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THE UNITED STATES AIR FORCE

INSTALLATION RESTORATION PROGRAM

FINAL

RECORD OF DECISION
FOR
SITES 5 AND 8
MAIN BASE OPERABLE UNIT

ANDERSEN AIR FORCE BASE, GUAM

August 2007

THE UNITED STATES AIR FORCE INSTALLATION RESTORATION PROGRAM

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August 2007

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13. ABSTRACT ***(Maximum 200 words)***

This Record of Decision (ROD) presents the rationale for selection of the preferred cleanup alternatives for Installation Restoration Program (IRP) Sites 5 and 8 located in the Main Base Operable Unit at Andersen AFB, Guam. This ROD summarizes the history, environmental background, extent of contamination, associated human health and ecological risks, evaluation of remedial alternatives, public involvement, and rationale for selecting the preferred remedies for Sites 5 and 8.

14. SUBJECT TERMS

- *Andersen AFB*
- *Remedial Investigation/Feasibility Study*
- *Installation Restoration Program*
- *Record of Decision*
- *Human Health Risk Assessment*
- *Ecological Risk Assessment*
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LIST OF ACRONYMS AND ABBREVIATIONS

95UCLM	95th percentile upper confidence limit of the mean
ADI	average daily intake
AE	average exposure
AFB	Air Force Base
AR	Administrative Record
ARAR	Applicable or Relevant and Appropriate Requirement
Battelle	Battelle Memorial Institute, Columbus
BGP	Base General Plan
bgs	below ground surface
BTV	Background Threshold Value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CSM	Conceptual Site Model
CRP	Community Relations Plan
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DERA	Defense Environmental Restoration Account
DSI	Detailed Site Inventory
DoD	Department of Defense
EA	EA Engineering, Science, and Technology, Inc.
EE/CA	Engineering Evaluation/Cost Analysis
EP	Excavation Pit
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESD	Explanation of Significant Difference
ESE	Environmental Science and Engineering
EQ	Ecological Quotient

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

FFA	Federal Facility Agreement
FS	Feasibility Study
Guam EPA	Guam Environmental Protection Agency
GTI	Groundwater Technology, Inc.
HARM	Hazard Assessment Rating Methodology
HEAST	Health Effects Assessment Summary Table
HHRA	Human Health Risk Assessment
HI	Hazard Index
HSWA	Hazardous and Solid Waste Act of 1982
HQ	hazard quotient
ICF	ICF Technology, Inc.
IEUBK	Integrated Exposure Uptake Biokinetic
IRP	Installation Restoration Program
IRIS	Integrated Risk Information System
LADI	lifetime average daily intake
LOAEL	Lowest Observed Adverse Effects Level
LTGM	Long-Term Groundwater Monitoring
LUC	Land Use Control
LUCMP	Land Use Control Management Plan
MCL	Maximum Contaminant Level
mg/kg	milligram(s) per kilogram
mg/kg/day	milligram(s) per kilogram per day
mg/kg-bw/day	milligram(s) of chemical per kilogram of body weight per day
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	No Observed Adverse Effect Level
NPL	National Priority List
NTCRA	Non-Time-Critical Removal Action
O&M	Operation and Maintenance
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PRG	Preliminary Remediation Goal

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfD	reference dose
RG	Remedial Goal
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROC	receptor of concern
ROD	Record of Decision
RPM	Remedial Program Manager
SAIC	Science Applications International Corporation
SARA	Superfund Amendments and Reauthorization Act of 1986
SF	Slope Factor
Shaw	Shaw Environmental, Inc.
SVOC	semivolatile organic compound
TAL	Target Analyte List
TBC	To Be Considered
TCDD	tetrachlorodibenzo-p-dioxin
TEQ	Toxicity Equivalent
TRV	Toxicity Reference Volumes
UCL	Upper Confidence Limit
USAF	United States Air Force
USC	United States Code
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

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1. DECLARATION FOR SITES 5 AND 8

1.1 SITE NAME AND LOCATION

Installation Restoration Program (IRP) Site 5 (Landfill 7) and Site 8 (Landfills 10A, 10B, 10C) are located in the Main Base Operable Unit (OU) at Andersen Air Force Base (AFB), Guam. The locations of Guam, Andersen AFB, the Main Base OU, and the subject IRP sites are identified in Figures 1-1 through 1-4. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number for Andersen AFB is GU6571999519.

1.2 STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) is a decision document prepared for Sites 5 and 8. The purpose of this ROD is to present the public with a consolidated source of information regarding the history, environmental background, extent of contamination, associated human health and ecological risks, evaluation of remedial alternatives, public involvement, and the selected remedy.

This decision document presents the selected remedy for Sites 5 and 8 which were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan of 1990 (NCP). This decision is based on the results of the Remedial Investigation (RI)/Feasibility Study (FS) for Sites 5 and 8 and the other Administrative Record (AR) files for these sites. The AR for the Main Base OU includes pertinent IRP documents, correspondence, and material related to the CERCLA investigations and remedies. The Andersen AFB AR files, which include the RI/FS for Sites 5 and 8, and other pertinent documents, are available for public review at the Robert F. Kennedy Library at the University of Guam and the Nieves M. Flores Memorial Library in Hagåtña.

The USAF and the United States Environmental Protection Agency (USEPA) have jointly selected the remedies and the Guam Environmental Protection Agency (Guam EPA) has concurred with the decision, under the guidelines established in the Federal Facilities Agreement (FFA) signed in February 1993 by representatives of USEPA Region 9, Guam EPA, and the USAF (USEPA et al., 1993).

1.3 ASSESSMENT OF THE SITES

The response actions selected in this ROD are necessary to protect public health and/or the environment from actual or threatened releases of hazardous substances from Sites 5 and 8, which may present an imminent and substantial endangerment to public health or the environment.

1.3.1 Site 5

No unacceptable human health risks were identified in surface soil at Site 5. The hazardous substances associated with unacceptable risks in subsurface soil at Site 5 include antimony, copper, lead, and manganese. These hazardous substances pose potential risks to human health (resident adults and children, and utility workers [lead only]). No unacceptable risks to the ecological receptors were identified at Site 5.

1.3.2 Site 8

Landfill 10A

No unacceptable human health or ecological risks were identified at Site 8 Landfill 10A.

Landfill 10B

No unacceptable human health or ecological risks were identified at Site 8 Landfill 10B.

Landfill 10C

The COCs identified in surface soil at Site 8 Landfill 10C include dieldrin and lead. The COCs identified in subsurface soil at Site 8 Landfill 10C include antimony, dieldrin, and lead. These COCs in surface and subsurface soil pose an unacceptable risk to human health (resident adults and children and occasional trespassers and workers). No unacceptable risks to ecological receptors were identified.

1.4 DESCRIPTION OF THE SELECTED REMEDIES

The preferred remedial alternatives presented in this ROD are necessary response actions to protect human health and the environment at Sites 5 and 8, and are summarized as follows:

Site	Selected Alternatives
Site 5	Institutional Controls
Site 8	Institutional Controls and Engineering Controls

1.4.1 Site 5

The *Institutional Controls* alternative is the selected remedial alternative for Site 5 and will mitigate the identified site risks to hypothetical future residents and utility workers by requiring proper site upkeep/maintenance and by controlling excavation/construction activities. The *Institutional Controls* alternative includes land use controls (LUCs) and 5-year reviews (Appendix A). The *Institutional Controls* alternative will mitigate the identified risks to human health by preventing exposure to residual COCs in subsurface soil. Under this *Institutional Controls* alternative, the Base General Plan (BGP) will be amended to control site use and development. Specific LUCs for Site 5 are being developed in a Land Use Control Management Plan (LUCMP).

1.4.2 Site 8

The *Institutional Controls and Engineering Controls* alternative is the selected remedial alternative for Site 8 and will mitigate the identified risks to occasional users/trespassers and hypothetical future on-site residents by controlling site use and preventing residential development of the Site. The *Institutional Controls and Engineering Controls* alternative includes LUCs and 5-year reviews (Appendix A). The LUCs also specify continued inspection and maintenance of the site fence and the posting of signs, as well as restricted excavation activities. Under this *Institutional Controls and Engineering Controls* alternative, the BGP will be amended to control site use and development. Specific LUCs for Site 8 are being developed in a LUCMP.

1.5 STATUTORY DETERMINATION

The Selected Remedies for Sites 5 and 8 are protective of human health and the environment, comply with Federal and Territory of Guam requirements that are applicable or relevant and appropriate to the remedial action, and are cost-effective. The Selected Remedies for Site 5 (Institutional Controls) and Site 8 (Institutional Controls and Engineering Controls) are not permanent solutions because some COC-impacted soil will remain on-site and will require LUCs to ensure the future protection of human health. No unacceptable ecological risks were identified at Sites 5 or 8.

Because each of the remedial alternatives selected for Sites 5 and 8 will result in some 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 remedial actions to assure that the remedies are or will be protective of human health and the environment.

1.6 ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summaries for Sites 5 and 8 of this ROD, along with reference tables, figures, and section numbers for both of the sites.

1.6.1 Site 5

- COCs and their respective concentrations for Site 5 are presented in Tables 2-1 and 2-2.
- The baseline human health risks represented by each COC are presented in Tables 2-3 through 2-8. The baseline ecological risks are presented in Tables 2-11 through 2-13. The summary of site risks is presented in Section 2.7.
- The established cleanup levels for each COC are presented in Table 2-14.
- The principal threats from COC sources are discussed in Section 2.11.
- The current and reasonably anticipated future land uses are presented in Section 2.6.

- The estimated present-worth remedial costs, including the projected number of years over which the remedial cost was estimated, are presented in Table 2-15 and in Sections 2.10 and 2.12.3.
- Key factors that led to selection of *Institutional Controls* as a preferred remedial alternative are presented in Section 2.12 and 2.13.

1.6.2 Site 8 (Landfills 10A, 10B, 10C)

- COCs and their respective concentrations for Site 8 are presented in Tables 3-2 and 3-3.
- The baseline human health risks represented by each COC are presented in Tables 3-4 and 3-5A,B,C. The baseline ecological risks are presented in Tables 3-9 through 3-12. The summary of site risks is presented in Section 3.7.
- The established cleanup levels for each COC are presented in Table 3-13.
- The principal threats from COC sources are discussed in Section 3.11.
- The current and reasonably anticipated future land uses are presented in Section 3.6.
- The estimated present-worth remedial costs, including the projected number of years over which the remedial cost was estimated, are presented in Table 3-14 and in Sections 3.10 and 3.12.3.
- Key factors that led to selection of *Institutional Controls* as a preferred remedial alternative are presented in Section 3.12 and 3.13.

Additional background information regarding the environmental investigations at Sites 5 and 8 can be found in the RI/FS for these sites which is available in the AR files at the Robert F. Kennedy Library at the University of Guam or the Nieves M. Flores Memorial Library in Hagåtña. The AR file is also available on the internet at: http://www.adminrec.com/PACAF.asp.

1.7 AUTHORIZING SIGNATURES AND SUPPORTED AGENCY ACCEPTANCE OF THE REMEDY

The following signature pages document that the USAF and the USEPA Region 9 have co-selected, and the Guam EPA concurs with, the remedies for Sites 5 and 8, as presented in this ROD.

This signature page documents that the USAF and the USEPA Region 9 have co-selected the remedies for Sites 5 and 8 described in this ROD.

Douglas H. Owens

DOUGLAS H. OWENS
Brigadier General, USAF
Commander

16 OCT 07
Date

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This signature page documents that the USAF and the USEPA Region 9 have co-selected the remedies for Sites 5 and 8 described in this ROD.

MICHAEL M. MONTGOMERY
Chief, Federal Facility and Site Cleanup Branch
U.S. Environmental Protection Agency, Region IX

Date 7/21/08

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This signature page documents that Guam EPA concurs with the remedies for Sites 5 and 8 co-selected by the USAF and the USEPA Region 9.

LORILEE T. CRISOSTOMO
Administrator
Guam Environmental Protection Agency

2-19-2008
Date

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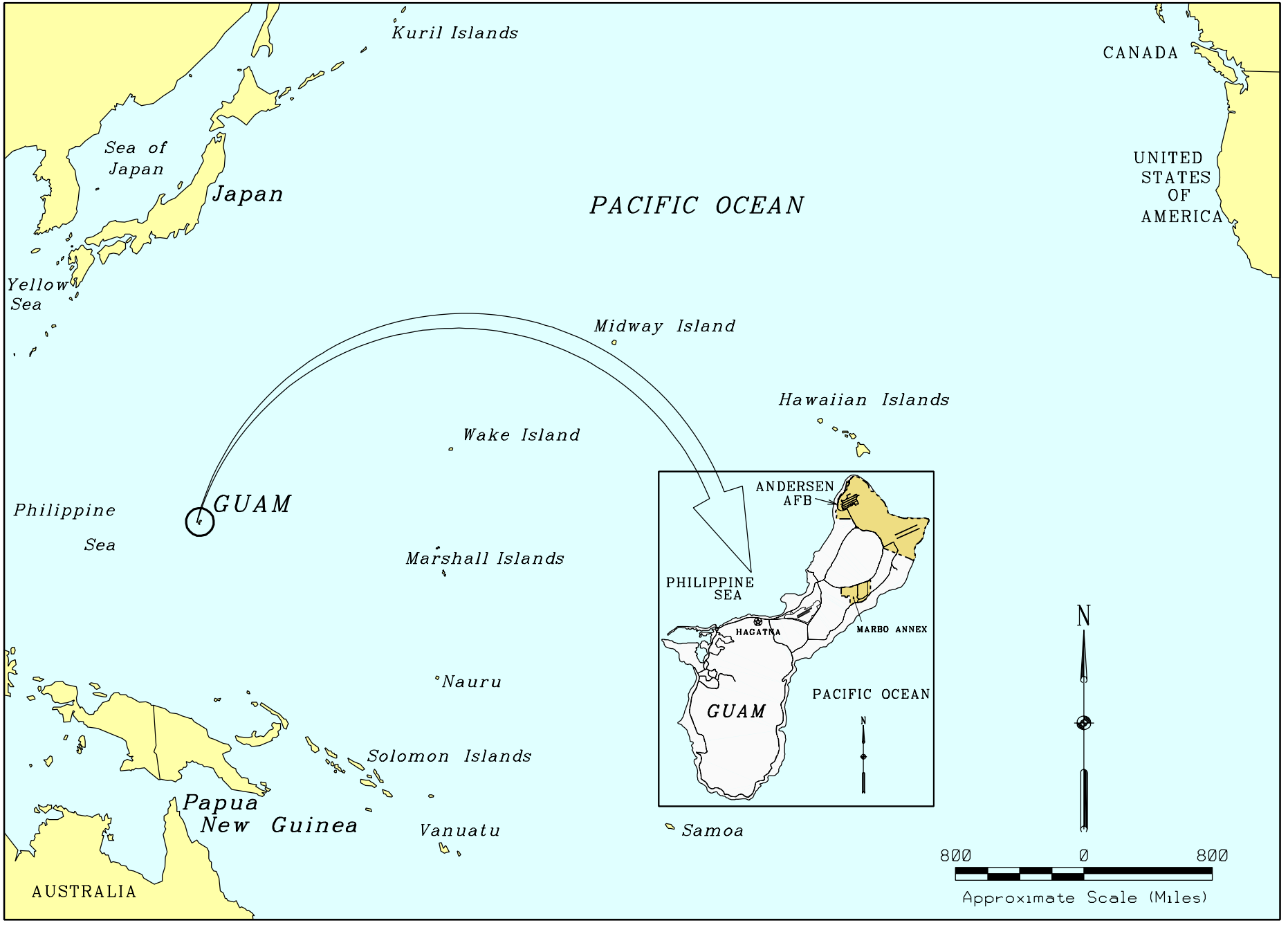

Figure 1-1. Location Map of Guam.

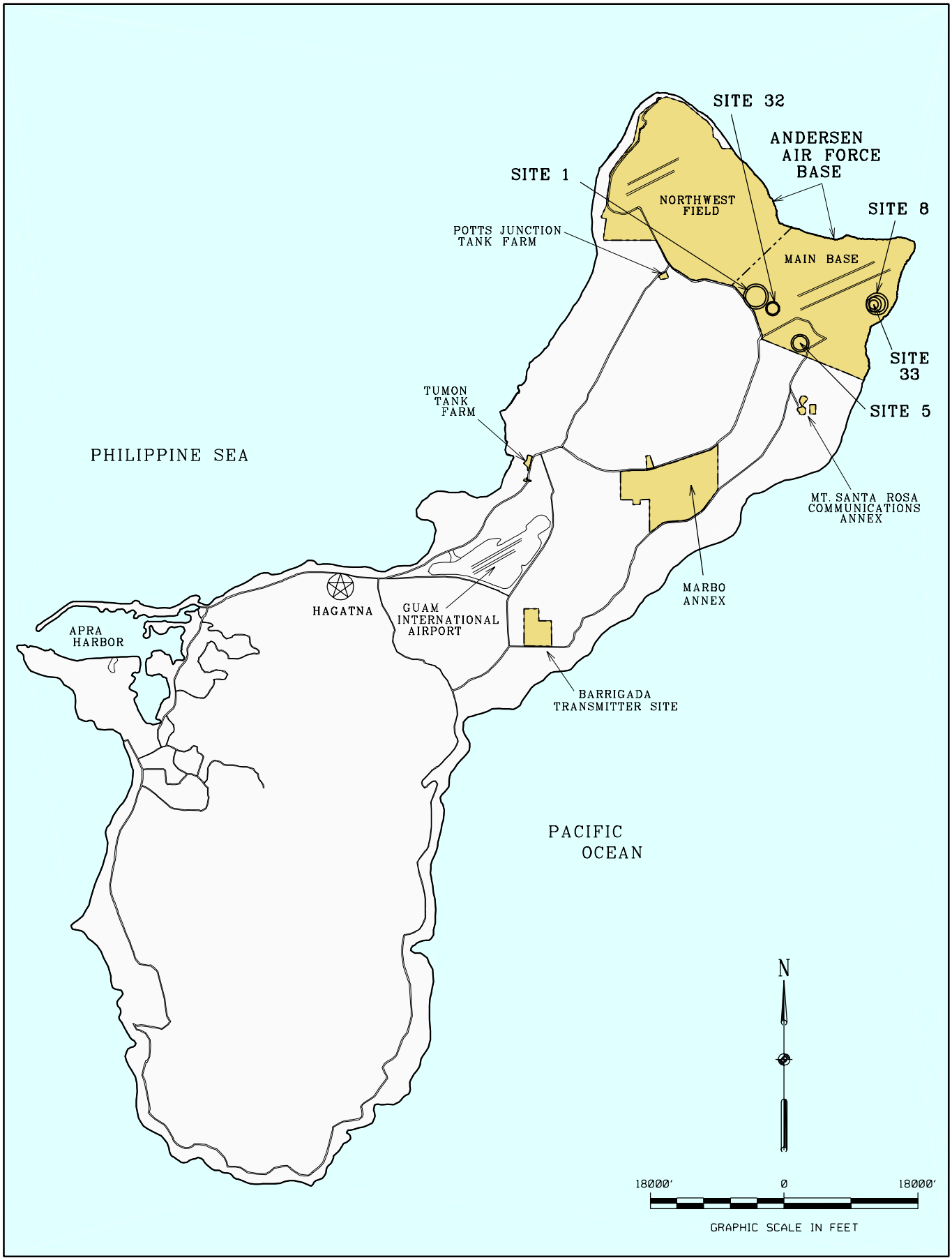

Figure 1-2. Location Map of Andersen Air Force Base on Guam.

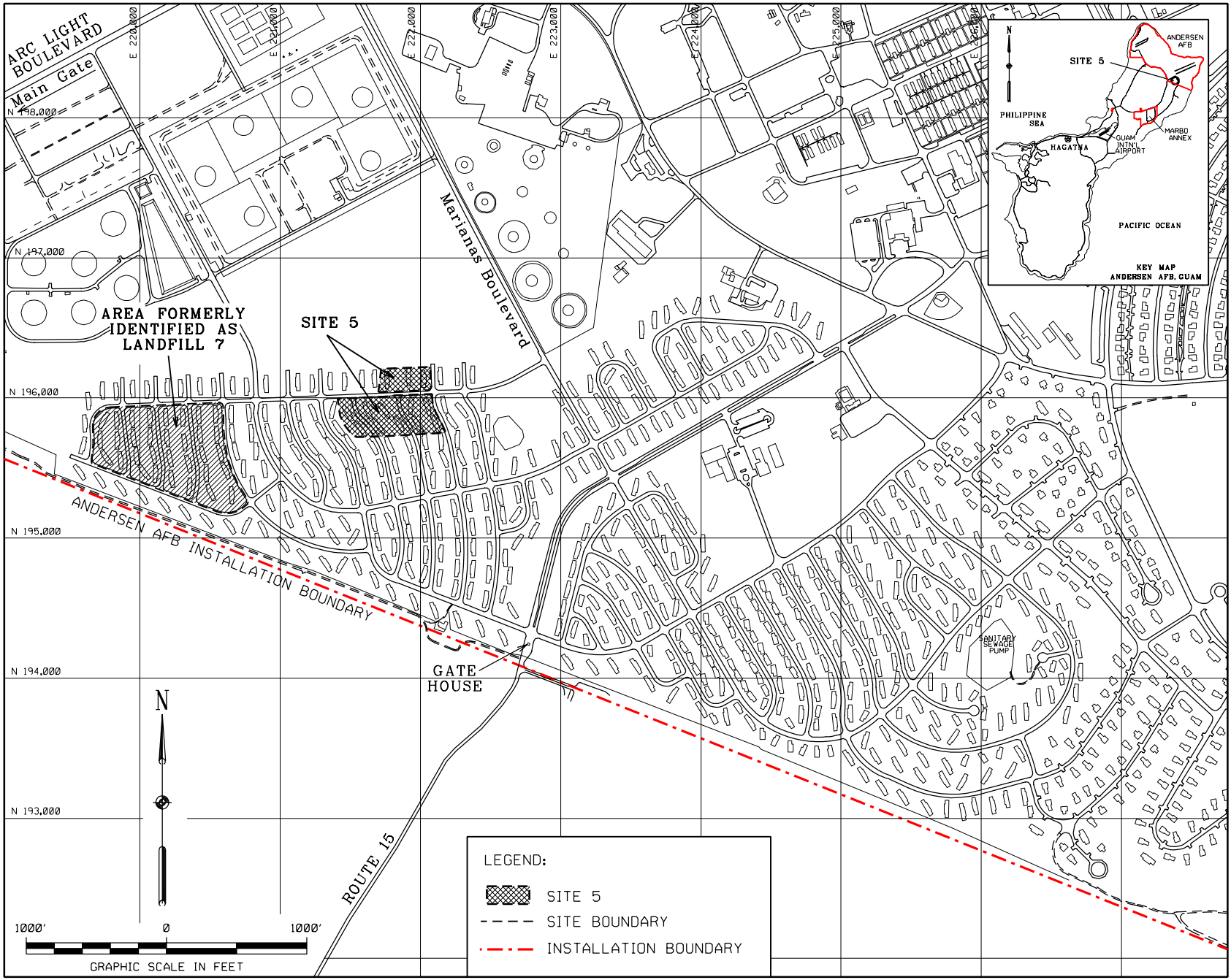

Figure 1-3. Location Map of Site 5, Main Base, Andersen AFB, Guam.

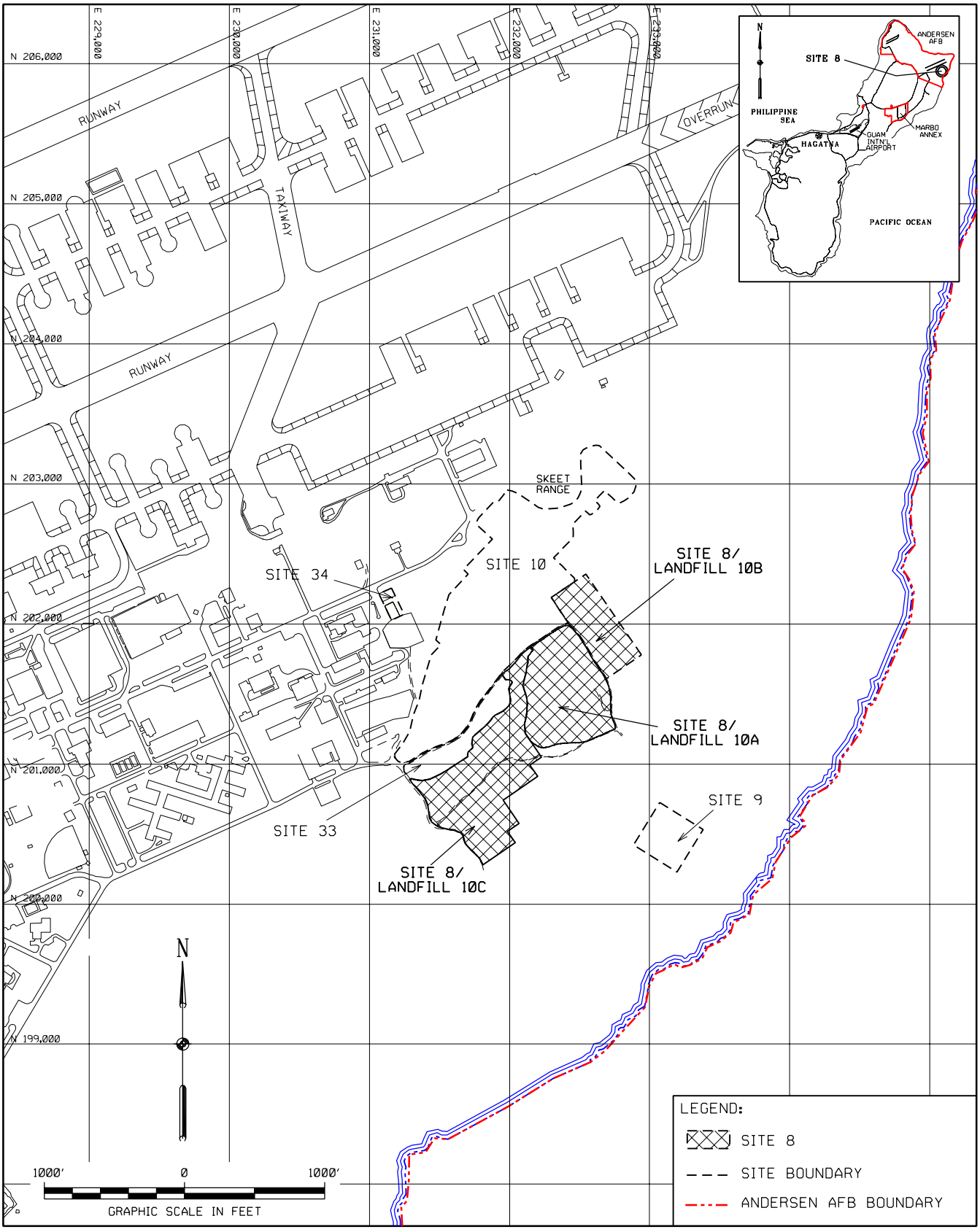

Figure 1-4. Location Map of Site 8, Main Base, Andersen AFB, Guam.

2. SITE 5 DECISION SUMMARY

This decision summary for Site 5 presents an overview of the site description, environmental characteristics, history, public involvement, nature and extent of contamination, associated human health and ecological risks, remedial alternatives, and rationale for selecting the preferred remedial action in light of the statutory requirements. The USAF has issued a detailed RI/FS that included Site 5 (EA Engineering, Science, and Technology, Inc. [EA], 2007).

Site 5 is located in the south central portion of the Main Base, within Andersen AFB's Capehart Housing Area (an active family housing area for USAF personnel) (Figures 1-2, 1-3, and 2-1). The investigation area covers 5.74 acres (Figure 1-3). Site 5 is intersected from east to west by Carabao Avenue and contains 13 dual-family, single-story, ranch-style, residential homes on the northern ends of Bataan, Hibiscus, and Gecko Lanes (Figure 2-1). Each residential unit includes a backyard patio, a carport, and a driveway. The area is landscaped and maintained by the USAF with grass lawn and shade trees. Jungle adjacent to the north of the Capehart Housing area forms the northern boundary of Site 5.

Funding is provided by the Defense Environmental Restoration Account (DERA); a funding source approved by Congress to clean up contaminated sites on U.S. Department of Defense (DoD) installations. Although the USAF is the lead agency under CERCLA, the USEPA and Guam EPA are support agencies for the cleanup activities. Site 5 is included in the National Superfund electronic database under CERCLIS identification number GU6571999519.

2.1 HISTORY OF SITE 5

2.1.1 Disposal and Reuse History

The USAF reportedly used Site 5 in the late 1950s for the disposal of sanitary wastes, industrial wastes, and other debris using a trench/fill method. The site consisted of a shallow excavated trench filled with metallic, concrete, wood, and solid construction debris. Soil cover was used to close the disposal area prior to construction of the Capehart Housing Area in 1958. Sections of the landfill were excavated during construction of the housing area in 1958. The remainder of the landfill was covered with soil as part of the grading and landscaping activities. Based on a records review (ICF Technology, Inc. [ICF], 1996), the landfill trench dimensions were estimated to be 400 feet long by 15 feet wide, with the ends flaring to 30 feet wide.

2.1.2 Environmental Investigations

Site 5 has been evaluated in the following seven environmental reports:

- *Installation Restoration Program Phase I: Records Search, Andersen Air Force Base, Guam* (Environmental Science and Engineering [ESE], 1985)
- *RCRA Facility Assessment of Solid Waste Management Units at Andersen AFB, Guam, USA* (Science Applications International Corporation [SAIC], 1986)

- *Final Basewide Work Plan for Operable Unit 6, Andersen Air Force Base, Guam* (ICF, 1994a)
- *Final Records Search for Andersen Air Force Base* (ICF, 1996)
- *Final Engineering Evaluation/Cost Analysis (EE/CA) for IRP Site 5/Landfill 7, Andersen Air Force Base, Guam* (EA, 2000a)
- *Remediation Verification Report, Interim Remedial Actions, Installation Restoration Program Site 5/Landfill 7, Main Base OU, Andersen Air Force Base, Guam* (Groundwater Technology, Inc. [GTI], 2002)
- *Remedial Investigation/Feasibility Study for Sites 1, 5, 8, 32, and 33, Main Base Operable Unit, Andersen Air Force Base, Guam* (EA, 2007)

Site 5 was one of 26 landfills at Andersen AFB identified in the IRP Phase I Records Search (ESE, 1985). The site was described in the report as approximately three acres in size and located beneath the housing area bordered by Wake, Kwajalein, and Guadalcanal Lanes. According to the report, the site was used between 1956 and 1958 for the disposal of Base sanitary trash utilizing a trench/fill method. Based on the limited information available, the report concluded that the landfill had minimal potential for contamination or hazardous leachate formation. The site was deleted from further consideration at that time.

The Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) (SAIC, 1986) included Site 5 as one of sixty-three Solid Waste Management Units identified on Andersen AFB. Site 5 was noted as a potential source of subsurface gas generation due to reported putrescible waste types and the then-current land use practices. Reportedly, no known release controls were employed while the landfill was active. The report stated that there was no known potential for past or ongoing releases to soil, groundwater, or air by hazardous contaminants. The RFA did acknowledge that the landfill received municipal-type refuse, which may have contained putrescible materials, and concluded there was the potential that methane might be generated by the landfill.

The Basewide Work Plan for OU 6 (ICF, 1994a) reiterates the information from the previous reports. However, because of a lack of physical and documented evidence concerning the exact boundary and location of the landfill, an exaggerated area approximately 14 acres in size was chosen to represent the site for the purposes of the RI/FS. Caraboa Avenue, Tarague Avenue, and Pacific Lane formed the borders of the expanded 14-acre site, incorporating the original 3-acre site delineated by the IRP Phase I Records Search (ESE, 1985). This site area, designated as "Area Formerly Identified as Landfill 7", is shown on Figure 1-4.

According to the 1996 Records Search (ICF, 1996), no written documentation pertaining to the use and operation of this landfill was made available during the June 1993 and June 1994 investigation. According to the report, construction drawings and a Master Plan were identified and reviewed but they provided no information that could be documented concerning whether the area was being used or had been used as a landfill. One Andersen AFB employee interview was included in the 1996 Records Search Report. The employee was one of the first occupants

of the Capehart Housing Area when it was opened in 1959, but the individual did not recall any landfills located east of the Base access road (Arc Light Boulevard).

Capehart Housing Area construction documents reviewed during the RI/FS focused on two areas (Figure 1-4): one delineated as the site by the Basewide Work Plan for OU 6 (ICF, 1994a); and one coinciding with a clearing observed in a 1956 aerial photograph. A landfill trench labeled "existing sanitary fill" was identified in the clearing observed in the 1956 aerial photograph. On the 1957 *Electrical Distribution Plan of Area 10 and Area 11*, the landfill is clearly shown as trending east-west below houses along the northern end of Gecko, Hibiscus, and Bataan lanes. The landfill dimensions, based on the plan scale, were 400 feet long by 15 feet wide, with the ends flaring to 30 feet wide. Portions of the sanitary fill were shown to be situated under the planned locations for houses and roads that were to be excavated to firm ground, backfilled to the finished grade, and compacted. The topographic maps also show the locations of 70 "borehole tests" in the area of the landfill trench. Fifteen of the boreholes contained layers labeled "trash/junk."

2.1.3 Non-Time-Critical Removal Action

The USAF already has conducted a partial cleanup of Site 5. In 2000, the USAF prepared an EE/CA in support of a CERCLA non-time-critical removal action (NTCRA) to address unacceptable non-cancer risks in subsurface soil associated with the utility worker and residential risk scenarios (EA, 2000a). No unacceptable risks were identified for surface soil. Antimony, lead, and tetrachlorodibenzo-p-dioxin (TCDD)-toxicity equivalent (TEQ) (i.e., dioxins) were identified as the COCs in subsurface soil for the utility worker exposure scenario. Antimony, manganese, and dioxins were identified as the COCs in subsurface soil for the future adult resident scenario.

The USAF selected a *Limited Soil Removal to Six Feet* alternative as the preferred NTCRA for Site 5. The rationale for excavating to 6 feet below ground surface (bgs) was based on the likelihood that future underground utility construction projects could transfer subsurface fill debris to the surface. The depth of the excavation was limited to 6 feet bgs because excavations associated with the repair or upgrade of underground utilities at the site are not anticipated to be greater than 6 feet. Therefore, once the fill material was removed to a depth of 6 feet via the NTCRA, future utility workers and residents would not be exposed to fill/soil containing COCs (hazardous substances). As per a USEPA comment (May 1999 Remedial Program Manager [RPM] meeting), excavation to a depth of 6 feet satisfies requirements for minimizing potential exposure to hazardous substances. The remaining fill material deeper than 6 feet bgs, containing hazardous substances exceeding remedial goals (RGs), was left in place, but capped with clean backfill to prevent an exposure pathway to human receptors. The hazardous substances in soil deeper than 6 feet bgs included metals and dioxins. These hazardous substances are relatively immobile in the soil and limestone bedrock and are not expected to migrate to groundwater.

In 2001, the USAF excavated approximately 1,688 loose cubic yards of soil from four excavation areas (Excavation Pit [EP]-A, EP-B, EP-C, and EP-D) (Figure 2-2) (GTI, 2002). The horizontal extent of the excavation was limited in some areas by the presence of existing structures which

could not be damaged (e.g., at the bottom of building footings), and at these locations, the excavations were sloped away at a 1:1 slope. Thus, some hazardous substance-impacted soil and debris remains at the site under building foundations and Hibiscus Lane. During excavation activities, visual observations were made to ensure that stained soil and debris were removed, to a maximum depth of 6 feet bgs, prior to the collection of confirmation samples. The hazardous substance concentrations in the confirmatory soil samples were below the project-specific RGs. Based on waste characterization samples of the excavated soil, the excavated material was characterized as non-hazardous and was disposed at the Base sanitary landfill. Site restoration activities included backfilling excavations with clean fill, replacing concrete patios and sidewalks that were removed during excavation activities, and capping the excavated areas with topsoil (6 feet in depth) and vegetation. The backfilling/capping conducted during the site restoration complies with RCRA Subtitle D (40 Code of Federal Regulations [CFR] 258, Subpart F) and Guam EPA Solid Waste Management Program (Title 22, Division 4, Chapter 23, Article 6) landfill closure requirements. Andersen AFB will continue to monitor groundwater under the Long-Term Groundwater Monitoring (LTGM) Program and maintain the cap (i.e., landscaping). The Base shop also replaced the 4-inch diameter sewer line encountered in area EP-D prior to completion of backfilling activities.

2.2 ENFORCEMENT ACTIVITIES

Due to its primary mission in national defense, the USAF has long been engaged in a wide variety of operations that involve the use, storage, and disposal of hazardous materials. On 14 October 1992, Andersen AFB was formally listed on the National Priority List (NPL) by the USEPA to investigate abandoned sites that may have been impacted by the use, storage, and disposal of hazardous materials.

The enforcement activities for Andersen AFB were initiated when the USAF entered into a FFA with USEPA Region 9 and Guam EPA. The FFA, finalized on 30 March 1993 (USEPA, Guam EPA, and USAF, 1993), established procedures for involving federal and territorial regulatory agencies, as well as the public, in the environmental restoration process at Andersen AFB. The FFA was based on applicable environmental laws, including CERCLA, Hazardous and Solid Waste Act of 1982 (HSWA), SARA, and the NCP.

2.3 COMMUNITY PARTICIPATION

In August 1992, Andersen AFB conducted 67 interviews with local government officials, residents, and concerned citizens to determine the level of community concern and interest in the environmental investigations. These community interviews provided the basis for the 1993 Community Relations Plan (CRP) (ICF, 1993). The 1993 CRP described activities to keep the nearby communities informed of the progress of the environmental investigations at Andersen AFB sites and provide opportunities for input from residents regarding cleanup plans. In response to the USEPA request, Andersen AFB conducted 27 additional interviews in 1998 and updated the CRP (EA, 1998).

The USAF has promoted community relations and encouraged public involvement in cleanup decisions through the Restoration Advisory Board (RAB), established in 1995. Currently, the RAB is comprised of community members, elected officials, USAF officials, and representatives from regulatory agencies. The RAB meets on a quarterly basis to discuss program progress and to advise the community on the status and plans for the various IRP sites. RAB meeting minutes are available for review as part of the AR.

In addition to RAB meetings, in 1993 Andersen AFB prepared a brochure to respond to community concerns and inform the public about Andersen AFB's IRP investigations. A summary of the history and status of community involvement in the IRP at Andersen AFB is presented in the December 2001 Final Management Action Plan (Andersen AFB, 2001a).

In order to provide access to the public, Andersen AFB has provided copies of reports related to Sites 5 and 8 to the AR file and the Information Repository at the following locations:

Nieves M. Flores Memorial Library
254 Martyr Street
Hagåtña, Guam 96910
Telephone: (671) 475-4751, 4752, 4753, or 4754

University of Guam
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The AR file is also available on the internet at: http://www.adminrec.com/PACAF.asp.

A notice of availability for the reports related to Sites 5 and 8 was published in the Guam edition of *Marianas Variety* on 26 July 2007 (Appendix B).

In July 2007, the Proposed Plan for Sites 5 and 8 was released to the public for a review and comment, with a public comment period from 26 July 2007 to 26 August 2007. A public meeting was held at the Guam Marriott Resort and Spa in Tumon on 2 August 2007, where the Proposed Plan was presented, and representatives from the USEPA Region 9, Guam EPA, and USAF responded to public comments. The results of the public meeting and responses to public comments are presented in Section 5 of this ROD.

2.4 SCOPE AND ROLE OF THE OPERABLE UNIT OR RESPONSE ACTION

Andersen AFB decided to use an OU approach to manage the investigation and remediation of environmental conditions at Andersen AFB. According to the 1993 FFA, the OUs were formed to:

- Expedite the completion of environmental activities;

- Evaluate sites with similar locations and potentially similar requirements as a group;
- Complete remedial design investigations at sites where closure decisions have been previously reached with the Government of Guam; and
- Provide a screening mechanism for evaluating newly or tentatively identified sites for inclusion in the RI/FS.

The environmental investigations at Sites 5 and 8 were performed under the Main Base OU. The Main Base OU addresses potential contamination in the surface soil, subsurface soil, and/or groundwater beneath sites within the OU. Sites 5 and 8 have been grouped together in this ROD as they require implementation of institutional or engineering controls.

2.5 SITE CHARACTERISTICS

2.5.1 Site 5 Physical Setting

Site 5 is located in the south central portion of the Main Base, within Andersen AFB's Capehart Housing Area (an active family housing area for USAF personnel) (Figures 1-2, 1-3, and 2-1). The investigation area is 5.74 acres (Figure 1-3). The site is intersected from east to west by Carabao Avenue and includes 13 dual-family, single-story, ranch-style, residential homes on the northern ends of Bataan, Hibiscus, and Gecko Lanes (Figure 2-1). Each residential unit includes a backyard patio, a carport, and a driveway. The area is landscaped and maintained by the USAF with grass lawn and shade trees. Jungle adjacent to the north of the Capehart Housing area forms the northern boundary of Site 5.

A site reconnaissance and detailed site inventory (DSI) were conducted during the 1998 field investigation to accurately define the environmental setting and boundary of the site, including identification of potentially hazardous wastes. In addition to the DSI, an ecological (flora and fauna) survey was performed to identify potential ecological receptors and exposure pathways (Section 2.7.2).

Much of the native soil at Site 5 has been disturbed during the construction and landscaping activities for the housing area or removed during the surface soil removal action. The remaining soils are representative of the Guam-Urban land complex. This unit is characteristic of land disturbed by urban development and consists of approximately 55 percent Guam Cobbly Clay loam and 45 percent Urban land. Permeability of this soil is moderately rapid and it has a very low water-holding capacity.

Groundwater beneath Site 5 is approximately 475 to 500 feet bgs, flows toward the east, and eventually discharges to the Pacific Ocean. There are no monitoring wells at the site; however, monitoring well IRP-05, and production wells Y-15 and USGS-128 are located within a 1.0 mile radius of the site. IRP-05 is located approximately 2,600 feet downgradient to crossgradient of the site, USGS-128 is located approximately 5,200 feet downgradient of the site, and Y-15 is located approximately 2,300 feet crossgradient from the site.

Site 5 is located within one major habitat type: "Active Base Area". Site 5 consists of a residential housing development constructed over the top of a former landfill. This area contains paved areas, ranch style homes, mowed grass, and landscaped shrub and tree growth. Approximately 40 percent of Site 5 consists of impervious surfaces (rooftops, sidewalks, and roadways). Manicured lawn (*Poaceae* species) dominated the habitat between the houses. A mixture of ornamental shrubs and trees were planted in accordance with the Base's landscape management plan. Additionally, ornamental vines, epiphytes (*Polypodum scolopendria*), and shrubs were present. The dominant trees were the Flame tree (*Delonix regia*), coconut palm (*Cocos nucifera*), and Australian pine (*Casuarina equisetifolia*). The landscaped areas compose approximately 60 percent of the site. The site lies within the designated foraging area of the Micronesian starling (*Aplonis opacus guami*). A description of ecological habitats and receptors is presented in Section 2.7.2 of this document.

2.5.2 Sampling History for Site 5

The RI (EA, 2007) was conducted to identify and characterize the contaminants of potential concern (COPCs) at the site and evaluate risks to human health and the environment. During the RI, surface and subsurface soil samples were collected at Site 5. A total of 32 surface soil samples were collected at Site 5, the results of which are summarized in the RI as well as Figure 2-3. Nineteen of the 32 surface soil samples and two duplicate samples were analyzed for the following parameters:

- Semivolatile organic compounds (SVOCs), USEPA Method SW8270C
- Polycyclic aromatic hydrocarbons (PAHs), USEPA Method SW8310
- Cyanide, USEPA Method SW9012
- Andersen AFB target analyte list (TAL) metals, USEPA Method SW6010B/SW7000 series

Ten additional surface soil samples and one duplicate sample were analyzed for dioxins/furans.

- Dioxins/Furans, USEPA Method SW8290

Surface soil samples were not analyzed for volatile organic compounds (VOCs) because geologic and climatic conditions on Guam induce volatilization and infiltration, thereby limiting the potential presence of VOCs in surface soil samples.

A total of 11 subsurface soil samples (including two duplicate samples) were collected so that buried waste materials could be characterized and the potential risks to human health and the environment could be evaluated. Subsurface soil samples were collected from the bottom of test pit excavations at depths ranging from 2.5 to 10 feet bgs, the results of which are summarized in the RI as well as Figure 2-4. No samples were collected from TP-05 because bedrock was encountered at a depth of 0.25 feet bgs. Subsurface soil samples were analyzed for the following parameters:

- VOCs, USEPA Method SW8260B (three samples including one duplicate)
- SVOCs, USEPA Method SW8270C (seven samples including one duplicate)
- PAHs, USEPA Method SW8310 (seven samples including one duplicate)
- Dioxins/Furans, USEPA Method SW8290 (six samples including one duplicate)
- Cyanide, USEPA Method SW9012 (seven samples including one duplicate)
- Andersen AFB TAL metals, USEPA Method SW6010B/SW7000 series (seven samples including one duplicate).

The surface and subsurface soil analytical results were compared to residential and industrial preliminary remedial goals (PRGs) that were developed by USEPA Region 9 to establish screening criteria for potentially contaminated sites (USEPA, 2000a; 2004a).

Because some metal concentrations in soils occur naturally at high concentrations in Guam, background threshold values (BTVs) were established (ICF, 1997; Andersen AFB, 2001b; EA, 2002a). The BTVs for six metals (aluminum, antimony, arsenic, chromium, manganese, and vanadium) exceed the respective residential PRGs. For these metals, the maximum observed concentration was compared to the BTV rather than the residential PRG.

If the maximum detected concentration of an analyte exceeded the screening value and BTV, that analyte was then retained as a COPC. Subsequent to determining the COPCs for Site 5, a human health risk assessment (HHRA) and an ecological risk assessment (ERA) were conducted to establish the contaminants of concern (COCs), the remedial action objectives (RAOs), and the RGs (Sections 2.7 and 2.8).

Although no groundwater monitoring wells are located directly on the site, three wells (monitoring well IRP-05 and production wells Y-15 and USGS-128) are located within a 1.0 mile radius of the site (Figure 1-4). Based on a review of semiannual groundwater monitoring results for these three wells, none of the contaminants detected in site soil have been detected in groundwater samples collected from these wells at concentrations above maximum contaminant levels (MCLs) (EA, 2006).

2.5.3 Conceptual Site Model for Site 5

Site 5 is situated within the south central portion of the Main Base and the investigation area covers 5.74 acres. Site 5 is located within a residential development (Capehart Housing Area) (Figure 2-1) which houses USAF families with children. Thirteen dual-family residences are located within the Site 5 boundary (Figure 2-1), with two of the residences situated directly above the former landfill trench (Figures 2-2 and 2-5). Unrestricted residential backyards and roadways above the former landfill are easily accessible to anyone within the community. The backyards in particular are widely used, as evidenced by the presence of children's recreational equipment, patio furniture, gardening projects, and pet tethers. A school bus stop is located on

site at the intersection of Caraboa Avenue and Hibiscus Lane. According to the BGP (Andersen AFB, 2005), Andersen AFB plans to continue use of the subdivision for residential housing for the foreseeable future.

Based on historical records research and interviews, Site 5 was operational in the early or mid-1950s for the disposal of sanitary wastes, industrial wastes, and other debris in a shallow trench. Soil cover was used to close the site prior to construction of the Capehart Housing Area in 1958. Sections of the landfill were reportedly excavated during construction of the housing area in 1958. The remainder of the landfill was covered with soil as part of the grading and landscaping activities. In 2001, the USAF performed a partial cleanup activity that included removing soil from the former landfill trench down to 6 feet bgs between homes and streets (Figure 2-2) to mitigate risks to human health from the disposed material.

Current and future residents (adults and children) are potential receptors at Site 5. Additional potential human receptors include utility workers who maintain services to the residences. Their activities include digging into soil to repair and replace underground utilities, structural additions, roadway repairs, and utility upgrades for power, community lighting, sewer, cable television, water, and phone service. Base personnel/contractors performing routine maintenance/services to the residences and grounds are also potential receptors performing grass trimming, water blasting, animal control, postal delivery, and municipal solid waste collection.

Media of concern identified at the site are surface soil, subsurface soil, groundwater, and air exposures that could result from dispersion of surface and subsurface soil into air. Although groundwater is considered a medium of concern at the site, as discussed in the RI (EA, 2007), none of the contaminants found at the site have been detected in groundwater collected from downgradient monitoring wells at concentrations above their respective MCLs. Groundwater is being monitored as a part of the on-going LTGM Program at Andersen AFB, and is therefore not evaluated further under this ROD.

The exposure pathways that are considered for the current and future resident adults and children scenario are incidental ingestion of, dermal contact with, and inhalation of dust particulates from surface soil. It is assumed that residents could be exposed to subsurface soil, which could be disturbed during digging or excavation activities and brought to the surface. Therefore, residents are evaluated for incidental ingestion of, dermal contact with, and inhalation of dust particulates from subsurface soil. The exposure pathways that are considered for current and future utility workers are incidental ingestion of, dermal contact with, and inhalation of airborne particulates of subsurface soil. The conceptual site model (CSM) for the Site 5 HHRA is presented in Figure 2-6.

2.5.4 Suspected Contamination Sources at Site 5

The USAF reportedly used Site 5 in the early- or mid-1950s for the disposal of sanitary wastes, industrial wastes, and other debris using a trench/fill method. The site consisted of a shallow excavated trench filled with metallic, concrete, wood, and solid construction debris. In 2001, the USAF completed a NTCRA to excavate accessible areas of contaminated soil and debris to a depth

of 6 feet bgs. The horizontal extent of the excavation was limited in some areas by the presence of existing structures which could not be damaged (e.g., at the bottom of building footings), and at these locations, the excavations were sloped away at a 1:1 slope. Thus, some hazardous substance-impacted soil and debris remain at the site under building foundations and Hibiscus Lane and at depths greater than 6 feet bgs.

2.5.5 Site 5 COPCs

Twenty-nine surface soil samples and three field duplicates were collected from Site 5. Based on analytical results, copper, vanadium, and TCDD-TEQs (i.e., dioxins) exceeded their respective screening value and BTV and were identified as surface soil COPCs.

Eleven subsurface soil samples (including two duplicate samples) were collected from Site 5 Based on analytical results, antimony, barium, cadmium, copper, lead, manganese, silver, zinc, and TCDD-TEQs were detected at concentrations that exceeded their respective screening value and BTV, and were identified as subsurface soil COPCs.

There were no air samples collected at Site 5, and air concentrations were modeled from both surface and subsurface soil concentrations for purposes of the risk assessment.

2.6 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Site 5 is currently a residential development that houses families with children. According to the BGP (Andersen AFB, 2005), Andersen AFB plans to continue use of the subdivision for residential housing for the foreseeable future. Potential human receptors at the site include resident adults, resident children, and utility workers.

2.7 SUMMARY OF SITE RISKS

A HHRA and an ERA were performed for Site 5 to evaluate whether the COPCs identified in surface and subsurface soil pose potential unacceptable risks to human health or the environment. The HHRA and ERA identified the COPCs, exposure concentrations, exposure duration, and exposure pathways, and estimated the risks to human health and the environment if no action was taken. COPCs that were determined to pose unacceptable risks to human health or the environment were designated as COCs. As a comprehensive HHRA and ERA for Site 5 are presented in the RI (EA, 2007), in accordance with USEPA Guidance (USEPA, 1999a), the HHRA and ERA are presented here in terms of COCs, only.

2.7.1 Baseline HHRA for Site 5

The baseline HHRA estimates what risks the site poses if no action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline HHRA for this site. The HHRA methodology is detailed in Appendix D.1 of the RI/FS

(EA, 2007) and, in general, involves a four-step process: (1) hazard identification, (2) toxicity assessment, (3) exposure assessment, and (4) risk characterization.

The HHRA for Site 5 was originally completed as part of an EE/CA (EA, 2000a). The HHRA was formally reviewed and approved by USEPA Region 9 as part of the EE/CA review process. In order to ensure that the results and conclusions presented in the EE/CA are still valid, a review of the HHRA was conducted. The following process was used to review and update the HHRA:

1. Selection of COPCs. All screening values (USEPA Region 9 PRGs) were reviewed and updated. There were some changes in PRGs. The only impact on COPCs selected was for lead, which would not be selected as a COPC in surface soil using 2004 PRGs. These changes were made to the COPC screening table and the exposure point concentration (EPC) summary table. There were no changes to COPCs identified in subsurface soil.
2. All exposure factor values were reviewed against current USEPA guidance (USEPA, 2004a). No changes were identified.
3. All toxicity values were reviewed against current guidance (USEPA, 2006). Few toxicity values changed for COPCs identified at Site 5. None of the changes were significant, but all changes have been made to the toxicity tables in the RI/FS.
4. Calculation of EPCs was reviewed against current USEPA guidance. Although USEPA has issued a new method for calculating EPCs using ProUCL, the potential impact on risk calculation results is expected to be small, and is not expected to have any impact on the conclusions for the site.
5. As an element of the risk management decision, risk characterization results were reviewed and compared to the risk range of 10^{-6} to 10^{-4}. The original HHRA identified cumulative cancer risks that exceeded 10^{-6} as unacceptable, and identified COCs on that basis. The review indicated that cumulative cancer risks for all receptors exposed to soil fall within the risk range of 10^{-6} to 10^{-4}.
6. The risks associated with background analytes were added to the Risk Characterization in the RI, in accordance with USEPA guidance.

