

---

**THE UNITED STATES NAVY**

**INSTALLATION RESTORATION PROGRAM**



**FINAL**

**RECORD OF DECISION FOR SITES 41, 42, & 43**

**MARBO ANNEX**

**ANDERSEN AIR FORCE BASE, GUAM**

**May 2010**

## TABLE OF CONTENTS

1.0	DECLARATION.....	1-1
1.1	SITE NAME AND LOCATION.....	1-1
1.2	STATEMENT OF BASIS AND PURPOSE.....	1-1
1.3	ASSESSMENT OF SITE.....	1-3
1.4	DESCRIPTION OF SELECTED REMEDY.....	1-3
1.5	STATUTORY DETERMINATIONS.....	1-5
1.6	DATA CERTIFICATION CHECKLIST.....	1-5
1.7	AUTHORIZING SIGNATURES.....	1-7
2.0	DECISION SUMMARY.....	2-1
2.1	SITE NAME, LOCATION, AND DESCRIPTION.....	2-1
2.2	SITE HISTORY AND ENFORCEMENT ACTIVITIES.....	2-4
2.3	COMMUNITY PARTICIPATION.....	2-6
2.4	SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION.....	2-9
2.5	SITE CHARACTERISTICS.....	2-12
2.5.1	Physiography and Climate.....	2-12
2.5.2	Geology and Hydrogeology.....	2-13
2.5.3	Surface Water and Groundwater Hydrology.....	2-16
2.5.4	Ecology.....	2-18
2.5.5	Previous Site Characterization Activities.....	2-19
2.5.6	Nature and Extent of Contamination.....	2-26
2.5.7	Conceptual Exposure Model.....	2-31
2.6	CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES.....	2-33
2.6.1	Land Use.....	2-33
2.6.2	Groundwater and Surface Water Uses.....	2-33
2.7	SUMMARY OF SITE RISKS.....	2-34
2.7.1	Summary of Human Health Risk Assessment.....	2-35
2.7.2	Summary of Ecological Risk Assessment.....	2-46
2.7.3	Basis for Action.....	2-55

2.8	REMEDIAL ACTION OBJECTIVES .....	2-55
2.9	DESCRIPTION OF ALTERNATIVES .....	2-58
2.9.1	Description of Remedy Components .....	2-59
2.9.2	Common Elements and Distinguishing Features of Each Alternative ..	2-62
2.9.3	Expected Outcome of Each Alternative .....	2-63
2.10	SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES .....	2-63
2.10.1	Overall Protection of Human Health and the Environment .....	2-69
2.10.2	Compliance with Applicable or Relevant and Appropriate Requirements	2-71
2.10.3	Long-Term Effectiveness and Permanence .....	2-72
2.10.4	Reduction of Toxicity, Mobility, or Volume Through Treatment .....	2-73
2.10.5	Short-Term Effectiveness .....	2-73
2.10.6	Implementability .....	2-74
2.10.7	Cost .....	2-75
2.10.8	Territory (Guam) Acceptance .....	2-75
2.10.9	Community Acceptance .....	2-76
2.11	PRINCIPAL THREAT WASTES .....	2-76
2.12	SELECTED REMEDY .....	2-77
2.12.1	Summary of the Rationale for the Selected Remedy .....	2-78
2.12.2	Description of the Selected Remedy .....	2-82
2.12.3	Summary of Estimated Remedy Costs .....	2-84
2.12.4	Expected Outcomes of Selected Remedy .....	2-84
2.13	STATUTORY DETERMINATIONS .....	2-92
2.13.1	Protection of Human Health and the Environment .....	2-93
2.13.2	Compliance with ARARs .....	2-93
2.13.3	Cost Effectiveness .....	2-94
2.13.4	Utilization of Permanent Solutions and Alternative Treatment Technologies .....	2-102
2.13.5	Preference for Treatment as a Principal Element .....	2-102
2.13.6	Five-Year Review Requirements .....	2-102
2.14	DOCUMENTATION OF SIGNIFICANT CHANGES .....	2-103

3.0 RESPONSIVENESS SUMMARY ..... 3-1  
3.1 STAKEHOLDER COMMENTS AND LEAD AGENCY RESPONSES ..... 3-1  
3.2 TECHNICAL AND LEGAL ISSUES ..... 3-2  
4.0 REFERENCES ..... 4-1

**ATTACHMENTS**

- Attachment 1 – List of Attendees at the Public Meeting
- Attachment 2 – Public Meeting Transcript
- Attachment 3 – Notice of Availability of the Proposed Plan
- Attachment 4 – USAF Responses to Regulatory Comments

## TABLES

2-1	Public Notification of Document Availability .....	2-7
2-2	Public Comment Period Requirements .....	2-8
2-3	Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations .....	2-36
2-4	Cancer Toxicity Data Summary.....	2-39
2-5	Non-Cancer Toxicity Data Summary.....	2-40
2-6A	Risk Characterization Summary – Carcinogens.....	2-44
2-6B	Risk Characterization Summary – Carcinogens.....	2-45
2-7A	Risk Characterization Summary – Non-Carcinogens.....	2-45
2-7B	Risk Characterization Summary – Non-Carcinogens.....	2-46
2-8A	Occurrence, Distribution, and Selection of Chemicals of Concern for Soil Invertebrates .....	2-48
2-8B	Occurrence, Distribution, and Selection of Chemicals of Concern for Plants .....	2-49
2-9A	Exposure Doses and Hazard Quotients for the Mariana Crow .....	2-52
2-9B	Exposure Doses and Hazard Quotients for the Yellow Bittern.....	2-53
2-10A	Summary of Remedial Alternatives Evaluated for Site 41.....	2-58
2-10B	Summary of Remedial Alternatives Evaluated for Site 42.....	2-58
2-10C	Summary of Remedial Alternatives Evaluated for Site 43.....	2-58
2-11	Common Elements and Distinguishing Features of Alternatives .....	2-64
2-12	Expected Outcome of Each Alternative.....	2-66
2-13	Matrix of Cost and Effectiveness Data for Sites 41, 42, and 43 .....	2-75
2-14A	Cost Estimate Summary for Site 41 – Capital Costs for Selected Remedy Component.....	2-85
2-14B	Cost Estimate Summary for Site 42 – Capital Costs for Selected Remedy Component.....	2-87
2-14C	Cost Estimate Summary for Site 43 – Capital Costs for Selected Remedy Component.....	2-89
2-15A	Cleanup Levels for Chemicals of Concern at Site 41.....	2-91
2-15B	Cleanup Levels for Chemicals of Concern at Site 42.....	2-91
2-15C	Cleanup Levels for Chemicals of Concern at Site 43.....	2-92
2-16	Description of ARARs and TBCs for Selected Remedy for Sites 41, 42 And 43.....	2-95
2-17A	Cost and Effectiveness Summary for Site 41.....	2-99
2-17B	Cost and Effectiveness Summary for Site 42.....	2-100
2-17C	Cost and Effectiveness Summary for Site 43.....	2-101

## FIGURES

2-1	Andersen Air Force Base Vicinity Map.....	following page 2-2
2-2	Location Map of Sites 41, 42, and 43, MARBO Annex .....	following page 2-2
2-3	Map of Site 41, MARBO Annex.....	following page 2-2
2-4	Map of Site 42, MARBO Annex.....	following page 2-2
2-5	Map of Site 43, MARBO Annex.....	following page 2-4
2-6	Extent of Contamination in Area A, Site 43, MARBO Annex .....	following page 2-24
2-7	Extent of Contamination in Area B, Site 43, MARBO Annex .....	following page 2-24
2-8	Extent of Contamination in Area C, Site 43, MARBO Annex .....	following page 2-24
2-9	Extent of Contamination in Area D, Site 43, MARBO Annex .....	following page 2-24
2-10	Site 41 Proposed Cleanup Areas, MARBO Annex .....	following page 2-84
2-11	Site 42 Proposed Cleanup Areas, MARBO Annex .....	following page 2-84
2-12	Site 43 Area A Proposed Cleanup Areas, MARBO Annex.....	following page 2-84
2-13	Site 43 Area B Proposed Cleanup Areas, MARBO Annex.....	following page 2-84
2-14	Site 43 Area C Proposed Cleanup Areas, MARBO Annex .....	following page 2-84
2-15	Site 43 Area D Proposed Cleanup Areas, MARBO Annex .....	following page 2-84

## ACRONYMS

1,2-DCA	1,2-dichloroethane
°F	degrees Fahrenheit
µg/dL	micrograms per deciliter
µg/m <sup>3</sup>	micrograms per cubic meter
ACM	asbestos-containing material
AF	Air Force
AFB	Air Force Base
ARAR	Applicable or Relevant and Appropriate Requirement
AST	above-ground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
BGP	Base General Plan
bgs	below ground surface
BLL	blood lead level
BTV	background threshold value
CAA	Clean Air Act
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
COPC	contaminant of potential concern
CRP	Community Relations Plan
cy	cubic yards
DSI	detailed site inventory
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DOT	Department of Transportation
EBS	environmental baseline survey
EM	electromagnetic
EPA	Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ESD	Explanation of Significant Differences
FFA	Federal Facilities Agreement
FS	Feasibility Study
GCA	Guam Code Annotated
GWA	Guam Waterworks Authority
HHRA	human health risk assessment
HI	hazard index
HMTA	Hazardous Materials Transportation Act
HQ	hazard quotient
IRIS	integrated risk information system

## ACRONYMS (continued)

IRP	Installation Restoration Program
lcy	loose cubic yards
LDR	land disposal restrictions
LOAEL	lowest-observed-adverse-effect level
LUC	land use control
LUCMP	Land Use Control Management Plan
MARBO	Marianas Bonins
MCL	maximum contaminant levels
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
mg/L	milligrams per liter
mgd	million gallons per day
MMRP	military munitions response program
mph	miles per hour
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NGL	Northern Guam Lens
NOAEL	no-observed-adverse-effect level
NPL	National Priorities List
O&M	operations and maintenance
OU	operable unit
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated bi-phenyl
PRG	preliminary remediation goal
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RfD	reference dose
RG	remedial goal
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROC	receptor of concern
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SF	slope factor
SVOC	semi-volatile organic compound
SWMA	Solid Waste Management Act
TAL	target analyte list

**ACRONYMS  
(continued)**

TBC	to be considered
TCLP	Toxicity Characteristic Leachate Procedure
TMV	toxicity, mobility, volume
TPH-DRO	total petroleum hydrocarbons-diesel range organics
TPH-GRO	total petroleum hydrocarbons-gasoline range organics
TSCA	Toxic Substances Control Act
TSP	triple superphosphate
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USN	United States Navy
UST	underground storage tank
VOC	volatile organic compound
WPCA	Water Pollution Control Act

## 1.0 DECLARATION

### 1.1 SITE NAME AND LOCATION

Facility Name: Andersen Air Force Base

Site Location: Marianas Bonins (MARBO) Annex, Guam

CERCLIS ID Number: GU6571999519

Operable Unit/Site: Three Installation Restoration Program (IRP) sites located in the Site Wide Operable Unit (OU):

- IRP Site 41
- IRP Site 42
- IRP Site 43

### 1.2 STATEMENT OF BASIS AND PURPOSE

This decision document presents the Selected Remedy for the United States Navy (USN) Sites 41, 42, and 43, in the Andersen Air Force Base (AFB) MARBO Annex, Guam that was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for this site, including pertinent IRP documents, correspondence and guidance related to CERCLA investigations and cleanups.

