be transported by truck over local roadways, resulting in increased truck traffic and potential neighborhood disturbances. This alternative is expected to require a Special Management Area (SMA) permit under Coastal Zone Management program. Local permitting is expected to be required in order to perform soil excavation work. This would include stormwater and soil erosion permitting. Excavation of soil along the cliff



edge at the northern edge of the property will require careful execution to prevent soil loss over the cliff.

### **6.2.3 Cost**

The total estimated cost for the Excavation and Offsite Landfill Disposal alternative, to meet the unrestricted land use RAL, is estimated at \$1,815,000. Details are provided in Table 6.

## **6.3 ALTERNATIVE 3 – ONSITE CONTAINMENT CELL FOR CATEGORY C AND D SOILS**

The removal and relocation of impacted soils to an onsite containment cell is a proven removal technology designed to improve the condition of targeted property and eliminate direct contact hazards associated with a contaminated soil or waste material.

Soils exceeding the unrestricted land use RAL of 23 mg/kg bioaccessible arsenic would be excavated and relocated to an engineered soil containment cell in the southwest corner of the property (Figure 11). The containment cell would be created by excavating clean soils (<23 mg/kg bioaccessible arsenic) to a pre-defined extent, with excavated clean soils stockpiled. After excavation and relocation of arsenic-impacted soils (Category C and D soils) in the containment cell, the stockpiled clean soil would be used for backfill of the soil removal excavation areas.

The containment cell would be excavated in clean Hilo Series clay loam soils in the western portion of the property, on a parcel that will remain in Industrial or Commercial zoning and will not be used for future residential redevelopment. The cell would extend approximately 8–10 ft deep into the clay soils, with sufficient extent (approximately 0.5 acre) to allow placement of all arsenic-impacted soils. The more heavily arsenic contaminated Category D soils would be placed in the containment cell first, in portions of the cell excavated to >10 ft below the final closed cell grade. Moderately arsenic-contaminated Category C soils would be placed above Category D soils. After arsenic-impacted soil placement, a demarcation barrier (e.g., geomembrane) and labeled warning tape would be placed above the contaminated soil and covered by at least 2 ft of clean cover soil and an asphalt final surface. In this fashion, Category D soils would be positioned at depths of 10 ft or greater below final grade. The placed soil and cover soil geometry would be designed to promote runoff of surface water from the cell. Finally, the containment cell area would be paved with asphalt to ensure long-term stability and prevent erosion. Stanchions would be placed at the four corners of the containment cell area, with signage indicating that arsenic-contaminated soils are present beneath the paved area.

Institutional controls to include deed notice and environmental covenant, with land use restrictions, and an Environmental Hazard Management Plan (EHMP), would be implemented as a final component of this removal action alternative.

### 6.3.1 Effectiveness

Storage within an onsite containment cell is an effective remedy to eliminate the potential for human and ecological direct contact with exposed arsenic-contaminated soils. The soils that present a potential short-term hazard by direct contact (Category D soils) are placed more than 10 ft below grade, effectively mitigating the potential for accidental exposure during unauthorized construction activities (if any were to occur). Arsenic in the Hilo Series clay-rich soils does not present a significant leaching hazard, and underlying groundwater is not used for drinking water purposes. Considering these factors, this remedy effectively mitigates human health and environmental hazards. This scenario is not considered a permanent solution, since the arsenic-contaminated soil has not been completely eliminated, but it does meet long-term effectiveness goals. Overall this alternative would protect human health and the environment. Storage in an onsite containment cell would not reduce the toxicity or volume of the arsenic-contaminated soil, but the engineered containment cell with demarcation barrier would provide a secure storage receptacle for the arsenic-impacted soil—preventing direct contact risks and significantly decreasing the mobility potential.

Long-term effectiveness of the cover system (demarcation barrier, cover soil and asphalt pavement) for the containment cell can be increased by engineering and institutional controls to prevent unwanted intrusive activities. Engineering controls include an asphalt paved surface and visible subsurface barriers (geotextile fabric, buried warning tape, perimeter stanchions, etc.). Institutional controls will ensure that the location and engineering features of the containment cell are known and documented to ensure long-term safety.

Short-term effectiveness is lessened by potential exposure to workers and the community during implementation of the excavation, encapsulation, and demarcation of the contaminated soil. This exposure risk can be overcome by proper worker PPE, air monitoring, and mitigations such as dust suppression, dust barriers, etc. This alternative would be in compliance with regulatory requirements. The onsite containment cell allows complete removal of soils to the RAL in areas planned for future residential development.

### 6.3.2 Implementability

This alternative is technically feasible and avoids transporting a large quantity of contaminated soil over public roadways, and will not consume valuable landfill space. An engineering design and construction plans would be described in a removal action work plan that would be prepared in advance of work to ensure proper implementation. All engineering and construction components of this remedy are readily implemented using standard environmental remediation and civil construction techniques. Dust control and soil erosion control measures will be implemented during soil excavation, relocation, and grading activities to prevent nuisance and contaminant migration. Because of the proximity of the source area to

the near-vertical cliff (approximately 30 ft), care must be taken to ensure safe working practices near the cliff and prevent contaminated soil erosion and migration from the worksite.

This alternative is expected to require a Special Management Area (SMA) permit under Coastal Zone Management program. Local permitting is expected to be required in order to perform soil excavation work and build an onsite soil containment cell. This would include stormwater and soil erosion permitting. Land use restrictions, in the form of a deed notice (environmental covenant) and an associated EHMP, will be recorded for the area of the property where the soil containment cell is placed.

### **6.3.3 Cost**

The total estimated cost for the Onsite Containment Cell for Category C and D Soils alternative is \$383,000. Details are provided in Table 7.

## **6.4 ALTERNATIVE 4 – ONSITE CONTAINMENT CELL FOR ARSENIC CATEGORY C SOILS, OFFSITE LANDFILL DISPOSAL OF ARSENIC CATEGORY D SOILS**

This remedy alternative is a combination of Alternatives 2 and 3, consisting of an onsite containment cell for Category C soils, coupled with offsite landfill disposal of Category D soils. Based on our analysis of soil arsenic levels, there are approximately 5,300 cy of Category C soils and approximately 800 cy of Category D soils. Under this alternative, the Category C soils would be relocated to a containment cell in the same location and with the same engineering features as described in Alternative 3. The containment cell would be excavated in clean Hilo Series clay loam soils in the western portion of the property, on a parcel that will remain in Industrial or Commercial zoning and will not be used for future residential redevelopment. The slightly lower soil volume for onsite containment in this alternative versus Alternative 3 (5,300 cy versus 6,100 cy) would result in a proportionally smaller containment cell volume. Category D soils would be transported for disposal at the West Hawaii Landfill.

As for Alternative 3, institutional controls would include deed notice and environmental covenant, with land use restrictions, and an EHMP.

### **6.4.1 Effectiveness**

This remedy alternative is highly effective. The soils with highest arsenic contamination (Category D soils) are removed from the site and disposed in a permitted landfill facility. Please refer to the effectiveness discussions for Alternatives 2 and 3 for details.

### **6.4.2 Implementability**

This alternative is technically feasible. Please refer to the feasibility discussion for Alternatives 2 and 3 for details.

This alternative is expected to require a Special Management Area (SMA) permit under Coastal Zone Management program. Local permitting is expected to be required in order to perform soil excavation work and build an onsite soil containment cell. This would include stormwater and soil erosion permitting. Land use restrictions, in the form of a deed notice (environmental covenant) and an associated EHMP, will be recorded for the area of the property where the soil containment cell is placed.

### **6.4.3 Cost**

The total estimated cost for the Onsite Containment Cell for Arsenic Category C Soils, Offsite Landfill Disposal of Arsenic Category D Soils alternative is \$572,000. Details are provided in Table 8.

## **6.5 ALTERNATIVE 5 – CONSOLIDATION AND CAPPING OF ARSENIC CATEGORY C AND D SOILS AT SOURCE AREA**

This alternative contemplates consolidation of all soils with arsenic levels above the RAL in the local area of the former pesticide mixing facility (“source area”, where the highest arsenic concentrations are observed extending to greatest depth). Shallow arsenic impacted soils from outlying areas will be excavated and relocated above the impacted soils in the source area. Soils in the source area would not be moved; therefore, some Category D soils (heavily arsenic impacted) would remain at depths less than 10 ft below grade, increasing the potential for direct exposure in the event of unauthorized construction activities. A capping system, similar to that described for the onsite containment cell remedy, would be placed over the consolidated materials, including 2 ft of clean soil cover, but with a vegetative soil surface instead of an asphalt cap. Under this remediation scenario, the footprint of arsenic-impacted soils is greatly lessened, and areas where arsenic-contaminated soils have been removed are available for redevelopment and reuse. The vegetated soil containment area would be suitable for use as open space within a future residential development.

Capping of impacted soils is a proven remedial technology to eliminate human and ecological direct contact risks. For arsenic-impacted clay loam soils at subject property, in a setting without an underlying drinking water source, contaminant leaching does not present an issue and, therefore, an impervious capping system is not required.