2.7.1.1 Identification of COCs for HHRA at Site 5

No surface soil COPCs were retained as COCs at Site 5. The range of detected concentrations (maximum and minimum) and the frequency of detection for each COC identified in subsurface soil at Site 5 are included in Table 2-1 using the format presented in *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (USEPA, 1999b).

The EPC for each COC is a statistically derived concentration based on the soil sample results that is used to calculate the risk associated with each COC. The EPCs for COCs in subsurface soil for Site 5 are included in Table 2-1.

For the reasonable maximum exposure (RME) scenario, the EPC for each COC is estimated using the arithmetic mean and the 95th upper confidence limit of the mean (95UCLM). The 95UCLM represents a high value for an EPC so there is 95 percent confidence that all other values will be below the 95UCLM value. The 95UCLM is used as the EPC in the exposure assessment for the RME assumptions. However, if the 95UCLM is greater than the maximum detected concentration, the maximum detected concentration value is used as the EPC and is listed in the table instead of the 95UCLM value. The arithmetic mean concentration is used as the central tendency EPC value using average exposure (AE) assumptions.

2.7.1.2 Exposure Assessment for HHRA at Site 5

An exposure assessment was conducted to estimate the magnitude of actual and/or potential human exposures. In the exposure assessment, average and maximum estimates of potential exposure were developed in accordance with USEPA guidance for both current and potential future land use assumptions. Current maximum exposure estimates were used to determine whether a potential health hazard exists based on current conditions. Future maximum potential exposure estimates were used to provide an understanding of potential future exposures and health hazards, and include a qualitative estimate of the likelihood of such exposures occurring.

Current and future resident adults and children, and current and future utility workers (occasional users) were considered the receptor populations for which risks were estimated.

Media of concern include surface soil, subsurface soil, groundwater, and air exposures that could result from dispersion of surface and subsurface soil into air. Although groundwater is considered a medium of concern at the site, as discussed in the RI (EA, 2007), none of the contaminants found at the site have been detected in groundwater collected from downgradient monitoring wells at concentrations above their respective MCLs. Groundwater is being monitored as a part of the ongoing LTGM Program at Andersen AFB, and is therefore not evaluated further under this ROD.

As shown in the CSM in Figure 2-6, the following human exposure pathways were evaluated for Site 5:

- Incidental ingestion of surface soil during residential activities (e.g., gardening)
- Incidental ingestion of subsurface soil during residential activities (e.g., gardening)
- Incidental ingestion of subsurface soil during utility activities (e.g., maintenance)
- Dermal contact with surface soil during residential activities (e.g., gardening)
- Dermal contact with subsurface soil during residential activities (e.g., gardening)
- Dermal contact with subsurface soil during utility activities (e.g., maintenance)
- Inhalation of suspended surface soil particles during residential activities (e.g., gardening)

- Inhalation of suspended subsurface soil particles during residential activities (e.g., gardening)
- Inhalation of suspended subsurface soil particles during utility activities (e.g., maintenance).

Air samples were not collected at Site 5; therefore, it was necessary to model concentrations of COPCs in suspended surface soil. The exposure modeling for this pathway was performed for potential receptors: resident adults and children and utility workers (occasional users). It should be noted that air modeling was only conducted for fugitive dust (suspended surface soil) emissions from the site, and not for VOC emissions, as VOCs were not identified as COCs at the site.

The final step in this exposure assessment was to estimate COC intakes for each of the pathways considered in the assessment. In the exposure assessment, two different measures of intake are provided, depending on the nature of the effect being evaluated. Intakes are averaged over the period of exposure (i.e., the averaging time) when evaluating long-term exposures to chemicals that produce adverse non-carcinogenic effects (USEPA, 1989). This measure of intake is referred to as the average daily intake (ADI) and is a less-than-lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the lifetime average daily intake (LADI) (USEPA, 1989).

The exposure factor values (exposure duration, exposure time, incidental ingestion rates of contaminated soil, inhalation rates of contaminated dust, and dermal exposure assumptions for potential human receptors under RME and AE scenarios) used in estimating intakes are presented in Appendix D.1 of the RI/FS (EA, 2007).

2.7.1.3 Toxicity Assessment for HHRA at Site 5

The toxicity assessment considers the types of potential adverse health affects associated with exposures to COCs. The toxicity assessment relies on existing toxicity information developed based on dose-response for specific COCs. Using this dose-response relationship, specific toxicity values were derived by USEPA that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels. The USEPA-derived toxicity values for COCs were called reference doses (RfDs) for non-carcinogens and slope factors (SFs) for potential carcinogens.

The cancer and non-cancer toxicity values used for COCs at Site 5 are presented in Appendix D.1 of the RI/FS (EA, 2007). The USEPA Integrated Risk Information System (IRIS) database was used for RfDs of non-carcinogenic COCs. If RfDs for COCs were not available from IRIS, the USEPA Health Effects Assessment Summary Table (HEAST) was used as a secondary data source. If RfDs for COCs were not available from IRIS or HEAST for one route of exposure but existed for another route, the existing value was examined for technical applicability to the alternate route and subsequently used, if appropriate.

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold; that is, there is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This "non-threshold" concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen.

2.7.1.4 HHRA Characterization for Site 5

Carcinogenic risk was estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen at the site. The numerical estimate of excess lifetime cancer risk was calculated by multiplying the LADI by the risk per unit dose (the slope factor), as shown in the following equation:

$$Risk = LADI \times SF$$

where: Risk = A unitless probability (e.g., 2×10^{-5}) of an individual developing cancer
LADI = Lifetime average daily intake (milligram[s] per kilogram per day [mg/kg/day])
SF = Cancer slope factor $(mg/kg/day)^{-1}$

Because the SF is the statistical 95th percent upper confidence limit (UCL) on the dose-response slope, this method provides a conservative, upper-bound estimate of risk.

Cancer risks were estimated for current and future residents and utility workers (occasional users). These risks are probabilities that usually are expressed in scientific notation. For example, an excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes not related to the site's past waste disposal. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally acceptable risk level for site-related exposures is 10^{-6}. USEPA has determined that risk in excess of 10^{-4} (1 in 10,000) is unacceptable. The risk range of 10^{-4} to 10^{-6} may be evaluated in the risk management context to determine whether risk is acceptable for future site conditions.

The potential human health risks associated with exposures to non-carcinogenic COCs at Site 5 were estimated by comparing ADIs with established RfDs, as per USEPA guidance (USEPA, 1989) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The hazard index (HI) is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQs from different contaminants and exposure routes,

toxic non-carcinogenic effects from all contaminants are unlikely. An HI >1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$HQ = \frac{ADI}{RfD}$$

where: HQ = Hazard quotient; ratio of average daily intake level to acceptable daily intake level (unitless)
ADI = Estimated average daily intake (mg/kg/day)
RfD = Reference dose (mg/kg/day)

ADI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

2.7.1.4.1 HHRA Results for Surface Soil Exposures at Site 5

The detailed exposure and risk calculations are presented in Appendix D.1 of the RI/FS (EA, 2007).

No unacceptable human health risks were identified in surface soil for any of the evaluated scenarios. Non-cancer HI values did not exceed USEPA's risk target of 1.0 and cancer risks fell below the acceptable risk level of 10^{-6}. No individual COPCs had cancer risks which exceeded 10^{-6}. Therefore, no surface soil COC was identified.

2.7.1.4.2 HHRA Results for Subsurface Soil Exposures at Site 5

The detailed exposure and risk calculations are presented in Appendix D.1 of the RI/FS (EA, 2007). The cancer and non-cancer risk assessment results for future resident adults and children, and utility workers exposed to subsurface soil under the RME scenario are presented in Tables 2-2 through 2-7, respectively. The cancer and non-cancer risk results are summarized below:

SUMMARY OF SUBSURFACE SOIL NON-CANCER RISKS AT SITE 5

Route of Exposure	Utility Workers		Resident Adults		Resident Children	
	AE	RME	AE	RME	AE	RME
Incidental Ingestion of Subsurface Soil	0.13	1.02	4.5	18	42	166
Dermal Contact with Subsurface Soil	0.04	0.23	1.8	4.1	7.9	36
Inhalation of Particles from Subsurface Soil	0.12	0.75	0.4	2.2	2.6	7.9
Total	**0.29**	**2.00**	**6.6**	**24**	**52**	**210**

Shaded cells indicate non-cancer risks exceeding risk target of 1.0.
AE = Average Exposure
RME = Reasonable Maximum Exposure

SUMMARY OF SUBSURFACE SOIL CANCER RISKS AT SITE 5

Route of Exposure	Utility Workers		Resident Adults		Resident Children	
	AE	RME	AE	RME	AE	RME
Incidental Ingestion of Subsurface Soil	1.22E-07	9.78E-07	1.54E-06	2.05E-05	6.39E-06	3.83E-05
Dermal Contact with Subsurface Soil	4.69E-08	2.63E-07	7.39E-07	5.62E-06	1.46E-06	1.00E-05
Inhalation of Particles from Subsurface Soil	7.96E-09	4.88E-08	9.49E-09	1.75E-07	2.74E-08	1.23E-07
Total	**1.77E-07**	**1.29E-06**	**2.29E-06**	**2.63E-05**	**7.88E-06**	**4.84E-05**

Shaded cells indicate cancer risks exceeding 1×10^{-6}.
AE = Average Exposure
RME = Reasonable Maximum Exposure

Unacceptable non-cancer risks were calculated under the resident child scenario. Exposures to COCs in subsurface soil and ambient air among resident children resulted in an estimated HI of 210 under RME conditions. Antimony (HI = 193), copper (HI = 4.2), and manganese (HI = 11.9) had HIs exceeding 1.0 under RME conditions (Table 2-5).

Unacceptable non-cancer risks were calculated for the resident adult scenario. Under RME conditions, the cumulative non-cancer risks from exposures of resident adults to COCs in subsurface soil and ambient air resulted in an estimated HI of 24. Antimony (HI = 20.8) and manganese (HI = 2.7) had HIs exceeding 1.0 under RME conditions (Table 2-2).

Under the utility worker scenario, unacceptable non-cancer risks were identified for subsurface soil as the total HI value (HI = 2.0) exceeded the USEPA's risk target of 1.0 (primarily associated with antimony with a cumulative HI = 1.19).

Cancer risks were within the risk range of 10^{-6} to 10^{-4} for resident adults (2.63×10^{-5}) and children (4.84×10^{-5}) for subsurface soil exposure. No unacceptable cancer risks were identified for utility workers associated with subsurface soil exposure.

2.7.1.5 HHRA Uncertainties for Site 5

The different types of uncertainty involved in the HHRA process are discussed in detail in the RI (EA, 2007), and are presented briefly in the following sections.

2.7.1.5.1 Sampling and Analysis Uncertainties

The sampling plan can have a significant impact on the results obtained in calculating human health risks at a site. To the extent that samples are collected in areas that are expected to be contaminated (biased sampling), the EPC used in calculating risk exposures and risks is likely to overestimate the actual concentration encountered at the site from random exposure across the site. Sampling bias generally results in an overestimate of exposures and risks at a site. The soil sampling at Site 5 incorporated a combination of random and biased samples. As the majority of soil samples collected at Site 5 was biased toward areas of suspected contamination, the measured concentrations and calculated health risks would tend to be overestimated.

2.7.1.5.2 Chemical Fate and Transport Modeling Uncertainties

The models used to estimate chemical concentrations associated with particulates in air at Site 5 are consistent with those recommended by the USEPA (1996). However, due to uncertainties in modeling methodologies, USEPA-recommended models are likely to overestimate actual concentrations at the site. Thus, use of models is likely to overestimate human health risks at Site 5.

2.7.1.5.3 Uncertainties of Toxicity Assessment

There are numerous uncertainties associated with the Toxicity Assessment. These are generally due to the unavailability of data to thoroughly calculate the toxicity of COPCs.

Uncertainties Associated with Non-Carcinogenic Effects

<u>Interspecies Extrapolation</u>

The majority of toxicological information comes from experiments with laboratory animals. Experimental animal data have been relied on by regulatory agencies to assess the hazards of human chemical exposures. Interspecies differences in chemical absorption, metabolism, excretion, and toxic response are not well understood; therefore conservative assumptions are applied to animal data when extrapolating to humans. These probably result in an overestimation of toxicity.

Intraspecies Extrapolation

Differences in individual human susceptibilities to the effects of chemical exposures may be caused by such variables as genetic factors (e.g., glucose-6-phosphate dehydrogenase deficiency), lifestyle (e.g., cigarette smoking and alcohol consumption), age, hormonal status (e.g., pregnancy), and disease. To take into account the diversity of human populations and their differing susceptibilities to chemically induced injury or disease, a safety factor is used. USEPA uses a factor between 1 and 10. This uncertainty may lead to overestimates of human health effects.

Exposure Routes

When experimental data available on one route of administration are different from the actual route of exposure that is of interest, route-to-route extrapolation must be performed before the risk can be assessed. Several criteria must be satisfied before route-to-route extrapolation can be undertaken. The most critical assumption is that a chemical injures the same organ(s) regardless of route, even though the injury can vary in degree. Another assumption is that the behavior of a substance in the body is similar by all routes of contact. This may not be the case when, for example, materials absorbed via the gastrointestinal tract pass through the liver prior to reaching the systemic circulation, whereas by inhalation the same chemical will reach other organs before the liver. However, when data are limited these extrapolations are made, and may result in overestimates of human toxicity.

Uncertainties Associated with Carcinogenic Effects

Interspecies Extrapolation

The majority of toxicological information for carcinogenic assessments comes from experiments with laboratory animals. There is uncertainty about whether animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a very small number of chemical substances are known to be human carcinogens. The fact that some chemicals are carcinogenic in some animal species but not in others raises the possibility that not all animal carcinogens are human carcinogens.

Regulatory agencies assume that humans are as sensitive to carcinogens as the most sensitive animal species. This is designed to prevent underestimation of risk and has the potential to overestimate carcinogenic risk.

High-Dose to Low-Dose Extrapolation

Typical cancer bioassays provide limited low-dose data on responses in experimental animals for chemicals being assessed for carcinogenic or chronic effects. Because dosing methods do not reflect how animals actually intake a chemical, a dose-response assessment normally requires extrapolation from high to low doses using mathematical modeling. A central problem with the low-dose extrapolation models is that they may fit experimental data equally well, but they may not all be plausible biologically. The dose-response curves derived from different models diverge substantially in the dose range of interest (National Research Council, 1983). Therefore, low-dose extrapolation is more than a curve-fitting process, and considerations of biological

plausibility of the models must be taken into account before choosing the best model for a particular set of data.

2.7.1.5.4 Uncertainties Analysis of Exposure Assessment

An analysis of uncertainties is an important aspect of the exposure assessment. It provides the risk assessor and reviewer with information relevant to the individual uncertainties associated with exposure factor assumptions and their potential impact on the final assessment.

Current Receptors

Site 5 is located within a residential development (Capehart Housing Area) which houses families with children. Under current use conditions at Site 5, the potential receptors are current and future resident adults and children, and utility workers (occasional users).

Exposure Factors

Soil Ingestion Rate

Soil ingestion rates for children are based on studies performed by Binder et al. (1986) and Clausing et al. (1987). Both were short-term studies, and as they were not based on average long-term exposures, they represent an overestimate of exposure. More recent published data have shown that average soil ingestion rates for 2-year-olds is less than 100 milligrams per day (Calabrese et al., 1989; Davis et al., 1990). Furthermore, USEPA soil ingestion rates for children ages 1 to 6 years are based on ingestion rates for children at age 18 months and are applied through age 6 years (USEPA, 1989). This is very unlikely because children over 2 years old do not ingest at the same rate as an 18-month-old. Additionally, a conservative estimate was used for the Fraction Ingested value of 1.0, which assumes that all soil ingested (for residential exposures) is ingested at the residence. This assumes that no activities take place elsewhere. Taken together, these suggest that intakes for this pathway are overestimated.

Exposure Duration

USEPA assumes the residential exposure duration for adults is 30 years, which represents the USEPA-derived 90^{th} percentile upper limit for time spent at one residence. The average (50^{th} percentile) time spent at one residence is 7 years. These values are recommended in the Superfund Guidance Manual (USEPA, 1989). Soil ingestion for children aged 1 to 6 years is assumed to continue for the entire 6-year time frame.

Exposure Frequency

Although the assumption was made that utility workers (occasional users) will be exposed to subsurface soils containing COCs for 40 days per year for 30 years, this is very unlikely. It does not seem feasible that there are enough housing developments built on land above the landfill to make it possible for utility workers (occasional users) to be exposed to this extent. Therefore, it

is highly likely that the RME risk estimates presented in this report significantly overestimate the potential human health risks.

2.7.1.5.5 Uncertainties in Risk Characterization

Uncertainties in the risk characterization can stem from the inherent uncertainties in the data evaluation, the exposure assessment process (including any modeling of EPCs in secondary media from primary media) and the toxicity assessment process. The individual uncertainties in these respective processes were addressed previously, in the previous sections.

2.7.2 Baseline Ecological Risk Assessment for Site 5

The purpose of the ERA was to determine the likelihood that adverse ecological effects may occur as a result of exposure to COCs. In addition to the DSI, an ecological (flora and fauna) survey was conducted at Site 5. The site is located within one major habitat type: Active Base Area.

The tracks and scat of feral deer (*Cervus mariannus*) and pigs (*Sus scrofa*) were noted on the lawns of the Site 5 study area (i.e., a residential area). Several birds were observed in this habitat including the endangered Micronesian starling *(Aplonis opacus guami)*, the black drongo *(Dicrurus macrocerus)*, the white tern *(Gygis alba)*, the Eurasian tree sparrow *(Passer montanus)*, and the Philippine turtle-dove *(Streptopeia Bitorquata)*. Other fauna observed were garden (*Argipe* sp.) and tent spiders *(Cyrtophora mollucensis)*, beetles (*Coleoptera*), flies and mosquitoes (*Diptera*), wasps, bees, and red and black ants (*Hymenoptera*), termites (*Isoptera*), moths (*Lepidoptera*), ear wigs (*Dermaptera*), grasshoppers and praying mantis (*Orthoptera*), blue banded king crow butterfly (*Euploea leucostictos*), and geckos (*Gekkonidae*).

Based on flora and fauna observed at Site 5, the CSM for the ERA is presented in Figure 2-7, and is based on simple direct contact and food-web models. The secondary source of COC exposure is surface soil. This exposure may be affected through direct contact with or ingestion of surface soil, or by ingestion of plant or animal tissue that had been exposed via surface soil. Exposure pathways and routes include:

- Direct Contact with Surface Soil – This exposure route is important for uptake of COCs for plants and for soil invertebrates. Most vertebrates, when foraging, may have the potential to be exposed to COPCs via dermal contact. However, the dermal exposure pathway is not believed to be important for birds, mammals, or reptiles because of limited contact with exposed soils. Many factors limit direct contact with exposed soils, including extensive ground cover by vegetation, the arboreal nature of most native species, and the protection from dermal contact by scales, feathers, or hair (USEPA, 2000b). Any incidental surface contamination of scales, feathers, or hair that is subsequently ingested during grooming is accounted for in the incidental soil ingestion pathway.

- Ingestion of Food (i.e., plants and biota that have taken up contaminants from soil) – Terrestrial herbivores and predators that forage in the terrestrial habitats may ingest plants or animal prey that have bioaccumulated COPCs from surface soils.
- Incidental Ingestion of Surface Soils – Herbivores and predators that forage in the terrestrial habitats may incidentally ingest some surface soil with their food or during other activities, such as grooming.

On the basis of this evaluation, complete exposure pathways to surface soil in ecological habitats are potentially impacted by releases of COPCs. From this environmental medium, some COPCs could bioconcentrate in plants and prey animals that may be eaten by other consumers.

The selection of assessment endpoints must be based on fundamental knowledge of the local ecology. Assessment endpoints typically relate to an effect on a population or community. Survival of the yellow bittern is an example of a population level assessment endpoint. Community level assessment endpoints could include the primary productivity of the limestone forest habitat. Examples of endpoints representing guilds of species are useful in that they convey information beyond the indicator species identified in the endpoint itself. An assessment endpoint involving a community index may provide more information about a site than an analysis of one species. Consequently, it is important to note that confirmation of the deleterious effects at the community level is an inherent confirmation that population level effects are occurring (Hartwell, 1997).

Based on the ecological survey at Site 5 the following ecological receptors were considered for the ERA:

- Soil-invertebrate communities (i.e., earthworm) and terrestrial plant communities
- Native terrestrial birds, represented by the Micronesian starling and yellow bittern.

For the purposes of this ERA, it is assumed that no future actions are expected at Site 5 that would change the potential use of the area by ecological receptors. The ERA methodology involves a four-step process: (1) identification of potential COCs, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization.

2.7.2.1 Identification of COCs for ERA at Site 5

To identify COCs for the ERA at Site 5, the maximum detected concentration for each chemical in surface soil was compared to the higher of (1) conservative toxicologically based screening criteria or (2) BTVs for Andersen AFB for inorganic contaminants (ICF, 1997; Andersen AFB, 2001b). A contaminant was excluded as a COC if the maximum detected concentration at Site 5 was lower than the screening value or if the contaminant was an essential nutrient.

The results of COC screening are shown in Table 2-8. The screening values were based on conservative threshold of ecological risk as recommended by the Dutch National Institute of Public Health and Environmental Protection (Dutch, 1994, 1995, and 1997).

2.7.2.2 Exposure Assessment for ERA at Site 5

Exposure refers to the degree of contact between ecological receptors at a site and the COPCs. Based on the CSM it is assumed ecological receptors at Site 5 are exposed to COPCs in surface soil either through direct contact, via dietary food web, or both.

The Mean Exposure Concentrations were estimated statistically to present the most appropriate representative concentrations of COPCs at Site 5. The distribution of data for each COPC was tested for normality or lognormality using the Shapiro-Wilk W-test (Shapiro and Wilk, 1965). For data fitting a normal distribution, the arithmetic mean was considered to be the most appropriate representative concentration. If the data fit a lognormal distribution, or a lognormal distribution was assumed because the data fit neither type of distribution, the lognormal mean of the contaminant data was used as the representative concentration consistent with USEPA guidance.

The following assumptions are made for arriving at each COPC exposure concentration:

- COPCs are assumed to be 100 percent bioavailable. That is, whether by direct contact or via food-web ingestion, all of the COPCs are available for absorption and expression of toxic effects, which is highly unlikely considering the soil chemistry at the site.
- The area use factor for the Micronesian starling and yellow bittern is assumed to be 1.0. This means that 100 percent of the dietary exposure would be from Site 5.

2.7.2.3 Toxicity Assessment for ERA at Site 5

Toxicity assessment is based on studies that determine the lowest concentrations of contaminants that may cause adverse effects on ecological receptors. In this ERA, toxicity assessments were completed for soil-invertebrate communities (earthworm), plant communities, and native terrestrial birds represented by the Micronesian starling and the yellow bittern, relative to COPCs in soil at Site 5.

Earthworms

Many of the earthworm toxicity reference values (TRVs) are from lowest observable adverse effect level (LOAEL) chronic effects data based on laboratory studies of earthworms (ICF, 1998). In the absence of sufficient data, no observed adverse effect level (NOAEL) data were used for chronic effects to derive earthworm TRVs.

Plants

Risks to plants, as with invertebrates, are expressed relative to concentrations observed in soil. Plant toxicity data were based on growth effects from Ecological Soil Screening Levels.

Native Terrestrial Birds

Food-web risks for avian species are expressed relative to a dose of chemical (milligram[s] of chemical per kilogram of body weight per day [mg/kg-bw/day]) taken up by the organism from food and soil. USEPA (1997a) guidance specifies that a screening ecotoxicity value should be "equivalent to a documented or best conservatively estimated chronic NOAEL." Literature-reported wildlife NOAEL and LOAEL TRVs were used as TRVs for food-web risk calculations.

2.7.2.4 ERA Characterization for Site 5

The ERA was characterized based on calculation of a HQ, or an ecological quotient (EQ):

$$EQ = Representative\ Concentration / TRV$$

$$HQ = Representative\ Dose / TRV$$

If the representative soil concentration is less than the TRV, then the HQ or EQ will be less than 1.0. In this circumstance, no adverse ecological risk is expected for the exposed ecological receptors. If the representative soil concentration is greater than the TRV, then the HQ or EQ will be greater than 1.0, and adverse ecological risk is expected for the exposed ecological receptors.

2.7.2.4.1 ERA Results for Site 5

Five COCs were identified at Site 5: copper, lead, vanadium, zinc, and TCDD-TEQ. Assessment and measurement endpoints identified for the ecological receptors (terrestrial plants, soil invertebrates, Micronesian starling, and yellow bittern) are presented in Table 2-9.

Acceptable risks were found for soil invertebrates (earthworms) for those COCs for which TRVs could be identified (Table 2-10). In the case of inorganic COCs, the representative soil concentrations are lower than the TRVs. Thus, the EQs are all less than 1.0. Consequently, no unacceptable risks to the earthworms are projected from inorganic COCs at Site 5. TRVs were not available for dioxin; therefore, the risk to earthworms from dioxin is unknown.

Acceptable risks were found for terrestrial plants for those COCs for which TRVs could be identified (Table 2-10). The EQs for vanadium and zinc exceeded the presumed risk threshold of 1.0. The vanadium HQ (97) was especially high. To determine whether or not the risks inferred by this HQ were credible, the nature of the TRV for vanadium was examined. The TRV of 2 milligrams per kilogram (mg/kg) was derived by Efroymson et al. (1997) based on two secondary references to unspecified toxic effects of vanadium on plants. The lowest value from the secondary references was 2.5 mg/kg. Efroymson et al. (1997) expressed low confidence in their screening value of 2 mg/kg. The credibility of this screening value is further reduced by noting that the background concentration of vanadium in soil at Andersen AFB (206 mg/kg, ICF, 1997) is 103 times higher than the screening value, and the background concentration is higher than the representative soil concentration at Site 5. Because of the poor quality of the

ecotoxicological-based screening value, the risk from vanadium is not accurately expressed by the HQ of 97. A more accurate expression of the risk of vanadium is had by using the background concentration of 206 mg/kg. Dividing this value into the representative soil concentration for Site 5 of 194 mg/kg produces an HQ of less than 1.0. Whereas the zinc TRV for plants is somewhat stronger (rated "moderate" confidence by Efroymson et al., 1997) than that of vanadium, it is again noteworthy that the representative soil concentration of 77.4 mg/kg at Site 5 is less than the background concentration of 111 mg/kg. When these risk thresholds greater than 1.0 are viewed against the nature of the toxicological data, and the Andersen AFB background data, the risk to terrestrial plants appears to be negligible.

To assess risk to these receptors due to dietary uptake of COCs, simple food-web models were constructed to estimate the dietary dose of COPCs to the Micronesian starling and yellow bittern[1]. With the exception of lead, acceptable risks were found for the avian receptors of concern (Micronesian starling and yellow bittern) for the individual COCs (Tables 2-11 and 2-12). The calculated HQs were less than 1.0; although the NOAEL-based HQ for lead was moderately elevated at 3.29, the LOAEL-based HQ was well under 1.0. The lead results may be confounded by the collection method. Monitor lizards[2] for tissue analysis were shot with lead pellets. Inclusion of fragments of lead pellets with the tissue samples would have biased the results high. Notwithstanding this possible bias, the fact that the LOAEL-based HQ was well under 1.0 suggests minimal risk to the bittern from lead.

Based on a combination of qualitative assessment and quantitative risk characterization, the COCs at Site 5 (copper, lead, vanadium, zinc, and TCDD-TEQ) were determined not to pose risk to ecological receptors of concern (ROCs). Given the "negligible potential for risk" (USEPA, 1997a), no further ecological evaluation is required.

2.7.2.4.2 ERA Uncertainties for Site 5

Ecological risk characterization includes analysis of uncertainty (USEPA, 1997a). Uncertainty is distinguished from variability, and arises from lack of knowledge about factors associated with the study. Sources of uncertainty can include the process of selecting COPCs, assumptions made in establishing the CSM, adequacy of ecological characterization of the site, estimates of toxicity to receptors, and selection of model parameters. A number of factors contribute to uncertainty in the ecological risk characterization for Site 5, as described below.

Environmental media at known or suspected waste sites are typically sampled in a non-random fashion. That is, sampling points are chosen to best characterize known or suspected areas of contamination. Peripheral and nearby areas are undersampled, if at all, and thus the average exposure of ecological receptors is biased high. This is generally true for Site 5. Because there

[1] The yellow bittern is not expected to nest at Site 5. They tend to nest in wetlands at the southern end of Guam, and fly out to forage for food all over the island. For purposes of the ERA, it was assumed that the yellow bittern will forage for 100 percent of its food at Site 5, which is again a very conservative assumption.

[2] The monitor lizard, for which there are available analytical tissue data, served as a surrogate for the various skinks, geckos, and other small animals that constitute the diet of the yellow bittern.

is little information available for the bird receptors, certain food-web model components are uncertain. For example, the assignment of feeding fractions for the starling (100 percent fruit) and the two percent incidental soil ingestion for both the starling and bittern are based on best professional judgment, in the absence of species- and site-specific data. Similarly, the use of the available tissue concentration data for papaya and monitor lizard as surrogates for the various food items eaten by the Micronesian starling and yellow bittern adds uncertainty. Toxicological data used in the risk characterization represents significant uncertainty. Because there are no known data on the effects of chemical contaminants on the Micronesian starling and yellow bittern, toxicological data for surrogate species are used, and this adds uncertainty. Even more uncertainty attends the necessary use of soil concentrations of dioxin as a surrogate for tissue concentrations at this site. As mentioned above, the food-web model assumptions of 100 percent bioavailabilty of COPCs and total food-web exposure from Site 5 (Area Use Factor = 1.0) represent significant uncertainty. Although the direction of bias of some uncertainties is unknown, the influence of the non-random media sampling and assumptions of 100 percent bioavailability and site exposure assures that, if anything, risk is overestimated rather than underestimated.

2.7.3 Basis for Action Statement

Based on the identified unacceptable human health risks associated with exposures to hazardous substances in subsurface under a future residential scenario (Section 2.7.1.4.2), the response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

2.8 REMEDIAL ACTION OBJECTIVES

RAOs are medium-specific and/or site-specific remediation goals for protecting human health and the environment. Based on HHRA results at Site 5, no COCs and, therefore, no unacceptable risks were identified for surface soil. However, antimony, copper, lead, and manganese were determined to be subsurface soil COCs. Under the RME exposure scenario, unacceptable non-cancer risks were identified for resident adults, resident children, and utility workers (occasional users) associated with COCs in subsurface soil. Cancer risks associated with exposures to subsurface soil were within the risk range of 10^{-6} to 10^{-4}. Due to the potential for dermal, ingestion, and inhalation exposures to the COC-impacted subsurface soil, there would be a potential adverse effect for onsite residents who may come into prolonged contact with subsurface soil at Site 5. Therefore, remedial action is necessary to be protective of human receptors at the site.

Based on a combination of qualitative assessment and quantitative risk characterization, the ecological-based COCs at Site 5 (copper, lead, vanadium, zinc, and TCDD-TEQ) were determined not to pose risk to ecological ROCs. Given the “negligible potential for risk” (USEPA, 1997a), no further ecological evaluation is required for ecological receptors.

During the EE/CA (EA, 2000a), the USAF established RAOs to reduce the exposure pathways to utility workers, resident adults, and resident children via incidental soil ingestion, dermal exposure,

and inhalation of dust particulates from subsurface soil that may be inadvertently placed on the surface through construction excavations. At that time, the COCs included antimony, manganese, lead, and TCDD-TEQs (dioxins) in subsurface soil and the USAF developed risk-based RGs to aid in evaluating remedial options and for risk management decisions. Given the completed NTCRA at the site (*Limited Soil Removal to Six Feet*) (Section 2.1.3), the following new RAOs were developed for Site 5 FS (EA, 2007):

- Prevent future resident and utility worker exposure to the residual hazardous substances at concentrations exceeding their respective RGs in subsurface soil (antimony above 63 mg/kg; copper above 3,100 mg/kg, manganese above 5,500 mg/kg, and lead above 400 mg/kg)
- Prevent off-site migration of soil containing landfill debris and/or hazardous substances above their respective RGs (antimony above 63 mg/kg, copper above 3,100 mg/kg, manganese above 5,500 mg/kg, and lead above 400 mg/kg).

With the completion of the NTCRA at Site 5 (Section 2.1.3), this ROD addresses the remaining actions necessary for the management of residual waste materials, the protection of human health and the environment, and compliance with applicable or relevant and appropriate requirements (ARARs), in accordance with the RAOs for Site 5.

Risk-based RGs were developed for COCs at Site 5 that are protective of human health for specific exposure scenarios established for the site. RGs were calculated by deriving the COC concentration in a given medium that corresponds to a cumulative HI for a specific target organ of 1.0. RGs have been established for Site 5 subsurface soil based on the HHRA results, as follows:

- A RG of 63 mg/kg was established for antimony based on the BTV;
- A RG of 3,100 mg/kg was established for copper based on the USEPA Region 9 residential PRG;
- A RG of 400 mg/kg was established for lead based on USEPA's Integrated Exposure Uptake Biokinetic Model (IEUBK) Lead Model; and
- A RG of 5,500 mg/kg was established for manganese based on the BTV.

SUMMARY OF RISK-BASED REMEDIAL GOALS
FOR SUBSURFACE SOIL AT SITE 5 FOR RESIDENT ADULTS AND CHILDREN

COC	RME EPC (mg/kg)	Calculated Risk for all Pathways	RG for HI = 1.0 (mg/kg)	RG for 10^{-6} (mg/kg)	RG for 10^{-5} (mg/kg)	RG for 10^{-4} (mg/kg)	2004 PRG Residential (mg/kg)	BTV (mg/kg)	Maximum Value (mg/kg)
Non-Cancer Risks									
Antimony	4,950	193	25.6	NA			30	**63[(a)]**	870
Copper	10,100	4.2	2,404				**3,100[(b)]**	72	3,164
Lead	56,000	NA	400				**400[(c)]**	166	22,427
Manganese	12,300	11.9	1,034				1,800	**5,500[(a)]**	3,085
Cancer Risks – No unacceptable risks were identified; therefore, no RGs were developed.									

(a) BTV exceeds the risk-based RG; therefore, the BTV is used as the proposed cleanup goal.
(b) PRG exceeds the RG; therefore, the PRG is used as the cleanup goal.
(c) The PRG represents the USEPA guideline for lead (Office of Solid Waste and Emergency Response [OSWER] Directive/IEUBK Model).

HI = Hazard Index
RG = Remedial Goal
BTV = Background Threshold Value
RME = Reasonable Maximum Exposure
PRG = Preliminary Remediation Goal
EPC = Exposure Point Concentration
COC = Contaminant of Concern
NA = Not Applicable

The RGs were used to estimate the area and volume of COCs to be addressed by the remedial alternative. The selected RGs, presented in the above table and Table 2-13, represent COC concentrations below which there are no unacceptable risks to either human health or the environment.

2.9 DESCRIPTION OF ALTERNATIVES

Using USEPA guidelines for screening remediation technologies (40 CFR 300.430[e][7]), numerous remedial technologies for soil were considered at Site 5 (EA, 2007). Many of these were eliminated from further consideration because they were not feasible for the physical and chemical properties of the Site 5 COCs and/or the unique environmental setting of the site. The remaining remedial technologies that were potentially feasible for the mitigation of Site 5 risks were screened according to their effectiveness, implementability, and, to a lesser extent, cost. Based on the remedial technology and alternative screenings, the following two remedial alternatives were retained for detailed analysis at Site 5:

- No Further Action
- Institutional Controls

Both of these remedial alternatives are summarized below. A more complete, detailed presentation of each alternative is presented in Chapter 2 of the FS (EA, 2007). A summary of the comparative analysis of these alternatives and a further description of the Selected Remedy for Site 5 are presented in Sections 2.10 and 2.12, respectively, of this ROD.

2.9.1 *No Further Action* Alternative

Pursuant to Section 300.430(e)(6) of the revised NCP, a "No Action" alternative is required to be developed to provide a baseline against which the other remedial alternatives are to be compared. Because the USAF has already conducted some remediation as part of a NTCRA (Section 2.1.3), this alternative becomes "No Further Action" for Site 5. The *No Further Action* alternative represents a true no action scenario, as no further institutional controls, engineering controls, or active treatment of the site soil/wastes would be performed. The remaining wastes and COC-impacted soil located underneath the site structures and below 6 feet bgs would remain at the site with no further protections or reviews to be implemented.

There are no costs associated with the *No Further Action* alternative.

2.9.2 *Institutional Controls* Alternative

To follow up the NTCRA already completed by the USAF at Site 5, which included the excavation of accessible COC/waste-impacted soil down to 6 feet bgs (Section 2.1.3) and capping with topsoil, the *Institutional Controls* alternative will include the following additional components to achieve the RAOs for Site 5:

- LUCs – The USAF will enact LUCs through amendments to the BGP to ensure the continued protection of human health and the environment. The full scope of the LUCs will be presented in a LUCMP to be developed by the USAF in coordination with the USEPA and Guam EPA during the Remedial Design phase following the signature of the final ROD. The LUCs will be applied to the full extent of the designated Site 5 area (i.e., 5.74 acres). Conceptually, the LUCs will include: (1) a requirement to preserve the integrity of existing site structures (e.g., houses, patios, roads) within the Site 5 area unless there is a USAF-approved plan for the work and restoration; (2) a requirement for the proper maintenance of the landscaping (e.g., erosion controls) and structures (e.g., houses, patios, roads) at Site 5 in accordance with an approved operation and maintenance (O&M) plan; (3) limitations and controls on any future excavation activities at the site (e.g., worker requirements, soil management, waste disposal); and (4) resident notification and signage requirements to inform residents and utility workers that excavation is restricted at the site. The LUCMP will include additional provisions such as (1) requirements for periodic (e.g., annual) inspections of the site conditions and use to ensure compliance with the LUCs; (2) periodic (e.g., annual) LUC Compliance Summary Reports to be provided to the USEPA and Guam EPA for informational updates; (3) protocols for LUC modification or termination; and (4) protocols for notification and correction of any LUC non-compliance events. The LUCs will remain in effect for as long as the site conditions are not suitable for unrestricted use and unlimited exposure. The USAF is responsible for implementing, maintaining, reporting on, and enforcing LUCs established in approved decision documents for IRP sites within Andersen AFB. A detailed discussion of the actions the USAF will be required to perform to ensure proper implementation of LUCs at Site 5 is provided in Table A-1 (Appendix A).

Five-Year Reviews – Following successful implementation of the above actions, the site will be suitable for continued use by the USAF as a residential area, but will not be suitable for unrestricted use and unlimited exposure due to the remaining hazardous substances under site structures. Therefore, the USAF, in conjunction with the USEPA and Guam EPA, will conduct 5-year reviews to ensure that the *Institutional Controls* alternative remains effective in the future for the continued protection of human health and the environment. The reviews will focus on the site conditions, the current and planned future site use, relevant data from any USAF monitoring programs, O&M and utility work records, and the LUC Compliance Summary Reports. The USAF will continue to conduct 5-year reviews for as long as hazardous substances remain at the site above levels that allow for unlimited use and unrestricted exposure.

The USAF will review groundwater data collected from the LTGM Program during the 5-year review process as part of the overall evaluation to assure the protection of human health and the environment (EA, 1995a). No groundwater monitoring wells are located on Site 5; however, three wells are located within a 1.0 mile radius of the site (monitoring well IRP-05, and production wells Y-15 and USGS-128).

The total net present worth costs associated with implementing the *Institutional Controls* alternative, for an assumed 30-year period of performance, are estimated at $380,000 (Table 2-14). The costs for the *Institutional Controls* alternative do not include the LTGM program as these are already funded under different funding mechanisms. The costs also assume that the total 5-year review costs will be shared among the various IRP sites at Andersen AFB that require such reviews.

2.10 COMPARATIVE ANALYSIS OF ALTERNATIVES

Evaluation criteria for comparison of cleanup alternatives are based on CERCLA statutory requirements, earlier program initiatives promulgated in the 20 November 1985 NCP, and site-specific experience gained in the Superfund program.

A total of nine criteria were developed for comparing the merits of each cleanup alternative:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Short-Term Effectiveness
- Long-Term Effectiveness
- Reduction of Toxicity, Mobility, or Volume Through Treatment
- Implementability
- Cost
- Territory (Guam) Acceptance
- Community Acceptance

The first two criteria are threshold factors that must be met by each alternative. The next five criteria are the primary balancing factors upon which the comparison of remedial alternatives is based. The last two criteria are modifying factors and are applied to ensure that the final cleanup alternative would meet public acceptance.

The nine criteria are presented in the following sections and a comparison of the two alternatives is made in decreasing order from the most to least advantageous alternative.

2.10.1 Overall Protection of Human Health and the Environment

This threshold criterion provides an overall assessment of human health and environmental protection based on how specific site remedial alternatives would achieve protection over time, how site risks associated with each hazardous substance would be reduced, and how each hazardous substance source would be eliminated, reduced, or controlled.

Both the *Institutional Controls* alternative and the No Further Action alternative would be protective of the environment because no unacceptable ecological risks were identified for Site 5. Although the Micronesian starling has been observed at Site 5, implementation of the *Institutional Controls* alternative would not adversely affect this endangered species. Similarly, Site 5 does not contain critical habitat for the threatened or endangered species of Guam.

The USAF's completed NTCRA to excavate soil with COCs to a depth of 6 feet bgs, except beneath onsite structures (homes and road), mitigated the risk exposure pathways of concern identified in the risk assessment (direct dermal contact, incidental ingestion of soil and inhalation of soil particulates) for both human and ecological receptors. The *Institutional Controls* alternative will be protective of human health and the environment by preventing potential exposure to the remaining landfill wastes and impacted soil which were not removed during the NTCRA. Under the *Institutional Controls* alternative, the USAF will maintain the existing land cover (e.g., soil, roadways, building foundations) to prevent future human contact with the remaining waste materials which could not be removed during the NTCRA. The LUCs will require the proper use and maintenance of the site cover into the future. As a conservative measure, the USAF will notify local residents about the site status through fact sheets in order to prevent disturbance of site soil. Subsurface utility work at the site (or any new construction work) will require coordination with the USAF. During the 1998 field investigation, no VOCs were detected in soil gas samples collected at Site 5. Therefore, residual wastes isolated beneath the building foundations are not expected to pose a hazard to onsite residents.

The *No Further Action* alternative would not be protective of human health because the identified unacceptable risks associated with the remaining COCs in subsurface soil beneath site buildings/structures and below 6 feet bgs would not be addressed (e.g., if intrusive construction activities were to occur or if houses were to be demolished in the future). No actions or controls would be implemented to address the RGs developed for Site 5.

2.10.2 Compliance with ARARs

This threshold criterion evaluates a remedial alternative's compliance with the federal and territorial (Guam) ARARs as defined in CERCLA Section 121. The applicable ARARs are those legally enforceable federal and territorial (Guam) requirements that specifically address hazardous substances, pollutants, removal actions, locations, or other circumstances found at the impacted areas. The ARARs and to be considered (TBC) documents for the selected remedy are presented in Table 2-15.

In conjunction with the NTCRA already completed by the USAF, the *Institutional Controls* alternative will satisfy the ARARs and TBCs identified for Site 5.

No ARARs were identified for the *No Further Action* alternative because no remedial actions are specified.

2.10.3 Short-Term Effectiveness

This balancing criterion addresses the impact of the remedial action during the construction and start-up phase, as well as the effectiveness for achieving RAOs. Factors evaluated may include protection of workers during the remedial actions, environmental impacts resulting from the implementation of the remedial action, and the time required to implement the proposed remedial alternative at the site.

The *Institutional Controls* alternative can be quickly implemented (e.g., within 1 year) and will be effective for achieving RAOs in the short term. The alternative will mitigate the residual risk concerns at Site 5 (i.e., residual hazardous substances in subsurface soil which were inaccessible during the NTCRA or which were below 6 feet bgs). Implementation of this alternative will present no new risks to the community, site workers, or the environment.

The *No Further Action* alternative would not be effective in the short-term because RAOs would not be achieved, although no new risks or environmental impacts would result from implementation of this alternative. The *No Further Action* alternative would not achieve the RAOs because there would be no steps taken to ensure that future utility workers or onsite residents do not come into contact with the residual COCs and landfill debris or to prevent landfill wastes from being disturbed and mobilized from the site.

2.10.4 Long-Term Effectiveness

This balancing criterion addresses the effectiveness of each remedial alternative over the life of the remedial action. It also assesses the results of the remedial action in terms of the risk remaining after the response objectives have been met. Particularly, the effectiveness of the controls is applied to manage the risk posed by the residual COCs in the impacted areas at the site (i.e., the risk to future residents).

The current and planned future use for the Site 5 area is a residential development which houses families with children. The *Institutional Controls* alternative will be effective in the long-term for mitigating the identified potential risks under the residential and utility worker scenarios at Site 5. Although some residual landfill wastes and COCs will remain on site under existing structures, the structures themselves (buildings, roads) and the newly established LUCs as part of the alternative will prevent future exposures to these wastes/COCs. Utility or construction work conducted at the site will require a work clearance permit, which must be approved by the USAF. The work clearance permit will require work plans for intrusive activities at the site to ensure that safe practices are followed with respect to the presence of COCs at the site. Along with the periodic LUC compliance inspections, the USAF will conduct a 5-year review process to verify that the physical and administrative waste containment/control measures remain effective and permanent. The 5-year review process will also consider information from the basewide LTGM program being conducted at Andersen AFB.

The *No Further Action* alternative would not be effective in the long-term because the identified risks associated with the remaining COCs in subsurface soil would persist at the site.

2.10.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

This balancing criterion assesses how each alternative would reduce the principal threats of the total mass of COCs, to provide irreversible reduction in COC mobility, and/or to reduce the total volume of impacted media. Factors of this criterion that are evaluated include the treatment process, the amount of COCs destroyed or treated, the degree of reduction in toxicity, mobility, or volume expected, and the type and quantity of untreated COC residuals.

Neither the *Institutional Controls* alternative nor the *No Further Action* alternative will reduce the toxicity, mobility, or volume of waste through treatment beyond what has already been reduced through the completed NTCRA (excavation, off-site disposal, and capping). However, the *Institutional Controls* alternative specifies LUCs and 5-year reviews that will be effective for verifying that the past NTCRA which reduced the toxicity, mobility, or volume of site wastes/hazardous substances remains effective for addressing the ongoing land use.

2.10.6 Implementability

This balancing criterion assesses the technical and administrative feasibility of implementing a remedial action and the availability of various services and materials required during implementation. Factors of technical feasibility include construction and operational difficulties, reliability of technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

The *Institutional Controls* alternative will be readily implementable at Site 5 because the LUCs can be implemented via modifications to the existing BGP and because the required equipment and services to maintain the LUCs and to conduct 5-year reviews are readily available. Institutional controls are a proven and accepted remedial option under the appropriate site

conditions such as those for Site 5 where remedial actions have occurred and residual wastes can be managed in-place.

The *No Further Action* alternative is not implementable because the RAOs would not be achieved and because the alternative does not meet the threshold evaluation criteria.

2.10.7 Territory (Guam) Acceptance

This modifying criterion accounts for the technical and administrative issues concerning the territory of Guam regarding each of the remedial alternatives. This factor includes the remedial actions that the territory would support, oppose, or would be concerned about. The Territorial Acceptance was evaluated based on comments received from the Guam EPA's representatives during RPM Meetings regarding IRP sites at Andersen AFB.

The *Institutional Controls* alternative is acceptable to the Territory (Guam) given that Site 5 will be appropriately managed and contained on USAF property and the identified risks will be mitigated in accordance with CERCLA.

The *No Further Action* alternative would not be acceptable to the Territory (Guam) because the identified unacceptable risks to human health would not be mitigated.

2.10.8 Community Acceptance

This modifying criterion accounts for the issues and concerns the property owner and the public may have regarding each of the remedial actions. The factors included the remedial actions that the property owner or the community would support, oppose, or be concerned about. Community Acceptance was evaluated based on comments received at the Public Meeting to present the Proposed Plan for Sites 5 and 8 held on 2 August 2007. Also the public was asked for written comments during the Public Comment Period from 26 July 2007 to 26 August 2007. Specific public comments and responses by Andersen AFB are summarized in Chapter 4.

The *Institutional Controls* alternative is acceptable to the community given that Site 5 will be appropriately managed and contained on USAF property and the identified risks will be mitigated in accordance with CERCLA.

The *No Further Action* alternative would not be acceptable to the community because the identified unacceptable risks to human health would not be mitigated.

2.10.9 Cost

This balancing criterion assesses the projected cost for the final list of alternatives at the conclusion of the cleanup alternatives screening process. Present worth analysis allows remedial actions to be compared on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life. When applicable, a required operating performance period

of 30 years will be used in calculating the present worth of the remedial alternatives. The remedial costs included capital costs and annual O&M costs. Capital costs consist of both direct and indirect costs. Direct costs include expenditures for the equipment, labor, and materials necessary to install removal actions. Indirect costs include expenditures for engineering, financial, and other services required when installing a remedial alternative at a site. Annual O&M costs include auxiliary monitoring, materials, and energy required to install remedial actions, disposal of residue, purchased services, administrative costs, insurance, taxes, license costs, maintenance reserve and contingency funds, rehabilitation costs, and costs for periodic site reviews.

Cost estimates are based upon a preliminary review of the anticipated requirements for each remedial alternative. The cost estimates are based upon approximate design specifications, costs incurred from similar operations, and vendor quotes, where possible. In some cases, assumptions were required for unknown elements. In accordance with USEPA CERCLA FS guidance (USEPA, 1988, 2000c), the preliminary cost estimates are anticipated to be between +50 and -30 percent of the actual costs for completing the remedial actions. Therefore, the costs portrayed are to be used as an order of magnitude comparison. More accurate cost estimates would be developed during the Remedial Design phase subsequent to the ROD.

There would be no costs associated with the *No Further Action* alternative.

The total net present worth costs associated with implementing the *Institutional Controls* alternative, for an assumed 30-year period of performance, are estimated at $380,000 (Table 2-14). The costs for the *Institutional Controls* alternative do not include the LTGM program as these are already funded under different funding mechanisms. The costs also assume that the total 5-year review costs will be shared among the various IRP sites at Andersen AFB that require such reviews.

2.11 PRINCIPAL THREAT POSED BY WASTE

According to USEPA guidelines, treatment alternatives must be used to address the principal threats posed by any site whenever practicable. In general, the term “principal threat wastes” includes the following:

- Liquid source material, such as waste contained in drums, lagoons or tanks, and free product in the subsurface containing hazardous substances;
- Mobile source material, such as surface or subsurface soil containing high concentrations of hazardous substances that are mobile due to wind entrainment, volatilization, surface runoff, or subsurface transport; and
- Highly toxic source materials, such as buried drums containing non-liquid wastes, buried tanks containing non-liquid wastes, or soils containing significant concentrations of highly toxic materials (USEPA, 1999a).

Wastes that are generally considered as "non-principal threat" include:

- Non-mobile contaminated source material of low to moderate toxicity, such as surface soil containing COCs that generally are relatively immobile in air and groundwater in the specific environmental setting; and
- Low toxicity source materials, such as surface soil and subsurface soil with concentrations of COCs not greatly above reference dose levels or that present an excess cancer risk near acceptable risk range (USEPA, 1999a).

The COC-impacted subsurface soil at Site 5 is a non-principal threat because:

- The major COCs are metals that are relatively immobile in the alkaline conditions of the limestone formations at Site 5; and
- The USAF has already completed a NTCRA to consolidate and contain some site wastes (Section 2.1.3).

The human health risks associated with COC-impacted subsurface soil justify a remedial action to protect human health. No unacceptable ecological risks were identified. As such, the *Institutional Controls* alternative was selected. The *Institutional Controls* alternative will augment the NTCRA already completed at Site 5.

2.12 SELECTED REMEDY

The USAF and USEPA Region 9 co-selected the *Institutional Controls* alternative in conjunction with concurrence from the Guam EPA.

2.12.1 Summary of the Rationale for the Selected Remedy

The primary rationale for selecting the *Institutional Controls* as a remedial alternative for Site 5 is that the USAF, USEPA Region 9, and Guam EPA have agreed that the *Institutional Controls* alternative would control exposures to resident adults and children and utility workers by prohibiting construction which would disturb the contaminated subsurface soil and expose residents and workers to hazardous substances. The *Institutional Controls* alternative will augment the NTCRA already completed at Site 5 to protect human health and the environment.

As presented in Section 2.10 of this ROD, the *Institutional Controls* alternative has advantages over the *No Further Action* alternative. The *Institutional Controls* alternative:

- Will meet RAOs, unlike the *No Further Action* alternative.
- Will be protective of human health and the environment, unlike the *No Further Action* alternative.

2.12.2 Detailed Description of the Selected Remedy

A detailed description of the actions that the USAF will be required to ensure proper implementation of institutional controls (i.e., LUCs) at Site 5, in accordance with this ROD, is provided in Table A-1 (Appendix A). Table A-1 provides a summary of (1) site risks relevant to the selected remedy; (2) a description of the property, including current and anticipated future property ownership, land use, and restrictions; (3) a description of onsite structures; (4) a description of LUC objectives; (5) a list of applicable engineering and institutional controls and other specific measures that are required to implement LUCs consistent with the selected remedy; (6) monitoring and reporting requirements; and (7) specific corrective actions to address non-compliant LUC events. The components necessary for implementation of the *Institutional Controls* alternative are as follows:

- Phase 1—Site Preparation, mobilization, and surveying
- Phase 2—Development of LUCMP and implementation of LUCs
- Phase 3—Periodic reviews (LUCs inspections and 5-year reviews).

