Decision Document
H-3 Landfill (Site 0001)
MARINE CORPS BASE HAWAII, OAHU, HAWAII

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Department of the Navy
Naval Facilities Engineering Command, Hawaii
400 Marshall Road
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Comprehensive Long-Term Environmental Action Navy
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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
$\mu g/m^3$	microgram per cubic meter
AR	Administrative Record
ARAR	applicable or relevant and appropriate requirement
ASTM	ASTM International
BERA	baseline ecological risk assessment
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
COPC	chemical of potential concern
CS	confirmation study
CSM	conceptual site model
CWA	Clean Water Act
CZM	Coastal Zone Management
DA	Department of the Army
DD	decision document
DDD	4,4'-dichlorodiphenyldichloroethane
DDE	4,4'-dichlorodiphenyldichloroethylene
DDT	4,4'-dichlorodiphenyltrichloroethane
DO	dissolved oxygen
DoD	Department of Defense
DOH	Department of Health, State of Hawaii
EAL	environmental action level
EC	engineering control
EE/CA	engineering evaluation/cost analyses
EPA	Environmental Protection Agency, United States
ERA	ecological risk assessment
ERV	ecotoxicity reference value
FIBC	flexible intermediate bulk container
FS	feasibility study
GSR	green and sustainable remediation
HAR	Hawaii Administrative Rules
HHRA	human health risk assessment
HI	hazard index
HOC	halogenated organic compound
HQ	hazard quotient
HRS	Hawaii Revised Statute
IAS	initial assessment study
IC	institutional control
ID	identification
ILCR	incremental lifetime cancer risk
JBPHH	Joint Base Pearl Harbor-Hickam
LDR	land disposal restriction
LOAEL	lowest-observed-adverse-effect level
LUC	land use control
Marine Corps	U.S. Marine Corps

MCB	Marine Corps Base
msl	mean sea level
MW	monitoring well
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
no.	number
NOAEL	no-observed-adverse-effects level
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbon
PAL	project action level
PCB	polychlorinated biphenyl
PM_{10}	particulate matter with an aerodynamic diameter of less than or equal to a nominal 10 micrometers
PP	proposed plan
PPE	personal protection equipment
ppt	part per thousand
R&HA	Rivers and Harbors Act
RA	response action
RACER	Remedial Action Cost Engineering and Requirements
RAO	response action objective
RAWP	remedial action work plan
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RSL	regional screening level
SARA	Superfund Amendments and Reauthorization Act
SO_x	sulfur oxides
SQV	sediment quality value
SRA	screening risk assessment
SVOC	semivolatile organic compound
TBC	to be considered
TCRA	time-critical removal action
TLF	temporary lodging facility
TOC	total organic carbon
U.S.	United States
VOC	volatile organic compounds
VSI	visual site inspection
yd^3	cubic yards

1. Declaration

1.1 Site Name and Location

The United States (U.S.) Marine Corps (Marine Corps) has prepared this decision document (DD) for the H-3 Landfill located at Marine Corps Base (MCB) Hawaii, Oahu, Hawaii.

1.2 Statement of Basis and Purpose

This DD presents the final remedy for the H-3 Landfill located at MCB Hawaii, Oahu, Hawaii. The final remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) (EPA 1986), to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and the Office of the President of the United States Executive Order 12580 (EO 1987). This decision is based on the Administrative Record (AR) file for this site.

The State of Hawaii Department of Health (DOH) has concurred with the final selected remedy.

1.3 Assessment of the Site

The response action (RA) selected in this DD is necessary to protect public health, welfare, or the environment from actual or threatened releases of hazardous substances into the environment.

Previous investigations at the H-3 Landfill resulted in a recommendation of no further action provided that the site usage remains the same (ATT 1988). However, in May 2009 MCB Hawaii personnel discovered that a portion of the landfill cover fronting the shoreline had receded, which exposed construction and demolition waste. A time-critical removal action (TCRA) was conducted in May 2009 to provide temporary remedial slope stabilization. Subsequently, other portions of the landfill side slopes were observed to be steep with evidence of erosion or scour at the toe. Therefore, a remedial investigation (RI) was initiated in November 2011 to evaluate whether the existing cover of the H-3 Landfill is still protective of human health and the environment, if the landfill presents potential risk to human health or ecological receptors, and if the existing landfill conditions are stable. The results of the investigation indicated that the existing cover is protective and the corresponding risks to human health and ecological receptors are within the risk management ranges or subject to risk management consideration. However, stabilization of the landfill side slopes is needed and further risk management activities may be necessary to ensure the long-term protection of human health and the environment.

1.4 Description of Selected Remedy

The Marine Corps and DOH have selected land use controls (LUCs) in combination with a removal action to repair the existing landfill cover (being completed under a separate project at the site [AECOM 2012a]) as the final remedy for the H-3 Landfill. The removal action (side slope stabilization) includes placing rock rip-rap, anchored by a sheet pile wall, at the base of the landfill slopes to repair the landfill cover and prevent further erosion and exposure of the wastes to ensure its continued protectiveness. This decision is based on the following:

- Results from previous investigations
- Results of a RI/feasibility study (FS) (AECOM 2012b) that included an evaluation process and considered alternatives, including no action, LUCs, and removal of remaining contaminated media

- Results from the removal action (initiated in 2012), during which the side slopes will be stabilized

Wastes disposed of in the landfill were reported to include lead, mercury, pesticides, paints, solvents, thinners, waste petroleum oils and lubricants, waste fuels, corrosive liquids, transformer oils, and tear gas (ATT 1988). Metals, organochlorine pesticides, polychlorinated biphenyls (PCBs) as congeners, and polynuclear aromatic hydrocarbons (PAHs) were detected in sediments at the site at concentrations exceeding the project action levels (PALs). Metals and PCBs were also detected in groundwater at concentrations exceeding the PALs. However, the groundwater is not significantly impacted, and the results of a human health risk assessment (HHRA) and ecological risk assessment (ERA) indicate the detected concentrations in sediment and groundwater do not pose a risk to human health or the environment. In addition, there was no indication of landfill gas being present.

Section 300.430(a)(iii)(B) of the NCP contains the expectation that engineering controls (ECs), such as containment, will be used for waste that poses a relatively low long-term threat and where treatment is impracticable. The preamble to the NCP identifies municipal landfills as a type of site where treatment of the waste may be impracticable because of the size and heterogeneity of the contents. Because treatment usually is impracticable, the U.S. Environmental Protection Agency (EPA) generally considers containment to be the appropriate RA, or the "presumptive remedy," for the source areas of municipal landfill sites. The presumptive remedy for municipal landfill sites relates primarily to containment of the landfill mass and collection and/or treatment of landfill gas. In addition, measures to control landfill leachate, affected groundwater at the perimeter of the landfill, and/or upgradient groundwater causing saturation of the landfill mass may be implemented as part of the presumptive remedy.

Since no leachate or landfill gas was found at the site, the selected remedy is intended to provide containment of the source material and ensure that risks to human and ecological receptors remain within acceptable levels. Following the implementation of the side slope stabilization to repair the landfill cover and ensure its continued protectiveness, the addition of LUCs, specifically institutional controls (ICs), would prevent disturbance of and limit exposure to landfill material. Future sampling and monitoring of the site will be unnecessary because there is no landfill gas present and the groundwater is not impacted to a significant extent (there is no cancer or non-cancer risk). The major components of the remedy for H-3 Landfill include the following elements:

- Complete side slope stabilization (AECOM 2012a) to prevent the further exposure of landfill waste to the adjacent sediments and surface water and ensure the landfill cover remains protective.
- Provide adequate notice of the presence of the contaminants to any potential landowners. In addition, per MCB Hawaii requirements, any party planning to excavate on the base must first apply for a dig permit with MCB Hawaii. Provide notice to dig permit applicants during the permit review process of the presence of landfill waste.
- Prevent unauthorized excavation, uncontrolled waste removal. Provide notice to dig permit applicants planning to excavate in this area that planned activities must include proper handling and disposal of landfill waste; and must prevent migration or relocation of landfill waste to areas where human or ecological exposure could occur..
- Perform CERCLA five-year reviews to ensure that LUCs remain in place.

The selected remedy does not reduce the toxicity, mobility, or volume of the contamination. However, the stabilization of the side slopes combined with LUCs will protect human health and the environment by preventing disturbance of and limiting exposure to landfill debris. This remedy

represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner. Specifically, this alternative provides the best short- and long-term effectiveness, is protective of human health and the environment, complies with applicable or relevant and appropriate requirements (ARARs), achieves response action objectives (RAOs), reduces contaminant mobility, and is technically feasible.

1.5 STATUTORY DETERMINATIONS

The selected remedy for the H-3 Landfill is protective of human health and the environment, complies with all ARARs, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The final remedy for the site does not satisfy the statutory preference for treatment as a principal element of the final remedy since the remedy includes leaving contaminants in place without undergoing any treatment. However, following stabilization of the side slopes, the landfill cover prevents direct contact with the underlying landfill waste. The landfill cover also reduces the mobility and potential for migration or relocation of waste to areas where human or ecological exposure could occur, reducing the likelihood they will further impact the environment.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of RA to ensure that the remedy is, or will be, protective of human health and the environment.

1.6 DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this DD (Section 2). Additional information can be found in the AR file for this site.

- Chemicals of concern (COCs) and their respective concentrations (Section 2.8)
- Baseline risk represented by the COCs (Section 2.7)
- How source materials constituting principal threats will be addressed (Section 2.11)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and DD (Section 2.6)
- Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section 2.12.4)
- Estimated capital costs, annual operation and maintenance, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.12.3)
- Key factors that led to selecting the remedy (Section 2.12)

If contamination posing unacceptable risks to human health or the environment is discovered after execution of this DD, the Marine Corps will undertake all necessary actions to ensure continued protection of human health and the environment.

1.7 SIGNATURE AND SUPPORT AGENCY ACCEPTANCE OF FINAL REMEDY

The Marine Corps and DOH have selected LUCs in combination with the landfill side slope stabilization as the final remedy for the H-3 Landfill. This remedy is protective of human health and the environment. In accordance with CERCLA requirements, five-year reviews will be necessary to ensure that the selected final remedy remains protective of human health and the environment at the H-3 Landfill at MCB Hawaii, Oahu, Hawaii.

29 MAY 2014

D. R. George
Captain, U.S. Marine Corps
Director, Environmental Compliance and Protection Department
By direction of the Commanding Officer

Date

The DOH concurs with the selected remedy as documented in this DD.

6-5-14

Keith E. Kawaoka, D. Env.
Program Manager
Hazard Evaluation and Emergency Response Office
State of Hawaii, Department of Health

Date

2. Decision Summary

This section summarizes site characteristics, potential human health risks, potential ecological risks, evaluation of RA alternatives, and the rationale for the decisions that led to selection of the final remedy for the H-3 Landfill.

2.1 SITE NAME, LOCATION, AND DESCRIPTION

The H-3 Landfill is an approximately 20-acre site located at the main entrance to MCB Hawaii at the end of the H-3 Freeway (ATT 1988). The volume of the landfill is approximately 500,000 cubic yards (yd^3). MCB Hawaii occupies the entire Mokapu Peninsula in Kaneohe Bay on the windward (northeast) coast of Oahu. The landfill is located on the southwest side of the peninsula (Figure 1). Currently, the site is a grassy, open area that houses the base pass and identification (ID) office and several static displays. The landfill is bordered by MCB Hawaii on the north, by Kaneohe Bay and Heleloa Pond on the southwest, and by Halekou Pond on the east and southeast (Figure 2). These ponds are part of an eight-member Nuupia Ponds complex connecting the narrow neck of Mokapu Peninsula to the main island of Oahu. The shallow waters of the ponds are interconnected with each other and Kaneohe Bay through a series of culverts. This former early Hawaiian fish pond complex is now Marine Corps-owned and -managed as a protected wetland/endangered species habitat eligible for listing in the National Register of Historic Places and is known as the Nuupia Ponds Wildlife Management area (ATT 1988). In addition, a protected jurisdictional wetland (known as the temporary lodging facility [TLF] wetland) is located adjacent to the landfill and included in the RI study of this site. The TLF wetland is also considered a habitat for protected species such as the Hawaiian stilt. The TLF wetland appears to be a closed system (i.e., there are no apparent streams or channels that feed into or out of the wetland). However, based on historical accounts and information received from MCB Hawaii, the wetland is integrally connected to the surrounding wildlife management area.

This DD was prepared under the Comprehensive Long-Term Environmental Action Navy III Program under contract number (no.) N62742-03-D-1837, contract task order no. HC31. This DD was prepared in accordance with the NCP requirements (40 CFR Part 300) and Department of Defense (DoD) policy (DoD 2001). The Marine Corps is the lead agency for this site and is supported by the U.S. Navy and DOH.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.2.1 Site History

The triangularly-shaped landfill was the MCB Hawaii main waste disposal area from 1940 to 1972, pre-dating the roadway that currently bisects the parcel in a north/south direction. The portion of the landfill west of H-3 Freeway was closed and covered with soil in late 1971 or early 1972. The eastern portion of the landfill was closed between 1972 and 1976. Details on the closure of the eastern portion of the landfill are not currently available; however, based on visual observations, the eastern portion of the landfill has a soil cover and is well landscaped with grass and static airplane displays. All wastes generated on base, except those from the housing area and wastes from contractors, were reportedly disposed of in the landfill during the years of its operation. Wastes disposed of in the landfill were reported to include lead, mercury, pesticides, paints, solvents, thinners, waste petroleum oils and lubricants, waste fuels, corrosive liquids, transformer oils, and tear gas (ATT 1988).

2.2.2 Site Investigations

The following sections provide discussion of previous investigations conducted at the project site. Historical data collected during these investigations are included in Table 1 and Table 2.

Table 1: Summary of Historical Groundwater Detections (ATT 1988)

Analyte	Analytical Group	Current PAL	503-K-MW1	503-K-MW2	503-K-MW3	503-K-MW4	503-K-MW5	503-K-MW6	503-K-MW7
Acetone	VOC	1,500	<10U	<10U	<10U	14B	<10U	<10U	<10U
Trichloroethylene	VOC	360	<1U	<1U	<1U	<1U	<1U	<1U	7
Toluene	VOC	130	<1U	<1U	4	2	6	5	<1U
Ethylbenzene	VOC	290	<1U	<1U	7	2	<1U	<1U	<1U
Xylenes	VOC	100	<1U	<1U	10	<1U	<1U	<1U	<1U
Aromatic Hydrocarbon	VOC	n/a	—	—	4E	—	—	—	—
A Ketone	VOC	n/a	—	—	8E	—	—	—	—
Alkane	VOC	n/a	—	—	—	9E	—	—	—
Unknown Hydrocarbon	SVOC	n/a	2E	20E	5E	10E	—	30E	—
Unknown Amide	SVOC	n/a	2E	—	—	—	—	—	—
Organic Acid	SVOC	n/a	—	30E	—	—	—	—	—
Alcohol	SVOC	n/a	—	—	—	—	30E	—	—
Alkane	SVOC	n/a	—	—	—	—	125E	—	—
Unknown	SVOC	n/a	—	—	—	—	110E	—	—
Branched Alkane	SVOC	n/a	—	—	—	—	—	20E	—
Sum of Petroleum Hydrocarbon	SVOC	n/a	2E	20E	38E	23E	131E	55E	—
Zinc	Metals	4.6	***20***	***<10U***	***<10U***	***<10U***	***<10U***	***<10U***	***<10U***
Nickel	Metals	5.0	***20***	***60***	***50***	***70***	***<10U***	***<10U***	***<10U***
Vanadium	Metals	19	<10U	10	<10U	<10U	<10U	<10U	<10U
Barium	Metals	2,000	100	70	60	110	100	60	<20 U
Arsenic	Metals	36	<2U	<2U	<2U	5	3	5	8
Antimony	Metals	30	***41***	19	20	20	<2U	3	<2U
Selenium	Metals	5.0	***24***	***39***	***21***	***15***	***8***	***12***	***<8U***

Note: All units in micrograms per liter.
Numbers in ***bold italic font*** signify values that exceed current PALs. Historical results from confirmation study (ATT 1988).

—	not detected, reporting limit is not available
<	not detected, less than the reporting limit
B	indicates the compound was found in the reagent blank
E	estimated concentration
MW	monitoring well
n/a	no PAL available
SVOC	semivolatile organic compound by EPA Method 625 (Groundwater)
U	indicates the compound was analyzed for but was not detected at a concentration above the detection limit
VOC	volatile organic compound by EPA Method 624

Table 2: Summary of Historical Sediment Detections (ATT 1988)

Analyte	Analytical Group	Current PAL	503-K-S1	503-K-S2	503-K-S3	503-K-S4	503-K-S5	503-K-S6	503-K-S7
Di-n-butyl phthalate	SVOC	1,160	<1.7U	<0.17TR	<1.7U	<0.34TR	<0.17U	<0.34U	0.37
Bis(2-Ethylhexyl)Phthalate	SVOC	123.2	<1.7U	0.43	<1.7U	0.73	<0.17U	<0.34U	2.8
Unknowns	SVOC	n/a	0.7E	—	0.8E	—	—	—	—
Unknown Hydrocarbons	SVOC	n/a	0.6E	11E	0.7E	4E	—	0.4E	18.7E
Alkenes	SVOC	n/a	—	2E	—	—	—	—	3.8E

Analyte	Analytical Group	Current PAL	503-K-S1	503-K-S2	503-K-S3	503-K-S4	503-K-S5	503-K-S6	503-K-S7
Branched Hydrocarbon	SVOC	n/a	—	5E	—	—	—	—	—
Organic Acid	SVOC	n/a	—	2E	0.4E	3E	—	—	—
Unknown Alkane	SVOC	n/a	—	2E	0.3E	—	—	—	—
Alcohol	SVOC	n/a	—	—	0.5E	—	—	—	—
An Aromatic	SVOC	n/a	—	—	—	—	2E	—	—
An Acid	SVOC	n/a	—	—	—	—	0.4E	—	—
Branched Alkane	SVOC	n/a	—	—	—	—	—	1.0E	—
Sum of Petroleum Hydrocarbon	SVOC	n/a	0.6E	20E	1.0E	4E	2E	1.4E	22.5E
Zinc	Metals	2.3	***26.7***	***12.1***	***82***	***36.5***	***43.3***	***43.9***	***23.8***
Nickel	Metals	15.9	***33.7***	***6.4***	***93.7***	***17.3***	***44.9***	***231***	***18.2***
Chromium	Metals	43.4	16.5	6.1	35.8	11.8	32.3	42.2	19.4
Copper	Metals	18.7	8.4	4.4	***41.6***	24.2	17.1	13.4	15.9
Cobalt	Metals	23	8.2	1.4	18.3	4.1	8.9	***25.7***	4.4
Vanadium	Metals	109.5	17.8	5.7	30.8	14.7	21.8	14.8	17.2
Barium	Metals	750	25	6.1	82.7	9.9	24.2	48.3	7.3
Arsenic	Metals	0.176	***8.8***	***2.2***	***15.1***	***4.9***	***9.9***	***7.5***	***4.8***
Cadmium	Metals	0.68	<0.2U	<0.2U	0.2	<0.2U	<0.5U	<0.5U	<0.2U
Lead	Metals	30.2	6	3.8	115	18.2	20	20.4	9.1
Antimony	Metals	2	1.1	1.7	2	<1.0U	<1.0U	<1.0U	<1.0U

Note: All units are in milligram per kilogram.
The available report indicates sediment samples were collected near monitoring wells MW-1 through MW-7; however, exact locations were not provided on a figure.
Numbers in ***bold italic font*** signify values that exceed current PALs. Historical results from confirmation study (ATT 1988).

—	not detected, reporting limit is not available
<	not detected, less than the reporting limit
B	indicates the compound was found in the reagent blank
E	estimated concentration
n/a	no PAL available
TR	indicates the compound was found at race levels below the detection limit
U	indicates the compound was analyzed for but was not detected at a concentration above the detection limit

2.2.2.1 *Initial Assessment Study*

An initial assessment study (IAS) was completed in 1984 (NEESA 1984). The IAS report recommended further assessment for the landfill site[1].

2.2.2.2 *Confirmation Study*

A follow-up confirmation study (CS) was completed in 1988, which comprised groundwater, sediment, and tissue sampling and analysis (ATT 1988). Based on the results of the investigation, the CS recommended no further action for the H-3 Landfill site provided that the site usage remains the same (ATT 1988).

2.2.3 Enforcement Activities

There have been no CERCLA enforcement activities at the H-3 Landfill.

[1] Text in blue font identifies where detailed cross-reference site information is available (Attachment B). In the event of any inconsistency between the text in this DD and the text in any of the cross-reference documents, the text in this DD will take precedence.

2.3 COMMUNITY PARTICIPATION

Public participation in the decision process for environmental activities at the H-3 Landfill has continually been encouraged throughout the environmental restoration and site closure processes. In an effort to involve the public in the decision-making process, the Marine Corps hosted a Public Informational Event and Open House on 14 May 2013, and issued fact sheets that summarize the site investigation and cleanup activities. In addition, the Marine Corps established a point-of-contact for the public at Commanding Officer, Attn: LE, Box 63062 Environmental, Kaneohe Bay, HI 96863-3062.

A Proposed Plan (PP) was prepared to formally present the selected remedy to the public and to solicit public comments. A Public Meeting for the PP was held in conjunction with the Public Informational Event and Open House on 14 May 2013 at the Aikahi Elementary School. Announcement of the availability of the PP and of the public meeting was placed in the *Honolulu Star-Advertiser* on 29 April 2013. The public comment period for the PP was held between 01 May 2013 and 30 May 2013. Questions and concerns received during the meeting were addressed at the meeting and documented in the meeting transcript. There were no written or verbal comments on the selected final remedy.

