results were screened against USEPA Region IX PRGs. PAHs were detected in 12 surface soil samples at concentrations exceeding residential PRGs. The PCB Aroclor-1254 also was detected at concentrations exceeding the residential PRG in three surface soil samples. The metals arsenic, cadmium, and lead were detected at concentrations that exceeded their respective residential PRGs and BTVs.

- A total of 33 subsurface soil samples (including duplicates) were collected from areas of interest within or from the bottom of the test pits and analyzed for a variety of parameters including; VOCs, PAHs, PCBs, and TAL metals. No VOCs, PAHs, or PCBs were detected in any of the subsurface soil samples at concentrations that exceeded the residential PRGs. Arsenic and vanadium were the only inorganic contaminants to equal or exceed the residential PRGs and BTVs in two subsurface soil samples.

UST Removal at Site 43. Two 3,000-gallon USTs were discovered during investigations at Site 43. Contents of one of the USTs were characterized as non-hazardous waste while contents of the second UST were characterized as hazardous waste with respect to benzene and 1,2-DCA. Both USTs were removed in March 2008 and the tanks and contents were disposed of at appropriate disposal facilities. Both tanks were found to be in good condition with no visible damage. Confirmation soil samples were collected from the excavation sidewalls and beneath the piping following removal, and were analyzed for VOCs, TPH-DRO and TPH-GRO, and Resource Conservation and Recovery Act (RCRA) lead. TPH-DRO was detected at concentrations exceeding the Guam EPA cleanup levels in three subsurface soil samples beneath the USTs (10 feet bgs), and in two soil samples beneath the piping (1 foot bgs).

Based on results of the investigations at Site 43, a Human Health Risk Assessment (HHRA) was conducted to evaluate the potential for risks from exposures to chemicals originating from Site 43. The HHRA evaluated whether current and potential future

land-use patterns pose unacceptable risks to human health under specified exposure conditions. As the future of Site 43 is currently undetermined, potential receptors at the site include residents, industrial workers, and construction workers.

A Screening Level Ecological Risk Assessment also was conducted to evaluate the potential for risks to the environment from exposures to chemicals at or originating from Site 43. Based on an examination of the entire site, major habitats were identified and characterized and the fauna and flora were inventoried. All of the identified ROCs are terrestrial and the following representative species were designated as ecological ROCs: Mariana crow, yellow bittern, terrestrial plants, and terrestrial invertebrates (earthworms).

2.5.6 Nature and Extent of Contamination

This section provides a brief summary of the results of previous investigations at Sites 41, 42, and 43, as much of the detail regarding previous investigations has been presented in Section 2.5.5 above.

Site 41. During the RI investigation, surface and subsurface soils at Site 41 were evaluated for potential contamination as a result of historical activities associated with former operational buildings. Former operational buildings at the site (and therefore potential sources of site contamination) include a tool shop, carpenter shop, generator shop, heavy vehicle shop, and vehicle maintenance shops. Discrete (grab) surface soil samples were collected from depths of 1.0 to 6.0 inches bgs, at biased locations based on previous investigation results. The samples were collected from around the perimeter of the concrete pads, inside drainage swale areas, and in areas associated with debris (**Figure 2-3**). Based on previous investigation results (which included analyses for VOCs, PAHs, PCBs, and TAL metals), all samples were analyzed for lead which was determined to be the only COC. In addition, subsurface soil samples were collected from the bottom of test pit excavations at depths ranging from 1.5 to 2.5 feet bgs. Based on previous investigation results, subsurface soil samples were analyzed

for lead. No historical objects or areas of archaeological or historical importance were identified during these investigations.

In summary, a total of 105 surface soil samples (including duplicate samples) were collected at Site 41 and analyzed for lead. Lead was found at concentrations exceeding the residential PRG in a total of 58 surface soil samples. Lead was not detected in any of the 25 subsurface samples. The extent of lead contamination at Site 41 is depicted in **Figure 2-3**. It is estimated that approximately 540 lcy of surface and shallow subsurface (up to one foot bgs) soil at Site 41 is impacted with COCs above the RGs, and will need to be removed from the site.