2.12.3 Summary of the Estimated Remedy Costs

A summary of the *Institutional Controls* alternative cost estimate is presented in Table 2-14. Implementation of the *Institutional Controls* alternative is estimated to cost approximately $380,000 (30-year present worth). This is an engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost. The cost information presented in Table 2-14 is based on the best available information regarding the anticipated scope of the remedial 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 remedial alternative. Major changes may be documented in the form of a memorandum in the AR, an explanation of significant difference (ESD), or a ROD amendment.

2.12.4 Expected Outcome of the Selected Remedy

The expected outcome of the Selected Remedy is the continued use of the property by Andersen AFB as a residential area. Under the *Institutional Controls* alternative, the BGP will be amended to prevent disturbances of the contaminated subsurface soil that may expose residents and workers to the identified hazardous substances. Periodic reviews would be conducted to ensure the long-term protection of human health and the environment.

2.13 STATUTORY DETERMINATION

This section describes how the Selected Remedy satisfies the statutory requirements of CERCLA §121 and the regulatory requirements of the NCP.

The Selected Remedy (*Institutional Controls*) is protective of human health and the environment, complies with Federal and Territory of Guam requirements that are applicable or relevant and appropriate to the remedial action, and is cost-effective.

Because the *Institutional Controls* alternative will result in hazardous substances, pollutants, or contaminants remaining on site above levels that do not allow for unlimited use and unrestricted exposure, 5-year reviews will be required.

2.13.1 Protection of Human Health and the Environment

The *Institutional Controls* alternative will be protective of human health and the environment by preventing disturbance of subsurface soil containing residual hazardous substances following the completed NTCRA. No unacceptable risks were associated with site surface soil; therefore, no additional engineering controls (i.e., barriers) are required for the protection of human health and the environment. The site monitoring and 5-year reviews will help to ensure the continued protection of human health and the environment into the future.

2.13.2 Compliance with ARARs

The *Institutional Controls* alternative meets each of its respective ARARs (Table 2-15).

2.13.3 Cost Effectiveness

According to USEPA guidelines (USEPA, 1999b), a remedy is cost effective if the cost is proportional to its overall effectiveness in protecting human health and the environment.

The *Institutional Controls* alternative will be protective of human health and the environment at costs displayed in Table 2-14.

2.13.4 Utilization of Permanent Solution

The *Institutional Controls* alternative is not a permanent solution for the site because it would not reduce the volume of hazardous substances or treat the hazardous substances remaining in subsurface soil following the completed NTCRA. Therefore, there are residual risks to potential future residents from leaving untreated hazardous substance-impacted soil areas exceeding RGs at the site. These risks will be mitigated through the use of LUCs.

2.13.5 Preference for Treatment as a Principal Element

The *Institutional Controls* alternative does not treat hazardous substances on site; however, the associated risks are mitigated through LUCs.

2.13.6 Five-Year Review Requirement

A 5-year review of this ROD will be necessary because residual hazardous substances will be left at Site 5 after implementing the *Institutional Control* alternative, per 42 United States Code (USC)§9621(c) and 40 CFR§300.430(f)(5)(iii)(C).

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

On 26 July 2007, the Proposed Plan for Sites 5 and 8 was released to the public for review and comments, with a Public Comment Period extending from 26 July 2007 to 26 August 2007. A public meeting was held at the Guam Marriott Resort and Spa in Tumon on 2 August 2007 to present the Proposed Plan to the public.

The same *Institutional Controls* alternative that is presented in this ROD was also presented in Proposed Plan and the public meeting as the preferred alternative. The USAF, USEPA Region 9, Guam EPA, and affected property owners have agreed that *Institutional Controls* is an acceptable alternative to address Site 5. Therefore, there are no significant changes in this ROD to the remedy as originally identified in the July 2007 Proposed Plan.

TABLE 2-1. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SUBSURFACE SOIL, SITE 5, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	Contaminant of Concern	Concentration Detected		Units	BTV	Residential/ Industrial PRG	Frequency of Detection	Exposure Point Concentration(1)	Exposure Point Concentration Units	Statistical Measure(2)
		Min	Max							
Site 5	Antimony	13.7	4,950	mg/kg	63	31/410	6/6	4,950	mg/kg	Max
	Copper	256	10,100	mg/kg	72.2	3,100/41,000	6/6	10,100	mg/kg	Max
	Lead	836	56,600	mg/kg	166	400/800	6/6	56,600	mg/kg	Max
	Manganese	554	12,300	mg/kg	5,500	1,800/19,000	6/6	12,300	mg/kg	Max

Key
COC contaminant of concern
EPC exposure point concentration
mg/kg: milligrams per kilograms
Max: Maximum Concentration
(1) 95UCLM value used for the EPC is the maximum measured value.
(2) Shapiro-Wilk W-Test indicates data are normally distributed.

The table presents the COCs and EPC for each of the COCs detected in subsurface soil (i.e., the concentration that will be used to estimate the exposure and risk from each COC in the subsurface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and how the EPC was derived.

Table 2-2. Summary of Cancer Risks For Resident Adults at Site 5, Andersen AFB, Guam-- Reasonable Maximum Exposure (RME)

***RME - Summary of Cancer Risks Across All Exposure Pathways**

Contaminant of Potential Concern	Incidental Ingestion of Subsurface Soil	Dermal Contact with Subsurface Soil	Inhalation of Particles from Subsurface Soil	Total	Percent Contribution Of Each COPC
	Risk	Risk	Risk		
Inorganics					
ANTIMONY	--	--	--	--	--
BARIUM	--	--	--	--	--
CADMIUM	--	--	1.37E-07	1.37E-07	0.52
COPPER	--	--	--	--	--
LEAD	--	--	--	--	--
MANGANESE	--	--	--	--	--
SILVER	--	--	--	--	--
ZINC	--	--	--	--	--
PCDDs/PCDFs					
2,3,7,8-TCDD-TEQ	2.05E-05	5.62E-06	3.80E-08	2.62E-05	99.48
Cumulative Risk	**2.05E-05**	**5.62E-06**	**1.75E-07**	**2.63E-05**	100.00
Percent Contribution of Each Pathway	78.00	21.34	0.67	100.00	

Table 2-3. Summary of Noncancer Risks for Resident Adults at Site 5, Andersen AFB, Guam-- Reasonable Maximum Exposure (RME)

***RME - Summary of Noncancer Risks Across All Exposure Pathways**

Contaminant of Potential Concern	Incidental Ingestion of Subsurface Soil	Dermal Contact with Subsurface Soil	Inhalation of Particles from Subsurface Soil	Total	Percent Contribution Of Each COPC
	HQ	**HQ**	**HQ**		
Inorganics					
ANTIMONY	1.70E+01	3.87E+00	--	2.08E+01	86.27
BARIUM	1.52E-02	3.46E-03	1.41E-02	3.27E-02	0.14
CADMIUM	2.74E-02	6.25E-03	--	3.36E-02	0.14
COPPER	3.74E-01	8.53E-02	--	4.59E-01	1.90
LEAD	--	--	--	--	--
MANGANESE	3.58E-01	8.17E-02	2.23E+00	2.67E+00	11.07
SILVER	2.25E-02	5.13E-03	--	2.77E-02	0.11
ZINC	7.35E-02	1.68E-02	--	9.03E-02	0.37
PCDDs/PCDFs					
2,3,7,8-TCDD-TEQ	--	--	--	--	--
Cumulative Risk	**1.78E+01**	**4.06E+00**	**2.24E+00**	**2.41E+01**	100.00
Percent Contribution of Each Pathway	73.86	16.84	9.30	100.00	

Table 2-4. Summary of Cancer Risks For Resident Children at Site 5, Andersen AFB, Guam-- Reasonable Maximum Exposure (RME)

***RME - Summary of Cancer Risks Across All Exposure Pathways**

Contaminant of Potential Concern	Incidental Ingestion of Subsurface Soil	Dermal Contact with Subsurface Soil	Inhalation of Particles from Subsurface Soil	Total	Percent Contribution Of Each COPC
	Risk	Risk	Risk		
Inorganics					
ANTIMONY	--	--	--	--	--
BARIUM	--	--	--	--	--
CADMIUM	--	--	9.63E-08	9.63E-08	0.20
COPPER	--	--	--	--	--
LEAD	--	--	--	--	--
MANGANESE	--	--	--	--	--
SILVER	--	--	--	--	--
ZINC	--	--	--	--	--
PCDDs/PCDFs					
2,3,7,8-TCDD-TEQ	3.83E-05	1.00E-05	2.67E-08	4.83E-05	99.80
Cumulative Risk	**3.83E-05**	**1.00E-05**	**1.23E-07**	**4.84E-05**	100.00
Percent Contribution of Each Pathway	79.10	20.65	0.25	100.00	

Table 2-5. Summary of Noncancer Risks for Resident Children at Site 5, Andersen AFB, Guam-- Reasonable Maximum Exposure (RME)

***RME - Summary of Noncancer Risks Across All Exposure Pathways**

Contaminant of Potential Concern	Incidental Ingestion of Subsurface Soil	Dermal Contact with Subsurface Soil	Inhalation of Particles from Subsurface Soil	Total	Percent Contribution Of Each COPC
	HQ	**HQ**	**HQ**		
Inorganics					
ANTIMONY	1.58E+02	3.44E+01	--	1.93E+02	91.55
BARIUM	1.42E-01	3.08E-02	4.94E-02	2.22E-01	0.11
CADMIUM	2.56E-01	5.56E-02	--	3.11E-01	0.15
COPPER	3.49E+00	7.59E-01	--	4.25E+00	2.02
LEAD	--	--	--	--	--
MANGANESE	3.35E+00	7.28E-01	7.84E+00	1.19E+01	5.66
SILVER	2.10E-01	4.57E-02	--	2.56E-01	0.12
ZINC	6.86E-01	1.49E-01	--	8.35E-01	0.40
PCDDs/PCDFs					
2,3,7,8-TCDD-TEQ	--	--	--	--	--
Cumulative Risk	**1.66E+02**	**3.62E+01**	**7.89E+00**	**2.10E+02**	100.00
Percent Contribution of Each Pathway	79.06	17.19	3.75	100.00	

Table 2-6. Summary of Cancer Risks For Utility Workers at Site 5, Andersen AFB, Guam-- Reasonable Maximum Exposure (RME)

***RME - Summary of Cancer Risks Across All Exposure Pathways**

Contaminant of Potential Concern	Incidental Ingestion of Subsurface Soil	Dermal Contact with Subsurface Soil	Inhalation of Particles from Subsurface Soil	Total	Percent Contribution Of Each COPC
	Risk	Risk	Risk		
Inorganics					
ANTIMONY	--	--	--	--	--
BARIUM	--	--	--	--	--
CADMIUM	--	--	3.82E-08	3.82E-08	2.96
COPPER	--	--	--	--	--
LEAD	--	--	--	--	--
MANGANESE	--	--	--	--	--
SILVER	--	--	--	--	--
ZINC	--	--	--	--	--
PCDDs/PCDFs					
2,3,7,8-TCDD-TEQ	9.78E-07	2.63E-07	1.06E-08	1.25E-06	97.04
Cumulative Risk	**9.78E-07**	**2.63E-07**	**4.88E-08**	**1.29E-06**	100.00
Percent Contribution of Each Pathway	75.83	20.38	3.79	100.00	

Table 2-7. Summary of Noncancer Risks for Utility Workers at Site 5, Andersen AFB, Guam-- Reasonable Maximum Exposure (RME)

***RME - Summary of Noncancer Risks Across All Exposure Pathways**

Contaminant of Potential Concern	Incidental Ingestion of Subsurface Soil	Dermal Contact with Subsurface Soil	Inhalation of Particles from Subsurface Soil	Total	Percent Contribution Of Each COPC
	HQ	**HQ**	**HQ**		
Inorganics					
ANTIMONY	9.69E-01	2.17E-01	--	1.19E+00	59.38
BARIUM	8.67E-04	1.94E-04	4.70E-03	5.76E-03	0.29
CADMIUM	1.57E-03	3.51E-05	--	1.60E-03	0.08
COPPER	2.14E-02	4.79E-03	--	2.62E-02	1.31
LEAD	--	--	--	--	--
MANGANESE	2.05E-02	4.59E-03	7.46E-01	7.71E-01	38.61
SILVER	1.29E-03	2.88E-04	--	1.58E-03	0.08
ZINC	4.20E-03	9.41E-04	--	5.14E-03	0.26
PCDDs/PCDFs					
2,3,7,8-TCDD-TEQ	--	--	--	--	--
Cumulative Risk	**1.02E+00**	**2.28E-01**	**7.50E-01**	**2.00E+00**	100.00
Percent Contribution of Each Pathway	51.01	11.41	37.58	100.00	

TABLE 2-8. ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN AT SITE 5, ANDERSEN AFB, GUAM.

Analyte	Ecological Screening Value	Range of Detections	Units	Frequency of Detection	Samples Greater Than Screen	Outliers That Exceeded Bulk of Samples	Contaminant of Potential Concern	Reason for Exclusion
INORGANICS								
Aluminum	173,500	14900 - 70400	mg/kg	17/17	0/17	No	No	Maximum detect less than background threshold
Antimony	63	1 - 4.8	mg/kg	17/17	0/17	No	No	Maximum detect less than background threshold
Arsenic	62	1.6 - 14.8	mg/kg	3/17	0/17	No	No	Maximum detect less than background threshold
Barium	413	11.1 - 93.3	mg/kg	17/17	0/17	No	No	Maximum detect less than screening level
Beryllium	3.34	0.24 - 1	mg/kg	17/17	0/17	No	No	Maximum detect less than background threshold
Cadmium	6.5	0.13 - 0.96	mg/kg	5/17	0/17	No	No	Maximum detect less than background threshold
Calcium	Not Applicable	4510 - 209000	mg/kg	17/17	Not Applicable	No	No	Low inherent toxicity, essential nutrient
Chromium	1,080	36 - 247	mg/kg	17/17	0/17	No	No	Maximum detect less than background threshold
Cobalt	70	7.7 - 30.9	mg/kg	17/17	0/17	No	No	Maximum detect less than screening level
Copper	113	26.5 - 122	mg/kg	17/17	1/17	No	Yes	
Cyanide	11(a)	0.25 - 0.39	mg/kg	6/17	0/17	No	No	Maximum detect less than screening level
Iron	Not Applicable	24400 - 94300	mg/kg	17/17	Not Applicable	No	No	Low inherent toxicity, essential nutrient
Lead	188	5.6 - 226	mg/kg	16/16	1/16	No	Yes	
Magnesium	Not Applicable	1980 - 11600	mg/kg	17/17	Not Applicable	No	No	Low inherent toxicity, essential nutrient
Manganese	3,150	338 - 1,100	mg/kg	17/17	0/17	No	No	Maximum detect less than background threshold
Mercury	5.2	0.06 - 0.79	mg/kg	17/17	0/17	No	No	Maximum detect less than screening level
Nickel	242.5	8.5 - 82	mg/kg	17/17	0/17	No	No	Maximum detect less than background threshold
Potassium	Not Applicable	151 - 603	mg/kg	17/17	Not Applicable	No	No	Low inherent toxicity, essential nutrient
Selenium	70	1.1 - 2.6	mg/kg	17/17	0/17	No	No	Maximum detect less than screening level
Silver	14.9	0.8 - 8.9	mg/kg	2/17	0/17	No	No	Maximum detect less than background threshold
Sodium	Not Applicable	172 - 701	mg/kg	17/17	Not Applicable	No	No	Low inherent toxicity, essential nutrient
Vanadium	206	64.6 - 279	mg/kg	17/17	9/17	No	Yes	
Zinc	430	27.9 - 432	mg/kg	17/17	1/17	No	Yes	

TABLE 2-8. ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN AT SITE 5, ANDERSEN AFB, GUAM.

Analyte	Ecological Screening Value	Range of Detections	Units	Frequency of Detection	Samples Greater Than Screen	Outliers That Exceeded Bulk of Samples	Contaminant of Potential Concern	Reason for Exclusion
PAH								
Sum PAH	21	0.0164 - 0.1082	mg/kg	10/14	0/14	No	No	Maximum detect less than screening level
Benz[a]anthracene	21(b)	0.0028 - 0.0054	mg/kg	5/14	Not Applicable	No		Not Applicable (use Sum PAH)
Benzo[a]pyrene	21(b)	0.0036 - 0.0071	mg/kg	5/14	Not Applicable	No		Not Applicable (use Sum PAH)
Benzo[b]fluoranthene	21(b)	0.0028 - 0.018	mg/kg	10/14	Not Applicable	No		Not Applicable (use Sum PAH)
Benzo[k]fluoranthene	21(b)	0.0028 - 0.0074	mg/kg	5/14	Not Applicable	No		Not Applicable (use Sum PAH)
Chrysene	21(b)	0.0094 - 0.015	mg/kg	5/14	Not Applicable	No		Not Applicable (use Sum PAH)
Fluoranthene	21(b)	0.0097 - 0.041	mg/kg	5/14	Not Applicable	No		Not Applicable (use Sum PAH)
Indeno[1,2,3-cd]pyrene	21(b)	0.0032 - 0.0047	mg/kg	3/14	Not Applicable	No		Not Applicable (use Sum PAH)
Pyrene	21(b)	0.013 - 0.028	mg/kg	3/14	Not Applicable	No		Not Applicable (use Sum PAH)
SVOC								
Total phthalates	30(c)	0.092 - 0.84	mg/kg	9/17	0/17	No	No	Maximum detect less than screening level
Butylbenzylphthalate	30(c)	0.084 - 0.72	mg/kg	2/17	Not Applicable	No		Not Applicable (use Total Phthalates)
Di-n-butyl phthalate	30(c)	0.12 - 0.12	mg/kg	1/17	Not Applicable	No		Not Applicable (use Total Phthalates)
bis(2-Ethylhexyl) phthalate	30(c)	0.092 - 0.38	mg/kg	9/17	Not Applicable	No		Not Applicable (use Total Phthalates)

TABLE 2-8. ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN AT SITE 5, ANDERSEN AFB, GUAM.

Analyte	Ecological Screening Value	Range of Detections	Units	Frequency of Detection	Samples Greater Than Screen	Outliers That Exceeded Bulk of Samples	Contaminant of Potential Concern	Reason for Exclusion
DIOXIN/FURANS								
1,2,3,4,6,7,8,9-OCDD	Not Available	15.6 - 2,040	ng/kg	10/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,4,6,7,8,9-OCDF	Not Available	2.9 - 99.2	ng/kg	9/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,4,6,7,8-HPCDD	Not Available	1.4 - 243	ng/kg	10/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,4,6,7,8-HPCDF	Not Available	2.4 - 53.5	ng/kg	9/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,4,7,8,9-HPCDF	Not Available	0.22 - 2.2	ng/kg	5/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,4,7,8-HXCDD	Not Available	0.7 - 2.2	ng/kg	4/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,4,7,8-HXCDF	Not Available	0.19 - 2.5	ng/kg	7/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,6,7,8-HXCDD	Not Available	0.39 - 10	ng/kg	8/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,6,7,8-HXCDF	Not Available	0.18 - 2.6	ng/kg	6/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,7,8,9-HXCDD	Not Available	0.4 - 7.8	ng/kg	6/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,7,8,9-HXCDF	Not Available	0.5 - 0.89	ng/kg	3/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,7,8-PECDD	Not Available	0.38 - 0.42	ng/kg	2/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
1,2,3,7,8-PECDF	Not Available	0.26 - 0.56	ng/kg	2/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
2,3,4,6,7,8-HXCDF	Not Available	0.25 - 4.8	ng/kg	7/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
2,3,4,7,8-PECDF	Not Available	0.52 - 2.2	ng/kg	3/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
2,3,7,8-TCDD	Not Available	0.11 - 0.34	ng/kg	2/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
2,3,7,8-TCDF	Not Available	0.31 - 0.64	ng/kg	3/8	Not Applicable	No		Not Applicable (use TCDD-TEQ)
ECO TCDD-TEQ	Not Available	0.41 - 5.97	ng/kg	10/10	Not Applicable	No	Yes	
TOTAL HPCDD	Not Available	21.4 - 482	ng/kg	9/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
TOTAL HPCDF	Not Available	1.6 - 137	ng/kg	10/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
TOTAL HXCDD	Not Available	3.1 - 86.3	ng/kg	9/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
TOTAL HXCDF	Not Available	0.25 - 65	ng/kg	9/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
TOTAL PECDD	Not Available	0.38 - 2.3	ng/kg	3/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
TOTAL PECDF	Not Available	0.78 - 54.9	ng/kg	8/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
TOTAL TCDD	Not Available	0.11 - 0.34	ng/kg	4/10	Not Applicable	No		Not Applicable (use TCDD-TEQ)
TOTAL TCDF	Not Available	0.31 - 12.9	ng/kg	8/9	Not Applicable	No		Not Applicable (use TCDD-TEQ)

(a) Based on free Cyanide

(b) PAH intervention is based on Total PAH. Exceedance based on summing all PAH.

(c) Phthalate intervention is based on Total Phthalates. Exceedance based on summing all Phthalates.

TABLE 2-9. ASSESSMENT AND MEASUREMENT ENDPOINTS FOR SITE 5, ANDERSEN AFB, GUAM.

Assessment Endpoint	Measurement Endpoint
Soil invertebrates: survival, growth and reproduction	Soil concentrations compared to literature screening benchmarks
Plants: survival, growth and reproduction	Soil concentrations compared to literature screening benchmarks
Plants: COPC concentrations jeopardize acceptability as food source	Dietary dose to higher receptors compared to toxicological threshold
Native birds (Micronesian starling and yellow bittern): survival, growth and reproduction	Dietary dose compared to toxicological threshold

TABLE 2-10. ECOLOGICAL QUOTIENTS FOR CONTAMINANTS OF POTENTIAL CONCERN AT SITE 5, EARTHWORMS AND PLANTS.

Analyte	Representative Soil Concentration (mg/kg)	Toxicity Reference Value (mg/kg)	Ecological Quotient
EARTHWORMS			
Copper	83.7	1,010	0.0829
Lead	16.1	6,630	0.0024
Vanadium	194	402	0.483
Zinc	77.4	11,000	0.0070
TCDD-TEQ	1.26E-06	--	--
PLANTS			
Copper	83.7	100	0.837
Lead	16.1	50	0.322
Vanadium	194	2	97
Zinc	77.4	50	1.55
TCDD-TEQ	1.26E-06	--	--

Notes: Toxicity Reference Values for Earthworms from ICF (1998); Toxicity Reference Values for plants from Efroymson et al. (1997).

TABLE 2-11. FOOD-WEB RISK RESULTS FOR THE MICRONESIAN STARLING AT SITE 5, ANDERSEN AFB, GUAM.

Analyte	Soil Mean (mg/kg)	Fruit Mean (mg/kg)	Soil Bioavailability	Area Use Factor	Dose Soil	Dose Fruit	Dose Total	NOAEL TRV	LOAEL TRV	NOAEL HQ	LOAEI HQ
					mg/kg-bw/day						
Copper	83.7	3.1	1	1	0.1001	0.8060	0.9061	47	61.7	0.02	0.01
Lead	16.1	0.07	1	1	0.0193	0.0182	0.0375	1.13	11.3	0.03	0.00
Vanadium	194	0.15	1	1	0.2320	0.0390	0.2710	11.4	114	0.02	0.00
Zinc	77.4	5.84	1	1	0.0926	1.5184	1.6110	14.5	131	0.11	0.01
TCDD-TEQ	1.26E-06	1.26E-06	1	1	1.51E-09	3.28E-07	3.29E-07	1.00E-06	1.00E-05	0.33	0.03

Additional model parameters: diet soil percent = 2 %; food ingestion rate = 0.26 kg/kg-bw/day;
% dry matter in fruit = 23 %

Foodweb Model Calculations:

Dose Soil = soil mean X soil bioavailability X area use factor X fraction soil X food ingestion rate X 0.23 fraction dry weight in food

Dose Fruit = fruit mean X area use factor X food ingestion rate

Dose Total = Dose Soil + Dose Fruit

Notes:
TRV = Toxicity Reference Value
Fruit mean concentrations from EA (1995a), with the exception of TCDD-TEQ which is conservatively assumed the same as dry soil.
Soil bioavailability and area use factor conservatively are assumed to be 100%.
NOAEL and LOAEL TRVs are from Sample et al. (1996).

TABLE 2-12. FOOD-WEB RISK RESULTS FOR THE YELLOW BITTERN AT SITE 5, ANDERSEN AFB, GUAM.

Analyte	Soil Mean (mg/kg)	Reptile Mean (mg/kg)	Soil Bioavailability	Area Use Factor	Dose Soil	Dose Reptile	Dose Total	NOAEL TRV	LOAEL TRV	NOAEL HQ	LOAEL HQ
					----------mg/kg-bw/day----------						
Copper	83.7	5.0	1	1	0.1480	1.3000	1.4480	47.0	61.7	0.03	0.76
Lead	16.1	14.2	1	1	0.0285	3.6920	3.7205	1.13	11.3	**3.29**	0.33
Vanadium	194	0.4	1	1	0.3430	0.1014	0.4444	11.4	114	0.04	0.00
Zinc	77.4	36.8	1	1	0.1368	9.5680	9.7048	14.5	131	0.67	0.07
TCDD-TEQ	1.26E-06	1.26E-06	1	1	2.23E-09	3.28E-07	3.30E-07	1.00E-06	1.00E-05	0.33	0.03

Additional model parameters: diet soil fraction = 0.02 mg/kg-bw/day; food ingestion rate = 0.26 kg/kg-bw/day;
% dry matter in reptiles = 34

Foodweb Model Calculations:

Dose Soil = soil mean X soil bioavailability X area use factor X fraction soil X food ingestion rate X 0.34 fraction dry weight in food (reptiles)

Dose Reptile = reptile mean X area use factor X food ingestion rate

Dose Total = Dose Soil + Dose Reptile

Notes:
Bolded values exceed the HQ of 1.0.
TRV = Toxicity Reference Value
Reptile mean concentrations from EA (1995a), with the exception of TCDD-TEQ which is conservatively assumed to be the same as dry weight soil.
Soil bioavailability and area use factor conservatively are assumed to be 100%.
NOAEL and LOAEL TRVs are from Sample et al. (1996).

TABLE 2-13. SUMMARY OF REMEDIAL GOALS FOR RESIDENTIAL USE AT SITE 5, ANDERSEN AFB, GUAM.

Future Site Users	Matrix	COC	PRG Residential (mg/kg)	BTV (mg/kg)	RG (mg/kg)
Residential Receptors	**SURFACE SOIL**	N/A	N/A		
	SUBSURFACE SOIL	Antimony	30	63	**63 (b)**
		Copper	3,100	72	**3100 (a)**
		Lead	400 (c)	166	**400 (a)**
		Manganese	1,800	5,500	**5500 (b)**

Notes: COC = contaminant of concern; BTV = background threshold value; PRG = 2004 USEPA Region 9 Preliminary Remediation Goal; RG = Remediation Goal; mg/kg = milligrams per kilogram; N/A = not applicable; (a) = RG based on PRG; (b) = RG based on BTV; (c) = The PRG represents the USEPA guideline for lead (OSWER Directive/IEUBK Model)

TABLE 2-14. COST ESTIMATE FOR THE INSTITUTIONAL CONTROLS ALTERNATIVE AT SITE 5, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth ($) at 5% discount rate for 30 years (rounded)
Capital Cost. Public Information						
Public Relations Manager Labor Hours	BPJ	8	Hour	$ 85	$ 680	
Project Manager Labor Hours	BPJ	8	Hour	$ 85	$ 680	
Public Relations Staff Labor Hours	BPJ	16	Hour	$ 65	$ 1,040	
Public Notice Fact Sheet	BPJ	1	Lump Sum	$ 500	$ 500	
Signage	BPJ	4	Each	$ 50	$ 200	
Press Release	BPJ	1	Lump Sum	$ 2,840	$ 2,840	
15% markup on ODC					$ 531	
4% Guam Tax					$ 238	
15% contingency					$ 891	
Subtotal					**$ 7,600**	**$ 7,600**
Capital Cost. Development of the LUCMP						
Sr. Labor Hours	BPJ	8	Hour	$ 135	$ 1,080	
Jr. Labor Hours	BPJ	40	Hour	$ 72	$ 2,880	
Clerical/Editor/Word Processor/CADD labor hours	BPJ	8	Hour	$ 60	$ 480	
ODCs - Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 500	$ 500	
15% markup on ODCs					$ 75	
15% contingency					$ 741	
4% Guam Tax					$ 198	
Subtotal					**$ 5,954**	**$ 6,000**
Capital Cost. Amendment of Base Master Plan						
Sr Labor Hours	BPJ	16	Hour	$ 135	$ 2,160	
Jr Labor Hours	BPJ	24	Hour	$ 72	$ 1,728	
Clerical/Editor/Word Processor/CADD labor hours	BPJ	8	Hour	$ 60	$ 480	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 500	$ 500	
15% markup on ODCs					$ 75	
15% contingency					$ 731	
4% Guam Tax					$ 195	
Subtotal					**$ 5,869**	**$ 5,900**
O&M Cost. Landscaping & Signage Maintanence (assume annual)						
Sr. Labor Hours	BPJ	2	Hour	$ 135	$ 270	
Mid Labor Hours	BPJ	40	Hour	$ 80	$ 3,200	
Jr. Labor Hours	BPJ	4	Hour	$ 72	$ 290	
Clerical/Editor/CADD labor hours	BPJ	2	Hour	$ 60	$ 120	
Field labor	Vendor Quote	16	Hour	$ 15	$ 240	
Dump Truck	Vendor Quote	1	Day	$ 450	$ 450	
Replacement signs	BPJ	1	Lump Sum	$ 50	$ 50	
Topsoil	BPJ	10	Cubic Yard	$ 80	$ 800	
Seeding	BPJ	1,500	Square Foot	$ 1	$ 1,500	
15% markup on ODC					$ 420	
15% contingency					$ 1,038	
4% Guam Tax					$ 277	
Subtotal					**$ 8,655**	**$141,800**
O&M Cost. Land Use Controls inspection/reporting (assume annual)						
Sr. Labor Hours	BPJ	4	Hour	$ 135	$ 540	
Mid Labor Hours	BPJ	40	Hour	$ 80	$ 3,200	
Jr. Labor Hours	BPJ	16	Hour	$ 72	$ 1,158	
Clerical/Editor/CADD labor hours	BPJ	4	Hour	$ 60	$ 240	
Report production	BPJ	1	Lump Sum	$ 1,000	$ 1,000	
15% markup on ODCs					$ 150	
15% contingency					$ 921	
4% Guam Tax					$ 246	
Subtotal					**$ 7,455**	**$122,100**

TABLE 2-14. COST ESTIMATE FOR THE INSTITUTIONAL CONTROLS ALTERNATIVE AT SITE 5, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth ($) at 5% discount rate for 30 years (rounded)
O&M Cost. Five-Year Reviews						
List of Assumptions:						
30-year period of performance (events performed at year 5, year 10, year 15, year 20, year 25, and year 30)						
Cost model assumes Periodic Site Review & Public Education costs shared with multiple IRP sites that have Institutional Controls.						
Includes fact sheets.						
Labor and Other ODC	**Rates**	**Hours**	**Labor Cost**	**Per Diem and Other**	**Total Labor and ODCs**	
Sr. Geologist	$130	40	$5,200	$0	$5,200	
Sr. Engineer	$135	40	$5,400	$500	$5,900	
Sr. Toxicologist	$120	24	$2,880	$300	$3,180	
Mid. Geologist	$80	24	$1,920	$300	$2,220	
Mid. CADD/GIS Operator	$60	40	$2,400	$500	$2,900	
ODCs		**Quantity**	**Unit**	**Rate ($)**	**Total ODC ($)**	
CADD/GIS Equipment		1	Lump Sum	$600	$600	
Car rental, airfare, travel		1	Lump Sum	$500	$500	
O&M (posting signs, fence fixing)		1	Lump Sum	$2,000	$2,000	
Press Release		1	Lump Sum	$500	$500	
Phone/communications		1	Lump Sum	$224	$224	
Copies, postage, shipping		1	Lump Sum	$300	$300	
4% Guam Tax on Labor			$712	$0	$712	
15% markup on ODCs			$0	$859	$859	
4% Guam Tax on ODCs			$0	$229	$229	
Subtotal					**$25,324**	**$95,800**
				TOTAL Capital Cost	**$ 19,423**	**$ 19,500**
				TOTAL O&M Cost (30-year)		**$ 359,700**
				TOTAL COST (30-year net present worth)		**$ 380,000**

Notes: (rounded)

BPJ = Best Professional Judgement; O&M = Operation & Maintenance; ODC = other direct cost; CADD = computer aided design and drafting; GIS = geographical information system; LUCMP = Land Use Control Management Plan; IRP = Installation Restoration Program; AFB = Air Force Base

TABLE 2-15. SUMMARY OF PERTINENT ARARs AND TBCs AND COMPLIANCE OF THE SELECTED REMEDY FOR SITE 5, ANDERSEN AFB, GUAM.

AUTHORITY	CITATION	ARAR DETERMINATION	SYNOPSIS OF REQUIREMENT	COMPLIANCE OF THE INSTITUTIONAL CONTROLS ALTERNATIVE
Chemical Specific				
No chemical specific ARARs or TBCs have been identified for Site 5.				
Location Specific				
Federal				
Endangered Species Act	16 USC 1531 and 50 CFR 200, 402	Relevant and Appropriate	Promotes actions to conserve endangered species or habitats.	ARAR will be met. The endangered Micronesian starling has been observed at Site 5. However, no unacceptable ecological risks have been identified on site and LUCs would not adversely impact endangered species or their habitat.
Territorial				
Fish, Game, Forestry & Conservation	5 Guam Code Annotated, Chapter 63	Relevant and Appropriate	Promotes actions to conserve endangered species or habitats.	ARAR will be met. The endangered Micronesian starling has been observed at Site 5. However, no unacceptable ecological risks have been identified on site and LUCs would not adversely impact endangered species or their habitat.
Action Specific				
No action specific ARARs or TBCs have been identified for Site 5.				

ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
LUC = Land Use Control
TBC = To Be Considered
USC = United States Code

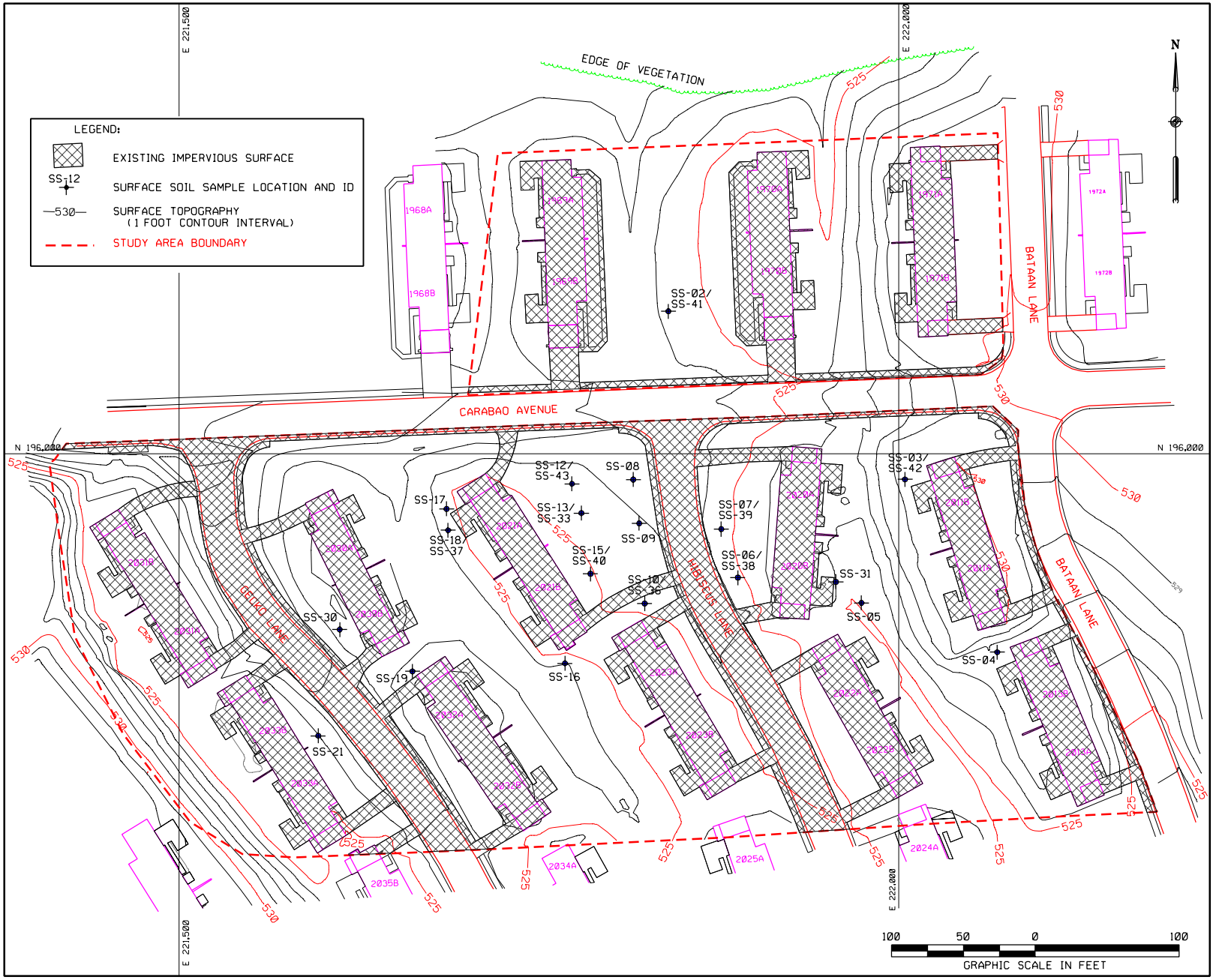

Figure 2-1. Active Base Area and Topographic Map Showing Location of Impervious Surfaces and Surface Soil Sample Locations at Site 5, Andersen AFB, Guam.

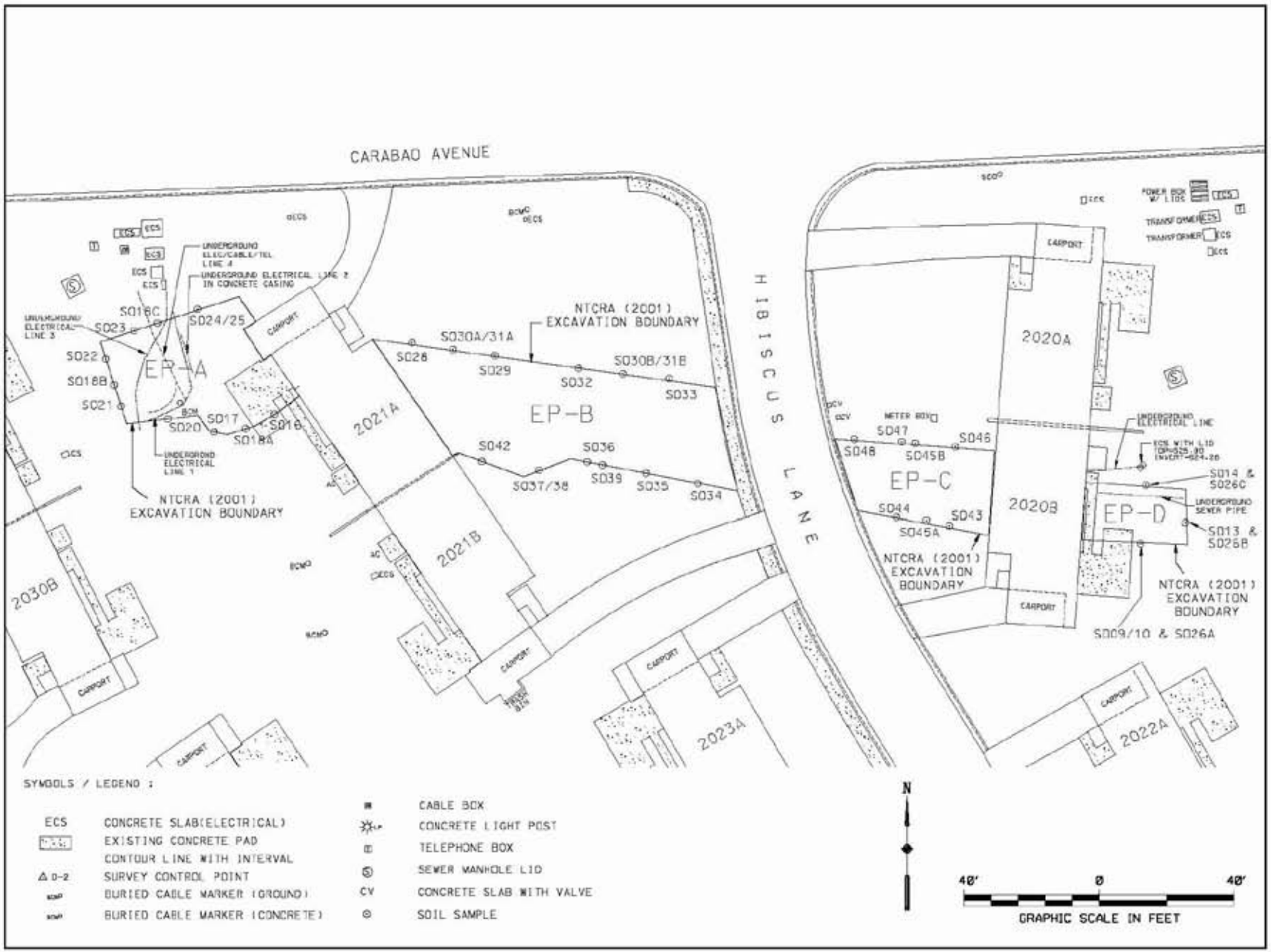

Figure 2-2. NTCRA (2001) Excavation Boundaries and Confirmation Soil Sample Locations for Site 5, Andersen AFB, Guam.

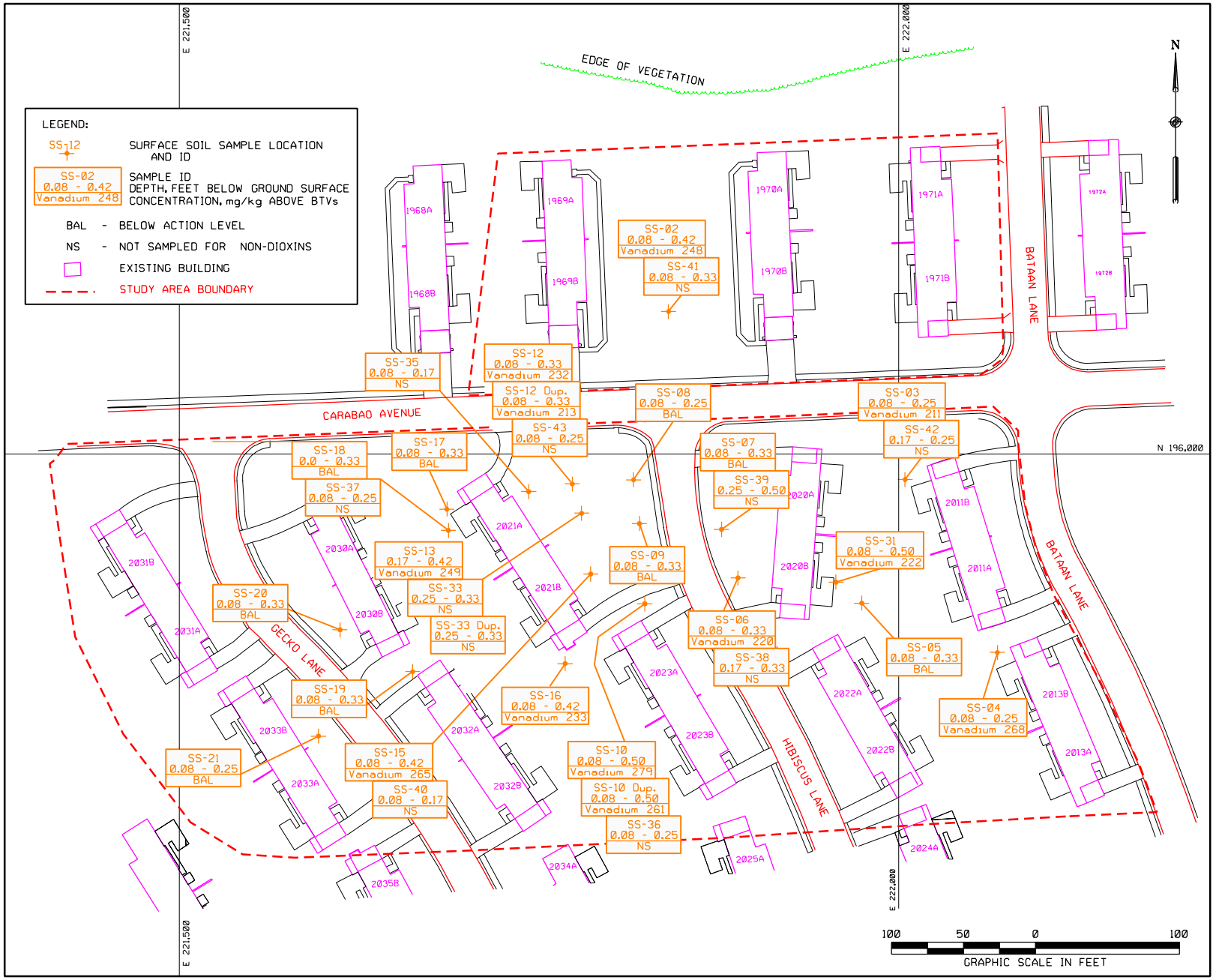

Figure 2-3. Surface Soil Sample Locations and Analytical Results Above BTV at Site 5, Andersen AFB, Guam.

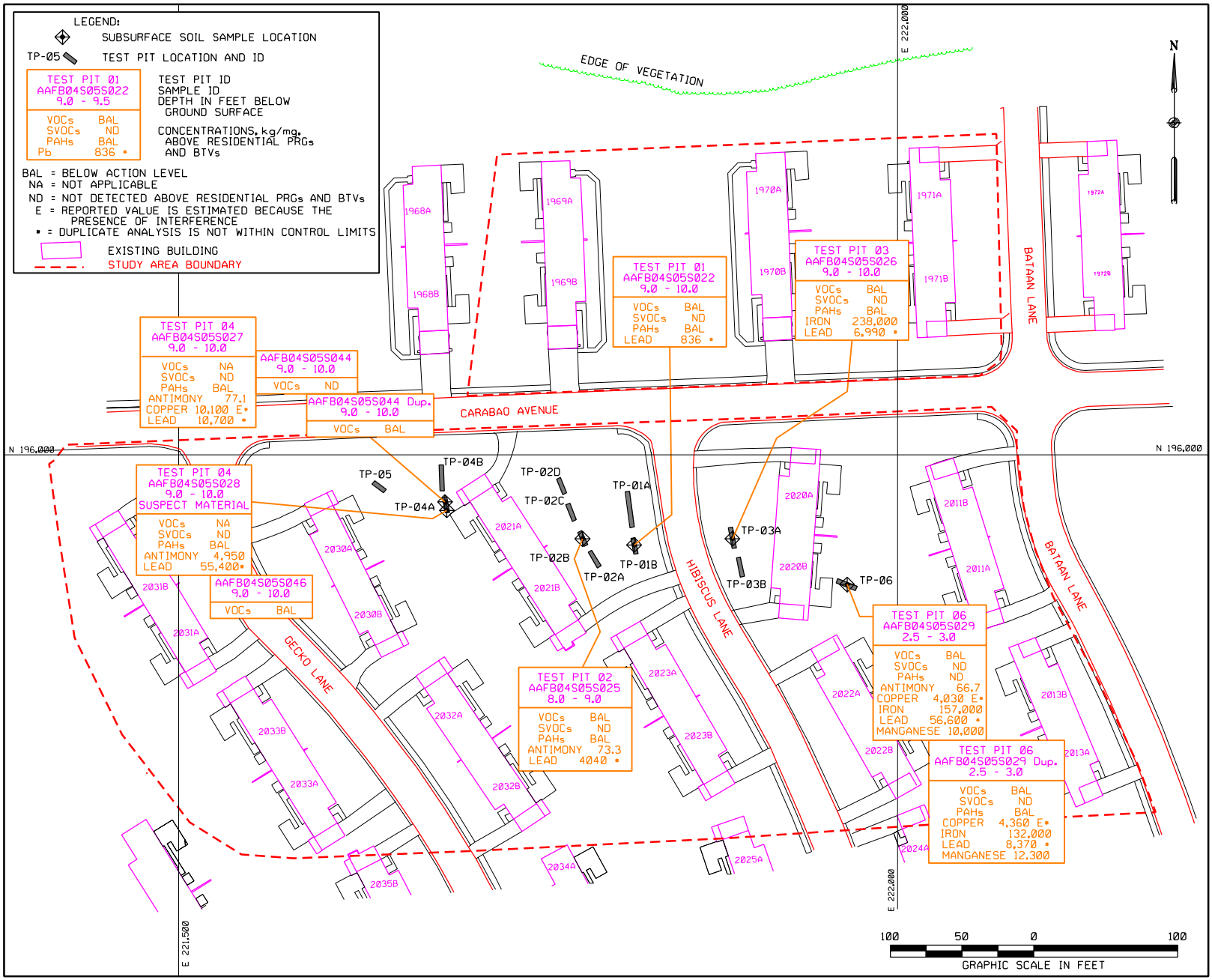

Figure 2-4. Subsurface Soil Sample Analytical Results at Site 5, Andersen AFB, Guam.

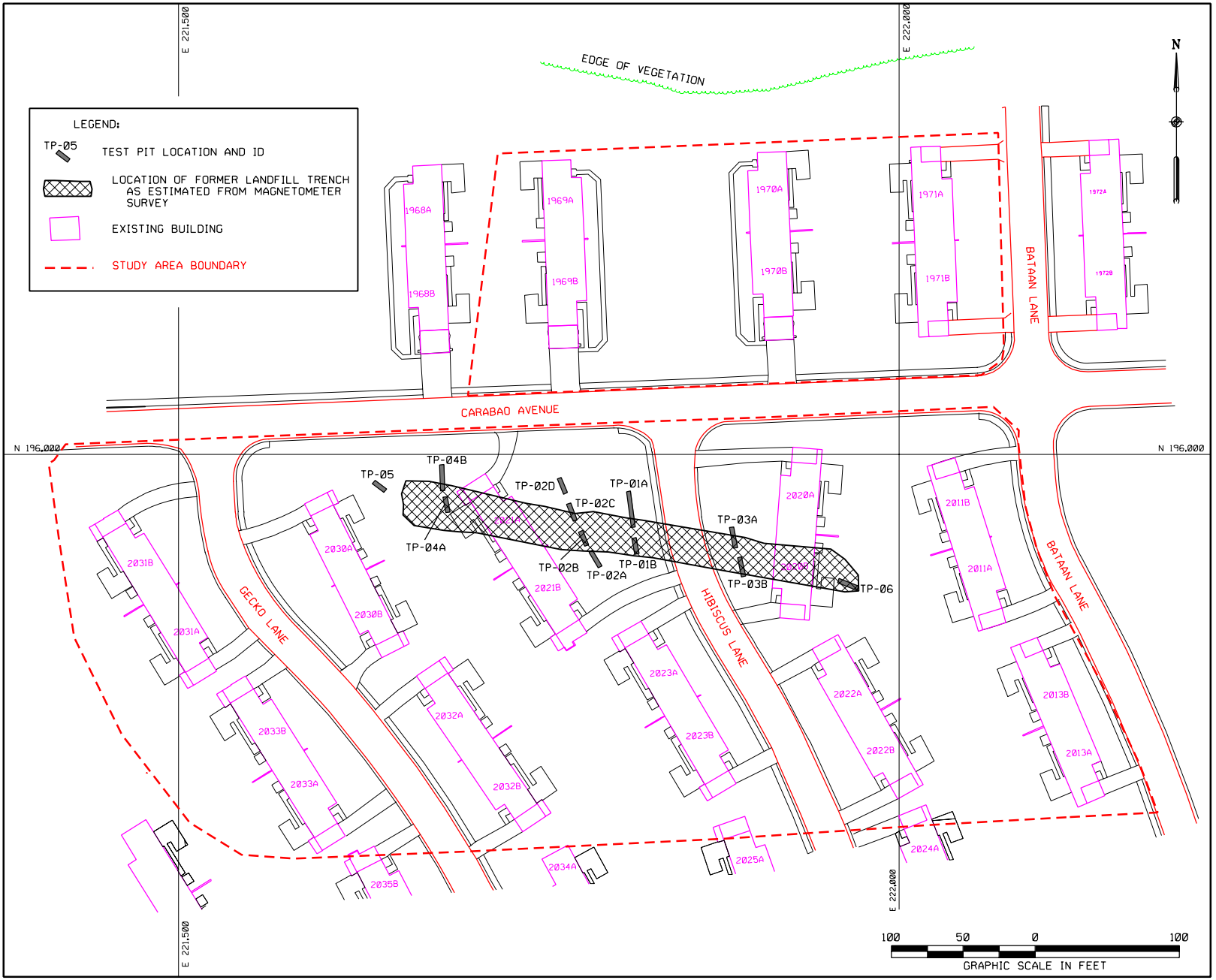

Figure 2-5. Location of Former Landfill Trench based on Magnetometer Survey at Site 5, Andersen AFB, Guam.