This document is issued by the Department of the Navy<sup>1</sup> as the lead agency. The Department of the Air Force (AF) was the original lead agency and was responsible for funding and conducting the site assessment, and subsequent remedy selection. However, administrative responsibility for management of real property, including implementation of the selected remedy, transferred to the USN on 1 October 2009. Therefore, the remainder of this document identifies the USN as the lead agency. References to the AF as the previous lead agency have been maintained where relevant and appropriate. Additionally, the USN has delegated signature authority for the ROD to the Andersen AFB Base Commanding Officer.

The USN is managing remediation of contamination at the Site Wide OU in accordance with CERCLA as required by the Defense Environmental Restoration Program (DERP). The USN, the AF, and the United States Environmental Protection Agency (USEPA) have jointly selected the remedy for the site, and Guam Environmental Protection Agency (Guam EPA) has concurred with the selected remedy, under the guidelines established in the Federal Facilities Agreement (FFA) signed in February 1993 by representatives of USEPA Region IX, Guam EPA, and the United States Air Force (USAF) (USEPA et al., 1993).

---

<sup>1</sup> The Department of Defense is in the process of realigning installation management functions at Andersen AFB. On October 1, 2009, pursuant to the 2005 Defense Base Closure and Realignment Commission Report, administrative custody of all real property on Andersen AFB and responsibility for installation support functions, including Environmental Restoration Program responsibilities, transferred within the Department of Defense from the Department of the Air Force to the Department of the Navy. Title to Andersen AFB real property will remain with the United States and the Air Force will continue to utilize the Base. The Navy will also utilize portions of the Base. In accordance with the April 15, 2008, Department of Defense Environmental Supplemental Guidance for Implementing and Operating a Joint Base, at the time of property transfer, the Navy, as the new property manager at the Base, assumed responsibility "for all existing and future environmental permits, requirements, plans, and agreements" at the Base (Ch. 1.1.2) and was required to "honor all existing, previously negotiated Federal Facility Agreements in place" (Ch. 2.17.5 of the Guidance).

In January 2009, the Navy and the Air Force entered into a separate Memorandum of Agreement, which delegated installation support and authority back to the Air Force General who is the Andersen Base Commanding Officer under the authority, control, and direction of the Joint Region Commander, who is a Navy Admiral. This delegation includes the authority to sign Records of Decision. The Andersen Base Commanding Officer and Andersen environmental staff continue to administer the FFA under Navy direction. Both the Air Force and the Navy notified USEPA of the change of administrative responsibility under the FFA (See Appendix A).

### 1.3 ASSESSMENT OF SITE

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

The USN is committed to implementing, monitoring, maintaining, and enforcing all components of the selected remedy to ensure that it remains protective of human health and the environment.

### 1.4 DESCRIPTION OF SELECTED REMEDY

Remedial alternatives for Sites 41, 42, and 43 were developed and evaluated through the *Final Feasibility Study (FS) for IRP Sites 41, 42, and 43, MARBO Annex* (EA Engineering, Science and Technology [EA], 2009a). Based on the results of the FS, the AF (previously the lead agency) selected Soil Removal (Unrestricted Land Use) as the preferred alternative for Sites 41, 42, and 43. The major components of the selected response action are presented below.

#### **Site 41: Soil Removal (Unrestricted Land Use)**

- Approximately 540 loose cubic yards (lcy) of lead-impacted soil will be excavated and disposed of at an approved offsite facility.
- Field screening and confirmation sampling will be conducted to ensure removal of all soil containing contaminants of concern (COCs) above the remedial goals (RGs).
- No institutional controls or five-year reviews would be required.

#### **Site 42: Soil Removal (Unrestricted Land Use)**

- Approximately 30 lcy of lead-impacted soil will be excavated and disposed of at an approved offsite facility. In addition, relatively small quantities of soil (less than 2 lcy) impacted with total petroleum hydrocarbons-diesel range organics (TPH-DRO) that was identified during the former underground storage tank (UST) removal will be excavated and disposed of at an approved offsite facility.
- Field screening and confirmation sampling will be conducted to ensure removal of all soil containing COCs above the RGs.
- No institutional controls or five-year reviews would be required.

#### **Site 43: Soil Removal (Unrestricted Land Use)**

- Approximately 890 lcy of COC-impacted soil (lead and other constituents) will be excavated and disposed of at an approved offsite facility. In addition, relatively small quantities of soil (less than 2 lcy) impacted with TPH-DRO identified during the former UST removal will be excavated and disposed of at an approved offsite facility.
- Approximately 22 square feet of asbestos-containing material (ACM) will be removed and disposed of at a Toxic Substances Control Act (TSCA)-approved facility.
- Field screening and confirmation sampling will be conducted to ensure removal of all soil containing COCs above RGs.
- No institutional controls or five-year reviews would be required.

The selected remedy for Sites 41, 42, and 43 addresses the principal threats posed by the site through excavation and removal of COC-impacted soil, thereby preventing

potential future exposure to contaminated soil. Successful implementation of the remedial alternative at Sites 41, 42, and 43 would effectively mitigate all unacceptable risks to human receptors at all three sites and render the sites suitable for unlimited use and unrestricted exposure. This would allow site closure under CERCLA.

## **1.5 STATUTORY DETERMINATIONS**

The selected remedy for Sites 41, 42, and 43 is protective of human health and the environment, complies with promulgated requirements that are applicable or relevant and appropriate to the remedial action, and is cost effective.

The selected remedy represents the maximum extent to which permanent solutions can be used in a practicable manner at the site. It provides the best balance or trade-offs in terms of balancing criteria while also considering the bias against offsite treatment and disposal and considering Territory of Guam and community acceptance.

The statutory preference for treatment as a principal element is established in CERCLA Section 121(b). The selected remedy for Sites 41, 42, and 43 does not satisfy the statutory preference for treatment as a principal element of the remedy because treatment will not be performed. The selected remedy utilizes excavation and offsite disposal of contaminated soil with COC concentrations exceeding regulatory cleanup levels, which is more practicable for remediation of the sites compared to treatment, and allows future unrestricted land use.

Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a five-year review will not be required for this remedial action.

## **1.6 DATA CERTIFICATION CHECKLIST**

The following information is included in the Decision Summary section of this ROD

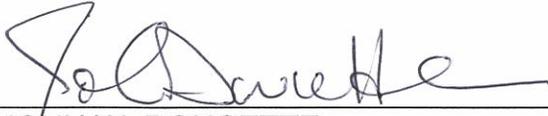
(Section 2). Additional information can be found in the Administrative Record file for Andersen AFB, Guam which is available for public review at the Robert F. Kennedy Library at the University of Guam and the Nieves M. Flores Memorial Library in Hagatna, Guam.

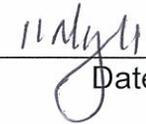
- List of COCs and their respective concentrations (Section 2.7.1)
- Risk represented by the COCs (Section 2.7.1)
- Cleanup levels established for COCs and the basis for these levels (Section 2.12.4)
- How source materials constituting principal threats will be addressed (Section 2.13.5)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater presented in the risk assessment and ROD (Section 2.6)
- Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section 2.12.4)
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.12.3)
- Key factor(s) that led to selecting the remedy (i.e., describe how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (Section 2.13).

## 1.7 AUTHORIZING SIGNATURES

The following signature sheets document the USN, Andersen AFB, USEPA Region IX, and Guam EPA approval of the remedy selected in this ROD for Sites 41, 42, and 43 within the MARBO Annex.

This signature sheet documents the USN and Andersen AFB co-selection of the remedy in this Record of Decision for Sites 41, 42, and 43 within the MARBO Annex.

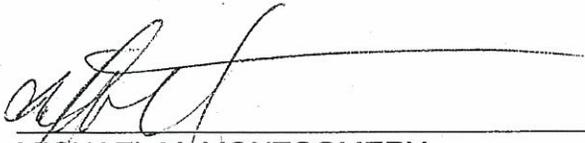
  
\_\_\_\_\_  
JOHN W. DOUCETTE  
Brigadier General, USAF  
Base Commanding Officer

  
\_\_\_\_\_  
Date

---

<sup>2</sup> Under Delegation of Authority from Commander Joint Region Marianas. See Foot Note 1.

This signature sheet documents the USEPA Region IX co-selection of the remedy in this Record of Decision for Sites 41, 42, and 43 within the MARBO Annex.



\_\_\_\_\_  
MICHAEL M. MONTGOMERY  
Assistant Director, Federal Facilities and Site Cleanup Branch  
U.S. Environmental Protection Agency, Region IX

..... 12/11/09  
Date

This signature sheet documents the Guam EPA concurrence in the selection of the remedy in this Record of Decision for Sites 41, 42, and 43 within the MARBO Annex.

---

IVAN C. QUINATA  
Administrator  
Guam Environmental Protection Agency

---

Date

## 2.0 DECISION SUMMARY

The Decision Summary identifies the Selected Remedy, explains how the remedy fulfills statutory and regulatory requirements, and provides a substantive summary of the Administrative Record file that supports the remedy selection decision.

### 2.1 SITE NAME, LOCATION, AND DESCRIPTION

Andersen AFB is located in northern Guam (see **Figure 2-1**). Guam is the largest and southernmost island in the Mariana Islands in the western Pacific Ocean. Relative to Guam, Hawaii is 3,700 miles to the east and Japan is 1,560 miles to the north. Guam is approximately 30 miles long, varies in width from 4 to 12 miles, and has a total land area covering approximately 209 square miles. Andersen AFB consists of multiple parcels of land located on the northern half of Guam, including the MARBO Annex where Sites 41, 42, and 43 are located (**Figure 2-1**). The MARBO Annex is located on a broad, uplifted limestone plateau underlain at depth by volcanic rocks. It is located approximately 4 miles south of Andersen AFB's main gate and covers approximately 2,437 acres. It is bounded by Marine Drive (Route 1) to the north, Route 15 to the south, and private properties to the east and west (**Figure 2-2**).

The following section presents descriptions of each of the three sites and their locations.

#### **Site 41**

Full Site Name: IRP Site 41

CERCLIS ID Number: GU6571999519

Site Location: Site Wide OU, MARBO Annex, Guam

Site 41 comprises approximately 8 acres of land with relatively flat to gently sloping topography. Site 41 consists of the concrete foundations of former operational buildings including: the tool shop, carpenter shop, generator shop, heavy vehicle shop, and vehicle maintenance shops (**Figure 2-3**). In addition, a vehicle maintenance pit associated with the former location of the heavy vehicle shop was located at the site. Due to past operations at the former shops, potentially hazardous materials were suspected to be discharged to the soils (EA, 1998a and ICF Technology, Inc [ICF], 1995). Although the area was once developed, the site is not currently maintained.

### **Site 42**

Full Site Name: IRP Site 42

CERCLIS ID Number: GU6571999519

Site Location: Site Wide OU, MARBO Annex, Guam

Site 42 comprises approximately 1.5 acres of land with relatively flat to gently sloping topography. Site 42 is a former gas station with two associated rusted above-ground storage tanks (ASTs) and one UST (**Figure 2-4**) (EA, 1998a and ICF, 1995). Due to past operations, discharge of fuel-related constituents to the soils may have occurred. The UST was discovered during test trenching activities and no historical records, plans, or maps for this UST have been found. The liquid content of the UST was analyzed and characterized as non-hazardous waste. The 3000-gallon UST and associated piping was excavated and removed in March 2008 (EA, 2008). The tank was found to be in good condition with no visible damage.

## Site 43

Full Site Name: IRP Site 43

CERCLIS ID Number: GU6571999519

Site Location: Site Wide OU, MARBO Annex, Guam

Site 43 comprises approximately 35 acres and is relatively flat, with a gentle slope to the south and southwest. Site 43 includes the foundations (concrete pads) of former operational support buildings (**Figure 2-5**). Due to past operations at the former shops, potentially hazardous materials were suspected to have been discharged at the site (EA, 1998a and ICF, 1995).