The transcript, PP, and other project documents, including work plans, technical reports, the RI/FS and other materials relating to the H-3 Landfill, can be found in the information repository at the following addresses:

Kailua Public Library
239 Kuulei Road
Kailua, Hawaii 96734
808-266-9911

Kaneohe Public Library
45-829 Kamehameha Highway
Kaneohe, Hawaii 96744
808-233-5676

Hamilton Library at the University of Hawaii at Manoa
Hawaiian and Pacific Collection
2550 McCarthy Mall
Honolulu, Hawaii 96822
808-956-8264

Additional project information is located in the AR file located at Naval Facilities Engineering Command, Pacific in Joint Base Pearl Harbor-Hickam (JBPHH). The address for the AR file is provided below:

Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Attn: NAVFAC PAC EV3
JBPHH Hawaii 96860-3134

2.4 SCOPE AND ROLE OF RESPONSE ACTION

In order to ensure the contaminants and waste remain on site, prevent the migration of contaminants off site, and prevent disturbance of contaminants from the site, the preferred alternative is LUCs in combination with side slope stabilization to repair the existing landfill cover and ensure continued

protectiveness. The side slope stabilization is being implemented under a removal action completed at the site, as discussed in Section 2.4.1. Containment has been identified as a presumptive remedy by EPA for landfills because it has been shown to be effective at similar sites. In most situations, the presumptive remedy requires long-term monitoring of groundwater and landfill gas to ensure protectiveness. However, based on an evaluation of data collected at the site, the groundwater is not significantly impacted, and chemicals detected above PALs in groundwater do not pose a risk to human health or the environment. In addition, there was no indication of landfill gas.

The DOH has determined that it is appropriate to apply the presumptive remedy at this site based on the contaminant characteristics, and because this site matches the type of site for which the presumptive remedy was designed to address. Following the implementation of the removal action to repair the landfill cover, the addition of LUCs would prevent disturbance of and limit exposure to landfill debris. CERCLA five-year reviews and long-term monitoring will ensure that the LUCs continue to protect human health and the environment in the future. Groundwater and landfill gas monitoring are not proposed because no landfill gas has been detected, historical and current groundwater results indicate that there is no significant impact to groundwater, and there was no unacceptable cancer or non-cancer risk.

The proposed RA fits with the overall strategy of MCB Hawaii by ensuring there are no disturbances to the main gate and no restrictions for base access. The area can be retained as the pass and ID office, a recreational and visitor area, and a protected wetland habitat.

The Marine Corps and DOH have agreed to the following:

- Ensure that environmental impacts associated with past and present activities conducted are thoroughly investigated and that appropriate RAs are taken, as necessary, to protect public health, welfare, and the environment.
- Establish a procedural framework and schedule for developing, implementing, and monitoring appropriate RAs in accordance with CERCLA, SARA, NCP, Superfund guidance and policy, Resource Conservation and Recovery Act (RCRA) guidance and policy, and applicable State of Hawaii law.
- Facilitate cooperation, exchange of information, and participation between the Marine Corps and the DOH.
- Ensure adequate assessment of potential injury to natural resources necessary to ensure the implementation of RAs appropriate for achieving project objectives.

The final remedy was chosen in accordance with CERCLA, as amended by the SARA, and to the extent practicable, the NCP. Information supporting the decisions leading to the selected remedy is contained in the AR file for the site.

2.4.1 Past Response Actions at H-3 Landfill

2.4.1.1 Time-Critical Removal Action

A TCRA was conducted in May 2009 when MCB Hawaii personnel discovered that a portion of the landfill fronting the shoreline had receded, which exposed construction and demolition waste. The eroded area was along the shoreline fronting the Mokapu Central Drainage Channel on the eastern side of the H-3 entrance to MCB Hawaii. This drainage channel is interconnected with historical fish ponds, which are considered sensitive ecological habitat and are frequented by several endangered species, including the Hawaiian stilt. The purpose of the TCRA was to provide temporary remedial slope stabilization. The temporary remedial slope stabilization was to remain in place until completion of

follow-on design analysis. Approximately 510 square feet of the landfill side slope was temporarily stabilized as part of the TCRA (AECOM 2011). The TCRA included the following activities:

- Measured water quality parameters (pH, turbidity, dissolved oxygen [DO], percent saturation, salinity, and temperature) prior to, during, and following construction activities.
- Installed a floating silt curtain in the surface water adjacent to the slope repair area.
- Consolidated loose waste against the base of the slope.
- Stacked sandbags forming a vertical wall against the consolidated waste to cover sharp edges and provide suitable substrate.
- Excavated a keyway at the toe of the slope.
- Placed excavated keyway material into voids in the face of slope.
- Laid non-woven, 16-ounce per square yard, geotextile on the slope face and down into keyway.
- Placed competent, crushed armor stone (4 to 8 inches in diameter) in the keyway and up against the slope repair area.

The final keyway dimensions were measured as 1 foot deep by 1.5 feet wide by 34 feet long, which was a slight variation from the proposed design of 2 feet deep by 2 feet wide by 34 feet long. Site conditions did not allow for excavation of the keyway to 2 feet wide as designed because the stability of the side walls could not be maintained and the material was too soft to excavate to 2 feet below ground surface (bgs). This deviation was not considered significant as the installed keyway dimensions provide adequate protection against toe erosion.

In addition, other portions of the landfill side slopes, including the portion that fronts the drainage channel/fish ponds, were observed to be steep with evidence of erosion or scour at the toe. The observation of erosion indicated that a study of the entire landfill cover would be necessary to evaluate whether the landfill cover at the H-3 Landfill site is still protective and if the site conditions are stable.

2.4.1.2 Engineering Evaluation/Cost Analysis

In 2012, an engineering evaluation/cost analysis (EE/CA) was prepared to initiate a removal action to repair the additional landfill slopes identified as needing repair and prevent the further exposure of landfill waste to the adjacent sediments and surface water (AECOM 2012a).

In accordance with EPA guidance (EPA 1993a), removal action alternatives for the site were developed by evaluating slope stabilization options and their ability to provide a long-term solution and to protect human health. In addition, removal action alternatives were developed based on the requirements for the site, such as its location, the need for action to repair the landfill slope, and the current and anticipated future uses of the site. The selected removal action alternative will prevent further erosion damage and repair areas of erosion along the landfill slope, prevent migration of landfill waste off site, and prevent human and ecological exposure to waste on site.

Prior to further development of the removal action alternatives, the existing remedy (installed at the site as part of the TCRA) was inspected and evaluated to determine its potential use as a long-term removal action alternative. A visual inspection of the site completed in April 2011 indicated that the removal action already installed at the site is stable, and is effectively preventing further erosion damage, preventing migration of landfill waste off site, and preventing human and ecological exposure to waste on site. Therefore, the slope stabilization employed for the TCRA was included for evaluation in the EE/CA.

General removal alternatives were evaluated to identify technologies that could repair the landfill slopes and prevent the further exposure of landfill waste to the adjacent sediments and surface water. Following a preliminary evaluation of alternatives based on effectiveness, implementability, and cost, three removal action alternatives were evaluated in detail based on the nine evaluation criteria specified by the NCP (40 CFR 300.430(e)(a)(iii)) and EPA *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA 1993a). The nine evaluation criteria specified by the NCP are discussed in more detail in Section 2.9.1. Descriptions of the retained alternatives are included in Table 3. Each removal action alternative was evaluated to assess its relative performance with respect to the NCP criteria and the other alternatives. As a result, each alternative was given a rating (i.e., poor, fair, good, very good, and excellent) for each criterion according to the ability of the alternative to achieve the objectives of the criterion. The detailed and comparative analysis of the three removal action alternatives for the site using the nine evaluation criteria specified by the NCP is presented in Table 4.

Table 3: Summary of Retained Removal Action Alternatives, H-3 Landfill Slope Stabilization

Alternative	Description
Alternative 1: Rock Rip-Rap	This slope stabilization alternative includes the installation of rock rip-rap to cover the exposed waste and debris and prevent further erosion of the slope and exposure of the landfill waste and debris. Sand bags would be placed at the toe of the slope to fill voids and cover the exposed waste and debris. The slope face would then be prepared for placement of geotextile. Waste or debris would not be removed from the face but vegetation would be cleared as necessary. A non-woven 16-oz/yd^2 geotextile fabric would then be placed on slope face and keyway. Armor stone, 4-inch to 8-inch diameter, would then be placed over the repair area. The geotextile and rock would be anchored with either a 12-inch deep by 18-inch wide keyway excavated into the tidal flat at the base of the slope, or at steep locations where the tidal flat is insufficient to allow construction of a keyway, a short sheet pile wall will be installed along the waterline. Geotextile and armor stone fill would be placed behind the wall and up the slope as needed. The sheet piles would also provide permanent protection against the higher erosion velocities seen in the drainage channel along the landfill's eastern bank. Conceptually, the sheet pile wall would extend approximately 1,745 feet along the heavily eroded southeastern bank. This alternative includes mobilization and demobilization, and all workers would require HAZWOPER training. A work plan and a health and safety plan would also be prepared.
Alternative 2: Erosion Control Matting	This slope stabilization alternative includes the installation of erosion control matting to cover the exposed waste and debris and prevent the further erosion of the slope and exposure of the landfill waste and debris. Sand bags would be placed at the toe of the slope to fill voids and cover the exposed waste and debris. Waste or debris would not be removed from the face but vegetation would be cleared as necessary. A non-woven 16-oz/yd^2 geotextile fabric and an erosion control mat would then be placed over the area. Erosion control matting requires installation of an anchor trench at the top of the slope. Therefore, the matting would be placed over the entire slope, not just the eroded area. The erosion control mat would be secured with the anchor trench at the top of the slope, and with mechanical earth anchors along the slope to the base. The erosion control mat and anchor mat would then be covered with soil and hydroseeded. This alternative includes mobilization and demobilization and all workers would require HAZWOPER training. A work plan and a health and safety plan would also be prepared.
Alternative 3: No Action	No action would be taken.

HAZWOPER Hazardous Waste Operations and Emergency Response
oz/yd^2 ounce per square yard

Following the evaluation shown in Table 4, the recommended removal action alternative for the H-3 Landfill site is side slope stabilization with rock rip-rap to repair the landfill cover and prevent further erosion and exposure of the wastes on the landfill side-slopes. This alternative would mitigate potentially unacceptable risks associated with direct exposure to the wastes and the potential migration of waste off site. Implementation of the removal action was initiated in January 2012 and is expected to be completed in May 2014. A removal verification report will be prepared and submitted for review to document the side slope stabilization. In addition, the removal action will be documented in the remedial action completion report.

Table 4: Detailed and Comparative Analysis of Alternatives, H-3 Landfill Slope Stabilization

Criterion	Alternative 1: Rock Rip-Rap	Alternative 2: Erosion Control Matting	Alternative 3: No Action
Effectiveness			
Overall Protection of Human Health and Environment	Provides protection of human health and the environment because continued erosion of the slope is mitigated, and the exposed landfill waste and debris is covered, removing the exposure pathway. This alternative results in significant risk reduction. Rating: Good	Provides protection of human health and the environment because continued erosion of the slope is mitigated, and the exposed landfill waste and debris is covered, removing the exposure pathway. This alternative results in significant risk reduction. Rating: Good	Provides no protection of human health and the environment. Rating: Poor
Compliance with ARARs and TBCs	Complies with ARARs and TBCs. Rating: Good	Complies with ARARs and TBCs. Rating: Good	Does not comply with ARARs or TBCs. Rating: Poor
Short-term Effectiveness	Construction activities associated with installation of rock rip-rap would temporarily expose construction workers to the landfill waste and debris. Workers would be protected during implementation of this alternative by monitoring, PPE, and ECs to mitigate concerns about dermal contact, fugitive dust emissions, and stormwater management in accordance with OSHA 1910.120 (OSHA 1998). As discussed in the EE/CA (AECOM 2012a), about 690 tons of greenhouse gases are estimated to be emitted as a result of this removal alternative and 8,200 million British thermal units of energy used. The largest component of the greenhouse gas emissions and energy consumption is from the production of the consumable materials, which for this alternative consists of the geotextile liner, sand, armor stone, and the steel sheet piles. The largest component of the NO_X, SO_X, and PM_{10} emissions as well as the main cause of injury/fatality risks is equipment use during the construction phase. Rating: Good	Construction activities associated with installation of an erosion control mat would temporarily expose construction workers to the landfill waste and debris. Workers would be protected during implementation of this alternative by monitoring, PPE, and ECs to mitigate concerns about dermal contact, fugitive dust emissions, and stormwater management in accordance with OSHA 1910.120 (OSHA 1998). As discussed in the EE/CA (AECOM 2012a), approximately 180 tons of greenhouses gases are estimated to be emitted as a result of this removal alternative and 5,200 million British thermal units of energy used. The largest component of the greenhouses gas emissions and energy consumption is from the production of the consumable materials, which includes the bulk materials such as sand, erosion control matting, geotextile liner, and soil. The largest component of the NO_X, SO_X, and PM_{10} emissions occurs as result of equipment use during removal action operations and maintenance, which in this case is mowing the grass and vegetation on the slope face in order to prevent shrubs and bushes from penetrating the geotextile liner and matting. The injury/fatality accident risks are similar for both the equipment used to construct the erosion control matting and the mowing to maintain it over the 30-year span of the remedy. Rating: Good	Not applicable. The No Action alternative does not have short-term effectiveness or risks. Rating: Poor
Long-term Effectiveness and Permanence	Can provide long-term effectiveness and permanence. Rating: Good	Can provide long-term effectiveness and permanence. Rating: Good	Does not provide long-term effectiveness. Rating: Poor
Reduction of Toxicity, Mobility, and Volume through Treatment	Does not provide reduction of toxicity, mobility, or volume through treatment. Rating: Poor	Does not provide reduction of toxicity, mobility, or volume through treatment. Rating: Poor	Does not provide reduction of toxicity, mobility, or volume through treatment. Rating: Poor

Criterion	Alternative 1: Rock Rip-Rap	Alternative 2: Erosion Control Matting	Alternative 3: No Action
Implementability			
Feasibility and Availability of Services	Uses conventional equipment for excavation, installation of sheet piles, and placement of geotextile fabric and rock rip-rap. The required materials are readily available on-island. Multiple on-island contractors are available and qualified to perform the work. In addition, this is a proven technology that has already been implemented at a portion of the landfill and is performing as designed. Rating: Excellent	Uses conventional equipment for excavation, placement of sandbags, and placement of geotextile fabric and erosion control mat. The required materials (including geotextile fabric and erosion control mat) are readily available on-island. Multiple on-island contractors are available and qualified to perform the work. However, this technology is not proven for application over landfill material, and it is not known if installation of the required anchors into the landfill material is feasible. In addition, the tidal environment may corrode the metal anchors. Rating: Poor	Not applicable.
Projected Regulatory Agency Acceptance	While regulatory agencies generally prefer treatment technologies that chemically destroy or alter contaminants, the EPA presumptive remedy for landfills is containment. Therefore, regulatory agency acceptance is expected. Rating: Very Good	While regulatory agencies generally prefer treatment technologies that chemically destroy or alter contaminants, the EPA presumptive remedy for landfills is containment. Therefore, regulatory agency acceptance is expected. Rating: Very Good	It is unlikely that regulatory agencies would accept the no action alternative because it does not mitigate the potential risks from landfill waste. Rating: Poor
Projected Community Acceptance	The public finds this alternative acceptable based on the lack of public comments. Rating: Good	The public finds this alternative acceptable based on the lack of public comments. Rating: Good	It is anticipated that the public would not find this alternative acceptable. Rating: Poor
Cost	$2,543,866 Rating: Poor	$999,318 Rating: Good	$0 Rating: Excellent
Overall Ranking	Very Good	Good	Poor

NO_x nitrogen oxides
OSHA Occupational Safety and Health Administration
PM_{10} particulate matter with an aerodynamic diameter of less than or equal to a nominal 10 micrometers
PPE personal protection equipment
SO_x sulfur oxides
TBC to be considered

2.5 SITE CHARACTERISTICS

2.5.1 Site Overview

This section describes the site characteristics at the H-3 Landfill. Site characteristics include surface features, landfill cover, meteorology, surface water, site geology, hydrogeology, and ecological habitat.

2.5.1.1 SURFACE FEATURES

The H-3 Landfill is an approximately 20-acre site located at the main entrance to MCB Hawaii at the end of the H-3 Freeway (ATT 1988). The volume of the landfill is approximately 500,000 yd^3. Currently, the site is a grassy, open area that houses the base pass and ID office and several static displays. A drainage channel and fish ponds border the south and eastern perimeter of the landfill, and the landfill side slopes are steep and have experienced erosion from either tidal and/or storm water runoff flows. In addition, a protected TLF wetland is located adjacent to the landfill. The adjacent fish ponds and TLF wetland are considered a sensitive ecological habitat and several endangered species frequent the area.

2.5.1.2 H-3 LANDFILL COVER

The purpose of the landfill cover is to protect human health and the environment. A landfill cover fulfills this purpose primarily through three functions:

- Restricting landfill gas movement.
- Promoting surface water run-off and minimizing surface water infiltration into the waste.
- Isolating wastes from human contact.

A primary role of the cover is surface water management. Effective surface water management promotes run-off from the landfill and reduces infiltration through the cover. Vegetation and cover integrity are key factors in cover performance. The performance of the cover for surface water management is primarily dependent on cover slope, cover thickness, material type, vegetation quality, and landfill stability.

The soil cover of the landfill is typically between 1 and 3 feet. The average thickness is more than 1.5 feet thick. The cover thickness and soil type provide adequate separation to prevent human contact with the waste. In addition, a surface scan of the landfill conducted as part of the RI indicated that the landfill has no issues related to landfill gas (AECOM 2012b). Well established vegetation exists on the cover and includes grasses and trees. The root system stabilizes the soils and intercepts precipitation. Deeper penetrating tree roots may provide surface water pathways through cover soil and uptake waste constituents. The water intercepting ability and evapotranspiration of the plants will help in minimizing surface water infiltration. Site inspection did not reveal any areas of distressed vegetation, bare soil, nor cracks in the cover soil (AECOM 2012b). Much of the landfill consists of gentle slopes. However, landfill side slopes along the Mokapu Central Drainage Channel are as steep as 1H:1V (horizontal: vertical). Surrounding areas to the west and northwest slope away from the site preventing surface water run-on. A limited area to the north drains toward the landfill. The topography of the landfill generally directs surface water off the landfill; however, ponding on the cover is present in two locations. The two areas of ponding are in a channel to the west of the H-3 Freeway, and also an area in the northeast portion of the landfill as indicated by the elevation contours shown on Figure 3. Surface water run-on and run-off that accumulates in low areas either infiltrates or evaporates.

Landfill stability along the perimeter side slopes is very important because a failure would cause landfill waste to slump into the water. The slope of the cover varies with location. Slopes range from very shallow to a maximum of 1H:1V along the Mokapu Central Drainage Channel. An analysis of the global stability of the landfill was performed to evaluate the site under both static and seismic conditions (AECOM 2012b). The factors of safety for the global stability are estimated to exceed 1.5 and 1.1 for static and seismic conditions respectively. The minimum acceptable factors of safety are 1.5 for static conditions and 1.0 for seismic conditions, therefore the landfill is considered stable.

The landfill was found to be stable and of suitable thickness and soil type to provide adequate containment for this site as described by the presumptive remedy for landfills. Therefore, characterization of the landfill material was not required. In addition, there were no issues with landfill gas. Additional evaluation of the groundwater and sediments in and around the landfill was conducted as part of the RI and discussed in Sections 2.5.3 and 2.5.4.

2.5.1.3 METEOROLOGY

The Hawaiian climate is temperate oceanic. There are two defined seasons, summer (from May through September) and winter (from October through April). Summer is characterized by northeast trade winds, partly cloudy skies, and scattered light showers. Winter has slightly cooler temperatures and higher rainfall. Tropical storms are likely once every year or two. The seasonal temperature variation on Mokapu Peninsula is 6 degrees Fahrenheit (°F). The average daily temperature variation is 9°F. Daily temperatures vary from the high 60s (°F) or low 70s to the high 70s or low 80s. The mean annual rainfall at the Mokapu Peninsula weather station is 38 inches. Approximately 75 percent of the annual rainfall occurs from October through April, with January typically being the wettest month (average rainfall is 5.5 inches). The daily relative humidity ranges from about 69 percent to about 80 percent. Relative humidity is fairly constant throughout the year (ATT 1988).

Summer trade winds are moderate to strong. Winter winds are light and sometimes variable. Wind speeds can vary between 9 to 95 miles per hour. The median annual wind speed is 34 miles per hour. Prevailing wind direction is from the east northeast over 90 percent of the time (ATT 1988).

2.5.1.4 SURFACE WATER

Surface runoff from the portion of the landfill west of H-3 Freeway likely flows directly into Kaneohe Bay. In the northeastern portion of the landfill, a shallow pond (which is an established wetland [TLF wetland]) extends southwest to northeast and contains water the majority of the time. When the TLF wetland reaches capacity, water likely discharges east to the Mokapu Central Drainage Channel, which is a large drainage channel that surrounds the eastern and southern portions of the landfill and discharges to Kaneohe Bay. Surface water runoff from the eastern portion of the landfill discharges either directly into the Mokapu Central Drainage Channel or the shallow TLF wetland. In the eastern portion of the landfill and Halekou Pond, shallow groundwater and surface water are likely hydraulically continuous, and the shallow groundwater may mix with the waters of Mokapu Central Drainage Channel and Halekou Pond. This mixing may be augmented by tidal action (ATT 1988).

Surface water samples collected from the Mokapu Central Drainage Channel during the TCRA (AECOM 2011) were monitored for pH, turbidity, DO, percent saturation, salinity, and temperature. The samples were collected on the southern tip of the landfill, upstream and downstream from the landfill repair area (AECOM 2011). The results of the chemistry parameters are summarized below:

- pH ranged from 7.44 to 8.31.
- Maximum turbidity at the site was 59.2 nephelometric turbidity units.

- DO ranged from 2.46 to 9.30 milligrams per liter.
- Percent saturation ranged from 40.30 to 140.10.
- Salinity ranged from 32.80 to 38.50 parts per thousand (ppt).
- Temperature ranged from 24.28 to 30.13 degrees Celsius.

2.5.1.5 SITE GEOLOGY

The Mokapu Peninsula is located along the northeast flank of the Koolau Mountain Range. The peninsula was formed on the eroded surface of older Koolau volcanics by successive reef building and geologically recent volcanic activity. Geologic conditions on the peninsula are characterized by a thick surface soil layer overlying relatively thick sedimentary deposits consisting of unconsolidated to semi-consolidated calcareous materials, volcanic alluvium, and weathered volcanics. The sedimentary deposits extend to depths between 1,000 and 3,000 feet bgs. The Koolau basalts underlie the sedimentary deposits (ATT 1988).

The landfill site comprises land reclaimed from Kaneohe Bay. Surface soil comprises fill material and waste, underlain by unconsolidated calcareous sands containing abundant coral fragments. The landfill area adjacent to the shoreline of Halekou Pond and Kaneohe Bay is covered by approximately 4 to 10 feet of fill. The fill comprises clayey and sandy silts containing varying amounts of coralline limestone fragments, metal, plastic, wood, and household debris (ATT 1988).