Results of the RI indicated that lead in surface soil poses a potential concern for adverse health effects to potential future residential receptors and transient industrial workers. Average lead concentrations in surface soil samples exceeded the USEPA risk-based target concentration for residential (400 mg/kg) and industrial (800 mg/kg) receptors. However, lead was not detected in any of the subsurface soil samples at concentrations exceeding the residential PRG.

Site 42. During the RI investigation, surface and subsurface soils at Site 42 were evaluated for potential contamination as a result of historical activities associated with former gas station. Two associated rusted ASTs and one UST were identified at the site. No historical objects or areas of archaeological or historical importance were identified at the site. Discrete (grab) surface soil samples were collected from depths of 1.0 to 6.0 inches bgs at biased locations based on previous investigation results. The samples were collected from around the perimeter of the northern-most concrete pad, the vicinity of the UST, and the mounded area near the two ASTs (**Figure 2-4**). All samples were analyzed for lead. In addition, subsurface soil samples were collected from the bottom of test pit excavations at depths ranging from 1.5 to 2.5 feet bgs. Based on previous investigation results (which included analyses for VOCs, PAHs, PCBs, and TAL metals), subsurface soil samples were analyzed for lead and VOCs.

In summary, lead was detected at concentrations exceeding the residential PRG in five of the 26 surface soil samples (**Figure 2-4**). Lead was also detected in shallow subsurface samples (one foot bgs) at concentrations exceeding the residential PRG in two soil samples beneath the former UST piping. In addition, lead was identified in concentrations above the residential PRG but below the industrial PRG in a subsurface soil sample collected at 16 feet bgs at the former UST location during the UST removal. The extent of lead contamination at Site 42 is depicted in **Figure 2-4**. Following UST removal in 2008, TPH-DRO was detected in three soil samples beneath the former UST piping at concentrations ranging from 62 to 85 mg/kg, exceeding the Guam EPA cleanup level of 50 mg/kg. It is estimated that approximately 30 lcy of surface and shallow subsurface (up to one foot bgs) soil at Site 42 is impacted with COCs above the RGs, and will need to be removed from the site.

Results of the RI samples indicate that lead in surface soil poses a potential concern for adverse health effects to potential future residential receptors. Average lead concentrations in surface soil samples exceeded the USEPA risk-based target concentration for residential (400 mg/kg) receptors but were below the risk-based target concentration for industrial (800 mg/kg) receptors. With the exception of the subsurface sample collected following UST removal, lead was not detected in any of the other subsurface soil samples collected during the RI at concentrations exceeding the residential PRG.

Site 43. During the RI investigation, surface and subsurface soils at Site 43 were evaluated for potential contamination as a result of historical activities associated with former operational support buildings. Former operational support buildings at the site (and therefore potential sources of site contamination) include a welding shop, carpenter shop, electric shop, battery shop, sign paint shop, and vehicle maintenance shops. No historical objects or areas of archaeological or historical importance were identified at the site. To facilitate field activities during the remedial investigation, Site 43 was divided into four areas; Area A, Area B, Area C, and Area D (**Figures 2-6** through **2-9**). Discrete (grab) surface soil samples were collected from depths of 0 to

6 inches bgs at biased locations based on previous sample results. The surface soil samples were typically collected around the perimeter of concrete pads and in areas associated with debris. Surface soil samples were analyzed for SVOCs, PAHs, PCBs, and TAL metals. Subsurface soil samples were collected from the bottom of test pit and test trench excavations at depths ranging from 1.5-to 6.0 feet bgs. All subsurface soil samples were analyzed for VOCs, PAHs, PCBs, and TAL metals.

A total of 173 surface soil samples and 33 subsurface soil samples were collected at Areas A through D and analyzed for VOCs, SVOCs, PAHs, PCBs, and TAL metals. Due to the large area and number of samples collected at Site 43, the remedial investigation results are presented and discussed by area. The results are as follows:

Area A

- Lead was detected at concentrations exceeding the residential PRG in 20 surface soil samples.
- Benzo(a)pyrene was detected at concentrations exceeding the residential PRG in two surface soil samples.
- No COCs were detected at concentrations exceeding PRGs in subsurface soils.