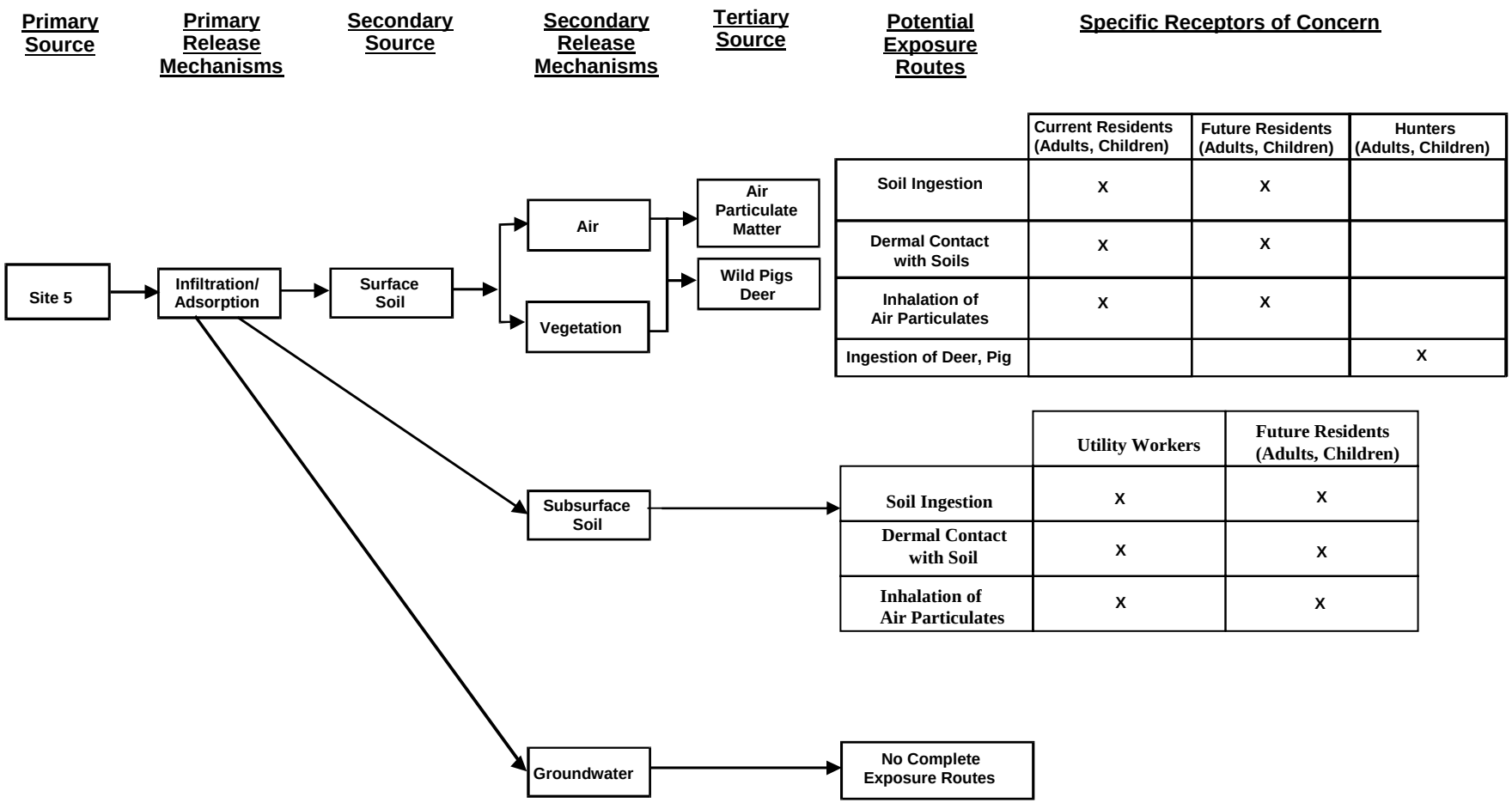

Figure 2-6. Human Health Risk Assessment Conceptual Site Model for Site 5, Andersen AFB, Guam.

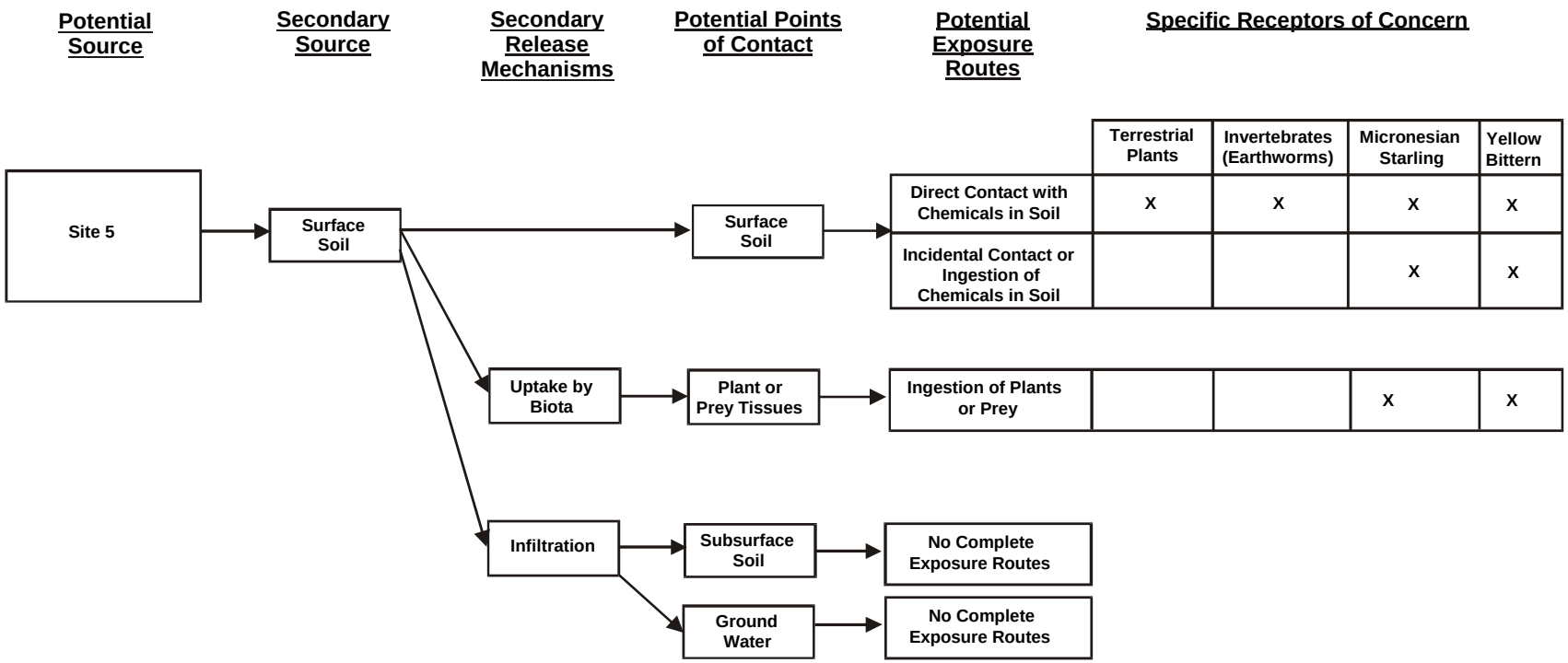

Figure 2-7. Ecological Risk Assessment Conceptual Site Model for Site 5, Andersen AFB, Guam.

3. SITE 8 DECISION SUMMARY

This decision summary for Site 8 presents an overview of the site description, environmental characteristics, history, public involvement, nature and extent of contamination, associated human health and ecological risks, remedial alternatives, and rationale for selecting the preferred remedial actions in light of the statutory requirements. The USAF has issued a detailed RI/FS that included Site 8 (EA, 2007).

Site 8 is located on approximately 27 acres along the eastern edge of the Main Base of Andersen AFB (Figures 1-2 and 1-5), and is comprised of three landfill areas (Landfills 10A, 10B, and 10C) that trend northeast-southwest (Figure 3-1). In general, the site topography slopes inward towards the quarry (Landfill 10A) and to a low area near monitoring well USGS-150. No buildings remain on the property and the forest habitat has been reclaiming the land since USAF operations stopped in this area. Ground cover currently consists of sparse to heavy undergrowth beneath a canopy of taller emergent trees. The site includes unpaved roads that traverse the site, an abandoned quarry (borrow pit), debris on the walls of the former quarry, and three concrete pads that were foundations of former building structures.

Funding is provided by DERA, a funding source approved by Congress to clean up contaminated sites on U.S. Department of Defense installations. Although the USAF is the lead agency under the CERCLA, the USEPA and Guam EPA are support agencies for the cleanup activities. Site 8 is included in the National Superfund electronic database under CERCLIS identification number GU6571999519.

3.1 HISTORY OF SITE 8

Site 8 was evaluated in the following eight environmental reports:

- *Installation Restoration Program Phase I: Records Search, Andersen Air Force Base, Guam* (ESE, 1985)
- *RCRA Facility Assessment* (RFA) *of Solid Waste Management Units at Andersen AFB, Guam, USA* (SAIC, 1986)
- *Installation Restoration Program, Phase II Confirmatory/Quantification, Stage 1, Andersen AFB, Guam* (Phase II, Stage 1 Report) (Battelle Memorial Institute [Battelle], 1989)
- *Final Records Search for Andersen Air Force Base* (ICF, 1996)
- *Final Engineering Evaluation/Cost Analysis (EE/CA) Report for IRP Site 8/Landfills 10A, 10B, and 10C, Andersen Air Force Base, Guam* (EA, 2000b)
- *Final Engineering Evaluation/Cost Analysis(EE/CA) Amendment for IRP Site 8/Landfills 10A, 10B, and 10C, Andersen Air Force Base, Guam* (EA, 2002b)

- *Remediation Verification Report, Interim Remedial Action, Installation Restoration Program Site 8/Landfills 10A, 10B, and 10C, Main Base OU, Andersen Air Force Base, Guam* (Shaw Environmental, Inc. [Shaw], 2004)
- *Remedial Investigation/Feasibility Study for Sites 1, 5, 8, 32, and 33, Main Base Operable Unit, Andersen AFB, Guam* (EA, 2007)

No written documents were discovered pertaining to the wastes disposed of at Landfills 10A, 10B, and 10C. However, a Base Civil Engineer drawing indicated that several buildings were located in the vicinity of Landfills 10A, 10B, and 10C. These structures were designated as "T" (temporary) buildings/structures that included an office building, aggregate plant, screening plant, and a water pump house. Andersen AFB Real Property records and September 1958 photographs confirm the existence of a quarry/aggregate plant and concrete batching facility on Landfills 10A and 10C.

The quarry was formerly known as the Andersen Quarry No. 2. These records also indicate that the facilities, designated as structure T-1459 (Rock Crusher Plant and associated conveyor system), were demolished in June 1963. Also, a small arms range was located 1,600 feet southeast of the quarry/aggregate plant (ICF, 1996).

One document entitled "Transfer of Construction", dated 10 August 1960, indicates a groundwater production well located next to the Andersen Quarry No. 2, adjacent to the Aggregate Plant. The well and pump house was formerly designated as structure T-1460. The pump house has been removed and the well is now designated as monitoring well USGS-150 (Figure 3-1). Landfill 10A is situated at the former Andersen Quarry No. 2, while the aggregate plant was situated in the area known as the "Processing Area" in Landfill 10C.

Based on the IRP Phase I Records Search (ESE, 1985), Landfill 10A was active in the early- to mid 1950s and was used for the disposal of scrap metal, empty 55-gallon drums, refuse, construction debris, asphalt wastes, sanitary waste, some occasional solvents, and petroleum, oil, and lubricants. The disposal methods of the period consisted of cliff dumping and area landfilling (ESE, 1985). According to the IRP Phase I Records Search Report, a Hazard Assessment Rating Methodology (HARM) score of 65 out of a possible 100 points was given for Landfill 10A due to the type of debris and the potential for contamination. The HARM score ranks the site relatively high, 4th out of the 20 sites evaluated at that time (ESE, 1985). The 1986 RFA confirmed the potential for contamination (SAIC, 1986). A previous electromagnetic survey indicated that there was no buried metal debris at the site (Battelle, 1989).

According to IRP Phase I Records Search, Landfill 10B was used for the disposal of asphalt materials, construction debris, and empty 55-gallon drums. Although no HARM score was assigned to Landfill 10B (ESE, 1985), the 1986 RFA stated that there was potential for the release of hazardous materials at Landfill 10B based on the types of waste and past landfill practices.

According to the IRP Phase I Record Search, Landfill 10C was used for the disposal of sanitary waste and small quantities of asphalt waste. The landfill had a minimal potential for

contamination or hazardous leachate formation and was not assigned a HARM rating (ESE, 1985). The 1986 RFA also concluded that no potential release of hazardous materials existed at this site (SAIC, 1986).

In 2000, the USAF completed an EE/CA (EA, 2000b) that included a HHRA and an ERA for the three landfills. Based on the ERA, the USAF identified "negligible potential for risk" and determined that no further ecological evaluation is required at Site 8. Based on the HHRA, the USAF identified no unacceptable human health risks at Landfill 10A or Landfill 10B; however, unacceptable human health risks were identified at Landfill 10C for potential future residents exposed to surface and subsurface soil and for occasional users/trespassers exposed to subsurface soil.

During the EE/CA, the USAF's recommended remedial alternative for a CERCLA NTCRA at Site 8 was a *Slope Stabilization and Soil Cover* because of the reasonable overall protection to the current and anticipated receptors and land use at the site (i.e., the occasional user/trespasser receptor). This recommendation also was based on the concern that the unstable slope above the quarry wall would fail and expose subsurface hazardous substances that would pose a risk to human health. However, in 2002 the USAF issued an EE/CA Amendment (EA, 2002b) which changed the recommended alternative to *Institutional Controls* based on changes in the understanding regarding the risk associated with potential slope failure at the site. Therefore, the USAF determined that the remediation alternative for Site 8 needed to address the soil ingestion and dermal contact pathways and not the inhalation pathway. Thus, the *Institutional Controls* alternative was considered a viable remedial action for Site 8. The USAF intended the *Institutional Controls* alternative to control exposure to potential receptors by restricting access to the site by occasional users/trespassers.

In 2004, the USAF completed an interim action at Site 8 (Shaw, 2004) that included the installation of a 6-foot-high chain-link fence along the boundary between the site and the Lower Civil Engineering Laydown Yard (Site 33 adjacent to the northwestern side of Landfill 10A) to limit access to the site (Figure 3-1). This fence also limits subsurface excavation near the northeast end of Site 33 and restricts further disposal of construction debris and sediment at the top of the Site 8 Landfill 10A (quarry) cliffline from Site 33. The fence is approximately 390 feet long, is constructed of galvanized chain-link fence, and has one 20-foot-wide, double-swing gate. An additional gate (10 feet wide) was installed across the access road to the Landfill 10C portion of Site 8, near the northwest end of the adjacent Site 33 (Figure 3-1). Signs were posted on both gates to warn workers and/or trespassers not to disturb the subsurface soil.

3.2 ENFORCEMENT ACTIVITIES

Due to its primary mission in national defense, the USAF has long been engaged in a wide variety of operations that involve the use, storage, and disposal of hazardous materials. On 14 October 1992, Andersen AFB was formally listed on the NPL by the USEPA to investigate abandoned sites that may have been impacted by the use, storage, and disposal of hazardous materials.

The enforcement activities for Andersen AFB were initiated when the USAF entered into a FFA with USEPA Region 9 and Guam EPA. The FFA, finalized on 30 March 1993 (USEPA et al., 1993), established procedures for involving federal and territorial regulatory agencies, as well as the public, in the environmental restoration process at Andersen AFB. The FFA was based on applicable environmental laws, including CERCLA, HSWA, SARA, and the NCP.

3.3 COMMUNITY PARTICIPATION

In August 1992, Andersen AFB conducted 67 interviews with local government officials, residents, and concerned citizens to determine the level of community concern and interest in the environmental investigations. These community interviews provided the basis for the 1993 CRP (ICF, 1993). The 1993 CRP described activities to keep the nearby communities informed of the progress of the environmental investigations at Andersen AFB sites and provide opportunities for input from residents regarding cleanup plans. In response to the USEPA request, Andersen AFB conducted 27 additional interviews in 1998 and updated the CRP (EA, 1998).

The USAF has promoted community relations and encouraged public involvement in cleanup decisions through the RAB, established in 1995. Currently, the RAB is comprised of community members, elected officials, USAF officials, and representatives from regulatory agencies. The RAB meets on a quarterly basis to discuss program progress and to advise the community on the status and plans for the various IRP sites. RAB meeting minutes are available for review as part of the AR.

In addition to RAB meetings, in 1993 Andersen AFB prepared a brochure to respond to community concerns and inform the public about Andersen AFB's IRP investigations (ICF, 1993). A summary of the history and status of community involvement in the IRP at Andersen AFB is presented in the December 2001 Final Management Action Plan (Andersen AFB, 2001a).

In order to provide access to the public, Andersen AFB has provided copies of reports related to Sites 5 and 8 to the AR file and the Information Repository at the following locations:

Nieves M. Flores Memorial Library
254 Martyr Street
Hagåtña, Guam 96910
Telephone: (671) 475-4751, 4752, 4753, or 4754

University of Guam
Federal Document Department, RFK Library, UOG Station
Mangilao, Guam 96923
Telephone: (671) 735-2321

The AR file is also available on the internet at: http://www.adminrec.com/PACAF.asp.

A notice of availability for the reports related to Sites 5 and 8 was published in the Guam edition of *Marianas Variety* on 26 July 2007 (Appendix B).

In July 2007, the Proposed Plan for Sites 5 and 8 was released to the public for a review and comment, with a public comment period from 26 July 2007 to 26 August 2007. A public meeting was held at the Guam Marriott Resort and Spa in Tumon on 2 August 2007, where the Proposed Plan was presented, and representatives from the USEPA Region 9, Guam EPA, and USAF responded to public comments. The results of the public meeting and responses to public comments are presented in Section 5 of this ROD.

3.4 SCOPE AND ROLE OF THE OPERABLE UNIT OR RESPONSE ACTION

Andersen AFB decided to use an OU approach to manage the investigation and remediation of environmental conditions at Andersen AFB. According to the 1993 FFA, the OUs were formed to:

- Expedite the completion of environmental activities;
- Evaluate sites with similar locations and potentially similar requirements as a group;
- Complete remedial design investigations at sites where closure decisions have been previously reached with the Government of Guam; and
- Provide a screening mechanism for evaluating newly or tentatively identified sites for inclusion in the RI/FS.

The environmental investigations at Sites 5 and 8 were performed under the Main Base OU. The Main Base OU addresses potential contamination in the surface soil, subsurface soil, and/or groundwater beneath site within the OU. Sites 5 and 8 have been grouped together in this ROD as they require implementation of institutional or engineering controls.

3.5 SITE CHARACTERISTICS

3.5.1 Site 8 Physical Setting

Site 8 is located on approximately 27 acres near the eastern edge of the Main Base of Andersen AFB and is comprised of three landfill areas (Landfills 10A, 10B, and 10C) (Figures 1-2 and 3-1). In general, the site topography slopes inward toward the quarry (Landfill 10A) and to a low area near monitoring well USGS-150. No buildings remain on the property and the forest habitat has been reclaiming the land since USAF operations stopped in this area. Ground cover currently consists of sparse to heavy undergrowth beneath a canopy of taller emergent trees. The site includes unpaved roads that traverse the site, an abandoned quarry (borrow pit), debris on the walls of the former quarry, debris on the floor of the site, deteriorated 55-gallon drums, and three concrete pads that were foundations of former building structures.

A site reconnaissance and DSI were conducted to accurately define the environmental setting and boundaries of the site, including identification of potentially hazardous wastes (Figure 3-2). In addition to the DSI, an ecological (flora and fauna) survey also was performed to identify potential ecological receptors and exposure pathways (Section 3.7.2).

The ground surface throughout most of the site has been disturbed, with the exception of the northern and eastern portions of Landfill 10B and the limestone forest located along the northwestern slope of Landfill 10C. The land directly south of the site is relatively undisturbed natural habitat.

The surface of Site 8 is underlain predominantly by Mariana Limestone. Groundwater beneath Site 8 is approximately 460 to 530 feet bgs, flows toward the east, and eventually discharges into the Pacific Ocean. Monitoring wells IRP-51 and USGS-150 are located at the site (Figure 3-1).

The ecological habitat at Site 8 primarily consists of mixed shrub, Leucaena forest, second-growth limestone forest, and active base area habitats. No Mariana fruit bat, Mariana crow, Micronesian starling, or endangered plants were observed (either directly or signs) during the habitat assessment. A description of ecological habitats and receptors is presented in Section 3.7.2 of this document.

3.5.2 Sampling History for Site 8

Seventy-one surface soil samples, including seven duplicate samples, were initially collected from 64 locations in June and September 1998. Forty-four additional surface soil samples, including four duplicate samples, were collected in January 1999 to delineate areas where the initial sample concentrations exceeded USEPA Region 9 residential PRGs and BTVs. Twenty-five additional surface soil samples were collected in February 2000 to further characterize the extent of lead and pesticides in soil. Laboratory analytical results for the surface soil samples are summarized in the RI (EA, 2007), as well as Figures 3-3 through 3-5. No soil samples were collected on the steeper quarry wall due to safety concerns for field workers collecting samples.

Surface soil samples were collected to characterize and evaluate the risks to human health and the environment. Discrete (grab) surface soil samples were collected at biased and random locations from 0 to 6 inches bgs. The biased samples were typically collected in areas associated with debris or fill material. Most surface soil samples were analyzed for the following parameters:

- SVOCs, USEPA Method SW8270C
- PAHs, USEPA Method SW8310
- Cyanide, USEPA Method SW9012
- Pesticides/polychlorinated biphenyls (PCBs), USEPA Method SW8081
- Andersen AFB TAL metals, USEPA Method SW6010B/SW7000 series

Surface soil samples were not analyzed for VOCs because geologic and climatic conditions on Guam induce volatilization and infiltration, thereby limiting the potential presence of VOCs in surface soil samples.

A total of 34 subsurface soils samples, including four duplicate samples, were collected from the bottom of test pit excavations at depths ranging from 2 to 10 feet bgs. Sixteen of the subsurface soil samples, including two of the duplicate samples, were collected from excavations during July and September 1998. During February 2000, 18 additional subsurface soil samples were collected to characterize the extent of pesticides and lead detected in previous samples. The sample results are summarized in the RI (EA, 2007), and on Figures 3-3, 3-4, and 3-5 for Landfills 10A, 10B, and 10C, respectively.

Subsurface soil samples were collected so that buried waste materials could be characterized and the potential risks to human health and the environment could be evaluated. Subsurface soil samples were analyzed for the following parameters:

- VOCs, USEPA Method SW8260B
- SVOCs, USEPA Method SW8270C
- PAHs, USEPA Method SW8310
- Pesticides/PCBs, USEPA Method SW8081
- Cyanide, USEPA Method SW9012
- Total organic carbon, Walkley-Black
- Andersen AFB TAL metals, USEPA Method SW6010B/SW7000 series

The surface and subsurface soil analytical results were compared to residential and industrial PRGs that were developed by USEPA Region 9 to establish screening criteria for potentially contaminated sites (USEPA, 2004a). As compared to industrial PRGs, the residential PRGs are more conservative regarding the future use of a property. According to the BGP (Andersen AFB 2005), there are no plans to develop the land for residential or commercial use in the foreseeable future.

Because some metal concentrations in soils occur naturally at high concentrations in Guam, BTVs were established (ICF, 1997; Andersen AFB, 2001b; EA, 2002a). Six metal BTVs (aluminum, antimony, arsenic, chromium, manganese, and vanadium) exceed the respective residential PRG. For these metals, the maximum observed concentration was compared to the BTV rather than the residential PRG.

If the maximum detected concentration of an analyte exceeded the screening value or BTV, that analyte was then retained as a COPC. Subsequent to determining the COPCs for Site 8, a HHRA and an ERA were conducted to establish the COCs, the RAOs, and the RGs (Sections 3.7 and 3.8).

Groundwater samples have been collected from three monitoring wells located within 0.5 mile of the site on a semiannual basis. Two of these wells (IRP-51 and USGS-150) are located within Landfill 10C (Figure 3-1). Monitoring well IRP-42 appears to be located cross-gradient from the site. These samples are analyzed for VOCs, SVOCs, PAHs, pesticides/PCBs, and Andersen AFB TAL metals; results are summarized in the RI (EA, 2007).

3.5.3 Conceptual Site Model for Site 8

Site 8 is located in the eastern portion of the Main Base, covers an area of approximately 27 acres, and is comprised of three landfill areas (10A, 10B, and 10C) (Figure 3-1). Based on historical records research and interviews, Site 8 was used in the early- to mid-1950s for quarrying aggregate and as a concrete batching facility.

Potential receptors at the site include occasional users/trespassers. This includes hunters or trespassers who may walk through the area, as well as maintenance workers who may work at the site on a limited basis. Limited hunting of deer and wild pigs occurs in this area of Andersen AFB. Therefore, adults and children who consume deer and pig meat were also considered receptors at the site. However, risks associated with ingestion of deer and wild pig meat have been addressed on a Basewide basis and are presented in a separate report (EA, 1995b). Andersen AFB will prepare a site-specific LUCMP to restrict future residential housing and recreational facilities from the site. The LUCMP shall serve as the operational "road map" for defining, implementing, and reporting on LUCs at Site 8. The area designated for management under LUCs (Landfill 10C) will be surveyed in the field and will be amended to the BGP and incorporated into the GeoBase System. No changes in the type of land use designated in the ROD shall be implemented within the designated LUC area without the prior knowledge and concurrence of the USAF, USEPA, and Guam EPA. Additionally, the LUCMP will include the fence constructed at Site 8 as a part of the permanent remedy. Therefore, it is highly unlikely that residential exposures would occur at the site in the future. However, as a conservative assumption and to serve as a baseline, risks to potential future residents were evaluated for Site 8.

Media of concern identified at the site are surface soil, subsurface soil, air exposures that could result from dispersion of surface and subsurface soil into air, and groundwater. Site 8 is located over one mile down-gradient of the nearest production well along the northeastern coast of Guam. Groundwater beneath Site 8 is not potable due to its high salinity and is not a potential drinking water source. In addition, COCs identified at Site 8 are largely immobile inorganic compounds or organic compounds that tend to be strongly sorbed to soils, so it is unlikely that any groundwater impacts would result from the concentrations of COCs present at this location. Therefore, the media of concern identified at the site are surface soil, subsurface soil, and air exposures, which could result from dispersion of surface and subsurface soil into air.

The exposure pathways that are considered for potential future resident adults and children are incidental soil ingestion and dermal exposures to surface soil, and inhalation of dust particulates from surface soil. It is assumed that residents could be exposed to subsurface soil that could be disturbed during digging or excavation activities and brought to the surface. Therefore, as a

conservative measure, potential future residents are also evaluated for incidental ingestion of and dermal contact with subsurface soil and inhalation of subsurface soil particles. The exposure pathways which are considered for current and future occasional users/trespassers are incidental ingestion of, and dermal contact with, and inhalation of airborne dust particulates of surface soil and subsurface soil (in the event that subsurface soil on the wall of the Landfill 10A becomes unstable and falls to the bottom of the landfill, where it could be contacted as surface soil). The CSM for Site 8 is presented in Figure 3-6. An exposure pathways analysis is presented in Table 3-1.

3.5.4 Suspected Contamination Sources at Site 8

Based on the DSI results for Landfill 10A, surface and slope debris, including deteriorated 55-gallon drums, were mostly concentrated along the north quarry floor and the lower quarry wall (Figure 3-2). More than 100 drums were observed in each of these areas. Most of the drums appeared to be remnant asphalt drums. One drum, 20 percent full of an unknown liquid, and a 1-foot-diameter pipe, possibly composed of asbestos-containing material, were observed within these drum areas. Miscellaneous construction debris, vehicle and aircraft parts, empty and partially full drums, empty paint cans, wooden utility poles, empty aluminum cans, and glass bottles were observed as loose debris on the north, east, and west walls of the quarry and at the base of these walls. Other surface debris scattered along the quarry floor included scrap metal, rusted piping, deteriorated metal containers, glass bottles, concrete slabs, steel reinforcement bar, automotive parts, wooden utility poles, deteriorated drum remnants, remnants of an old conveyor, and various types of vehicle tires. Small mounds identified at Landfill 10A were composed of limestone rubble. Concrete rubble and poured concrete were observed at the southern end of the quarry. Most of the soil on the quarry floor consisted of fine, limestone silt (lime dust) that is likely a remnant of the former aggregate plant activities. Poured concrete is the likely remnant of the former concrete batching operation.

Road asphalt cold patch was observed along the southwestern corner of Landfill 10B (Figure 3-2). Other surface debris at Landfill 10B included scrap metal, rusted piping, glass bottles, concrete slabs, steel reinforcement bar, and automotive parts. A suspected fill area was observed in the southeastern corner of the Landfill 10B.

Landfill 10C contained remnants of a former concrete batch plant. Surface debris identified in Landfill 10C included three concrete foundations and a northeast-southwest orientated trench (Figure 3-2). These foundations are consistent with the photos of the former aggregate plant. A large batch of poured concrete was observed on the southern portion of Landfill 10C. Other surface debris included deteriorated 55-gallon drums, scrap metal, rusted piping, deteriorated metal containers, glass bottles, concrete slabs, steel reinforcement bar, automotive parts, and wooden utility poles. Fill material was observed along the ridges forming the northeast and southern borders of Landfill 10C. On the northern edge of Landfill 10C, the contents and remnants of twenty-nine 55-gallon drums were observed. The steel drums had deteriorated, leaving behind an unknown, solid, green and brown material.

3.5.5 Site 8 COPCs

Seventy-one surface soil samples, including seven duplicate samples, were initially collected from 64 locations in June and September 1998. Forty-four additional surface soil samples, including four duplicate samples, were collected in January 1999 to delineate areas where the initial sample concentrations exceeded USEPA Region 9 residential PRGs and BTVs. Twenty-five additional surface soil samples were collected in February 2000 to further characterize the extent of lead and pesticides in soil (Figures 3-3 through 3-5):

- Benzo(a)pyrene exceeded its respective USEPA Region 9 residential PRG and was identified as surface soil COPC at Landfill 10A.

- Lead exceeded its respective USEPA Region 9 residential PRG and BTV and was identified as a surface soil COPC at Landfill 10B.

- Four metals (barium, cadmium, copper, and lead), four PAHs (benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene), and four pesticides (dichlorodiphenyldichloroethene [DDE], dichlorodiphenyltrichloroethane [DDT], dieldrin, and heptachlor epoxide) exceeded their respective USEPA Region 9 residential PRGs and BTVs and were identified as surface soil COPCs at Landfill 10C.

Thirty-four subsurface soil samples, including four duplicate samples, were collected during June and September 1998. During February 2000, 18 additional subsurface soil samples were collected to delineate the extent of pesticides and lead detected in previous samples. Sample results are summarized in the RI (EA, 2007), on Figures 3-3 through 3-5, and as follows:

- Based on the analytical results and risk-based screening, no COPCs were identified in subsurface soils at Landfill 10A.

- Copper and benzo(a)pyrene exceeded their respective USEPA Region 9 residential PRGs and BTVs, and were identified as subsurface soil COPCs at Landfill 10B.

- Four metals (antimony, cadmium, copper, and lead), five PAHs (benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene) and nine pesticides (aldrin, alpha-chlordane, DDE, DDT, dieldrin, endrin, gamma-chlordane, heptachlor, and heptachlor epoxide) exceeded their respective USEPA Region 9 residential PRGs and BTVs, and were identified as subsurface soil COPCs at Landfill 10C.

3.6 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Potential receptors at the site include occasional users/trespassers. This includes hunters or trespassers who may walk through the area, as well as maintenance workers who may work at the site on a limited basis. Andersen AFB future land reuse plans designate Site 8 for open space (Andersen AFB, 2005) and will restrict residential housing and recreational facilities from the

site. Therefore, it is highly unlikely that residential exposures would occur at the site in the future. However, as a conservative assumption and to serve as a baseline, risks to potential future onsite residents have been evaluated for Site 8.

3.7 SUMMARY OF SITE RISKS

A HHRA and an ERA were performed for Site 8 to evaluate whether the COPCs identified in surface and subsurface soil pose potential unacceptable risks to human health or the environment. The HHRA and ERA identified the COPCs, exposure concentrations, exposure duration, and exposure pathways, and estimated the risks to human health and the environment assuming no further remedial/removal actions were taken at the site. COPCs that were determined to pose unacceptable risks to human health or the environment were designated as COCs. A comprehensive HHRA and ERA for Site 8 are presented in the RI (EA, 2007), in accordance with USEPA guidance (USEPA, 1999a); therefore, the HHRA and ERA are presented in terms of COCs, only.

3.7.1 Baseline HHRA for Site 8

The baseline HHRA estimates what risks the site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline HHRA for this site. The HHRA methodology is detailed in Appendix D.2 of the RI/FS (EA, 2007) and, in general, involves a four-step process: (1) hazard identification, (2) toxicity assessment, (3) exposure assessment, and (4) risk characterization.

The HHRA for Site 8 was originally completed as part of the EE/CA (EA, 2000b). The HHRA was formally reviewed and approved by USEPA Region 9 as part of the EE/CA review process.

In order to ensure that the results and conclusions presented in the EE/CA are still valid, a review of the HHRA was conducted. The following process was used to review and update the HHRA:

1. Selection of COPCs. All screening values (USEPA Region 9 PRGs) were reviewed and updated. There were some changes in PRGs. The only impact on COPCs selected was for manganese, which would not be selected as a COPC in surface soil at Landfill 10B using 2004 PRGs. These changes were made to the COPC screening tables and EPC summary tables in the RI/FS. There were no changes to COPCs identified in subsurface soil at any of the three landfills.
2. All exposure factor values were reviewed against current USEPA guidance (USEPA, 2004a). No changes were identified.
3. All toxicity values were reviewed against current guidance (USEPA, 2006). A few changes to toxicity values for COPCs at Site 8 were identified. None of the changes were significant; all changes have been noted in the toxicity tables in the RI/FS.

4. Calculation of EPCs was reviewed against current USEPA guidance. Although USEPA has issued a new method for calculating EPCs using ProUCL, the potential impact on risk calculation results is expected to be small, and is not expected to have any impact on the conclusions for the site.
5. As an element of the risk management decision, risk characterization results were reviewed and compared to the risk range of 10^{-6} to 10^{-4}. The original HHRA identified cumulative cancer risks that exceeded 10^{-6} as unacceptable, and identified COCs on that basis. The review indicated that cumulative cancer risks for all receptors exposed to surface soil fall within the risk range of 10^{-6} to 10^{-4}.
6. The risks associated with background analytes were added to the Risk Characterization in the RI/FS, in accordance with USEPA guidance.

3.7.1.1 Identification of COCs for HHRA at Site 8

The range of detected concentrations (maximum and minimum) and the frequency of detection for each COC identified in surface and subsurface soils at Site 8 are included in Tables 3-2 and 3-3 using the format presented in *A Guide to Preparing Superfund Proposed Plans, Records of Decisions, and Other Remedy Selection Decision Documents* (USEPA, 1999b).

The EPC for each COC is a statistically derived concentration based on the soil sample results that is used to calculate the risk associated with each COC. The EPCs for COCs in surface and subsurface soils for Site 8 are included in Tables 3-2 and 3-3.

For the RME scenario, the EPC for each COC is estimated using the arithmetic mean and the upper 95UCLM. The 95UCLM represents a high value for an EPC so there is 95 percent confidence that all other values will be below the 95UCLM value. The 95UCLM is used as the EPC in the exposure assessment for the RME assumptions. However, if the 95UCLM is greater than the maximum detected concentration, the maximum detected concentration value is used as the EPC and is listed in the table instead of the 95UCLM value. The arithmetic mean concentration is used as the central tendency EPC value using AE assumptions.

3.7.1.2 Exposure Assessment for HHRA at Site 8

An exposure assessment was conducted to estimate the magnitude of actual and/or potential human exposures. In the exposure assessment, average and maximum estimates of potential exposure were developed in accordance with USEPA guidance for both current and potential future land use assumptions. Current maximum exposure estimates were used to determine whether a potential health hazard exists based on current conditions. Future maximum potential exposure estimates were used to provide an understanding of potential future exposures and health hazards, and include a qualitative estimate of the likelihood of such exposures occurring.

Due to limited access to the site, occasional users/trespassers were identified as potential receptor populations. Current and future land use also includes recreational hunters. However, risks associated with ingestion of wild pig and deer meat have been addressed on a Basewide

basis and have been presented in separate document (EA, 1995b). Andersen AFB future land reuse plans designate Site 8 for open space (Andersen AFB, 2005) and will restrict residential housing and recreational facilities from the site. Therefore, it is highly unlikely that residential exposures will occur at the site in the future. However, as a conservative baseline (and as per USEPA Region 9 guidance), future onsite resident adults and children were evaluated as potential receptors.

Media of concern identified at the site are surface soil, subsurface soil, groundwater, and air exposures that could result from dispersion of surface and subsurface soil into air. Groundwater monitoring in the vicinity of Site 8 has detected benzo(a)pyrene at concentrations exceeding MCLs, and benzo(a)pyrene is potentially sourced from Site 8. However, as discussed in the RI (EA, 2007), groundwater is being addressed as part of the ongoing LTGM Program at Andersen AFB, and is therefore not evaluated further under this ROD.

As shown in the CSM in Figure 3-6, the following human exposure pathways were evaluated at Site 8:

- Incidental ingestion of surface soil during residential activities (e.g., gardening)
- Incidental ingestion of surface soil during occasional user/trespassing activities
- Dermal contact with surface soil during residential activities (e.g., gardening)
- Dermal contact with surface soil during occasional user/trespassing activities
- Inhalation of suspended surface soil particles during residential activities (e.g., gardening)
- Inhalation of suspended surface soil particles during occasional users/trespassing activities
- Incidental ingestion of subsurface soil during residential activities (e.g., gardening)
- Dermal contact with subsurface soil during residential activities (e.g., gardening)
- Inhalation of suspended subsurface soil particles during residential activities (e.g., gardening)

Air samples were not collected at Site 8; therefore, it was necessary to model concentrations of COPCs in suspended surface soil. The exposure modeling for this pathway was performed for potential receptors: resident adults and children and occasional users/trespassers. It should be noted that air modeling was only conducted for fugitive dust (suspended surface soil) emissions from the site, and not for VOC emissions as VOCs were not identified as COCs at the site.

The final step in this exposure assessment was to estimate COC intakes for each of the pathways considered in the assessment. In the exposure assessment, two different measures of intake are provided, depending on the nature of the effect being evaluated. Intakes are averaged over the period of exposure when evaluating longer-term exposures to chemicals that produce adverse non-carcinogenic effects (i.e., the averaging time) (USEPA, 1989). This measure of intake is

referred to as the ADI and is a less-than-lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the LADI (USEPA, 1989).

The exposure factor values (exposure duration, exposure time, incidental ingestion rates of contaminated soil, inhalation rates of contaminated dust, and dermal exposure assumptions for resident adults, resident children, occasional users [workers], and trespassers under RME and central tendency scenarios) used in estimating intakes are presented in Appendix D.2 of the RI (EA, 2007).

3.7.1.3 Toxicity Assessment for HHRA at Site 8

The toxicity assessment considers the types of potential adverse health affects associated with exposures to COCs. The toxicity assessment relies on existing toxicity information developed based on dose-response for specific COCs. Using this dose-response relationship, specific toxicity values were derived by USEPA that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels. The USEPA-derived toxicity values for COCs are called RfDs for non-carcinogens and SFs for potential carcinogens.

The USEPA IRIS database was used for RfDs of non-carcinogenic COCs. If RfDs for COCs were not available from IRIS, the USEPA HEAST was used as a secondary data source. If RfDs for COCs were not available from IRIS or HEAST for one route of exposure but existed for another route, the existing value was examined for technical applicability to the alternate route and subsequently used, if appropriate.

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold; that is, there is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This "non-threshold" concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen.

3.7.1.4 HHRA Characterization for Site 8

Carcinogenic risk was estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen at the site. The numerical estimate of excess lifetime cancer risk was calculated by multiplying the LADI by the risk per unit dose (the slope factor), as shown in the following equation:

$$Risk = LADI \times SF$$

where: Risk = A unitless probability (e.g., 2×10^{-5}) of an individual developing cancer
LADI = Lifetime average daily intake (mg/kg/day)
SF = Cancer slope factor $(mg/kg/day)^{-1}$

Because the SF is the statistical 95th percent UCL on the dose-response slope, this method provides a conservative, upper-bound estimate of risk.

Cancer risks were estimated for current and future occasional users/trespassers and for potential future residents. These risks are probabilities that usually are expressed in scientific notation. For example, an excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the RME estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes not related to the site, such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally acceptable risk level for site-related exposure is 10^{-6}. USEPA has determined that risk in excess of 10^{-4} (1 in 10,000) is unacceptable. The risk range of 10^{-4} to 10^{-6} may be evaluated in the risk management context to determine whether risk is acceptable for future site conditions.

The potential human health risks associated with exposures to non-carcinogenic COCs at Site 8 were estimated by comparing ADIs with established RfDs, as per USEPA guidance (USEPA, 1989) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a HQ. An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An HI >1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$HQ = \frac{ADI}{RfD}$$

where: HQ = Hazard quotient; ratio of average daily intake level to acceptable daily intake level (unitless)
ADI = Estimated average daily intake (mg/kg/day)
RfD = Reference dose (mg/kg/day)

ADI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

3.7.1.4.1 HHRA Results for Surface Soil Exposures at Site 8

The detailed exposure and risk calculations are presented in Appendix D.2 of the RI/FS (EA, 2007).

No unacceptable human health risks were identified in surface soil for Landfills 10A or 10B for any of the evaluated exposure scenarios.

For Landfill 10C, the only identified unacceptable risks in surface soil were non-cancer risks associated with the future resident child scenario under RME conditions (HI = 2.11) (Table 3-4). The COC with a cumulative HQ exceeding 1.0 for resident children was dieldrin (HQ = 2.0). Lead was also identified as a COC for resident children.

Cancer risks were within the risk range of 10^{-6} to 10^{-4} for resident adults and children (8.39×10^{-5}). The original HHRA identified cumulative cancer risks that exceeded 10^{-6} as unacceptable, and identified COCs on that basis. For these combined receptors, three COCs had a cumulative cancer risk exceeding 10^{-6} during original HHRA: benzo(a)pyrene, DDE, and dieldrin. Andersen AFB future land reuse plans will restrict residential housing and recreational facilities at Site 8. As an element of the risk management decision in the RI (EA, 2007), risk characterization results were reviewed and compared to the risk range of 10^{-6} to 10^{-4} as a conservative measure. Excess lifetime cancer risks were 8.4×10^{-5} and 1.3×10^{-6} under RME and AE conditions, respectively. Based on the planned future land use at the site (open space [Andersen AFB, 2005]) and the identified risk (8.4×10^{-5} for resident adults and children), no carcinogenic COCs were identified for surface soil. LUCs will be implemented at the site to prevent residential exposures and protect evaluated receptors.

3.7.1.4.2 HHRA Results for Subsurface Soil Exposures at Site 8

The detailed exposure and risk calculations are presented in Appendix D.2 of the RI/FS (EA, 2007).

No unacceptable human health risks were identified in subsurface soil for Landfills 10A or 10B for any of the evaluated scenarios.

For Landfill 10C, the identified unacceptable risks in subsurface soil included both cancer and non-cancer risks for resident adults and children, and occasional users/trespassers (Tables 3-5A through 3-5C). For non-cancer risks under RME conditions, the HI values exceeded 1.0 for resident adults (HI = 17.6, where dieldrin was the only COC with an HQ exceeding 1.0), resident children (HI = 160, where antimony and dieldrin each had an HQ exceeding 1.0), and occasional users/trespassers (HI = 1.7, where dieldrin was the only COC with an HQ exceeding 1.0). For cancer risks under RME conditions, the calculated excess lifetime risks exceeded the acceptable risk level of 10^{-6} for resident adults and children (5.9×10^{-3}) and occasional users/trespassers (5.7×10^{-4}). Lead was also identified as a COC for residents at Landfill 10C based on the results of the IEUBK Model.

3.7.1.5 HHRA Uncertainties for Site 8

The different types of uncertainty involved in the HHRA process are discussed in detail in the RI (EA, 2007), and are presented briefly in the following sections.

3.7.1.5.1 Sampling and Analysis Uncertainties

The sampling plan can have a significant impact on the results obtained in calculating human health risks at a site. To the extent that samples are collected in areas that are expected to be contaminated (biased sampling), the EPC used in calculating risk exposures and risks is likely to overestimate the actual concentration encountered at the site from random exposure across the site. Sampling bias will generally result in an overestimate of exposures and risks at a site. The soil sampling at Site 8 incorporated a combination of random and biased samples. As the majority of soil samples collected at Site 8 were biased toward suspected contamination, the measured concentrations and calculated health risks would tend to be overestimated.

3.7.1.5.2 Chemical Fate and Transport Modeling Uncertainties

The models used to estimate chemical concentrations associated with particulates in air at Site 8 are consistent with those recommended by USEPA (1996). However, due to uncertainties in modeling methodologies, USEPA-recommended models are likely to overestimate actual concentrations at the site. Thus, use of models is likely to overestimate health risks at Site 8.

3.7.1.5.3 Uncertainties of Toxicity Assessment

There are numerous uncertainties associated with the Toxicity Assessment. These are generally due to the unavailability of data to thoroughly calculate the toxicity of COPCs.

Uncertainties Associated with Non-Carcinogenic Effects

Interspecies Extrapolation

The majority of toxicological information comes from experiments with laboratory animals. Experimental animal data have been relied on by regulatory agencies to assess the hazards of human chemical exposures. Interspecies differences in chemical absorption, metabolism, excretion, and toxic response are not well understood; therefore, conservative assumptions are applied to animal data when extrapolating to humans. These probably result in an overestimation of toxicity.

Intraspecies Extrapolation

Differences in individual human susceptibilities to the effects of chemical exposures may be caused by such variables as genetic factors (e.g., glucose-6-phosphate dehydrogenase deficiency), lifestyle (e.g., cigarette smoking and alcohol consumption), age, hormonal status (e.g., pregnancy), and disease. To take into account the diversity of human populations and their differing susceptibilities to chemically induced injury or disease, a safety factor is used. USEPA

uses a factor between 1 and 10. This uncertainty may lead to overestimates of human health effects.

Exposure Routes

When experimental data available on one route of administration are different from the actual route of exposure that is of interest, route-to-route extrapolation must be performed before the risk can be assessed. Several criteria must be satisfied before route-to-route extrapolation can be undertaken. The most critical assumption is that a chemical injures the same organ(s) regardless of route, even though the injury can vary in degree. Another assumption is that the behavior of a substance in the body is similar by all routes of contact. This may not be the case when, for example, materials absorbed via the gastrointestinal tract pass through the liver prior to reaching the systemic circulation, whereas by inhalation the same chemical will reach other organs before the liver. However, these extrapolations are made when data are limited, and may result in overestimates of human toxicity.

Uncertainties Associated with Carcinogenic Effects

Interspecies Extrapolation

The majority of toxicological information for carcinogenic assessments comes from experiments with laboratory animals. There is uncertainty about whether animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a very small number of chemical substances are known to be human carcinogens. The fact that some chemicals are carcinogenic in some animal species but not in others raises the possibility that not all animal carcinogens are human carcinogens. Regulatory agencies assume that humans are as sensitive to carcinogens as the most sensitive animal species. This is designed to prevent underestimation of risk, and has the potential to overestimate carcinogenic risk.

High-Dose to Low-Dose Extrapolation

Typical cancer bioassays provide limited low-dose data on responses in experimental animals for chemicals being assessed for carcinogenic or chronic effects. Because dosing methods do not reflect how animals actually intake a chemical, a dose-response assessment normally requires extrapolation from high to low doses using mathematical modeling. A central problem with the low-dose extrapolation models is that they may fit experimental data equally well, but they may not all be plausible biologically. The dose-response curves derived from different models diverge substantially in the dose range of interest (National Research Council, 1983). Therefore, low-dose extrapolation is more than a curve-fitting process, and considerations of biological plausibility of the models must be taken into account before choosing the best model for a particular set of data.

3.7.1.5.4 Uncertainties Analysis of Exposure Assessment

An analysis of uncertainties is an important aspect of the exposure assessment. It provides the risk assessor and reviewer with information relevant to the individual uncertainties associated with exposure factor assumptions and their potential impact on the final assessment.

Potential Receptors

Under current use conditions at Site 8, the only potential human receptors are occasional users/trespassers. The USAF does not plan residential development of this site. However, as a conservative baseline (and as per USEPA Region 9 guidance), future onsite resident adults and children were evaluated as potential receptors. The results of the HHRA indicate that there are unacceptable risks to future residential receptors (adults and children) and to occasional users/trespassers at Landfill 10C. No unacceptable risks were identified for human receptors at Landfills 10A and 10B.

Exposure Factors

Soil Ingestion Rate

Soil ingestion rates for children are based on studies performed by Binder et al. (1986) and Clausing et al. (1987). Both were short-term studies, and as they were not based on average long-term exposures, they represent an overestimate of exposure. More recent published data have shown that average soil ingestion rates for 2-year-olds is less than 100 mg/day (Calabrese et al., 1989; Davis et al., 1990). Furthermore, USEPA soil ingestion rates for children ages 1 to 6 years are based on ingestion rates for children at age 18 months and are applied through age 6 years (USEPA, 1989). This is very unlikely because children over 2 years old do not ingest at the same rate as an 18-month-old. Additionally, a conservative estimate was used for the Fraction Ingested value of 1.0, which assumes that all soil ingested (for residential exposures) is ingested at the residence. This assumes that no activities take place elsewhere. Taken together, these suggest that intakes for this pathway are overestimated.

Exposure Duration

USEPA assumes the residential exposure duration for adults is 30 years, which represents the USEPA-derived 90th percentile upper limit for time spent at one residence. The average (50th percentile) time spent at one residence is 7 years. These values are recommended in the Risk Assessment Guidance for Superfund (USEPA, 1989). Soil ingestion for children age 1 to 6 years is assumed to continue for the entire 6-year time frame.

Exposure Frequency

Although the assumption was made that occasional users/trespassers will be exposed to subsurface soils containing COCs for 40 days per year for 30 years, this is very unlikely. It does not seem feasible that there are enough housing developments built on land above landfills to make it possible for occasional users/trespassers to be exposed to this extent. Therefore, it is

highly likely that the RME risk estimates presented in this report significantly overestimate the potential human health risks.

3.7.1.5.5 Uncertainties in Risk Characterization

Uncertainties in the risk characterization can stem from the inherent uncertainties in the data evaluation, the exposure assessment process (including any modeling of EPCs in secondary media from primary media) and the toxicity assessment process. The individual uncertainties in these respective processes were addressed in previous sections.

3.7.2 Baseline ERA for Site 8

The purpose of the ERA was to determine the likelihood that adverse ecological effects may occur as a result of exposure to COCs. In addition to the DSI, an ecological (flora and fauna) survey was conducted at Site 8. Three major habitat types were identified within Site 8: mixed shrub (15 percent), leucaena forest (77 percent), and second-growth limestone forest (7 percent) (Figure 3-7).

The major habitat types are described below, including wildlife observed within each habitat type.

- Mixed Shrub – The mixed shrub habitat occurs on the eastern portion of the site and covers approximately 15 percent of Site 8. Landfill 10B is in this area and approximately 90 percent of it is mixed shrub habitat (Figure 3-7). Cell No. B-300 was investigated as a representative sample cell of the mixed shrub habitat. A mixture of trees (3 to over 30 feet tall) along with herbs (up to 3 feet tall) dominates the habitat. The dominant trees were banyan *(Ficus prolixa)* (greater than 10 to 30 feet tall) and the lipstick tree *(Ochrosia mariannensis)*, false elder *(Premna obtusifolia)*, mapunyao (*Aglaia mariannensis*), cycad (*Cycas circinalis*), and tangantangan *(Leucaena leucocephala*) (greater than 3 to 10 feet tall). One additional tree identified included the inkberry (*Cestrum* sp.). Additionally, vines, herbs, and shrubs were present. Three vines were identified: *Jasminum marianum*, balsam-apple (*Momordica charantia*), and *Passiflora suberosa*. Three herbs were identified: the fern *Polypodium punctatum*, *Eupatorium odoratum*, and false verbena (*Sida* sp.). One shrub, limeberry (*Tiphasia trifolia*), was identified.

  Game trails and scat are prevalent across the habitat indicating that feral deer (*Cervus mariannus*) and feral pigs (*Sus scrofa*) migrate across and live on the site. Several birds were observed transiting this habitat, including the black drongo (*Dicrurus macrocerus*) and the yellow bittern (*Ixobrychus sinensis*). Numerous spiders and insects were found, including beetles, flies, mosquitoes, grasshoppers, crickets, praying mantis, ants, wasps, bees, blue banded king crow butterflies, and black citrus swallowtail butterflies. Empty land snail shells were also observed. In addition, one reptile, the curious skink (*Carlia fusca*), and one amphibian, the marine toad (*Bufo marinus*), were identified at this site.

- Leucaena Forest – The leucaena forest habitat occupies the majority of Site 8 (Figure 3-7) on the quarry floor and quarry bench, where the soil layer is thin. The habitat is in a succession stage following quarry activity and covers approximately 77 percent of Site 8. The Leucaena Forest habitat comprises all of Landfill 10A and the majority of Landfill 10C. Cell No. F-600 was investigated as a representative sample cell for this habitat. A mixture of trees (3 to 10 feet tall) and vines (up to 3 feet tall) dominate the habitat. Additionally, grass, herbs, and shrubs were identified. The site is dominated by the tangantangan tree (*Leucaena leucocephala*), with lesser amounts of small trees, including the lipstick tree (*Ochrosia mariannensis*) and the inkberry (*Cestrum* sp.). One grass, small foxtail grass (*Pennisetum polystachion*), was identified. The dominant vine was *Momordica charantia*, and additional vines included leafless orange (*Cassytha filiformis*) and *Passiflora suberosa*. Four herbs were identified: beggar's tick (*Bidens pilosa*), chili pepper (*Capsicum frutescens*), *Eupatorium odoratum*, and false verbena (*Sida* sp.). Shrubs identified included Indian mulberry (*Morinda citrifolia*) and limeberry (*Tiphasia trifolia*).