H-3 Landfill Cover. The cover soils on the flatter top areas of the landfill generally include silty materials. The cover soils on the steep side slopes are sandier in nature. The cover soil is underlain by a sequence of intermixed soil and waste (concrete rubble, metal, glass, wood, plastic, and household debris) with an average thickness of approximately 6.5 feet. The waste and debris are underlain by dense silty and clayey coralline sand and gravel with occasional layers of soft/loose silty clay (AECOM 2012b).

2.5.1.6 HYDROLOGY

Groundwater. The hydrogeology of the peninsula is relatively complex due to inter-layered geologic units, including sedimentary formations with relatively low permeability that act as barriers and restrict or impede shallow groundwater flow. Groundwater gradients vary locally because of this phenomenon. Previous studies indicate that the groundwater within the H-3 Landfill likely migrates laterally into adjacent bodies of water (Kaneohe Bay, Heleloa Pond, and Halekou Pond) and adjacent marshlands, as well as vertically into the underlying soils. There is also some indication that the deeper drinking water aquifer in the Koolau Basalts is under artesian pressure, which prevents any potential migration of the shallow groundwater into the deeper formation (ATT 1988).

During the CS field investigation, the shallow groundwater was encountered between 4 to 12 feet bgs. Groundwater table elevations were reportedly between 1.4 feet and 2.2 feet above mean sea level (msl). Based on this groundwater level data, the CS concluded that the groundwater flows in a southwesterly direction toward Kaneohe Bay under a very slight gradient from inland areas (ATT 1988). Groundwater elevations collected on 9 December 2010 during the RI ranged from 6.81 feet bgs (1.35 feet above msl) to 14.08 feet bgs (1.42 feet above msl). Groundwater depths and elevations are presented in Table 5. Based on the 9 December 2010 gauging data, the groundwater gradient was generally flat, showing a slight groundwater gradient toward Kaneohe Bay and the Mokapu Central Drainage Channel (Figure 3). However, the predominant flow direction for the site is estimated to be toward Kaneohe Bay as previously determined.

Table 5: Groundwater Elevation (AECOM 2012b)

Well	Time	Depth to Groundwater from TOC (ft)	TOC Elevation (ft above msl)	Water Level Elevation (ft above msl)
MW-1	1518	7.85	9.24	1.39
MW-3	1521	6.81	8.16	1.35
MW-4	1506	14.08	15.50	1.42
MW-7	1512	10.24	11.82	1.58
MW-8	1450	13.59	14.93	1.34
MW-9	1456	11.89	13.31	1.42

Note: Based on data collected on December 9, 2010 (AECOM 2012b).
ft feet
MW monitoring well
TOC top of casing

Information obtained during the CS indicates that the groundwater elevation is likely affected by one or more outside influences, which may include the following (ATT 1988):

- Tidal variations within Kaneohe Bay and the other adjacent bodies of water
- Surface water infiltration during rainy periods of the year, which could create perched or elevated water conditions within the landfill
- Variations in subsurface conditions within the landfill, which could create internal boundaries or other conditions that affect groundwater levels and flow patterns

2.5.1.7 VEGETATION, ENDANGERED SPECIES, AND ECOLOGICAL HABITAT

The site includes both upland and wetland areas. Portions of the upland area exist as maintained (mowed) lawn. Dominant vegetation includes Koa haole (*Leucaena leucocephala*), and guinea grass (*Panicum maximum*). Additional vegetation identified on site includes coconut palms (*Cocos nucifera*), hala (*Pandanus tectorius*), ironwood (*Casuarina equisetifolia*), California grass (*Brachiaria mutica*), and Bermuda grass (*Cynodon dactylon*). The shoreline vegetation is dominated by pickle weed (*Batis maritima*), with scattered red mangrove (*Rhizophora mangle*) extending into the water, and Indian fleabane (*Pluchea indica*), and pago (*Hibiscus tillaceus*) above the normal high tide elevation.

The landfill is bordered by Heleloa Pond on the southwest, and by Halekou Pond on the east and southeast (Figure 2). These ponds are part of an eight-member Nuupia Ponds complex connecting the narrow neck of Mokapu Peninsula to the main island of Oahu. The shallow waters of the ponds are interconnected with each other and Kaneohe Bay through a series of culverts. This former early Hawaiian fish pond complex is now Marine Corps-owned and -managed as a protected wetland/endangered species habitat eligible for listing in the National Register of Historic Places and is known as the Nuupia Ponds Wildlife Management area (ATT 1988). In addition, a protected jurisdictional wetland (TLF wetland) is located adjacent to the landfill, to the northeast (AECOM 2012b). The TLF wetland is also considered a habitat for protected species such as the Hawaiian stilt. These wetlands are part of the Koolaupoko ecosystem, an inter-related patchwork of small but essential habitat fragments for endangered Hawaiian water birds and migratory waterfowl. MCB Hawaii wetlands represent a significant piece of this network and the wetland management activities provide important regional benefits for these bird populations. Studies have confirmed that individual water birds (e.g., Hawaiian stilt) move around the regional wetlands to various nesting and feeding sites based on variables such as water quality, food availability, time of year, and human and predator disturbance. The MCB Hawaii wildlife management area hosts 10 percent of the endangered Hawaiian stilt's population. The Hawaii stilt and three other endangered water birds

(Hawaiian coot, moorhen, and duck) and over 60 species of native and migratory birds have been recorded here. Regular surveys, such as the bi-annual State of Hawaii sponsored water bird survey and the Hawaii Audubon sponsored Christmas Bird Count, continue to be conducted at MCB Hawaii and provide valuable data on species presence and population trends. One example is the noticeable increase in the number of koloa and hybrid koloa (Hawaiian ducks) present over the past 10 years (MCB Hawaii and SRG 2011). In addition, exhibit C5-1 of the *Marine Corps Base Hawaii Integrated Natural Resources Management Plan Update* (MCB Hawaii and SRG 2011), indicates that (although the counts can vary from year to year) the Hawaiian stilt population has been steadily increasing since counting began in 1947. A survey of endangered water bird utilization of available habitat on MCB Hawaii was conducted in 2006–2007. The survey documents the cumulative results of wetland and watershed improvement projects, documents Hawaiian stilt productivity, and records foraging and nesting use by other Hawaiian birds in the study areas (e.g., the wetlands located in the Nuupia Ponds). The survey results, which are supported by several decades of State and Hawai'i Audubon sponsored bird counts, indicate that MCB Hawaii wetlands continue to serve an important function in supporting seasonal visits by a wide diversity of migratory waterfowl and resident water birds (MCB Hawaii and SRG 2011).

2.5.2 Conceptual Site Model

The conceptual site models (CSMs) (Figure 4 and Figure 5) provide a basis for understanding present site conditions by incorporating site-specific physical characteristics, nature and extent of contaminants in the physical system, and potential migration pathways/receptors. Media evaluated in the CSMs included subaqueous surface sediment, groundwater, and surface water. Receptors evaluated included the excavation/construction worker, the occupational worker, and the adult and child recreational visitors.

Exposure pathways included for the quantification of health risks include complete pathways from contact with various media surrounding the site that may have been contaminated as a result of chemicals leaching from the landfill material. Such pathways consist of incidental ingestion and dermal contact with sediment, as well as incidental ingestion and dermal contact to either groundwater or surface water. No attenuation or dilution factor was applied to groundwater data to assess exposure to surface water. It was assumed that chemicals of potential concern (COPCs) detected in groundwater would be detected in surface water at the same concentrations.

Groundwater on site is not a source of drinking water for any receptor. Groundwater has been encountered between 4 and 12 feet bgs; however, it is tidally influenced from Kaneohe Bay and, as a result, has a high salinity.

2.5.3 Sampling Strategy

A RI/FS was conducted to evaluate RA alternatives for the H-3 Landfill to ensure the landfill remains protective of human health and the environment and provide adequate information for decision makers (AECOM 2012b). The sampling strategy for the RI/FS incorporated various field techniques and methodologies for sampling groundwater, surface water, and sediment at the site; conducting a visual site inspection (VSI); completing a surface scan; and visually observing the extent of the landfill by digging shallow test pits. Sampling locations and shallow test pit locations selected for the investigation are shown on Figure 6.

A VSI was performed to assess the stability of the side slopes and determine the presence of fissures or gaps in the landfill cover. A surface scan of the landfill was performed in order to assess the presence of landfill gas, to provide an initial assessment of the continuity of the landfill cover, and to evaluate whether any landfill gas is escaping the cover.

A total of 10 shallow soil samples (SB-01 through SB-10) were collected from the H-3 Landfill for geotechnical analysis including particle size using the ASTM International (ASTM) D422 (ASTM 2007) and Atterberg Limits using ASTM D4318 (ASTM 2005). The locations were used to visually evaluate the thickness of the soil cover (Figure 6). A total of 21 surface sediment samples (SS-01 through SS-21) were collected and analyzed for semivolatile organic compounds (SVOCs), PAHs, PCBs, organochlorine pesticides, total organic carbon (TOC), and total metals and mercury. Two groundwater monitoring wells (MWs) (MW-8 and MW-9) were installed and samples were collected from the two new and four existing MWs (MW-1, MW-3, MW-4, and MW-7) to evaluate whether the H-3 Landfill has impacted the groundwater with COPC concentrations above the risk-based screening criteria (Figure 6). Volatile organic compounds (VOCs), SVOCs, PAHs, PCBs, organochlorine pesticides, TOC, dissolved metals, and mercury, and general chemistry parameters were included in the analyte list based on the characteristics of the wastes reportedly disposed of in the H-3 Landfill.

Eight test pits (T-02, T-03, T-04, T-07A, T-07B, T-09, T-10, and T-12) were excavated at locations along the estimated limit of the landfill boundary to verify the extent of the landfill (Figure 6). Additional test pits were originally planned but were abandoned due to either subsurface conditions or the presence of utilities.

Surface water samples were collected from the TLF wetland and analyzed for general chemistry parameters and COPCs including SVOCs, PAHs, organochlorine pesticides, PCBs, and metals. In addition, one surface water sample was collected from the Mokapu Central Drainage Channel (in the area closest to the wetland) to evaluate the hydraulic connectivity of the TLF wetland and the Central Drainage Channel. This surface water sample was analyzed for general chemistry parameters only.

2.5.4 Nature and Extent of Contamination

2.5.4.1 Sources

The H-3 Landfill was the MCB Hawaii main waste disposal area from 1940 to 1972. Wastes disposed of in the landfill were reported to include lead, mercury, pesticides, paints, solvents, thinners, waste petroleum oils and lubricants, waste fuels, corrosive liquids, transformer oils, and tear gas (ATT 1988). The RI results indicate that the carcinogenic and non-carcinogenic risks from the associated chemicals detected at the site (as discussed below) are acceptable for the current and future site use.

2.5.4.2 Surface Sediment

Metals. A total of 13 metals were detected in surface sediment at concentrations exceeding PALs: antimony, arsenic, cadmium, total chromium, cobalt, copper, iron, lead, manganese, nickel, silver, thallium, and zinc (Figure 7). Other metals, such as aluminum, barium, beryllium, calcium, magnesium, molybdenum, potassium, selenium, vanadium, and mercury were detected in sediment samples but at concentrations that did not exceed the PAL. The majority of maximum levels of metals exceedances in sediments were collected from the TLF wetland, the inland listed wetland adjacent to the landfill. Several metals were also detected in sample SS-20. As sediment sample SS-20 was collected in the channel upgradient of the landfill, the sample represents sediments potentially impacted by up-stream sources of contamination unrelated to historical activities at the H-3 Landfill. There were also several metals detected in SS-08, which is located along the eastern edge of the landfill adjacent to Halekou Pond. Every sediment sampling location had at least two exceedances, including arsenic and nickel. The concentrations of arsenic and nickel are relatively consistent across the site. Metals concentrations from the samples collected in Kaneohe Bay are generally lower than concentrations from other samples. Concentrations detected in the upgradient samples (SS-20 and SS-21 were collected upgradient from the landfill boundary) are similar to or higher than concentrations detected in

sediments collected from adjacent to the landfill, suggesting there might be other contributing sources to the metals observed in sediments near the landfill. However, the drainage channel is subject to tidal variations, which could also account for these concentrations.

Organochlorine Pesticides. A total of six organochlorine pesticides were detected in surface sediment at concentration exceeding PALs: 4,4′-dichlorodiphenyldichloroethane (DDD), 4,4′-dichlorodiphenyldichloroethylene (DDE), 4,4′-dichlorodiphenyltrichloroethane (DDT), dieldrin, endrin, and methoxychlor (Figure 8). 4,4′-DDD and 4,4′-DDT were only detected in sampling location SS-07 located on the southeast corner of the site, bordering Mokapu Central Drainage Channel. Methoxychlor was only detected in SS-14, located in the TLF wetland. 4,4´-DDE was detected in a majority of the samples, however, concentrations were varied across the site with no discernible pattern. Concentrations of 4,4′-DDE and dieldrin in upgradient sample SS-20 were similar to concentrations detected in samples collected from adjacent to the landfill. This could indicate there are other contributing sources to the contaminants observed in sediments near the landfill. However, there were no exceedances of organochlorine pesticides in samples collected from SS-21, which is further upgradient of the site than SS-20. In addition, as stated previously, tidal fluctuations could also account for the concentrations that were observed in upgradient samples SS-20 and SS-21. The majority of exceedances were detected in the southern tip of the landfill, at SS-03, SS-04, SS-05, SS-06, SS-07, SS-08, and SS-09. Exceedances were also detected in the inland wetland of the landfill. The most widespread detections were of 4,4′-DDE and dieldrin.

PCBs as Congeners. PCBs as congeners were detected in seven surface sediment sampling locations (in eight total samples) at concentrations exceeding PALs. Exceedances are shown on Figure 9. Concentrations of total PCBs as congeners were reported in SS-08, SS-09, SS-14, SS-16, SS-17, SS-18, and upgradient sampling location SS-20. Exceedances were detected in the TLF wetland, along the eastern edge of the landfill (SS-08 and 09) and in upgradient sample SS-20 (there were no exceedances in SS-21).

PAHs. The following 12 PAHs were detected in surface sediment at concentrations exceeding PALs: acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b,k)fluoranthene, benzo(g,h,l)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, pyrene, and total PAHs (Figure 10). Sediment sampling location SS-07, on the southeast corner of the landfill bordering Halekou Pond, had the most exceedances of PAHs, compared to the other sediment sampling locations at the site. Several exceedances were also detected in SS-14, SS-16, SS-17, SS-18, and SS-19 from the inland wetland. Exceedances were also detected at SS-03 and SS-04 (located on either side of the main entrance road to the base), SS-12 located toward the northern end of the landfill, and in SS-20 (the upgradient sampling location). The most widespread detections were of benzo(a)pyrene, benzo(b,k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)-pyrene.

Summary. No SVOCs were detected at levels exceeding PALs in surface sediment. The majority of exceedances in metals appear to be concentrated in the TLF sediment wetland samples, in SS-07, SS-08, and SS-09 along the southwestern edge of the landfill, and in upgradient sediment sample SS-20. Concentrations detected in the upgradient samples (SS-20 and SS-21 were collected upgradient from the landfill boundary) are similar to or higher than concentrations detected in sediments collected from adjacent to the landfill. The sampling location SS-21, which is further upgradient than SS-20, had several exceedances of metals but no other COPCs were detected in SS-21. The current distribution of COPCs in sediments suggests there could be upgradient influences of metals (as suggested by the number of detections in SS-21); however, this could also be attributable to background levels of metals in the surrounding soils that are deposited into the channel and result as sediment in the channel.

2.5.4.3 GROUNDWATER

Metals. A total of six metals (barium, cobalt, copper, lead, nickel, and zinc) were reported in groundwater at concentrations exceeding PALs (Figure 11). Concentrations of copper and lead were reported exceeding PALs in four of the six wells (MW-1, MW-3, MW-4, and MW-7). Concentrations of zinc were reported exceeding PALs in four of the six wells (zinc concentrations in MW-8 and MW-9 did not exceed PALs). Concentrations of cobalt exceeding PALs were detected in two wells (MW-8 and MW-9). Nickel was detected in MW-8 at concentrations exceeding the PAL and barium was detected in MW-3 at concentrations exceeding the PAL. Although other metals (including mercury) were detected in groundwater, those detections did not exceed PALs. As shown on Figure 11, copper, lead, and zinc were also detected in MW-7, the upgradient well. This suggests that concentrations of copper lead, and zinc in groundwater may not be solely attributable to the H-3 Landfill, but also an alternate upgradient source.

PCBs as Congeners. PCB exceedances were detected in MW-1 and MW-3, the groundwater monitoring wells on the west side of the landfill property, bordering Kaneohe Bay (Figure 11).

Summary. No organochlorine pesticides, SVOCs, VOCs, or PAHs were detected at levels exceeding PALs in any of the groundwater samples collected. Metals and PCBs were the only COPCs detected in groundwater from the site. Concentrations of copper, lead, and zinc in the upgradient MW (MW-7) were similar to or higher than concentrations of COPCs detected from the onsite MWs. While the groundwater at the site is also subject to tidal influences, MW-7 is located more than 800 feet inland, which suggests that concentrations of copper lead, and zinc in groundwater may not be solely attributable to the H-3 Landfill.

2.5.4.4 SURFACE WATER

Metals. Two metals (arsenic and mercury) were detected in surface water at concentrations exceeding the PALs (Figure 12). Although other metals were detected in surface water, those detections did not exceed PALs.

PCBs as Congeners. PCBs as congeners were detected in surface water samples SW-01 and SW-02 (Figure 12). Concentrations of total PCBs were reported to exceed PALs in both samples.

Summary. No organochlorine pesticides, SVOCs, or PAHs were detected at levels exceeding PALs in any of the surface water samples collected. Metals (arsenic and mercury) and PCBs were the only COPCs detected in surface water from the TLF wetland at concentrations that exceeded PALs.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

2.6.1 Land Uses

The current land use is considered industrial and is an active MCB. In addition, the site includes the base Pass and ID office, several static displays intended for recreational visitors, and it is located adjacent to a Wildlife Management Area. Possible future use scenarios at this site may include the construction of occupational or recreational buildings; however, because the site is a landfill, future LUCs will limit the allowed use of the site (i.e., residential use is not considered a reasonably expected future land use scenario). The residential use scenario would only be a viable alternative if all the landfill material were to be removed. The Nuupia Ponds Wildlife Management area adjacent to the H-3 Landfill is owned and managed by the Marine Corps as a protected wetland/endangered species habitat and may have recreational use.

2.6.2 Groundwater and Surface Water Uses

Previous studies indicate that the groundwater within the H-3 Landfill likely migrates laterally into adjacent bodies of water (Kaneohe Bay, Heleloa Pond, and Halekou Pond) and adjacent marshlands, as well as vertically into the underlying soils. There is also some indication that the deeper drinking water aquifer in the Koolau Basalts is under artesian pressure, which prevents any potential migration of the shallow groundwater into the deeper formation (ATT 1988).

The salinity of the shallow groundwater encountered at the perimeter of the landfill ranged from 2 to 32 ppt, indicating that the groundwater is under tidal influence from Kaneohe Bay and the adjacent fish ponds. Because of the salinity of the shallow groundwater, it is not considered a source of potable water (ATT 1988).

2.7 SUMMARY OF SITE RISKS

Chemicals in sediment, surface water, and groundwater detected at concentrations above conservative PALs were identified as COPCs and further evaluated in a human health and ecological risk assessment. Chemicals detected above PALs in surface sediment samples collected at the H-3 Landfill included metals, pesticides, PCBs, and PAHs. Chemicals detected in groundwater samples that exceeded PALs included metals and PCBs. Chemicals detected in surface water samples that exceeded PALs included metals and PCBs. Non-detected chemical concentrations in surface sediment, groundwater, and surface water samples were also screened against DOH environmental action levels (EALs) (DOH 2011) and EPA regional screening levels (RSLs) (EPA 2012). Those chemicals that had levels of detection that exceeded screening criteria were further evaluated.

A risk assessment is ultimately an integrated evaluation of historical, chemical, analytical, environmental, demographic, and toxicological data that is as site-specific as possible, with each parameter having an associated uncertainty. To minimize the effects of the uncertainties in the evaluation, each step is biased toward protective health estimations. Because each step builds on the previous one, the biased approach compensates for the risk assessment uncertainties.

2.7.1 Human Health Risk Assessment

The baseline HHRA addressed the potential for human health to be adversely affected because of exposure to COPCs detected at the project site. The complete HHRA is included in the RI/FS (AECOM 2012b). A description of exposure pathways reasonably anticipated for each impacted medium at the H-3 Landfill is presented in the CSMs (Figure 4 and Figure 5) and summarized below.

2.7.1.1 SUMMARY OF POTENTIAL RECEPTORS AND EXPOSURE PATHWAYS

Occupational Workers

Occupational workers were evaluated via assessment of potential exposure conditions. Specifically, the occupational worker was assumed to be people who work in the base Pass and ID Office, guards at the main gate, or landscapers and maintenance workers. These occupational workers are assumed to contact COPCs through exposure to groundwater that has migrated to surface water surrounding the site and surface water within the TLF wetland, which is incidentally ingested and dermally contacted. Additionally, the occupational worker is assumed to contact sediment via incidental ingestion and dermal contact. Both of these exposure scenarios would most likely be infrequent, which has been accounted for in the exposure assumptions. There are no volatile COPCs present in sediment or groundwater, thus inhalation of volatiles migrating to indoor air is an incomplete exposure pathway.

Construction Worker

The construction worker was selected as a receptor being potentially exposed to chemicals through exposure to surface sediment, groundwater, and groundwater that has migrated to surface water along with surface water within the TLF wetland. The construction worker could be exposed to COPCs in sediment via incidental ingestion and dermal contact while excavating. In addition, the construction worker could be exposed to COPCs in groundwater or surface water through incidental ingestion and dermal contact also during excavation or construction activities. There are no volatile COPCs present in sediment, groundwater, or surface water, thus inhalation of volatiles is an incomplete exposure pathway for the construction worker.

Recreational Visitor

Recreational visitors (adult/child) were evaluated assuming exposure parameters that are relevant to potential exposure conditions. The recreational visitor was assumed to be visitors to the Pass and ID Office or nearby residents walking or riding the bike path bordering the site. The recreational visitors were selected as a receptor being potentially exposed to chemicals through exposure to groundwater that has migrated to surface water surrounding the site and surface water within the TLF wetland via incidental ingestion and dermal contact. In addition, they are thought to be exposed through incidental ingestion and dermal contact with sediment. There are no volatile COPCs present in sediment or groundwater, thus inhalation of volatiles is an incomplete exposure pathway. Additionally, while a recreational user may at some time trespass onto the property and fish, the property is a highly controlled area and fishing is not allowed in the area of the fish ponds or near the shores of Kaneohe Bay. As a result, such occurrences would be infrequent and any exposure is likely insignificant.