The approximate areas where soils will be excavated, and the area of consolidation and capping, are shown on Figure 12. Similar to the onsite containment cell remedy, a cover system

would be constructed over arsenic-impacted soils above the RAL, consisting of a geotextile material overlying contaminated soil (demarcation barrier), followed by a minimum of 2 ft of clean soil with surface vegetation. Final grades would be implemented using clean fill soils to ensure stormwater runoff and prevention of erosion. The parcel containing the capped area will remain in Industrial or Commercial zoning and will not be used for future residential redevelopment. Institutional controls consisting of an environmental covenant and EHMP would be employed.

### **6.5.1 Effectiveness**

Capping is an effective remedy to eliminate the potential for human and ecological direct contact with exposed arsenic-contaminated soils. Arsenic in the Hilo Series soils does not present a significant leaching hazard, and underlying groundwater is not used for drinking water purposes. Considering these factors, this remedy effectively mitigates environmental hazards. This scenario is not considered a permanent solution, since the arsenic-contaminated soil has not been completely eliminated, but it does meet long-term effectiveness goals. Overall this alternative would protect human health and the environment. Consolidation and capping would not reduce the toxicity or volume of the arsenic, but the engineered cover system would prevent direct contact risks. Since some Category D soils would be located at less than 10 ft below the final containment surface, there is a limited potential for direct contact hazard during unauthorized construction activities (if they were to occur).

Long-term effectiveness of the cover system (demarcation barrier, cover soil and vegetation) can be improved by engineering and institutional controls to prevent unwanted intrusive activities. Engineering controls include physical and visible subsurface barriers (robust geotextile and warning tape). Institutional controls will ensure that the location and engineering features of the containment cell are known and documented to ensure long-term safety.

Short-term effectiveness is lessened by potential exposure to workers and community during implementation of the excavation, encapsulation and demarcation of the contaminated soil. This exposure risk can be overcome by proper worker PPE, air monitoring, and mitigations such as dust suppression, dust barriers, etc. Because of the proximity of the source area to the near-vertical cliff (approximately 30 ft), care must be taken to ensure safe working practices near the cliff and prevent contaminated soil erosion and migration from the worksite. This alternative would be in compliance with regulatory requirements.

This remedy is not effective in improving the environmental condition of the localized area where consolidation and capping of arsenic-impacted soils will occur. Based on preliminary residential development plans (lot lines shown on Figure 12), approximately three 0.5-acre lots will be unavailable for redevelopment and reuse. In addition, adjacent lots may lose value due to their proximity to the arsenic-impacted soil consolidation area.

The source area, where consolidation and capping would occur, is located within 50 ft of a near vertical cliff adjacent to the Pacific Ocean. Although the underlying substrate (clay soils on lava rock) appears very stable, there may be long-term concerns about the safety of leaving arsenic-impacted soils in such close proximity to a known erosional feature.

### **6.5.2 Implementability**

This alternative is technically feasible and avoids transporting a large quantity of contaminated soil over public roadways, and will not consume valuable landfill space. All engineering and construction components of this remedy are readily implemented using standard environmental remediation techniques. Dust control and soil erosion control measures will be implemented during soil excavation, relocation and grading activities to prevent nuisance and contaminant migration. Because of the proximity of the source area to the near-vertical cliff (approximately 30 ft), care must be taken to ensure safe working practices near the cliff and prevent contaminated soil erosion and migration from the worksite. This alternative is expected to require a Special Management Area (SMA) permit under Coastal Zone Management program. Local permitting is expected to be required in order to perform soil excavation work and build an onsite soil containment cell. This would include stormwater and soil erosion permitting. Land use restrictions, in the form of a deed notice (environmental covenant) and an associated EHMP, will be recorded for the area of the property where the soil consolidation and capping is placed.

### **6.5.3 Cost**

Total estimated cost for the Consolidation and Capping of Arsenic Category C and D Soils at Source Area alternative is \$189,000. Details are provided in Table 9.

## **6.6 COMPARISON OF ALTERNATIVES AND RECOMMENDATION**

Table 10 provides a comparison of the removal action alternatives presented herein. Of the four removal action alternatives presented, Alternative 1 (No Action) does not meet the minimum requirements of protecting human health and the environment, since RAOs are not achieved and, in particular, because hazards posed by soils containing arsenic above the RAL are not addressed.

Comparison of Alternative 2 (excavation and offsite landfill disposal), Alternatives 3 (onsite containment cell), Alternative 4 (combination of onsite containment cell and offsite landfill disposal) and Alternative 5 (consolidation and onsite capping) on the basis of effectiveness, implementability, and cost, provides some noticeable contrasts.

In terms of effectiveness, all four remedies are generally effective at preventing human direct contact exposure with contaminated soils. Since arsenic in soil cannot be eliminated, the differentiator is the location where the material will reside for the long term. Alternative 2 provides the greatest long-term effectiveness since the contaminated soil is moved to a permitted landfill facility designed and managed for the purpose of long-term storage of solid waste materials. Alternative 4 provides the next best effectiveness since the highest concentration arsenic soils (Category D soils) are landfill disposed, and only moderately-impacted arsenic soils are contained onsite. Alternative 3 is nearly equivalent to Alternative 4 in effectiveness, since the heavily arsenic-impacted soils (Category D soils) would be placed at the base of the containment cell, more than 10 ft below final grade, minimizing the potential for disturbance by unauthorized construction activities. Alternative 5 (consolidation and onsite capping) is less effective than the other two remedies since materials remain near the cliff, and in close proximity to areas planned for residential redevelopment. In addition, Category D soils would remain near the surface, increasing the potential for direct contact hazard by unauthorized disturbance.

From a technical and construction perspective, all alternatives can be readily implemented. Care must be taken in performing soil excavation and/or capping activities near the cliff to the north of the arsenic source area. Alternative 2 (excavation and offsite landfill disposal), and to a lesser degree Alternative 4, involves significant truck traffic through the local community and across county roads, which increases traffic safety risk and nuisance issues, whereas Alternatives 3 and 5 keep soil relocation activities confined to the site. Alternatives 2, 3, 4, and 5, will require SMA permitting under the Hawaii Coastal Zone Management Act provisions. Community input will be provided through the HDOH removal action approval process and county SMA permitting process. Alternatives 3, 4 and 5, which include onsite containment of arsenic impacted soils with engineering controls will require land use restrictions, in the form of a deed notice (environmental covenant) and an associated EHMP.

Alternative 2 (excavation and offsite landfill disposal) provides the least restrictions on future use and redevelopment at the property, in that no areas are subject to land use restrictions designed to prevent intrusion through the impounded soil capping system. Alternatives 3 and 4 (onsite containment cell) provide only minor land use restriction by placing the contaminated soil in an area away from the coastline that is not planned for future residential development. Alternative 5 has the greatest impact on future use of the property, in that a portion of the ocean-fronting property will be used for long-term containment of contaminated soil and cannot be used for purposes other than open space or parking (if paved).

The cost of Alternative 2 (excavation and offsite landfill disposal) is the highest of all alternatives at \$1,815,000. For the onsite remedies, Alternatives 3 and 4 (which include an onsite containment cell) have a higher cost than Alternative 5 (consolidation and capping at the source area), because there is more material handling and a more robust engineered cover system. Alternative 4, consisting of a combination of offsite landfill disposal and an onsite containment

cell, is estimated to be approximately \$200,00 higher cost than the Alternative 3 (all soils in onsite containment cell), providing increased long-term benefits due to removal of highly contaminated soils to a more controlled environment. Based on comparison of the remedial alternatives, Alternative 4 provides the best balance of effectiveness, implementability and cost, and is recommended for selection by HDOH as the approved removal action alternative.



## **7 CONCEPTUAL DESIGN AND IMPLEMENTATION**

This section provides a description of the conceptual design for implementation of Alternative 4, consisting of excavation and relocation of arsenic Category C soil to an onsite containment cell and offsite landfill disposal of arsenic Category D soil.

### **7.1 SUPPLEMENTAL INVESTIGATION AND REMOVAL ACTION WORK PLAN**

Following HDOH approval of the recommended remedy, a removal action work plan containing construction specifications and implementation plans, will be prepared and submitted to HDOH for review and comment before commencing work. A supplemental soil investigation will be performed to more precisely determine the spatial distribution (extent) of Category C and D soils, to support containment cell design, and efficient excavation and disposition of excavated soils. Estimated areas and thicknesses of Category C and D soils will be documented in figures included in the work plan. The supplemental investigation will also include study of soils in the vicinity of the former seed dipping effluent at the east of the property. In addition, soil characterization will be performed as required by the landfill to support development of a waste profile.

### **7.2 SOIL REMOVAL AND CONFIRMATION TESTING USING MI SAMPLING**

Sampling and analysis of surface soils performed to date provides good definition of the extent of soil impacts above the RAL. Further arsenic delineation, especially in the subsurface, will be conducted during the soil excavation activities by use of a handheld XRF device. All soils exceeding the RAL (Category C and D soils) will be excavated. Category C soils will be transported to the onsite containment cell for placement (see Section 7.3 below). Category D soils will be transported by truck for disposal at the West Hawaii landfill. Confirmation MI sampling and analysis for bioaccessible arsenic levels will be performed after soil removal has been conducted. Each proposed residential and commercial/industrial lot (see lot boundaries on Figure 7) will be considered a DU, and a MI surface soil sample will be collected from each lot to confirm attainment of RAL. One lot will be selected for triplicate analysis for determination of sampling and analysis quality assurance (measurement variance).