Area B

- Arochlor-1254 was detected at concentrations exceeding the residential PRG in 3 surface soil samples.
- Cadmium was detected at concentrations exceeding the residential PRG in 2 surface soil samples.
- Lead was detected at concentrations exceeding the residential PRG in 4 surface soil samples.

- Arsenic and Vanadium were detected at concentrations exceeding the residential PRG in 2 subsurface soil samples.

Area C

- Arsenic was detected at concentrations exceeding the residential PRG in 4 surface soil samples.
- Lead was detected at concentrations exceeding the residential PRG in 7 surface soil samples.
- No COCs were detected at concentrations exceeding PRGs in subsurface soils.

Area D

- Benzo(a)pyrene was detected at concentrations exceeding the residential PRG in 9 surface soil samples.
- Benzo(a)fluoranthene was detected at concentrations exceeding the residential PRG in 1 surface soil sample.
- Lead was detected at concentrations exceeding the residential PRG in 14 surface soil samples.
- No COCs were detected at concentrations exceeding PRGs in subsurface soils.

Seven samples of potential ACM were collected in Areas A and B, and analyzed for asbestos. Approximately 22 square feet of ACM was observed at Areas A and B (**Figure 2-6** and **Figure 2-7**) in the form of transite, floor tiles, mastic, paint/coating materials, and residue. The extent of contamination at Site 43 in Areas A, B, C, and D is depicted in **Figures 2-6** through **2-9**, respectively. It is estimated that approximately

890 lcy of surface (to one foot bgs) and subsurface (up to eight feet bgs) soil at Site 43 is impacted with COCs above the RGs, and will need to be removed from the site.

Following UST removal in 2008, TPH-DRO was detected at concentrations ranging from 53 to 78 mg/kg, exceeding the Guam EPA cleanup levels, in three subsurface soil samples beneath the USTs (10 feet bgs), and in two soil samples (77 mg/kg and 150 mg/kg) beneath the UST piping (1 foot bgs).

2.5.7 Conceptual Exposure Model

A conceptual exposure model was developed to depict the potential relationship (i.e., the exposure pathway) between chemical sources and receptors. An exposure pathway describes the means by which a receptor can be exposed to contaminants in environmental media. These pathways are based upon current and reasonably likely future land uses and the potential beneficial use of groundwater and surface water at the MARBO Annex.

At Sites 41 and 42, lead is the only COC. Lead has low mobility, and it has not been detected above its maximum contaminant levels (MCL) in groundwater samples collected in the MARBO Annex as part of the Long-term Groundwater Monitoring Program. There is no surface water at Site 41 or Site 42. Lead is not volatile, but could become airborne as part of windborne dust.

Human receptors that utilize Sites 41 and 42 could be exposed to lead in surface soil through incidental soil ingestion, dermal contact with soil, and inhalation of dust. Sites 41 and 42 are not currently in use. Trespassers and industrial/construction workers could be present at Sites 41 and 42 at the current time on an intermittent basis. It is possible that residents or industrial/construction workers could become receptors at Sites 41 and 42 on a regular basis in the future. Residential land use has been considered to determine whether Sites 41 and 42 would be suitable for unrestricted use or unlimited exposure, as described within this ROD.

At Site 43, metals (lead, arsenic, and vanadium), PCBs, and PAHs have been released to surface soil above PRGs. None of these constituents have been detected above MCLs in groundwater samples collected in the MARBO Annex as part of the Long-term Groundwater Monitoring Program. There is no surface water at Site 43. These constituents are not volatile, but they could become airborne as part of windborne dust.

Human receptors that utilize Site 43 could be exposed to constituents in surface or subsurface soil (if brought to the surface) through incidental soil ingestion, dermal contact with soil, and inhalation of dust. Site 43 is not currently in use. Trespassers and industrial/construction workers could be present at Site 43 at the current time on an intermittent basis. It is possible that residents or site workers could become receptors at Site 43 on a regular basis in the future. Residential land use has been considered in the human health risk assessment for Site 43 to determine whether the site would be suitable for unrestricted use or unlimited exposure, as described within this ROD.

Ecological receptors at Site 43 may also be exposed to site constituents. The source of constituents at this site is the discharge of potentially hazardous materials from storage tanks and from activities at buildings. These constituents were released to surface soil, which is the exposure media for receptors.