To facilitate field activities during the remedial investigation, Site 43 was divided into four areas; Area A, Area B, Area C, and Area D (**Figure 2-5**). Area A consists of the northern portion of Site 43 and includes the following former buildings: T4-421 (welding shop), T4-420 (carpenter shop), T4-419 (electric shop), T4-418 (plumbing shop), T4-417 (refrigerator shop), T4-436 (preventative maintenance shop), T4-415 (sign paint shop), and a battery shop. Area B consists of a small area in the western central portion of Site 43, and includes the following former buildings: T4-432 (grease stand) and T4-442 (shed). Area C consists of the eastern central portion of Site 43, and includes the area around T4-431 (former motor pool building garage). Area D consists of the southern section of Site 43 and includes the following former buildings: T4-433 (machine shop), T4-440 (generator shack), and T4-475 through T4-478 (warehouses).

Two USTs and one AST were discovered at Site 43 during the detailed site inventory. No records, plans, or maps for any of the USTs have been found. Liquid samples collected from the two USTs were characterized as non-hazardous material. The second UST was characterized as hazardous material with respect to benzene and 1,2-dichloroethane (1,2-DCA). The two 3,000-gallon USTs and associated piping were

excavated and removed in March 2008 (EA, 2008). Both tanks were found to be in good condition with no visible damage.

## **2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES**

This section provides background information and summarizes the series of investigations that led to the ROD. It describes the CERCLA response actions undertaken at Sites 41, 42, and 43.

**Site History.** According to the Andersen AFB archives, MARBO Annex has historically contained military housing, warehousing, industrial support facilities, and operational facilities. From 1944 through 1950, MARBO Annex was under the jurisdiction of the Naval Government of Guam. Following the Organic Act of 1950, the United States government took control of MARBO Annex and the USN administered the facilities. By 1956 most "industrial" operations at MARBO Annex had ceased, except for continued operation of the USN Power Plant, the MARBO Laundry, and the water production wells. On 25 June 1958, the AF assumed control of MARBO Annex. Based on review of available records at the Real Property Office at Andersen AFB, all temporary buildings (Quonset huts) on the MARBO Annex were removed prior to June 1960.

The barracks and housing along the southern portion of MARBO Annex (referred to as Andersen South Housing Area) are not currently in use and are fenced off from the rest of the MARBO Annex (**Figure 2-2**). The former USN Power Plant is now under the control of the Government of Guam. The power plant is currently not operational. The MARBO Laundry (**Figure 2-2**) was in operation from 1948 through 1973, and was modified in 1970 to also operate as a dry cleaning facility. The dry cleaning operations ceased in 1973, and the building was used intermittently as a storage and warehouse facility until it was demolished in 2005.

The AF initially installed nine water production wells at the MARBO Annex between 1945 and 1965 (MW-1 through MW-9). Production wells MW-2 and MW-4 are no

longer in service. MW-2 was taken out of operation in 1998 (EA, 1998b). There are no available records for when MW-4 was taken out of operation. The seven remaining production wells (MW-1, MW-3, MW-5, MW-6, MW-7, MW-8, and MW-9; **Figure 2-2**) are currently in operation supplying drinking water for Andersen AFB.

**Summary of Previous Investigations.** A Phase I Environmental Baseline Survey (EBS) was completed for Sites 41, 42, and 43 in January 1995. As a result of the Phase I EBS, these sites were identified as sources of suspected release and recommended for further investigation under a Phase II EBS that included sampling. The Phase II EBS for all three sites was completed between 1996 and 1997 (EA, 1998a). Following the Phase II EBS, additional investigations were conducted as part of the remedial investigation (RI) activities. The RI investigations were performed in 2006 and included a detailed site inventory (DSI), an electromagnetic (EM) geophysical survey, test trench excavations, test pit excavations, surface soil sampling, and subsurface soil sampling (EA, 2009b).

The majority of the anomalies detected at Site 41 during EM geophysical survey corresponded to areas with concrete pads, pipe, and metallic debris/waste. At Site 42, the majority of anomalies corresponded to areas with concrete pads, an asphalt road, a UST, and a utility line. At Site 43, the majority of anomalies corresponded to areas of surficial metallic debris, concrete pads, a UST, ASTs, utility lines, and two conex containers.

In addition to the RI activities, investigations were performed in the vicinity of the USTs that were identified at Sites 42 and 43 following removal of the USTs. Additional details regarding the Phase II EBS, RI investigations, and post-UST removal investigations, including results, are presented in Section 2.5.5 (Previous Site Characterization Activities) and Section 2.5.6 (Nature and Extent of Contamination).

**Enforcement Actions.** Andersen AFB was listed on the National Priorities List (NPL) on 14 October 1992. The enforcement activities for Andersen AFB were initiated when

the AF entered into a FFA agreement with USEPA Region IX and Guam EPA. The FFA, finalized on 30 March 1993, established a framework for performing detailed environmental investigations at Andersen AFB. The FFA was based on applicable environmental laws including CERCLA, SARA, and the NCP.

As the lead agency for remedial activities, the USN is conducting environmental restoration at the Site Wide OU in accordance with CERCLA under the DERP which was established by Section 211 of the SARA of 1986.

As the support agencies, the USEPA and Guam EPA provide primary oversight of the environmental restoration actions, in accordance with the FFA (USEPA et al., 1993). Funding is provided by the Defense Environmental Restoration Account, a funding source approved by Congress to clean up contaminated sites on U.S. Department of Defense (DoD) installations.

To the extent practicable, National Environmental Policy Act (NEPA) values have been incorporated throughout the CERCLA process culminating in this ROD. Separate NEPA documentation will not be issued.

### **2.3 COMMUNITY PARTICIPATION**

NCP Section 300.430(f)(3) establishes a number of public participation activities that the lead agency must conduct following preparation of the Proposed Plan and review by the support agency (USEPA and Guam EPA). The AF (previously the lead agency) followed a remedy selection process in accordance with the public participation requirements of CERCLA Sections 113(k)(2)(B)(i-iv) and 117. Additional requirements as outlined in the Andersen AFB Community Relations Plan (CRP) were also fulfilled. Components of these items and documentation of how each component was satisfied for Sites 41, 42, and 43 are described in **Tables 2-1** and **2-2** below.

TABLE 2-1

**PUBLIC NOTIFICATION OF DOCUMENT AVAILABILITY  
ANDERSEN AIR FORCE BASE, GUAM**

Requirement:	Satisfied by:
<p>Notice of availability of the Proposed Plan and Remedial Investigation / Feasibility Study (RI/FS) must be made in a widely-read section of a major local newspaper.</p>	<p>Notice of availability was published in the public announcements section of the Pacific Daily News, a major local newspaper.</p>
<p>Notice of availability should occur at least two weeks prior to the beginning of the public comment period.</p>	<p>Notice of availability was published on 14 April 2009.</p>
<p>Notice of availability must include a brief abstract of the Proposed Plan which describes the alternatives evaluated and identifies the preferred alternative (NCP Section 300.430(f)(3)(i)(A))</p>	<p>Notice of availability included all of the required components.</p>
<p>Notice of availability should consist of the following information:</p> <ul style="list-style-type: none"> <li>• Site name and location</li> <li>• Date and location of public meeting</li> <li>• Identification of lead and support agencies</li> <li>• Alternatives evaluated in the detailed analysis</li> <li>• Identification of preferred alternative</li> <li>• Request for public comments</li> <li>• Public participation opportunities including: <ul style="list-style-type: none"> <li>- Location of information repositories and Administrative Record file</li> <li>- Methods by which the public may submit written and oral comments, including a contact person</li> <li>- Dates of public comment period</li> <li>- Contact person for the community advisory group (e.g., Restoration Advisory Board) if applicable</li> </ul> </li> </ul>	<p>Notice of availability included all required and pertinent information.</p>

TABLE 2-2

**PUBLIC COMMENT PERIOD REQUIREMENTS  
ANDERSEN AIR FORCE BASE, GUAM**

Requirement:	Satisfied by:
Lead agency should make document available to public for review on same date as newspaper notification.	Document was made available to the public on 14 April 2009. The notification of availability was made on 14 April 2009.
Lead agency must ensure that all information that forms the basis for selecting the response action is included as part of the Administrative Record file and made available to the public during the public comment period.	Andersen AFB maintains the Administrative Record file for Andersen IRP sites, including Sites 41, 42, and 43 in the MARBO Annex. All data collected and all CERCLA primary documents produced for Sites 41, 42, and 43 are maintained as part of this file at the Robert F. Kennedy Library at the University of Guam and the Nieves M. Flores Memorial Library in Hagatna, Guam.
CERCLA Section 177(a)(2) requires the lead agency to provide the public with a reasonable opportunity to submit written and oral comments on the Proposed Plan.  NCP Section 300.430(f)(3)(i) requires the lead agency to allow the public a minimum of 30 days to comment on the RI/FS and the Proposed Plan.	The AF (previously the lead agency) provided a public comment period for the Proposed Plan from 14 April 2009 to 14 May 2009.
The lead agency must extend the public comment period by at least 30 additional days upon timely request.	No request for extension of the public comment period was received by the AF.
The lead agency must provide the opportunity for a public meeting to be held at or near the site during the public comment period. A transcript of this meeting must be made available to the public and be maintained in the Administrative Record for the site (pursuant to NCP Section 300.430(f)(3)(i)(E)).	A public meeting was held on 30 April 2009 at the Guam Marriott in Tumon. A transcript of this meeting has been added to the Administrative Record file, and is also included as an attachment to this ROD.

Responses by the AF to comments received during the public meeting are included in Section 3 of the ROD (Responsiveness Summary). A transcript of the proceedings of the meeting is also included as an attachment to this ROD.

## 2.4 SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

As with many large sites, the environmental problems at Andersen AFB, Guam are complex. As a result, the AF (previously the lead agency), with concurrence from the USEPA Region IX and Guam EPA, has organized the environmental restoration work at Andersen AFB into six OUs as described below.

- Main Base OU
- Northwest Field OU
- MARBO Annex OU
- Harmon Annex OU
- Urunao OU
- Site Wide OU

With the exception of the Site Wide OU, the Andersen AFB OUs were chosen based on geographical areas rather than environmental concerns. The Site Wide OU, however, consists of IRP sites that have been added to the program in recent years, and are therefore distributed geographically across the Main Base, Northwest Field, and MARBO Annex (e.g., Sites 41, 42, and 43, which are the subject of this ROD).

Final RODs have been completed for MARBO Annex (May 1998), Harmon Annex (July 2002), and Urunao Annex (December 2003). A Five-Year ROD Review was completed for MARBO Annex in July 2004. The second Five-Year ROD Review for MARBO was completed in 2009.

**Main Base OU (Sites 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 25, 26, 27, 28, 29, 34, and 35).** Records of Decision addressing the Main Base OU are either completed or

are in the process of completion. The sites are proposed to be addressed in six separate ROD documents as follows:

- Sites 6, 9, and 12 (Group 1)
- Sites 5 and 8 (Group 2)
- Sites 4, 11, 25, 28, and 34 (Group 3)
- Sites 3, 10, 13, and 27 (Group 4)
- Sites 29 and 35
- Site 2, 4, 15 and 26 (Grouping not yet assigned)

Final RODs for Groups 1, 2, and 3 were completed in 2007, and the RODs for the remaining sites are currently under development.