### **7.3 CONTAINMENT CELL DESIGN AND IMPLEMENTATION**

The preliminary design extent of the soil containment cell is shown on Figure 11, and is capable of holding the estimated 5,300 cy of soil. Considering an approximate 10 percent fluff for excavated soil, the cell will be designed to accommodate approximately 5,800 cy of Category C

soil. The area shown on Figure 11 is approximately 0.5 acre in dimension (100 by 200 ft). An excavation to 10-ft depth, with angled side slopes, would accommodate the anticipated arsenic-impacted soil volume.

The containment cell capping components will consist of the following elements from bottom to top:

- Substrate Soil – Hilo Series silty, clay loam soils are present at the site up to 15 ft in thickness.<sup>2</sup> The cell will be designed such that a minimum of 2 feet of Hilo Series soils remains at the base of the cell, below the placed arsenic-contaminated soil above underlying bedrock; this underlying soil will provide an excellent attenuation function should minor arsenic be carried downward by infiltrating water. Based on the lack of detections of arsenic (at 0.5 mg/L reporting levels) in TCLP testing of soils from source area soils, it is unlikely that significant arsenic will be mobilized by infiltrating waters. The containment cell will be excavated to a bottom depth of 10 ft below grade prior to arsenic-contaminated soil placement.
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- Placement of Category C Soils (moderately arsenic contaminated) – Relocated Category C soils will be placed in the bottom of the excavated containment cell in 1–2 ft lifts and compacted. The thickness of Category C soils in the containment cell will be approximately 8–10 ft.
- Demarcation barrier – a layer of geotextile fabric will be placed over the arsenic contaminated soils in the containment cell. The geotextile fabric is intended to provide a physical separation between arsenic-impacted soils below and clean cover soils above. In addition to preventing mixing of soils during cap placement, it will function as an indicator of the location of impacted soils in the event of future subgrade intrusions. A labeled metal warning tape will be placed in a 10-ft grid across the geotextile, with printed warning indicating arsenic-contaminated soils are located below.
- Clean Cover Soils – Soils devoid of debris or other waste materials, and capable of sustaining vegetative growth, will be placed over the demarcation barrier and contoured to final grade specifications. A minimum thickness of 2 ft of cover soils will be placed above the demarcation barrier. Additional thickness of clean cover soils will be placed and compacted as needed to ensure that all Category D soils will be located more than 10 ft below final grade.
- Asphalt – An asphalt cap will be constructed over the clean cover soils, consisting of a base course and wearing course appropriate for light vehicle use as a parking lot.

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<sup>2</sup> Depth of Hilo Series soils will be determined in design phase for inclusion in the removal action work plan. Final area and depth of cell will be designed accordingly.

- Concrete-filled metal pipe stanchions will be placed at each of the four corners of the containment cell, with signage attached notifying of the contaminated soil containment area with the perimeter of the stanchions.

The soil containment cell will be constructed in accordance with design specifications, which will be submitted for HDOH approval in a removal action work plan. Final design will require a site topographic survey in order to engineer fill geometries and determine final grade contours. The project will be implemented in accordance with the following sequence:

- Mobilization and Site Preparation – Accessible areas on the site will be identified for the storage of equipment and supplies and vehicle parking. Vegetation will then be cut to grade and removed to an adjacent disposition area. Erosion and sedimentation controls will be placed adjacent to and downgradient of the arsenic-impacted soil areas and the containment cell area to manage potential soil transport during storm events. A site perimeter (exclusion zone), surrounding the impacted soils areas and containment cell area, will be established and marked with stakes and colored tape. Specific ingress and egress locations (contaminant reduction zones) will be marked to control equipment and personnel flow into and out of the construction areas and allow for decontamination of equipment and removal of worker personal-protective equipment. Specific locations for worker ingress/egress and PPE donning and decontamination will be established.
- Excavation of Containment Cell – Soils will be excavated from the containment cell area and staged near the contaminated soil source area for use as clean backfill after soil relocation has been completed. Once this clean soil stockpile has been constructed, erosion and sedimentation controls will be placed.
- Excavation and Offsite Landfill Disposal of Category D Soils – Category D soils will be excavated and directly loaded into dump trucks for transport and disposal at the West Hawaii Landfill. A portable XRF will be used to confirm removal of Category D soils.
- Excavation and Relocation of Category C Soils – Following removal of Category D soils, remaining Category C soils will be removed by excavator and transported by small dump truck from the impacted soils area to the containment cell. At the containment cell, the soils will be dumped in the cell and spread to create an approximate 2-ft soil lift prior to compaction. During excavation work, soil arsenic concentrations in excavation sidewalls and bottoms will be evaluated by portable XRF device to ensure that removal is complete to the designated RAL.
- Confirmation Sampling of Excavated Areas – After removal of soil, before backfilling occurs, MI sampling of proposed residential lots (DUs) will occur. The MI sample increments will be collected from throughout the DU, including excavated and un-excavated areas. The MI samples will be processed and analyzed for bioaccessible arsenic content.

- Backfill of Excavated Areas – Stockpiled clean soils will be used to backfill excavation areas after completion of confirmation sampling and once it has been determined that RALs have been achieved. Soil will be placed and compacted using standard construction equipment. Backfill soils and other disrupted areas will be vegetated with grasses according to specifications outlined in the removal action work plan. Erosion and sediment controls will remain in place and be inspected until vegetation is firmly established.
- Placement of Demarcation Barrier at Containment Cell - Once all arsenic-impacted soils have been relocated and placed within the containment cell, a demarcation barrier consisting of geotextile material and a grid of metallic warning tape will be placed over the impacted soil extending to the lateral limits of the planned cell area.
- Placement of Final Cover at Containment Cell – A minimum thickness of 2 ft of clean soils, consisting of a portion of the soils originally excavated from the containment cell, will be used to create a clean soil cover over the relocated Category C soils and demarcation barrier. Once placed on the containment cell, the soils will be graded to match design grade using survey stakes for elevation guidance. Soils will be placed in no greater than 1-ft lifts and compacted with heavy equipment between lifts (e.g., five passes of bulldozer). Once clean cover soils have been placed, site controls for management of exposure to site contaminants can be removed. Asphalt pavement will be installed over the clean cover soils. Specifications for the final asphalt cover, including base course and surface course, will be included in the removal action work plan.
- .
- Final Documentation and Placement of Institutional Controls – Upon completion of the removal action work, a removal action completion report will be submitted describing the work performed and certifying attainment of the RAL. Along with the completion report, an EHMP will be submitted, with descriptions and survey information regarding the soil containment cell, and including description of long-term maintenance activities necessary for the containment cell area. The EHMP, and a No Further Action letter from HDOH, will be recorded with the property deed to provide future notice of the environmental conditions.

## **8 CONCLUSIONS AND RECOMMENDATIONS**

This removal action report addresses the need for remedial action of arsenic-impacted soils at the subject property. Based on soil investigations at the site, it has been determined that arsenic is present at concentrations requiring a response action. RAOs have been developed as follows:

1. Remediate portions of the property anticipated for future unrestricted (residential) land use to appropriate bioaccessible arsenic soil concentrations, herein defined as the RAL
2. Prevent migration of contaminants to surface or groundwater
3. Minimize potential risk to human health or ecological receptors from exposure to arsenic impacted soil, during and after the removal action.

Four removal action alternatives (plus the No Action alternative) were evaluated in term of effectiveness, implementability, and cost. Alternative 4, Onsite Containment Cell for Arsenic Category C Soils, Offsite Landfill Disposal of Arsenic Category D Soils, was determined to provide the best balance of human health and environmental protectiveness at a reasonable cost. Only offsite landfilling of all Category C and D soils provides a higher value of improvement to site conditions, but the costs for that option are very high, and would involve over 530 large truck loads of soil being hauled to and disposed in the West Hawaii landfill.

Upon approval of the recommended removal action alternative by HDOH, a removal action work plan will be prepared to provide design specifications and guidance in implementing the proposed remedy.