2.7.1.2 Summary of Baseline Human Health Risk Assessment Results for each Exposure Scenario

Using the analytical results of subaqueous surface sediment samples, groundwater samples, and surface water samples from within the TLF wetland, the baseline HHRA evaluated the potential cancer risks and noncancer health hazards associated with exposure of potential receptors to the H-3 Landfill. Results show that the potential incremental lifetime cancer risks (ILCRs) for all receptors at the H-3 Landfill are below or within the EPA target cancer risk management range of 10^{-6} to 10^{-4}. In addition, the total hazard indexes (HIs) for all receptors are either below or equal to the EPA target HI of 1. A summary of the cancer and noncancer site-specific risks to human receptors at the H-3 Landfill is discussed in Table 6.

Table 6: Summary Cancer Risk and Non-Cancer Hazards at the H-3 Landfill

Receptor	Excavation/ Construction Workers	Occupational Workers	Adult Recreational Visitors	Child Recreational Visitors
Reasonable Maximum Exposure				
ILCR				
ILCR (surface sediment)	1E–06	2E–05	1E–05	3E–05
ILCR (groundwater)	2E–07	NA	NA	NA
ILCR (surface water)	2E–07	5E–06	4E–06	1E–06
ILCR (TLF surface water)	2E–06	4E–05	4E–05	2E–05
Total ILCR	3E–06	7E–05	5E–05	5E–05
HQ				
HQ (surface sediment)	0.3	0.2	0.2	1
HQ (groundwater)	0.02	NA	NA	NA
HQ (surface water)	0.02	0.02	0.01	0.05

Receptor	Excavation/ Construction Workers	Occupational Workers	Adult Recreational Visitors	Child Recreational Visitors
HQ (TLF surface water)	0.08	0.08	0.03	0.07
Total HI	0.4	0.3	0.2	1
Central Tendency Exposure				
ILCR				
ILCR (surface sediment)	2E–07	2E–07	2E–07	6E–07
ILCR (groundwater)	5E–08	NA	NA	NA
ILCR (surface water)	5E–08	9E–07	6E–07	2E–07
ILCR (TLF surface water)	4E–07	9E–06	5E–06	2E–06
Total ILCR	8E–07	1E–05	6E–06	3E–06
HQ				
HQ (surface sediment)	0.07	0.003	0.003	0.03
HQ (groundwater)	0.004	NA	NA	NA
HQ (surface water)	0.004	0.002	0.0003	0.001
HQ (TLF surface water)	0.02	0.01	0.002	0.002
Total HI	0.1	0.02	0.01	0.03

HQ hazard quotient
NA not analyzed for
RME reasonable maximum exposure

2.7.2 Ecological Risk Assessment

The ERA estimated risks to ecological receptors potentially exposed to chemicals that may have been released to sediment or groundwater because of past disposal practices at the H-3 Landfill. The ERA is divided into two tiers based on Navy ERA guidance (DON 2003). Tier 1 is the ecological screening risk assessment (SRA) that uses a conservative approach to identify COPCs in the various site media. Chemicals that pass the conservative Tier 1 screening step are removed from further consideration as risk drivers. Those chemicals that fail the Tier 1 screening are evaluated in Tier 2, Step 3a, which is part of the problem formulation phase of a baseline ecological risk assessment (BERA). In Tier 2, Step 3a the COPCs and exposure pathways identified in Tier 1 are reassessed using less conservative, more realistic exposure assumptions to better identify those COPCs that are likely to cause adverse effects to ecological receptors and eliminate those COPCs retained because of the conservative nature of the Tier 1 process. The complete ERA is included in the RI/FS (AECOM 2012b).

2.7.2.1 TIER 1 CONCLUSIONS/RECOMMENDATIONS

In the Tier 1 ecological SRA, it was determined that complete exposure pathways exist from the H-3 Landfill to groundwater/surface water and sediment where aquatic and benthic organisms could be exposed to site-related chemicals. In turn, water birds feeding on aquatic and benthic organisms could be indirectly exposed to site-related chemicals. Table 7 presents a summary of the COPCs recommended for further evaluation in Tier 2, Step 3a. This assessment illustrated that there is a concern for ecological receptors from contaminated groundwater, surface water, and sediment at the H-3 Landfill that warrants further attention.

Table 7: Summary of Final Tier 1 COPCs Recommended for Evaluation in the Tier 2, Step 3a BERA

COPC	Sediment Screen (AE 3)	Sediment Assessment Endpoint: Black-Crowned Heron (AE 2)	Sediment Assessment Endpoint: Black-Necked Stilt (AE 1)	Surface Water Screen (AE 4)	Surface Water Assessment Endpoint: Black-Crowned Heron (AE 2)	Surface Water Assessment Endpoint: Black-Necked Stilt (AE 1)	Groundwater Screen (AE 4)	Groundwater Assessment Endpoint: Black-Crowned Heron (AE 2)	Groundwater Assessment Endpoint: Black-Necked Stilt (AE 1)
Aluminum	—	HQ = 9	HQ = 30	—	—	—	—	—	—
Antimony	Exceeds SQV	—	—	—	—	—	—	—	—
Arsenic	Exceeds SQV	—	HQ = 1	—	—	—	—	—	—
Cadmium	Exceeds SQV	—	HQ = 1	—	—	—	—	—	—
Chromium	Exceeds SQV	HQ = 1	HQ = 5	—	—	—	—	—	—
Cobalt	—	—	—	—	—	—	Exceeds EAL	—	—
Copper	Exceeds SQV	—	HQ = 3	—	—	—	Exceeds EAL	—	—
Iron	Exceeds SQV	HQ = 20	HQ = 70	—	—	—	—	—	—
Lead	Exceeds SQV	HQ = 5	HQ = 20	—	—	—	Exceeds EAL	—	—
Manganese	Exceeds SQV	—	—	—	—	HQ = 1	—	—	—
Mercury	Exceeds SQV	—	HQ = 1	Exceeds EAL	HQ = 6	HQ = 10	DL > EAL	—	—
Nickel	Exceeds SQV	HQ = 2	HQ = 7	—	—	—	Exceeds EAL	—	—
Silver	Exceeds SQV	—	—	—	—	—	—	—	—
Thallium	—	—	HQ = 1	—	—	—	—	—	—
Vanadium	—	HQ = 2	HQ = 10	—	HQ = 4	HQ = 10	—	—	HQ = 2
Zinc	Exceeds SQV	—	HQ = 1	—	—	—	Exceeds EAL	HQ = 2	HQ = 6
4,4'-DDD	Exceeds SQV	—	—	DL > EAL	—	—	DL > EAL	—	—
4,4'-DDE	Exceeds SQV	—	—	DL > EAL	—	—	DL > EAL	—	—
4,4'-DDT	Exceeds SQV	—	—	DL > EAL	—	—	DL > EAL	—	—
Chlordane (technical)	—	—	—	DL > EAL	—	—	DL > EAL	—	—
Aldrin	DL > SQV	—	—	—	HQ=1	—	—	—	—
Dieldrin	Exceeds SQV	HQ = 3	HQ =9	DL > EAL	—	—	DL > EAL	—	—
Endosulfan I	DL > SQV	—	—	—	—	—	—	—	—
Endosulfan Sulfate	DL > SQV	—	—	—	—	—	—	—	—
Endrin	Exceeds SQV	HQ = 2	HQ = 7	DL > EAL	—	—	DL > EAL	—	—
Gamma-BHC	DL > SQV	—	—	—	—	—	—	—	—
Methoxychlor	Exceeds SQV	—	—	—	—	—	—	—	—
Heptachlor	—	—	—	DL > EAL	—	—	DL > EAL	—	—
Heptachlor epoxide	DL > SQV	—	—	DL > EAL	—	—	DL > EAL	—	—
Total endosulfan	DL > SQV	—	—	—	—	—	—	—	—

COPC	Sediment Screen (AE 3)	Sediment Assessment Endpoint: Black-Crowned Heron (AE 2)	Sediment Assessment Endpoint: Black-Necked Stilt (AE 1)	Surface Water Screen (AE 4)	Surface Water Assessment Endpoint: Black-Crowned Heron (AE 2)	Surface Water Assessment Endpoint: Black-Necked Stilt (AE 1)	Groundwater Screen (AE 4)	Groundwater Assessment Endpoint: Black-Crowned Heron (AE 2)	Groundwater Assessment Endpoint: Black-Necked Stilt (AE 1)
Total PCBs	Exceeds NOAA Environmental Research Laboratories	—	HQ = 1	Exceeds EAL	HQ = 4	HQ = 3	Exceeds EAL	—	—
4-Chloraniline	—	—	—	DL > EAL	—	—	—	—	—
2,4-Dimethylphenol	DL > SQV	—	—	—	—	—	—	—	—
Hexachlorobenzene	DL > SQV	—	—	—	—	—	—	—	—
Diethyl phthalate	—	—	—	DL > EAL	—	—	—	—	—
Dimethyl phthalate	—	—	—	DL > EAL	—	—	—	—	—
Hexachlorobenzene	—	—	—	—	—	—	—	—	—
Acenaphthene	Exceeds SQV	—	—	—	—	—	—	—	—
Benzo(a)anthracene	Exceeds SQV	—	—	DL > EAL	—	—	DL > EAL	—	—
Benzo(a)pyrene	Exceeds SQV	—	—	DL > EAL	—	—	DL > EAL	—	—
Benzo(b)fluoranthene	—	—	—	DL > EAL	—	—	DL > EAL	—	—
Benzo(b,k)fluoranthene	Exceeds SQV	—	—	—	—	—	—	—	—
Benzo(g,h,i)perylene	Exceeds SQV	—	—	DL > EAL	—	—	DL > EAL	—	—
Indeno(1,2,3-cd)pyrene	—	—	—	DL > EAL	—	—	DL > EAL	—	—
Chrysene	Exceeds SQV	—	—	—	—	—	—	—	—
Dibenzo(a,h)anthracene	Exceeds SQV	—	—	—	—	—	—	—	—
Fluoranthene	Exceeds SQV	—	—	—	—	—	—	—	—
Pyrene	Exceeds SQV	—	—	—	—	—	—	—	—
Total PAHs	—	—	—	—	—	—	—	—	—

— concentration or dose does not exceed screening level
AE assessment endpoint
DL detection limit
NOAA National Oceanic and Atmospheric Administration

Groundwater. A total of 21 COPCs in groundwater were retained for further evaluation in Tier 2. Maximum detected concentrations for 6 of the 21 COPCs exceeded the EAL while 14 COPCs had detection limits that exceeded the EAL. For the black-crowned night heron and the black-necked stilt, 2 COPCs (i.e., vanadium and zinc) had a hazard quotient (HQ) >1.

Surface Water. A total of 21 COPCs in surface water were retained for further evaluation in Tier 2. Maximum detected concentrations for 2 of the 21 COPCs exceeded the EAL while 16 COPCs had detection limits that exceeded the EAL. For the black-crowned night heron and the black-necked stilt, 5 COPCs (i.e., manganese, mercury, vanadium, aldrin, and total PCBs) had an HQ ≥1.

Sediment. A total of 39 COPCs detected in sediment were retained for further evaluation in Tier 2. Maximum detected concentrations for 27 of the 39 COPCs exceeded the EPA Region 3 sediment quality values (SQVs) while 8 of the COPCs had detection limits that exceeded the SQV (EPA Region 3 2006). For the black-crowned heron, 8 COPCs had an HQ ≥1 while 15 COPCs had an HQ ≥1 for the black-necked stilt.

2.7.2.2 Scientific/Management Decision Point

The Tier 1 ecological SRA was submitted to the DOH for regulatory review. A scientific management decision point conference call was conducted on 28 April 2011 with the DOH and Navy risk managers to discuss the Tier 1 results. There was agreement that the receptors, exposure pathways, and COPCs identified in the Tier 1 SRA would be carried forward for further evaluation in a Tier 2, Step 3a BERA for the H-3 Landfill.

2.7.2.3 Tier 2, Step 3a Conclusions/Recommendations

No-observed-adverse-effects level (NOAEL)-based ecotoxicity reference values (ERVs) were used in the SRA to protect wildlife species at the individual level. This may be appropriate to protect threatened or endangered species where the loss of one individual may have an adverse effect on the survival of the population. However, the conservative use of NOAEL-based ERVs may overestimate risk to populations of non-endangered species. Lowest-observed-adverse-effect level (LOAEL)-based ERVs were used in the BERA in conjunction with the NOAEL-based ERVs to establish a range of risk for sediment, surface water, and groundwater for consideration by risk managers in making risk management decisions for the site. Generally, the preliminary remediation goals are established at a level bounded by the NOAEL and LOAEL ERVs. Chemicals with a NOAEL-based HQ less than 1 do not present a risk to individual wildlife and no further action is necessary to protect wildlife. Chemicals with a LOAEL-based HQ value greater than 1 could cause adverse effects to wildlife receptor populations and require risk management actions. Chemicals with a NOAEL-based HQ greater than 1 but a LOAEL-based HQ value less than 1 could cause adverse effects to individual wildlife receptors but are unlikely to cause adverse effects to wildlife populations (indeterminate risk) and be subject to risk management considerations. All those chemicals with a NOAEL-based HQ equal to or greater than 1 and the associated LOAEL-based HQ are listed in Table 8.

Table 8: Summary of Chemicals with Tier 2 Food Chain NOAEL- and LOAEL-Based HQs Exceeding 1

	Black-Crowned Night Heron		Black-Necked Stilt	
COPC	NOAEL-Based HQ	LOAEL-Based HQ	NOAEL-Based HQ	LOAEL-Based HQ
Groundwater				
Vanadium	<1	<1	1	<1
Zinc	2	<1	4	<1

COPC	Black-Crowned Night Heron		Black-Necked Stilt	
	NOAEL-Based HQ	LOAEL-Based HQ	NOAEL-Based HQ	LOAEL-Based HQ
Surface Water				
Mercury	4	<1	9	<1
Vanadium	3	<1	7	<1
Total PCBs	3	<1	2	<1
Sediment				
Chromium	<1	<1	2	<1
Lead	<1	<1	3	<1
Nickel	1	<1	3	<1
Vanadium	<1	<1	5	<1
Dieldrin	<1	<1	1	<1
Endrin	<1	<1	2	<1

The results of the site-specific Tier 2, Step 3a BERA for the H-3 Landfill surface sediment, surface water, and groundwater show risk of adverse effects from the presence of site-related chemicals are within NOAEL-based HQ and LOAEL-based HQ ranges. The risk of adverse effects to wildlife through food chain exposure to site-related chemicals in surface sediment, surface water, and groundwater is acceptable for the protection of water bird populations although adverse effects may occur in some individuals and, therefore, the site is subject to risk management consideration.

The RA selected in this DD is necessary to protect public health, welfare, or the environment from actual or threatened releases of hazardous substances into the environment.

2.8 RESPONSE ACTION OBJECTIVES

This section describes the RAOs identified for the project site. RAOs consist of media-specific objectives for protecting human health and the environment. RAOs specify COPCs, exposure routes, receptors, and an acceptable contaminant level or range of levels for each exposure route (i.e., remediation goals). Current and anticipated future site land use scenarios must also be considered during RAO development.

Results from the RI reveal that COPCs above the PALs are present in sediment, groundwater, and surface water at the site. COPCs exceeding the PALs are presented in Figure 7 through Figure 12. However, the risks to human health are within the risk management ranges for receptors (occupational workers, construction workers, and recreational visitors) and for all potential pathways (groundwater, surface water, and sediments in the wetland and drainage channel). In addition, the RI indicated that while there are some risks to benthic organisms and individual wildlife receptors, risks to wildlife populations are within the NOAEL-based HQ and LOAEL-based HQ for all potential pathways (groundwater, surface water, and sediments in the wetland and drainage channel). The risks to ecological receptors are therefore subject to risk management considerations. Because all COPCs were within the risk management ranges, COCs and cleanup levels were not developed for this site. In addition, the current land use of the H-3 Landfill site is considered industrial and is an active MCB; no land use changes are proposed for this site. Therefore, the following RAOs were identified to address the impacted media at the site:

- Ensure that contaminants and waste remain on site.
- Prevent migration of contaminants off site.
- Prevent disturbance of contaminants from the site, which would result in greater environmental degradation than that of existing conditions.

The implementation of the recommended removal action alternative described in Section 2.4.1.2, side slope stabilization with rock rip-rap, addresses the first two RAOs. Stabilization of the side slopes will ensure that contaminants and waste remain on site and will prevent migration of wastes off site. In addition, it will prevent further erosion and exposure of the wastes on the landfill side-slopes, and thus mitigate potentially unacceptable risks to individual wildlife receptors associated with direct exposure to the wastes and potential migration of waste materials and constituent chemicals. Implementation of the removal action was initiated in January 2012 and is expected to be completed in May 2014.

2.9 DESCRIPTION AND COMPARATIVE ANALYSIS OF RESPONSE ACTION ALTERNATIVES

This section describes the final RA alternatives, the alternative evaluation process, and the alternative selected as the final remedy for the H-3 Landfill. Detailed evaluation of the RA alternatives and the rationale for recommending the alternative selected as final remedy is presented in the RI/FS (AECOM 2012b).

2.9.1 Description of Response Action Alternatives

RA alternatives were evaluated to identify technologies that could potentially satisfy the final RAOs for the project site as presented in Section 2.8. RA alternatives are broad classes of actions that may meet the RAOs for a site, and can include treatment, containment, excavation, extraction, disposal, institutional actions (e.g., LUCs), or a combination of these actions. The following alternatives for the final RA were evaluated in detail in the RI/FS (AECOM 2012b):

- *Alternative 1:* No Further Action
- *Alternative 2:* LUCs (in combination with the Side Slope Stabilization implemented under the removal action)
- *Alternative 3:* Clean Closure (no LUCs) – Excavate Contaminated Sediments and Landfill Material, and Transport to an Off-Island, CERCLA-Approved Solid Waste Landfill

2.9.1.1 DESCRIPTION OF REMEDY COMPONENTS

Alternative 1: No Further Action. The no further action alternative is required by CERCLA as a baseline to reflect current conditions without remediation. This alternative is used for comparison with each of the other alternatives. The implementation of side slope stabilization (AECOM 2012a) will repair the landfill cover, prevent further exposure of landfill waste to the adjacent sediments and surface water, and ensure the landfill cover is protective. The no further action alternative assumes that site conditions will be left in their current state. For this RA alternative, no additional action would be conducted to prevent exposure to, removal of, or containment of the landfill material.

Alternative 2: LUCs (in combination with the Side Slope Stabilization implemented under the Removal Action). The implementation of side slope stabilization (AECOM 2012a) will repair the landfill cover, prevent further exposure of landfill waste to the adjacent sediments and surface water, and ensure the landfill cover is protective. Following implementation of the side slope stabilization, additional safeguards are necessary to ensure that human health and the environment remain protected. This goal can be achieved with LUCs. The HHRA and ERA determined that risk from

COPCs in the groundwater, surface water, and sediments are within the risk management range for human and ecological receptors. Therefore, LUCs would be implemented to provide protection to future receptors and ensure current conditions remain protective for onsite occupational workers and trespassers/recreational visitors. LUCs would also provide protection of ecological receptors by ensuring the landfill material and wetland sediments are not disturbed, which could result in increased exposure.

Side slope stabilization to repair the landfill cover and the implementation of LUCs meets the substantive requirements of the presumptive remedy for landfills because it will ensure the continued protection of human health and the environment. Alternative 2 would implement LUCs, specifically ICs to prevent disturbance and exposure to landfill waste (Figure 13).

Future actions associated with the LUC alternative are expected to be easy to implement, effective in protecting human health and the environment, and cost effective. Therefore, this alternative was retained for further evaluation.

Alternative: 3 Clean Closure (Excavate Contaminated Sediments and Landfill Material, and Transport to an Off-Island, CERCLA Approved Solid Waste Landfill). Sediments in the wetland would be removed by excavation. Approximately 762 yd^3 of sediments in the wetland would be removed (Figure 14). Sediment confirmation samples would be collected from the excavation bottom to ensure the vertical extent of impacted sediment has been removed. Once the results of the confirmation samples are below the PALs, a waste profile would be created for all of the excavated media in accordance with the requirements of the offsite, CERCLA-approved solid waste landfill facility. Once the waste profile has been accepted by the landfill facility, the sediment would be prepared for shipment. The sediment would be loaded into flexible intermediate bulk containers (FIBCs). The FIBCs will then be packed into maritime containers approved for solid waste transport and mobilized to the harbor by truck and an authorized disposal company. These containers would then be sent to a CERCLA-approved facility off island.

Alternative 3 also includes excavating all remaining site waste for disposal off site, leaving the site safe for human and ecological receptors and allowing unrestricted use (Figure 14). Total volume of media to be removed is estimated to be approximately 500,000 yd^3, assuming a conservative 10-foot average depth of excavation across the entire site. The excavated area will be backfilled with clean soil to a revised grade as agreed upon with the MCB Hawaii. For planning purposes it is estimated that approximately 300,000 yd^3 of fill material will be needed. The site would then be revegetated with indigenous flora. In this alternative, LUCs (i.e., ECs and ICs), long-term monitoring, and compliance reporting will not be required.

2.9.1.2 Common Elements and Distinguishing Features of Each Alternative

Alternative 1: No Further Action. This alternative does not comply with the identified ARARs and to be considered (TBC) criteria because no additional controls would be placed on the site to ensure the long-term protection of the landfill cover. In addition, this alternative does not reduce toxicity, mobility, or volume through treatment. The implementation is easy and has no cost since the alternative requires no further action.

Alternative 2: LUCs (in combination with the Side Slope Stabilization implemented under the Removal Action). Alternative 2 would provide protection of human health because the LUCs prevent human receptors from conducting activities on the site that would increase their health risk. LUCs would prevent physical disturbances of the surface cover or sediments in the TLF wetland. Environmental protection would be enhanced by limiting disturbance; therefore reducing the potential for exposure to contaminated sediment and landfill waste. Alternative 2 also satisfies the

substantive requirements of the presumptive remedy applied to military landfills containing municipal or low-hazard military-specific waste (EPA 1996). Alternative 2 provides for containment through the existing landfill cap and the placement of LUCs. The data indicate that there is no landfill gas present and groundwater is not impacted to a significant extent; therefore, future sampling and monitoring of the site is unnecessary.