Receptors may directly contact or ingest surface soil at the site. In addition, receptors may ingest constituents that bioaccumulate in plants or invertebrates as part of their diet. Of these exposure routes, direct contact is most important for plants and soil invertebrates; soil ingestion and diet are the most important exposure routes for vertebrates.

Direct contact (dermal exposure) is not important for some species due to lack of contact with exposed soil. For other species where dermal contact is more common, soil ingestion is likely to capture most of the dermal exposure that occurs. This is because activities such as preening lead to soil ingestion.

Exposure by inhalation has not been included as an exposure pathway. The estimation of inhalation dose is difficult to quantify, and for metals and nonvolatile constituents such as PCBs and PAHs, this route of exposure is expected to be minimal. Consequently, inhalation has not been included in the conceptual exposure model.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

2.6.1 Land Use

The current land use of Sites 41, 42, and 43 is industrial. There are no active residential areas located within the MARBO Annex, though former AF barracks and housing are located to the south of the sites (**Figure 2-2**). These barracks and housing are not currently in use and are fenced off from the rest of the MARBO Annex. As the lead agency, the USN has the authority to determine the future anticipated land use of Sites 41, 42, and 43. Currently, the future use of Sites 41, 42, and 43 is undetermined. Therefore, there is a potential for the sites to be developed for residential or industrial use.

The current land use of adjacent/surrounding land including MARBO Annex is industrial. The current use of adjacent/surrounding land is expected to remain the same over the foreseeable future.

2.6.2 Groundwater and Surface Water Uses

The aquifer beneath and in the vicinity of MARBO Annex is the NGL as described in Section 2.5.2. The NGL occurs as a freshwater lens floating on seawater. The water table elevations in the MARBO Annex range from approximately 4 to 6 feet above msl. Based on results of groundwater monitoring conducted at the MARBO Annex as part of the Long-term Groundwater Monitoring Program, surface and shallow subsurface soil contamination at Sites 41, 42, and 43 does not appear to be impacting the underlying groundwater aquifer.

The AF initially installed nine water production wells at the MARBO Annex between 1945 and 1965 (MW-1 through MW-9). Although production wells MW-2 and MW-4 have since been taken out of service, the seven remaining production wells are currently in operation supplying drinking water for Andersen AFB.

Although groundwater has not been identified as a medium of concern at Sites 41, 42, or 43, the USN is currently conducting a Long-term Groundwater Monitoring Program to address water quality issues Basewide. This program is conducted independent of the individual site investigations and incorporates several groundwater monitoring wells within a 1 mile radius of Sites 41, 42, and 43, as well as three water supply production wells (MW-3, MW-8, and MW-9) that are located within a 0.5 mile radius of Sites 41, 42, and 43.

As discussed in Section 2.5.3, the thin soil and the limestone bedrock underlying Sites 41, 42, and 43 are very porous and permeable. 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.

2.7 SUMMARY OF SITE RISKS

This section summarizes the human health and ecological risk assessments that have been performed at Sites 41, 42, and 43. The COCs associated with unacceptable site risk are identified, as well as the potentially exposed populations and exposure pathways of primary concern. A summary of the findings of the ecological risk assessment is also presented. Based on the presence of unacceptable risks to human health, remedial action is being recommended to reduce the risks.

2.7.1 Summary of Human Health Risk Assessment

The risk assessment 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 approaches used and the results of the risk assessment for this site.

The HHRA is divided into the following sections: identification of COCs (hazard assessment), exposure assessment, toxicity assessment, and risk characterization. Potential risks for both current and future site occupants are discussed. Key assumptions and uncertainties associated with the HHRA are also identified. The chemicals, exposure pathways, and populations associated with unacceptable risk are highlighted, as they serve as the primary basis for remedial action.

2.7.1.1 Identification of Chemicals of Concern

This section identifies those chemicals associated with unacceptable risk at the site and that are the basis for the proposed remedial action. Although other chemicals were detected at the site, these COCs are the primary risk-driving chemicals. The data used in this risk assessment were deemed to be of sufficient quality and quantity for the intended use. The detection frequency, range of detected concentrations, and the exposure point concentrations (EPCs) for chemicals and media of concern are presented in **Table 2-3**.