  Game trails and scat were prevalent across the habitat, indicating that feral deer (*Cervus mariannus*), and feral pigs (*Sus scrofa*) migrate across and live on the site. Several birds were observed transiting this habitat including the black drongo (*Dicrurus macrocerus*), Eurasian tree sparrow (*Passer montanus*), and Philippine turtle-dove *(Streptopeia bitorquata)*. Spiders, land snail shells, coconut crab (*Birgus latro*), and numerous insects (including beetles, flies, mosquitoes, grasshoppers, crickets, praying mantis, ants, wasps, bees, the black citrus swallowtail butterfly, and the blue banded king crow butterfly) were found on site. Four reptiles identified include the brown tree snake (*Boiga irregularis*), the curious skink (*Carlia fusca*), the blue-tailed skink (*Emoia caeruleocauda*), and the monitor lizard (*Varanus indicus*). Shed skin was observed as evidence of the presence of the brown tree snake, and burrows for the monitor lizard were observed on site. One amphibian, the marine toad (*Bufo marinus*), was also observed.

- Second-Growth Limestone Forest – The limestone forest occurs only on Landfill 10C, and covers approximately 7 percent of the area. Much of the vegetation at the site was affected by Typhoon Paka in December 1997, and at the time of the site visit, the vegetation was stressed from drought conditions occurring on Guam. Dead trees/snags were observed, including large, dead Ifit trees and small *Pandanus* and tangantangan trees. Cell No. R-700 was investigated as a representative sample cell for this habitat (Figure 3-7). A mixture of trees (10 to 30 feet tall) and vines (up to 3 feet tall) dominate the habitat. Dominant trees included the Mapunyao tree (*Aglaia mariannensis*), banyan tree (*Ficus prolixa*), and false elder (*Premna obtusifolia*). Additional trees identified include papaya (*Carica papaya*), inkberry (*Cestrum* sp.), cycad (*Cycas circinalis*), paipai (*Guamia mariannae*), tangantangan (*Leucaena leucocephala*), lipstick tree (*Ochrosia mariannensis*), silvery Pipturus (*Pipturus argenteus*), and *Vitex parviflora*. The dominant vine was balsam-apple (*Momordica charantia*). Leafless orange (*Cassytha filiformis*), *Jasminum marianum*, and *Passiflora suberosa* were also identified. Three

herbs (beggar's tick, *Eupatorium odoratum*, and false verbena [*Sida* sp.]) and two shrubs (Indian mulberry and limeberry) were also identified.

Game trails were prevalent across the habitat, indicating that feral deer (*Cervus mariannus*) and pigs (*Sus scrofa*) migrate across and live on the site. Several birds were observed transiting this habitat, including the black drongo (*Dicrurus macrocerus*), Eurasian tree sparrow *(Passer montanus*), Philippine turtle-dove *(Streptopeia bitorquata)*, and white tern (*Gygis alba*). Four reptiles, the curious skink (*Carlia fusca*), the blue-tailed skink (*Emoia caeruleocauda*), the mutilated gecko (*Gehyra mutilata*), and the monitor lizard (*Varanus indicus*), were identified at this site, along with spiders and numerous insect species (including beetles, flies, mosquitoes, grasshoppers, ants, wasps, bees, termites, moths, and the blue banded king crow butterfly).

Based on the habitat and the potential sources of chemical stressors to this habitat, a CSM was developed (Figure 3-8). Incomplete exposure pathways were found for subsurface soil and groundwater to ecological receptors. Because there is no surface water, and the site is distant from the sea, no aquatic exposure is expected from chemical stressors. This leaves potentially complete exposure pathways only via surface soil and biota living within and on this soil. Exposure pathways and routes include:

- Direct Contact with Surface Soil—This exposure route is important for uptake of COCs by plants and for soil invertebrates. Most vertebrates, when foraging, may have the potential to be exposed to COCs via dermal contact. However, the dermal exposure pathway is not believed to be important for birds, mammals, or reptiles because of the lack of contact with exposed soils. Many factors limit direct contact with exposed soils, including the extensive ground cover by vegetation, the arboreal nature of most native species, and the protection from dermal contact by scales, feathers, or hair (USEPA, 2000b). Any incidental surface contamination of scales, feathers, or hair that is subsequently ingested during grooming is accounted for in the incidental soil ingestion pathway.
- Ingestion of Food (i.e., plants and biota that have taken up constituents from soil)—Terrestrial herbivores and predators that forage in the terrestrial habitats may ingest plants or animal prey that have bioaccumulated COCs from surface soils.
- Incidental Ingestion of Surface Soils—Herbivores and predators that forage in the terrestrial habitats may incidentally ingest some surface soil with their food or during other activities, such as grooming.

On the basis of this evaluation, complete exposure pathways to surface soil in ecological habitats are potentially impacted by releases of COCs. From this environmental medium, some COCs could bioconcentrate in plants and prey animals that may be eaten by other consumers.

The selection of assessment endpoints must be based on fundamental knowledge of the local ecology. Assessment endpoints typically relate to an effect on a population or community. Survival of the yellow bittern is an example of a population level assessment endpoint.

Community level assessment endpoints could include the primary productivity of the limestone forest habitat. Examples of endpoints representing guilds of species are useful in that they convey information beyond the indicator species identified in the endpoint itself. An assessment endpoint involving a community index may provide more information about a site than an analysis of one species. Consequently, it is important to note that confirmation of the deleterious effects at the community level is an inherent confirmation that population level effects are occurring (Hartwell, 1997).

Based on the ecological survey at Site 8 the following ecological receptors were considered for the ERA:

- Soil-invertebrate communities (i.e., earthworm) and terrestrial plant communities
- Native terrestrial birds, represented by the Mariana crow, Micronesian starling, and yellow bittern.

For the purposes of this ERA, it is assumed that no future actions are expected at Site 8 that would change the potential use of the area by ecological receptors. The ERA methodology involves a four-step process: (1) identification of potential COCs, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization.

3.7.2.1 Identification of COPCs for ERA at Site 8

To identify COPCs for the ERA at Site 8, the maximum detected concentration for each chemical in surface soil was compared to the higher of (1) conservative toxicologically based screening criteria or (2) BTVs for the Base for inorganic constituents (ICF, 1997; Andersen AFB, 2001b). A contaminant was excluded as a COPC if the maximum detected concentration at Site 8 was lower than the screening value, or the contaminant was an essential nutrient. The results of COPC screening for Landfills 10A, 10B, and 10C are shown in Tables 3-6A through 3-6C, respectively.

3.7.2.2 Exposure Assessment for ERA at Site 8

Exposure refers to the degree of contact between ecological receptors at a site and the COPCs. Based on the CSM, it is assumed that ecological receptors at Site 8 are exposed to COPCs in surface soil either through direct contact, via dietary food web, or both.

The exposure concentrations were estimated statistically to present the most appropriate representative concentrations of COCs at Site 8. The distribution of data for each COPC was tested for normality or lognormality using the Shapiro-Wilk W-test (Shapiro and Wilk, 1965). If the data fit neither the normal nor lognormal distribution according to the Shapiro-Wilks test, a lognormal distribution was assumed consistent with USEPA guidance (USEPA, 1992). For data fitting a normal distribution, the arithmetic mean was considered to be the most appropriate representative concentration. If the data fit a lognormal distribution, or a lognormal distribution

was assumed because the data fit neither type of distribution, the lognormal mean of the constituent data was used as the representative concentration consistent with USEPA guidance.

The following assumptions are made for arriving at each COC exposure concentration:

- COPCs are assumed to be 100 percent bioavailable. That is, whether by direct contact or via food-web ingestion, all of the COCs are available for absorption and expression of toxic effects, which is highly unlikely considering the soil chemistry at the site.
- The area use factor for the Mariana crow, Micronesian starling, and yellow bittern receptors is assumed to be 1.0. This means that 100 percent of the Mariana crow, Micronesian starling, and yellow bittern food comes from Site 8.

3.7.2.3 Toxicity Assessment for ERA at Site 8

Toxicity assessment is based on studies that determine the lowest concentrations of contaminants that may cause adverse effects on ecological receptors. In this ERA, toxicity assessments were completed for soil-invertebrate communities (earthworm), plant communities, native terrestrial birds represented by the Mariana crow, Micronesian starling, and the yellow bittern relative to COPCs in surface soils at Site 8.

Earthworms

Many of the earthworm TRVs are from LOAEL chronic effects data based on laboratory studies of earthworms (ICF, 1998). In the absence of sufficient data, NOAEL data were used for chronic effects to derive earthworm TRVs.

Plants

Risks to plants, as with invertebrates, are expressed relative to concentrations observed in soil. Plant toxicity data were based on growth effects from Ecological Soil Screening Levels.

Native Terrestrial Birds

Food-web risks for avian species are expressed relative to a dose of chemical (mg/kg-bw/day) taken up by the organism from food and soil. USEPA (1997a) guidance specifies that a screening ecotoxicity value should be "equivalent to a documented or best conservatively estimated chronic NOAEL." Literature-reported wildlife NOAEL and LOAEL TRVs were used as TRVs for food-web risk calculations.

3.7.2.4 ERA Characterization for Site 8

The ERA was characterized based on calculation of a HQ or an EQ:

EQ = Representative Concentration / TRV
HQ = Representative Dose / TRV

If the Representative Soil Concentration is less than the TRV, then the HQ or EQ will be less than 1.0. In this circumstance, an adverse ecological risk is not expected for the exposed ecological receptors. If the representative soil concentration is greater than the TRV, then the HQ or EQ will be greater than 1.0, and adverse ecological risk is expected for the exposed ecological receptors.

3.7.2.4.1 ERA Results for Site 8

The ERA identified the following potential receptors at Site 8: the Mariana crow, the Micronesian starling, the yellow bittern, terrestrial plants, and terrestrial invertebrates (earthworms). Seven soil COPCs were identified for invertebrates and plants at Site 8: barium, cadmium, copper, lead, zinc, dieldrin, and total DDT. Seven soil COPCs were identified for avian species at Site 8: barium, cadmium, copper, lead, zinc, dieldrin, and total DDT. Table 3-7 shows assessment and measurement endpoints identified for the ecological receptors (plants, soil invertebrates, Mariana crow, Micronesian starling, and yellow bittern) in this ERA. These endpoints have been revisited in Table 3-8, along with the results of this Tier I ERA.

Acceptable risks were found for invertebrate ROCs (i.e., earthworms). The results of the earthworm assessment at Site 8 (Table 3-9) document that in the case of all COPCs, all Representative Soil Concentrations are lower than the TRVs. Thus, the EQs are all less than 1.0. Consequently, no risks to the earthworm are projected from COPCs at Landfills 10A, 10B, or 10C at Site 8.

Acceptable risks were found for vegetative ROCs (i.e., plants). The EQs for plants were calculated in the same manner as those for earthworms. TRVs for plants are the toxicological benchmarks for terrestrial plants provided by Oak Ridge National Laboratory (Efroymson et al., 1997). The EQ for lead in Landfill 10C exceeded 1.0 (Table 3-9); however, the exceedance of the TRV was less than a factor of 2. Risk is inferred from this concentration, but it is judged to be low.

Acceptable risks were found for avian ROCs (i.e., birds). Some COPCs resulted in a food-web NOAEL HQ greater then 1.0: lead in Landfills 10A and 10B, and lead and total DDT in Landfill 10C (Tables 3-10 through 3-12). However, in each case, the LOAEL HQ was less than 1.0. The calculations of risks between the NOAEL and LOAEL levels suggest slight risk to the Mariana crow and yellow bittern from lead and total DDT. No risk was calculated for the Micronesian starling from barium, cadmium, copper, lead, zinc, dieldrin, or total DDT.

In summary, based on a combination of qualitative assessment and quantitative risk characterization, five of the seven COPCs at Site 8 (barium, cadmium, copper, zinc, and dieldrin) were determined not to pose unacceptable risk to ecological receptors. Lead was determined to pose slight risk to one or more ecological receptors at all three landfills. Slight risks were calculated from total DDT to birds at Landfill 10C. Given the "negligible potential for risk" (USEPA, 1997b), no further ecological evaluation is required.

3.7.2.4.2 ERA Uncertainties for Site 8

Ecological risk characterization includes analysis of uncertainty (USEPA, 1997a). Uncertainty is distinguished from variability, and arises from lack of knowledge about factors associated with the study. Sources of uncertainty can include the process of selecting COPCs, assumptions made in establishing the CSM, adequacy of ecological characterization of the site, estimates of toxicity to receptors, and selection of model parameters. A number of factors contribute to uncertainty in the ecological risk characterization for Site 8, as described below.

Environmental media at known or suspected waste sites are typically sampled in a non-random fashion. That is, sampling points are chosen to best characterize known or suspected areas of contamination. Peripheral and nearby areas are undersampled, if at all, and thus the average exposure of ecological receptors is biased high. This is an example of sampling to characterize suspected areas of contamination, even though this area represents a small proportion of the entire Site 8, or any one of the landfills. Because there is little information available for the bird receptors, certain food-web model components are uncertain. For example, the assignment of feeding fractions for the bittern (100 percent of reptile) and the two percent incidental soil ingestion are based on best professional judgment, in the absence of species- and site-specific data. Similarly, the use of the available tissue concentration data for monitor lizard as a surrogate for the various food items eaten by the yellow bittern adds uncertainty. Toxicological data used in the risk characterization represents significant uncertainty. Because there are no known data on the effects of chemical contaminants on the Mariana crow, Micronesian starling, or yellow bittern, toxicological data for surrogate species were used, and this adds uncertainty. As mentioned above, the food-web-model assumptions of 100 percent bioavailability of COPC and total food-web exposure from each of the landfills (Area Use Factor = 1.0) represent significant uncertainty. Although the direction of bias of some uncertainties is unknown, the influence of the non-random media sampling and assumptions of 100 percent bioavailability and site exposure assures that, if anything, risk is overestimated rather than underestimated.

3.7.3 Basis for Action Statement

Based on the identified unacceptable human health risks under the future resident adult/child and occasional users/trespassers scenarios associated with surface and subsurface soil (Sections 3.7.1.4.1 and 3.7.1.4.2), the response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

3.8 REMEDIAL ACTION OBJECTIVES

RAOs are medium-specific and/or site-specific remediation goals for protecting human health and the environment. Based on the ERA (Section 3.7.2), no unacceptable risks to the environment were identified; therefore, no RAOs are required for the protection of ecological receptors. Based on the HHRA (Section 3.7.1), no unacceptable human health risks were identified at Landfills 10A or 10B; however, unacceptable human health risks were identified at Landfill 10C for future residents exposed to surface and subsurface soil and for occasional users/trespassers exposed to subsurface soil. During the EE/CA (EA, 2000b), the USAF established RAOs to reduce the exposure pathways for occasional users/trespassers to site COCs via incidental soil ingestion, dermal exposure, and inhalation of dust particulates from surface soil and subsurface soil that may become surface soil due to slope instability. In the EE/CA Amendment (EA, 2002b), the USAF revised the RAOs based upon a revised understanding of the potential human health risk concerns at Site 8 (the USAF determined that the remediation alternative for Site 8 needed to address the soil ingestion and dermal contact pathways and not the inhalation pathway). The USAF selected the *Institutional Controls* alternative in the EE/CA Amendment in order to control exposure to potential receptors by restricting access to the site by occasional users/trespassers. In 2004, the USAF installed a fence as an interim action at Site 8 (Shaw, 2004). Given the completed interim action at the site (i.e., site fence), the following new RAOs were developed for the Site 8 FS (EA, 2007):

- Prevent incidental ingestion and dermal exposure by future residents to surface soil with lead concentrations in excess of 400 mg/kg and dieldin concentrations in excess of 2.8 mg/kg.
- Prevent incidental ingestion and dermal exposure by future residents to subsurface soil with lead concentrations in excess of 400 mg/kg, antimony concentrations in excess of 63 mg/kg, and dieldrin concentrations in excess of 0.7 mg/kg.
- Prevent incidental ingestion and dermal exposure by occasional users/trespassers to subsurface soil with dieldrin concentrations in excess of 7.5 mg/kg.

With the completion of the interim action (Section 3.1), this ROD addresses the remaining actions necessary for the management of residual waste materials, the mitigation of identified risks, and compliance with ARARs, in accordance with the RAOs for Site 8.

Risk-based RGs were developed for COCs at Site 8 that are protective of human health for specific exposure scenarios established for the site. No unacceptable risks were identified at Landfills 10A and 10B; therefore, no RGs were developed for Landfill 10A or 10B. Unacceptable risks were identified for Landfill 10C; therefore, RGs for Landfill 10C were calculated by deriving the COC concentration in a given medium that corresponds to a cumulative HQ for a specific target organ of 1.0, and a cumulative cancer risk equal to a risk level of 10^{-6}, 10^{-5}, and 10^{-4}. RGs have been established for Site 8 Landfill 10C surface and subsurface soil based on the HHRA results, as follows:

- For future residents, a dieldrin RG of 2.8 mg/kg and 0.7 mg/kg was established in surface and subsurface soils, respectively, based on the non-cancer RG. For occasional users/trespassers, a dieldrin RG of 7.5 mg/kg was established for subsurface soil based on the cancer RG.
- For future residents, a lead RG of 400 mg/kg was established in surface and subsurface soils based on the USEPA Region 9 residential PRG.
- For future residents, an antimony RG of 63 mg/kg was established in subsurface soil based on the BTV.

SUMMARY OF RISK-BASED REMEDIAL GOALS FOR SURFACE AND SUBSURFACE SOIL AT SITE 8, LANDFILL 10C, FOR RESIDENT ADULTS AND CHILDREN

COC	RME EPC (mg/kg)	Calculated Risk for all Pathways	RG for HI = 1.0 (mg/kg)	RG for 10^{-6} (mg/kg)	RG for 10^{-5} (mg/kg)	RG for 10^{-4} (mg/kg)	2004 Residential PRG (mg/kg)	BTV (mg/kg)	Maximum Value (mg/kg)
Surface Soil									
Non-Cancer Risks									
Dieldrin	5.6	2.0	**2.8**[(b)]	NA			0.03	NA	5.6
Lead	610[(a)]	---	NA				**400**[(c)]	166	14,200
Cancer Risks – No unacceptable risks identified; no RGs developed									
Subsurface Soil									
Non-Cancer Risks									
Antimony	46	1.5	30.7	NA			31	**63**[(d)]	78.5
Dieldrin	420	160	2.6				0.03	NA	420
Lead	490	---	NA				**400**[(c)]	166	2,380
Cancer Risks									
Dieldrin	420	5.90E-03	NA	0.07	**0.7**[(b)]	7.0	0.03	NA	420

(a) The central tendency EPC value was used to calculate risks in the Human Health Risk Assessment.
(b) RG exceeds the USEPA Region 9 PRG; therefore, the RG is used as the cleanup goal.
(c) RG is based on OSWER Directive/IEUBK Model.
(d) BTV exceeds the RG; therefore, the BTV is used as the cleanup goal.

HI = Hazard Index
RG = Remedial Goal
BTV = Background Threshold Value
RME = Reasonable Maximum Exposure
PRG = Preliminary Remediation Goal
EPC = Exposure Point Concentration
COC = Contaminant of Concern
NA = Not Applicable

SUMMARY OF RISK-BASED REMEDIAL GOALS FOR SUBSURFACE SOILS AT SITE 8, LANDFILL 10C, FOR OCCASIONAL USERS/TRESSPASSERS

COC	RME EPC (mg/kg)	Calculated Risk for all Pathways	RG for HI=1.0 (mg/kg)	RG for 10^{-6} (mg/kg)	RG for 10^{-5} (mg/kg)	RG for 10^{-4} (mg/kg)	2004 Industrial PRG (mg/kg)	BTV (mg/kg)	Maximum Value (mg/kg)
Non-Cancer Risks									
Dieldrin	420	1.6	262	NA			0.11	NA	420
Cancer Risks									
Dieldrin	420	5.60E-04	NA	0.75	**7.5**[(a)]	75	0.11	NA	420

(a) RG exceeds the USEPA Region 9 PRG; therefore, the RG is used as the cleanup goal

HI = Hazard Index
RG = Remedial Goal
BTV = Background Threshold Value
RME = Reasonable Maximum Exposure
PRG = Preliminary Remediation Goal
EPC = Exposure Point Concentration
COC = Contaminant of Concern
NA = Not Applicable

The RGs were used to estimate the area and volume of COCs to be addressed by the remedial alternative. The selected RGs, presented in the above table and in Table 3-13, represent COC concentrations below which there are no unacceptable risks to either human health or the environment.

3.9 DESCRIPTION OF ALTERNATIVES

Using USEPA guidelines for screening remediation technologies (40 CFR 300.430[e][7]), numerous remedial technologies for soil were considered for use at Site 8 (EA, 2007). Many of these were eliminated from further consideration because they were not feasible for the physical and chemical properties of the Site 8 COCs and/or the unique environmental setting. The remaining remedial technologies that were potentially feasible for the mitigation of Site 8 risks were screened according to their effectiveness, implementability, and, to a lesser extent, cost. Remedial technologies retained from the screening process were grouped into remedial alternatives that were further screened based on their effectiveness, implementability, and cost. Based on the remedial technology and alternative screenings, the following three remedial alternatives were retained for detailed analysis:

- No Further Action
- Institutional Controls and Engineering Controls
- Slope Stabilization with Soil Cover

Each of these remedial alternatives is summarized below. A more complete, detailed presentation of each alternative is presented in Chapter 3 of the FS (EA, 2007). A summary of the comparative analysis of these alternatives and a further description of the Selected Remedy for Site 8 are presented in Sections 3.10 and 3.12, respectively, of this ROD.

3.9.1 *No Further Action* Alternative

Pursuant to Section 300.430(e)(6) of the revised NCP, a "No Further Action" alternative is required to provide a baseline against which the other remedial alternatives are to be compared. Because the USAF has already implemented engineering controls (fencing) as part of an interim action (Section 3.1), this alternative becomes "No Further Action" for Site 8. The *No Further Action* alternative represents a true no action scenario, as no further institutional controls, engineering controls, or active treatment of the site soil/wastes would be performed. The remaining wastes and hazardous substance-impacted soil would remain on site in its current condition with no further protections or reviews to be implemented.

There are no costs associated with the *No Further Action* alternative.

3.9.2 *Institutional Controls and Engineering Controls* Alternative

The USAF already has completed an interim action to limit unauthorized access to the site. The interim action consisted of installing a 6-foot-high chain-link fence on the northwest side of Landfill 10A (quarry) and near the northeast boundary of adjacent Site 33, plus the installation of an additional gate across the access road to the Landfill 10C portion of Site 8, near the northwest end of the adjacent Site 33 (Section 3.1). Under the *Institutional Controls and Engineering Controls* alternative, the hazardous substance-impacted soil will remain at the site, but the exposure to the impacted areas will be controlled by limiting access by way of maintaining the site fencing and through administrative controls to prevent exposure to site hazardous substances (i.e., prevent direct contact and incidental ingestion of soil hazardous substances by hypothetical future residents and occasional users/trespassers at the site). The fence will be a part of the permanent remedy at the site. The *Institutional Controls and Engineering Controls* alternative will include the following additional components to achieve the new RAOs for Site 8:

- LUCs – The USAF will enact LUCs through amendments to the BGP (Andersen AFB, 2005) to ensure the continued protection of human health and the environment. The full scope of the LUCs will be presented in a LUCMP, which is currently being developed by the USAF in coordination with the USEPA and Guam EPA. The LUCs will be applied to Landfill 10C only. Conceptually, the LUCs will include: (1) a prohibition on redevelopment or reuse of Landfill 10C (Landfills 10A and 10B are suitable for unrestricted use), (2) engineering control requirements for continued inspection and maintenance of the site fence and the posting of signs; and (3) limitations and controls on any future excavation activities at the site (e.g., worker requirements, soil management, waste disposal). The LUCMP will include additional provisions such as (1) requirements for periodic (e.g., annual) inspections of the site conditions and use to ensure compliance with the LUCs; (2) periodic (e.g., annual) LUC Compliance Summary Reports to be provided to the USEPA and Guam EPA for informational updates; (3) protocols for LUC modification or termination; and (4) protocols for notification and correction of any LUC non-compliance events. The LUCs will remain in effect for as long as the site conditions are not suitable for unrestricted use and unlimited exposure. The USAF is responsible for implementing, maintaining, reporting on, and enforcing LUCs established in

approved decision documents for IRP sites within Andersen AFB. A detailed discussion of the actions the USAF will be required to perform to ensure proper implementation of LUCs at Site 8 is provided in Table A-2 (Appendix A).

Five-Year Reviews – Following successful implementation of the above actions, the site (Landfill 10C) will be suitable for continued use by the USAF as open space, but will not be suitable for unrestricted use and unlimited exposure due to the remaining hazardous substances on site. Therefore, the USAF, in conjunction with the USEPA and Guam EPA, will conduct 5-year reviews to ensure that the *Institutional Controls and Engineering Controls* alternative remains effective in the future for the continued protection of human health and the environment. The reviews will focus on the site conditions, the current and planned future site use, relevant data from any USAF monitoring programs, engineering controls maintenance records, and the LUC Compliance Summary Reports. The USAF will continue to conduct 5-year reviews for as long as hazardous substances remain at the site above levels that allow for unlimited use and unrestricted exposure.

Following implementation of the *Institutional Controls and Engineering Controls* alternative, the site will be rendered suitable for continued use by Andersen AFB. The *Institutional Controls and Engineering Controls* alternative will control exposures to resident children and adults by prohibiting development of the land for residential use.

The total net present worth costs associated with implementing the *Institutional Controls and Engineering Controls* alternative, for an assumed 30-year period of performance, are estimated at $239,000 (Table 3-14).

3.9.3 *Slope Stabilization with Soil Cover* Alternative

This alternative was initially developed during the EE/CA (EA, 2000b). The *Slope Stabilization and Soil Cover* alternative consists of grading the fill slope into the former quarry to decrease the grade and placing a 1-foot-thick soil cover (i.e., cap) over the fill material to minimize exposure. The soil cover would be seeded to prevent soil erosion. The soil cover design is conceptual at this stage, but would be designed to meet RCRA and Guam EPA requirements regarding landfill closures. Site controls, including installing a fence around the perimeter of the fill area above the quarry cliffline and at the access road into the quarry, and modification of the BGP would be established to control future excavation of the fill material. The *Slope Stabilization and Soil Cover* alternative consists of the following components:

- Slope Grading – Prior to grading the slope, the quarry floor would be cleared to allow space to redistribute the slope fill. Slope fill with hazardous substance concentrations exceeding the RGs would be graded to decrease the slope and reduce the potential for a soil slump or slide. Utilizing the available sample data, an excavation plan would be developed for earth moving and to spread the slope fill out onto the former quarry floor. The slope fill would be graded until the quarry wall is exposed. The slope fill would be moved to the quarry floor. The fill area at the top of the cliffline would be excavated and graded to prevent soil erosion at the top of the cliffline. The soil excavated at the top of the cliffline would be

moved to the quarry floor. The fill moved to the quarry floor would be graded to a slope no greater than 3:1. Partially filled asphalt drums would be separated from the fill and disposed of at the Base Landfill. Approximately 12,800 cubic yards of the hazardous substance-impacted subsurface soil would be moved from the slope and to the quarry floor.

- Soil Cover and Seeding – The soil would be graded to 3 feet thick and would cover approximately 115,200 square feet. A 1-foot-thick clean soil cover would be placed on top of the graded fill. The cover would be installed to minimize the exposure pathways (inhalation, dermal contact, and incidental ingestion) of fill containing hazardous substances above RGs. Clean fill material would be brought in as soil cover from off site. The soil cover design is conceptual at this stage, but would be designed to meet RCRA and Guam EPA requirements regarding landfill closures. After the soil cover has been placed over the fill, it would be seeded to prevent soil erosion. The soil would be seeded only once and would be allowed to grow back to the natural habitat. Currently, the habitat in the quarry is a tangantangan forest. The cover material would be analyzed for pesticides and PAHs to ensure that the cover material does not exceed the RGs for occasional users/trespassers.
- Site Control – A 6-foot-tall chain-link fence and warning signs would be installed on the perimeter of the fill area at the top of the quarry cliffline and at the entrance to the quarry access road. The BGP would be revised to ensure that subsurface excavation at the site would be limited and controlled by the USAF. If the property is transferred, the USAF would contact the General Services Administration to obtain permission for a deed restriction to place legal constraints on the future land use.
- Periodic Site Review – Following successful implementation of the above actions, the site would be suitable for continued use by the USAF as open space, but would not be suitable for unrestricted use and unlimited exposure due to the remaining hazardous substances on site. Therefore, the USAF, in conjunction with the USEPA and Guam EPA, would conduct 5-year reviews to ensure that the alternative remains effective in the future for the continued protection of human health and the environment. The reviews would focus on the site conditions, the current and planned future site use, relevant data from any USAF monitoring programs, engineering controls maintenance records, and the LUC Compliance Summary Reports. The USAF would continue to conduct 5-year reviews for as long as hazardous substances remain at the site above levels that allow for unlimited use and unrestricted exposure.

The total net present worth costs associated with implementing the *Slope Stabilization and Soil Cover* alternative, for an assumed 30-year period of performance, are estimated at $836,000 (Table 3-15).

3.10 COMPARATIVE ANALYSIS OF ALTERNATIVES

Evaluation criteria for comparison of cleanup alternatives are based on CERCLA statutory requirements, earlier program initiatives promulgated in the 20 November 1985 NCP, and

site-specific experience gained in the Superfund program. A total of nine criteria were developed for comparing the merits of each cleanup alternative:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Short-Term Effectiveness
- Long-Term Effectiveness
- Reduction of Toxicity, Mobility, or Volume Through Treatment
- Implementability
- Cost
- Territory (Guam) Acceptance
- Community Acceptance

The first two criteria are threshold factors that must be met by each alternative. The next five criteria are the primary balancing factors upon which the comparison of remedial alternatives is based. The last two criteria are modifying factors and are applied to ensure that the final cleanup alternative would meet public acceptance.

The nine criteria are presented in the following sections and a comparison of the alternatives is made in decreasing order from the most to least advantageous alternative.

3.10.1 Overall Protection of Human Health and the Environment

This threshold criterion provides an overall assessment of human health and environmental protection based on how specific site remedial alternatives would achieve protection over time, how site risks associated with each COC would be reduced, and how each COC source would be eliminated, reduced, or controlled.

Based upon the results of an ERA conducted as part of the Site 8 EE/CA (EA, 2000b), there are no unacceptable ecological risks at Site 8. Therefore, each of the alternatives would be equally protective of ecological ROCs.

The *Institutional Controls and Engineering Controls* alternative will be protective of human health by mitigating the exposure pathways of concern (i.e., dermal contact and incidental ingestion of hazardous substances in site soil by occasional users/trespassers). Part of the risk concern is associated with slope failure along the quarry wall where subsurface hazardous substances could be brought to the surface. The *Institutional Controls and Engineering Controls* alternative will address the identified residential risk by prohibiting residential development of the site. The alternative will address the identified risk for occasional users/trespassers by reducing the chance of exposure (e.g., soil excavation restrictions) and the exposure time (average daily dose) from the identified exposure pathways. This alternative will be protective

of human health, even if a slope failure does occur. The USAF installed a 6-foot-high chain-link fence along the boundary between the site and the Lower Civil Engineering Laydown Yard in January and February 2004 in order to limit access to the site (Shaw, 2004). Under the *Institutional Controls and Engineering Controls* alternative, the USAF will continue to maintain the site fencing as a part of the permanent remedy and will implement additional LUCs to prevent exposure to site hazardous substances and to ensure the proper use and maintenance of the site into the future.

The *Slope Stabilization and Soil Cover* alternative would adequately meet the criteria for overall protection of human health and the environment from unacceptable risks to occasional users/trespassers posed by COCs for both the short-term and long-term. By grading the fill slope and covering the fill, the exposure pathways identified in the risk assessment (direct dermal contact, incidental ingestion of soil, and inhalation of soil particulates) are controlled for human and ecological receptors. This alternative, however, is not protective of future residential receptors and LUCs would have to be implemented to prevent residential development.

The *No Further Action* alternative would not be protective of human health because it includes no provisions to address future site use/exposure or to ensure the site fencing remains sufficient/effective. Similarly, the *No Further Action* alternative includes no provisions to prevent residential development of Site 8. Therefore, the *No Further Action* alternative would not be protective of human health.

3.10.2 Compliance with ARARs

This threshold criterion evaluates a remedial alternative's compliance with the federal and territorial (Guam) ARARs as defined in CERCLA Section 121. The applicable ARARs are those legally enforceable federal and territorial (Guam) requirements that specifically address hazardous substances, pollutants, removal actions, locations, or other circumstances found at the impacted areas. The ARARs and TBC documents for the site are presented in Tables 3-16, 3-17, and 3-18.

The *Institutional Controls and Engineering Controls* alternative meets each of its respective ARARs in conjunction with the interim action already completed by the USAF.

The *Slope Stabilization and Soil Cover* alternative meets each of its respective ARARs in conjunction with the interim action already completed by the USAF.

No ARARs were identified for the *No Further Action* alternative because no remedial actions are specified.

3.10.3 Short-Term Effectiveness

This balancing criterion addresses the impact of the remedial action during the construction and start-up phase, as well as the effectiveness for achieving RAOs. Factors evaluated include protection of workers during the remedial actions, environmental impacts resulting from the

implementation of the remedial action, and the time required to implement the proposed remedial alternative at the site.

The *Institutional Controls and Engineering Controls* alternative can be quickly implemented (e.g., within 1 year) and will be effective for achieving RAOs in the short term. Although the alternative does not treat the site hazardous substances, the LUCs implemented under this alternative will mitigate the unacceptable exposure pathways and identified risk concerns that are associated with future land use and the hazardous substances that remain at Site 8. Implementation of the *Institutional Controls and Engineering Controls* alternative will not present new risks to site workers or the community.

The *Slope Stabilization and Soil Cover* alternative may expose remediation workers to COCs during the remedial action (e.g., incidental inhalation of soil particulates). Although the short-term exposure period would not likely exceed acceptable CERCLA risk levels, engineering controls such as dust suppression would be implemented if weather conditions are such that the soil is dry and dust is prevalent. Workers at the site would wear dust particulate masks and standard work clothing and gloves to prevent dermal contact and incidental ingestion of soil. Barriers would be established to prevent potential future residents from contacting soil. In addition, standard practices such as washing hands and face and no eating or smoking at the site will minimize the risk of incidental ingestion of soil.

The *No Further Action* alternative would not be effective in the short-term because RAOs would not be achieved, although no new risks or environmental impacts would result from implementation of this alternative. The *No Further Action* alternative would does not achieve the RAOs because there would be no steps taken to ensure that current or future receptors do not come into contact with the residual COCs and landfill wastes.

3.10.4 Long-Term Effectiveness

This balancing criterion addresses the effectiveness of each remedial alternative over the life of the remedial action. It also assesses the results of the remedial action in terms of the risk remaining after the response objectives have been met. Particularly, the effectiveness of the controls is applied to manage the risk posed by the residual COCs in the impacted areas at the site (i.e., the risk to future residents).

The *Institutional Controls and Engineering Controls* alternative will be effective in the long-term for mitigating the identified unacceptable risks under the future resident and occasional user/trespasser scenarios at Site 8. Currently, Site 8 is inactive as there are no ongoing operations and no new disposal activities. Although this alternative does not reduce the volume or treat the hazardous substances at the site, the associated site risks will be addressed through administrative and engineering controls to mitigate the potential exposure pathway. The USAF already has constructed site fencing to deter unauthorized access to Landfill 10C. The fence will be a part of the permanent remedy at the site. LUCs to be implemented include a modification to the BGP to prohibit residential or other non-industrial use of the site. The LUCs will also require the continued maintenance of site fencing and that any intrusive work at the site must first be

approved by the USAF. To ensure the continued protection in the future, the LUCs will require that if the DoD decides the property is excess land, the USAF will implement deed restrictions (or similar) prior to property transfer in order to continue the necessary protections for human health. The LUCs will be a permanent amendment to the BGP and these provisions will be changeable only if approved by the USEPA and Guam EPA. Along with the periodic LUC compliance inspections, the USAF will conduct 5-year reviews to verify that the physical and administrative waste containment/control measures remain effective and permanent to protect human health over time.

The *Slope Stability and Soil Cover* alternative would address slope stability and exposure pathways. Currently, the fill material on top of the cliffline is covered and does not pose a CERCLA risk to occasional users/trespassers. The slope fill material also at this time does not pose a risk unless the slope fails. Fractures in the slope fill indicate that the slope is not stable and may fail during a future heavy rain event, typhoon, or earthquake. By grading the slope fill into the quarry and covering the fill material, the risk of exposure is reduced. This alternative does not reduce the volume or treat the hazardous substances at the site. Therefore, there are residual risks from untreated waste. As long as the hazardous substances remain in the subsurface soil there is no complete exposure pathway. The hazardous substances are not very mobile and are unlikely to migrate from subsurface soil to groundwater due to depth to groundwater. Soil erosion would be controlled by the stabilization and soil cover actions. Maintenance of the site fencing and LUCs would further mitigate human health risks in the long-term.

The *No Further Action* alternative would not be effective in the long-term because the identified unacceptable risks associated with the remaining COCs in soil would persist at the site. The completed interim action at the site (fencing) partially mitigated the identified human health risk by reducing the potential for site access. However, COCs would remain such that the site is not suitable for unrestricted exposure and unlimited use. Since no additional controls would be put in place, the *No Action* alternative would not be effective in the long-term for ensuring the continued protection of human health from the COCs remaining on site.

3.10.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

This balancing criterion assesses how each alternative would reduce the principal threats of the total mass of COCs, to provide irreversible reduction in COC mobility, and/or to reduce the total volume of impacted media. Factors of this criterion that are evaluated include the treatment process, the amount of COCs destroyed or treated, the degree of reduction in toxicity, mobility, or volume expected, and the type and quantity of untreated COC residuals.

The *Slope Stabilization and Soil Cover* alternative does not reduce the toxicity or volume of COCs through treatment, although the mobility of COCs would be reduced through slope stabilization/soil cover actions.

The *Institutional Controls and Engineering Controls* alternative will not reduce the toxicity, mobility, or volume of waste through treatment. However, the interim action (fencing) and the

proposed LUCs will mitigate the risks associated with the COCs by preventing a complete exposure pathway.

The *No Further Action* alternative does not reduce the toxicity, mobility, or volume of the COCs present in soil.

3.10.6 Implementability

This balancing criterion assesses the technical and administrative feasibility of implementing a remedial action and the availability of various services and materials required during implementation. Factors of technical feasibility include construction and operational difficulties, reliability of technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

The *Institutional Controls and Engineering Controls* alternative will be readily implementable as the LUCs will be implemented via modifications to the existing BGP and because the required equipment and services to maintain the LUCs and to conduct 5-year reviews are readily available. Any future work conducted at the site that may disturb site soil will require a work clearance permit that must be approved by the USAF. Water quality data collected from the LTGM Program will be reviewed as part of the 5-year review. Institutional controls and engineering controls are proven and accepted remedial options under the appropriate site conditions, such as those for Site 8 where the site risks do not warrant remediation and can be addressed effectively through administrative actions and maintenance of the existing site fence.

The *Slope Stabilization and Soil Cover* alternative uses technologies that are common practices proven to be implementable and effective at many sites. The difficulty at Site 8 would be with bringing down the slope fill and retaining the rock quarry wall behind the fill in a safe manner. The slope fill is very steep and proper engineering measures will be required to safely grade the slope. The soil excavation technology requires clean backfill. Excavation, transport, and seeding equipment are readily available on the island. The volume of soil to be moved directly affects the volume of clean backfill required to cover the moved soil. The volume of soil to be moved is an estimate; the exact volume is unknown. Moving the soil and covering the material is expected to more than 30 days. Prior to using the material as backfill and cover, composite soil samples would be collected from the soil stockpiles and analyzed for metals, PAHs, and pesticides.

The *No Further Action* alternative is not implementable because the RAOs would not be achieved and because the alternative does not meet the threshold evaluation criteria.

3.10.7 Territory (Guam) Acceptance

This modifying criterion accounts for the technical and administrative issues concerning the Territory of Guam regarding each of the remedial alternatives. This factor includes the remedial actions that the territory would support, oppose, or would be concerned about. The Territorial Acceptance was evaluated based on comments received from the Guam EPA's representatives during RPM Meetings regarding IRP sites at Andersen AFB.

The *Institutional Controls and Engineering Controls* alternative is acceptable by the Territory (Guam) because the identified risks to human health will be properly mitigated in accordance with CERCLA requirements.

The *Slope Stabilization and Soil Cover* alternative would be acceptable by the Territory (Guam) because the identified risks to human health would be properly mitigated in accordance with CERCLA requirements.

The *No Further Action* alternative would not be acceptable to the Territory (Guam) because the identified unacceptable risks to human health would not be mitigated.

3.10.8 Community Acceptance

This modifying criterion accounts for the issues and concerns the property owner and the public may have regarding each of the remedial actions. The factors included the remedial actions that the property owner or the community would support, oppose, or would be concerned about. Community Acceptance was evaluated based on comments received at the Public Meeting to present the Proposed Plan for Sites 5 and 8 held on 2 August 2007. Also the public was asked for written comments during the Public Comment Period from 26 July 2007 to 26 August 2007. Specific public comments and responses by Andersen AFB are summarized in Chapter 4.

The *Institutional Controls and Engineering Controls* alternative is acceptable to the community given that Site 8 will be appropriately managed and contained on USAF property and the identified risks will be mitigated in accordance with CERCLA.

The *Slope Stabilization and Soil Cover* alternative would be acceptable to the community given that Site 8 would be appropriately managed and contained on USAF property and the identified risks would be mitigated in accordance with CERCLA.

The *No Further Action* alternative would not be acceptable to the community because the identified unacceptable risks to human health would not be mitigated.

3.10.9 Cost

This balancing criterion assesses the projected cost for the final list of alternatives at the conclusion of the cleanup alternatives screening process. Present worth analysis allows remedial actions to be compared on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life. When applicable, a required operating performance period of 30 years will be used in calculating the present worth of the remedial alternatives. The remedial costs included capital costs and annual O&M costs. Capital costs consist of both direct and indirect costs. Direct costs include expenditures for the equipment, labor, and materials necessary to install removal actions. Indirect costs include expenditures for engineering, financial, and other services required when installing a remedial alternative at a site. Annual

O&M costs include auxiliary monitoring, materials, and energy required to install remedial actions, disposal of residue, purchased services, administrative costs, insurance, taxes, license costs, maintenance reserve and contingency funds, rehabilitation costs, and costs for periodic site reviews.

Cost estimates are based upon a preliminary review of the anticipated requirements for each remedial alternative. The cost estimates are based upon approximate design specifications, costs incurred from similar operations, and vendor quotes, where possible. In some cases, assumptions were required for unknown elements. In accordance with USEPA CERCLA FS guidance (USEPA, 1988, 2000c), the preliminary cost estimates are anticipated to be between +50 and -30 percent of the actual costs for completing the remedial actions. Therefore, the costs portrayed are to be used as an order of magnitude comparison. More accurate cost estimates would be developed during the Remedial Design phase subsequent to the ROD.

There are no costs associated with the *No Further Action* alternative.

The total net present worth costs associated with implementing the *Institutional Controls and Engineering Controls* alternative, for an assumed 30-year period of performance, are estimated at $239,000 (Table 3-14).

The total net present worth costs associated with implementing the *Slope Stabilization and Soil Cover* alternative, for an assumed 30-year period of performance, are estimated at $836,000 (Table 3-15). The total costs for this project are largely related to the volume of soil to be moved. The estimated fill on the unstable slope is a calculated volume based on comparing the bedrock wall gradient where it crops out to the slope gradient where fill was observed. The actual cost will likely differ, as the exact volume of soil is unknown. This cost does not include the removal of large, inert surface debris.

3.11 PRINCIPAL THREAT POSED BY WASTE

According to USEPA guidelines, treatment alternatives must be used to address the principal threats posed by any site whenever practicable. In general, the term “principal threat wastes” includes:

- Liquid source material, such as waste contained in drums, lagoons or tanks, and free product in the subsurface containing hazardous substances;
- Mobile source material, such as surface or subsurface soil containing high concentrations of hazardous substances that are mobile due to wind entrainment, volatilization, surface runoff, or subsurface transport; and
- Highly toxic source materials, such as buried drums containing non-liquid wastes, buried tanks containing non-liquid wastes, or soils containing significant concentrations of highly toxic materials (USEPA, 1999a).

Wastes that are generally considered as "non-principal threats" include:

- Non-mobile contaminated source material of low to moderate toxicity, such as surface soil containing COCs that generally are relatively immobile in air and groundwater in the specific environmental setting; and
- Low toxicity source materials, such as surface and subsurface soil with concentrations of COCs not greatly above reference dose levels or that present an excess cancer risk near the acceptable risk level (USEPA, 1999a).

The hazardous substance-impacted surface and subsurface soils at Site 8 are a non-principal threat because:

- The major hazardous substances are metals that are relatively immobile in the alkaline conditions of the limestone formations at Site 8; and
- The site is not currently, and is not planned to be, a residential area.

There are no plans to develop this site for residential use in the future. However, as a conservative assumption and to serve as a baseline, risks to potential future residents were evaluated for Site 8. Under current use conditions at Site 8, the only potential current receptors are occasional users/trespassers. The results of the HHRA indicate that there are unacceptable risks to future residential receptors (adults and children) and to occasional users/trespassers at Landfill 10C. No unacceptable ecological risks were identified. As such, the *Institutional Controls and Engineering Controls* alternative was selected.

3.12 SELECTED REMEDY

The USAF and USEPA Region 9 co-selected the *Institutional Controls and Engineering Controls* alternative in conjunction with concurrence from the Guam EPA and affected property owners.

3.12.1 Summary of the Rationale for the Selected Remedy

The primary rationale for selecting *Institutional Controls and Engineering Controls* as a remedial alternative for Site 8 is that the USAF, USEPA Region 9, and Guam EPA have agreed that the *Institutional Controls and Engineering Controls* alternative would control exposures to resident children and adults by prohibiting development of the land for residential use. There are no plans to develop this site for residential use in the future.

As presented in Section 3.10 of this ROD, the *Institutional Controls and Engineering Controls* alternative has advantages over the *Slope Stabilization and Soil Cover* alternative and the *No Further Action* alternative. The *Institutional Controls and Engineering Controls* alternative:

- Will be protective of human health and the environment, but at a cost less than that estimated for the *Slope Stabilization and Soil Cover* alternative.

- Will meet RAOs, but at a cost less than that estimated for the *Slope Stabilization and Soil Cover* alternative.

3.12.2 Detailed Description of the Selected Remedy

A detailed description of the actions that will be required to ensure proper implementation of institutional controls (i.e., LUCs) at Site 8, in accordance with this ROD, is provided in Table A-2 (Appendix A). Table A-2 provides a summary of (1) site risks relevant to the selected remedy, (2) a description of the property, including current and anticipated future property ownership, land use, and restrictions, (3) a description of onsite structures, (4) a description of LUC objectives, (5) a list of applicable engineering and institutional controls and other specific measures that are required to implement LUCs consistent with the selected remedy, (6) monitoring and reporting requirements, and (7) specific corrective actions to address non-compliant LUC events. The components necessary for implementation of the *Institutional Controls and Engineering Controls* alternative are as follows:

- Phase 1—Site Preparation, mobilization, and surveying
- Phase 2—Development of LUCMP and implementation of LUCs
- Phase 3—Periodic reviews (LUCs inspections and 5-year reviews).

3.12.3 Summary of the Estimated Remedy Costs

A summary of the *Institutional Controls and Engineering Controls* alternative cost estimate is presented in Table 3-14. Implementation of the *Institutional Controls and Engineering Controls* alternative is estimated to cost approximately $239,000 (30-year present worth). This is an engineering cost estimate that is expected to be within +50 percent to –30 percent of the actual project cost. The cost information presented in Table 3-14 is based on the best available information regarding the anticipated scope of the remedial 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 remedial alternative. Major changes may be documented in the form of a memorandum in the AR, an ESD, or a ROD amendment.

3.12.4 Expected Outcome of the Selected Remedy

The expected outcome of the Selected Remedy is the continued use of the property by Andersen AFB as an undeveloped parcel. Under the *Institutional Controls and Engineering Controls* alternative, the BGP will be amended to prevent any residential development at the site. The fence will be a part of the permanent remedy at the site. Periodic reviews would be conducted to ensure the long-term protection of human health and the environment.

3.13 STATUTORY DETERMINATION

This section describes how the Selected Remedy satisfies the statutory requirements of CERCLA §121 and the regulatory requirements of the NCP.

The Selected Remedy (*Institutional Controls and Engineering Controls*) is protective of human health and the environment, complies with Federal and Territory of Guam requirements that are applicable or relevant and appropriate to the remedial action, and is cost effective.

Because the *Institutional Controls and Engineering Controls* alternative will result in hazardous substances, pollutants, or contaminants remaining on site above levels that do not allow for unlimited use and unrestricted exposure, a 5-year review will be required.

3.13.1 Protection of Human Health and the Environment

The *Institutional Controls and Engineering Controls* alternative will be protective of human health and the environment as it will eliminate exposure to residential receptors by preventing residential development on or adjacent to the site. There is no likelihood that Site 8 would be developed for future residential use. Work conducted at the site would require a clearance permit that must be approved by the USAF. Additionally, the fence will be a part of the permanent remedy at the site. This alternative will not remove or reduce the volume of soil exceeding the RGs.

3.13.2 Compliance with ARARs

The *Institutional Controls and Engineering Controls* alternative meets each of its respective ARARs (Table 3-18).

3.13.3 Cost Effectiveness

According to USEPA guidelines (USEPA, 1999b), a remedy is cost effective if the cost is proportional to its overall effectiveness in protecting human health and the environment.

The *Institutional Controls and Engineering Controls* alternative will be protective of human health and the environment, but at a cost less than that estimated for the *Slope Stabilization and Soil Cover* alternative.

3.13.4 Utilization of Permanent Solution

The *Institutional Controls and Engineering Controls* alternative is not a permanent solution for the site because it would not reduce the volume of hazardous substances or treat the hazardous substances remaining in soil. Therefore, there are residual risks to potential future residents and occasional users/trespassers from leaving untreated hazardous substance-impacted soil areas exceeding RGs at the site. These risks will be mitigated through the use of LUCs.

3.13.5 Preference for Treatment as a Principal Element

The *Institutional Controls and Engineering Controls* alternative does not treat site hazardous substances; however, the associated risks are mitigated through LUCs.

3.13.6 Five-Year Review Requirement

A 5-year review of this ROD will be necessary because residual hazardous substances will be left at Site 8 after implementing the *Institutional Controls and Engineering Controls* alternative, per 42 USC§9621(c) and 40 CFR§300.430(f)(5)(iii)(C).

3.14 DOCUMENTATION OF SIGNIFICANT CHANGES

On 26 July 2007, the Proposed Plan for Sites 5 and 8 was released to the public for review and comments, with a Public Comment Period extending from 26 July 2007 to 26 August 2007. A public meeting was held at the Guam Marriott Resort and Spa in Tumon on 2 August 2007 to present the Proposed Plan to the public.

The same *Institutional Controls and Engineering Controls* alternative that is presented in this ROD was also presented in Proposed Plan and the public meeting as the preferred alternative. The USAF, USEPA Region 9, Guam EPA, and affected property owners have agreed that *Institutional Controls and Engineering Controls* is an acceptable alternative to address Site 8. Therefore, there are no significant changes in this ROD to the remedy as originally identified in the July 2007 Proposed Plan.

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TABLE 3-1. SELECTION OF EXPOSURE PATHWAYS, SITE 8, ANDERSEN AFB, GUAM.