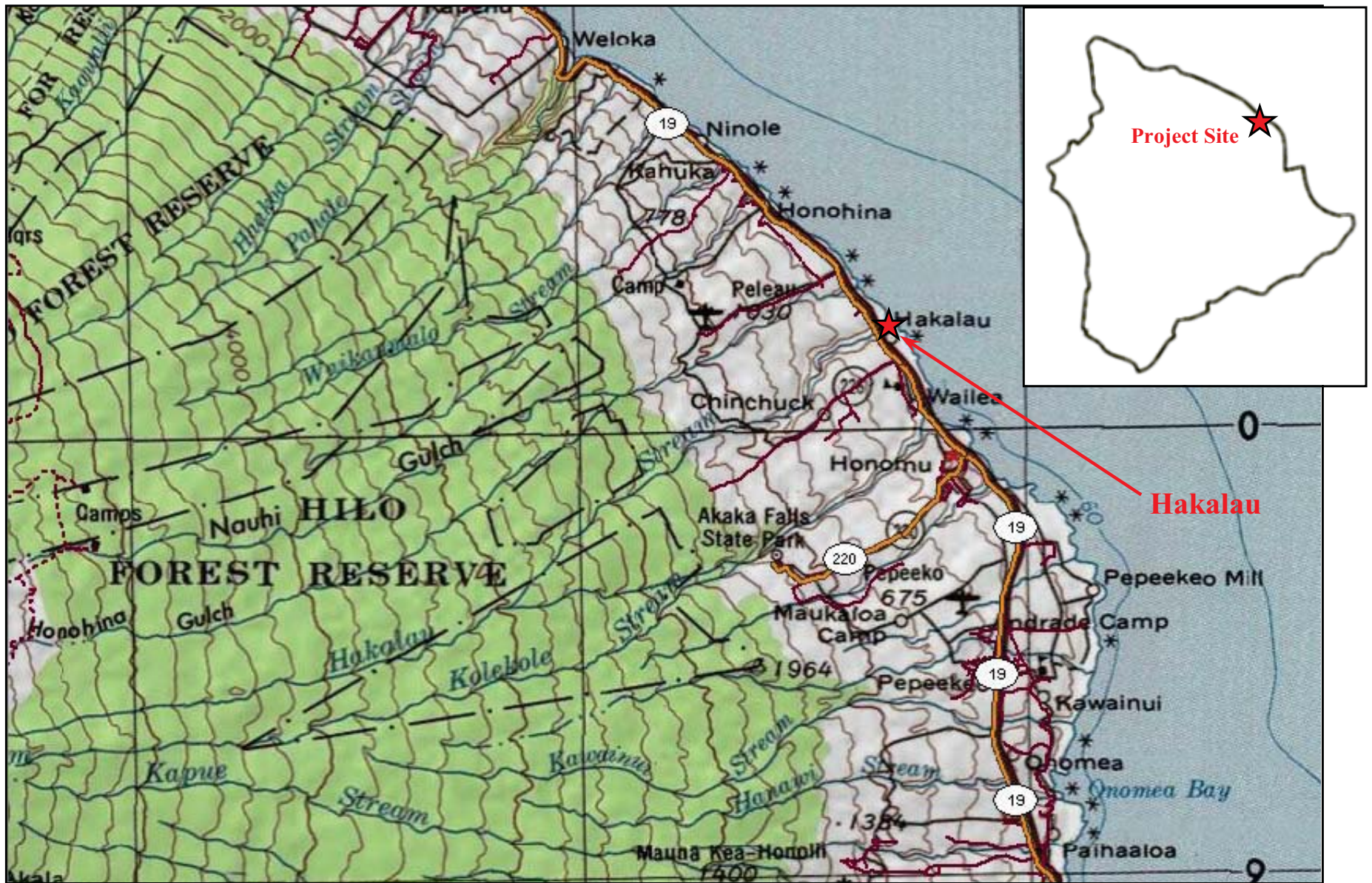
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## FIGURES

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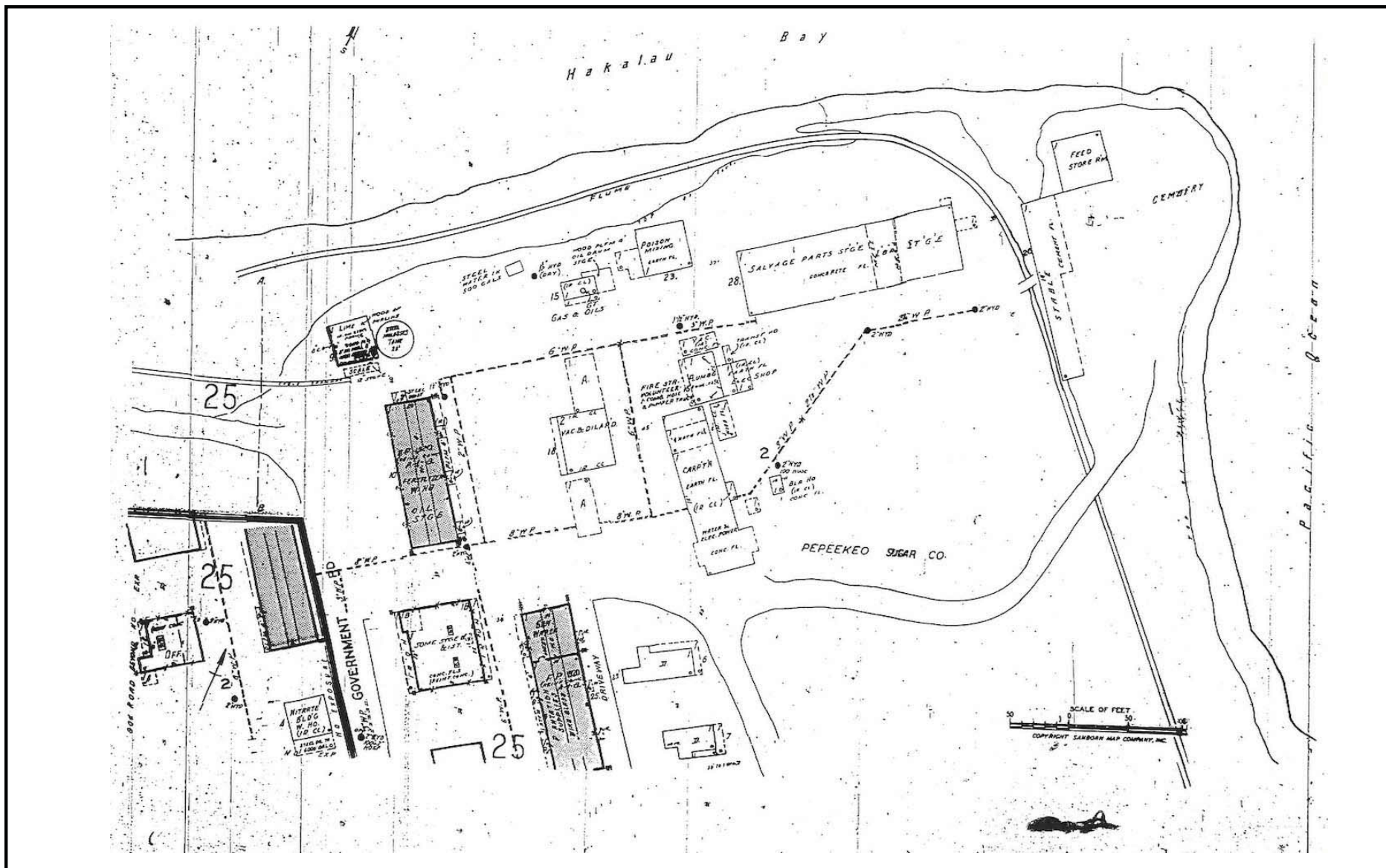