**Northwest Field OU (Sites 7, 16, 17, 21, 30, 31, and 36).** A final ROD addressing Sites 7, 16, 17, 31, and 36 was completed in September 2007. It is anticipated that the ROD for Site 21 will be completed in April 2011. Due to presence of munitions and explosives of concern (MEC), Site 30 was transferred to the Air Force's Military Munitions Response Program (MMRP). Under the MMRP, a ROD will be completed for Site 30 following further investigation/feasibility study with respect to the MEC.

**MARBO Annex (Sites 20, 22, 23, 24, 37, and 38).** A final ROD for the MARBO Annex OU was completed in May 1998. The first Five-Year Review to evaluate remedial action effectiveness at the MARBO Annex was completed in July 2004. The second Five-Year Review for MARBO Annex was completed in 2009.

**Harmon Annex OU (Sites 18, 19, and 39).** A final ROD for the Harmon Annex OU was completed in July 2002.

**Urunao OU (Site 40).** A final ROD for the Urunao OU was completed in December 2003.

**Sitewide OU (Sites 41 through 78).** The Site Wide OU consists of IRP Sites that have been added to the program in recent years, and are therefore distributed geographically across the Main Base, Northwest Field, MARBO Annex, and Tumon Tank Farm. Records of Decision addressing these sites are in various stages of development and are anticipated to be completed in 2011, with the exception of Site 54, which is currently under remedial investigation/feasibility study. The sites are proposed to be addressed in separate ROD documents as follows:

Sites 45, 49, 59, 61, 67, 68, and 69 (Group A)

- Sites 48, 56, 58, 70, and 73 (Group B)
- Sites 47, 50, 51, 53, and 55 (Group C)
- Sites 63, 64, 65, 66, 72, and 77 (Group D)
- Sites 57, 71, 74, 75, 76, and 78 (Group E)
- Sites 44 and 46 (Group F)
- Sites 41, 42, and 43 (Group G)
- Site 54

Due to presence of MEC, two sites (52 and 60) were transferred to the Air Force's MMRP. Site 62 is also expected to be transferred to the MMRP in the near future due to the presence of MEC. Under the MMRP, RODs will be completed for these sites after further investigations/feasibility studies are completed with respect to MEC.

## 2.5 SITE CHARACTERISTICS

### 2.5.1 Physiography and Climate

This section provides brief descriptions of the physical characteristics of each of the three IRP sites addressed in this ROD. This section also describes the general climate conditions for the island of Guam and provides details on the physiography of the three IRP sites.

#### 2.5.1.1 Physiography

Guam is the largest and southernmost island in the Mariana Islands located in the western Pacific Ocean (**Figure 2-1**). Physiographically, the island of Guam may be divided into northern and southern regions, which are separated by the Adelup Fault (**Figure 2-1**). The northern region is a limestone plateau consisting of rolling hills and cliffines ranging from 200 to 600 feet above mean sea level (msl). The southern region is a volcanic upland of mountains and valleys, with Mount Lam Lam being the highest point on the island at 1,335 feet above msl (Tracey, et al., 1964). Guam is designated as a Seismic Risk Zone 4 because it is located near the Mariana Trench. The Mariana Trench is an active seismic subduction zone, and forms the world's deepest ocean trench at 37,521 feet below msl.

Andersen AFB consists of multiple parcels of land located on the northern half of Guam including the MARBO Annex where Sites 41, 42, and 43 are located (**Figure 2-2**). The MARBO Annex is located on a broad, uplifted limestone plateau underlain at depth by volcanic rocks. It is located approximately 4 miles south of Andersen AFB's main gate. It is bounded by Marine Corps Drive (Route 1) to the north, Route 15 to the south, and private properties to the east and west (EA, 1998a). The surface elevation in the vicinity of Sites 41, 42, and 43 ranges from approximately 300 to 400 feet above msl (United States Geological Survey, 1978).

### **2.5.1.2 Climate**

Guam is located at 13° 27' north latitude (approximately 900 miles north of the equator) creating a year-round warm and humid climate. The mean annual temperature is 81 degrees Fahrenheit (°F). Daily temperatures range from the lower 70s to the upper 80s °F. Relative humidity ranges from 65 to 80 percent in the afternoon and 85 to 100 percent in the evening. Guam has two distinct seasons: a wet and a dry season. The dry season is typically from December to June, and the wet season occurs from July through November. Approximately 65 percent of the annual precipitation falls during these five rainy months and the annual rainfall on northern Guam averages between 80 and 100 inches.

The dominant winds are the trade winds, blowing from the east or northeast with velocities between 4 and 12 miles per hour (mph) throughout the year. These winds are strongest during the dry season, averaging 15 to 25 mph and calms are rare. During the wet season, the trade winds are still dominant, but not constant. The winds can blow from any direction with wind speeds generally less than 15 mph, interspersed with frequent calms. Storms may occur at any time during the year, although tropical storms and typhoons are more frequent during the rainy season. Large rainfall events associated with typhoons are common with as much as 25 inches in a 24-hour period (Ward et al., 1965).

### **2.5.2 Geology and Hydrogeology**

The Mariana Islands are a complex geological island-seamount system forming the Mariana Archipelago. Guam, Rota, Tinian, and Saipan are part of an older frontal arc (middle Eocene-age). The islands in the Mariana Arc are located on the Philippine Plate near a feature known locally as the "andesite line" that separates the Pacific Basin from the Philippine Plate.

The island of Guam has two distinct physiographic provinces: the Northern Limestone Plateau and the Southern Volcanics, which are separated by the Adelup Fault. South of the fault, the island is composed almost entirely of volcanic rocks, and north of the fault the island is composed almost entirely of limestone (excluding portions of Mt. Santa Rosa and Mataguac Hill – **Figure 2-1**). Andersen AFB is situated on an undulating limestone plateau with surficial karst features. The geology of the Main Base consists of the Mariana and Barrigada Limestones, which are underlain at depth by the volcanic rocks of the Alutom Formation (Tracey et al., 1964). The Pliocene and Pleistocene-aged Mariana Limestone consists of the reefal, detrital, molluscan, and fore-reef facies. The reefal facies is situated along the cliffline faces and consists predominantly of corals in position of growth in a matrix of encrusting calcareous algae. The reefal facies is white, massive, generally compact, and porous to cavernous (Tracey et al., 1964). The detrital facies is lagoonal in origin, varies from friable to well-cemented, ranges in grain size from coarse to fine, and is generally porous (Tracey et al., 1964). The molluscan facies consists of fine-grained (mud), white to tan limestone of lagoonal origin containing abundant casts and molds of mollusks (Tracey et al., 1964). The fore-reef facies consists of a well-bedded, friable to indurated foraminiferal limestone deposited as fore-reef sand and debris.

The Miocene-aged Barrigada Limestone lies beneath the Mariana Limestone. The Barrigada Limestone is generally a deep-water deposit of medium- to coarse-grained texture and ranges from compact and well lithified to extremely friable. The formation contains abundant foraminifera *Operculina*, *Gypsina*, and *Cycloclypeus* (Tracey et al., 1964). It is a principal water-bearing unit, and contains abundant solution openings, voids, and fissures. The Eocene/Oligocene-aged Alutom Formation unconformably underlies the Barrigada Limestone and consists of well-bedded, fine- to coarse-grained volcanic and volcanoclastic rocks.

Throughout most of northern Guam, fresh groundwater floats on seawater in an approximate buoyant equilibrium, described by the Ghyben-Herzberg model. Practical application of this model, when combined with the effect of dynamics of flow of the

freshwater, results in a lens-shaped body of freshwater with parabolic surfaces at both the freshwater-air interface and the freshwater-seawater interface (Ward et al., 1965). This freshwater lens is generally referred to as the Northern Guam Lens (NGL).

The surface of the limestone plateau on Northern Guam is interrupted by two volcanic peaks, Mount Santa Rosa and Mataguac Hill (**Figure 2-1**). These low-permeability volcanic outcrops extend into the subsurface to form a lateral barrier that directs the groundwater flow from MARBO Annex westward toward Tumon Bay, where freshwater springs discharge along the coastline.

#### **2.5.2.1 Geology and Hydrogeology of Site 41**

Site 41 is underlain by the Barrigada Limestone, which is underlain by the volcanic deposits of the Alutom Formation. Surface soils and bedrock are very porous and permeable and as a result, no rivers or streams are present in the northern portion of the island. Precipitation, except that portion lost to evapotranspiration, contributes to the groundwater lens. Groundwater beneath Site 41 is approximately 340 feet bgs, under basal conditions, and flow is interpreted to be toward the east-southeast (EA, 2007).

#### **2.5.2.2 Geology and Hydrogeology of Site 42**

Site 42 is underlain by the Barrigada Limestone, which is underlain by the volcanic deposits of the Alutom Formation. Surface soils and bedrock are very porous and permeable and as a result, no rivers or streams are present in the northern portion of the island. Precipitation, except that portion lost to evapotranspiration, contributes to the groundwater lens. Groundwater beneath Site 42 is approximately 375 feet bgs, under basal conditions, and flow is interpreted to be toward the northeast (EA, 2007).

### **2.5.2.3 Geology and Hydrogeology of Site 43**

Site 43 is underlain by the Barrigada Limestone, which is underlain by the volcanic deposits of the Alutom Formation. Surface soils and bedrock are very porous and permeable and as a result, no rivers or streams are present in the northern portion of the island. Precipitation, except that portion lost to evapotranspiration, contributes to the groundwater lens. Groundwater beneath Site 43 is approximately 330 to 370 feet bgs, under basal conditions, and flow is interpreted to be toward the northeast (EA, 2007).

### **2.5.3 Surface Water and Groundwater Hydrology**

MARBO Annex is located on the northern plateau of Guam with flat-lying limestone, gently-rolling topography, and limited surface runoff. No wetlands or surface water are located in the vicinity of Sites 41, 42, and 43. The thin soil and the limestone bedrock is very porous and permeable (Stearns, 1937 and Mink, 1976). Therefore, rainwater readily infiltrates downward through the interconnected pore spaces of the vadose zone preventing the formation of surface streams, rivers, and lakes (Stearns, 1937 and Mink, 1976). The nearest surface water body is the Pacific Ocean, located approximately 2 miles to the southeast.

Groundwater resources on northern Guam are encountered at approximately 400 to 600 feet bgs. The water table elevations at the MARBO Annex range from 4.5 to 6 feet above msl, with a freshwater lens thickness of approximately 100 feet. The freshwater aquifer is highly conducive to groundwater flow. Hydraulic conductivities as high as 20,000 feet per day were observed during the MARBO Annex OU remedial investigation (ICF, 1997) and during dye trace studies conducted on the Main Base. A brackish transition zone (mixing zone) exists between the freshwater lens and the underlying marine water. The transition zone is approximately 20 feet thick (EA, 2009c).

The important factors governing the volume of freshwater in the lens are: the effects of mixing freshwater and marine water, the permeability of the limestone formations, and the rate of recharge (Ward et al., 1965). Though some infiltrating precipitation is captured as storage in vadose zone primary porosity, the vast majority of infiltration that percolates through the vadose zone (in secondary porosity) migrates to the top of the freshwater lens. The rapid infiltrating recharge to the upper portion of the freshwater lens propagates quickly (weeks to months) to coastal discharge areas (seeps and/or large-scale dissolution features), and creates strongly oxidized groundwater conditions throughout the freshwater lens. The strongly oxidized groundwater condition is evidenced by shallow and deep dissolved oxygen concentrations generally ranging from 5 to 8 milligrams per liter (mg/L), and oxidation-reduction potential ranging from 100 to 500 millivolts (EA, 2009c). A strong lateral flow component is observed in the upper portion of the freshwater lens based on contaminant trends.