This alternative complies with the identified ARARs and TBC criteria. Alternative 2 would achieve long-term effectiveness. However, contaminated sediment and waste would remain in place at the site, requiring implementation of LUCs and CERCLA five-year reviews (42 U.S.C. sections (§§) 9601-9675) as long as contamination remains at the site. The LUCs and annual inspections would ensure that the contaminated areas are not disturbed and potential routes for exposure are not created by future land use changes. Because the contaminated sediment and waste will not be removed from site, the toxicity, mobility, or volume would not be reduced through treatment.

This alternative is technically feasible. The cost to implement the LUCs under Alternative 2 is estimated to be $493,508.00. The total cost to implement this alternative (including the cost for slope stabilization) is $3,037,374.00.

Alternative: 3 Clean Closure (Excavate Contaminated Sediments and Landfill Material, and Transport to an Off-Island, CERCLA Approved Solid Waste Landfill). Alternative 3 would provide protection of human health and the environment by removing contaminated sediment and waste. The alternative increases the mass of waste material at the disposal facility, which is mitigated by recycling excavated concrete and placement of waste in a facility specially designed to receive the waste and to ensure long-term containment of the waste through monitoring. Additional audits of the disposal facility performed by the DOH, as required by the CERCLA Off-Site Rule, would further ensure protection of public health and environment.

The alternative complies with the identified ARARs and TBC criteria. Because the contaminated sediment and waste would be removed from the site, the alternative would achieve long-term effectiveness and permanence because contaminated media are removed from the site and replaced with clean, locally sourced fill material. Following removal, long-term effectiveness for the alternative would be continued because the contaminated media would be contained within a facility specially designed, constructed, and monitored to receive such wastes. This alternative does not comply with the EPA preference for treatment because the toxicity, mobility, or volume of contamination will not be reduced through treatment. The contaminated sediments and waste would no longer remain on site, but would be transferred to another landfill.

The alternative will be implemented by using conventional equipment for excavation, transport, and disposal. Since this action involves movement of landfill waste and sampling to confirm removal of contamination, verification of RAOs is straight forward. However, since waste was placed in the old fish pond, there is waste below groundwater, which would make excavation of saturated material difficult (excavated material may require dewatering). Currently, one facility (PVT Landfill) on Oahu is approved to accept CERCLA waste. However, wastes generated from this site have been classified as hazardous. Therefore, it is likely that at least a portion of the waste generated from this alternative would require off-island disposal. The procedures for pre-shipment acceptance manifest requirements and transport and disposal are reliable and easily implemented. However, containerizing and shipping off-island would be more difficult to implement. The estimated cost for this alternative is $701,321,488.00.

2.9.1.3 EXPECTED OUTCOMES OF EACH ALTERNATIVE

Alternative 1: No Further Action. Alternative 1 provides no additional protection of human health and the environment beyond that which presently exists. It is anticipated that the regulatory agencies and community would not find this alternative to be acceptable due to the potential future risks that may remain.

Alternative 2: LUCs (in combination with the Side Slope Stabilization implemented under the Removal Action). Currently, the land use is restricted for industrial use only and would not change in the future. Although Alternative 2 will meet all of the RAOs, regulatory agencies prefer remedies that destroy contaminants or include treatment. The public had no comments on this alternative and therefore it is anticipate they would find this alternative acceptable. Additional RAs could be required if the regulatory agencies do not concur that the remedy serves as the final remedy since contaminants will be left on site.

Alternative: 3 Clean Closure (Excavate Contaminated Sediments and Landfill Material, and Transport to an Off-Island, CERCLA Approved Solid Waste Landfill). Removal of all impacted media at the site would result in no potential exposure for future receptors; therefore, the future site use would be unrestricted. However, regulatory agencies prefer remedies that destroy contaminants or include treatment. Regulatory agencies also prefer remedies that do not involve off-island disposal. The public had no comments on this alternative and therefore it is anticipate they would find this alternative acceptable.

2.10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

2.10.1 Evaluation Criteria

The RA alternative analysis was based on the nine criteria specified by the NCP (40 CFR 300.430(e)(a)(iii)) and EPA guidance for conducting RIs and FSs under CERCLA (EPA 1988). The NCP criteria are listed in Table 9.

Table 9: NCP Criteria for Analysis of Response Action Alternatives

Criterion	Application of Criterion and Rating on 5-Tiered Scale
Threshold Criteria	
Overall Protectiveness of Public Health and the Environment	Application: Assesses the ability of an alternative to eliminate, reduce, or control the risks associated with exposure pathways, including direct contact, potential migration, and risks to ecosystems. Rating: Excellent if highly protective. Poor if not protective.
Compliance with ARARs	Application: Evaluates the potential of an alternative to comply with chemical-, location-, and action-specific ARARs and TBC criteria. Rating: Excellent if compliant. Poor if non-compliant.
Primary Balancing Criteria	
Long-Term Effectiveness and Permanence	Application: Measures the ability of an alternative to permanently protect human health and the environment. Rating: Excellent if highly effective. Poor if not effective.
Reduction of Toxicity, Mobility, or Volume Through Treatment	Application: Evaluates the ability of an alternative to permanently or significantly reduce the toxicity, mobility, or volume of the constituents through treatment. Rating: Excellent if reduces all contaminants of concern. Poor if no reduction.
Short-Term Effectiveness	Application: Assesses the capability of an alternative to protect human health and the environment during implementation of a RA. Rating: Excellent if highly effective. Poor if not effective.

Criterion	Application of Criterion and Rating on 5-Tiered Scale
Implementability	Application: Evaluates technical feasibility and the difficulty of applying the alternative at the site, the reliability of the technology, the unknowns associated with the alternative, and the need for treatability studies. Assesses administrative requirements, including regulatory agency approval, permits and waivers, mobilization needs, accessibility of equipment, and availability of trained personnel required to implement the alternative. Rating: Excellent if highly feasible and available. Poor if not feasible and available.
Cost	Application: Assesses the capital, operation, and maintenance costs of each alternative. Rating: Excellent if < $1 Million. Poor if >$4 Million.
Modifying Criteria	
Regulatory Agency Acceptance	Application: Evaluates the likelihood of approval by the regulatory agencies. Rating: Excellent if highly acceptable. Poor if not acceptable.
Public Acceptance	Application: Assesses the anticipated level of acceptance by the public. Rating: Excellent if highly acceptable. Poor if not acceptable.

The first two criteria (i.e., overall protection of human health and the environment, and compliance with ARARs and TBC criteria) are threshold criteria representing the statutory requirements that a RA must achieve in order to comply with CERCLA requirements. The next five criteria (i.e., long-term effectiveness and permanence; reduction in toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost) are the primary balancing criteria upon which selection of a RA is based. Together, these first seven criteria are considered evaluation criteria; the final two criteria (i.e., state and public acceptance) are considered modifying criteria.

The following sections compare the relative performance of each RA alternative with respect to the NCP criteria to identify the most appropriate final remedy for the H-3 Landfill.

2.10.2 Detailed Analysis of Alternatives

Each RA alternative was evaluated against the NCP criteria listed in Table 9 and rated for general effectiveness, implementability, and cost. The ratings for each alternative were then compared to assess their relative performance and identify the most appropriate alternative for the final remedy. A summary of the RA alternative analysis is presented in Table 10. A five-tiered scale (poor, fair, good, very good, and excellent) was then applied to each of the final alternatives as shown in Table 11, which assesses the relative performance of each alternative and select the preferred alternative.

The cost estimates for Alternative 2 and Alternative 3 were developed using the DoD cost-estimating software program *Remedial Action Cost Engineering and Requirements* (RACER), which bases cost estimates on historical cost averages for individual activities, adjusted for typical cost variations within the general region of the subject site.

2.11 PRINCIPAL THREAT WASTE

The NCP establishes an expectation that treatment will be used to address the principal threats (i.e., source material that is highly toxic and/or highly mobile) posed by a site wherever practicable. No highly toxic or highly mobile source material was identified at the H-3 Landfill; therefore, no principal threat wastes exist.

Table 10: Evaluation of Response Action Alternatives

Evaluation Criteria	Alternative 1: No Further Action	Alternative 2: LUCs (in combination with the Side Slope Stabilization implemented under the Removal Action)	Alternative 3: Clean Closure (Excavation, Dredging, and Disposal)
Threshold Criteria			
Overall Protection of Human Health and the Environment	Provides no additional protection of human health and the environment beyond that which presently exists.	Would provide protection of human health because the LUCs prevent human receptors from conducting activities on the site that would increase their health risk. LUCs would prevent physical disturbances of the surface cover or sediments in the TLF wetland. Environmental protection would be enhanced by limiting disturbance; therefore reducing the potential for exposure to contaminated sediment and landfill waste.	Would provide protection of human health and the environment by removing contaminated sediment and waste. Increases the mass of waste material at the disposal facility, which is mitigated by recycling excavated concrete and placement of waste in a facility specially designed to receive the waste and to ensure long-term containment of the waste through monitoring. Additional audits of the disposal facility performed by the DOH, as required by the CERCLA Off-Site Rule, would further ensure protection of public health and environment.
Compliance with ARARs and TBCs	Does not comply with all the identified ARARs and TBC criteria because no further action is taken to ensure the long term protection of human health and the environment.	Complies with the identified ARARs and TBC criteria.	Complies with the identified ARARs and TBC criteria.
Primary Balancing Criteria			
Long-Term Effectiveness and Permanence	Provides no long-term effectiveness or permanent protection.	Would achieve long-term effectiveness. However, contaminated sediment and waste would remain in place at the site, requiring implementation of LUCs and CERCLA five-year reviews (42 U.S.C. §§9601-9675) as long as contamination remains at the site. The LUCs and annual inspections would ensure that the contaminated areas are not disturbed and potential routes for exposure are not created by future land use changes.	Would achieve long-term effectiveness and permanence because contaminated media are removed from the site and replaced with clean, locally sourced fill material. Following removal, long-term effectiveness for the alternative would be continued because the contaminated media would be contained within a facility specially designed, constructed, and monitored to receive such wastes.
Reduction in Toxicity, Mobility, and Volume Through Treatment	Does not reduce toxicity, mobility, or volume through treatment.	Would not reduce toxicity, mobility, or volume through treatment.	Would not reduce toxicity, mobility, or volume through treatment.

Evaluation Criteria	Alternative 1: No Further Action	Alternative 2: LUCs (in combination with the Side Slope Stabilization implemented under the Removal Action)	Alternative 3: Clean Closure (Excavation, Dredging, and Disposal)
Short-Term Effectiveness	Requires no short-term physical disturbances, but would not prevent physical disturbances.	Would not involve short-term physical disturbances, and thus would be protective in the short-term. The onsite activities required for this alternative would have a very minor effect on economic and natural resources, ecology, human health and safety, and quality of life. Less than 1 ton of GHGs are estimated to be emitted as a result of this alternative and 5.8 MMBTUs of energy used. The largest component of the NO_x, SO_x, and PM_{10} emissions as well as the main cause of injury/fatality risks is from transportation of personnel to and from the site for annual and five-year site inspections.	This alternative would be hazardous to workers due to past records documenting drums, ordnance, etc. Workers would be protected during implementation of this alternative with monitoring, personal protective equipment, and ECs to mitigate concerns about fugitive dust emissions. Transport of non-hazardous materials is not considered dangerous; however, heavy equipment and multiple daily trips to the landfill and recycling sites elevate the risks to transport workers and surrounding populations. Additionally, removal operations would also increase risk. Approximately 182,000 tons of GHG emissions are estimated as a result of this alternative and 2,100,000 MMBTUs of energy used. The largest component of the GHG emissions and energy consumption is from the transportation of personnel and equipment, which includes the transportation of 782,000 tons of excavated landfill waste by barge from Honolulu Harbor to the receiving harbor at Long Beach, CA. The largest component of the NO_x, SO_x, and PM_{10} emissions occurs as result of residual waste handling, which in this case is emissions related to transportation via semi-truck of the containerized 500,762 yd^3 of excavated sediment and waste both from the project site to Honolulu Harbor and from the receiving harbor at Long Beach, CA to the off-island disposal facility at Kettleman City, CA (>20,000 two hundred mile road-driven trips).
Implementability	Easily implemented since the alternative requires no further action.	This alternative is technically feasible and could be readily implemented within 1 year.	Uses conventional equipment for excavation, transport, and disposal. Since this action involves movement of waste and sampling to confirm removal of contamination, verification of RAOs is straight forward. However, since waste was placed in the old fish pond, there is waste below groundwater, which would make excavation of saturated material difficult (excavated material may require dewatering). Therefore, it is anticipated that implementation of this alternative could take more than 1 year. Currently, one facility (PVT Landfill) on Oahu is approved to accept CERCLA waste. However, wastes generated from this site have been classified as hazardous. Therefore, it is likely that at least a portion of the waste generated from this alternative would require off-island disposal. The procedures for pre-shipment acceptance manifest requirements and transport and disposal are reliable and easily implemented. However, containerizing and shipping off-island would be more difficult to implement.
Cost	$0.00	$493,508.00 [a] Total cost of alternative (including costs to implement side slope stabilization): **$3,037,374.00**	$701,321,488.00

Evaluation Criteria	Alternative 1: No Further Action	Alternative 2: LUCs (in combination with the Side Slope Stabilization implemented under the Removal Action)	Alternative 3: Clean Closure (Excavation, Dredging, and Disposal)
Modifying Criteria			
Regulatory Acceptance	It is unlikely that regulatory agencies would accept the no further action alternative because it does not mitigate potential risks from landfill waste.	Regulatory agencies generally prefer alternatives that employ treatment to destroy or alter contaminants. Additional response actions may be required at the site if the regulators do not concur that the action serves as a final response action.	Regulatory agencies generally prefer alternatives that employ treatment to destroy or alter contaminants. Additional response actions may be required at the site if the regulators do not concur that the action serves as a final response action.
Community Acceptance	It is anticipated that the public would not find this alternative acceptable.	There were no comments received on this alternative at the public meeting or during the public comment period, indicating the public finds this alternative acceptable.	There were no comments received on this alternative at the public meeting or during the public comment period, indicating the public finds this alternative acceptable.

GHG greenhouse gas
MMBTU one million British Thermal Units
[a] Does not include costs to implement the Side Slope Stabilization; these costs are provided in the EE/CA (AECOM 2012a).

Table 11: Response Action Alternative Ratings

Criterion	5-Tiered Scale [a]	Alternative 1: No Further Action	Alternative 2: LUCs (in combination with the Side Slope Stabilization implemented under the Removal Action)	Alternative 3: Clean Closure (no LUCs)
Overall Protectiveness of Public Health/Environment	Excellent if highly protective. Poor if not protective.	Poor	Very Good	Excellent
Compliance with ARARs	Excellent if alternative complies with all ARARs. Poor if alternative does not comply with all ARARs.	Poor	Excellent	Excellent
Long-Term Effectiveness and Permanence	Excellent if highly effective. Poor if not effective.	Poor	Very Good	Excellent
Reduction of Toxicity, Mobility, or Volume Through Treatment	Excellent if reduces all contaminants. Poor if no reduction.	Poor	Poor	Poor
Short-Term Effectiveness, including GSR Evaluation	Excellent if highly effective. Poor if not effective.	Excellent	Excellent	Fair
Implementability	Excellent if highly feasible and available. Poor if not feasible and available.	Excellent	Excellent	Fair
Capital Cost [b]	Excellent if <$1,000,000. Good if <$3,000,000. Poor if >$4,000,000.	Excellent	Excellent	Poor
Regulatory Agency Acceptance	Excellent if highly acceptable. Poor if not acceptable.	Poor	Very Good	Very Good
Public Acceptance	Excellent if highly acceptable. Poor if not acceptable.	Poor	Very Good	Very Good
Overall Ranking	—	Poor [c]	Very Good	Good

[a] The 5-tiered scale is a subjective scale that includes the following categories in decreasing order used to indicate the degree to which criteria are met: Excellent, Very Good, Good, Fair, and Poor.
[b] See detailed cost estimates in the RI/FS (AECOM 2012b).
[c] Ranked “Poor” because alternative does not meet the threshold criteria.

2.12 SELECTED FINAL REMEDY

2.12.1 Summary of the Rationale for the Selected Final Remedy

Based on the screening of RA technologies, RA alternatives, the evaluation and comparative analysis of retained alternatives, and the appropriate components of the *Presumptive Remedy for CERCLA Municipal Landfill Sites* (EPA 1993b), the recommended RA alternative is Alternative 2, LUCs (in combination with the Side Slope Stabilization implemented under the removal action). Following implementation of the removal action (i.e., side slope stabilization), the addition of LUCs would limit future exposure to subsurface waste, and is the most cost-effective alternative given the current and intended future site uses. Because Alternative 2 would not remove the contaminated sediment and waste from the site, LUCs, specifically ICs, would be implemented to prevent disturbance and exposure to landfill waste.

2.12.2 Description of the Selected Final Remedy

The elements of the selected final remedy include the following:

- Implementation of the removal action to repair the landfill cover and stabilize the side slopes
- LUCs
- Annual inspections and maintenance (as required)
- Five-year reviews

Removal Action. The implementation of the removal action (i.e., side slope stabilization) (AECOM 2012a) will prevent the further exposure of landfill waste to the adjacent sediments and surface water and will ensure the landfill cover is protective. Following implementation of the side slope stabilization, additional safeguards are necessary to ensure that human health and the environment remain protected. This goal can be achieved with LUCs.

LUCs. LUCs consist of ICs and ECs to limit disturbance and exposure to landfill waste in accordance with the presumptive remedy. ICs and ECs would ensure that all future site users and environmental regulators are aware that contamination is present at the site and that land use restrictions have been imposed.

ICs are primarily legal mechanisms imposed to ensure the continued effectiveness of land use restrictions. ICs will be placed in Marine Corps land use registries to include notice of site contamination and LUCs restricting excavation, removal, or transportation of landfill waste off site from within the site boundaries. In the event the landfill is excavated, prior written approval from the DOH must be obtained, or the waste must be properly transported to and disposed of at a facility that is acceptable for disposal of CERCLA waste under the Off-Site Disposal Rule (40 CFR 300.440). Other controls that may be required include easements, covenants, notices (in the deed and/or local newspapers), zoning, education materials, permits, and agreements with regulatory agencies.

ECs are physical mechanisms that minimize or eliminate exposure to hazardous substances. The existing soil cover will be maintained.

LUCs will be maintained until the concentrations of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure.

A remedial action work plan (RAWP) will be prepared as the land use component of the remedial design. Within 90 days of DD signature, the Marine Corps shall prepare and submit to DOH for

review and approval a RAWP that shall contain implementation and maintenance actions, including periodic inspections by the Marine Corps to address both ICs and ECs.

Annual Inspections and Maintenance. Annual site inspections will be conducted to document site conditions. If maintenance is required, the Marine Corps will take timely action to address the maintenance issues to minimize the chance of unauthorized access and disturbance of the landfill waste.

Five-Year Reviews. CERCLA five-year reviews (42 U.S.C. §§9601-9675) will be conducted to ensure that the LUC mechanisms remain in place, and to verify that legal and physical notices of LUCs are maintained until restrictions are no longer necessary to be protective. Advances in science and technology, site use exposure assumptions, relevant regulations and screening levels, and chemical toxicity values will be reviewed to ensure that that selected remedy remains protective.

2.12.2.1 Land Use Control Performance Objectives

The performance objectives of these LUCs are as follows:

- Ensure that the site is not used for any purpose that violates the objectives of the LUCs by restricting the site to industrial or commercial use only and prohibiting the development and use of this area for residential purposes, residential housing, schools, child care centers, or playgrounds.
- Minimize or eliminate direct human contact with or ingestion of landfill waste.
- Provide adequate notice of the presence of the contaminants to any potential landowners. In addition, per MCB Hawaii requirements, any party planning to excavate on the base must first apply for a dig permit with MCB Hawaii. Provide notice to dig permit applicants during the permit review process of the presence of landfill waste.
- Prevent unauthorized excavation, uncontrolled waste removal. Provide notice to dig permit applicants planning to excavate in this area that planned activities must include proper handling and disposal of landfill waste; and must prevent migration or relocation of landfill waste to areas where human or ecological exposure could occur.

LUCs will be required within the H-3 Landfill site boundaries shown on Figure 13 in perpetuity, or until it is determined that they are no longer necessary. The Marine Corps is responsible for implementing, reporting on, maintaining, and enforcing the LUCs.

Although the Marine Corps may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Marine Corps shall retain ultimate responsibility for remedy integrity.

2.12.3 Cost Estimate for the Selected Final Remedy

The information in the cost estimate summary table is based on the best available information regarding the anticipated scope of the RA alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the RA alternative. Major changes may be documented in the form of a memorandum in the AR file, an Explanation of Significant Difference, or a DD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

The estimated cost of the selected final remedy, including the implementation of the removal action and legal and administrative costs for LUC implementation and five-year reviews over 30 years, is

$3,037,374.00. The RACER cost estimate documentation report for the selected final remedy is presented in the RI/FS (AECOM 2012b).

2.12.4 Expected Outcome of the Selected Final Remedy

The selected final remedy for the H-3 Landfill site will reduce potential future human health and ecological risks associated with residual contaminants at the site and landfill material by preventing disturbance and exposure to landfill waste that could pose unacceptable risks or hazards under the current or potential future land-use scenarios. Site use will remain restricted to industrial or commercial use only. Due to the high salinity of the groundwater underlying the site, the groundwater is not currently used as a source of potable water, and will not be used as a potable water source in the future. The final remedy does not change the current or planned future land or groundwater use. The final remedy does not reduce the toxicity or volume of waste or contaminants through treatment at the site, and requires that LUCs be implemented because site conditions will not be compatible with unrestricted land use.

2.13 STATUTORY DETERMINATIONS

Under CERCLA and the NCP, the lead agency must select a remedy that is protective of human health and the environment, comply with ARARs, is cost-effective, and utilizes permanent solutions to the maximum extent practicable. The following sections discuss how the selected remedy meets these statutory requirements.

2.13.1 Protection of Human Health and the Environment

The selected remedy for the H-3 Landfill is protective of human health and the environment, complies with all ARARs, is cost-effective, and uses permanent solutions and alternative technologies to the maximum extent practicable.