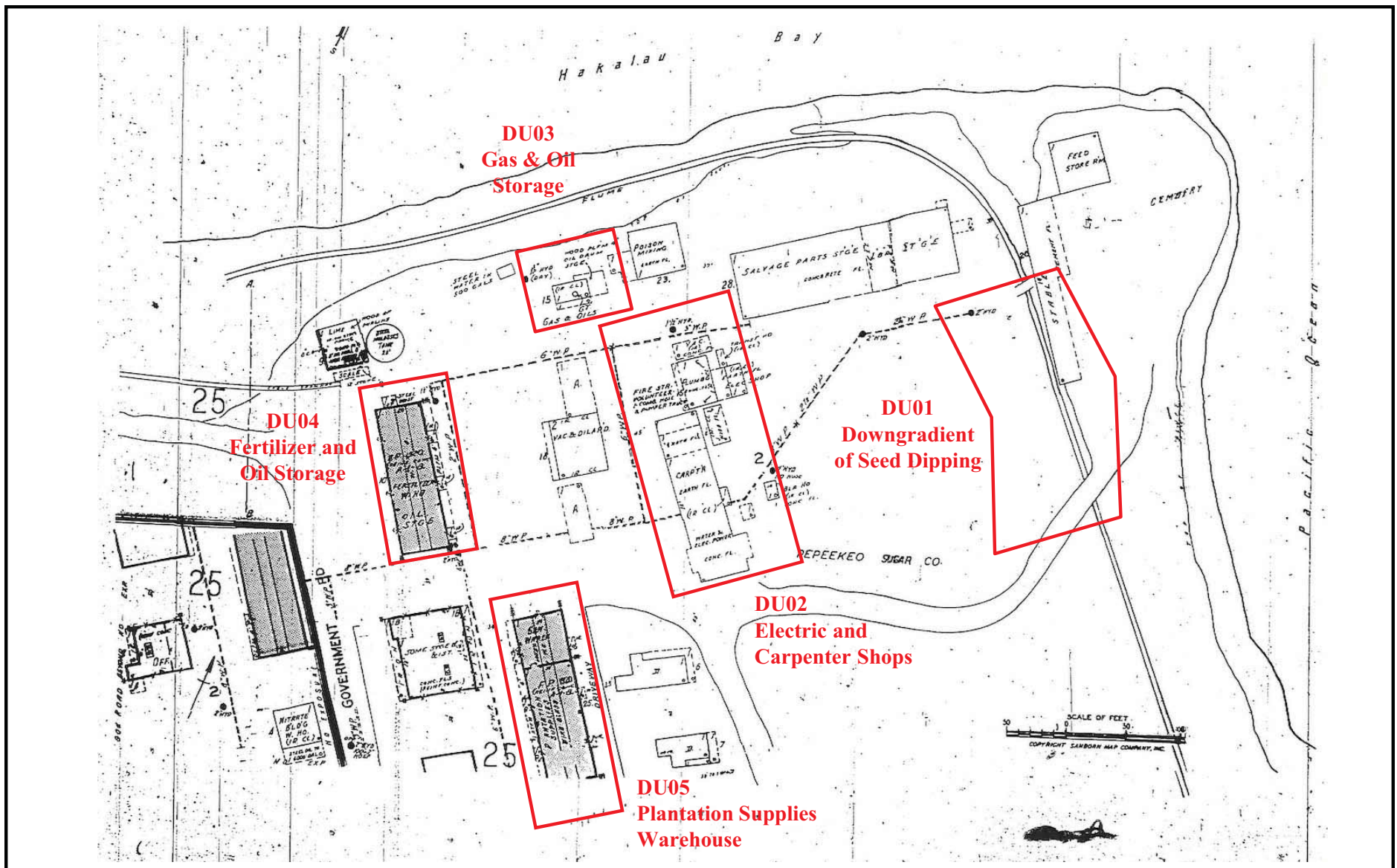




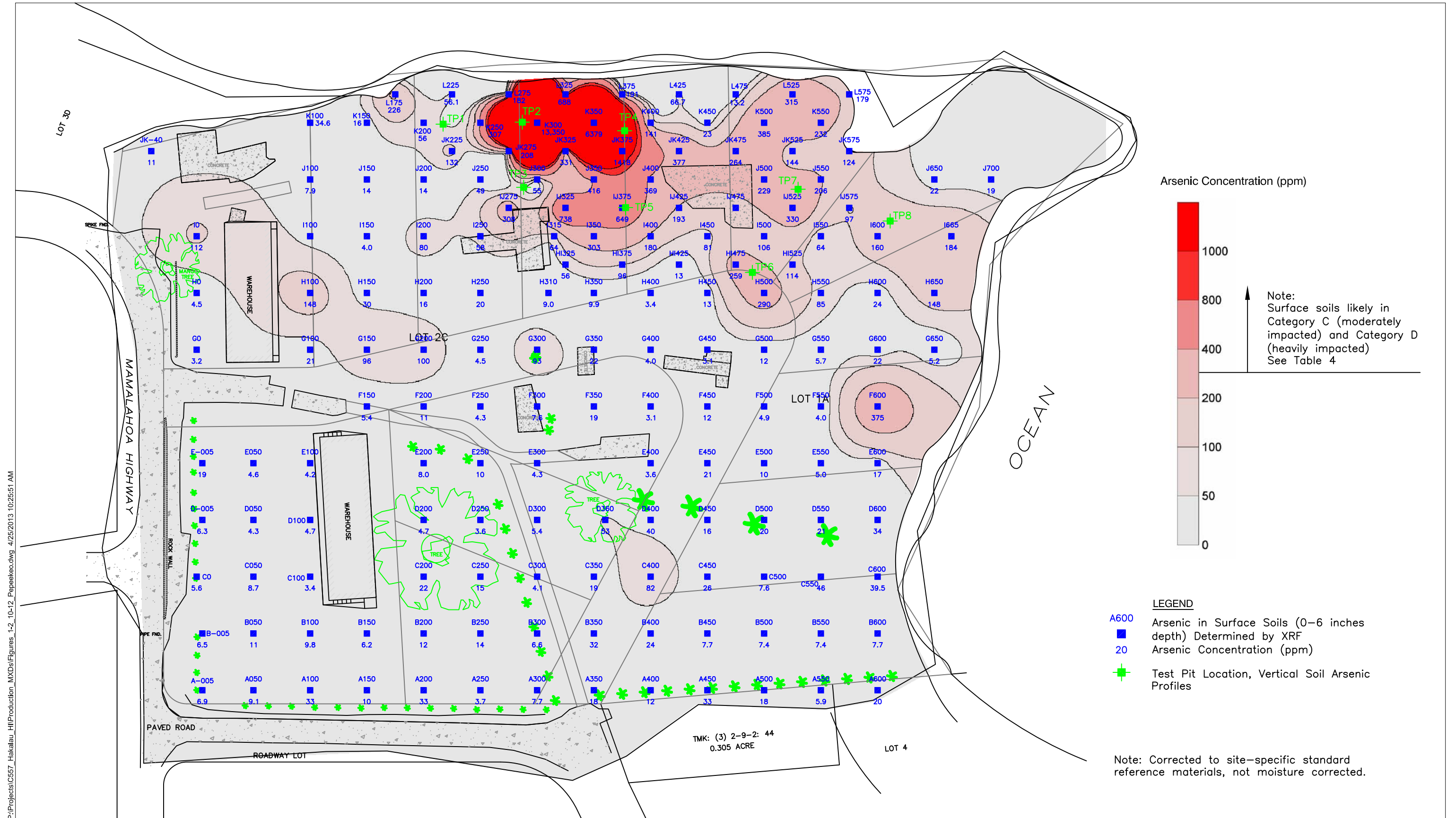
**Figure 7.**  
Soil Arsenic Screening by XRF Data Posting  
Former Pepeekeo Sugar Company Property  
TMKs: (3) 2-9-2:79 & 81  
Hakalau, Hawaii





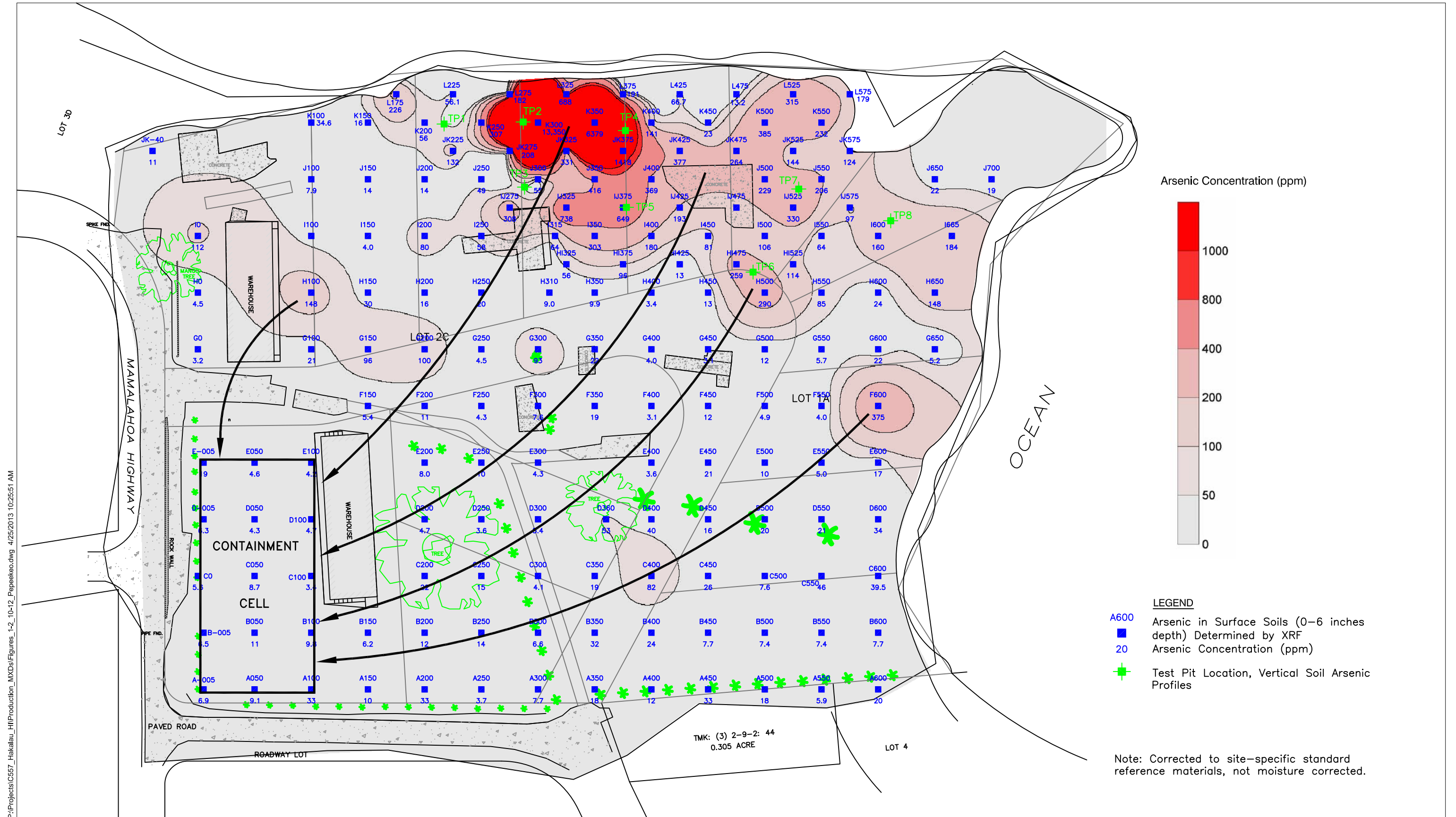






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**Figure 10.**  
Environmental Hazard Map  
Former Pepekeo Sugar Company Property  
TMKs: (3) 2-9-2:79 & 81  
Hakalau, Hawaii