The elevation of the water table and thickness of the freshwater lens vary in response to rapid stimuli (large short-term rain events), moderate-term stimuli (seasonal rainfall and monsoonal wind effects on sea level), and long-term stimuli (precipitation fluctuations due to El Niño/Southern Oscillation events and eustatic sea level rise).

Regionally, the groundwater flow direction in the NGL is from the limestone/volcanic contacts toward the sea. Faults, fractures, brecciated zones, joints, solution channels, or cavities can affect flow and pumping wells.

On the northern half of Guam, potable drinking water comes primarily from the porous limestone aquifer, the NGL. The USEPA has designated the NGL as a sole-source aquifer (Barrett, Harris, & Associates, 1982). Potable groundwater in the vicinity of the three sites is currently being developed by Guam Waterworks Authority (GWA) and Andersen AFB. Currently, seven of the Andersen AFB production wells (MW-series wells) located in MARBO Annex are used for water production (**Figure 2-2**). These seven operating production wells can yield 2.1 million gallons per day (mgd), meeting the average Base consumption of 1.6 mgd (EA, 2009b). Production well MW-9 is the

closest production well to Sites 41 and 43. Production well MW-9 is located approximately 1,500 feet north of Site 43 and 1,500 feet east of Site 41. The closest production wells to Site 42 are MW-7, MW-8, and Y-21A. Production wells MW-7 and MW-8 are located approximately 1,500 feet south of Site 42 and GWA production well Y-21 is located approximately 1,500 feet north of Site 42 and north of Marine Drive.

#### **2.5.4 Ecology**

The ecological habitat for each site was identified during the ecological survey performed during the RI. The sites are located in the interior of Guam, away from the coastal cliff line and marine environments. The sites are not within the range of the critical habitats of threatened or endangered species such as the Mariana crow (*Corvus Kubaryi*), the Mariana fruit bat (*Pteropus mariannus*), the Fire tree (*Serianthes nelsonii*), and the Ufa-Halomtano tree (*Heritiera longipetiolata*) (USAF, 1994 and Department of Aquatic and Wildlife Resources, 1988).

The distinct vegetation at MARBO Annex includes mixed shrub and secondary growth limestone forest. The mixed shrub is mainly composed of grasses and herbs located near the northern property line (south of Marine Corps Drive) and to the east of the western-most boundary of MARBO Annex. The secondary growth limestone forest is predominant throughout the area, except for the access roads and clearings due to earlier development.

Based on the ecological survey, there are no wetland communities or critical habitats at MARBO Annex. The observed fauna includes insects, arachnids, lizards, birds (including yellow bittern), feral pigs, snakes, feral deer and feral dogs. Domesticated chickens and horses are also present at MARBO Annex.

#### **2.5.4.1 Ecological Receptors and Critical Habitats at Site 41**

Two primary habitats were identified at Site 41; mixed shrub vegetation and secondary growth limestone forest vegetation. Although there are several threatened and endangered species of flora and fauna on Guam, none of the critical habitats for these species are located within or near Site 41.

#### **2.5.4.2 Ecological Receptors and Critical Habitats at Site 42**

Two primary habitats were identified at Site 42; mixed shrub vegetation and secondary growth limestone forest vegetation. Although there are several threatened and endangered species of flora and fauna on Guam, none of the critical habitats for these species are located within or near Site 42.

#### **2.5.4.3 Ecological Receptors and Critical Habitats at Site 43**

Two primary habitats were identified at Site 43; mixed shrub vegetation and secondary growth limestone forest vegetation. Three representative species were designated as ecological receptors of concern (ROCs) for Site 43: yellow bittern, terrestrial plants, and terrestrial invertebrates (earthworms).

#### **2.5.5 Previous Site Characterization Activities**

A Phase I EBS was completed for Sites 41, 42, and 43 in January 1995. As a result of the Phase I EBS, these sites were identified as sources of suspected release and recommended for further investigation under a Phase II EBS that included sampling. The Phase II EBS for all three sites was completed between 1996 and 1997. Results of the Phase II EBS, subsequent RI activities, and UST removal activities are summarized below. No historical objects or areas of archaeological or historical importance were identified during these investigations.

**Site 41.** The Phase II EBS field activities included collecting soil gas samples and both composite and discrete surface soil samples. No subsurface soil samples were collected during the Phase II EBS.

- A total of 56 soil gas samples were collected during the Phase II EBS from around each of the former building foundations at a depth of 4 feet bgs and analyzed for volatile organic compounds (VOCs). None of the soil gas samples had detectable VOC concentrations.
- Initial surface soil samples collected at Site 41 were composited from groups of 4 to 6 samples. The analytical results were then compared to screening levels (preliminary remediation goals [PRGs] and background threshold values [BTVs]) and discrete surface soil samples were collected from within five feet of building foundations to further characterize the areas with exceedances. Nine composite surface soil samples were collected from around the building foundations at depths of 0 to 6 inches bgs, and analyzed for semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and Target Analyte List (TAL) metals. No SVOCs or PCBs were detected in any of these samples at concentrations exceeding screening levels. However, lead was detected at concentrations exceeding the risk-based screening level in four composite surface soil samples near the foundations of the T5-103 Shop, the T5-5-X Shop, the T5-108 Heavy Vehicle Shop, and the T5-109 Shop (**Figure 2-3**).
- Aluminum and antimony were both detected at concentrations exceeding the screening levels in one composite surface soil sample.
- Additional discrete surface soil samples were collected and analyzed for lead, aluminum and antimony. Lead was detected at concentrations exceeding screening levels in seven of 11 discrete surface soil samples. Aluminum and antimony were not detected in any of the discrete surface soil samples at concentrations exceeding the screening levels. Therefore, aluminum and

antimony were not considered to pose any significant risk to human or ecological receptors.

During the subsequent RI investigation at Site 41, surface and subsurface sampling was also performed. Samples were also collected from trenches and test pits (Figure 2-3).

Results are as follows:

- Thirty three surface soil samples (including duplicates) were initially collected from around the perimeter of the concrete pads and inside drainage swale areas. Lead was found at concentrations exceeding residential PRGs in 14 of these samples. An additional 72 surface soil samples were collected from the areas surrounding the 14 surface soil samples found to contain lead. The additional surface soil samples were also analyzed for lead. Lead was detected at concentrations exceeding the residential PRG in 44 of these additional surface soil samples. Many of these detections also exceeded the industrial PRG of 800 milligrams per kilogram (mg/kg). In addition, 25 subsurface samples were collected and analyzed for lead. None of the subsurface soil samples indicated lead impacts exceeding the residential PRG.
- Based on the analysis of 105 surface soil samples (including duplicates), lead concentrations ranged from 19 to 53,300 mg/kg. The average concentration of lead in surface soil samples was 1,256 mg/kg, which is above the USEPA risk-based target concentration for both residential (400 mg/kg) and industrial (800 mg/kg) receptors. Therefore, lead in surface soil poses a potential concern for adverse health effects to potential future residential receptors and current industrial workers.
- Lead was not detected in any of the 15 subsurface soil samples (including duplicates) collected within the test pits or from the bottom of test pits at concentrations exceeding the residential PRG (400 mg/kg).

**Site 42.** The Phase II EBS field activities included the collection of soil gas samples and composite soil samples. No subsurface soil samples were collected during the Phase II EBS.

- A total of 10 soil gas samples were collected at Site 42 from around the ASTs. Each soil gas sample was collected from a depth of 4 feet bgs and analyzed for VOCs. None of the soil gas samples had detectable VOC concentrations.
- Two composite surface soil samples were collected from within five feet of the ASTs. The composite surface soil samples were analyzed for SVOCs, PCBs, and TAL metals. No SVOCs or PCBs were detected in any of these samples at concentrations exceeding screening levels.
- Lead was detected at a concentration exceeding the risk-based screening level in one composite surface soil sample. No subsequent discreet surface soil samples were collected at Site 42.

During the subsequent RI investigation at Site 42, surface and subsurface sampling was also performed. Samples were also collected from trenches and test pits (**Figure 2-4**). Results are as follows:

- Fifteen surface soil samples were collected from the perimeter of the concrete pad in the vicinity of the UST, and the mounded area near the two ASTs (**Figure 2-4**). Lead was detected at concentrations exceeding the residential PRG in four surface soil samples. Eleven additional surface soil samples were collected in the area surrounding the four surface soil samples found to contain lead at concentrations exceeding the residential PRG. Lead was detected at a concentration exceeding the residential PRG in one surface soil sample.
- Four subsurface soil samples were collected during test pitting activities. None of the subsurface soil samples contained lead or VOCs at concentrations

exceeding their respective residential PRGs. Locations of the subsurface samples are also shown on **Figure 2-4**.

- Based on the analysis of 26 surface soil samples (including duplicates), lead concentrations ranged from 25 to 3,370 mg/kg, with an average concentration of 484 mg/kg. The mean concentration is above the USEPA risk-based target concentration for residential (400 mg/kg) and below the industrial (800 mg/kg) receptors.
- Lead was not detected in any of the four subsurface soil samples collected within the test pits or from the bottom of test pits at concentrations exceeding the residential PRG (400 mg/kg).

**UST Removal at Site 42.** One 3,000-gallon UST was discovered during test-trenching activities at Site 42 as part of the RI. Contents of the UST were characterized as non-hazardous waste. The UST was removed in March 2008 and the tank and contents were disposed of at appropriate disposal facilities. The tank was found to be in good condition with no visible damage. Confirmation samples were collected from the excavation sidewalls at depths of approximately 13 feet bgs. An additional grab sample was collected from the bottom of the excavation (approximately 16 feet bgs). Samples were also collected beneath the piping at approximately one foot bgs. Samples were analyzed for VOCs, TPH-DRO and TPH-gasoline range organics (GRO), and lead. Lead was detected in the soil beneath the UST (16 feet bgs) at a concentration of 510 mg/kg, exceeding the residential PRG, but less than the industrial PRG. Lead was also detected at concentrations of 670 mg/kg and 680 mg/kg, exceeding the residential PRG, in two soil samples beneath the piping (1 foot bgs). Additionally, TPH-DRO was detected in three soil samples beneath the piping at concentrations ranging from 62 to 85 mg/kg, exceeding the Guam EPA cleanup level of 50 mg/kg.

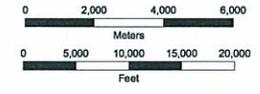
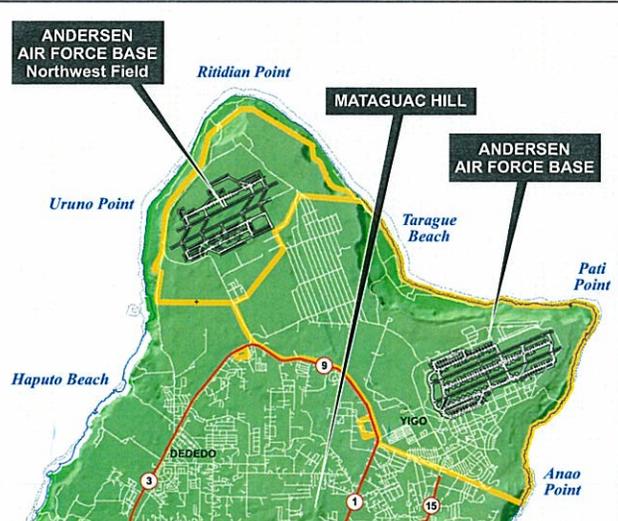
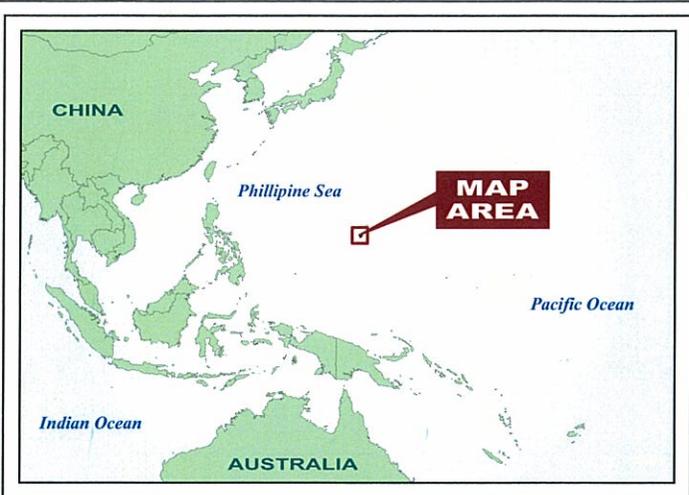
**Site 43.** The Phase II EBS field activities included the collection of soil gas samples and both composite and discrete surface soil samples. No subsurface soil samples

were collected due to the presence of limestone bedrock at depths shallower than 2 feet bgs.