The selected final remedy focuses on containment and LUCs to limit exposure pathways to COPCs that could pose unacceptable risk to human or ecological receptors. The slope stabilization with rock rip-rap will prevent the further erosion and exposure of the wastes on the landfill side-slopes, and thus mitigate potentially unacceptable risks associated with direct exposure to the wastes and potential migration of waste materials and constituent chemicals. LUCs will ensure that human health and the environment remain protected by preventing disturbance of contaminants from the site and restricting the site use to industrial or commercial.

Because this remedy results in hazardous substances, pollutants, or COPCs remaining on site above levels that allow for unlimited use and unrestricted exposure, statutory reviews will be conducted every 5 years after initiation of the selected final remedy until the site is suitable for unrestricted use, as required under CERCLA Section 121(c) and NCP (40 CFR 300.430(f)(4)(ii)). The five-year reviews will be performed to ensure that the LUCs remain protective of human health and the environment over time.

2.13.2 Compliance with Applicable or Relevant and Appropriate Requirements

Detailed discussions of the ARARs and TBC criteria that were considered to evaluate the RA alternatives and select the final remedy are presented in the FS (AECOM 2012b). The ARARs and TBC criteria identified for the selected final remedy are summarized in Table 12.

Table 12: ARARs and TBCs for the H-3 Landfill

Policy/Regulation	Issues and Requirements	ARAR/TBC Status
Chemical-specific ARARs and TBCs		
RCRA hazardous waste determination (40 CFR 261.24)	Chemical-specific criteria for the toxicity characteristic to identify RCRA hazardous waste.	An ARAR for waste generated as part of a RA at the site.
EPA RSLs for soil for residential land use (EPA 2012)	Chemical-specific human health risk-based screening requirement. Levels are based on current EPA toxicological and risk assessment data.	TBC for COPCs at the site. EPA RSLs for soil feature two sets of exposure criteria: one set of criteria for sites used for commercial or industrial purposes and a more conservative set of criteria for sites used for residential purposes. Residential soil RSLs were identified as TBC criteria for screening to evaluate the need for further investigation, RA, or no further action for soil.
DOH Tier 1 EALs (DOH 2012)	Chemical-specific human health risk-based screening requirement. Groundwater action levels for areas where potentially impacted groundwater is not a current or potential drinking water source, and where a surface water body is located within 150 meters of the release site (2011 EALs Table D-1c).	TBC for COPCs at the site. The DOH Tier 1 EALs for soil provide sets of exposure criteria designed to address specific exposure pathways and scenarios. DOH Tier 1 EALs that address the exposure pathways and scenarios that may exist in the investigation area were identified as TBC criteria for screening to evaluate the need for further investigation, response action, or no further action for soil.
EPA Region 3 BTAG 9 marine and freshwater SQVs EPA Region 3 2006[a]	Chemical-specific ecological risk-based screening criteria for sediment in both fresh water and salt water.	TBC for COPCs at the site. EPA Region 3 BTAG 9 marine and freshwater SQVs (EPA Region 3 2006) for sediment in both fresh water and salt water are included as screening levels because the previous confirmation study determined that the groundwater at this site is tidally influenced and is a mixture of fresh water and brackish water (ATT 1988).
Location-specific ARARs and TBCs		
Endangered Species Act of 1973 (16 U.S.C. §1536[a])	Conservation of endangered species or threatened species.	An ARAR for the site. All RA activities to be conducted near areas identified as containing or potentially containing endangered species or sensitive receptors will be conducted in a manner that is not likely to jeopardize the continued existence of listed species or modify their critical habitat.
Hawaii Endangered and Threatened Species Regulations (HAR 13 Part II 122, 124 [DLNR 1997], 2010)	Regulations prohibit the taking of any wild bird species including native, introduced, and past species, without obtaining a permit.	An ARAR for the site. All RA activities to be conducted near areas identified as containing or potentially containing endangered species or sensitive receptors will be conducted in a manner that is not likely to jeopardize the continued existence of listed species or modify their critical habitat.
CWA Section 401 Water Quality Certification	Regulations requiring permitting program in conjunction with the CWA Section 404 Permit, the R&HA Section 10 Permit, and the CWA Section 402 NPDES Permit.	An ARAR for the site. All RA activities will be conducted in compliance with the substantive requirements of these regulations.
CWA Section 404 DA Permit	Regulations regarding the discharge of fill material into navigable waters of the United States.	An ARAR for the site. All RA activities will be conducted in compliance with the substantive requirements of these regulations.
R&HA Section 10 DA Permit	Prohibition of the obstruction or alteration of navigable waters of the United States.	An ARAR for the site. All RA activities will be conducted in compliance with the substantive requirements of these regulations.
CWA Section 402 NPDES Construction General Permit	Regulations regarding storm water discharges from construction activities that result in land disturbance of equal to or greater than 1 acre, where discharges enter waters of the United States.	A TBC for the site because the area to be disturbed is less than 1 acre.
CZM Program Federal Consistency	Requirement for a consistency determination to assure that the project meets the state CZM Program policy guidelines.	An ARAR for the site. All RA activities will be conducted in compliance with the substantive requirements of these regulations.

Policy/Regulation	Issues and Requirements	ARAR/TBC Status
Conservation District, (HRS 183C [LUC 2008])	Regulation to conserve, protect, and preserve the important natural resources of the State through appropriate management and use.	The site is within the conservation district; therefore, this is an ARAR for the site. All RA activities will be conducted in compliance with the substantive requirements of these regulations.
Action-specific ARARs and TBCs		
Off-site Rule for CERCLA Waste (40 CFR 300.440)	Requires that wastes generated during a CERCLA action be received off site only at a facility that the EPA has determined "acceptable" to receive CERCLA wastes. Potential receiving facilities include RCRA Subtitle C and D landfills and incinerators.	Potentially an ARAR for the site. Any waste generated during the RA may require off-island disposal at a Subtitle C facility.
RCRA Hazardous Waste Determination (40 CFR 262.11)	Requires generators of solid waste to determine whether their waste is regulated as hazardous waste, according to 40 CFR 261.	Potentially an ARAR for the site. Any waste generated during the RA may be classified as hazardous under RCRA.
RCRA LDRs (40 CFR 268.40)	Non-liquid hazardous wastes containing HOCs at total concentration greater than or equal to 1,000 mg/kg cannot be disposed of in a landfill, and therefore must be incinerated.	Potentially an ARAR for the site. Although no HOCs have been detected at concentrations above RCRA criteria in landfill waste, the LDRs may apply if off-island disposal is required and HOCs are detected during waste profiling.
Ambient Air Quality Standards (40 CFR 50.6 and 50.12)	Construction and excavation actions must comply with ambient air quality standards during excavation activities.	An ARAR for the site. The RA must include monitoring of dust emissions created during excavation activities. Air pollution controls, such as dust suppression techniques, may be necessary to maintain air quality and minimize particulate emissions. Ambient air standards are PM_{10} concentrations of 50 µg/m^3 (12-month average), 150 µg/m^3 (24-hour average) and a lead concentration of 1.5 µg/m^3 (calendar–quarter average).
RCRA Subtitle D Regulations	RCRA Section 4001 of Subtitle D provides regulations to promote environmentally sound disposal methods, maximize the reuse of recoverable resources, and foster resource conservation.	A TBC for the site because the H-3 Landfill is an old landfill site not actively regulated by RCRA Subtitle D regulations.
Federal Regulatory Guidance; Presumptive Remedy for CERCLA Municipal Landfill Sites; Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills	Establishes source containment as the presumptive remedy for municipal landfill sites and similar military landfill sites.	A TBC for the site. The selected remedy will comply with these policies through containment of hazardous substances.
Federal Regulatory Guidance; DoD Policy and Guidance Document on Land Use Controls Associated with Environmental Restoration Activities for Active Installations	Used to identify, evaluate, and select appropriate LUCs (e.g., landfill cap, fencing, deed restrictions, and legal notifications) for the protection of the human health and the environment at the site. Provides guidance on implementing, documenting, and managing LUCs at active military installations.	A TBC for the site. The selected remedy will comply with these policies through implementation of LUCs.

[a] EPA Region 9 does not provide region-specific benchmarks for sediment. EPA Region 3 sediment benchmarks not region specific, incorporate commonly used benchmarks, and are an appropriate substitute.

µg/m^3 microgram per cubic meter
BTAG Biological Technical Assistance Group
CWA Clean Water Act
CZM Coastal Zone Management
DA Department of the Army
HAR Hawaii Administrative Rules
HOC halogenated organic compound
HRS Hawaii Revised Statute
LDR land disposal restriction
NPDES National Pollutant Discharge Elimination System
R&HA Rivers and Harbors Act

2.13.3 Cost-Effectiveness

The selected final remedy is cost-effective and represents a reasonable value for the expended public funding. Each RA alternative was evaluated to determine whether the overall effectiveness satisfied the cleanup criteria. The relationship of the overall effectiveness of the selected alternative was determined to be proportional to its costs. The selected final remedy is effective in meeting RAOs and protecting human health and the environment, is implementable, and is cost-effective.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected final remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner. Specifically, this alternative provides the best short- and long-term effectiveness, is protective of human health and the environment, complies with ARARs, achieves RAOs, reduces contaminant mobility, and is technically feasible. Details of the RA alternative evaluation are presented in the FS (AECOM 2012b) and are summarized in Table 10 and Table 11 of this DD.

2.13.5 Preference for Treatment as a Principal Element

This final remedy does not satisfy the statutory preference for treatment as a principal element of the final remedy. The NCP (40 CFR §300.430(a)(1)(iii)(A)) establishes the expectation that treatment will be used to address the principal threats at a site where practicable. A principal threat waste is source material with toxicity and mobility characteristics that combine to pose a potential risk greater than the risk level that is acceptable for the current or future exposure scenarios. There are no principal threat wastes at the H-3 Landfill. Because there are no principal threat wastes, treatment is not necessary as a principal element of the final remedy for the H-3 Landfill.

2.13.6 Five-Year Review Requirement

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the RA to ensure that the remedy is, or will be, protective of human health and the environment.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

The PP identified Alternative 2, LUCs in combination with the Side Slope Stabilization, as the final selected remedy for the H-3 Landfill. The PP was released for public comment on 1 May 2013. The public comment period for the PP was held between 1 May 2013 and 30 May 2013. No public comments were received. Therefore, no significant changes to the final remedy, as originally identified in the PP, were necessary or appropriate.

3. Responsiveness Summary

A public notice announcing availability for review of the PP was placed in the *Honolulu Star-Advertiser* on 29 April 2013. The public comment period for the PP was held between 1 May 2013 and 30 May 2013. The public meeting for the PP was held on 14 May 2013 at the Aikahi Elementary School. There were no written or verbal comments received on the final remedy.

3.1 Stakeholder Issues and Lead Agency Responses

The transcript of the public meeting conducted on 14 May 2013 was thoroughly reviewed by the Marine Corps. The Marine Corps, with concurrence from the DOH, has selected the final remedy for the H-3 Landfill only after careful consideration of the public's feedback on the PP.

3.2 Technical and Legal Issues

Potential technical and legal issues for the selected final remedy consist of establishing LUCs, including restrictions on future land use. The Marine Corps is responsible for ensuring long-term protection of human health at the site, and is committed to implementing the final remedy as required to achieve this objective. The Marine Corps has no foreseeable plans to transfer this property; however, if there are any changes to this plan in the future, the land owner will be responsible for compliance with the conditions of the LUCs. Any activities conducted at the H-3 Landfill site that might have impact on the integrity of the ground cover materials will require approval from the Marine Corps and concurrence from the DOH. The Marine Corps will retain ultimate responsibility for the long-term integrity of the final remedy.

Although the Marine Corps may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Marine Corps shall retain ultimate responsibility for remedy integrity.

4. References

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Attachment A
Figures

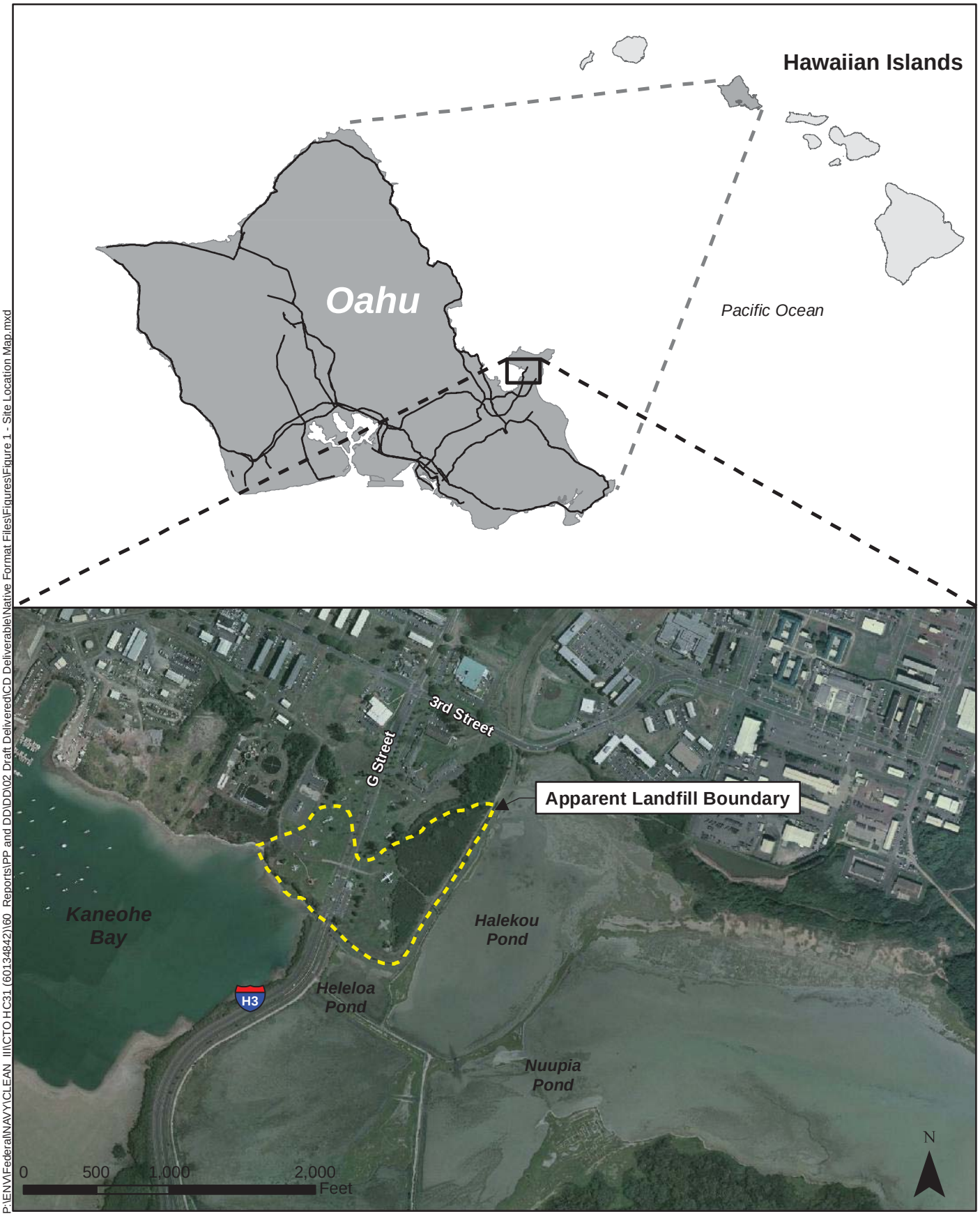

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Figure 1
Site Location Map
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

LOCATION MAP

LEGEND

- Groundwater Monitoring Well Location
- Former Monitoring Well
- Sediment Sampling Location
- Soil Boring Sampling Location
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- Nuupia Ponds Wildlife Management Area Boundary

NOTES

1. Map projection: Hawaii State Plane Zone 3, NAD83.
2. Base map source: USGS 2006.
3. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.

N

0 100 200 400 Feet

Figure 2
Project Site Map
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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LEGEND

- Groundwater Monitoring Well Location
- Former Monitoring Well
- Groundwater Table Contour (ft. msl)
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- General Groundwater Flow Direction

NOTES

1. ft = feet
2. Water table elevations are presented in feet above mean sea level (amsl). The values of water table elevation are presented below the monitoring well symbols.
3. The area between MW-4 and MW-3 and MW-8 exhibits slight groundwater flow reversal (inland). The groundwater flow reversal is most likely due to tidal fluctuations at shoreline areas.
4. The groundwater contours are generated based on groundwater level measurements collected on September 10, 2012.
5. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.
6. Map projection: Hawaii State Plane Zone 3, NAD83.
7. Base map source: USGS 2006.

N

0 100 200 400 Feet

Figure 3
Groundwater Sampling Locations and Potentiometric Water Level
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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Contributing Source	Transport Mechanism	Exposure Route	Scenario	Receptor: Onsite Occupational Worker	Receptor: Onsite Construction Worker	Receptor: Onsite Resident (Adult/Child)	Receptor: Recreational Visitor (Adult/Child)
Landfill Material							
Surface Soil	Direct Contact	Incidental Ingestion: Dermal Contact:	Current:	Incomplete	Incomplete	N/A	Incomplete
			Future:	Incomplete	Incomplete	Incomplete	Incomplete
			Rationale: Contaminated surface soil is not anticipated on the landfill surface due to a clean protective cover already in place. Available information indicates fill soil was utilized to cover the landfill in accordance with general solid waste landfill industry standards at the time of closure. This fill material is free of landfill debris or contaminants. Therefore, direct contact through incidental ingestion or dermal contact is considered incomplete for all receptors.				
	Air Transport	Inhalation of VOCs:	Current:	Insignificant	Insignificant	N/A	Insignificant
			Future:	Insignificant	Insignificant	Incomplete	Insignificant
			Rationale: VOCs may volatilize into soil air spaces from landfill material and migrate to the soil surface where they may be emitted to the atmosphere. While there is no soil data available, a surface scan using a FID was performed in which no VOCs were detected, therefore, although this pathway is complete, it is likely insignificant for the occupational worker, construction worker, and recreational visitor. In addition, because there is no residential use of the area, this pathway is considered incomplete.				
		Inhalation of Particulates:	Current:	Incomplete	Incomplete	N/A	Incomplete
			Future:	Incomplete	Incomplete	Incomplete	Incomplete
			Rationale: Contaminated surface soil is not anticipated on the landfill surface due to a clean protective cover already in place. Therefore, inhalation of surface soil particulates is considered incomplete for all receptors.				
	Bio-uptake	Ingestion of Plants/Animals:	Current:	Incomplete	Incomplete	N/A	Incomplete
			Future:	Incomplete	Incomplete	Incomplete	Incomplete
			Rationale: Because there are no agricultural activities on site and because the site is well maintained, it is expected that only non-edible species would inhabit the landfill. Therefore, it is unlikely that any receptor would ingest plants and animals from the site.				
	Stormwater Runoff to Surface Water or Sediment	Incidental Ingestion: Dermal Contact:	Current:	**Potentially Complete**	**Potentially Complete**	N/A	**Potentially Complete**
			Future:	**Potentially Complete**	**Potentially Complete**	Incomplete	**Potentially Complete**
			Rationale: COPCs in surface water and sediment are relatively inaccessible to occupational workers on the property. However, large storm surges or rain events could result in surface water or sediment migration towards more accessible areas. Construction workers could be directly exposed to surface water or sediment during excavation activities. Recreational users could be directly exposed to surface water or sediment during recreational activities. In addition, all receptors could be exposed to surface water or sediment within the inland water feature at the site. Therefore, these pathways are potentially complete. There is no residential use of the area; therefore, this pathway is considered incomplete.				
		Inhalation of VOCs:	Current:	Insignificant	Insignificant	N/A	Insignificant
			Future:	Insignificant	Insignificant	Incomplete	Insignificant
			Rationale: VOCs were not detected at the site and therefore any inhalation exposure is likely insignificant. There is no residential use of the area; therefore, this pathway is considered incomplete.				

Notes:
COPC chemical of potential concern
FID flame ionization detector
N/A non-applicable
VOC volatile organic compound

Figure 4 (page 1 of 2)
Human Health Exposure Pathway Evaluation
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

Contributing Source	Transport Mechanism	Exposure Route	Scenario	Onsite Occupational Worker	Onsite Construction Worker	Onsite Resident (Adult/Child)	Recreational Visitor (Adult/Child)
Landfill Material → Subsurface Soil	Direct Contact	Incidental Ingestion: Dermal Contact:	Current:	Incomplete	Insignificant	N/A	Incomplete
			Future:	Incomplete	Insignificant	Incomplete	Incomplete
		Rationale: COPCs in subsurface soil are inaccessible to occupational workers and recreational users on the property because they are covered by a clean soil cover. Because subsurface soil is expected to be a mixture of soil and debris, future landfill controls will limit the allowed use of the site, as well as any potential construction activities. As a result, any exposure to a construction worker is considered insignificant compared to other exposure pathways such as incidental ingestion and direct contact with sediment. In addition, there is no residential use of the area, therefore, this pathway is considered incomplete.					
	Air Transport	Inhalation of VOCs:	Current:	Incomplete	Insignificant	N/A	Incomplete
			Future:	Incomplete	Insignificant	Incomplete	Incomplete
		Rationale: COPCs in subsurface soil are inaccessible to occupational workers and recreational users on the property because they are covered by a clean soil cover and because there is no residential use of the area; these pathways are considered incomplete. VOCs were not detected at the site and therefore any inhalation exposure to the construction worker during excavation activities is likely insignificant.					
		Inhalation of Particulates:	Current:	Incomplete	Insignificant	N/A	Incomplete
			Future:	Incomplete	Insignificant	Incomplete	Incomplete
		Rationale: COPCs in subsurface soil are inaccessible to occupational workers and recreational users on the property because they are covered by a clean soil cover and because future landfill controls will limit the allowed use of the site, as well as any potential construction activities, exposure to subsurface soil for a construction worker is insignificant. In addition, because there is no residential use of the area; these pathways are also considered incomplete.					
	Leaching to Groundwater	Incidental Ingestion: Dermal Contact:	Current:	Incomplete	**Potentially Complete**	N/A	Incomplete
			Future:	Incomplete	**Potentially Complete**	Incomplete	Incomplete
		Rationale: The groundwater at this site is not a drinking water source and is therefore inaccessible to occupational workers and recreational users on the property. There is no residential use of the area, therefore, this pathway is considered incomplete. Construction workers could be directly exposed to groundwater during excavation activities. However, VOCs were not detected at the site and therefore any inhalation exposure is likely insignificant.					
		Inhalation of VOCs:	Current:	Incomplete	Insignificant	N/A	Incomplete
			Future:	Incomplete	Insignificant	Incomplete	Incomplete
		Rationale: The groundwater at this site is not a drinking water source and is therefore inaccessible to occupational workers and recreational users on the property. There is no residential use of the area, therefore, this pathway is considered incomplete. 1,2-dichloroethylene (cis) was the only VOC detected at the site and therefore any inhalation exposure to the construction worker during excavation activities is likely insignificant.					
	Groundwater Discharge to Surface water and Sediments in Kaneohe Bay or Nu'upia Ponds	Incidental Ingestion: Dermal Contact:	Current:	**Potentially Complete**	**Potentially Complete**	N/A	**Potentially Complete**
			Future:	**Potentially Complete**	**Potentially Complete**	Incomplete	**Potentially Complete**
		Rationale: Construction workers could be directly exposed to surface water or sediments during excavation activities. Recreational users could be directly exposed to surface water or sediments during recreational activities. Therefore, these pathways are potentially complete. There is no residential use of the area and surface water and sediments surrounding the site are relatively inaccessible to occupational workers; therefore, these pathways are considered incomplete.					
		Inhalation of VOCs:	Current:	Insignificant	Insignificant	N/A	Insignificant
			Future:	Insignificant	Insignificant	Incomplete	Insignificant
		Rationale: 1,2-dichloroethylene (cis) was the only VOC detected at the site and therefore any inhalation exposure from surface water or sediment is likely insignificant. There is no residential use of the area; therefore, this pathway is considered incomplete.					
	Bio-uptake	Ingestion of Fish/Shellfish:	Current:	Incomplete	Incomplete	N/A	Insignificant
			Future:	Incomplete	Incomplete	Incomplete	Insignificant
		Rationale: While a recreational user may at some time trespass onto the property and fish, the property is a highly controlled area and fishing is not allowed in the area of the fish ponds or near the shores of Kaneohe Bay. As a result, such occurrences would be infrequent and any exposure is likely insignificant. Occupational and excavation/construction workers are not expected to fish in the area and because there is no residential use of the area, these pathways are considered incomplete.					