**Figure 11.**  
Alternatives 3 and 4 - Containment Cell  
Former Pepeekeo Sugar Company Property  
TMKs: (3) 2-9-2:79 & 81  
Hakalau, Hawaii





## TABLES

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Table 1. HDOH Study - Surface Soil Sampling Results

Sample ID Number Sample Date Location	EAL <sup>a</sup>	Basis <sup>b</sup>	HPM-DU-1 9/18/2007 Pesticide Mixing	HPM-DU-2 9/18/2007 Pesticide Mixing	HDA-DU-1 9/18/2007 Drainage Area	HDA-DU-2 9/18/2007 Drainage Area	HDA-DU-3 9/18/2007 Drainage Area	HSDV-DU-1 9/18/2007 Seed Dipping Area
<b>Parameters</b>								
<b>Total Metals (mg/kg)</b>								
Antimony	2.4	bkgrd	4.83	4.57	1.2 J	1.22 J	1.13 J	ND (< 0.29)
Arsenic	24	bkgrd	127	150	84.8	80.2	78.5	3.84
Barium	1000	gross	63.8	66.7	43.7	40.8	43.5	25.7
Beryllium	31	dir.exp.	0.84 J	0.83 J	0.42 J	0.44 J	0.43 J	1 J
Cadmium	14	dir.exp.	10.5	8.53	14.2	13.5	13.6	8.97
Chromium	1100	bkgrd	168	127	231	207	208	44.5
Copper	630	dir.exp.	63.9	60.5	78.9	85.8	84.5	29.8
Lead	200	dir.exp.	43	50	65.4	59.2	62.1	39.1
Mercury	4.7	dir.exp.	ND(< 0.02)	ND(< 0.02)	ND(< 0.02)	ND(< 0.02)	ND(< 0.02)	1.06
Nickel	760	dir.exp.	26.5	26.6	27.7	26.3	27.9	11.3
Selenium	78	dir.exp.	1.15 J	1.08 J	0.62 J	0.4 J	0.59 J	ND(< 0.25)
Silver	78	dir.exp.	1.57	1.51	0.42 J	0.45 J	0.63 J	0.64 J
Zinc	1000	gross	200	196	322	319	276	202
<b>Pesticides/SVOCs (µg/kg)</b>								
2,3,4,6-Tetrachlorophenol	590	leach	ND(< 50)	60.1	ND(<50)	ND(< 50)	ND(< 50)	
4,4'-DDT	1700	dir.exp.	ND(< 2.0)	ND(< 2.0)	ND(< 2.0)	ND(< 2.0)	3.0	
Chlordane (technical)	16000	dir.exp.	4.3	3.3	3.9	ND(< 0.99)	4.5	
Dieldrin	1500	dir.exp.	ND(< 2.0)	3.6	3.5	3.9	2.8	
Endrin aldehyde <sup>c</sup>	3700	dir.exp.	2.6	ND(< 2.0)	ND(< 2.0)	ND(< 2.0)	ND(< 2.0)	
Pentachlorophenol	890	dir.exp.	ND(< 3.3) H	ND(< 3.3) H	69 H	56 H	110 H	
<b>Dioxins TEQ - total (ng/kg)</b>	240	dir.exp.	18	33	16	18	18	

Only detected compounds shown in table, empty cells indicate not analyzed.

Highlighted values exceed the EAL.

ND(<x) = Not detected at a detection limit of x.

H = sample prepped or analyzed beyond the specified holding time

J = estimated value. Analyte detected at a level less than the reporting limit and greater than or equal to the method detection limit.

Specific Notes:

<sup>a</sup> HDOH Tier 1 Environmental Action Levels (EALs) for soil where groundwater is not current or potential source of drinking water and is less than 150m to surface water body (HDOH 2011).

<sup>b</sup> Basis for Tier 1 EAL: bkgrd = background level; dir.exp. = direct exposure human health hazard; gross = gross contamination; leaching = leaching threat to groundwater

<sup>c</sup> EAL for Endrin

Table 2. Current Study - Sampling Decision Units

DU ID	Description	Analysis
DU01	Downgradient from Seed Dipping Area	Mercury
DU02	Electric and Carpenter Shops (demolished)	TPH, PCBs, metals <sup>a</sup> , Chlordane
DU03	Gas and Oil Storage (demolished)	TPH, PCBs, metals, Chlordane
DU04	Warehouse (existing) - Fertilizer and Oil Storage	TPH, metals
DU05	Warehouse (existing) - Plantation Supplies	TPH, metals

Notes:

<sup>a</sup> Metals are Resource Conservation and Recovery Act (RCRA) toxic metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver.

Table 3. Current Study - Surface Soil Sampling Results

Sample ID Number Sample Date	EAL <sup>a</sup>	Basis <sup>b</sup>	AG-DU01 9/18/2007	AG-DU02 9/18/2007	AG-DU03 9/18/2007	AG-DU04 9/18/2007	AG-DU05 9/18/2007	EqR <sup>c</sup> 9/18/2007
Location			Downgradient of Seed Dipping Area	Electric & Carpenter Shops	Gas & Oil Storage	Fertilizer & Oil Storage	Plantation Supplies Warehouse	Equipment Rinsate Sample
Parameters								
<b>RCRA Metals (mg/kg)</b>								<b>(µg/L)</b>
Arsenic	23	dir.exp.		84.8	127	24.9	11.9	ND(< 20)
Barium	1000	gross		43.3	41.3	53.3	40.6	ND(< 20)
Cadmium	14	dir.exp.		ND(< 1.5)	ND(< 1.6)	2.74	1.65	ND(< 5)
Chromium	1100	bkgrd		80.7	179	109	86.3	ND(< 5)
Lead	200	dir.exp.		94.1	90.7	135	148	ND(< 5)
Mercury	4.7	dir.exp.	2.48	0.85	0.42	0.36	0.28	ND(<0.025)
Selenium	78	dir.exp.		ND(< 7.7)	ND(< 8.1)	ND(< 6.2)	ND(< 7.3)	ND(< 20)
Silver	78	dir.exp.		ND(< 3.9)	ND(< 4.1)	ND(< 3.1)	ND(<3.6)	ND(< 10)
<b>Petroleum Hydrocarbons (mg/kg)</b>								
Gasoline Range	100	gross		ND(< 0.46)	ND(< 0.5)	ND(< 0.49)	ND(< 0.46)	
Diesel Range	500	gross		34.8	90.7	57.6	ND(<397)	
Oil Range	500	gross		ND(< 99)	RL1	ND(< 197)	RL1	ND(< 1990)
<b>PCBs <sup>d</sup> (mg/kg)</b>	1.1			ND(< 0.07)	ND(< 0.07)			
<b>Chlordane (mg/kg)</b>	16			ND(< 0.03)	ND(< 0.03)			

Only detected compounds shown in table, empty cells indicate not analyzed.

Highlighted values exceed the EAL.

ND(<x) = Not detected at a detection limit of x.

RL1 = reporting limit raised due to sample matrix effects.

Specific Notes:

<sup>a</sup> HDOH Tier 1 Environmental Action Levels (EALs) for soil where groundwater is not current or potential source of drinking water and is less than 150m to surface water body. (January 2012)

<sup>b</sup> Basis for Tier 1 EAL: bkgrd = background level; dir.exp. = direct exposure human health hazard; gross = gross contamination; leaching = leaching threat to groundwater

<sup>c</sup> Equipment Rinsate Sample, results in µg/L

<sup>d</sup> PCB analysis include Aroclors: 1016, 1221, 1232, 1242, 1248, 1254, 1260

Table 4. Predicted Total Arsenic by XRF for HDOH Soil Arsenic Categories

HDOH Soil Category	Category Lower Limit Bioacc. As (mg/kg) <sup>b</sup>	Predicted Total As by XRF (mg/kg) <sup>a</sup>	
		Surface Soils/Fill	Subsurface Hilo Series
C (moderately impacted)	23	288	575
D (heavily impacted)	95	1188	2375

Notes:

<sup>a</sup> Field moist bulk sample, XRF analysis

<sup>b</sup> <0.25-mm fraction, air dried (40°C), bioaccessible As extraction



Table 5. Summary of Soil Environmental Hazards

Parameters	Max Concentration	Background	Direct Exposure		Vapor Emissions to Indoor Air	Terrestrial Ecotoxicity	Gross Contamination		Leaching (threat to groundwater)	
			Potential Hazard?	EAL Tier 1 <sup>a</sup>	Potential Hazard?	EAL Tier 1	Potential Hazard?	EAL Tier 1	Potential Hazard?	Tier 1 EAL
Total Metals (mg/kg)										
Antimony	4.83	2.4	YES	1.6	N/A	site-specific	NO	1000	...	(Use batch test)
Arsenic	150	24	YES	23 <sup>d</sup>	N/A	site-specific	NO	1000	...	(Use batch test)
Barium	66.7	690	NO	3100	N/A	site-specific	NO	1000	...	(Use batch test)
Beryllium	0.84	3	NO	31	N/A	site-specific	NO	1000	...	(Use batch test)
Cadmium	14.2	2.3	YES	14	N/A	site-specific	NO	1000	...	(Use batch test)
Chromium	231	1100	NO <sup>c</sup>	N/A	N/A	site-specific	NO	N/A	...	(Use batch test)
Copper	85.8	250	NO	630	N/A	site-specific	NO	1000	...	(Use batch test)
Lead	148	73	NO	200	N/A	site-specific	NO	1000	...	(Use batch test)
Mercury	2.48	0.72	NO	4.7	(Use soil gas)	site-specific	NO	500	...	(Use batch test)
Nickel	27.9	410	NO	760		N/A	site-specific	NO	1000	...
Selenium	1.15	7.1	NO	78	N/A	site-specific	NO	1000	...	(Use batch test)
Silver	1.57	1.5	NO	78	N/A	site-specific	NO	1000	...	(Use batch test)
Zinc	322	350	NO	4700	N/A	site-specific	NO	1000	...	(Use batch test)
Pesticides/SVOCs (µg/kg)										
2,3,4,6-Tetrachlorophenol	60.1	N/A	NO	370000	N/A	site-specific	NO	500000	NO	590
Chlordane (Technical)	4.5	N/A	NO	16000	N/A	site-specific	NO	1000000	NO	29000
4,4'-DDT	3	N/A	NO	1700	N/A	site-specific	NO	1000000	NO	5600
Dieldrin	3.9	N/A	NO	1500	N/A	site-specific	NO	1000000	NO	30000
Endrin aldehyde <sup>b</sup>	2.6	N/A	NO	3700	N/A	site-specific	NO	500000	NO	30000
Pentachlorophenol	110	N/A	NO	890	N/A	site-specific	NO	500000	NO	6500
Petroleum Hydrocarbons (mg/kg)										
Diesel Range	90.7	N/A	NO	500	N/A	N/A	NO	500	NO	500

Only detected compounds shown in table, empty cells indicate not analyzed

Specific Notes:

<sup>a</sup> HDOH Environmental Action Levels (EALs) for soil where groundwater is not current or potential source of drinking water and is less than 150m to surface water body. (Fall 2011)

<sup>b</sup> EAL for Endrin

<sup>c</sup> Chromium below EAL Background Value of 1100 mg/kg

<sup>d</sup> EAL for direct exposure to arsenic based on bioaccessible arsenic concentration

Table 6. Cost Estimate for Alternative 2  
Excavation and Offsite Landfill Disposal of Arsenic Category C and D Soils

**Remedy Description:** Excavate all arsenic Category C and D soils and dispose at West Hawaii Landfill.  
Backfill excavation with clean soils. No Institutional Controls required.

Item Description	Quantity	Unit	Unit Cost	Item Cost	Assumptions
<b>I. Site Preparation</b>					
Mobilization, Site Preparations	1	lot	\$5,000	\$5,000	Contractor mobilizes equipment, surveyor stake excavation areas, install E&S/HAZWOPER controls
Seed Dipping Effluent Investigation	1	lot	\$5,000	\$5,000	Soil sampling and analysis at former seed dipping effluent sump location and vicinity
<b>II. Material Excavation/Loading for Offsite Disposal</b>					
Material Handling	54	days	\$1,500	\$80,291	6100 in-place cy (10,700 tons) of Category C & D soils @ 20 tons per truck = 535 truck runs. Assume excavator loads dumps without soil staging. 1 run per day per truck @ \$800. 10 trucks per day= 54 days. Assume 1 composite sample per 500 cy
Soil Characterization for Disposal Facility	12	analyses	\$250	\$3,000	
<b>III. Off-Site Disposal of Solid Wastes</b>					
Waste Soil Transport to West HI Landfill	6100	cy			\$95/hour per truck@ 8 hours per 20 ton load Waste Management, Inc.
Tipping Fee at West HI Landfill	10,700	tons	\$38	\$406,600	
	10,700	tons	\$92	\$984,400	
<b>IV. Site Restoration</b>					
Post-Excavation Confirmatory Sampling	13	analyses	\$500	\$6,600	Assume 1 MI sample from each 1/4-acre area of excavation. Collection, in-vitro As lab, reporting.
Clean Soil Backfilling and Grading	6,700	cy	\$15	\$100,500	Assume local soil obtained, placed and graded. Assume 10% compaction.
Site Restoration, Revegetation	3.3	acres	\$1,000	\$3,300	Assume revegetation by hydroseeding and minor maintenance
<b>Subtotal Direct Construction</b>				<b>\$1,595,000</b>	Rounded to nearest \$1000
Workplans, H&S Plan, E&S Plan, Permitting	1	ea	\$15,000	\$15,000	Plans provided to HDOH for review and comment, SMA permitting support
Project Management, Engineering Support	1	ea	\$30,000	\$30,000	Field oversight, safety program, surveying, sampling, documentation
Close-out Report, Obtain No Further Action	1	ea	\$10,000	\$10,000	Written report and meetings with HDOH
Institutional Controls, Legal Support	1	ea	\$0	\$0	No ICs required
<b>Subtotal Indirect Costs</b>				<b>\$55,000</b>	
<b>Project Subtotal</b>				<b>\$1,650,000</b>	
<b>Contingency for Unforeseen (10%)</b>				<b>\$165,000</b>	
<b>Projected Opinion of Probable Cost</b>				<b>\$1,815,000</b>	Rounded to nearest \$1000

Table 7. Cost Estimate for Alternative 3  
Onsite Containment Cell for Arsenic Category C and D Soils

Remedy Description: Excavate all Category C & D soils and place in onsite containment cell in southwest corner of property. Backfill excavation with clean soils.

Item Description	Quantity	Unit	Unit Cost	Item Cost	Assumptions
<b>I. Site Preparation</b>					
Mobilization, Site Preparations	1	lot	\$5,000	\$5,000	Contractor mobilizes equipment, surveyor stake excavation areas, install E&S/HAZWOPER controls
Supplemental Arsenic Soil Investigation	1	lot	\$20,000	\$20,000	Focused test pits and onsite XRF analyses to define in-place limits of arsenic-impacted soils prior to excavation
Seed Dipping Effluent Investigation	1	lot	\$5,000	\$5,000	Soil sampling and analysis at former seed dipping effluent sump location and vicinity
<b>II. Consolidation Cell Preparation/Closure</b>					
Excavate Soils to prepare Cell	6,100	cy	\$10	\$61,000	Dozer, loader. Prepare soil staging area for clean soils removed.
Geotextile Fabric and 2-ft Clean Soil Cover	1	lot	\$25,000	\$25,000	0.5 acre cell: 20,000 sq. ft. geotextile and 2' thick clean soil, plus labor and equipment.
Asphalt Paving of Containment Cell	20,000	sq.ft	\$2	\$40,000	Asphalt paving, including base coarse
<b>III. Material Excavation/Loading</b>					
Material Excavation, On-site Transport, Placement	25	days	\$1,500	\$37,500	6100 cy @ 250 cy/day.
Soil Characterization for IC Documentation	6	analyses	\$250	\$1,500	Assume 1 composite sample per 1000 cy for documentation support of institutional controls
<b>IV. Site Restoration</b>					
Post-Excavation Confirmatory Sampling	13	analyses	\$250	\$3,300	Assume 1 MI sample from each 1/4-acre area of excavation. Collection, in-vitro As lab, reporting.
Clean Soil Backfill and Grading	6,100	cy	\$10	\$61,000	Use soil excavated from on-site cell, transported, placed and graded.
Site Restoration, revegetation	3.30	acres	\$1,000	\$3,300	Assume revegetation by hydroseeding and minor maintenance
<b>Subtotal Direct Construction</b>				<b>\$263,000</b>	Rounded to nearest \$1000
Survey Support for Cell Design and As-built	1	ea	\$10,000	\$10,000	Registered surveyor
Cell Design, Workplans, H&S Plan, E&S Plan,	1	ea	\$25,000	\$25,000	Plans provided to HDOH for review and comment, SMA permitting support
Project Management, Engineering Support	1	ea	\$25,000	\$25,000	Field oversight, safety program, surveying, sampling, documentation
Close-out Report, Obtain No Further Action	1	ea	\$10,000	\$10,000	Written report and meetings with HDOH
Institutional Controls, Legal Support	1	ea	\$15,000	\$15,000	Deed Notice (Environmental Covenant), EHMP
<b>Subtotal Indirect Costs</b>				<b>\$85,000</b>	
<b>Project Subtotal</b>				<b>\$348,000</b>	
<b>Contingency for Unforeseen (10%)</b>				<b>\$34,800</b>	
<b>Projected Opinion of Probable Cost</b>				<b>\$383,000</b>	Rounded to nearest \$1000

Table 8. Cost Estimate for Alternative 4  
Onsite Containment Cell for Arsenic Category C Soils, Offsite Landfill Disposal of Arsenic Category D Soils

Remedy Description: Excavate all Category C soils and place in onsite containment cell at western portion of property.  
Excavate and offsite dispose of all Category D soils at West Hawaii Landfill. Backfill excavations with clean soils.