- A total of 74 soil gas samples were collected. No target VOCs were detected in the soil gas samples.
- Composite surface soil samples were analyzed for polycyclic aromatic hydrocarbons (PAHs), SVOCs, PCBs, and TAL metals. No PCBs were detected in any of these samples at concentrations exceeding screening levels.
- Lead was detected at concentrations exceeding screening levels in four composite surface soil samples.
- Benzo(a)pyrene, a PAH, was detected at concentrations exceeding screening levels in three composite surface soil samples.
- Seven additional discrete soil samples were collected and analyzed for lead and PAHs to verify the presence and extent of lead and benzo(a)pyrene detected in the composite surface soil samples.
- Lead was detected at concentrations exceeding screening levels in one discrete surface soil sample. Benzo(a)pyrene was detected at concentrations exceeding screening levels in two discrete surface soil samples.

During the subsequent RI investigation at Site 43, surface and subsurface sampling was also performed. Samples were also collected from trenches and test pits. Results are as follows:

- A total of 173 surface soil samples (including duplicates) were collected from Areas A, B, C, and D (**Figures 2-6 through 2-9**, respectively), and analyzed for a variety of parameters including PAHs, PCBs, and TAL metals. The sample



- Installation boundary
- Major roads
- Minor roads
- - - Reef

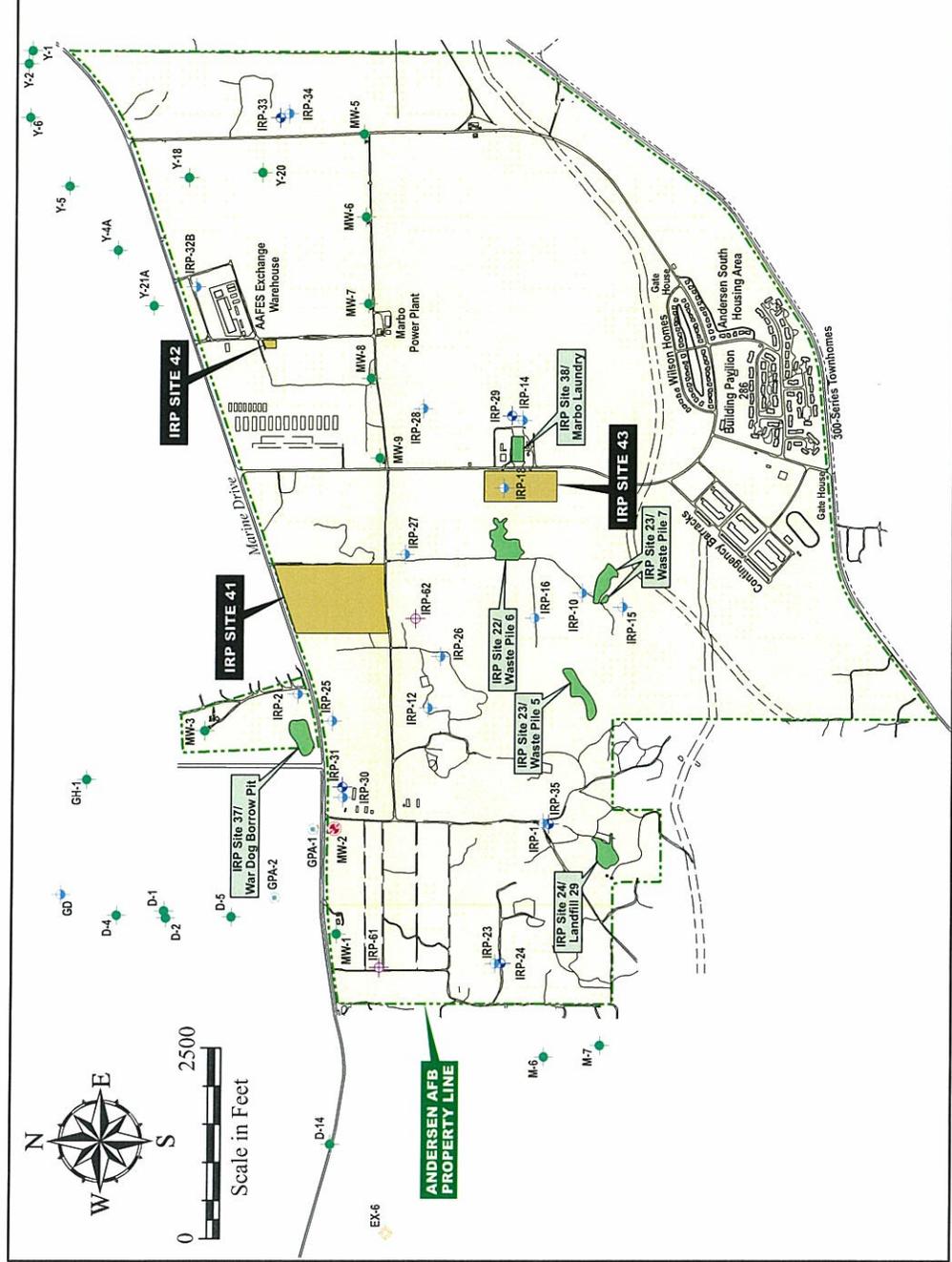


ANDERSEN AIR FORCE BASE  
GUAM

Vicinity Map

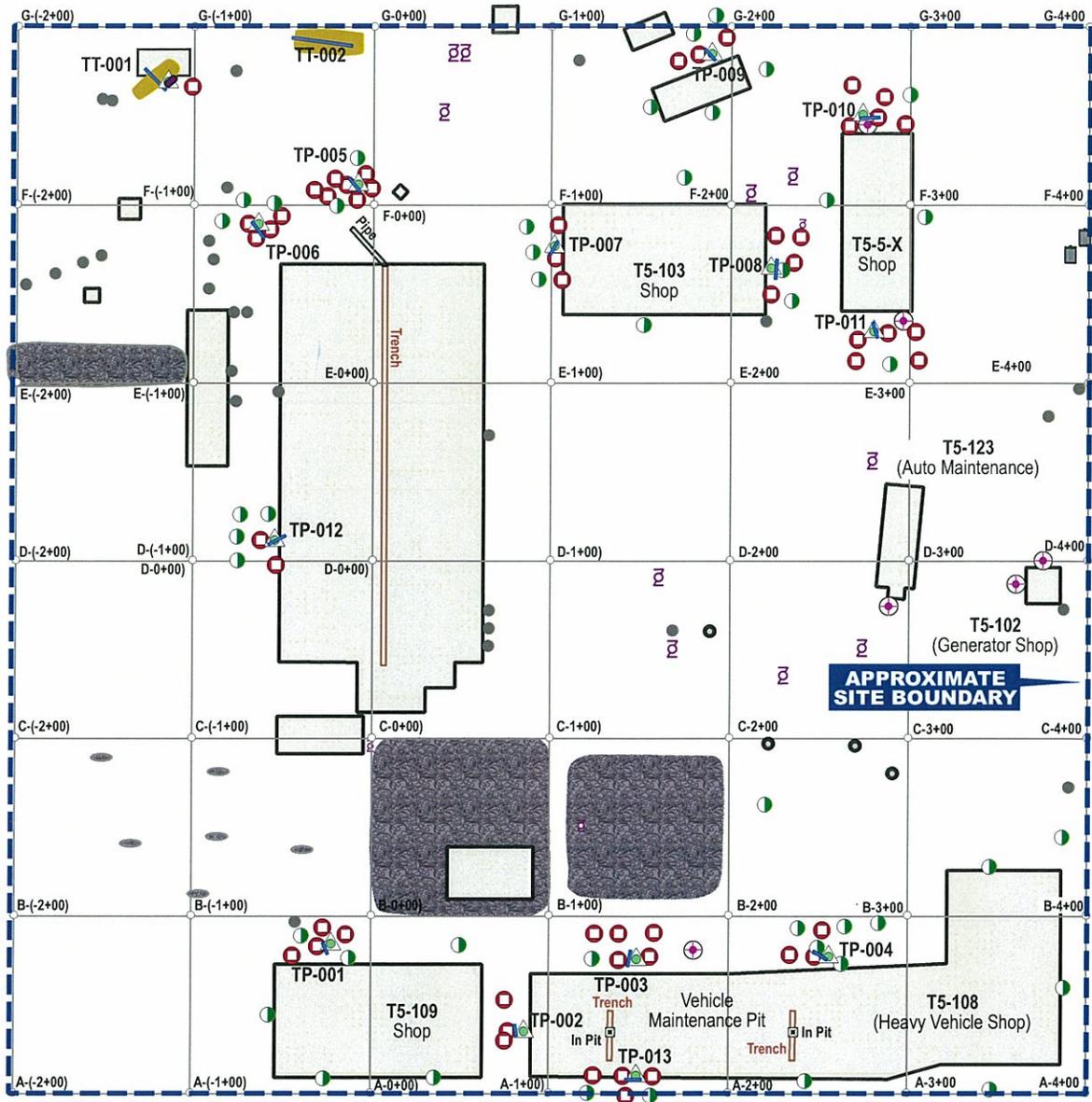
FIGURE 2-1

ANDERSEN AIR FORCE BASE  
GUAM  
Location Map of Sites  
41, 42, 43  
MARBO Annex  
FIGURE 2-2



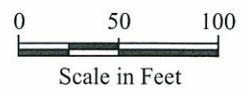
**EXPLANATION**

	IRP site, including groundwater beneath the sites, in the MARBO Annex Operable Unit
	IRP site addressed in this proposed plan
	Deep monitoring well
	Shallow monitoring well
	Full screened monitoring well across the water table
	Production well
	Exploratory borehole
	Deep open borehole
	Inactive production well
	Existing roads
	Existing unimproved roads
	Existing building or pad
	Former building or pad