Notes:
COPC chemical of potential concern
FID flame ionization detector
N/A non-applicable
VOC volatile organic compound

Figure 4 (page 2 of 2)
Human Health Exposure Pathway Evaluation
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

Contributing Source	Affected Media	Exposure Route	Terrestrial Receptors: Plants	Terrestrial Receptors: Soil Invertebrates	Terrestrial Receptors: Herbivores/Invertivores/ Omnivores
H3 Landfill Material	Surface Soil	Direct Contact:	Incomplete	Incomplete	Incomplete
		Incidental Ingestion:	N/A	Incomplete	Incomplete
		Food Web Transfer:	N/A	N/A	Incomplete

Rationale: Surface soil on the landfill is not anticipated to be contaminated due to a clean protective cover already in place. Available information indicates fill soil was utilized to cover the landfill in accordance with general solid waste landfill industry standards at the time of closure. This fill material is free of landfill debris or contaminants. Therefore, direct contact with Landfill COPC is not expected to occur through the surface soil exposure and the pathway is incomplete.

	Subsurface Soil	Incidental Ingestion: Direct Contact: Inhalation:	Incomplete	Incomplete	Incomplete

Rationale: Ecological receptors are not expected to come into significant contact with subsurface soils. While burrowing animals may access deeper soils, exposure to subsurface soil is considered negligible compared to that for surface soil. There are no known burrowing birds (no identified seabird nesting colonies) or mammals on site. The majority of bird and mammal exposure comes from the ingestion of food (plants and invertebrates). The majority of plant and invertebrate chemical exposure occurs in the upper 2 feet, or less, of soil. Plants may send roots into subsurface soil and some invertebrates burrow into deeper soil but most nutrient uptake by plants and most foraging by invertebrates is assumed to occur within the upper bioactive layer of soil. Less than 3 percent of exposure is from incidental soil ingestion. Therefore, all exposure pathways are incomplete for subsurface soil.

	Surface Water (Freshwater and/or Groundwater Seeps)	Ingestion:	**Incomplete**	**Incomplete**	**Incomplete**

Rationale: There are no groundwater seeps on site.

Contributing Source	Affected Media	Exposure Route	Aquatic Receptors: Aquatic Life (incl. Plankton)	Aquatic Receptors: Sediment Biota	Aquatic Receptors: Fish (all Trophic Levels)	Aquatic Receptors: Invertivorous/ Piscivorous Birds
	Groundwater Discharge/ Transition Zone	Direct Contact:	**Potentially Complete**	**Potentially Complete**	**Potentially Complete**	**Potentially Complete**

Rationale: Aquatic organisms and birds foraging in areas where groundwater discharges may come into contact with groundwater as it discharges to water bodies adjacent to the H3 Landfill site.

	Freshwater/Marine Surface Water	Direct Contact: Ingestion:	**Potentially Complete**	N/A	**Potentially Complete**	**Potentially Complete**
		Food Web Transfer:	N/A	N/A	**Potentially Complete**	**Potentially Complete**

Rationale: Aquatic organisms are directly exposed to surface water in the pond or shoreline areas that may be contaminated by groundwater discharge. Waterbirds my ingest surface water as well as invertebrates and fish that have taken-up COPC from surface water into their body tissues. This pathway is considered complete. While sediment invertebrates are exposed to overlying water, the majority of their exposure is to sediment and porewater.

	Freshwater/Marine Sediment (and/or Porewater)	Direct Contact: Ingestion:	N/A	**Potentially Complete**	**Potentially Complete**	**Potentially Complete**
		Food Web Transfer:	N/A	N/A	**Potentially Complete**	**Potentially Complete**

Rationale: Sediment invertebrates and fish may be directly exposed to COPC in sediment in the pond or shoreline areas. Waterbirds may ingest sediment as well as invertebrates and fish that have taken-up COPC from sediments into their body tissues. This pathway is considered complete. While aquatic life (surface water organisms) are potentially exposed to sediment, the majority of their exposure is to surface water.

N/A not applicable: Exposure route does not exist, or is not normally evaluated as such in ecological risk assessment.
COPC Chemical of potential concern

Figure 5
Ecological Receptors Exposure Pathway Evaluation
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

LEGEND

- Soil Boring Sampling Location
- Surface Water Sampling Location
- Sediment Sampling Location
- Test Pit Location
- Groundwater Monitoring Well Location
- Former Monitoring Well
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- General Groundwater Flow Direction

NOTES

1. ft = feet
2. Water table elevations are presented in feet above mean sea level (amsl). The values of water table elevation are presented below the monitoring well symbols.
3. Map projection: Hawaii State Plane Zone 3, NAD83.
4. Base map source: USGS 2006.
5. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.

N

0 100 200 400 Feet

Figure 6
Sampling Locations and Topographic Map
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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SS-14	
Analyte	(mg/kg)
Arsenic	48.2 J
Total Chromium	99.6 J
Cobalt	33.7 J
Copper	26.5 J
Iron	46,800 J
Nickel	145 J
Thallium	1.8 J
Zinc	193 J

SS-17*	
Analyte	(mg/kg)
Antimony	2.7
Arsenic	15.8 J
Cadmium	1.6
Total Chromium	171 J
Cobalt	41.9 J
Copper	77.3 J
Iron	95,200
Lead	55.3
Manganese	931
Nickel	231
Silver	1.1 J
Zinc	274 J

SS-15	
Analyte	(mg/kg)
Arsenic	78.9 J
Total Chromium	68.7 J
Cobalt	41.1 J
Copper	43.9 J
Iron	67,500 J
Lead	38.6 J
Manganese	764 J
Nickel	157 J
Thallium	1.6 J
Zinc	221 J

SS-18	
Analyte	(mg/kg)
Arsenic	10.4 J
Cadmium	0.9
Total Chromium	120 J
Cobalt	32.4 J
Copper	53.5 J
Iron	66,800
Manganese	654
Nickel	166
Silver	0.8 J
Zinc	151 J

SS-19	
Analyte	(mg/kg)
Arsenic	11.5 J
Cadmium	0.91
Total Chromium	109 J
Cobalt	31 J
Copper	37.8 J
Iron	59,500
Manganese	661
Nickel	165
Silver	2.6 J

SS-21	
Analyte	(mg/kg)
Arsenic	17.1 J
Total Chromium	184 J
Cobalt	48.5 J
Copper	36.5 J
Iron	80,600
Manganese	727
Nickel	289
Silver	1.5 J

SS-16	
Analyte	(mg/kg)
Arsenic	11.7 J
Cadmium	1
Total Chromium	132 J
Cobalt	31.5 J
Copper	56.3 J
Iron	65,600
Manganese	516
Nickel	181
Zinc	192 J

SS-01	
Analyte	(mg/kg)
Arsenic	20.4 J
Nickel	25.8 J
Thallium	0.8 J

SS-02*	
Analyte	(mg/kg)
Arsenic	8.7
Total Chromium	57.8
Iron	20,600
Nickel	55.2

SS-03	
Analyte	(mg/kg)
Arsenic	14.2 J
Lead	65.3 J
Nickel	47.1 J
Thallium	1.3 J

SS-04	
Analyte	(mg/kg)
Arsenic	27.1 J
Copper	41.9 J
Lead	138 J
Nickel	62.9 J
Zinc	182 J

SS-05	
Analyte	(mg/kg)
Arsenic	44.3 J
Total Chromium	43.8 J
Copper	42.8 J
Iron	32,400 J
Lead	452 J
Nickel	114 J
Zinc	200 J

SS-06	
Analyte	(mg/kg)
Arsenic	52.9 J
Total Chromium	51 J
Cobalt	25.4 J
Copper	86.9 J
Iron	40,900 J
Lead	156 J
Nickel	132 J
Zinc	287 J

SS-07	
Analyte	(mg/kg)
Arsenic	43.9 J
Total Chromium	67.7 J
Copper	57.3 J
Iron	36,200 J
Lead	67.5 J
Nickel	141 J
Zinc	181 J

SS-08*	
Analyte	(mg/kg)
Arsenic	47.4 J
Cadmium	0.76 J
Total Chromium	54.9 J
Cobalt	30.2 J
Copper	101 J
Iron	42,100 J
Lead	84.1 J
Manganese	610 J
Nickel	172 J
Thallium	3.2 J
Zinc	265 J

SS-20	
Analyte	(mg/kg)
Antimony	4.6
Arsenic	23.6 J
Cadmium	1.6
Total Chromium	141 J
Cobalt	27.1 J
Copper	65.7 J
Iron	61,300
Lead	94.6
Manganese	557
Nickel	162
Silver	2.6 J
Zinc	202 J

SS-13	
Analyte	(mg/kg)
Arsenic	36.1 J
Nickel	60.9 J

SS-12	
Analyte	(mg/kg)
Arsenic	27.6 J
Iron	24,000 J
Nickel	165 J

SS-11	
Analyte	(mg/kg)
Arsenic	33.9 J
Copper	21.3 J
Iron	29,600 J
Nickel	117 J

SS-10	
Analyte	(mg/kg)
Arsenic	41.9 J
Iron	23,300 J
Nickel	73.7 J
Thallium	1.0 J

SS-09	
Analyte	(mg/kg)
Arsenic	48.9 J
Total Chromium	55.4 J
Cobalt	34.8 J
Copper	20.5 J
Iron	43,100 J
Manganese	580 J
Nickel	180 J
Thallium	0.98 J

LEGEND

- Sediment Sampling Location
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- Nuupia Ponds Wildlife Management Area Boundary

NOTES

1. Map projection: Hawaii State Plane Zone 3, NAD83.
2. Aerial photo source: USGS 2006.
3. mg/kg milligrams per kilogram
   J estimated concentration
4. * Duplicate sample collected at SS-02, SS-08 and SS-17; maximum concentrations reported.
5. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.
6. Project action levels:

Analyte	(mg/kg)
Antimony	2
Arsenic	0.39
Cadmium	0.68
Total Chromium	43.4
Cobalt	23
Copper	18.7
Iron	20,000
Lead	30.2
Manganese	460
Nickel	15.9
Silver	0.73
Thallium	0.78
Zinc	121

Project action levels based on DOH EAL (DOH 2011), EPA Region 9 RSLs for Residential Soil (EPA 2012), and EPA Region 3 Biological Technical Assistance Group ecological marine sediment quality values (EPA 2006).

N

0 100 200 400 Feet

Figure 7
Metals Exceedances in Sediment
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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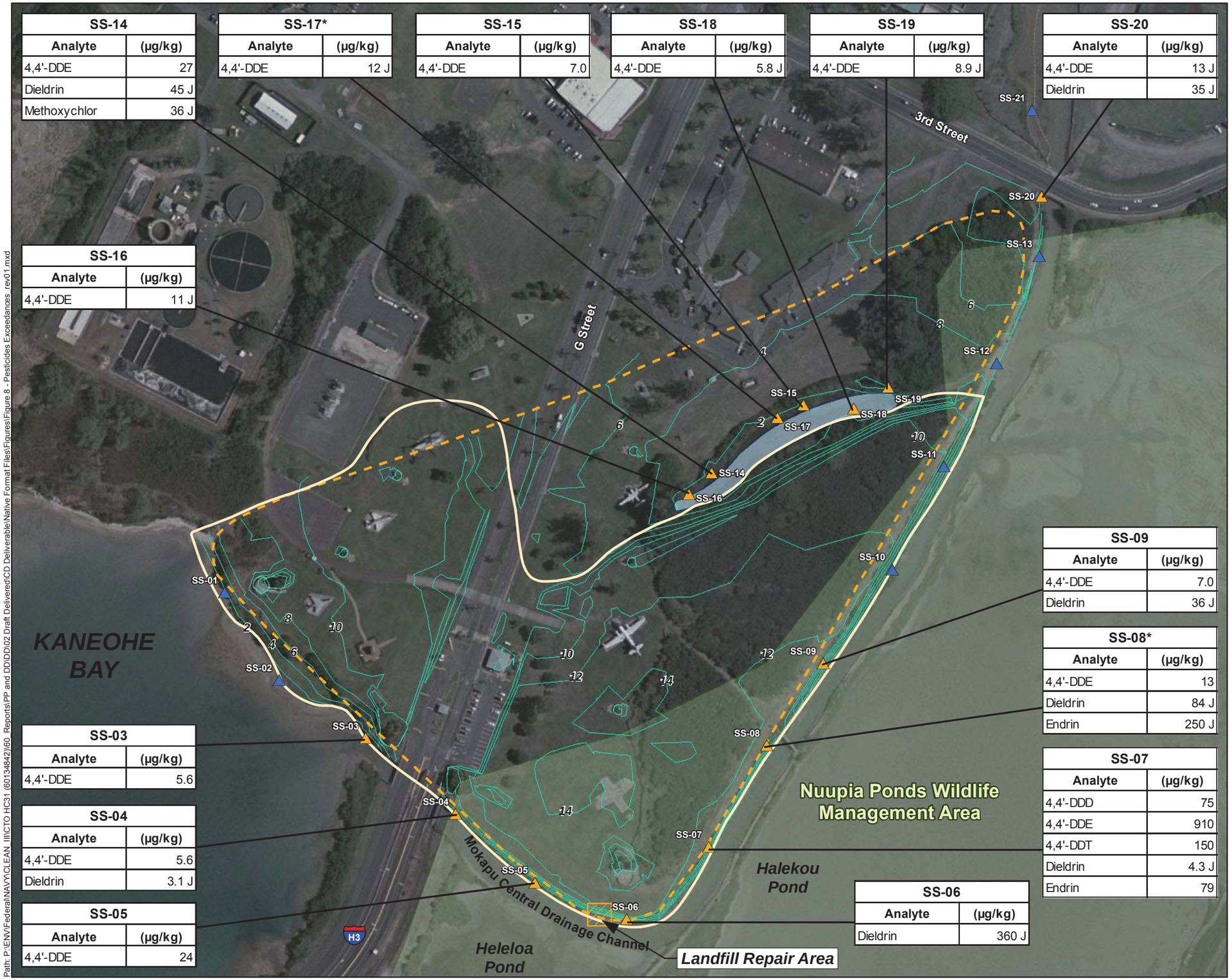

SS-14	
Analyte	(µg/kg)
4,4'-DDE	27
Dieldrin	45 J
Methoxychlor	36 J

SS-17*	
Analyte	(µg/kg)
4,4'-DDE	12 J

SS-15	
Analyte	(µg/kg)
4,4'-DDE	7.0

SS-18	
Analyte	(µg/kg)
4,4'-DDE	5.8 J

SS-19	
Analyte	(µg/kg)
4,4'-DDE	8.9 J

SS-20	
Analyte	(µg/kg)
4,4'-DDE	13 J
Dieldrin	35 J

SS-16	
Analyte	(µg/kg)
4,4'-DDE	11 J

SS-09	
Analyte	(µg/kg)
4,4'-DDE	7.0
Dieldrin	36 J

SS-08*	
Analyte	(µg/kg)
4,4'-DDE	13
Dieldrin	84 J
Endrin	250 J

SS-07	
Analyte	(µg/kg)
4,4'-DDD	75
4,4'-DDE	910
4,4'-DDT	150
Dieldrin	4.3 J
Endrin	79

SS-03	
Analyte	(µg/kg)
4,4'-DDE	5.6

SS-04	
Analyte	(µg/kg)
4,4'-DDE	5.6
Dieldrin	3.1 J

SS-05	
Analyte	(µg/kg)
4,4'-DDE	24

SS-06	
Analyte	(µg/kg)
Dieldrin	360 J

LEGEND

- Sediment Sampling Location with Organochlorine Pesticides Exceedance
- Sediment Sampling Location with No Organochlorine Pesticides Exceedance
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- Nuupia Ponds Wildlife Management Area Boundary

NOTES

1. Map projection: Hawaii State Plane Zone 3, NAD83.
2. Aerial photo source: USGS 2006.
3. µg/kg micrograms per kilogram
   J estimated concentration
4. * Duplicate sample collected at SS-08 and SS-17; maximum concentrations reported.
5. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.
6. Project action levels:

Analyte	(µg/kg)
Pesticides	
4,4'-DDD	3.6
4,4'-DDE	3.2
4,4'-DDT	0.8
Dieldrin	2.2
Endrin	2.2
Methoxychlor	18.7

Project action levels based on DOH EAL (DOH 2011), EPA Region 9 RSLs for Residential Soil (EPA 2012), and EPA Region 3 Biological Technical Assistance Group ecological marine sediment quality values (EPA 2006).

N

0 100 200 400 Feet

Figure 8
Organochlorine Pesticides Exceedances in Sediment
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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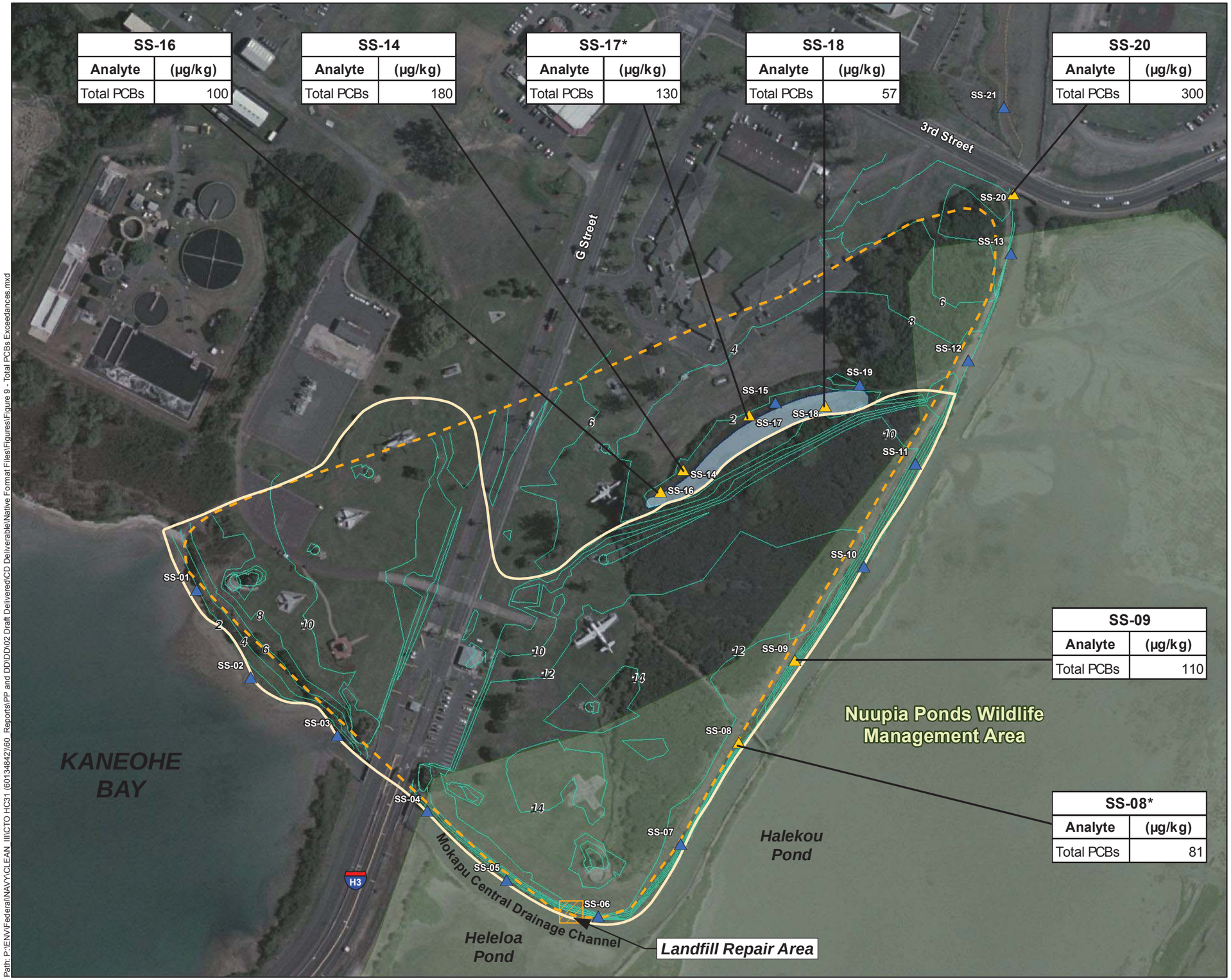

LEGEND

- Sediment Sampling Location with Total PCBs Exceedance
- Sediment Sampling Location with No Total PCBs Exceedance
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- Nuupia Ponds Wildlife Management Area Boundary

NOTES

1. Map projection: Hawaii State Plane Zone 3, NAD83.
2. Aerial photo source: USGS 2006.
3. µg/kg micrograms per kilogram
   J estimated concentration
4. * Duplicate sample collected at SS-08 and SS-17; maximum concentrations reported.
5. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.
6. Project action levels:

Analyte	(µg/kg)
Total PCBs	40

Project action levels based on DOH EAL (DOH 2011), EPA Region 9 RSLs for Residential Soil (EPA 2012), and EPA Region 3 Biological Technical Assistance Group ecological marine sediment quality values (EPA 2006).