Item Description	Quantity	Unit	Unit Cost	Item Cost	Assumptions
<b>I. Site Preparation</b>					
Mobilization, Site Preparations	1	lot	\$5,000	\$5,000	Contractor mobilizes equipment, surveyor stake excavation areas, install E&S/HAZWOPER controls
Supplemental Arsenic Soil Investigation	1	lot	\$20,000	\$20,000	Focused test pits and onsite XRF analyses to define in-place limits of arsenic-impacted soils prior to excavation
Seed Dipping Effluent Investigation	1	lot	\$5,000	\$5,000	Soil sampling and analysis at former seed dipping effluent sump location and vicinity
<b>II. Consolidation Cell Preparation/Closure</b>					
Excavate Soils to prepare Cell	5,300	cy	\$10	\$53,000	Dozer, loader. Prepare soil staging area for clean soils removed.
Geotextile Fabric and 2-ft Clean Soil Cover	1	lot	\$25,000	\$25,000	0.5 acre cell: 20,000 sq. ft. geotextile and 2' thick clean soil, plus labor and equipment.
Asphalt Paving of Containment Cell	20,000	sq.ft	\$2	\$40,000	Asphalt paving, including base coarse
<b>III. Material Excavation/Loading/Onsite Handling</b>					
Material Excavation, On-site Transport, Placement	22	days	\$1,500	\$33,000	5300 cy of Category C soils @ 250 cy/day.
Soil Characterization for IC Documentation	6	analyses	\$250	\$1,500	Assume 1 composite sample per 1000 cy for documentation support of institutional controls
<b>II. Material Excavation/Loading for Offsite Disposal</b>					
Material Handling	7	days	\$1,500	\$10,500	800 in-place cy (1,400 tons) of Category D soils @ 20 tons per truck = 70 truck runs. Assume excavator loads dumps without soil staging. 1 run per day per truck @ \$800. 10 trucks per day= 7 days.
Soil Characterization for Disposal Facility	2	analyses	\$250	\$500	Assume 1 composite sample per 500 cy
<b>III. Off-Site Disposal of Solid Wastes</b>					
Waste Soil Transport to West HI Landfill	800	cy			
	1,400	tons	\$38	\$53,200	\$95/hour per truck@ 8 hours per 20 ton load
Tipping Fee at West HI Landfill	1,400	tons	\$92	\$128,800	Waste Management, Inc.
<b>IV. Site Restoration</b>					
Post-Excavation Confirmatory Sampling	13	analyses	\$250	\$3,300	Assume 1 MI sample from each 1/4-acre area of excavation. Collection, in-vitro As lab, reporting.
Clean Soil Backfill and Grading	5,300	cy	\$10	\$53,000	Use soil excavated from on-site cell, transported, placed and graded.
Site Restoration, revegetation	3.3	acres	\$1,000	\$3,300	Assume revegetation by hydroseeding and minor maintenance
<b>Subtotal Direct Construction</b>				<b>\$435,000</b>	Rounded to nearest \$1000
Survey Support for Cell Design and As-built	1	ea	\$10,000	\$10,000	Registered surveyor
Cell Design, Workplans, H&S Plan, E&S Plan,	1	ea	\$25,000	\$25,000	Plans provided to HDOH for review and comment, SMA permitting support
Project Management, Engineering Support	1	ea	\$25,000	\$25,000	Field oversight, safety program, surveying, sampling, documentation
Close-out Report, Obtain No Further Action	1	ea	\$10,000	\$10,000	Written report and meetings with HDOH
Institutional Controls, Legal Support	1	ea	\$15,000	\$15,000	Deed Notice (Environmental Covenant), EHMP
<b>Subtotal Indirect Costs</b>				<b>\$85,000</b>	
<b>Project Subtotal</b>				<b>\$520,000</b>	
<b>Contingency for Unforeseen (10%)</b>				<b>\$52,000</b>	
<b>Projected Opinion of Probable Cost</b>				<b>\$572,000</b>	Rounded to nearest \$1000

Table 9. Cost Estimate for Alternative 5  
Consolidation and Capping of Arsenic Category C & D Soils at Source Area

Remedy Description: Consolidate all Category C & D soils at Source Area (former Pesticide Storage Area). Backfill excavations with clean soils. Place 2-foot thick cover soils over all consolidated Category C & D soils.

Item Description	Quantity	Unit	Unit Cost	Item Cost	Assumptions
<b>I. Site Preparation</b>					
Mobilization, Site Preparations	1	lot	\$5,000	\$5,000	Contractor mobilizes equipment, surveyor stake excavation areas, install E&S/HAZWOPER controls
Seed Dipping Effluent Investigation	1	lot	\$5,000	\$5,000	Soil sampling and analysis at former seed dipping effluent sump location and vicinity
<b>II. Material Excavation/Loading</b>					
Material Excavation, On-site Transport, Placement	10	days	\$1,500	\$15,000	2500 cy @ 250 cy/day.
Soil Characterization for IC Documentation	3	analyses	\$250	\$750	Assume 1 composite sample per 1000 cy
<b>III. Site Restoration and Capping Consolidated Soils</b>					
Post-Excavation Confirmatory Sampling	9	analyses	\$250	\$2,300	Assume 1 MI sample from each 1/4-acre area of excavation. Collection, in-vitro As lab, reporting.
Excavation Soil Backfill and Grading	2,500	cy	\$15	\$37,500	Assume local soil obtained, placed and graded.
Geotextile Fabric and 2-feet Clean Soil placed over Arsenic Soil	1	lot	\$25,000	\$25,000	0.5 acre consolidation area: 20,000 sq. ft. geotextile and 2' thick clean soil, plus labor and equipment.
Site Restoration, revegetation	3.30	acres	\$1,000	\$3,300	Assume revegetation by hydroseeding and minor maintenance
<b>Subtotal Direct Construction</b>				<b>\$94,000</b>	Rounded to nearest \$1000
Survey Support for Cell Design and As-built Documentation	1	ea	\$10,000	\$10,000	Registered surveyor
Workplans, H&S Plan, E&S Plan, Permitting	1	ea	\$25,000	\$25,000	Plans provided to HDOH for review and comment, SMA permitting support
Project Management, Engineering Support	1	ea	\$20,000	\$20,000	Field oversight, safety program, surveying, sampling, documentation
Close-out Report, Obtain No Further Action	1	ea	\$8,000	\$8,000	Written report and meetings with HDOH
Institutional Controls, Legal Support	1	ea	\$15,000	\$15,000	Deed Notice (Environmental Covenant), EHMP
<b>Subtotal Indirect Costs</b>				<b>\$78,000</b>	
<b>Project Subtotal</b>				<b>\$172,000</b>	
<b>Contingency for Unforeseen (10%)</b>				\$17,200	
<b>Projected Opinion of Probable Cost</b>				<b>\$189,000</b>	Rounded to nearest \$1000

Table 10. Comparison of Removal Action Alternatives

Removal Action	Effectiveness	Implementability	Estimated Cost <sup>a</sup>
<b>Alternative 1: No Action</b>	<b>Low</b> Does not address RAOs	<b>Low</b> Does not address RAOs	<b>\$0</b>
<b>Alternative 2: Excavation and Offsite Landfill Disposal of Arsenic Category C and D Soils</b>	<b>Very High</b> Achieves RAOs Short-term: Increase in truck traffic Long Term: No soils above RALs remain on site All property available for unrestricted reuse	<b>High</b> Achieves RAOs Standard construction methods No permitting and ICs for on-site soil containment	<b>\$1,815,000</b>
<b>Alternative 3: Onsite Containment Cell for Arsenic Category C and D Soils</b>	<b>High</b> Achieves RAOs Short term: All activities conducted on site Long Term: Soils above RALs placed in engineered cell. Category D soils placed >10 ft below grade 1/2-acre parcel in SW corner restricted for soil containment cell	<b>High</b> Achieves RAOs Standard construction methods Requires permitting and ICs for on-site soil containment	<b>\$383,000</b>
<b>Alternative 4: Onsite Containment Cell for Arsenic Category C Soils, Offsite Landfill Disposal of Arsenic Category D Soils</b>	<b>High</b> Achieves RAOs Short term: Some truck traffic, most activities conducted on site Long Term: Category D soils sent to landfill, lower risk Category C soils managed on site 1/2-acre parcel in west portion restricted for soil containment cell	<b>High</b> Achieves RAOs Standard construction methods Requires permitting and ICs for on-site soil containment	<b>\$572,000</b>
<b>Alternative 5: Onsite Consolidation and Capping of Arsenic Category C and D Soils at Source Area</b>	<b>Moderate</b> Achieves RAOs Short term: All activities conducted on site Long Term: Soils above RALs consolidated at source area. Category D soils left <10 ft below grade, presenting higher risk for incidental exposure 1/2-acre parcel at Source Area restricted for soil containment	<b>Moderate</b> Achieves RAOs Standard construction methods Requires permitting and ICs for on-site soil containment	<b>\$189,000</b>

Notes:

<sup>a</sup> Preliminary engineering estimate, including 10% contingency for unforeseens