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type Of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Groundwater	Groundwater	Tap Water	Commercial Worker	Adult	Ingestion	Onsite	None	Groundwater will be evaluated under a different program.
	Surface Soil	Surface Soil	IRP Site 8	Trespasser/Occasional User	Adult	Ingestion	Onsite	Quant	Trespasser may walk through area.
						Dermal	Onsite	Quant	Trespasser may walk through area.
				Commercial Worker	Adult	Ingestion	Onsite	Quant	Workers are present at site.
						Dermal	Onsite	Quant	Workers are present at site.
		Air	IRP Site 8	Trespasser/Occasional User	Adult	Inhalation	Onsite	Quant	Soil particled may be inhaled.
				Commercial Worker	Adult	Inhalation	Onsite	Quant	Soil particled may be inhaled.
		Animal tissue	Wild Deer Meat	Hunter	Adult	Ingestion	Onsite	Quant	
					Child	Ingestion	Onsite	Quant	
		Animal tissue	Wild Pig Meat	Hunter	Adult	Ingestion	Onsite	Quant	
					Child	Ingestion	Onsite	Quant	
	Subsurface Soil	Subsurface Soil	IRP Site 8	Utility Worker	Adult	Ingestion	Onsite	Quant	
						Dermal	Onsite	Quant	
		Air	IRP Site 8	Utility Worker	Adult	Inhalation	Onsite	Quant	
	Sediment	None	IRP Site 8	Trespasser/Occasional User	Adult	Ingestion	Onsite	None	No sediment found at site.
	Surfacewater	None	IRP Site 8	Trespasser/Occasional User	Adult	Ingestion	Onsite	None	No surfacewater at site.
Future	Groundwater	Groundwater	Tap Water	Resident	Adult	Ingestion	Onsite	None	
					Child	Ingestion	Onsite	None	
	Surface Soil	Surface Soil	IRP Site 8	Resident	Adult	Ingestion	Onsite	Quant	Future use of site assumes residential.
						Dermal	Onsite	Quant	Future use of site assumes residential.
					Child	Ingestion	Onsite	Quant	
						Dermal	Onsite	Quant	
		Air	IRP Site 8	Resident	Adult	Inhalation	Onsite	Quant	
					Child	Inhalation	Onsite	Quant	
	Subsurface Soil	Subsurface Soil	IRP Site 8	Resident	Adult	Ingestion	Onsite	Quant	
						Dermal	Onsite	Quant	
					Child	Ingestion	Onsite	Quant	
						Dermal	Onsite	Quant	
				Trespasser/Occasional User	Adult	Ingestion	Onsite	Quant	Future occasional user/trespasser may contact unstable subsurface soil as surface soil
						Dermal	Onsite	Quant	
				Construction Worker	Adult	Ingestion	Onsite	Quant	
						Dermal	Onsite	Quant	
		Air	IRP Site 8	Resident	Adult	Inhalation	Onsite	Quant	
					Child	Inhalation	Onsite	Quant	
				Trespasser/Occasional User	Adult	Inhalation	Onsite	Quant	Receptors may contact subsurface soil as surface soil
				Construction Worker	Adult	Inhalation	Onsite	Quant	
	Sediment		IRP Site 8	Resident	Adult	Ingestion	Onsite	None	No sediment found at site.
	Surfacewater		IRP Site 8	Resident	Child	Ingestion	Onsite	None	No surfacewater at site.

TABLE 3-2. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SURFACE SOIL, SITE 8, LANDFILL 10C, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	Contaminant of Concern	Concentration Detected		Units	BTV	Residential/ Industrial PRG	Frequency of Detection	Exposure Point Concentration(a)	Exposure Point Concentration Units	Statistical Measure
		Min	Max							
Site 8 Landfill 10C	Dieldrin	0.0032	5.604	mg/kg	NA	0.030/0.11	13/16	5.604	mg/kg	Max[2]
	Lead	3.1	14,200	mg/kg	166	400/800	31/31	1,435	mg/kg	95% UCL-T[1]

Key

95% UCL-T: 95% Upper Confidence Limit of Lognormal Data
BTV: Background Threshold Value
Max: Maximum Concentration
mg/kg: milligrams per kilogram
NA: not applicable
PRG: Preliminary Remediation Goal
1: Shapiro-Wilk W-Test indicates distribution of the data is lognormal.
2: D'Agostino Test indicates distribution of the data is lognormal.
(a) Reasonable Maximum Exposure

The table presents the COCs and EPC for each of the COCs detected in surface soil (i.e., the concentration that will be used to estimate the exposure and risk from each COC in the surface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the surface site), the EPC, and how the EPC was derived.

TABLE 3-3. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SUBSURFACE SOIL, SITE 8, LANDFILL 10C, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	Contaminant of Concern	Concentration Detected		Units	BTV	Residential/ Industrial PRG	Frequency of Detection	Exposure Point Concentration(a)	Exposure Point Concentration Units	Statistical Measure
		Min	Max							
Site 8 Landfill 10C	Antimony	0.41	78.5	mg/kg	63	31/410	10/10	46.4	mg/kg	95% UCL-T[1]
	Dieldrin	0.0026	420.1	mg/kg	NA	0.030/0.11	13/17	420.1	mg/kg	Max[2]
	Lead	2	2,380	mg/kg	166	400/800	20/20	2,380	mg/kg	Max[2]

Key

95% UCL-T: 95% Upper Confidence Limit of Log-Normal Data
BTV: Background Threshold Value
mg/kg: milligrams per kilogram
Max: Maximum Concentration
NA: not applicable
PRG: Preliminary Remediation Goal
1: Shapiro-Wilk W-Test indicates distribution of the data is lognormal
2: D'Agostino Test indicates distribution of the data is lognormal.
(a) Reasonable Maximum Exposure

The table presents the COCs and EPC for each of the COCs detected in subsurface soil (i.e., the concentration that will be used to estimate the exposure and risk from each COC in the subsurface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and how the EPC was derived.

TABLE 3-4. RISK ASSESSMENT SUMMARY, REASONABLE MAXIMUM EXPOSURE, SITE 8, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Contaminant	Carcinogenic Risk [1]				Contaminant	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Site 8--Landfill 10C	LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZO[A]PYRENE	1.3E-06	--	5.3E-07	1.8E-06	BENZO[A]PYRENE		--	--	--	--
			DDE	7.8E-07	--	2.5E-07	1.0E-06	DDE		--	--	--	--
			DDT	5.3E-07	--	1.7E-07	7.0E-07	DDT	liver	6.3E-02	--	2.8E-02	9.1E-02
			DIELDRIN	5.6E-05	--	1.8E-05	7.4E-05	DIELDRIN	liver	1.4E+00	--	6.2E-01	2.0E+00
			(Total)	5.86E-05	--	1.90E-05	7.76E-05	(Total)		1.46E+00	--	6.48E-01	2.11E+00
	Air	Site 8--Landfill 10C	LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZO[A]PYRENE	--	4.9E-10	--	4.9E-10	BENZO[A]PYRENE		--	--	--	--
			DDE	--	7.1E-10	--	7.1E-10	DDE		--	--	--	--
			DDT	--	4.7E-10	--	4.7E-10	DDT		--	--	--	--
			DIELDRIN	--	5.0E-08	--	5.0E-08	DIELDRIN		--	1.0E-03	--	1.0E-03
			(Total)	--	5.17E-08	--	5.17E-08	(Total)		--	1.0E-03	--	1.0E-03
						Total Risk Across Medium	7.76E-05					Total Hazard Index Across All Media and All Exposure Routes	2.11E+00

(1) Carcinogenic Risks are combined for both Resident Adult and Child.

Total Liver HI =	2.11E+00

TABLE 3-5A. RISK ASSESSMENT SUMMARY, REASONABLE MAXIMUM EXPOSURE, SITE 8, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Contaminant	Carcinogenic Risk (1)				Contaminant	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Subsurface Soil	Site 8--Landfill 10C	ANTIMONY	--	--	--	--	ANTIMONY	blood	1.6E-01	--	--	1.6E-01
			LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZ[A]ANTHRACENE	7.8E-07	--	3.2E-07	1.1E-06	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	1.6E-05	--	6.4E-06	2.2E-05	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	3.0E-06	--	1.2E-06	4.2E-06	BENZO[B]FLUORANTHENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	2.2E-06	--	9.1E-07	3.1E-06	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	1.5E-06	--	6.0E-07	2.1E-06	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			ALDRIN	1.2E-05	--	3.7E-06	1.6E-05	ALDRIN		4.7E-02	--	2.2E-02	6.9E-02
			ALPHA-CHLORDANE	1.2E-06	--	3.7E-07	1.6E-06	ALPHA-CHLORDANE		1.4E-02	--	6.2E-03	2.0E-02
			DDE	4.1E-07	--	1.3E-07	5.4E-07	DDE		--	--	--	--
			DIELDRIN	4.5E-03	--	1.4E-03	5.9E-03	DIELDRIN	liver	1.2E+01	--	5.2E+00	1.7E+01
			GAMMA-CHLORDANE	1.1E-06	--	3.5E-07	1.5E-06	GAMMA-CHLORDANE		1.3E-02	--	5.8E-03	1.9E-02
			HEPTACHLOR	5.9E-07	--	1.9E-07	7.8E-07	HEPTACHLOR		5.4E-04	--	2.4E-04	7.8E-04
			HEPTACHLOR EPOXIDE	2.5E-06	--	8.1E-07	3.3E-06	HEPTACHLOR EPOXIDE		4.4E-02	--	2.0E-02	6.4E-02
			(Total)	4.54E-03	--	1.41E-03	5.96E-03	(Total)		1.23E+01	--	5.25E+00	1.75E+01
	Air	Site 8--Landfill 10C	ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZ[A]ANTHRACENE	--	3.0E-10	--	3.0E-10	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	6.0E-09	--	6.0E-09	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	1.1E-09	--	1.1E-09	BENZO[B]FLUORANTHENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	8.4E-10	--	8.4E-10	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	--	--	--	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			ALDRIN	--	1.1E-08	--	1.1E-08	ALDRIN		--	--	--	--
			ALPHA-CHLORDANE	--	1.0E-09	--	1.0E-09	ALPHA-CHLORDANE		--	6.3E-05	--	6.3E-05
			DDE	--	3.7E-10	--	3.7E-10	DDE		--	--	--	--
			DIELDRIN	--	4.1E-06	--	4.1E-06	DIELDRIN		--	2.1E-02	--	2.1E-02
			GAMMA-CHLORDANE	--	9.9E-10	--	9.9E-10	GAMMA-CHLORDANE		--	5.9E-05	--	5.9E-05
			HEPTACHLOR	--	5.4E-10	--	5.4E-10	HEPTACHLOR		--	9.9E-07	--	9.9E-07
			HEPTACHLOR EPOXIDE	--	2.3E-09	--	2.3E-09	HEPTACHLOR EPOXIDE		--	8.2E-05	--	8.2E-05
			(Total)	--	4.12E-06	--	4.12E-06	(Total)		--	2.12E-02	--	2.12E-02
						Total Risk Across Medium	5.96E-03					Total Hazard Index Across All Media and All Exposure Routes	1.76E+01

(1) Carcinogenic Risks are combined for both Resident Adult and Child

Total Blood HI =	1.6E-01
Total Liver HI =	1.7E+01

TABLE 3-5B. RISK ASSESSMENT SUMMARY, REASONABLE MAXIMUM EXPOSURE, SITE 8, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Contaminant	Carcinogenic Risk (1)				Contaminant	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Subsurface Soil	Site 8--Landfill 10C	ANTIMONY	--	--	--	--	ANTIMONY	blood	1.5E+00	--	--	1.5E+00
			LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZ[A]ANTHRACENE	--	--	--	--	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	--	--	--	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	--	--	--	BENZO[B]FLUORANTHENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	--	--	--	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	--	--	--	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			ALDRIN	--	--	--	--	ALDRIN		4.4E-01	--	1.9E-01	6.3E-01
			ALPHA-CHLORDANE	--	--	--	--	ALPHA-CHLORDANE		1.3E-01	--	5.5E-02	1.9E-01
			DDE	--	--	--	--	DDE		--	--	--	--
			DIELDRIN	--	--	--	--	DIELDRIN	liver	1.1E+02	--	4.7E+01	1.6E+02
			GAMMA-CHLORDANE	--	--	--	--	GAMMA-CHLORDANE		1.2E-01	--	5.2E-02	1.7E-01
			HEPTACHLOR	--	--	--	--	HEPTACHLOR		5.0E-03	--	2.2E-03	7.2E-03
			HEPTACHLOR EPOXIDE	--	--	--	--	HEPTACHLOR EPOXIDE		4.1E-01	--	1.8E-01	5.9E-01
			(Total)	--	--	--	--	(Total)		1.13E+02	--	4.75E+01	1.60E+02
	Air	Site 8--Landfill 10C	ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZ[A]ANTHRACENE	--	--	--	--	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	--	--	--	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	--	--	--	BENZO[B]FLUORANTHENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	--	--	--	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	--	--	--	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			ALDRIN	--	--	--	--	ALDRIN		--	--	--	--
			ALPHA-CHLORDANE	--	--	--	--	ALPHA-CHLORDANE		--	2.2E-04	--	2.2E-04
			DDE	--	--	--	--	DDE		--	--	--	--
			DIELDRIN	--	--	--	--	DIELDRIN		--	7.5E-02	--	7.5E-02
			GAMMA-CHLORDANE	--	--	--	--	GAMMA-CHLORDANE		--	2.1E-04	--	2.1E-04
			HEPTACHLOR	--	--	--	--	HEPTACHLOR		--	3.5E-06	--	3.5E-06
			HEPTACHLOR EPOXIDE	--	--	--	--	HEPTACHLOR EPOXIDE		--	2.9E-04	--	2.9E-04
			(Total)	--	--	--	--	(Total)		--	7.57E-02	--	7.57E-02
			Total Risk Across Medium				--	Total Hazard Index Across All Media and All Exposure Routes					1.60E+02

(1) Carcinogenic Risks are combined for both Resident Adult and Child.

Total Blood HI =	1.5E+00
Total Liver HI =	1.6E+02

TABLE 3-5C. RISK ASSESSMENT SUMMARY, REASONABLE MAXIMUM EXPOSURE, SITE 8, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Trespasser/Occasional User
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Contaminant	Carcinogenic Risk				Contaminant	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Subsurface Soil	Site 8--Landfill 10C	ANTIMONY	--	--	--	--	ANTIMONY	blood	1.2E-02	--	--	1.2E-02
			LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZ[A]ANTHRACENE	5.1E-08	--	6.0E-08	1.1E-07	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	1.0E-06	--	1.2E-06	2.2E-06	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	1.9E-07	--	2.3E-07	4.2E-07	BENZO[B]FLUORANTHENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	1.4E-07	--	1.7E-07	3.1E-07	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	9.6E-08	--	1.1E-07	2.1E-07	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			ALDRIN	7.7E-07	--	7.0E-07	1.5E-06	ALDRIN		3.5E-03	--	3.2E-03	6.7E-03
			ALPHA-CHLORDANE	7.5E-08	--	6.9E-08	1.4E-07	ALPHA-CHLORDANE		1.0E-03	--	9.2E-04	1.9E-03
			DDE	2.6E-08	--	2.4E-08	5.0E-08	DDE		--	--	--	--
			DIELDRIN	2.9E-04	--	2.7E-04	5.6E-04	DIELDRIN	liver	8.5E-01	--	7.8E-01	1.6E+00
			GAMMA-CHLORDANE	7.1E-08	--	6.5E-08	1.4E-07	GAMMA-CHLORDANE		9.5E-04	--	8.7E-04	1.8E-03
			HEPTACHLOR	3.8E-08	--	3.5E-08	7.3E-08	HEPTACHLOR		4.0E-05	--	3.6E-05	7.6E-05
			HEPTACHLOR EPOXIDE	1.7E-07	--	1.5E-07	3.2E-07	HEPTACHLOR EPOXIDE		3.3E-03	--	3.0E-03	6.3E-03
			(Total)	2.93E-04	--	2.73E-04	5.65E-04	(Total)		8.71E-01	--	7.88E-01	1.66E+00
	Air	Site 8--Landfill 10C	ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZ[A]ANTHRACENE	--	6.7E-12	--	6.7E-12	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	1.3E-10	--	1.3E-10	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	2.5E-11	--	2.5E-11	BENZO[B]FLUORANTHENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	1.9E-11	--	1.9E-11	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	--	--	--	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			ALDRIN	--	2.4E-10	--	2.4E-10	ALDRIN		--	--	--	--
			ALPHA-CHLORDANE	--	2.3E-11	--	2.3E-11	ALPHA-CHLORDANE		--	7.8E-07	--	7.8E-07
			DDE	--	8.2E-12	--	8.2E-12	DDE		--	--	--	--
			DIELDRIN	--	9.1E-08	--	9.1E-08	DIELDRIN		--	2.6E-04	--	2.6E-04
			GAMMA-CHLORDANE	--	2.2E-11	--	2.2E-11	GAMMA-CHLORDANE		--	7.3E-07	--	7.3E-07
			HEPTACHLOR	--	1.2E-11	--	1.2E-11	HEPTACHLOR		--	1.2E-08	--	1.2E-08
			HEPTACHLOR EPOXIDE	--	5.1E-11	--	5.1E-11	HEPTACHLOR EPOXIDE		--	1.0E-06	--	1.0E-06
			(Total)	--	9.15E-08	--	9.15E-08	(Total)		--	2.63E-04	--	2.63E-04
						Total Risk Across Medium	5.66E-04					Total Hazard Index Across All Media and All Exposure Routes	1.66E+00

Total blood HI =	1.2E-02
Total liver HI =	1.6E+00

TABLE 3-6A. COPC IDENTIFICATION, SITE 8/LANDFILL 10A, ANDERSEN AFB, GUAM.

Analyte	Ecological Screening Value (mg/kg)	Range of Detections	Frequency of Detection	Samples Greater Than Screen	Outliers That Exceed Bulk of Samples	COPC	Rationale For Selection
Inorganic							
ALUMINUM	173500	113 - 29400	25/25	0/25		No	BSL
ANTIMONY	63	0.69 - 6.9	25/25	0/25		No	BSL
ARSENIC	62	0.23 - 3.2	21/25	0/25		No	BSL
BARIUM	413	1.4 - 81	25/25	0/25		No	BSL
BERYLLIUM	3.34	0.02 - 0.64	17/25	0/25		No	BSL
CADMIUM	6.5	0.08 - 2.1	21/25	0/25		No	BSL
CALCIUM METAL	N/A	308000 - 388000	25/25	0/25		No	NUT
CHROMIUM, TOTAL	1080	1.9 - 157	25/25	0/25		No	BSL
COBALT	70	0.77 - 6.4	16/25	0/25		No	BSL
COPPER	113	0.75 - 22.3	23/25	0/25		No	BSL
IRON	N/A	36.2 - 33600	25/25	0/25		No	NUT
LEAD	188	1.7 - 337	25/25	2/25		Yes	ASL
MAGNESIUM	N/A	1820 - 3450	25/25	0/25		No	NUT
MANGANESE	5,500	2.6 - 458	25/25	0/25		No	BSL
MERCURY (INORGANIC)	5.2	0.07 - 0.4	12/25	0/25		No	BSL
NICKEL	242.5	0.62 - 19.7	21/25	0/25		No	BSL
POTASSIUM	N/A	26.6 - 208	25/25	0/25		No	NUT
SELENIUM	70	2.1 - 3.4	25/25	0/25		No	BSL
SODIUM	N/A	131 - 365	25/25	0/25		No	NUT
THALLIUM	1.42	0.12 - 0.12	1/25	0/25		No	BSL
VANADIUM	206	1.3 - 20.3	19/25	0/25		No	BSL
ZINC	430	3.1 - 948	25/25	2/25		Yes	ASL
PAHs							
Total PAH	21 (a)	0.02075 - 1.4207	19/27	0/27		No	BSL
BENZ[A]ANTHRACENE	21 (a)	0.0023 - 0.043	12/27	0/27		No	BSL
BENZO[A]PYRENE	21 (a)	0.0025 - 0.07	18/27	0/27		No	BSL
BENZO[B]FLUORANTHENE	21 (a)	0.0022 - 0.14	18/27	0/27		No	BSL
BENZO[K]FLUORANTHENE	21 (a)	0.0023 - 0.064	16/27	0/27		No	BSL
CHRYSENE	21 (a)	0.0063 - 0.13	6/27	0/27		No	BSL
DIBENZ[A,H]ANTHRACENE	21 (a)	0.0079 - 0.0079	1/25	0/25		No	BSL
FLUORANTHENE	21 (a)	0.016 - 0.73	5/27	0/27		No	BSL
INDENO[1,2,3-C,D]PYRENE	21 (a)	0.0023 - 0.044	14/27	0/27		No	BSL
PYRENE	21 (a)	0.015 - 0.45	5/27	0/27		No	BSL
PESTICIDES							
Total DDT	2 (b)	0.0053 - 0.1116	2/5	0/5		No	BSL
DDD	2 (b)	0.0093 - 0.0093	1/5	0/5		No	BSL
DDE	2 (b)	0.0211 - 0.0211	1/5	0/5		No	BSL
DDT	2 (b)	0.0012 - 0.0812	2/5	0/5		No	BSL
DIELDRIN	2	0.0002 - 0.0027	2/5	0/5		No	BSL
ENDOSULFAN II	N/A	0.0011 - 0.0011	1/5	0/5		N/A	N/A
GAMMA-CHLORDANE	6.25 (c)	0.00133 - 0.00197	2/5	0/5		No	BSL
METHOXYCHLOR	6.25 (c)	0.0029 - 0.0029	1/5	0/5		No	BSL

N/A = Not Applicable

(a) PAH intervention is based on Total PAH only. Exceedences based on summing all PAH.

(b) DDT screen based on Total DDT products, exceedance based on summing all DDT products.

(c) Based on chlordane.

TABLE 3-6B. COPC IDENTIFICATION, SITE 8/LANDFILL 10B, ANDERSEN AFB, GUAM.

Analyte	Ecological Screening Value (mg/kg)	Range of Detections	Frequency of Detection	Samples Greater Than Screen	Outliers That Exceed Bulk of Samples	COPC	Rationale For Selection
Inorganic							
ALUMINUM	173500	3210 - 112000	14/14	0/14		No	BSL
ANTIMONY	63	1.1 - 7.7	14/14	0/14		No	BSL
ARSENIC	62	0.44 - 8.3	14/14	0/14		No	BSL
BARIUM	413	3.4 - 52.7	14/14	0/14		No	BSL
BERYLLIUM	3.34	0.05 - 2.8	14/14	0/14		No	BSL
CADMIUM	6.5	0.3 - 4.3	14/14	0/14		No	BSL
CALCIUM METAL	N/A	42100 - 359000	14/14	0/14		No	NUT
CHROMIUM, TOTAL	1080	24.5 - 418	14/14	0/14		No	BSL
COBALT	70	0.95 - 12	13/14	0/14		No	BSL
COPPER	113	2 - 32.2	12/14	0/14		No	BSL
CYANIDE (FREE)	11 (a)	0.29 - 0.5	3/14	0/14		No	BSL
IRON	N/A	4010 - 64000	14/14	0/14		No	NUT
LEAD	188	1.6 - 495	18/18	1/18		Yes	ASL
MAGNESIUM	N/A	1650 - 3950	14/14	0/14		No	NUT
MANGANESE	5,500	7.8 - 4190	16/16	0/16		No (d)	BSL
MERCURY (INORGANIC)	5.2	0.08 - 1.9	14/14	0/14		No	BSL
NICKEL	242.5	1.7 - 36.5	14/14	0/14		No	BSL
POTASSIUM	N/A	64.4 - 595	14/14	0/14		No	NUT
SELENIUM	70	0.58 - 3.6	13/14	0/14		No	BSL
SODIUM	N/A	259 - 709	14/14	0/14		No	NUT
THALLIUM	1.42	0.11 - 0.68	9/14	0/14		No	BSL
VANADIUM	206	1.5 - 48.7	14/14	0/14		No	BSL
ZINC	430	3.5 - 178	13/14	0/14		No	BSL
PAHs							
Total PAH	21 (b)	0.0052 - 0.1925	8/14	0/14		No	BSL
BENZ[A]ANTHRACENE	21 (b)	0.0035 - 0.015	4/13	0/13		No	BSL
BENZO[A]PYRENE	21 (b)	0.0031 - 0.026	6/13	0/13		No	BSL
BENZO[B]FLUORANTHENE	21 (b)	0.0028 - 0.031	8/14	0/14		No	BSL
BENZO[K]FLUORANTHENE	21 (b)	0.0028 - 0.014	5/13	0/13		No	BSL
CHRYSENE	21 (b)	0.0094 - 0.017	2/13	0/13		No	BSL
DIBENZ[A,H]ANTHRACENE	21 (b)	0.0028 - 0.0028	1/13	0/13		No	BSL
FLUORANTHENE	21 (b)	0.0099 - 0.038	2/13	0/13		No	BSL
INDENO[1,2,3-C,D]PYRENE	21 (b)	0.0036 - 0.0098	3/13	0/13		No	BSL
PYRENE	21 (b)	0.013 - 0.043	2/13	0/13		No	BSL
PESTICIDES							
Total DDT	2 (c)	0.0008 - 0.0008	1/1	0/1		No	BSL
DDE	2 (c)	0.0008 - 0.0008	1/1	0/1		No	BSL

N/A = Not Applicable

(a) Based on free cyanide.

(b) PAH intervention is based on Total PAH only. Exceedences based on summing all PAH.

(c) DDT screen based on Total DDT products, exceedance based on summing all DDT products.

TABLE 3-6C. COPC IDENTIFICATION, SITE 8/LANDFILL 10C, ANDERSEN AFB, GUAM.

Analyte	Ecological Screening Value (mg/kg)	Range of Detections	Frequency of Detection	Samples Greater Than Screen	Outliers That Exceed Bulk of Samples	COPC	Rationale For Selection
Inorganic							
ALUMINUM	173500	473 - 27000	25/25	0/25		No	BSL
ANTIMONY	63	0.66 - 3.9	25/25	0/25		No	BSL
ARSENIC	62	0.29 - 12.3	25/25	0/25		No	BSL
BARIUM	413	1.6 - 652	25/25	2/25		Yes	ASL
BERYLLIUM	3.34	0.02 - 0.59	18/25	0/25		No	BSL
CADMIUM	6.5	0.07 - 29.8	25/25	1/25		Yes	ASL
CALCIUM METAL	N/A	232000 - 386000	25/25	0/25		No	NUT
CHROMIUM, TOTAL	1080	3 - 151	25/25	0/25		No	BSL
COBALT	70	0.78 - 7.2	19/25	0/25		No	BSL
COPPER	113	2.5 - 3890	20/25	2/25		Yes	ASL
IRON	N/A	358 - 31100	25/25	0/25		No	NUT
LEAD	188	3.1 - 14200	31/31	10/31		Yes	ASL
MAGNESIUM	N/A	1850 - 3920	25/25	0/25		No	NUT
MANGANESE	5,500	19.6 - 659	25/25	0/25		No	BSL
MERCURY (INORGANIC)	5.2	0.04 - 0.75	15/25	0/25		No	BSL
NICKEL	242.5	1.2 - 16.8	22/25	0/25		No	BSL
PHOSPHORUS	N/A	232 - 301	2/2	0/2		N/A	N/A
POTASSIUM	N/A	26.5 - 373	25/25	0/25		No	NUT
SELENIUM	70	1.9 - 3.4	25/25	p		No	BSL
SILVER	14.9	0.14 - 0.14	1/25	0/25		No	BSL
SODIUM	N/A	158 - 643	25/25	0/25		No	NUT
THALLIUM	1.42	0.13 - 0.18	2/25	0/25		No	BSL
VANADIUM	206	0.56 - 47.5	24/25	0/25		No	BSL
ZINC	430	4.4 - 316	25/25	0/25		No	BSL
PAHs							
Total PAH	21 (a)	0.0285 - 7.629	56/57	0/57		No	BSL
ANTHRACENE	21 (a)	0.0083 - 0.14	11/57	0/57		No	BSL
BENZ[A]ANTHRACENE	21 (a)	0.0034 - 1	50/57	0/57		No	BSL
BENZO(G,H,I)PERYLENE	21 (a)	0.093 - 0.49	9/25	0/25		No	BSL
BENZO[A]PYRENE	21 (a)	0.0025 - 0.76	52/57	0/57		No	BSL
BENZO[B]FLUORANTHENE	21 (a)	0.0028 - 0.98	55/57	0/57		No	BSL
BENZO[K]FLUORANTHENE	21 (a)	0.0022 - 0.45	47/57	0/57		No	BSL
CHRYSENE	21 (a)	0.0059 - 1.1	30/41	0/41		No	BSL
DIBENZ[A,H]ANTHRACENE	21 (a)	0.0042 - 0.079	19/55	0/55		No	BSL
FLUORANTHENE	21 (a)	0.01 - 1.3	39/57	0/57		No	BSL
INDENO[1,2,3-C,D]PYRENE	21 (a)	0.0023 - 0.32	42/57	0/57		No	BSL
PHENANTHRENE	21 (a)	0.093 - 0.27	4/24	0/24		No	BSL
PYRENE	21 (a)	0.011 - 1.5	35/57	0/57		No	BSL
PESTICIDES							
ALPHA-CHLORDANE	6.25 (c	0.00087 - 1.395	13/16	0/16		N/A	N/A
Total DDT	2 (b)	0.0074 - 6.205	16/16	3/16		Yes	ASL
DDD	2 (b)	0.0218 - 0.2943	2/16	0/16		No	BSL
DDE	2 (b)	0.0017 - 3.687	16/16	1/16		No	ASL
DDT	2 (b)	0.0034 - 2.481	16/16	1/16		No	ASL
DELTA-BHC	N/A	0.0004 - 0.00094	4/16	0/16		N/A	N/A
DIELDRIN	2	0.0032 - 5.604	13/16	1/16		Yes	ASL
ENDOSULFAN II	N/A	0.0009 - 0.0426	5/16	0/16		N/A	N/A
ENDRIN	0.2 (d)	0.0011 - 0.0359	4/16	0/16		No	BSL
GAMMA-CHLORDANE	6.25 (c)	0.00083 - 0.9851	14/16	0/16		No	BSL
HEPTACHLOR	6.25 (c)	0.00143 - 0.0141	2/16	0/16		No	BSL
HEPTACHLOR EPOXIDE	6.25 (c)	0.0628 - 0.0628	1/16	0/16		No	BSL
METHOXYCHLOR	6.25 (c)	0.0054 - 0.0177	2/16	0/16		No	BSL
Semivolatiles							
Total Phthalates	30 (e)	0.255 - 1.53	10/24	0/24		No	BSL
BIS(2-ETHYLHEXYL)PHTHALATE	30 (e)	0.08 - 1.4	10/24	0/24		No	BSL
DIBUTYLPHTHALATE	30 (e)	0.13 - 0.13	1/23	0/23		N/A	N/A

N/A = Not Applicable

(a) PAH intervention is based on Total PAH only. Exceedences based on summing all PAH.

(b) DDT screen based on Total DDT products, exceedance based on summing all DDT products.

(c) Based on chlordane.

(d) Based on aldrin as a surrogate.

TABLE 3-7. ASSESSMENT AND MEASUREMENT ENDPOINTS FOR ECOLOGICAL RISK ASSESSMENT FOR SITE 8, ANDERSEN AFB, GUAM.

Assessment Endpoint	Measurement Endpoint
Soil invertebrates: survival, growth and reproduction	Soil concentrations compared to literature screening benchmarks
Plants: survival, growth and reproduction	Soil concentrations compared to literature screening benchmarks
Plants: COPC concentrations jeopardize acceptability as food source	Dietary dose to higher receptors compared to toxicological threshold
Native birds (Yellow bittern, Micronesian starling, Mariana Crow): survival, growth and reproduction	Dietary dose compared to toxicological threshold

TABLE 3-8. SUMMARY OF ERA RESULTS FOR SITE 8, ANDERSEN AFB, GUAM.

Assessment Endpoint	Measurement Endpoint	Result
Soil invertebrates: survival, growth and reproduction	Soil concentrations compared to literature screening benchmarks	• For Landfill 10A, EQ is less than 1.0 for lead and zinc, indicating acceptable invertebrate risk levels from these COPCs. • For Landfill 10B, EQ is less than 1.0 for lead and manganese, indicating acceptable invertebrate risk levels from these COPCs. • For Landfill 10C, EQ is less than 1.0 for barium, cadmium, copper. Lead, and total DDT, indicating acceptable invertebrate risk levels from these COPCs.
Plants: survival, growth and reproduction	Soil concentrations compared to literature screening benchmarks	• For Landfill 10A, EQ is less than 1.0 for lead and zinc, indicating acceptable plant risk levels from these COPCs. • For Landfill 10B, EQ is less than 1.0 for lead, indicating acceptable plant risk levels from this COPC. • For Landfill 10B, the EQ for manganese exceeded 1.0. The exceedance of the TRV was not large, just under a factor of 3. Risk is inferred from this concentration, but is judged to be low. • For Landfill 10C, EQ is less than 1.0 for barium, cadmium, and copper, indicating acceptable plant risk levels from these COPCs. • For Landfill 10C, the EQ for lead exceeded 1.0. The exceedance of the TRV was not large; less than a factor of 2. Risk is inferred from this concentration, but is judged to be low. • No primary toxicological references were found for total DDT, therefore, there is the potential for unacceptable risk from this COPC.
Plants: COPC concentrations jeopardize acceptability as food source	Dietary dose to higher receptors compared to toxicological threshold	• For Landfill 10A, EQ is less than 1.0 for lead and zinc, indicating acceptable plant risk levels from these COPCs. • For Landfill 10B, EQ is less than 1.0 for lead, indicating acceptable plant risk levels from this COPC. • For Landfill 10B, the EQ for manganese exceeded 1.0. The exceedance of the TRV was not large, just under a factor of 3. Risk is inferred from this concentration, but is judged to be low. • For Landfill 10C, EQ is less than 1.0 for barium, cadmium, and copper, indicating acceptable plant risk levels from these COPCs. • For Landfill 10C, the EQ for lead exceeded 1.0. The exceedance of the TRV was not large; less than a factor of 2. Risk is inferred from this concentration, but is judged to be low. • No primary toxicological references were found for total DDT, therefore, there is the potential for unacceptable risk from this COPC.

TABLE 3-8. SUMMARY OF ERA RESULTS FOR SITE 8, ANDERSEN AFB, GUAM.

Assessment Endpoint	Measurement Endpoint	Result
Native birds (Yellow bittern, Micronesian starling, Mariana Crow): survival, growth and reproduction	Dietary dose compared to toxicological threshold	• For the yellow bittern, NOAEL HQ for zinc at Landfill 10A; manganese at Landfill 10B; and barium, cadmium, copper, and dieldrin at Landfill 10C were less than 1.0 indicating risks from these COPCs are acceptable, and no further evaluation is necessary. • For the yellow bittern, NOAEL HQ is greater then 1.0 for lead in Landfills 10A and 10B; and lead and total DDT in Landfill 10C. However, in each case, the LOAEL HQ was less than 1.0. Risks are inferred from these concentrations, but are judged to be low. • For the Micronesian starling, NOAEL HQ for lead and zinc at Landfill 10A; lead and manganese at Landfill 10B; and barium, cadmium, copper, dieldrin, lead, and total DDT at Landfill 10C were less than 1.0 indicating risks from these COPCs are acceptable, and no further evaluation is necessary. • For the Mariana crow, NOAEL HQ for zinc at Landfill 10A; manganese at Landfill 10B; and barium, cadmium, copper, and dieldrin at Landfill 10C were less than 1.0 indicating risks from these COPCs are acceptable, and no further evaluation is necessary. • For the Mariana crow, NOAEL HQ is greater then 1.0 for lead in Landfills 10A and 10B; and lead and total DDT in Landfill 10C. However, in each case, the LOAEL HQ was less than 1.0. The calculations of risks between the NOAEL and LOAEL levels suggests slight risk to the Mariana crow from lead and total DDT.

EQ = Ecological Quotient; NOAEL = No observed adverse effects level; LOAEL = Lowest observed adverse effects level; COPC = Constituent of potential concern; HQ = Hazard Quotient; TRV = Toxicity reference value

TABLE 3-9. ECOLOGICAL QUOTIENTS FOR COPCs FOR SITE 8, ANDERSEN AFB, GUAM.

COPC	Representative Soil Concentration (mg/kg)	Toxicity Reference Value [(1)] (mg/kg)	Ecological Quotient
Earthworms			
Landfill 10A			
Lead	13.29	6,630	0.0020
Zinc	17.52	11,000	0.0016
Landfill 10B			
Lead	18.59	6,630	0.0028
Manganese	1434.40	52,000	0.0276
Landfill 10C			
Barium	18.78	3,000	0.0063
Cadmium	0.63	132	0.0048
Copper	7.10	1,010	0.0070
Lead	66.48	6,630	0.0100
Total DDT	0.0634	11	0.0058
Plants			
Landfill 10A			
Lead	13.29	50	0.2658
Zinc	17.52	50	0.3504
Landfill 10B			
Lead	18.59	50	0.3718
Manganese	1434.40	500	2.8688
Landfill 10C			
Barium	18.78	500	0.0376
Cadmium	0.63	4	0.1573
Copper	7.10	100	0.0710
Lead	66.48	50	1.3296
Total DDT	0.0634	no screening value	------

Notes:

(1) Toxicity Reference Values for earthworms are from USAF (1998); Toxicity Reference Values for plants are from Efroymson et al. (1997b).

TABLE 3-10. FOOD-WEB RISK RESULTS FOR THE MARIANA CROW FOR SITE 8, ANDERSEN AFB, GUAM.

COPC	Mean			Soil Bioavailability [3]	Area Use Factor [3]	Dose				TRV [4]		HQ	
	Soil (mg/kg)	Fruit [1] (mg/kg)	Reptile [2] (mg/kg)			Soil	Fruit	Reptile	Total	NOAEL	LOAEL	NOAEL	LOAEL
						mg/kg-bw/day							
Landfill 10A													
Lead	13.29	0.0717	14.2	1	1	0.0159	0.0075	1.4910	1.5144	1.13	11.3	1.34	0.13
Zinc	17.52	5.84	36.8	1	1	0.0210	0.6132	3.8640	4.4982	14.5	131	0.31	0.03
Landfill 10B													
Lead	18.59	0.0717	14.2	1	1	0.0223	0.0075	1.4910	1.5208	1.13	11.3	1.35	0.13
Manganese	1434.40	2.54	2.0	1	1	1.7170	0.2667	0.2100	2.1937	997	4985	<0.01	<0.01
Landfill 10C													
Barium	18.78	0.23	0.23	1	1	0.0225	0.0242	0.0242	0.0708	20.8	41.7	<0.01	<0.01
Cadmium	0.629	0.04	0.227	1	1	0.0008	0.0042	0.0238	0.0288	1.45	20	0.02	<0.01
Copper	7.10	3.07	5.01	1	1	0.0085	0.3224	0.5261	0.8569	47	61.7	0.02	0.01
Dieldrin	0.0108	0.0017	0.0017	1	1	0.000013	0.000179	0.000179	0.000370	0.077	ND	<0.01	NC
Lead	66.48	0.0717	14.2	1	1	0.0796	0.0075	1.4910	1.5781	1.13	11.3	1.40	0.14
Total DDT	0.0634	0.00165	0.062	1	1	0.0001	0.0002	0.0065	0.0068	0.003	0.028	2.25	0.24

Additional model parameters [5]: diet soil fraction = 0.02; food ingestion rate = 0.21 kg/kg-bw/day;
% dry matter in fruit = 23 and reptiles = 34 (combined % dry matter in food = 28.5)

Food web Model Calculations:

Dose Soil = soil mean X soil bioavailability X area use factor X fraction soil X food ingestion rate X 0.285 combined fraction dry weight in food

Dose Fruit = fruit mean X area use factor X food ingestion rate X 0.5 fraction fruit in diet

Dose Reptile = reptile mean X area use factor X food ingestion rate X 0.5 fraction reptiles in diet

Dose Total = Dose Soil + Dose Reptile + Dose Fruit

Notes:
(1) Fruit mean concentrations from EA (1995a)
(2) Reptile mean concentrations from EA (1995a)
(3) Soil bioavailability and area use factor conservatively assumed to be 100%
(4) NOAEL and LOAEL TRVs from Sample et al. (1996)
(5) Diet soil fraction, food ingestion rate, and % dry matter in reptiles and fruit based on EPA (1993)
ND = No data
NC = Not Calculated

TABLE 3-11. FOOD-WEB RISK RESULTS FOR THE MICRONESIAN STARLING FOR SITE 8, ANDERSEN AFB, GUAM.

COPC	Mean Soil (mg/kg)	Mean Fruit [1] (mg/kg)	Soil Bioavailability [2]	Area Use Factor [2]	Dose Soil (mg/kg-bw/day)	Dose Fruit (mg/kg-bw/day)	Dose Total (mg/kg-bw/day)	TRV [3] NOAEL (mg/kg-bw/day)	TRV [3] LOAEL (mg/kg-bw/day)	HQ NOAEL	HQ LOAEL
Landfill 10A											
Lead	13.29	0.0717	1	1	0.0159	0.0186	0.0345	1.13	11.3	0.03	<0.01
Zinc	17.52	5.84	1	1	0.0210	1.5184	1.5394	14.5	131	0.11	0.01
Landfill 10B											
Lead	18.59	0.0717	1	1	0.0222	0.0186	0.0409	1.13	11.3	0.04	<0.01
Manganese	1434.40	2.54	1	1	1.7155	0.6604	2.3759	997	4985	<0.01	<0.01
Landfill 10C											
Barium	18.78	0.23	1	1	0.0225	0.0598	0.0823	20.8	41.7	<0.01	<0.01
Cadmium	0.629	0.04	1	1	0.0008	0.0104	0.0112	1.45	20	0.01	<0.01
Copper	7.10	3.07	1	1	0.0085	0.7982	0.8067	47	61.7	0.02	0.01
Dieldrin	0.0108	0.0017	1	1	0.00001	0.0004	0.0005	0.077	ND	0.01	<0.01
Lead	66.48	0.0717	1	1	0.0795	0.0186	0.0982	1.13	11.3	0.09	0.01
Total DDT	0.0634	0.00165	1	1	0.0001	0.0004	0.0005	0.003	0.028	0.17	0.02

Additional model parameters [4]: diet soil fraction = 0.02; food ingestion rate = 0.26 kg/kg-bw/day;
% dry matter in fruit = 23

Food web Model Calculations:

Dose Soil = soil mean X soil bioavailability X area use factor X fraction soil X food ingestion rate X 0.23 fraction dry weight in food

Dose Fruit = fruit mean X area use factor X food ingestion rate

Dose Total = Dose Soil + Dose Fruit

Notes:
(1) Fruit mean concentrations from EA (1995a)
(2) Soil bioavailability and area use factor conservatively assumed to be 100%
(3) NOAEL and LOAEL TRVs from Sample et al. (1996)
(4) Diet soil fraction, food ingestion rate, and % dry matter in fruit based on EPA (1993)

TABLE 3-12. FOOD-WEB RISK RESULTS FOR THE YELLOW BITTERN FOR SITE 8, ANDERSEN AFB, GUAM.

COPC	Mean Soil (mg/kg)	Mean Reptile [1] (mg/kg)	Soil Bioavailability [2]	Area Use Factor [2]	Dose Soil (mg/kg-bw/day)	Dose Reptile (mg/kg-bw/day)	Dose Total (mg/kg-bw/day)	TRV [3] NOAEL (mg/kg-bw/day)	TRV [3] LOAEL (mg/kg-bw/day)	HQ NOAEL	HQ LOAEL
Landfill 10A											
Lead	13.29	14.2	1	1	0.0235	3.6920	3.7155	1.13	11.3	3.29	0.33
Zinc	17.52	36.8	1	1	0.0310	9.5680	9.5990	14.5	131	0.66	0.07
Landfill 10B											
Lead	18.59	14.2	1	1	0.0329	3.6920	3.7249	1.13	11.3	3.30	0.33
Manganese	1434.40	2.0	1	1	2.5360	0.5200	3.0560	997	4985	<0.01	<0.01
Landfill 10C											
Barium	18.78	0.23	1	1	0.0332	0.0598	0.0930	20.8	41.7	<0.01	<0.01
Cadmium	0.629	0.227	1	1	0.0011	0.0590	0.0601	1.45	20	0.04	<0.01
Copper	7.10	5.01	1	1	0.0126	1.3026	1.3152	47	61.7	0.03	0.02
Dieldrin	0.0108	0.0017	1	1	0.00002	0.0004	0.0005	0.077	ND	0.01	NC
Lead	66.48	14.2	1	1	0.1175	3.6920	3.8095	1.13	11.3	3.37	0.34
Total DDT	0.0634	0.062	1	1	0.0001	0.0161	0.0162	0.003	0.028	5.41	0.58

Additional model parameters [4]: diet soil fraction = 0.02; food ingestion rate = 0.26 kg/kg-bw/day;
% dry matter in reptiles = 34

Food web Model Calculations:

Dose Soil = soil mean X soil bioavailability X area use factor X fraction soil X food ingestion rate X 0.34 fraction dry weight in food

Dose Reptile = reptile mean X area use factor X food ingestion rate

Dose Total = Dose Soil + Dose Reptile

Notes:
(1) Reptile mean concentrations from EA (1995a)
(2) Soil bioavailability and area use factor conservatively assumed to be 100%
(3) NOAEL and LOAEL TRVs from Sample et al. (1996)
(4) Diet soil fraction, food ingestion rate, and % dry matter in reptile based on EPA (1993)

TABLE 3-13. SUMMARY OF CLEANUP STANDARDS FOR RESIDENTIAL USE AT SITE 8, ANDERSEN AFB, GUAM.

Future Site Users	Cleanup Matrix	COC	PRG Residential (mg/kg)	BTV (mg/kg)	RG (mg/kg)
Residential Receptors	**SURFACE SOIL**	Dieldrin	0.03	NA	**2.8(a)**
		Lead	400	166	**400(b)**
	SUBSURFACE SOIL	Antimony	31	63	**63(c)**
		Dieldrin	0.03	NA	**0.7(a)**
		Lead	400	166	**400(b)**

Notes: COC = contaminant of concern; BTV = background threshold value; PRG = 2004 USEPA Region 9 Preliminary Remediation Goal; RG = Remediation Goal; mg/kg = milligrams per kilogram; N/A = not applicable; (a) = RG exceeds the USEPA Region 9 PRG; therefore, the RG is used as the cleanup goal; (b) = RG is based on OSWER Directive/IEUBK Model; (c) = BTV exceeds the RG; therefore, the BTV is used as the cleanup goal.

TABLE 3-14. COST ESTIMATE FOR THE INSTITUTIONAL CONTROLS AND ENGINEERING CONTROLS ALTERNATIVE AT SITE 8, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth ($) at 5% discount rate for 30 years (rounded)
Capital Cost. Development of the LUCMP						
Sr. Labor Hours	BPJ	8	Hour	$ 135	$ 1,080	
Jr. Labor Hours	BPJ	40	Hour	$ 72	$ 2,880	
Clerical/Editor/Word Processor/CADD labor hours	BPJ	8	Hour	$ 60	$ 480	
ODCs - Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 500	$ 500	
15% markup on ODCs					$ 75	
15% contingency					$ 741	
4% Guam Tax					$ 198	
Subtotal					**$ 5,954**	**$ 6,000**
Capital Cost. Amendment of Base Master Plan						
Sr Labor Hours	BPJ	16	Hour	$ 135	$ 2,160	
Jr Labor Hours	BPJ	24	Hour	$ 72	$ 1,728	
Clerical/Editor/Word Processor/CADD labor hours	BPJ	8	Hour	$ 60	$ 480	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 500	$ 500	
15% markup on ODCs					$ 75	
15% contingency					$ 731	
4% Guam Tax					$ 195	
Subtotal					**$ 5,869**	**$ 5,900**
O&M Cost Site Maintenance (assume once per 5 years)						
Laborers	BPJ	8	Hour	$ 100	$ 800	
Fence Maintenance	BPJ	50	Linear Feet	$ 18	$ 900	
Sign replacement	BPJ	1	Lump Sum	$ 50	$ 50	
15% markup on ODCs					$ 143	
15% contingency					$ 263	
4% Guam Tax					$ 70	
Subtotal					**$ 2,226**	**$8,500**
O&M Cost. Land Use Controls inspection/reporting (assume annual)						
Sr. Labor Hours	BPJ	4	Hour	$ 135	$ 540	
Mid Labor Hours	BPJ	40	Hour	$ 80	$ 3,200	
Jr. Labor Hours	BPJ	16	Hour	$ 72	$ 1,158	
Clerical/Editor/CADD labor hours	BPJ	4	Hour	$ 60	$ 240	
Report production	BPJ	1	Lump Sum	$ 1,000	$ 1,000	
15% markup on ODCs					$ 150	
15% contingency					$ 921	
4% Guam Tax					$ 246	
Subtotal					**$ 7,455**	**$122,100**
O&M Cost. Five-Year Reviews						

List of Assumptions:

30-year period of performance (events performed at year 5, year 10, year 15, year 20, year 25, and year 30)

Cost model assumes Periodic Site Review & Public Education costs shared with multiple IRP sites that have Institutional Controls. Includes fact sheets.

Labor and Other ODC	Rates	Hours	Labor Cost	Per Diem and Other	Total Labor and ODCs
Sr. Geologist	$130	40	$5,200	$0	$5,200
Sr. Engineer	$135	40	$5,400	$500	$5,900
Sr. Toxicologist	$120	24	$2,880	$300	$3,180
Mid. Geologist	$80	24	$1,920	$300	$2,220
Mid. CADD/GIS Operator	$60	40	$2,400	$500	$2,900

ODCs	Quantity	Unit	Rate ($)	Total ODC ($)
CADD/GIS Equipment	1	Lump Sum	$600	$600
Car rental, airfare, travel	1	Lump Sum	$500	$500
O&M (posting signs, fence fixing)	1	Lump Sum	$2,000	$2,000
Press Release	1	Lump Sum	$500	$500
Phone/communications	1	Lump Sum	$224	$224
Copies, postage, shipping	1	Lump Sum	$300	$300
4% Guam Tax on Labor		$712	$0	$712
15% markup on ODCs		$0	$859	$859
4% Guam Tax on ODCs		$0	$229	$229
Subtotal				**$25,324**	**$95,800**
TOTAL Capital Cost				**$ 11,823**	**$ 11,900**
TOTAL O&M Cost (30-year)					**$ 226,400**
TOTAL COST (30-year net present worth)					**$ 239,000**
					(rounded)

TABLE 3-15. COST ESTIMATE FOR THE SLOPE STABILIZATION AND SOIL COVER ALTERNATIVE AT SITE 8, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth ($) at 5% discount rate for 30 years (rounded)
Capital Cost. Slope Stabilization and Soil Cover						
Writing Site-Specific Workplan	BPJ	1	task	$10,000	$10,000	
Program & Project Manager	BPJ	1	task	$1,800	$1,800	
Administration	BPJ	10	hour	$60	$600	
Project Travel/Per Diem	BPJ	1	task	$8,000	$8,000	
Other Direct Cost (ODC)						
Press Release	vender quote	2	notice	$1,420	$2,840	
Mobilization/Demobilization	vendor quote	2	task	$400	$800	
Trackhoe/Dozer Rental	vendor quote	66	day	$680	$44,880	
Grader	BPJ	15	day	$680	$10,200	
Equipment Operator*	vendor quote	660	hour	$55	$36,300	
Oversight, Prep, & Mob/Demob	BPJ	660	hour	$60	$39,600	
Health and Safety Officer	BPJ	660	hour	$55	$36,300	
Dump Truck and Driver*	vendor quote	260	day	$400	$104,000	
Steam/Water Truck	vendor quote	7	day	$1,000	$7,000	
Reseeding	vendor quote	115,200	ft^2	$0.40	$46,080	
Clean Backfill**	vendor quote	4,270	yd^3	$23	$98,210	
15% Markup on ODC					$63,510	
15% contingency					$66,992	
4% Guam Tax					$20,410	
Subtotal Slope Stabilization and Soil Cover					**$597,522**	**$597,600**
Capital Cost. Development of the LUCMP						
Sr. Labor Hours	BPJ	8	Hour	$ 135	$ 1,080	
Jr. Labor Hours	BPJ	40	Hour	$ 72	$ 2,880	
Clerical/Editor/Word Processor/CADD labor hours	BPJ	8	Hour	$ 60	$ 480	
ODCs - Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 500	$ 500	
15% markup on ODCs					$ 75	
15% contingency					$ 741	
4% Guam Tax					$ 198	
Subtotal					**$ 5,954**	**$ 6,000**
Capital Cost. Amendment of Base Master Plan						
Sr Labor Hours	BPJ	16	Hour	$ 135	$ 2,160	
Jr Labor Hours	BPJ	24	Hour	$ 72	$ 1,728	
Clerical/Editor/Word Processor/CADD labor hours	BPJ	8	Hour	$ 60	$ 480	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 500	$ 500	
15% markup on ODCs					$ 75	
15% contingency					$ 731	
4% Guam Tax					$ 195	
Subtotal					**$ 5,869**	**$ 5,900**
O&M Cost Site Maintenance (assume once per 5 years)						
Laborers	BPJ	8	Hour	$ 100	$ 800	
Fence Maintenance	BPJ	50	Linear Feet	$ 18	$ 900	
Sign replacement	BPJ	1	Lump Sum	$ 50	$ 50	
15% markup on ODCs					$ 143	
15% contingency					$ 263	
4% Guam Tax					$ 70	
Subtotal					**$ 2,226**	**$8,500**
O&M Cost. Land Use Controls inspection/reporting (assume annual)						
Sr. Labor Hours	BPJ	4	Hour	$ 135	$ 540	
Mid Labor Hours	BPJ	40	Hour	$ 80	$ 3,200	
Jr. Labor Hours	BPJ	16	Hour	$ 72	$ 1,158	
Clerical/Editor/CADD labor hours	BPJ	4	Hour	$ 60	$ 240	
Report production	BPJ	1	Lump Sum	$ 1,000	$ 1,000	
15% markup on ODCs					$ 150	
15% contingency					$ 921	
4% Guam Tax					$ 246	
Subtotal					**$ 7,455**	**$122,100**

TABLE 3-15. COST ESTIMATE FOR THE SLOPE STABILIZATION AND SOIL COVER ALTERNATIVE AT SITE 8, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth ($) at 5% discount rate for 30 years (rounded)
O&M Cost. Five-Year Reviews						
List of Assumptions:						
30-year period of performance (events performed at year 5, year 10, year 15, year 20, year 25, and year 30)						
Cost model assumes Periodic Site Review & Public Education costs shared with multiple IRP sites that have Institutional Controls.						
Includes fact sheets.						
Labor and Other ODC	**Rates**	**Hours**	**Labor Cost**	**Per Diem and Other**	**Total Labor and ODCs**	
Sr. Geologist	$130	40	$5,200	$0	$5,200	
Sr. Engineer	$135	40	$5,400	$500	$5,900	
Sr. Toxicologist	$120	24	$2,880	$300	$3,180	
Mid. Geologist	$80	24	$1,920	$300	$2,220	
Mid. CADD/GIS Operator	$60	40	$2,400	$500	$2,900	
ODCs		**Quantity**	**Unit**	**Rate ($)**	**Total ODC ($)**	
CADD/GIS Equipment		1	Lump Sum	$600	$600	
Car rental, airfare, travel		1	Lump Sum	$500	$500	
O&M (posting signs, fence fixing)		1	Lump Sum	$2,000	$2,000	
Press Release		1	Lump Sum	$500	$500	
Phone/communications		1	Lump Sum	$224	$224	
Copies, postage, shipping		1	Lump Sum	$300	$300	
4% Guam Tax on Labor			$712	$0	$712	
15% markup on ODCs			$0	$859	$859	
4% Guam Tax on ODCs			$0	$229	$229	
Subtotal					**$25,324**	**$95,800**
				TOTAL Capital Cost	**$ 609,345**	**$ 609,500**
				TOTAL O&M Cost (30-year)		**$ 226,400**
				TOTAL COST (30-year net present worth)		**$ 836,000**

Notes: (rounded)

BPJ = Best Professional Judgement; O&M = Operation & Maintenance; ODC = other direct cost; CADD = computer aided design and drafting; GIS = geographical information system; LUCMP = Land Use Control Management Plan; IRP = Installation Restoration Program; AFB = Air Force Base

TABLE 3-16. SUMMARY OF PERTINENT ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 8, ANDERSEN AFB, GUAM.