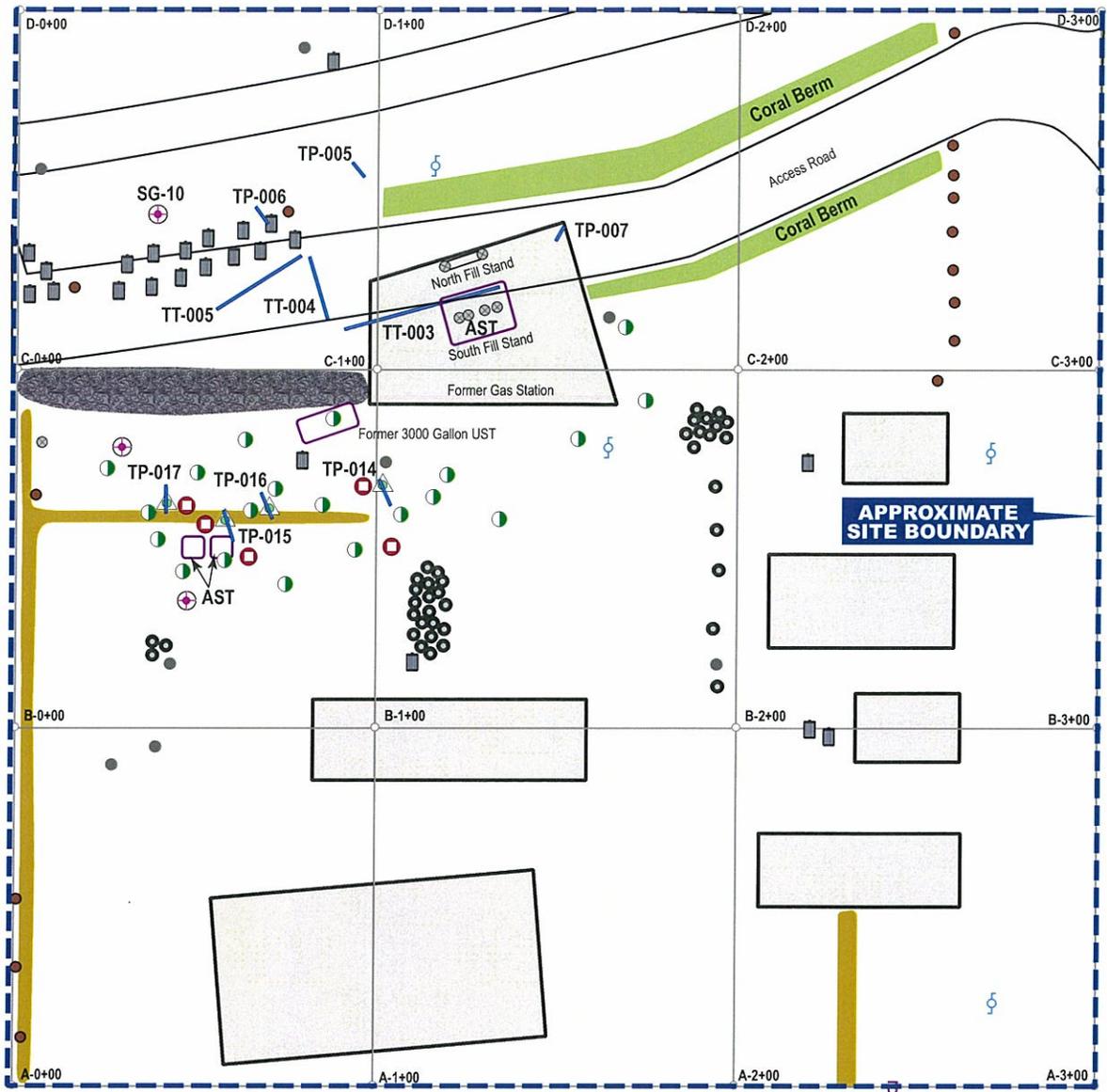
**EXPLANATION**

- Tar/asphalt area
- Surface soil sample locations above regulatory limits
- Surface soil sample locations below residential remedial goal
- Subsurface soil sample locations below residential remedial goal
- Soil gas and surface soil composite sample location
- Deteriorated 55 gallon drum or suspected drum remnants
- Miscellaneous debris including household waste
- Test pits/trenches
- Metal waste /debris
- Tire debris
- Asphalt debris area
- Mounded area
- Wooden utility poles on the ground
- Existing wooden utility pole
- Concrete pad
- Existing trench



**ANDERSEN AIR FORCE BASE  
GUAM**  
**Map of Site 41  
MARBO Annex**

**FIGURE 2-3**



**EXPLANATION**

- Tar/asphalt area
- Surface soil sample locations above regulatory limits
- Surface soil sample locations below residential remedial goal
- Subsurface soil sample locations below residential remedial goal
- Soil gas and surface soil composite sample location
- Miscellaneous debris including household waste
- Test pits/trenches
- Metal waste /debris
- Tire debris
- Mounded area
- Unknown pipe stub-up
- Wooden utility poles on the ground
- Existing wooden utility pole
- Fence post
- Concrete pad
- Storage Tanks

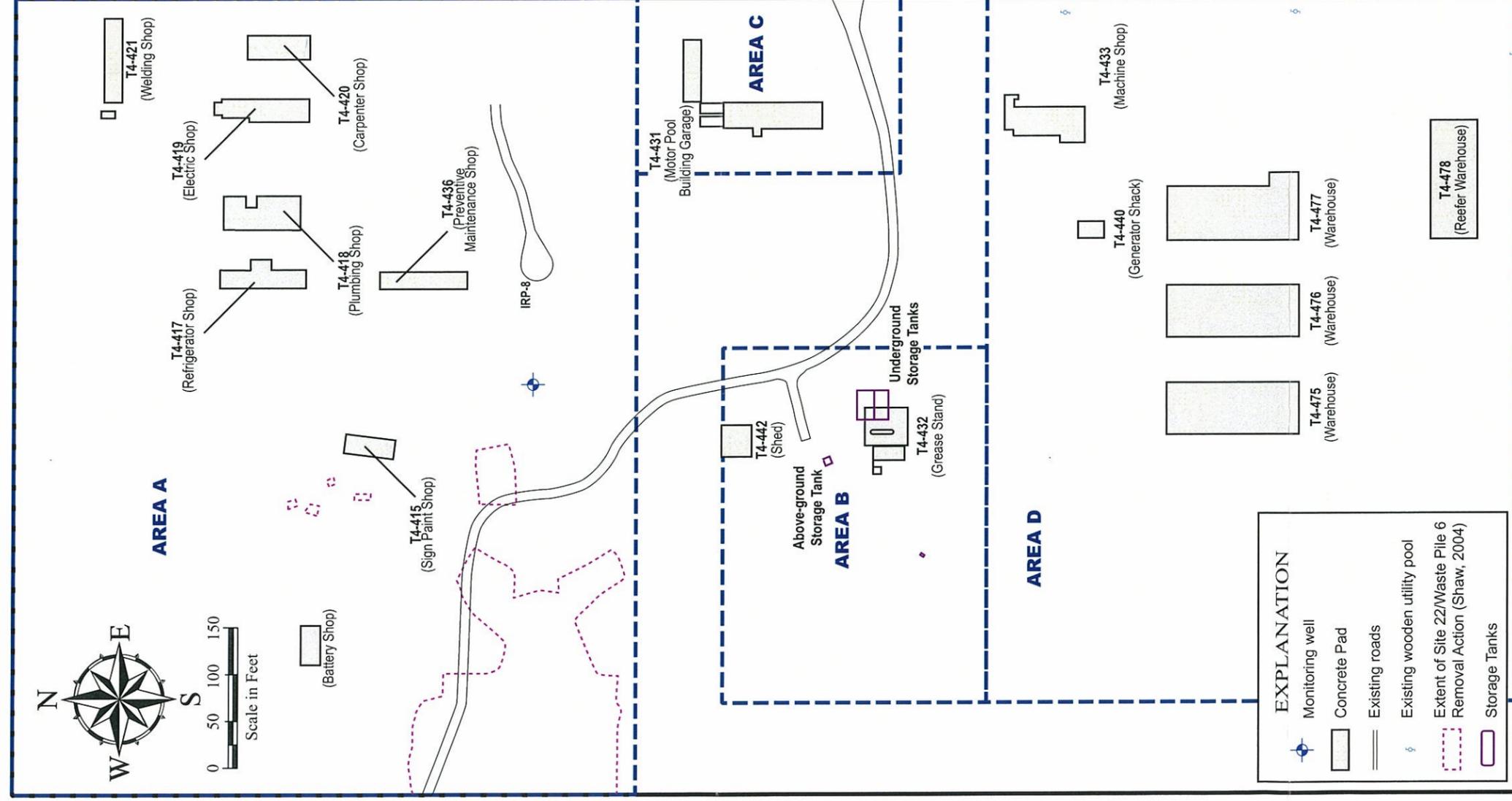
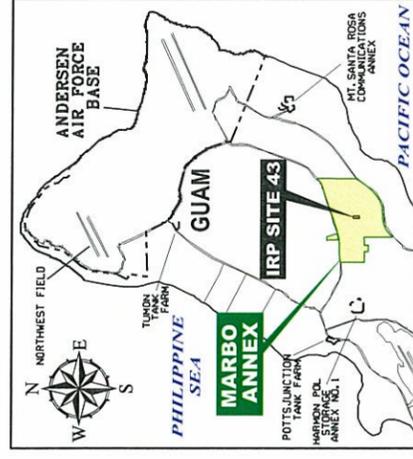