N

0 100 200 400 Feet

Figure 9
Total PCBs Exceedances in Sediment
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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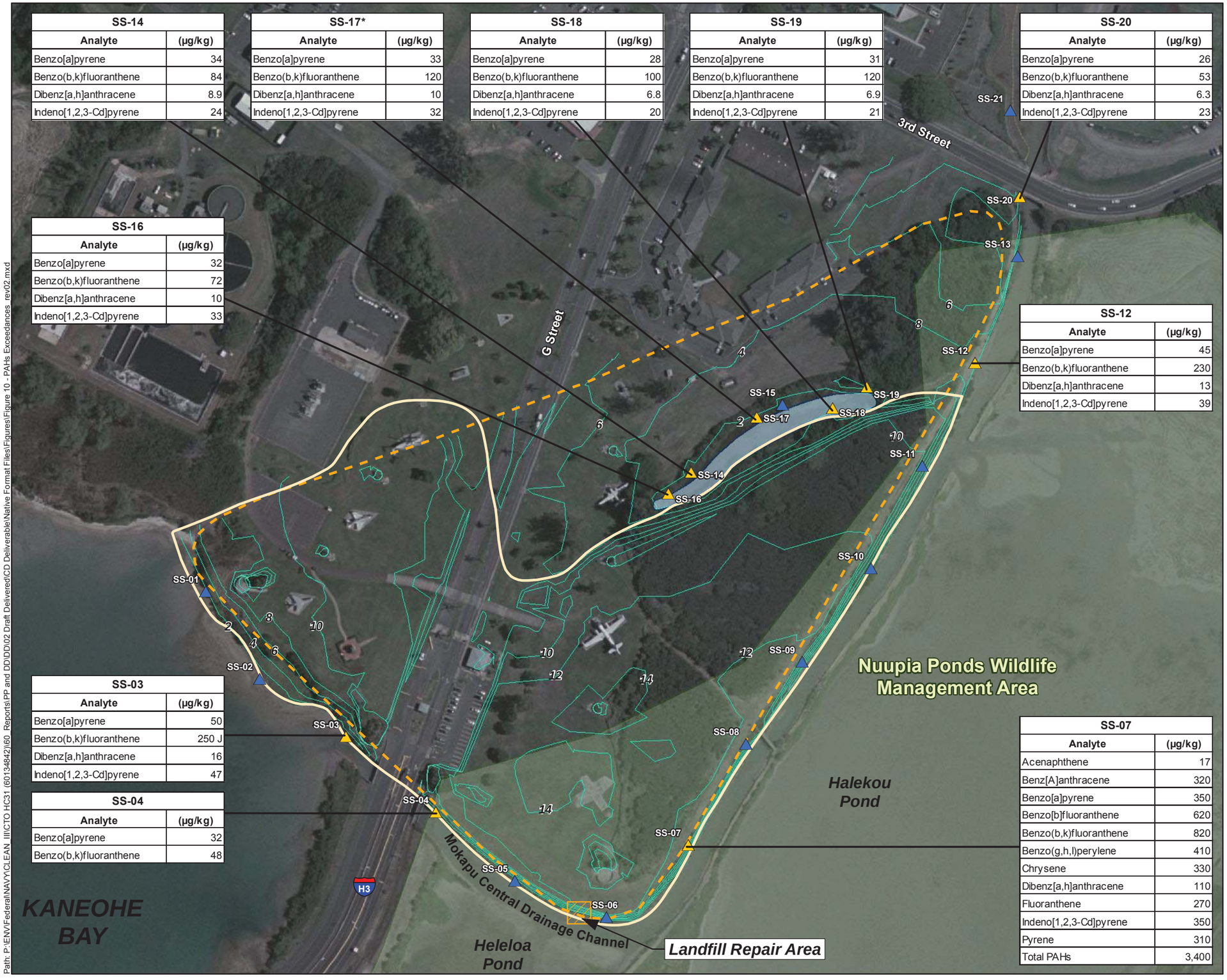

SS-14	
Analyte	**(µg/kg)**
Benzo[a]pyrene	34
Benzo(b,k)fluoranthene	84
Dibenz[a,h]anthracene	8.9
Indeno[1,2,3-Cd]pyrene	24

SS-17*	
Analyte	**(µg/kg)**
Benzo[a]pyrene	33
Benzo(b,k)fluoranthene	120
Dibenz[a,h]anthracene	10
Indeno[1,2,3-Cd]pyrene	32

SS-18	
Analyte	**(µg/kg)**
Benzo[a]pyrene	28
Benzo(b,k)fluoranthene	100
Dibenz[a,h]anthracene	6.8
Indeno[1,2,3-Cd]pyrene	20

SS-19	
Analyte	**(µg/kg)**
Benzo[a]pyrene	31
Benzo(b,k)fluoranthene	120
Dibenz[a,h]anthracene	6.9
Indeno[1,2,3-Cd]pyrene	21

SS-20	
Analyte	**(µg/kg)**
Benzo[a]pyrene	26
Benzo(b,k)fluoranthene	53
Dibenz[a,h]anthracene	6.3
Indeno[1,2,3-Cd]pyrene	23

SS-16	
Analyte	**(µg/kg)**
Benzo[a]pyrene	32
Benzo(b,k)fluoranthene	72
Dibenz[a,h]anthracene	10
Indeno[1,2,3-Cd]pyrene	33

SS-12	
Analyte	**(µg/kg)**
Benzo[a]pyrene	45
Benzo(b,k)fluoranthene	230
Dibenz[a,h]anthracene	13
Indeno[1,2,3-Cd]pyrene	39

SS-03	
Analyte	**(µg/kg)**
Benzo[a]pyrene	50
Benzo(b,k)fluoranthene	250 J
Dibenz[a,h]anthracene	16
Indeno[1,2,3-Cd]pyrene	47

SS-04	
Analyte	**(µg/kg)**
Benzo[a]pyrene	32
Benzo(b,k)fluoranthene	48

SS-07	
Analyte	**(µg/kg)**
Acenaphthene	17
Benz[A]anthracene	320
Benzo[a]pyrene	350
Benzo[b]fluoranthene	620
Benzo(b,k)fluoranthene	820
Benzo(g,h,I)perylene	410
Chrysene	330
Dibenz[a,h]anthracene	110
Fluoranthene	270
Indeno[1,2,3-Cd]pyrene	350
Pyrene	310
Total PAHs	3,400

LEGEND

- Sediment Sampling Location with PAHs Exceedance
- Sediment Sampling Location with No PAHs Exceedance
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- Nuupia Ponds Wildlife Management Area Boundary

NOTES

1. Map projection: Hawaii State Plane Zone 3, NAD83.
2. Aerial photo source: USGS 2006.
3. µg/kg micrograms per kilogram
   J estimated concentration
4. * Duplicate sample collected at SS-17; maximum concentration reported.
5. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.
6. Project action levels:

Analyte	(µg/kg)
Acenaphthene	5.9
Benz[A]anthracene	75
Benzo[a]pyrene	15
Benzo[b]fluoranthene	150
Benzo(b,k)fluoranthene	27
Benzo(g,h,I)perylene	170
Chrysene	108
Dibenz[a,h]anthracene	6.2
Fluoranthene	113
Indeno[1,2,3-Cd]pyrene	17
Pyrene	153
Total PAHs	1,610

Project action levels based on DOH EAL (DOH 2011), EPA Region 9 RSLs for Residential Soil (EPA 2012), and EPA Region 3 Biological Technical Assistance Group ecological marine sediment quality values (EPA 2006).

N

0 100 200 400 Feet

Figure 10
PAHs Exceedances in Sediment
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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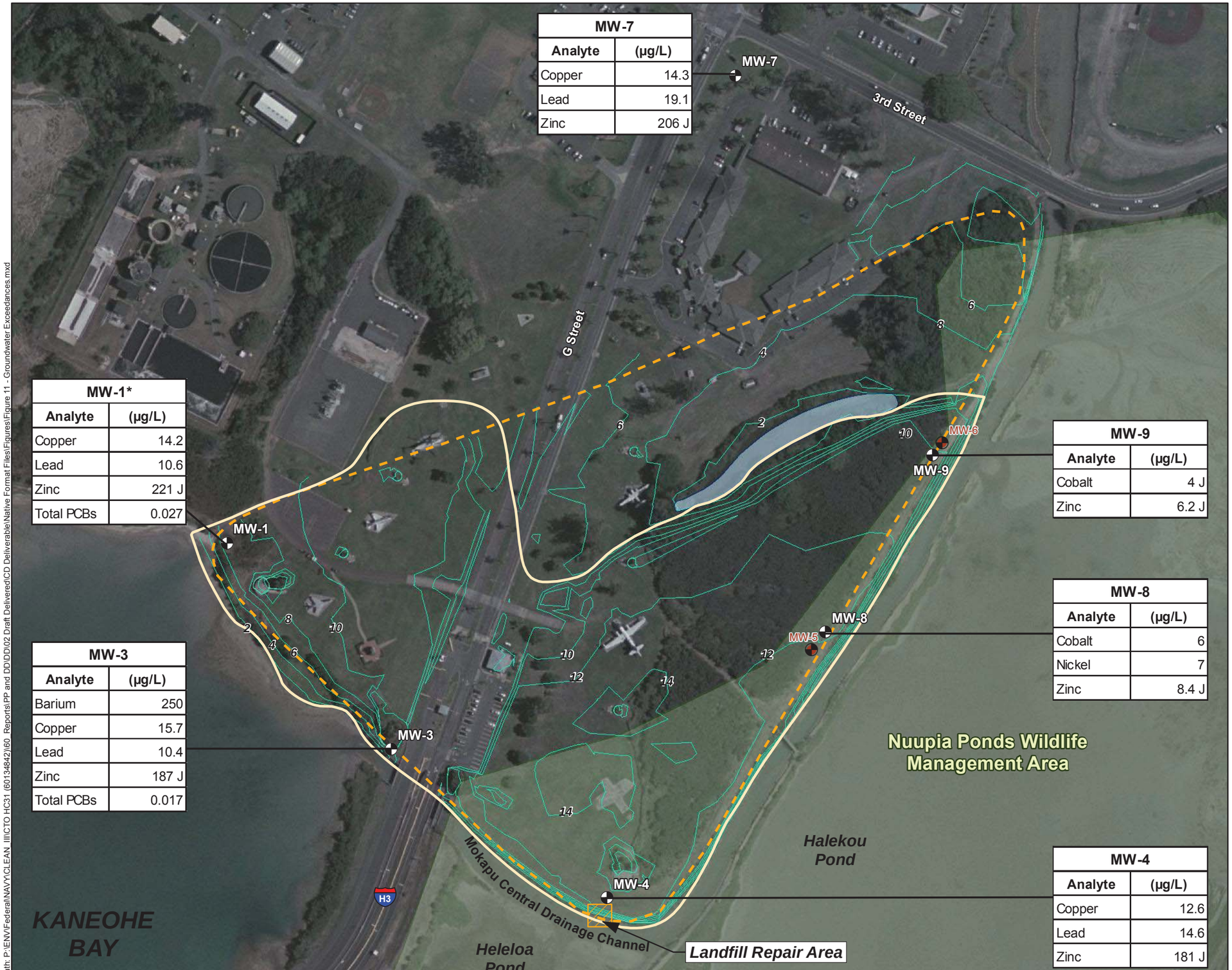

MW-7	
Analyte	(µg/L)
Copper	14.3
Lead	19.1
Zinc	206 J

MW-1*	
Analyte	(µg/L)
Copper	14.2
Lead	10.6
Zinc	221 J
Total PCBs	0.027

MW-3	
Analyte	(µg/L)
Barium	250
Copper	15.7
Lead	10.4
Zinc	187 J
Total PCBs	0.017

MW-9	
Analyte	(µg/L)
Cobalt	4 J
Zinc	6.2 J

MW-8	
Analyte	(µg/L)
Cobalt	6
Nickel	7
Zinc	8.4 J

MW-4	
Analyte	(µg/L)
Copper	12.6
Lead	14.6
Zinc	181 J

LEGEND

- Groundwater Monitoring Well Location
- Former Monitoring Well
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- Nuupia Ponds Wildlife Management Area Boundary

NOTES

1. Map projection: Hawaii State Plane Zone 3, NAD83.
2. Aerial photo source: USGS 2006.
3. µg/L micrograms per liter
   J estimated concentration
4. * Duplicate sample collected at MW-01; maximum concentration reported.
5. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.
6. Project action levels:

Analyte	(µg/L)
Metals	
Barium	200
Cobalt	3
Copper	1.94
Lead	5.6
Nickel	5.0
Zinc	4.6
Total PCBs	0.014

Project action levels for groundwater is based on DOH EALs (DOH 2011).

N

0 100 200 400 Feet

Figure 11
Exceedances in Groundwater
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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LEGEND

- Surface Water Sampling Location
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- Nuupia Ponds Wildlife Management Area Boundary

NOTES

1. Map projection: Hawaii State Plane Zone 3, NAD83.
2. Aerial photo source: USGS 2006.
3. µg/L micrograms per liter
   J estimated concentration
4. * Duplicate sample collected at SW-02; maximum concentration reported.
5. SW-03 was only tested for general chemistry parameters.
6. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.
7. Project action levels:

Analyte	(µg/L)
Metals	
Arsenic	4.9
Mercury	0.12
Total PCBs	0.0001

Project action levels for surface water is based on DOH EALs (DOH 2011).

N

0 100 200 400 Feet

Figure 12
Exceedances in Surface Water
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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LOCATION MAP

LEGEND

- Groundwater Monitoring Well Location
- Former Monitoring Wells
- Sediment Sampling Location
- Soil Boring Sampling Location
- Proposed Land Use Control Area
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- Nuupia Ponds Wildlife Management Area Boundary

NOTES

1. Map projection: Hawaii State Plane Zone 3, NAD83.
2. Base map source: USGS 2006.
3. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.

N

0 100 200 400 Feet

Figure 13
Alternative 2
Land Use Controls
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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LOCATION MAP

LEGEND

- Groundwater Monitoring Well Location
- Sediment Sampling Location
- Soil Boring Sampling Location
- Former Monitoring Well
- Confirmation Sediment Sampling Location
- Confirmation Landfill Soil Sampling Location
- Area to be Dredged
- Excavation Area
- Apparent Landfill Boundary
- Previous Estimated Boundary of the H-3 Landfill
- Existing Landfill Repair Area
- Temporary Lodging Facility Wetland
- Surveyed Elevation Contour (2-ft Interval)
- Nuupia Ponds Wildlife Management Area Boundary

NOTES

1. Map projection: Hawaii State Plane Zone 3, NAD83.
2. Base map source: USGS 2006.
3. Apparent landfill boundary was derived from aerial photo evaluations and visusal observations of test pits advanced throughout the site.

N

0 100 200 400 Feet

Figure 14
Alternative 3
Clean Closure
Decision Document
H-3 Landfill (Site 0001)
Marine Corps Base Hawaii
Oahu, Hawaii

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Attachment B
Detailed Reference Table

Table B-1: Detailed Reference Table

Item	Reference Phrase in DD	Location in DD	Identification of Referenced Document Available in the Administrative Record
1	The IAS report recommended further assessment for the landfill site	Section 2.2.2.1, Page 2-3	Naval Energy and Environmental Support Activity (NEESA). 1984. *Initial Assessment Study of Marine Corps Air Station Kaneohe Bay, Hawaii.* April.
2	the CS recommended no further action for the H-3 Landfill site provided that the site usage remains the same	Section 2.2.2.2, Page 2-3	Aqua Terra Technologies, Inc. (ATT). 1988. *Verification Phase Confirmation Study Site 7 – MCAS Kaneohe, H-3 Sanitary Landfill, Kaneohe Bay, Oahu, Hawaii.* September.
3	Proposed Plan (PP)	Section 2.3, Page 2-4	Department of the Navy (DON). 2013. *Proposed Plan, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii*. JBPHH, HI: Naval Facilities Engineering Command, Pacific. May.
4	TCRA	Section 2.4.1.1, Page 2-5	AECOM Technical Services, Inc. (AECOM). 2011. *Remediation Verification Report, Time-Critical Removal Action for H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* Pearl Harbor, HI: Naval Facilities Engineering Command, Pacific. February.
5	other portions of the landfill side slopes, including the portion that fronts the drainage channel/fish ponds, were observed to be steep with evidence of erosion or scour at the toe	Section 2.4.1.1, Page 2-6	AECOM Technical Services, Inc. (AECOM). 2011. *Remediation Verification Report, Time-Critical Removal Action for H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* Pearl Harbor, HI: Naval Facilities Engineering Command, Pacific. February.
6	engineering evaluation/cost analysis (EE/CA)	Section 2.4.1.2, Page 2-6	AECOM Technical Services, Inc. (AECOM). 2012. *Engineering Evaluation and Cost Analyses, H-3 Landfill Shoreline Repair, Marine Corps Base Hawaii, Oahu, Hawaii.* Pearl Harbor, HI: Naval Facilities Engineering Command, Pacific. January.
7	the recommended removal action alternative for the H-3 Landfill site is side slope stabilization with rock rip-rap	Section 2.4.1.2, Page 2-7	AECOM Technical Services, Inc. (AECOM). 2012. *Engineering Evaluation and Cost Analyses, H-3 Landfill Shoreline Repair, Marine Corps Base Hawaii, Oahu, Hawaii.* Pearl Harbor, HI: Naval Facilities Engineering Command, Pacific. January.
8	The cover thickness and soil type provide adequate separation to prevent human contact with the waste	Section 2.5.1.2, Page 2-10	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.
9	the landfill has no issues related to landfill gas	Section 2.5.1.2, Page 2-10	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.
10	The topography of the landfill generally directs surface water off the landfill	Section 2.5.1.2, Page 2-10	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.
11	the landfill is considered stable	Section 2.5.1.2, Page 2-11	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.
12	a protected jurisdictional wetland (TLF wetland) is located adjacent to the landfill	Section 2.5.1.7, Page 2-13	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.
13	RI/FS	Section 2.5.3, Page 2-14	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.

Item	Reference Phrase in DD	Location in DD	Identification of Referenced Document Available in the Administrative Record
14	current land use is considered industrial and is an active MCB	Section 2.6.1, Page 2-17	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.
15	Because of the salinity of the shallow groundwater, it is not considered a source of potable water	Section 2.6.2, Page 2-18	Aqua Terra Technologies, Inc. (ATT). 1988. *Verification Phase Confirmation Study Site 7 – MCAS Kaneohe, H-3 Sanitary Landfill, Kaneohe Bay, Oahu, Hawaii.* September.
16	human health and ecological risk assessment	Section 2.7, Page 2-18	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.
17	risks to human health are within the risk management ranges	Section 2.8, Page 2-24	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.
18	risks to wildlife populations are within the NOAEL-based HQ and LOAEL-based HQ	Section 2.8, Page 2-24	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.
19	The implementation of the recommended removal action alternative described in Section 2.4.1.2, side slope stabilization with rock rip-rap, addresses the first two RAOs	Section 2.8, Page 2-25	AECOM Technical Services, Inc. (AECOM). 2012. *Remedial Investigation/Feasibility Study, H-3 Landfill (Site 0001), Marine Corps Base Hawaii, Oahu, Hawaii.* JBPHH, HI: Naval Facilities Engineering Command, Pacific. November.

Attachment C
Federal Facility Land Use Control DD Checklist

EPA Region 9 Federal Facility Land Use Control DD Checklist for Navy LUC DDs

No.	Checklist Item	Location Where Addressed in the H-3 Landfill DD
1	Map/Figure showing boundaries of the land use controls.	Figure 13.
2	Document risk exposure assumptions and reasonably anticipated land uses, as well as any known prohibited uses which might not be obvious based on the reasonably anticipated land uses. (For example, where "unrestricted industrial" use is anticipated, list prohibited uses such as on-site company day-care centers, recreation areas, etc.).	Section 2.6, Current and Potential Future Land and Resource Uses, page 2-17; and Section 2.5.2, Conceptual Site Model, page 2-14.
3	Describe the risks necessitating the LUCs.	Section 2.7.1, Human Health Risk Assessment, page 2-18; and Section 2.7.2, Ecological Risk Assessment, page 2-20.
4	LUCs, specifically ICs, would be implemented as a final response action alternative to prevent disturbance and exposure to contaminated soil.	Section 2.12.2, Description of the Selected Final Remedy, page 2-34.
5	Generally describe the LUC, the logic for its selection and any related deed restrictions/notifications.	Section 2.12.2, Description of the Selected Final Remedy, page 2-34.
6	Duration language: *"Land Use Controls will be maintained until the concentrations of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure."*	Section 2.12.2, Description of the Selected Final Remedy, page 2-34, 6th paragraph.
7	Include language that the Marine Corps is responsible for implementing, maintaining, reporting on, and enforcing the land use controls. This may be modified to include another party should the site-specific circumstances warrant it.	Section 2.12.2.1, Land Use Control Performance Objectives, page 2-35, 2nd paragraph.
8	Where someone else will or the Marine Corps plans that someone else will ultimately be implementing, maintaining, reporting on, and enforcing land use controls, the following language should be included: *"Although the Marine Corps may later transfer [has transferred] these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Marine Corps shall retain ultimate responsibility for remedy integrity."*	Section 2.12.2.1, Land Use Control Performance Objectives, page 2-35, 3rd paragraph; and Section 3.2, Technical and Legal Issues, page 3-1, 2nd paragraph.
9	Refer to the remedial design (RD) or remedial action work plan (RAWP) for the implementation actions. Because this is a new idea (i.e., including the LUC implementation actions in either or both of these two primary documents), to ensure that the requirement is clear and enforceable, we developed the following language where it makes sense: *"A Remedial Action Work Plan (RAWP) will be prepared as the land use component of the Remedial Design. Within 90 days of DD signature, the Marine Corps shall prepare and submit to DOH for review and approval the RAWP that shall contain implementation and maintenance actions, including periodic inspections by the Marine Corps to address both ICs and ECs."*	Section 2.12.2, Description of the Selected Final Remedy, page 2-34, 7th paragraph.