AUTHORITY	CITATION	ARAR DETERMINATION (may not pertain to each remedial alternative)	SYNOPSIS OF REQUIREMENT
Chemical Specific			
No chemical specific ARARs or TBCs have been identified for Site 8.			
Location Specific			
Federal			
Endangered Species Act	16 USC 1531 and 50 CFR 200, 402	Relevant and Appropriate	Promotes actions to conserve endangered species or habitats.
Territorial			
Guam Wellhead Protection Program	Guam EPA (August 1993)	Relevant and Appropriate	Protects groundwater resources in areas that supply drinking water.
Historical Objects and Sites	21 Guam Code Annotated, Chapter 76	Relevant and Appropriate	Promotes historic preservation, restoration and presentation of historic sites and objects.
Fish, Game, Forestry & Conservation	5 Guam Code Annotated, Chapter 63	Relevant and Appropriate	Promotes actions to conserve endangered species or habitats.
Action Specific			
Federal			
RCRA Subtitle D Municipal Solid Waste	40 CFR 258, Subpart F	Relevant and Appropriate	Specifies landfill closure (e.g., capping) criteria and post-closure care requirements.
Resource RCRA regulations for Identification of Hazardous Waste 40 CFR 261, Transport of Hazardous, and for LDRs and landfills	40 CFR 261 40 CFR 263	Applicable	These requirements identify the maximum concentrations of contaminants for which a waste would be considered a RCRA characteristic waste due to toxicity. The analytical test specified in Appendix II of 40 CFR 61 is referred to as the Toxic Characteristic Leaching Procedure (TCLP).

TABLE 3-16. SUMMARY OF PERTINENT ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 8, ANDERSEN AFB, GUAM.

AUTHORITY	CITATION	ARAR DETERMINATION (may not pertain to each remedial alternative)	SYNOPSIS OF REQUIREMENT
RCRA Generator Requirements for Manifesting Waste for Offsite Disposal	40 CFR 262	Applicable	Standards for manifesting, marking, and recording hazardous waste shipments for offsite treatment/disposal.
RCRA - Subpart I, Use and Management of Containers	40 CFR 264, Subpart I	Applicable	Outlines use and management standards applicable to owners and operators of all hazardous waste facilities that store containers of hazardous waste.
RCRA Standards Applicable to Generators of Hazardous Waste	40 CFR 262	Applicable	These regulations establish standards for generators of hazardous waste including labeling, manifesting, and reporting requirements.
EPA Office of Solid Waste and Emergency Response (OSWER)	Publication 9345.3-03 FS (January 1992)	To Be Considered	Management of wastes generated during remedial activities must ensure protection of human health and the environment.
Land Disposal Restrictions ("Land Ban")	40 CFR 268	Applicable	LDR treatment standards for contaminated soils require that contaminated soils that will be land disposed be treated to reduce concentrations of hazardous constituents by 90 percent or meet hazardous constituent concentrations that are ten times the universal treatment standards.
Clean Air National Air Quality Standards (NAAQSs)	40 CFR 50	To Be Considered	Promotes guideline air quality standards to protect human health and welfare.
Corrective Action Management Unit (CAMU) Regulations	40 CFR 264.552	Relevant and Appropriate	Regulates the management and disposal of RCRA defined hazardous waste as part of corrective response actions and remedial actions.
Territorial			
Hazardous Waste Management Program	10 Guam Code Annotated, 51103	Applicable	Regulates the storage, treatment, handling, transport, and disposal of hazardous waste. Also establishes a program that identifies hazardous waste, regulates hazardous waste storage, treatment, handling, transport and disposal, and establishes capabilities for inspection and enforcement to ensure that hazardous waste management activities will not jeopardize human health and are carried out in an environmentally sound manner.

TABLE 3-16. SUMMARY OF PERTINENT ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 8, ANDERSEN AFB, GUAM.

AUTHORITY	CITATION	ARAR DETERMINATION (may not pertain to each remedial alternative)	SYNOPSIS OF REQUIREMENT
Solid Waste Management Act	10 Guam Code Annotated, Chapter 51	Applicable	Regulates the management of solid waste and hazardous waste.
Guam Solid Waste Management Program	Rules and Regulations for the Guam Environmental Protection Agency (Guam EPA) Solid Waste Disposal, Title 22, Division 4, Chapter 23, Article 6 (§23601 and §23602)	Relevant and Appropriate	Specifies landfill closure (e.g., capping) criteria and post-closure care requirements.
Air Pollution Control Act	10 Guam Code Annotated, Chapter 49	Applicable	Prohibits the generation of fugitive dust emissions.

ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
COC = Contaminant of Concern
Guam EPA = Guam Environmental Protection Agency
HHRA = Human Health Risk Assessment
LDR = Land Disposal Restrictions
PRG = Preliminary Remediation Goal
RBC = Risk-Based Concentration
RCRA = Resource Conservation and Recovery Act
TBC = To Be Considered
TCLP = Toxicity Characteristic Leaching Procedure
USC = United States Code
USEPA = U.S. Environmental Protection Agency

TABLE 3-17. COMPARISON OF ARARs COMPLIANCE FOR REMEDIAL ALTERNATIVES FOR SITE 8, ANDERSEN AFB, GUAM.

AUTHORITY	REMEDIAL ALTERNATIVE		
	No Further Action	**Institutional Controls and Engineering Controls**	**Slope Stabilization and Soil Cover**
Chemical Specific			
No chemical specific ARARs or TBCs have been identified for Site 8.			
Location Specific			
Endangered Species Act	Not applicable.	ARAR would be met. No endangered species have been observed at the site and none of the critical habitats for these species are included within Site 8. However, Site 8 is potentially within the foraging range of the Mariana crow and the Micronesian starling. No unacceptable ecological risks have been identified onsite. Institutional controls would not adversely impact endangered species or their habitat.	ARAR would be met. No endangered species have been observed at the site and none of the critical habitats for these species are included within Site 8. However, Site 8 is potentially within the foraging range of the Mariana crow and the Micronesian starling. No unacceptable ecological risks have been identified onsite. The remedial action plan would be assessed to ensure that there is no adverse impact to potential nesting or foraging habitat of endangered species.
Guam Wellhead Protection Program	Not applicable.	Not applicable.	Groundwater is not a media of concern for the Feasibility Study. However, all groundwater on the Northern Plateau has been designated as a Sole Source Aquifer. Guam EPA must review any project in this aquifer regardless if a permit is required.
Historical Objects and Sites	Not applicable.	Not applicable.	Although Site 8 is not listed for protection under the National Historic Preservation Act, remedial actions would be conducted in accordance with the substantive requirements of this regulation.

TABLE 3-17. COMPARISON OF ARARs COMPLIANCE FOR REMEDIAL ALTERNATIVES FOR SITE 8, ANDERSEN AFB, GUAM.

AUTHORITY	REMEDIAL ALTERNATIVE		
	No Further Action	**Institutional Controls and Engineering Controls**	**Slope Stabilization and Soil Cover**
Fish, Game, Forestry & Conservation	Not applicable.	ARAR would be met. No endangered species have been observed at the site and none of the critical habitats for these species are included within Site 8. However, Site 8 is potentially within the foraging range of the Mariana crow and the Micronesian starling. No unacceptable ecological risks have been identified onsite. Institutional controls would not adversely impact endangered species or their habitat.	ARAR would be met. No endangered species have been observed at the site and none of the critical habitats for these species are included within Site 8. However, Site 8 is potentially within the foraging range of the Mariana crow and the Micronesian starling. No unacceptable ecological risks have been identified onsite. The remedial action plan would be assessed to ensure that there is no adverse impact to potential nesting or foraging habitat of endangered species.
Action Specific			
40 CFR 258, Subpart F RCRA Subtitle D Municipal Solid Waste	Not applicable.	Not applicable.	ARAR would be met. The final cover system would be designed and constructed to minimize infiltration and erosion in accordance with the RCRA Subtitle D requirements. Post-closure care activities would also be conducted in accordance with those requirements.
RCRA regulations for Identification of Hazardous Waste 40 CFR 261 Transport of Hazardous Waste 40 CFR 263, and for LDRs and landfills	Not applicable.	Not applicable.	Any excavated material to be disposed offsite would be tested for hazardous waste characteristics (ignitability, reactivity, corrosivity, or TCLP). Any material classified as hazardous waste would be handled, stored, transported, and disposed in accordance with RCRA.
RCRA Generator Requirements for Manifesting Waste for Offsite Disposal	Not applicable.	Not applicable.	If remedial actions require the offsite disposal of RCRA-defined hazardous waste, then the substantive requirements of these regulations would be followed.

TABLE 3-17. COMPARISON OF ARARs COMPLIANCE FOR REMEDIAL ALTERNATIVES FOR SITE 8, ANDERSEN AFB, GUAM.

AUTHORITY	REMEDIAL ALTERNATIVE		
	No Further Action	**Institutional Controls and Engineering Controls**	**Slope Stabilization and Soil Cover**
RCRA - Subpart I, Use and Management of Containers	Not applicable.	Not applicable.	If remedial actions require storage of hazardous waste in containers, then the substantive requirements of these regulations would be followed.
RCRA Standards Applicable to Generators of Hazardous Waste	Not applicable.	Not applicable.	Remediation-derived waste may be characterized as hazardous waste. If so, the material would be handled in compliance with the substantive requirements of these standards.
40 CFR 268 Land Disposal Restrictions ("Land Ban")	Not applicable.	Not applicable.	Any soil classified as a hazardous waste that is to be disposed offsite, would be treated as necessary, to meet the established LDR treatment standards.
Corrective Action Management Unit (CAMU) Regulations	Not applicable.	Not applicable.	No hazardous waste or recently generated waste would be placed at the site. Groundwater in the vicinity of the site would be monitored under a separate program.
Guam Hazardous Waste Management Program	Not applicable.	Not applicable.	Any hazardous waste remediation at Site 8 would be conducted in accordance with the substantive requirements of these regulations.
Guam Solid Waste Management Act	Not applicable.	Not applicable.	Any solid waste remediation at Site 8 would be conducted in accordance with the substantive requirements of these regulations.

TABLE 3-17. COMPARISON OF ARARs COMPLIANCE FOR REMEDIAL ALTERNATIVES FOR SITE 8, ANDERSEN AFB, GUAM.

AUTHORITY	REMEDIAL ALTERNATIVE		
	No Further Action	**Institutional Controls and Engineering Controls**	**Slope Stabilization and Soil Cover**
Guam Solid Waste Management Program	Not applicable.	Not applicable.	ARAR would be met. The final cover system would be designed and constructed to minimize infiltration and erosion in accordance with these requirements. Post-closure care activities would also be conducted in accordance with these requirements.
Guam Air Pollution Control Act	Not applicable.	Not applicable.	Remedial activities would be conducted in a manner to minimize fugitive dust emissions.

ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
Guam EPA = Guam Environmental Protection Agency
LDR = Land Disposal Restrictions
RCRA = Resource Conservation and Recovery Act
TBC = To Be Considered
TCLP = Toxicity Characteristic Leaching Procedure

TABLE 3-18. ARARs COMPLIANCE OF THE SELECTED REMEDY FOR SITE 8, ANDERSEN AFB, GUAM.

AUTHORITY	INSTITUTIONAL CONTROLS AND ENGINEERING CONTROLS ALTERNATIVE
Chemical Specific	
No chemical specific ARARs or TBCs have been identified.	
Location Specific	
Endangered Species Act	ARAR would be met. No endangered species have been observed at the site and none of the critical habitats for these species are included within Site 8. However, Site 8 is potentially within the foraging range of the Mariana crow and the Micronesian starling. No unacceptable ecological risks have been identified onsite. Institutional controls would not adversely impact endangered species or their habitat.
Fish, Game, Forestry & Conservation	ARAR would be met. No endangered species have been observed at the site and none of the critical habitats for these species are included within Site 8. However, Site 8 is potentially within the foraging range of the Mariana crow and the Micronesian starling. No unacceptable ecological risks have been identified onsite. Institutional controls would not adversely impact endangered species or their habitat.
Action Specific	
No action specific ARARs or TBCs have been identified.	

ARAR = Applicable or Relevant and Appropriate Requirement
TBC = To Be Considered

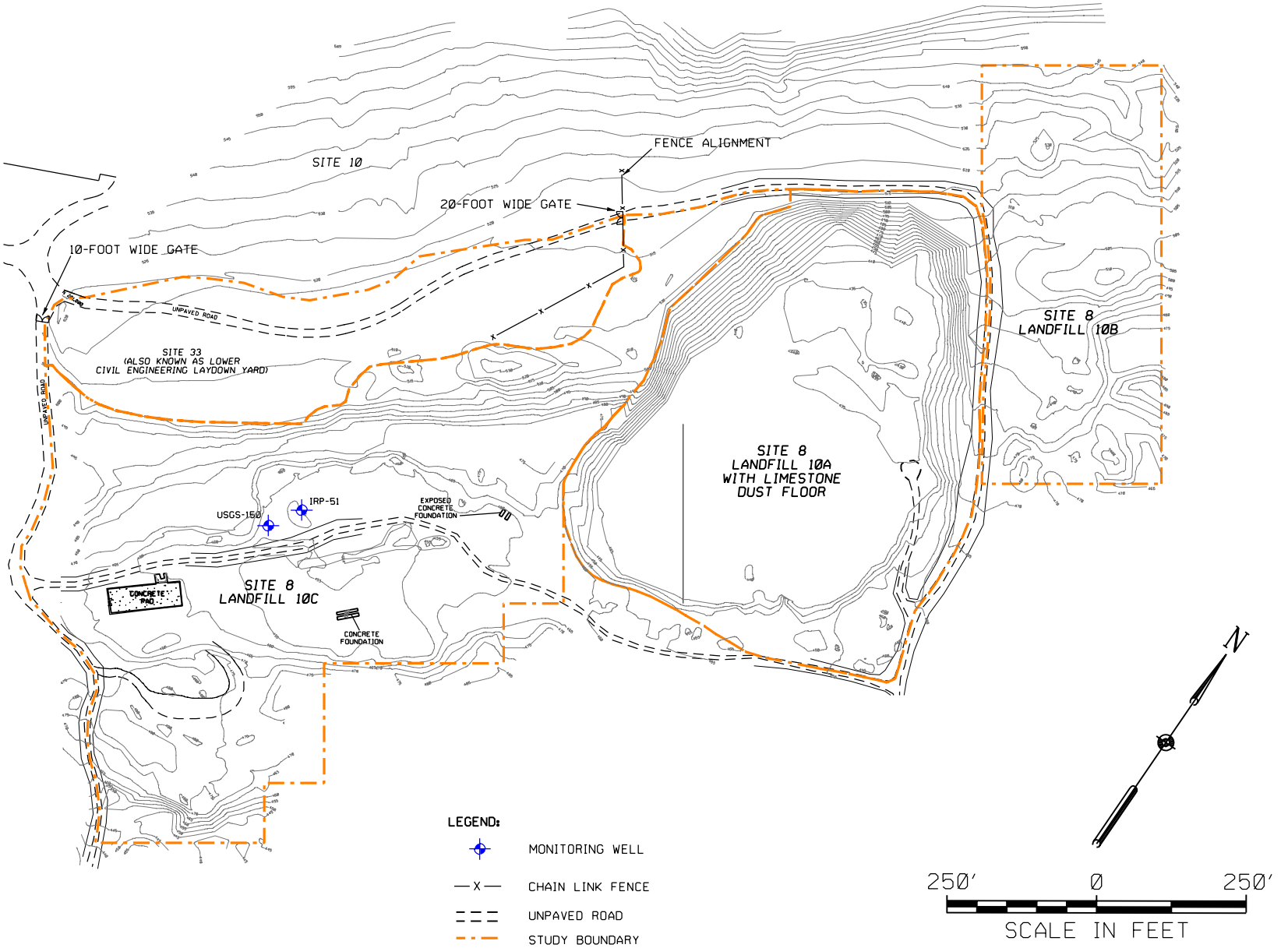
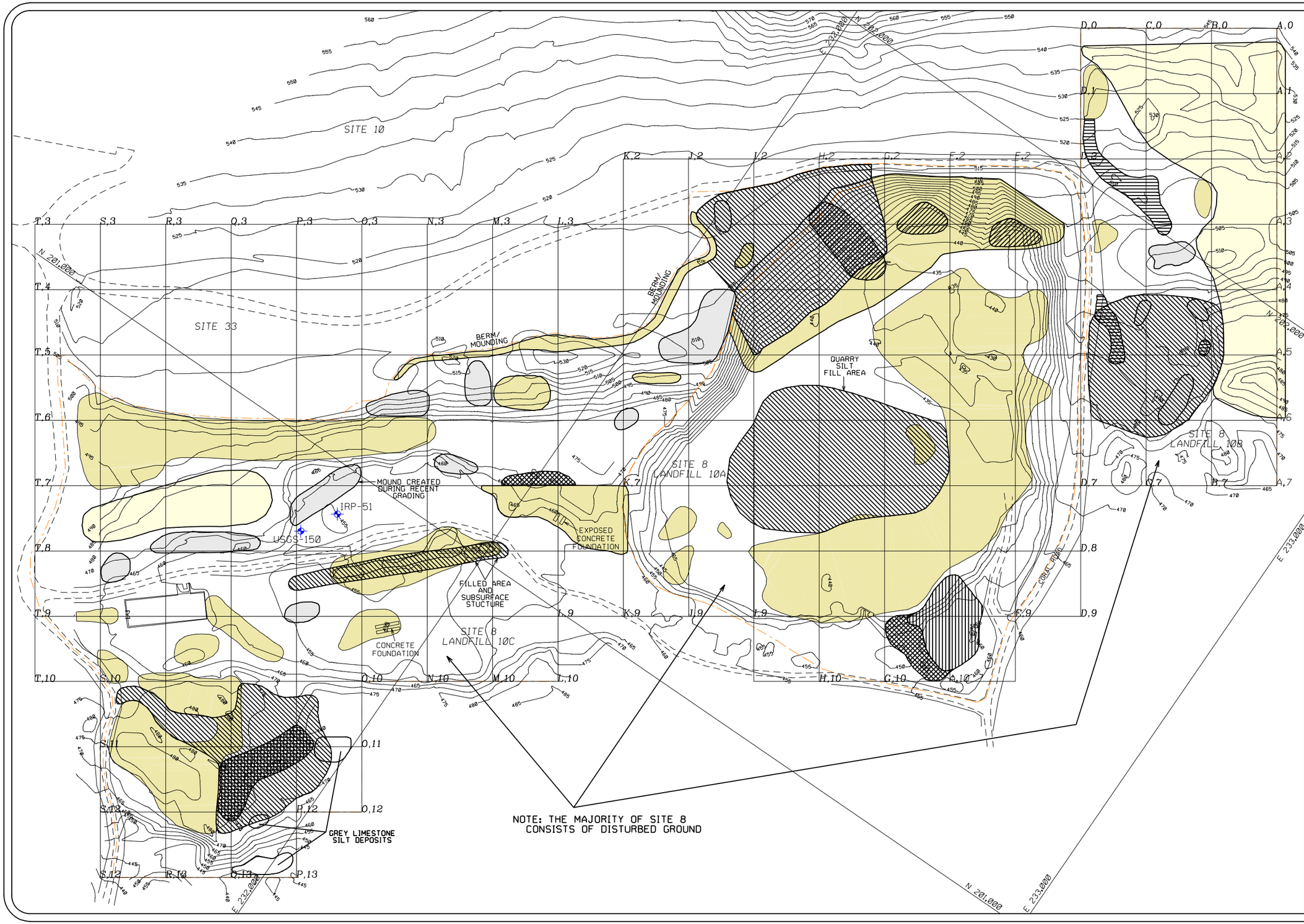
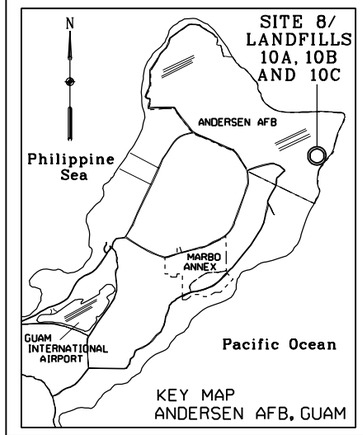


Figure 3-1. Surface Topography and Site Map of Site 8, Landfills 10A, 10B, and 10C, Andersen AFB, Guam.





KEY MAP
ANDERSEN AFB, GUAM

LEGEND:

- APPROXIMATE AREAS OF SURFACE DEBRIS
- MOUNDS
- AREAS OF ASPHALT PILES
- LIMESTONE BOULDERS
- POURED CONCRETE SURFACE
- CONCRETE RUBBLE
- DRUM PILES
- DEEP FILL AREA
- UNDISTURBED GROUND
- 470 — 5 FOOT SURFACE TOPOGRAPHY CONTOURS, ABOVE MEAN SEA LEVEL
- STUDY BOUNDARY
- MONITORING WELL
- D,9 GRID CELL IDENTIFICATION

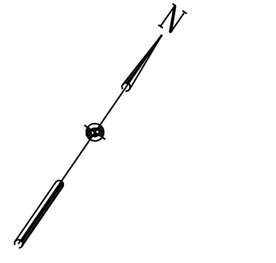


Figure 3-2.
Site Inventory Results
and Site Characteristics
at Site 8/Landfills
10A, 10B and 10C,
Andersen AFB, Guam

AAFB05S08S009 0.33 - 0.50
ANR
ND
ND
ANR
BAL

AAFB05S08S010 0.25 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S162 0.00 - 0.20
ANR
ANR
ANR
BAL
ANR

AAFB05S08S011 0.17 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S012 0.33 - 0.50
ANR
ND
ND
ANR
BAL

AAFB05S08S020 0.17 - 0.33
ANR
ND
BAL
ANR
BAL

AAFB05S08S013 0.17 - 0.33
ANR
ND
ND
ANR
BAL

AAFB05S08S008 0.33 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S163/ AAFB05S08S163 (DUP) 0.00 - 0.30
ANR
ANR
ANR
BAL
ANR

AAFB05S08S003 0.17 - 0.42
ANR
ND
BAL
ANR
BAL

AAFB05S08S002 0.17 - 0.50
ANR
ND
ND
ANR
BAL

AAFB05S08S007 0.33 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S006 0.33 - 0.50
ANR
ND
ND
ANR
BAL

AAFB05S08S165 0.00 - 0.30
ANR
ANR
ANR
ND
ANR

AAFB05S08S022 0.17 - 0.25
ANR
ND
BAL
ANR
BAL

AAFB05S08S014 0.17 - 0.33
ANR
ND
BAL
ANR
BAL

AAFB05S08S099/ AAFB05S08S099 (DUP) 0.17 - 0.25
ANR
ANR
ANR
ANR
BAL

AAFB05S08S135 0.17 - 0.25
ANR
ANR
BAL
ANR
ANR

AAFB05S08S015 0.17 - 0.25
ANR
ND
BENZO(A)PYRENE 70
ANR
BAL

AAFB05S08S134 0.17 - 0.33
ANR
ANR
ND
ANR
ANR

AAFB05S08S019 0.17 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S028 0.17 - 0.25
ANR
ND
ND
ANR
BAL

AAFB05S08S016 0.25 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S001 0.17 - 0.50
ANR
ND
ND
ANR
BAL

AAFB05S08S161 0.00 - 0.30
ANR
ANR
ANR
BAL
ANR

AAFB05S08S057 7.00 - 8.00
ND
ND
ND
ANR
BAL

AAFB05S08S023 0.17 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S004/ AAFB05S08S004 (DUP) 0.08 - 0.42
ANR
ND
BAL
ANR
BAL

AAFB05S08S027 0.17 - 0.33
ANR
ND
BAL
ANR
BAL

AAFB05S08S025/ AAFB05S08S025 (DUP) 0.17 - 0.33
ANR
ND
BAL
ANR
BAL

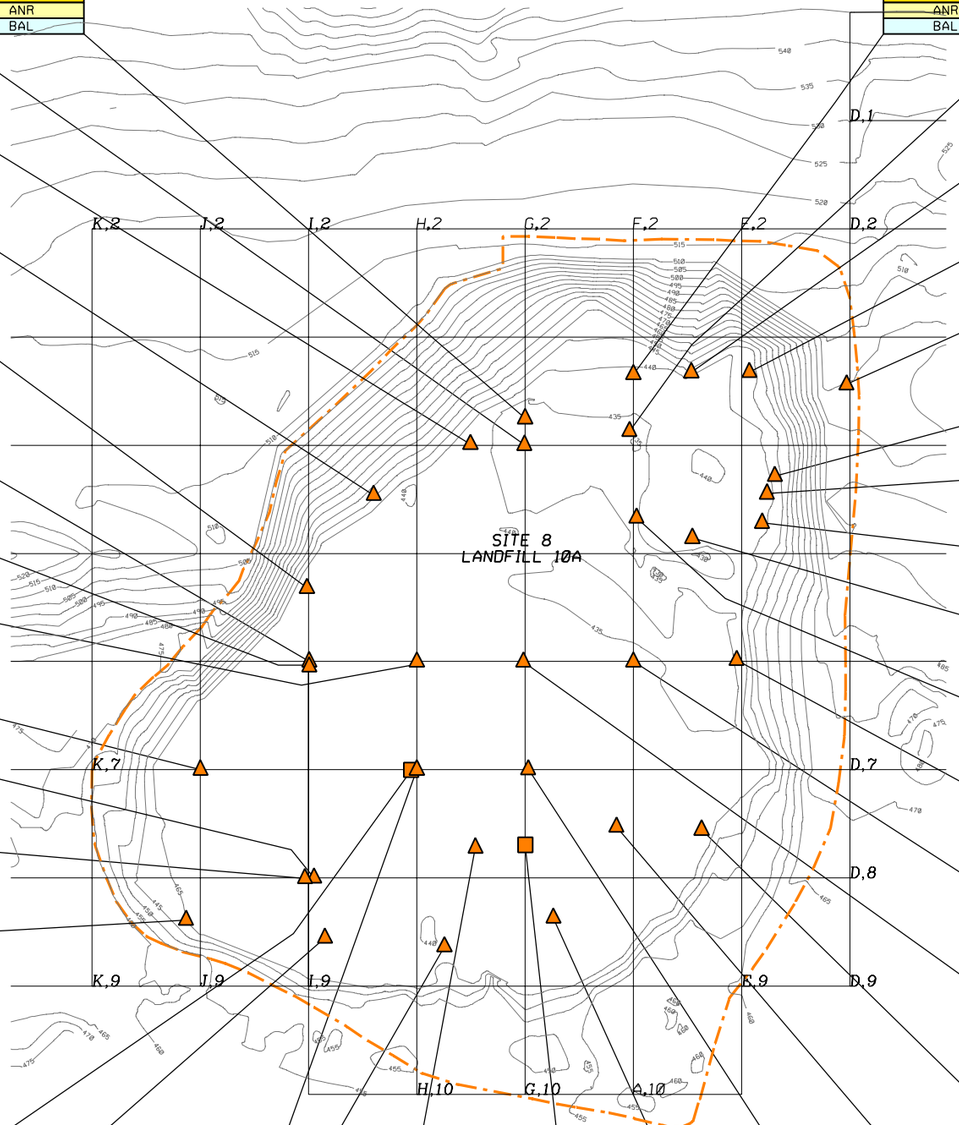
AAFB05S08S064 1.50 - 2.00
ND
ND
BAL
ANR
BAL

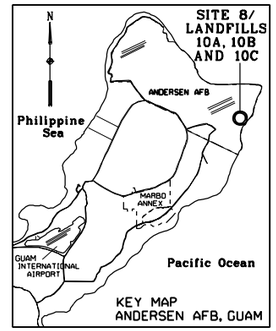
AAFB05S08S024 0.17 - 0.33
ANR
ND
BAL
ANR
BAL

AAFB05S08S160 0.00 - 0.30
ANR
ANR
ANR
BAL
ANR

AAFB05S08S021 0.17 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S017/ AAFB05S08S017 (DUP) 0.17 - 0.25
ANR
ND
BAL
ANR
BAL





LEGEND:

- SURFACE SOIL SAMPLE LOCATION
- SUBSURFACE SOIL SAMPLE LOCATION
- STUDY BOUNDARY
- 478 — 5 FOOT SURFACE TOPOGRAPHY CONTOURS, ABOVE MEAN SEA LEVEL
- D,9 GRID CELL IDENTIFICATION

SAMPLE LOCATIONS IN RED EXCEED BTVs AND/OR INDUSTRIAL PRGs

AAFB05S08S135 0.17 - 0.25	
ANR	SAMPLE ID
ANR	SAMPLE DEPTH IN FEET
BAL	VOCs, UG/KG
ANR	SVOCs, UG/KG
ANR	PAHs, UG/KG
	PESTICIDES/PCBs, UG/KG
	INORGANICs, MG/KG

REPORTABLE HITS ABOVE RESIDENTIAL OR INDUSTRIAL PRGs AND/OR BTVs

BOLD = BOLDED VALUES INDICATE CONCENTRATIONS EXCEED BTVs AND/OR EPA's INDUSTRIAL PRGs

NON-BOLDED VALUES INDICATE CONCENTRATIONS EXCEED BTVs AND/OR EPA's RESIDENTIAL PRGs

ND = NOT DETECTED

P = DIFFERENCE BETWEEN 2 GC COLUMNS EXCEEDS 40%

ANR = ANALYSIS NOT REQUIRED

BAL = BELOW ACTION LEVELS

J = CONCENTRATION IS APPROXIMATE

NJ = ANALYTE IS TENTATIVELY IDENTIFIED AND CONCENTRATION IS APPROXIMATE

D = DILUTED SAMPLE

N = SPIKED SAMPLE RECOVERY IS NOT WITHIN THE CONTROL LIMITS

✳ = DUPLICATE ANALYSIS IS NOT WITHIN CONTROL LIMITS

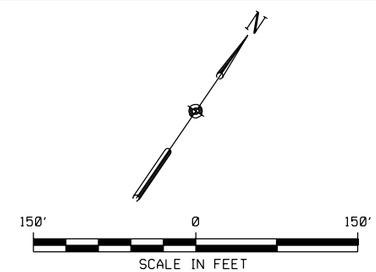


Figure 3-3.
Surface and Subsurface Soil Sample Locations and Results Exceeding Action Levels at Site 8/Landfill 10A, Andersen AFB, Guam.

AAFB05S08S029 0.17 - 0.42
ANR
ND
ND
ANR
BAL

AAFB05S08S031 0.17 - 0.42
ANR
ND
BAL
ANR
BAL

AAFB05S08S103 0.08 - 0.33
ANR
ANR
ANR
ANR
BAL

AAFB05S08S101 0.17 - 0.33
ANR
ANR
ANR
ANR
BAL

AAFB05S08S038/ AAFB05S08S038 Dup. 0.08 - 0.42
ANR
ND
BAL
ANR
LEAD 495

AAFB05S08S099/ AAFB05S08S099 Dup. 0.17 - 0.25
ANR
ANR
ANR
ANR
BAL

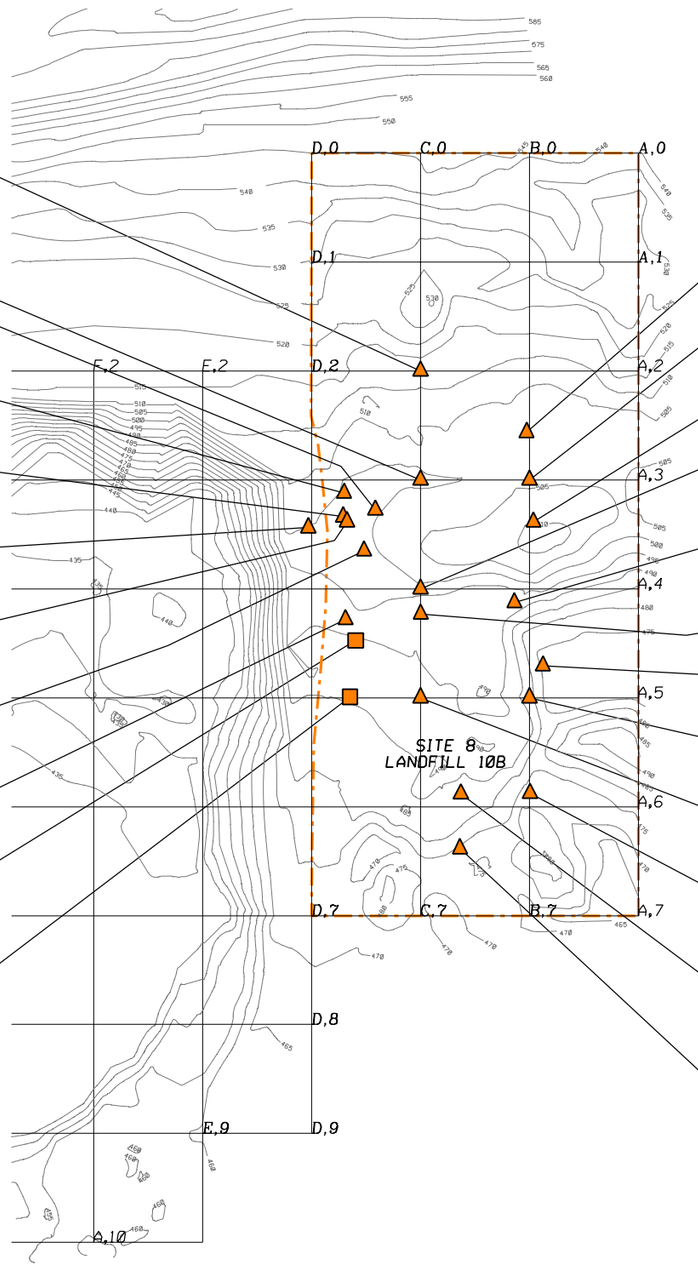
AAFB05S08S181 0.00 - 0.20
ANR
ANR
ANR
BAL
ANR

AAFB05S08S102 0.33 - 0.42
ANR
ANR
ANR
ANR
BAL

AAFB05S08S040 0.17 - 0.33
ANR
ND
BAL
ANR
BAL

AAFB05S08S065 8.00 - 9.00
ND
ND
BAL
ANR
BAL

AAFB05S08S066 9.00 - 10.0
ND
BAL
BENZO(A)PYRENE 150
ANR
BAL



AAFB05S08S137 0.17 - 0.25
ANR
ANR
ANR
ANR
BAL

AAFB05S08S030 0.08 - 0.33
ANR
ND
ND
ANR
MANGANESE 4,190

AAFB05S08S136 0.00 - 0.08
ANR
ANR
ANR
ANR
BAL

AAFB05S08S032 0.17 - 0.33
ANR
ND
BAL
ANR
BAL

AAFB05S08S041 0.17 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S042 0.17 - 0.33
ANR
ND
BAL
ANR
BAL

AAFB05S08S035 0.17 - 0.50
ANR
ND
ND
ANR
BAL

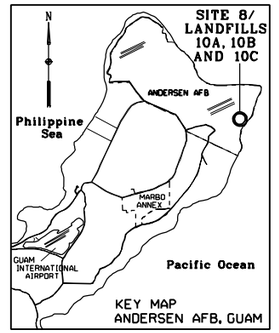
AAFB05S08S034 0.17 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S033 0.17 - 0.50
ANR
ND
BAL
ANR
BAL

AAFB05S08S036 0.08 - 0.33
ANR
ND
ND
ANR
BAL

AAFB05S08S037 0.17 - 0.33
ANR
ND
ND
ANR
BAL

AAFB05S08S043 0.33 - 0.50
ANR
ND
ND
ANR
BAL



LEGEND:

- SURFACE SOIL SAMPLE LOCATION
- SUBSURFACE SOIL SAMPLE LOCATION
- STUDY BOUNDARY
- 470 5 FOOT SURFACE TOPOGRAPHY CONTOURS, ABOVE MEAN SEA LEVEL
- D,9 GRID CELL IDENTIFICATION

SAMPLE LOCATIONS IN RED EXCEED BTVs AND/OR INDUSTRIAL PRGs

AAFB05S08S032 0.17 - 0.33	
ANR	VOCs, UG/KG
ND	SVOCs, UG/KG
BAL	PAHs, UG/KG
ANR	PESTICIDES/PCBs, UG/KG
BAL	INORGANICs, MG/KG

SAMPLE ID
SAMPLE DEPTH IN FEET

REPORTABLE HITS ABOVE RESIDENTIAL OR INDUSTRIAL PRGs AND/OR BTVs

BOLD = BOLDED VALUES INDICATE CONCENTRATIONS EXCEED BTVs AND/OR EPA's INDUSTRIAL PRGs

NON-BOLDED VALUES INDICATE CONCENTRATIONS EXCEED BTVs AND/OR EPA's RESIDENTIAL PRGs

ND = NOT DETECTED

P = DIFFERENCE BETWEEN 2 GC COLUMNS EXCEEDS 40%

ANR = ANALYSIS NOT REQUIRED

BAL = BELOW ACTION LEVELS

J = CONCENTRATION IS APPROXIMATE

NJ = ANALYTE IS TENTATIVELY IDENTIFIED AND CONCENTRATION IS APPROXIMATE

D = DILUTED SAMPLE

N = SPIKED SAMPLE RECOVERY IS NOT WITHIN THE CONTROL LIMITS

✳ = DUPLICATE ANALYSIS IS NOT WITHIN CONTROL LIMITS

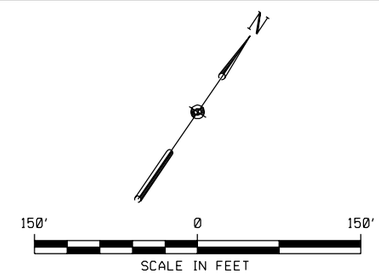
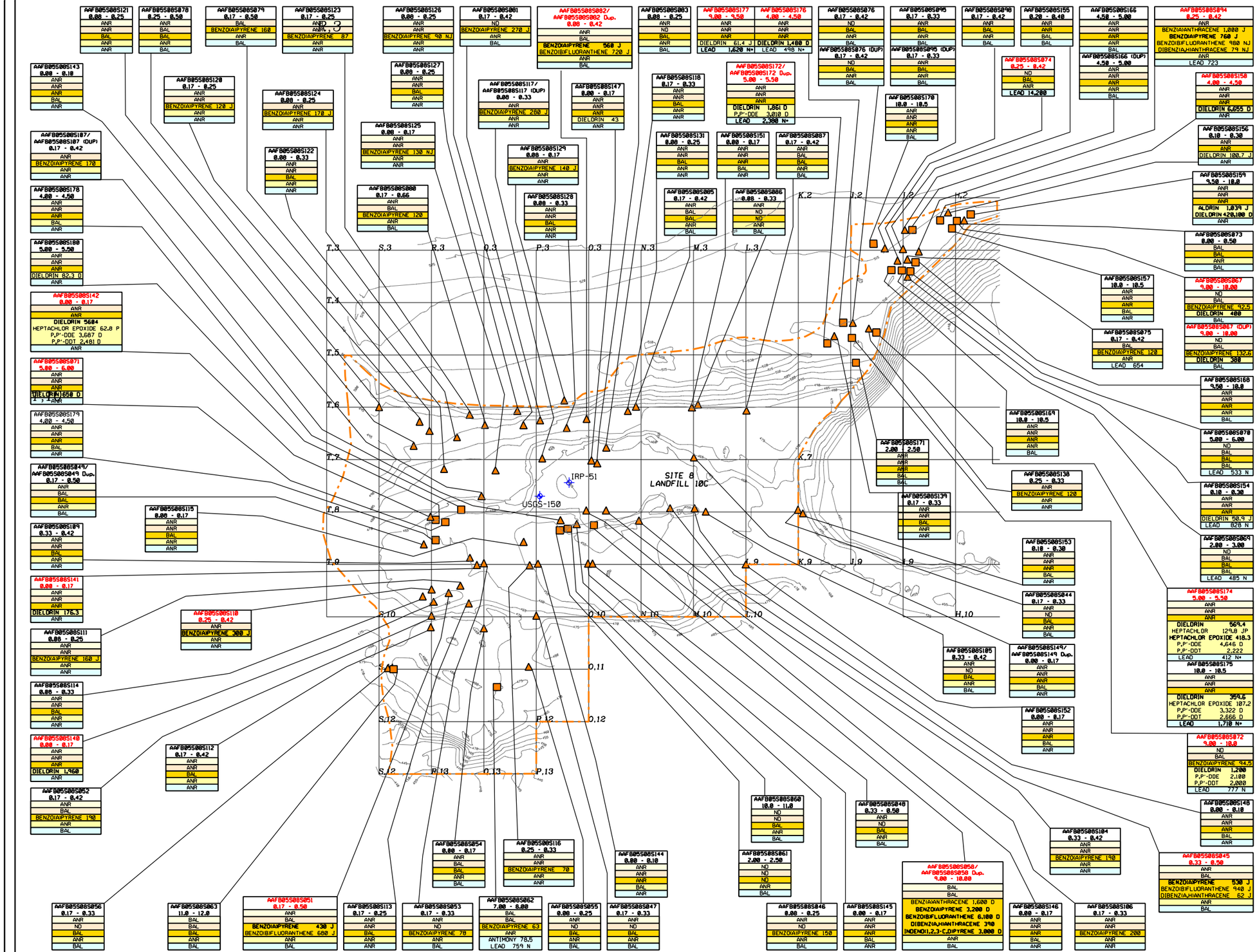
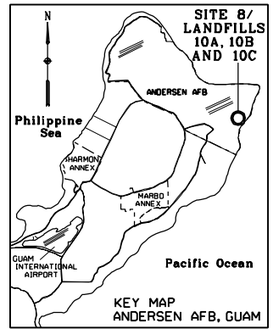


Figure 3-4.
Surface and Subsurface Soil Sample Locations and Results Exceeding Action Levels at Site 8/Landfill 10B, Andersen AFB, Guam.





LEGEND:

- SURFACE SOIL SAMPLE LOCATION
- SUBSURFACE SOIL SAMPLE LOCATION
- MONITORING WELL
- STUDY BOUNDARY
- 470 5 FOOT SURFACE TOPOGRAPHY CONTOURS, ABOVE MEAN SEA LEVEL
- D,9 GRID CELL IDENTIFICATION

SAMPLE LOCATIONS IN RED EXCEED BTVs AND/OR INDUSTRIAL PRGs

AAFB05S085158 4.00 - 4.50	SAMPLE ID / SAMPLE DEPTH IN FEET
ANR	VOCs, UG/KG
ANR	SVOCs, UG/KG
ANR	PAHs, UG/KG
DIELDRIN 6,655 D	PESTICIDES/PCBs, UG/KG
ANR	INORGANICs, MG/KG

REPORTABLE HITS ABOVE RESIDENTIAL OR INDUSTRIAL PRGs AND/OR BTVs

BOLD = BOLDED VALUES INDICATE CONCENTRATIONS EXCEED BTVs AND/OR EPA's INDUSTRIAL PRGs

NON-BOLDED VALUES INDICATE CONCENTRATIONS EXCEED BTVs AND/OR EPA's RESIDENTIAL PRGs

ND = NOT DETECTED

P = DIFFERENCE BETWEEN 2 GC COLUMNS EXCEEDS 40%

ANR = ANALYSIS NOT REQUIRED

BAL = BELOW ACTION LEVELS

J = CONCENTRATION IS APPROXIMATE

NJ = ANALYTE IS TENTATIVELY IDENTIFIED AND CONCENTRATION IS APPROXIMATE

D = DILUTED SAMPLE

N = SPIKED SAMPLE RECOVERY IS NOT WITHIN THE CONTROL LIMITS

✳ = DUPLICATE ANALYSIS IS NOT WITHIN CONTROL LIMITS

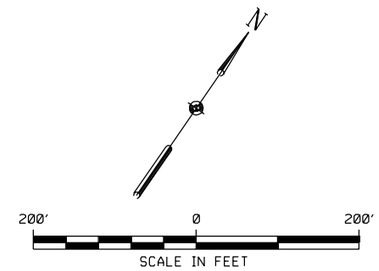


Figure 3-5.
Surface and Subsurface Soil Sample Locations and Results at Site 8/Landfill 10C, Andersen AFB, Guam.

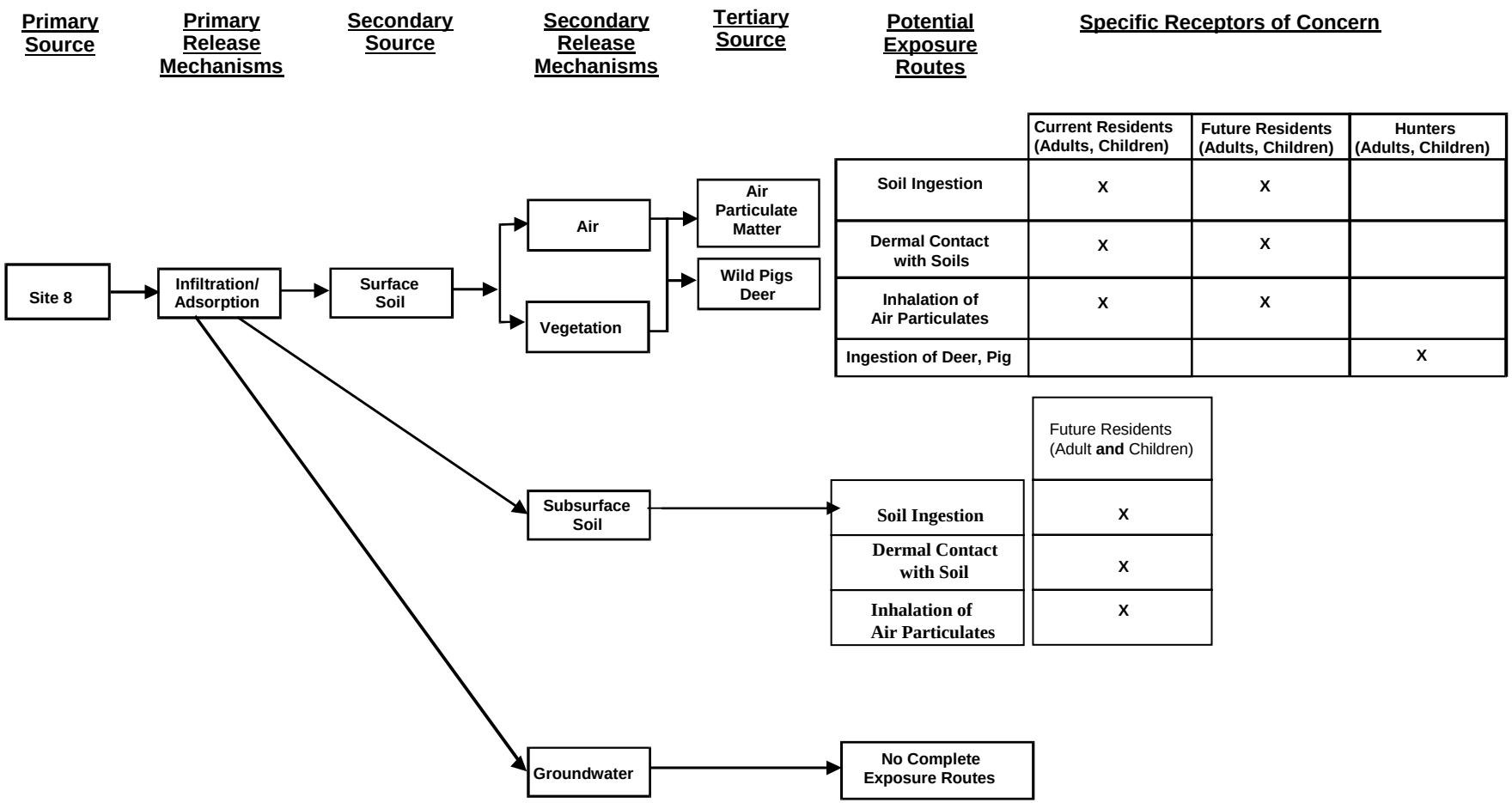
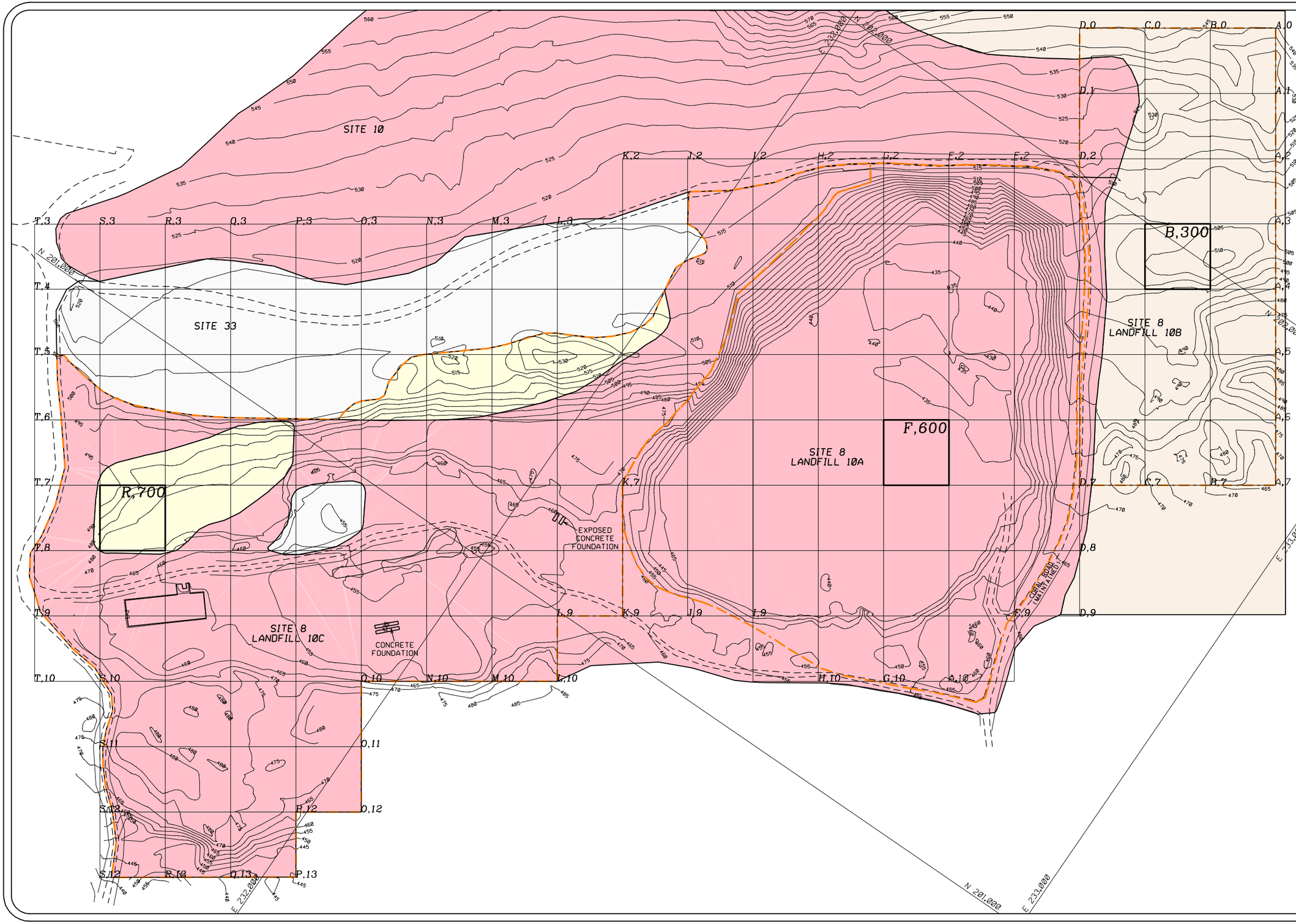
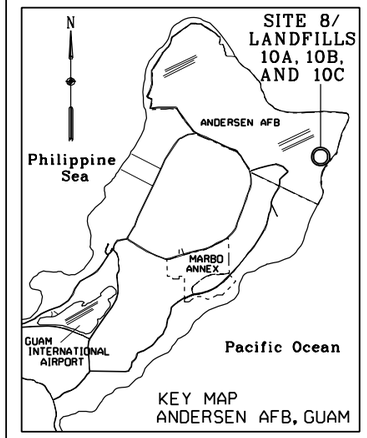


Figure 3-6. Human Health Risk Assessment Conceptual Site Model for Site 8, Andersen AFB, Guam.