**ANDERSEN AIR FORCE BASE  
GUAM**

**Map of Site 42  
MARBO Annex**

**FIGURE 2-4**

Fig 2-5 MARBO Area 43 Location map2.ai



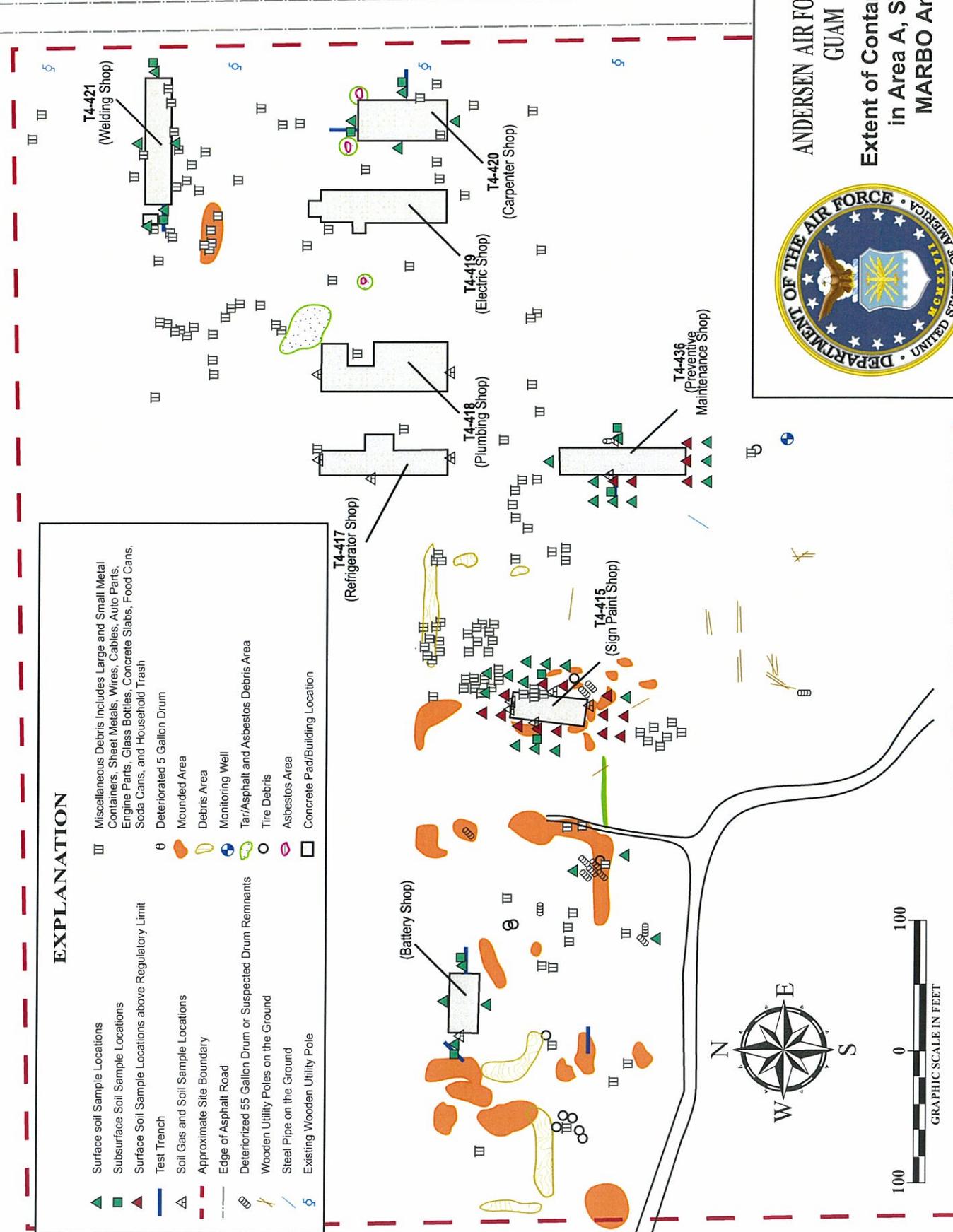
ANDERSEN AIR FORCE BASE  
GUAM

Map of Site 43,  
Areas A, B, C, and D,  
MARBO Annex

Figure 2-5

### EXPLANATION

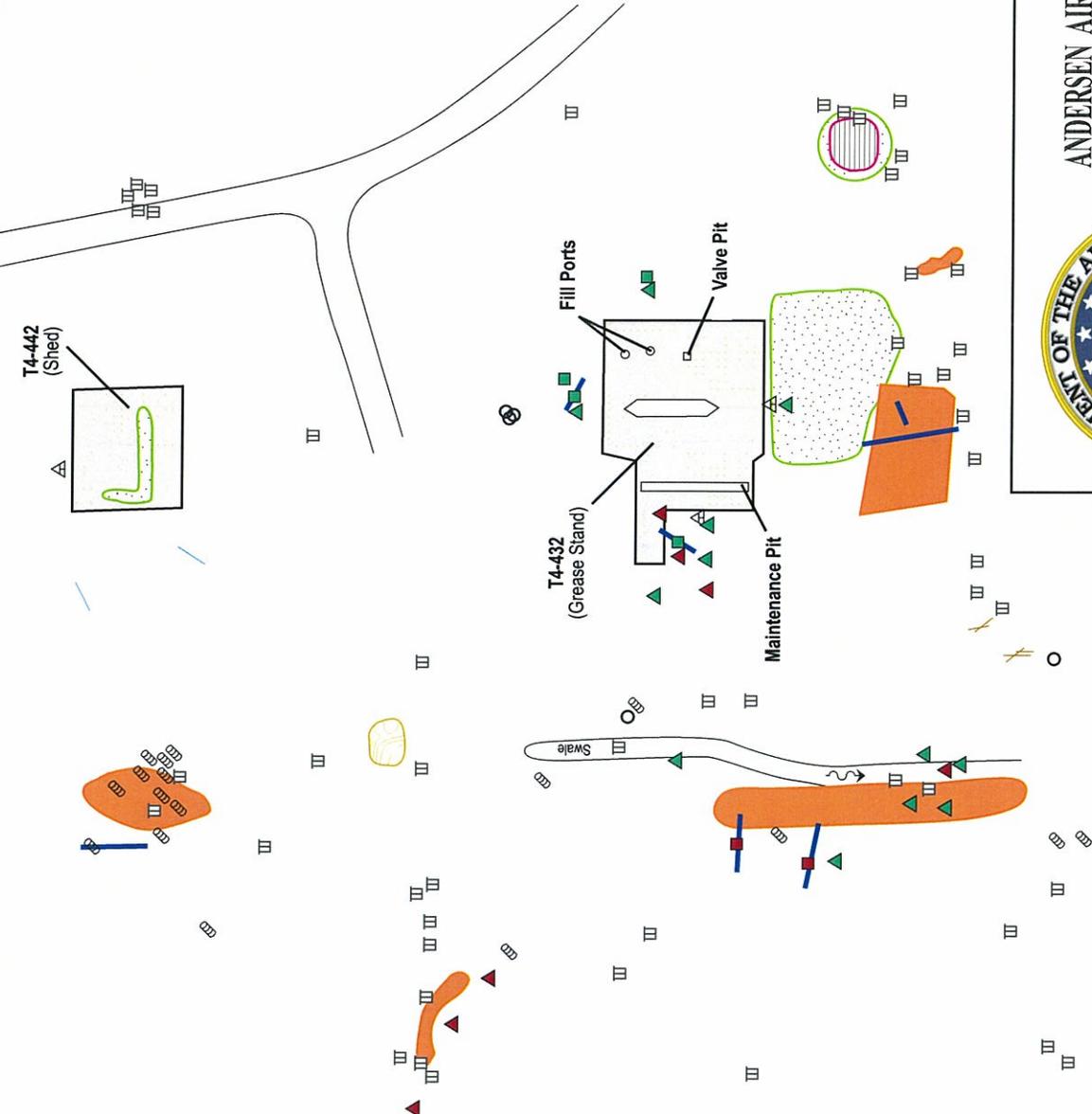
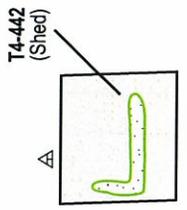
<ul style="list-style-type: none"> <li>▲ Surface Soil Sample Locations</li> <li>■ Subsurface Soil Sample Locations</li> <li>▲ Surface Soil Sample Locations above Regulatory Limit</li> <li>— Test Trench</li> <li>▲ Soil Gas and Soil Sample Locations</li> <li>--- Approximate Site Boundary</li> <li>— Edge of Asphalt Road</li> <li>○ Deteriorated 55 Gallon Drum or Suspected Drum Remnants</li> <li>○ Wooden Utility Poles on the Ground</li> <li>○ Steel Pipe on the Ground</li> <li>○ Existing Wooden Utility Pole</li> </ul>	<ul style="list-style-type: none"> <li>■ Miscellaneous Debris Includes Large and Small Metal Containers, Sheet Metals, Wires, Cables, Auto Parts, Engine Parts, Glass Bottles, Concrete Slabs, Food Cans, Soda Cans, and Household Trash</li> <li>⊖ Deteriorated 5 Gallon Drum</li> <li>○ Mounded Area</li> <li>○ Debris Area</li> <li>○ Monitoring Well</li> <li>○ Tarr/Asphalt and Asbestos Debris Area</li> <li>○ Tire Debris</li> <li>○ Asbestos Area</li> <li>○ Concrete Pad/Building Location</li> </ul>
---	--



ANDERSEN AIR FORCE BASE  
GUAM

**Extent of Contamination  
in Area A, Site 43  
MARBO Annex**

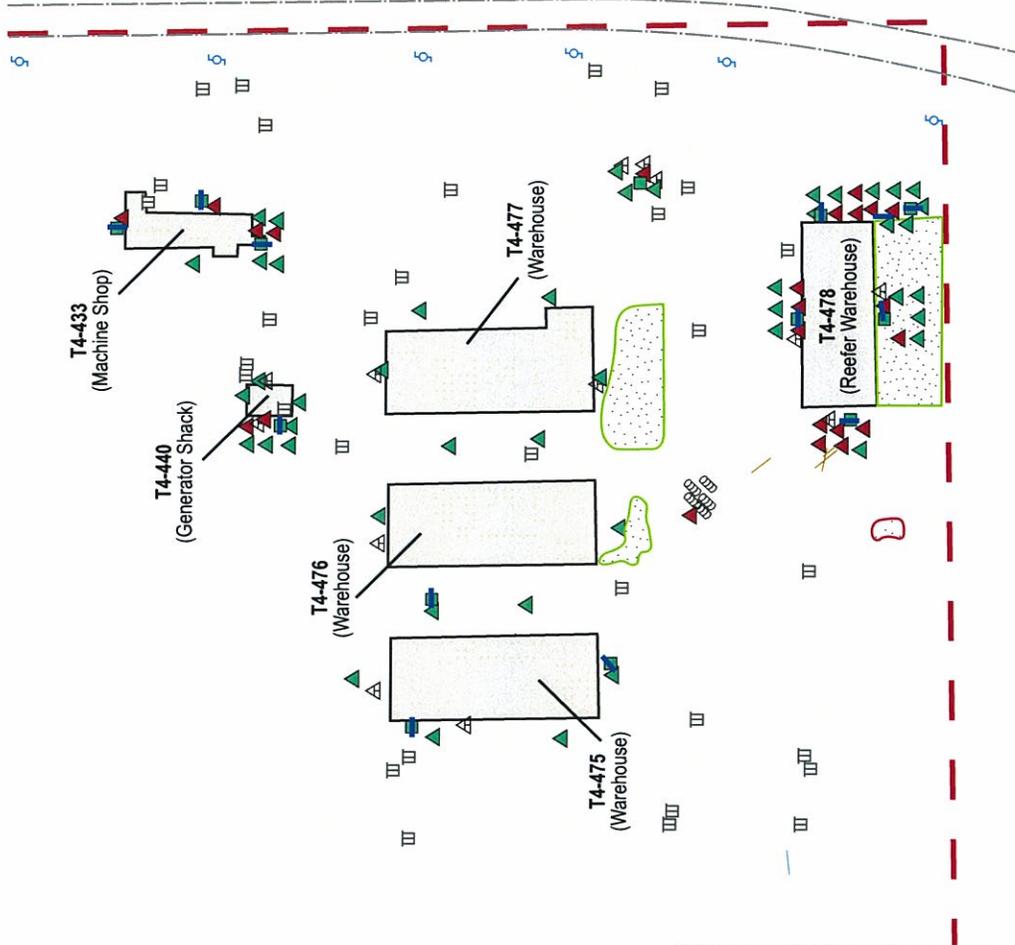
FIGURE 2-6



EXPLANATION	
	Surface Soil Sample Locations
	Subsurface Soil Sample Locations
	Surface Soil Sample Locations above Regulatory Limit
	Subsurface Soil Sample Locations above Regulatory Limit
	Test Trench
	Soil Gas and Soil Sample Locations
	Deteriorated 55 Gallon Drum or Suspected Drum Remnants
	Wooden Utility Poles on the Ground
	Steel Pipe on the Ground
	Miscellaneous Debris Includes Large and Small Metal Containers, Sheet Metals, Wires, Cables, Auto Parts, Engine Parts, Glass Bottles, Concrete Slabs, Food Cans, Soda Cans, and Household Trash
	Mounded Area
	Debris Area
	Tar/Asphalt and Asbestos Debris Area
	Tire Debris
	Asbestos Area
	Flow Direction
	Concrete Pad/Building Location



ANDERSEN AIR FORCE BASE  
GUAM  
Extent of Contamination  
in Area B, Site 43  
MARBO Annex  
FIGURE 2-7



EXPLANATION	
	Surface Soil Sample Locations
	Subsurface Soil Sample Locations
	Surface Soil Sample Locations above Regulatory Limit
	Test Trench
	Soil Gas and Soil Sample Locations
	Approximate Site Boundary
	Edge of Asphalt Road
	Deteriorated 55 Gallon Drum or Suspected Drum Remnants
	Wooden Utility Poles on the Ground
	Steel Pipe on the Ground
	Existing Wooden Utility Pole
	Miscellaneous Debris Includes Large and Small Metal Containers, Sheet Metals, Wires, Cables, Auto Parts, Engine Parts, Glass Bottles, Concrete Slabs, Food Cans, Soda Cans, and Household Trash
	Debris Area
	Tar/Asphalt and Debris Area
	Tire Debris
	Concrete Pad/Building Location



ANDERSEN AIR FORCE BASE  
GUAM  
Extent of Contamination  
in Area D, Site 43  
MARBO Annex  
FIGURE 2-9