LEGEND:

VEGETATIVE COMMUNITIES

- LEUCAENCA FOREST
- MIXED SHRUBS
- LIMESTONE FOREST
- ACTIVE BASE AND MAINTAINED GRASS AREAS

B,4 FLORA AND FAUNA SAMPLING CELL

470 5 FOOT SURFACE TOPOGRAPHY CONTOURS, ABOVE MEAN SEA LEVEL

STUDY BOUNDARY

D,9 GRID CELL IDENTIFICATION

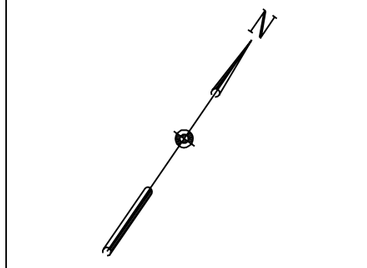


Figure 3-7. Vegetative Communities and Habitat at Site 8/Landfills 10A, 10B, and 10C, Andersen AFB, Guam.

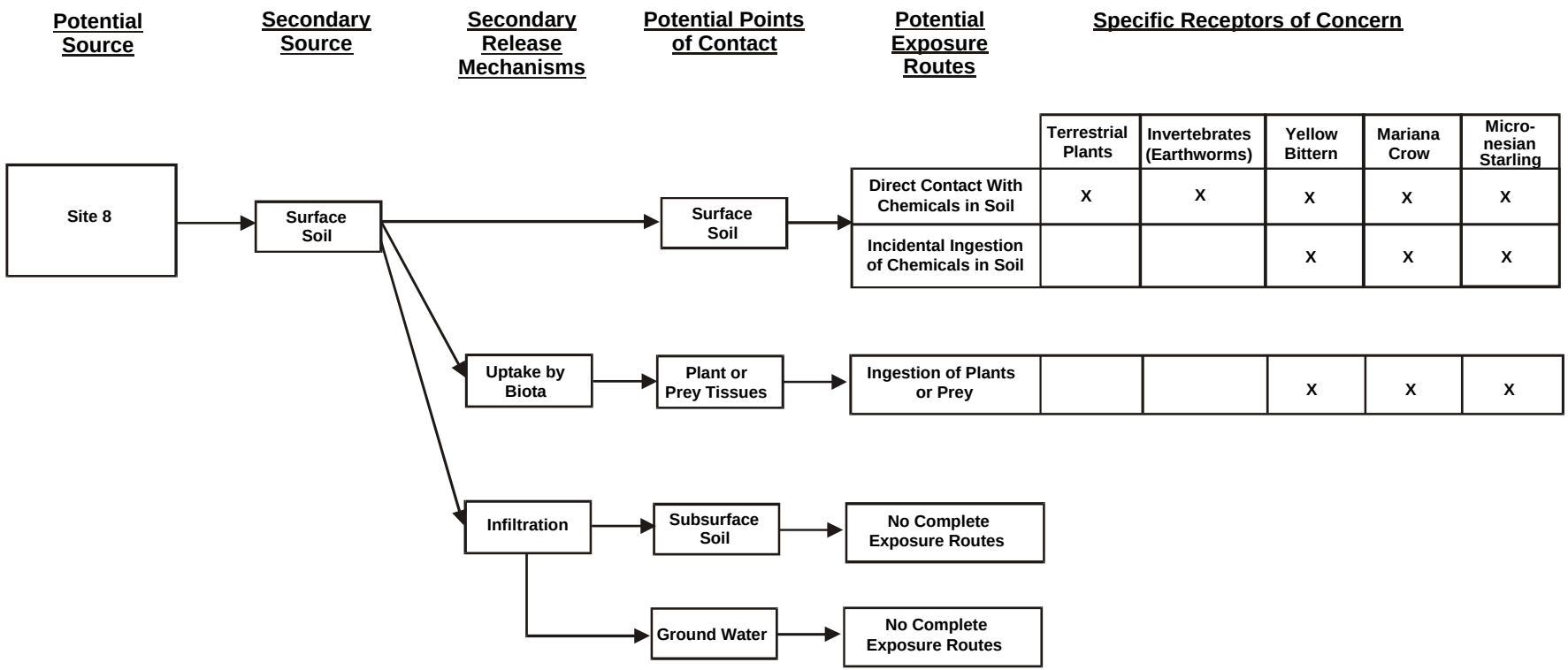


Figure 3-8. Ecological Risk Assessment Conceptual Site Model for Site 8, Andersen AFB, Guam.

4. RESPONSIVENESS SUMMARY

In this section, a summary of public involvement and comments regarding Sites 5 and 8 is presented.

In an effort to inform and involve the local community, the RAB was established in 1995 and includes community members, elected officials, USAF officials, and representatives from regulatory agencies. The RAB serves as a major focal point for environmental exchange between Andersen AFB and the local community. Since 1995, the RAB has held regular quarterly meetings that are open to the public. During the RAB meetings, the progress of the environmental investigations at Andersen AFB's IRP sites is discussed.

The Proposed Plan for Sites 5 and 8 was released to the public for review and comment on 26 July 2007. Andersen AFB published a notice of availability for the Proposed Plan documents in the Guam edition of *Marianas Variety* on 30 July 2007. The notice also included the dates of the public comment period from 26 July to 26 August 2007. A public meeting was held at the Guam Marriott Resort and Spa, Tumon on 2 August 2007, where the Proposed Plan was presented and representatives from USEPA, Guam EPA, and Andersen AFB responded to the public's questions regarding the Proposed Plan.

Upon completion of the public comment period, no written questions/comments were received [PENDING]. General and site-specific questions and responses generated at the public meeting are presented below. A transcript of the public meeting is included in the AR.

General Questions

Ms. Torres asked if there are records available to demonstrate where contaminated materials were disposed of after site cleanup activities. Mr. Ikehara stated that disposal of cleanup materials is a highly regulated activity that is very carefully documented. Information regarding the disposal of cleanup materials is reported in the final Remediation Verification Reports, which are available to the public through the information repositories or the online administrative record.

Ms. Torres asked if the Air Force is going to investigate health concerns related to individuals who may have been exposed to site contaminants prior to or during remediation activities: Mr. Ikehara responded; it is unfortunately impossible to go back and determine historical health impacts. However, current epidemiological studies can be used to try and determine if there are linkages between present day health concerns and potential historical exposures to contaminants, but it is very difficult to draw any clear one-to-one correlation of cause and effect; we'll do the best we can.

Ms. Brown asked if measures are taken to identify potentially contaminated sites so that the public is aware of there locations. Mr. Ikehara stated that signs were posted at the sites with contact numbers in case people wish to enter those areas. Interested parties can contact the Environmental Office on Andersen and provide them with the site name, whereupon the Environmental Office can identify the risks or hazards posed at the site. Engineering controls

such as fencing or soil cover are used at sites that carry significant exposure risk, if deemed necessary.

Ms. Brown asked if there will be any further evaluation of sites with only slight risk or those which have been remediated once they have been closed. Mr. Ikehara responded that CERCLA allows for sites to be reopened if more information is uncovered that indicates that the site still poses significant risk. Andersen Air Force Base is currently scheduled to address all of the IRP sites by the year 2012.

Site 5

Ms. Brown asked for clarification regarding the efforts that were made to clean materials from areas that are currently located under residences at Site 5, and if residents were made aware of the conditions that exist under the foundations of their homes. Mr. Ikehara responded; landfill materials at the site were first identified during the construction phase of the residences around 1953-1954 time frame. Landfill material was excavated down to approximately five feet, for engineering purposes, to allow the concrete structures to be built. A public meeting was held at the time the original Site 5 cleanup activities took place in order to inform residents of materials that would remain under building structures following completion of the cleanup. Mr. Ikehara added that institutional controls were included as part of the selected remedy to address proper management and reevaluation of these materials over time.

Ms. Brown asked how many homes were involved. Mr. Ikehara stated that about nine duplex homes are involved. Mr. Ikehara further stated that at some point in the future, as the homes become obsolete, their destruction may be necessary to allow complete cleanup of materials currently located under their foundations.

5. REGULATORY COMMENTS AND AIR FORCE RESPONSES

In this section of the ROD, all USEPA and Guam EPA comments are presented in tabular format along with the USAF responses. It should be noted that all reference figure, table, and section numbers in the comments refer to the July 2007 Agency Draft ROD. Some of these section and table numbers have been revised in this August 2007 version of the ROD.

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Review of the Agency Draft
Record of Decision for Sites 5 and 8
Main Base Operable Unit, Andersen Air Force Base, Guam
July 2007

Item	Page	Section	Comments	Contractor Response to Comments
Comments provided by Mark Ripperda, USEPA Region 9, via e-mail				
Specific Comments				
1	Page 3-28 and Table 3-2	Site 8	Initial Comment: The risk assessment for Site 8 (page 3-28) shows a surface soil lead EPC of 610 while Table 3-2 has an EPC of 1435 for lead. Which one is correct? It makes a difference because at 610 mg/kg your LUC control remedy is appropriate. At 1435 mg/kg you would need additional restrictions against industrial and recreational/trespass.	Initial Response: You are correct, the table on page 3-28 states that 610 mg/kg is the RME EPC for lead. Actually, 610 mg/kg is the arithmetic mean lead concentration in surface soil at Site 8, LF10C. Table 3-2 states that the EPC for lead is 1435 mg/kg based on 95% UCL for log normally distributed data (95-UCL H). However, in order to determine the risks associated with lead in the RI, we used the arithmetic mean of the raw data (610 mg/kg) as the input parameter into the IEUBK model, and not any of the pro-UCL suggested outputs for 95% UCL for Lognormal-, Gamma-, or Non-parametric distributed data. This approach was intentional and deemed appropriate by our risk assessor. Questions related to the EPC came up during your review of the Proposed Plan. We had originally stated only the max concentration (14200 mg/kg) and you requested that we state the EPC. Because the EPC was 1435 mg/kg we had some discussion that engineering controls (i.e., a fence as part of the permanent remedy) would be part of the selected remedial alternative along with LUCs. We will make similar adjustments to the description of the preferred remedial alternative in the

Item	Page	Section	Comments	Contractor Response to Comments
				ROD. Agency Proposed Plan Comment: The lead EPC is at 1400, well over the PRG of 800. We either need to evaluate a hot-spot removal or cover of the area with 14,000 to bring down the overall EPC, or make the fence part of the permanent remedy as an engineering control, along with more description of the inaccessibility of 10C. A fence or other physical restriction is an engineering control, not an LUC. Contractor Response to Proposed Plan Comment: The PP document will be modified to include text that specifically states the fence will be part of the permanent remedy at Site 8, Landfill 10C. Where appropriate, the document will identify the fence as an engineering control that will be employed in addition to the LUCs under the selected alternative (Alternative 2). Additional text will be added that describes the inaccessibility of Site 10C. As part of Alternative 3, soil-cover placed on the hotspots was an evaluated remedy but due to instability of the slope, this remedy was not considered practicable. Contractor Response: The ROD has been clarified to state that the selected remedy is the "*Institutional Controls and Engineering Controls* Alternative". A footnote was added to the in-text table titled "SUMMARY OF RISK-BASED REMEDIAL GOALS FOR SURFACE AND SUBSURFACE SOIL AT SITE 8, LANDFILL 10C, FOR RESIDENT ADULTS AND CHILDREN" located
			Agency Response: We can continue with the EPC of 1,435 mg/kg and make it clear in the ROD that the remedy is both LUCs and engineering controls, or you can report only the RME and have a remedy of simply LUCs.	

Item	Page	Section	Comments	Contractor Response to Comments
				on page 3-28 of the ROD. The updated table will be presented in the Final ROD on page 3-28.
2	Pages 2-28 and 3-30 and Appendix A		In reference to the *Sample Federal Facility Land Use Control ROD Checklist with Suggested Language*: Please add language for item 7 that states that the Air Force is responsible for implementing, maintaining, reporting on, and enforcing the land use controls. This could go on page 2-28 and 3-30 and in the Appendix.	Comment acknowledged. The second to last sentences of the bulleted paragraphs in Sections 2.9.2 and 3.9.2 have been reworded as follows: "The USAF (36 CES/CEVR) is responsible for implementing, maintaining, reporting on, and enforcing LUCs established in approved decision documents for IRP sites within Andersen AFB." The following sentence has been to Appendix A, Tables A-1 (page A-4) and A-2 (page A-8): "The USAF's 36 CES/CEVR is responsible for implementing, maintaining, reporting on, and enforcing the LUCs established in approved decision documents for IRP sites within Andersen AFB." The sentence is located in the "Prepare and Maintain a LUCMP" section, as the second sentence of the first paragraph.
3		Appendix A	In reference to the *Sample Federal Facility Land Use Control ROD Checklist with Suggested Language*: Items 8, 10, 11, 12, 13, 14, and 15 should have the checklist language included VERBATIM.	Comment acknowledged. The verbatim language has been added to Appendix A as outlined below. Item 8: Tables A-1 (page A-5) and A-2 (page A-9)—The second sentence of the "Lease or Transfer of Property" section has been replaced with the verbatim language. Item 10: Tables A-1 (page A-4) and A-2 (page A-8)—The first sentence, third paragraph, of the "Prepare and Maintain a LUCMP" section has been replaced with the verbatim language.

Item	Page	Section	Comments	Contractor Response to Comments
				Item 11: Tables A-1 (page A-4) and A-2 (page A-8)—The second sentence, third paragraph, of the "Prepare and Maintain a LUCMP" section has been replaced with the verbatim language. Item 12: Tables A-1 (page A-4) and A-2 (page A-8)—The verbatim language has been added to the "Prepare and Maintain a LUCMP" section as the as the third sentence of the third paragraph. Item 13: Tables A-1 (page A-5) and A-2 (page A-9)—Sentences 3 through 5 of the "Lease or Transfer of Property" section have been replaced with the verbatim language. Item 14: Table A-1 (page A-5)—The second to last sentence of the "Base General Plan" section has been replaced with the verbatim language. Table A-2 (pages A-9 and A-10)—The second and third to last sentences of the "Base General Plan" section have been replaced with the verbatim language. Item 15: Tables A-1 (page A-6) and A-2 (page A-10)—A section titled "Monitoring and Reporting" containing the verbatim language has been added directly following the "Base General Plan" section.

Item	Page	Section	Comments	Contractor Response to Comments
Comments provided by Lewis Maldonado, Senior Counsel, USEPA Region 9, via e-mail				
Specific Comments				
1	Page 1-4	Section 1.7, Declaration	In the phrase "...the USAF and the USEPA Region 9 have co-selected, and the Guam EPA concurs with...", there should be a comma after the words "concurs with". The word "selected" before the word "remedies" should also be deleted since the sentence already earlier says "co-selected".	Comment acknowledged. A comma has been inserted and the word “selected” has been deleted as requested.
2	Pages 1-5, 1-7, and 1-9	Declaration, Signature Page Documents	At the top of p. 1-5, 1-7, and 1-9, there is some language missing relating to Guam and the sentence should also be rewritten. The sentence at the top of p.1-5 and 1-7 should read: "This signature page documents that the USAF and the USEPA Region 9 have co-selected the remedies for Sites 5 and 8 described in this ROD." The sentence at the top of p. 1-9 should read: "This signature page documents that Guam EPA concurs with the remedies for Sites 5 and 8 co-selected by the USAF and the USEPA Region 9."	Comment acknowledged. The sentences at the tops of pages 1-5, 1-7, and 1-9 have been rewritten as requested.
3	Page 2-29	Section 2.9.2, *Institutional Controls* Alternative	I don't think we usually view the Five Year Reviews as part of the selected remedy. Rather, where waste is left in place, as here, five year reviews are required by statute. I would leave the paragraph where it is but would take out the bullet and simply have the five year review paragraph be a regular non-indented paragraph.	Comment acknowledged. The paragraph has been left as-is, and the bullet and the indentation have been removed as requested.

Item	Page	Section	Comments	Contractor Response to Comments
4	Page 2-31	Section 2.10.2, Compliance with ARARs	I would delete the first sentence of the last paragraph, which begins "The No Further Action alternative would not comply with chemical-specific TBCs because the remaining COC concentrations..." EPA's view is that for a no action alternative no ARARs should be identified because no action is being taken and ARARs, including chemical-specific ARARs and TBCs, only come into play to evaluate a response action, not the absence of a response action. After deleting the first sentence, the second sentence could then be rewritten as follows: "No ARARs were identified for the No Further Action alternative because no remedial actions are specified."	Comment acknowledged. The first sentence of the last paragraph has been deleted and the second sentence has been rewritten as requested.
5	Page 2-35	Section 2.12, Selected Remedy	I would recommend deleting the words "and affected property owners" since the property owners' concurrence is not a requirement (although community acceptance is one of the nine criteria) and they are not signing the ROD.	Comment acknowledged. The words "and affected property owners" have been deleted as requested.
6	Tables 2-15 and 2-16		As discussed below, I think there should be just one ARARs Table for Site 5 that sets forth the ARARs for the selected IC remedy. Thus in the parenthetical I would replace the reference to Tables 2-15 and 2-16 with a reference to a new Table 2-15. See next comment for more details.	Comment acknowledged. The table callout in Section 2.10.2 was rewritten as: “The ARARs and to be considered (TBC) documents for the selected remedy are presented in Table 2-15.” The table callout in Section 2.13.2 was rewritten as: “The *Institutional Controls* alternative meets each of its respective ARARs (Table 2-15).

Item	Page	Section	Comments	Contractor Response to Comments
7	Tables 2-15 and 2-16		Instead of Tables 2-15 and 2-16, there should be one Table 15 that is reworked to just state the ARARs for the selected remedy (there are only a couple). ARARs don't need to be evaluated for a no action alternative. I would also delete the references to the PRGs since they don't come into play for either no action or for the IC remedy. They are TBCs that could be considered for a soils excavation or treatment remedy, which we don't have here.	Comment acknowledged. The tables have been reworked into one to only state the ARARs for the selected remedy. References to PRGs and the reference to Risk Assessment Guidance (as noted in comment 11a) have been removed. Table 2-15 has been renamed "Summary of Pertinent ARARs and TBCs and Compliance of the Selected Remedy for Site 5, Andersen AFB, Guam". The updated Table 2-15 will be presented in the Final ROD.
8	Page 3-31	Section 3.9.2, *Institutional Controls* Alternative	With respect to the bullet on Five Year Reviews as a component of the remedy, see comment 3 above.	Comment acknowledged. The paragraph has been left as-is, and the bullet and the indentation have been removed as requested.
9	Page 3-34	Section 3.10.2, Compliance with ARARs	I would add a reference to a new Table 3-18 to the sentence "The ARARs and TBC documents for the site are presented in Tables 3-16, 3-17, and 3-18." See discussion below regarding the new table.	Comment acknowledged. The table callout in Section 3.10.2 was rewritten as: "The ARARs and TBC documents for the site are presented in Tables 3-16, 3-17, and 3-18." The table callout in Section 3.13.2 was rewritten as: "The *Institutional Controls and Engineering Controls* alternative meets each of its respective ARARs (Table 3-18)."
10	Page 3-34	Section 3.10.2, Compliance with ARARs	With respect to the paragraph that begins "The No Further Action alternative would not comply with chemical-specific TBCs..." see comment 4 above.	Comment acknowledged. The sentences have been deleted or rewritten as described in comment 4.
11	Tables 3-16 and 3-17		I think the ARARs tables (Tables 3-16 and 3-17) need to be modified somewhat and a Table 3-19 added. My main	Comments acknowledged. The updated tables (Tables 3-16, 3-17, and 3-18) will be presented in the Final ROD.

Item	Page	Section	Comments	Contractor Response to Comments
			concern here is that typically there should be an ARARs table that sets forth just the ARARs for the selected remedy. Table 3-16 describes all the potential ARARs and Table 3-17 does an ARARs comparison of the alternatives. a) Table 3-16. I would delete the references to the PRGs as TBCs. I don't think that these TBCs would be triggered either the No Action alternative (no ARARs are triggered by a No Action alternative) or the Institutional Controls alternative. I would also delete the Risk Assessment Guidance as a TBC. The risk assessment process really precedes the selection of the remedy. The guidance needs to be followed as part of that process but it is not a requirement that the remedial action itself complies with. b) Table 3-17. Again, I would delete the references to the PRGs as TBCs and the reference to the Risk Assessment Guidance as a TBC. I would also change the title of Table 3-17 to "Comparison of ARARs Compliance for Remedial Alternatives for Site 8, Andersen AFB, Guam", to distinguish it from Table 16. Right now Tables 3-16 and 3-17 have the same title, which is confusing since the two tables serve different purposes.	a) The references to PRGs and the reference to Risk Assessment Guidance have been deleted as requested. b) The references to PRGs and the reference to Risk Assessment Guidance have been deleted as requested. The title of the table has been changed to “Comparison of ARARs Compliance for Remedial Alternatives for Site 8, Andersen AFB, Guam”.

Item	Page	Section	Comments	Contractor Response to Comments
			c) Add a short Table 3-18 that will list only the ARARs that the selected remedy is complying with. I believe there may only be two ARARs.	c) Table 3-18 was created and added to the Final ROD, listing only the ARARs that the selected remedy is complying with.

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APPENDIX A

LAND USE CONTROLS FOR SITES 5 AND 8

APPENDIX A. LAND USE CONTROLS (LUCs) FOR SITES 5 AND 8

In support of the remedies selected for the Record of Decision (ROD) for Sites 5 and 8, the United States Air Force (USAF) will implement the following actions to ensure that current and future land use activities remain compatible with the land use restrictions that are imposed by the ROD, and that they remain protective of human health and the environment. The following tables (A-1 and A-2) provide a summary of each of the sites with respect to the following: (1) site risks relevant to the selected remedy, (2) a description of the property including current and anticipated future property ownership, land use, and restrictions, (3) a description of on-site structures, (4) a description of LUC objectives, (5) a list of the engineering and institutional controls and other specific measures that are required to implement LUCs consistent with the selected remedy, (6) monitoring and reporting requirements, and (7) specific corrective actions to address non-compliant LUC events.

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TABLE A-1. SUMMARY TABLE FOR IDENTIFYING LUC OBJECTIVES AND IMPLEMENTING LUCs AT SITE 5, ANDERSEN AFB, GUAM

Risk Summary: There are no unacceptable risks to ecological receptors. With the completion of a non-time-critical removal action (NTCRA), there are no unacceptable risks to human health associated with surface soil. There are no unacceptable cancer risks to human health associated with subsurface soil. Unacceptable non-cancer risks to human health were identified for resident adults/children and utility worker exposure to subsurface soil.

Hazardous Substances: Antimony, copper, lead, and manganese.

Selected Remedy: Institutional Controls (ICs) (follows an already-completed NTCRA).

Purpose of LUCs: Control direct exposure of residents and utility workers to contaminated subsurface soil within the site. The selected remedy does not include the removal of contaminated soil from the site, but is a follow-up action to a completed 2001 NTCRA that included the excavation of contaminated soil to a depth of 6 feet below ground surface (bgs). The selected remedy will result in contaminated subsurface soil remaining on site at concentrations that could pose potential unacceptable risks to future residents and utility workers. Following the NTCRA, clean soil was backfilled into the excavated area and no unacceptable risks are associated with surface soil. Institutional controls shall be required to control direct exposure to the remaining contaminated subsurface soil/wastes and to eliminate unacceptable exposure pathways. The institutional controls shall include LUCs and engineering controls. The area designated for LUCs at Site 5 is presented in Figure A-1. The specific coordinates defining the LUC area for Site 5 will be surveyed and amended to the Base General Plan (BGP) and incorporated into the GeoBase System.

Property Ownership: The site is owned by the USAF and is located within the Main Base portion of Andersen AFB, Guam.

Site Constraints: The site is located within an existing residential area (USAF families) of the Main Base and site access is limited to personnel with access to the Base. There is no fencing to restrict access to the site; however, the areas of contaminated soil is located over 6 feet bgs or beneath an existing building foundation. There is no unacceptable risk associated with surface soil under any of the evaluated risk scenarios. The LUCs will include prohibiting the disturbance of soil and existing structures. The LUCs will be implemented through amendments to the BGP that will effectively act as deed restrictions. The BGP amendments will be completed within sixty (60) days of ROD approval. The USAF will amend the BGP with one of the following sections: (1) a new section entitled “Prohibited and Permitted Uses at Environmental Restoration Sites” or (2) text to an existing section of the BGP that addresses LUC restrictions at Andersen AFB. The USAF will utilize its BGP as an administrative LUC to prevent uses that are inconsistent with the approved ROD.

Area Subject to Controls: Approximately 0.4 acres (to be surveyed). The area defining the "restricted" LUC areas will be clearly marked and posted with appropriate signage.

Current On-site Structures/Facilities: Site 5 contains an existing residential development comprised of dual-family, single-story, ranch-style, residential homes and landscaped lawns. There are two buildings contained within the area affected by the LUCs. Underground utilities are present.

Future Land Use Restrictions: The designated LUC area is prohibited from further residential development as long as the site conditions are not suitable for unrestricted use and unlimited exposure. In addition, disturbance of soil and existing structures within the designated LUC area is prohibited.

LUCs

The following are LUCs for Site 5:

- Preserve the integrity of existing site structures (e.g., houses, patios, roads) within the Site 5 area unless there is a USAF-approved plan for the work and restoration.
- Maintain the landscaping (e.g., erosion controls) and structures (e.g., buildings, patios, roads) at Site 5 in accordance with an approved Operation and Maintenance (O&M) plan.
- Limit and control any future excavation activities at the site (e.g., worker requirements, soil management, waste disposal).
- Notify residents and provide signage to inform residents and utility workers that excavation is prohibited at the site.
- Require Dig and Construction Permits prior to intrusive activities within the LUC area.
- In the Base General Plan, identify the designated LUC area as prohibited from further residential development.

The LUCs will be enforced through the Land Use Control Management Plan (LUCMP) process. The LUCMP defines the engineering and institutional controls and other specific measures that are required to implement LUCs consistent with the selected remedy at each IRP Site. The LUCMP also outlines the process and procedures in place for USAF compliance with the state LUCs.

Management of LUCs

Prepare and Maintain a LUCMP: The LUCMP shall serve as the operational "road map" for defining, implementing, and reporting on LUCs at Site 5. The USAF is responsible for implementing, maintaining, reporting on, and enforcing the LUCs established in approved decision documents for IRP sites within Andersen AFB. The USAF is responsible for maintaining the LUCMP to assure that activities within the designated LUC area are in accordance with the remedies selected in the approved ROD and other pertinent decision documents.

The LUCMP includes protocols or a "process" for: (1) daily management of the LUCMP process; (2) annual inspections of Site 5 to ensure compliance with the LUCs; (3) specifications for annual LUC-compliance reporting requirements; (4) property lease or transfer (note: currently, there are no plans for property lease or transfer); (5) LUC modification or termination; and (6) notification process and relevant corrective actions for LUC non-compliant events.

Any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs will be addressed by the USAF as soon as practicable, but in no case will the process be initiated later than 15 days after the USAF becomes aware of the breach. The USAF will notify USEPA and Guam EPA as soon as practicable but no longer than 10 days after discovery of any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs. The USAF will notify USEPA and Guam EPA regarding how the USAF has addressed or will address the breach within 10 days of sending USEPA and Guam EPA notification of the breach. The USAF shall notify USEPA and Guam EPA 45 days in advance of any proposed land use changes that are inconsistent with the land use control objectives or the selected remedy. The LUCMP will be reviewed annually to assure that land use restrictions and controls are maintained as per the remedy selected in the ROD. The annual LUCMP monitoring reports will summarize (1) inspection activities performed in the prior year; (2) deficiencies or inconsistencies in maintaining the LUCs; (3) corrective actions taken; and (4) effectiveness of the corrective actions. The annual LUCMP monitoring reports will be used in preparation of the 5-year review to evaluate the effectiveness of the remedy. The LUCs will remain in effect as long as hazardous substances in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Lease or Transfer of Property: Site 5 is located on the Main Base, and there are no current plans for the USAF to lease or transfer the property. Although the USAF may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the USAF shall retain ultimate responsibility for remedy integrity. The USAF will provide notice to USEPA and Guam EPA at least six (6) months prior to any transfer or sale of Site 5 so that USEPA and Guam EPA can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for the facility to notify USEPA and Guam EPA at least six months prior to any transfer or sale, then the facility will notify USEPA and Guam EPA as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions above, the USAF further agrees to provide USEPA and Guam EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. The USAF shall provide a copy of executed deed or transfer assembly to EPA and Guam EPA.

Dig and Construction Permits: No intrusive activities shall occur within the designated LUC area without prior approval of the USAF. If intrusive activities are conducted

within the designated LUC area, the work would require an approved health and safety plan and procedures for the proper handling and disposal of displaced wastes and/or soils. Dig and construction permits shall be maintained in the LUCMP for Site 5. This requirement shall be subject to an annual review (see above section for reporting requirements) and will remain in effect as long as hazardous substances in subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Base General Plan: The BGP will be amended within sixty (60) days of ROD approval to identify the designated LUC area as prohibited from further residential development as long as the site conditions are not suitable for unrestricted use and unlimited exposure. AFI 32-7062 (*Air Force Comprehensive Planning*) requires that installations develop and maintain a BGP as a central repository for information deemed essential for planning and managing the installation's physical assets, including environmental planning constraints such the LUCs. AFI 32-1021 (*Planning and Programming Military Construction Projects*) requires installations to comply with their BGP to ensure that there are no conflicts with land-use constraints stemming from the LUCs of the ERP that would impact facility planning and construction. Any requests for invasive activities (i.e., utility or construction work) through excavation permits, such as AF Form 103, or the construction review process, as per AFI 32-1001 (*Operations Management*), will be denied, unless the procedures for proposed land use changes described in the approved ROD, and amended to the BGP, are followed. The LUCs amended to the BGP will be monitored, maintained, and reported on through existing land-use management programs, such as the BCE Work Clearance Form (AF Form 103) (*Digging Permit*) and the construction review process (AFI 32-1001). The USAF shall notify USEPA and Guam EPA in writing in advance of any changes to the internal procedures that would affect the LUCs. The USAF shall not modify or terminate LUCs, implementation actions, or modify land use without approval by USEPA and the Guam EPA. The USAF shall seek prior concurrence before any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs. This requirement shall be reviewed as part of the regular 5-year ROD review (2012) and remain in effect as long as hazardous substances in subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Monitoring and Reporting: Monitoring of the environmental use restrictions and controls will be conducted annually by the USAF. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the USEPA and the Guam EPA. The annual monitoring reports will be used in preparation of the Five Year Review to evaluate the effectiveness of the remedy.

The annual monitoring report, submitted to the regulatory agencies by the USAF, will evaluate the status of the ICs and how any IC deficiencies or inconsistent uses have been addressed. The annual evaluation will address whether the use restrictions and controls referenced above were communicated in the deed(s), whether the owners and state and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed with such restrictions and controls.

Engineering Controls

Survey and Mark LUC Boundaries and Post Signage: Site 5 will require a survey to locate and install permanent markers to mark the corners of the designated LUC areas. Signs will be posted around the perimeter of the site and will meet the following requirements:

- Lettering shall be legible from a distance of at least 25 feet.
- Signs shall contain contact information for USAF personnel for long-term oversight.
- Signs shall be visible from surrounding areas and at potential routes of entry.
- The warning signs shall contain language similar to the following:

WARNING – Area Contains Potential Hazardous Substances Below 6 Feet. Digging or Excavating Below 6 Feet is Prohibited. Contact Env. Mgmt. at Ext 4692.

These requirements shall be fulfilled as soon as practical, and shall be monitored annually as part of the O&M activities.

Fencing: No fencing is required.

Operation and Maintenance: O&M activities shall include annual site visits to assure the proper upkeep of the existing structures and landscaped areas. "Event driven" inspections may be required after natural disasters, such as typhoons or earthquakes. Warning signs shall be posted by the LUC restricted area to prevent intrusive activities without USAF approval. Annual site inspections shall be conducted to: (1) confirm the integrity of existing structures; (2) confirm the integrity of existing landscaped areas; (3) confirm that boundary markers and signage are intact; (4) determine that no unapproved structures have been constructed or intrusive activities have been performed; and (5) ensure that the LUCMP is properly maintained and all activities relevant to the designated LUC area (i.e., proper documentation of digging permits, etc.) are properly documented. The USAF will be responsible for summarizing the findings of the previous calendar year in an annual LUC Compliance Summary Report. The LUCs shall remain in effect as long as hazardous substances in subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

TABLE A-2. SUMMARY TABLE FOR IDENTIFYING LUC OBJECTIVES AND IMPLEMENTING LUCs AT SITE 8, ANDERSEN AFB, GUAM

Risk Summary: There are no unacceptable risks to ecological receptors. Potential unacceptable cancer and non-cancer risks to occasional users/trespassers and resident adults and children exposed to surface and subsurface soil were identified (Landfill 10C).

Hazardous Substances: Antimony, lead, and dieldrin.

Selected Remedy: Institutional Controls and Engineering Controls

Purpose of LUCs: Control direct exposure to contaminated surface and subsurface soil within the site (Landfill 10C). The selected remedy does not include the removal of contaminated soil from the site and will result in contaminated subsurface soil remaining on site at concentrations that could pose potential unacceptable risks to future resident adults and children. A fence already has been installed to control access to portions of the site (Landfill 10C) and to control direct exposure to contaminated surface soil within the site. Institutional controls shall be required to control direct exposure to contaminated surface and subsurface soil and to eliminate unacceptable exposure pathways under a future residential scenario. The institutional controls shall include LUCs and engineering controls. The area designated for LUCs at Site 8 is presented in Figure A-2. The specific coordinates defining the LUC restricted area for Site 8 (Landfill 10C) will be surveyed in the field and will be amended to the BGP and incorporated into the GeoBase System.

Property Ownership: The site is owned by the USAF and is located within the Main Base portion of Andersen AFB.

Site Constraints: The site is located on the active Main Base and site access is limited to personnel with access to the Base. In addition, the site is located in an area of the Base that is only accessible to vehicles through locked gates. There is no soil cover to act as an engineering control; however, there is some fencing present to restrict access to the site (Figure A-2). The land will be prohibited from future residential development and disturbance of soil through implementation of LUCs that will be amended into the BGP that will effectively act as deed restrictions. The BGP amendments will be completed within sixty (60) days of ROD approval. The USAF will amend the BGP with one of the following sections: (1) a new section entitled “Prohibited and Permitted Uses at Environmental Restoration Sites” or (2) text to an existing section of the BGP that addresses LUC restrictions at Andersen AFB. This section shall state that residential use and certain types of industrial/recreational development such as elementary and secondary schools, child care facilities, playgrounds, medical facilities, or similar activities are prohibited. The USAF will utilize its BGP as an administrative LUC to prevent uses that are inconsistent with the approved ROD.

Area Subject to Controls: Approximately 11.5 acres (to be surveyed). Access to the area of Landfill 10C that will be subject to LUCs is partially controlled by a chain link fence

and locking gates. The corners defining the "restricted" LUC areas will be clearly marked and posted with appropriate signage.

Current On-site Structures/Facilities: Other than three concrete pads that were the foundations of former buildings, there are no permanent surface structures or underground piping/cables located within the designated LUC area.

Future Land Use Restrictions: The designated LUC area is prohibited from residential use as long as the site conditions are not suitable for unrestricted use and unlimited exposure. In addition, no permanent facilities or structures should be constructed within the designated LUC area that would present a potential exposure pathway for child receptors (i.e., prohibit the development and use of property for elementary and secondary schools, child care facilities, recreational facilities, and playgrounds, at or near the site). Disturbance (i.e., excavation) of soil and existing structures within the designated LUC area is prohibited.

LUCs

The following are LUCs for Site 8:

- Prohibit the redevelopment of Site 8 (Landfill 10C area; specifically prohibition of residential use or use that would result in exposures to children) without prior approvals from the USEPA and Guam EPA.
- Limit access to the site through the installation and maintenance of barriers (i.e., fencing).
- Post signage indicating that the designated LUC area poses a potential health risk, and that individuals should not enter the restricted area without prior consultation and consent from the USAF and the proper training.
- Limit and control any future intrusive activities at the site (e.g., worker requirements, soil management, waste disposal).
- Require Dig and Construction Permits prior to intrusive activities within the LUC area.
- In the Base General Plan, identify the designated LUC area as prohibited from future residential development.

The LUCs will be enforced through the LUCMP process. The LUCMP defines the engineering and institutional controls and other specific measures that are required to implement LUCs consistent with the selected remedy at each IRP Site. The LUCMP also outlines the process and procedures in place for USAF compliance with the state LUCs.

Management of LUCs

Prepare and Maintain a LUCMP: The LUCMP shall serve as the operational "road map" for defining, implementing, and reporting on LUCs at Site 8. The USAF is responsible for implementing, maintaining, reporting on, and enforcing the LUCs established in approved decision documents for IRP sites within Andersen AFB. The USAF is

responsible for maintaining the LUCMP to assure that activities within the designated LUC area are in accordance with the remedies selected in the approved ROD and other pertinent decision documents.

The LUCMP includes protocols or a "process" for: (1) daily management of the LUCMP process; (2) annual inspections of Site 8 (Landfill 10C) to ensure compliance with the LUCs; (3) specifications for annual LUC-compliance reporting requirements; (4) property lease or transfer (note: currently, there are no plans for property lease or transfer); (5) LUC modification or termination; and (6) notification process and relevant corrective actions for LUC non-compliant events.

Any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs will be addressed by the USAF as soon as practicable, but in no case will the process be initiated later than 15 days after the USAF becomes aware of the breach. The USAF will notify USEPA and Guam EPA as soon as practicable but no longer than 10 days after discovery of any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs. The USAF will notify USEPA and Guam EPA regarding how the USAF has addressed or will address the breach within 10 days of sending USEPA and Guam EPA notification of the breach. The USAF shall notify USEPA and Guam EPA 45 days in advance of any proposed land use changes that are inconsistent with the land use control objectives or the selected remedy. The LUCMP will be reviewed annually to assure that land use restrictions and controls are maintained as per the remedy selected in the ROD. The annual LUCMP monitoring reports will summarize (1) monitoring activities performed in the prior year; (2) deficiencies or inconsistencies in maintaining the LUCs; (3) corrective actions taken; and (4) effectiveness of the corrective actions. The annual LUCMP monitoring reports will be used in preparation of the 5-year review to evaluate the effectiveness of the remedy. The LUCs will remain in effect as long as hazardous substances in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Lease or Transfer of Property: Site 8 is located on the Main Base, and there are no current plans for the USAF to lease or transfer the property. Although the USAF may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the USAF shall retain ultimate responsibility for remedy integrity. The USAF will provide notice to USEPA and Guam EPA at least six (6) months prior to any transfer or sale of Site 8 so that USEPA and Guam EPA can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for the facility to notify USEPA and Guam EPA at least six months prior to any transfer or sale, then the facility will notify USEPA and Guam EPA as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions above, the USAF further agrees to provide USEPA and Guam EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. The USAF shall provide a copy of executed deed or transfer assembly to EPA and Guam EPA.

Dig and Construction Permits: No intrusive activities shall occur within Landfill 10C without prior approval of the USAF. If intrusive activities are conducted within the designated LUC area, the work would require an approved health and safety plan and procedures for the proper handling and disposal of displaced wastes and/or soils. Dig and construction permits shall be maintained in the LUCMP for Site 8 (Landfill 10C). This requirement shall be subject to an annual review (see above section for reporting requirements) and will remain in effect as long as hazardous substances in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Base General Plan: The BGP will be amended within sixty (60) days of the ROD approval to identify the designated LUC area as prohibited from residential development as long as the site conditions are not suitable for unrestricted use and unlimited exposure. AFI 32-7062 (*Air Force Comprehensive Planning*) requires that installations develop and maintain a BGP as a central repository for information deemed essential for planning and managing the installation's physical assets, including environmental planning constraints such the LUCs. AFI 32-1021 (*Planning and Programming Military Construction Projects*) requires installations to comply with their BGP to ensure that there are no conflicts with land-use constraints stemming from the LUCs of the ERP that would impact facility planning and construction. Any requests for residential use or invasive activities (i.e., construction) through excavation permits, such as AF Form 103, or the construction review process, as per AFI 32-1001 (*Operations Management*), will be denied, unless the procedures for proposed land use changes described in the approved ROD, and amended to the BGP, are followed. The LUCs amended to the BGP will be monitored, maintained, and reported on through existing land-use management programs, such as the BCE Work Clearance Form (AF Form 103) (*Digging Permit*) and the construction review process (AFI 32-1001). Land use shall be limited to open space where USAF personnel are on-site only intermittently. The USAF shall notify USEPA and Guam EPA in writing in advance of any changes to the internal procedures that would affect the LUCs. The USAF shall not modify or terminate LUCs, implementation actions, or modify land use without approval by USEPA and the Guam EPA. The USAF shall seek prior concurrence before any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs. This requirement shall be reviewed as part of the regular 5-year ROD review (2012) and remain in effect as long as hazardous substances in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Monitoring and Reporting: Monitoring of the environmental use restrictions and controls will be conducted annually by the USAF. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the USEPA and the Guam EPA. The annual monitoring reports will be used in preparation of the Five Year Review to evaluate the effectiveness of the remedy.

The annual monitoring report, submitted to the regulatory agencies by the USAF, will evaluate the status of the ICs and how any IC deficiencies or inconsistent uses have been

addressed. The annual evaluation will address whether the use restrictions and controls referenced above were communicated in the deed(s), whether the owners and state and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed with such restrictions and controls.

Engineering Controls

Survey and Mark LUC Boundaries and Post Signage: Site 8 (Landfill 10C) will require a survey to locate and install permanent markers to mark the corners of the designated LUC areas. Signs will be posted around the perimeter of the site and will meet the following requirements:

- Lettering shall be legible from a distance of at least 25 feet.
- Signs shall contain contact information for USAF personnel for long-term oversight.
- Signs shall be visible from surrounding areas and at potential routes of entry.
- The warning signs shall contain language similar to the following:

WARNING – Area Contains Potential Hazardous Substances
Access is Prohibited
Contact Env. Mgmt. at Ext 4692.

These requirements shall be fulfilled as soon as practical, and shall be monitored annually as part of the O&M activities described below.

Fencing: Fencing already exists along a portion of the upper perimeter of Landfill 10C and a gate across the access road near the eastern corner of Landfill 10C (Figure A-2) and it must be maintained as long as LUCs are required.

Operation and Maintenance: O&M activities shall include annual site visits to assure the fencing, boundary markers, and warning signs are properly maintained. "Event driven" inspections may be required after natural disasters, such as typhoons or earthquakes. Warning signs shall be posted around the periphery of Landfill 10C to prevent intrusive activities (e.g., driving trucks, trenching, or excavation) that allow for exposure to hazardous substances. Annual site inspections shall be conducted to: (1) confirm that fencing is properly maintained; (2) confirm that boundary markers and signage are intact; (3) determine that no unapproved structures have been constructed or intrusive activities have been performed; and (4) ensure that the LUCMP is properly maintained and all activities relevant to the designated LUC area (i.e., proper documentation of digging permits, etc.) are properly documented. The USAF will be responsible for summarizing the findings of the previous calendar year in an annual LUC Compliance Summary Report. The LUCs shall remain in effect as long as hazardous substances in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

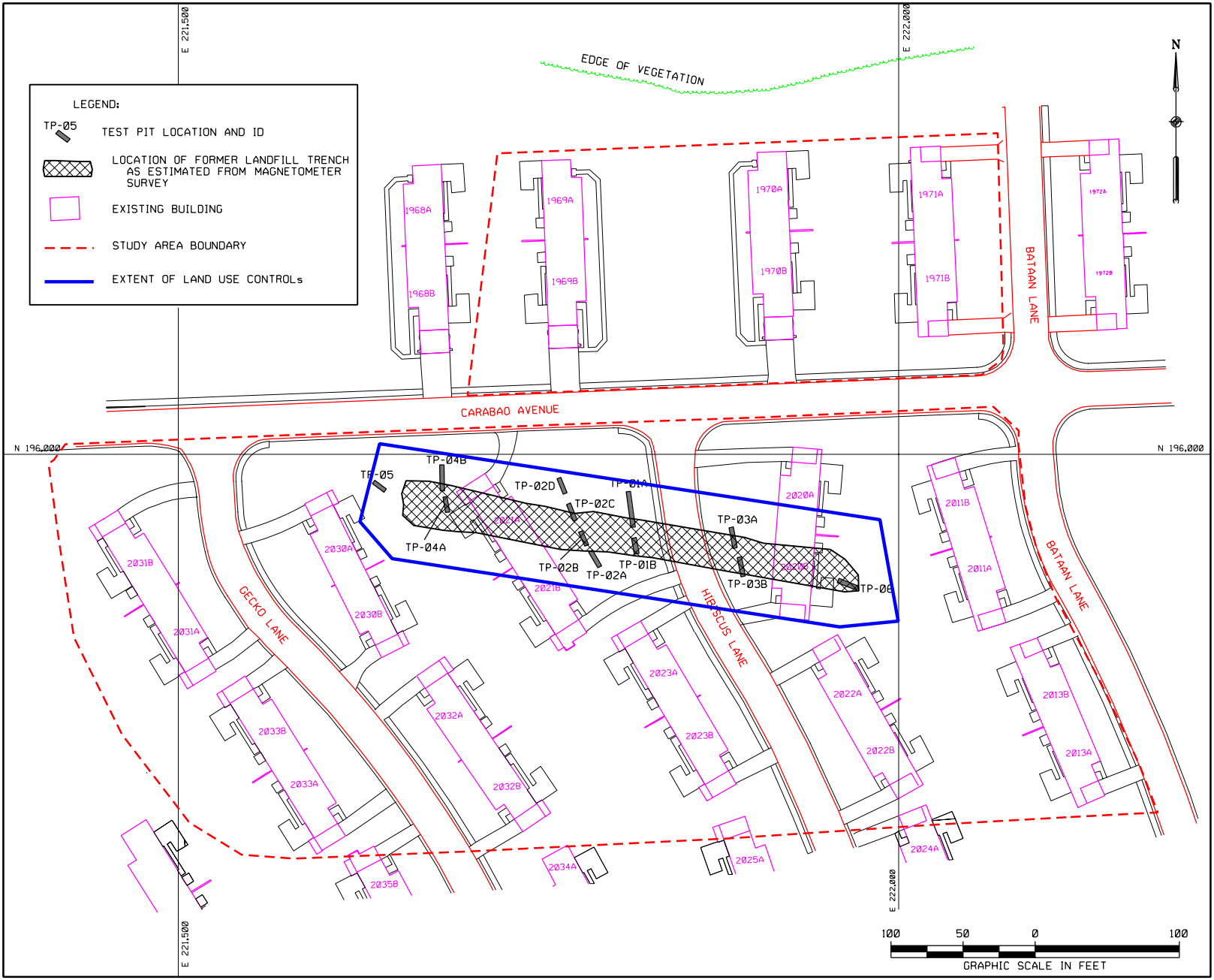
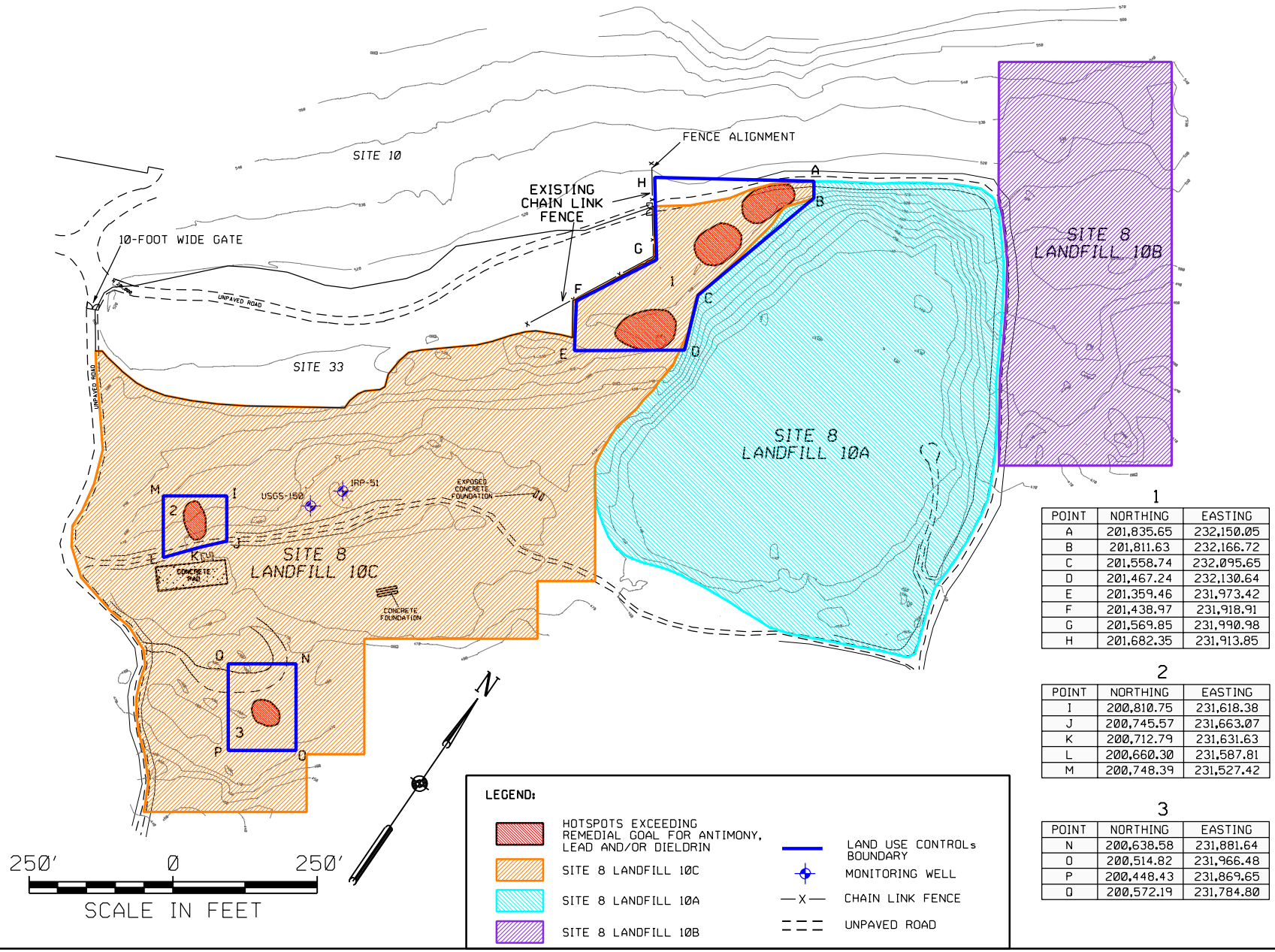


Figure A-1. Extent of Land Use Controls at Site 5, Andersen AFB, Guam.



1

POINT	NORTHING	EASTING
A	201,835.65	232,150.05
B	201,811.63	232,166.72
C	201,558.74	232,095.65
D	201,467.24	232,130.64
E	201,359.46	231,973.42
F	201,438.97	231,918.91
G	201,569.85	231,990.98
H	201,682.35	231,913.85

2

POINT	NORTHING	EASTING
I	200,810.75	231,618.38
J	200,745.57	231,663.07
K	200,712.79	231,631.63
L	200,660.30	231,587.81
M	200,748.39	231,527.42

3

POINT	NORTHING	EASTING
N	200,638.58	231,881.64
O	200,514.82	231,966.48
P	200,448.43	231,869.65
Q	200,572.19	231,784.80

Figure A-2. Extent of Land Use Controls at Sites 8, Main Base, Andersen AFB, Guam.

APPENDIX B

NOTICE REGARDING PUBLIC MEETING

ANDERSEN AFB
INSTALLATION RESTORATION
PROGRAM
PUBLIC MEETING

A public meeting to present the Final Proposed Plan for Remedial Alternatives at Sites 4, 5, 7, 8, 11, 16, 17, 25, 28, 31, 34, and 36 will be held on Thursday, August 2, 2007 at 6:30p.m. at the Guam Marriot Resort & Spa, 2nd floor, Ballroom A, Tumon, Guam.

Documents are available for public viewing at Nieves M. Flores Memorial Library, Hagatna, Guam and Robert F. Kennedy Memorial Library, Mangilao, Guam.

For questions regarding the Proposed Plans, please call the Remedial Project Manager, Mr. Gregg Bohara at 366-4602.

NOTICE OF AVAILABILITY

Andersen Air Force Base Installation Restoration Program has prepared three Proposed Plans for Remedial Alternatives for Sites within the Main Base Operable Unit and the Northwest Field Operable Unit. The Sites addressed in the three Proposed Plans are presented in the following groups:

***Main Base Operable Unit* – Sites 5 and 8**
***Main Base Operable Unit* – Sites 4, 11, 25, 28, and 34**
***Northwest Field Operable Unit* – Sites 7, 16, 17, 31, and 36**

The Proposed Plans describe the remedies considered for these Sites and evaluate the potential risks posed to human and ecological receptors, and establish a risk-based cleanup standard. The preferred remedies presented in the plans include institutional controls and no action. Additional remedies considered in the evaluation process included soil removal with treatment and soil removal with institutional controls. The final remedy will be selected after public comments are received.

The Proposed Plans are available for public review at the Nieves M. Flores and Robert F. Kennedy Memorial Libraries. The 30-day public comment period for the Proposed Plans will end 26 August 2007. Comments can be mailed to 36 CES/CEVR Unit 14007, APO AP 96543-4007 and must be postmarked on or before 26 August 2007.

For questions regarding the Proposed Plans, please call the Remedial Project Manager, Mr. Gregg Bohara at 366-4602.