For Sites 41 and 42, lead is the only COC in surface soil. No other COCs were identified in surface soil, and there are no subsurface soil COCs. As the future use of Sites 41 and 42 is undetermined, a conservative (most protective) residential receptor was used as a baseline to establish the COCs.

For surface soil at Site 43, the COCs are arsenic, cadmium, lead, Aroclor 1254, and benzo(a)pyrene. For subsurface soil, arsenic and vanadium have been identified as COCs.

TABLE 2-3

SUMMARY OF CHEMICALS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS ANDERSEN AIR FORCE BASE, GUAM

Media	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Statistical Measure
		Min	Max				
Site 41: On-Site Surface Soil - Direct Contact	Lead	19.6	53300	mg/kg	105/105	1257	Mean
Site 42: On-Site Surface Soil - Direct Contact	Lead	25.6	3370	mg/kg	26/26	485	Mean
Site 43: On-Site Surface Soil - Direct Contact	Aroclor 1254	0.56	31	mg/kg	3/27	15	UCL
	Benzo(a)pyrene	0.00057	83	mg/kg	39/93	10	UCL
	Arsenic	5.5	116	mg/kg	27/32	45	UCL
	Cadmium	0.7	226	mg/kg	19/27	97	UCL
	Lead	7	9390	mg/kg	130/130	653	Mean
Site 43: On-Site Subsurface Soil - Direct Contact	Arsenic	30	64	mg/kg	3/11	64	Max
	Vanadium	2	225	mg/kg	7/11	225	Max

Key

Max maximum detected concentration
mg/kg milligrams per kilogram
min minimum detected concentration
UCL 95% upper confidence limit on the mean

2.7.1.2 Exposure Assessment

This section documents the populations and exposure pathways that were quantitatively evaluated in the risk assessment. As described in this section, both current and future populations have been evaluated based on current and reasonably anticipated future land use. The contaminated media to which human receptors may be exposed is also discussed.

For Sites 41, 42, and 43, contaminated media include surface and subsurface soil. These sites are currently inactive. Construction workers or trespassers may currently be present at these sites intermittently. Residents (including children) and industrial workers were conservatively assumed to potentially be present at these sites in the future.

Current and potential future receptors were assumed to potentially be exposed to soil constituents through incidental soil ingestion, dermal exposure to soil, dust inhalation, and inhalation of constituents that volatilize into air. Soil ingestion is the exposure route leading to the greatest risks; dermal exposure is also significant.

For lead, soil ingestion (as well as indoor dust derived from contaminated soil) is the most significant exposure route. Lead exposure was not quantified; rather, the potential for lead to pose a significant risk was made by comparison to residential and industrial PRGs.

Sites 41 and 42 were evaluated on a screening basis, comparing constituent concentrations to PRGs and background threshold values. No explicit exposure assumptions were made by the risk assessment; rather, the PRGs incorporate default USEPA guidance. Major assumptions about exposure frequency, duration, and other exposure factors for Site 43 are included in Appendix E of the *Final Remedial Investigation Report for MARBO Annex IRP Sites 41, 42, and 43* (EA, 2009b).

2.7.1.3 Toxicity Assessment

This section describes the carcinogenic and non-carcinogenic toxicity criteria used to calculate the potential risk for each COC. When available, these toxicity criteria are separated into ingestion, inhalation, and dermal routes of exposure. Also included is the source of the toxicity criteria and the primary health endpoint and organ of concern for each COC. Toxicity data for carcinogens are presented in **Table 2-4** and for non-carcinogens in **Table 2-5**.

Aroclor 1254 is a mixture of PCBs. PCBs are considered by USEPA to be a B2, probable human carcinogen, based on sufficient evidence of carcinogenicity in animals; specifically, liver tumors in rats (Integrated Risk Information System [IRIS]). Based on how PCBs are absorbed into the body, Aroclor 1254 is expected to be carcinogenic by oral, dermal, and inhalation exposure routes. Studies of rhesus monkeys dosed with Aroclor 1254 resulted in exudates from the eyes and reductions in antibody levels.

Arsenic is classified as a Class A (known) human carcinogen. Increased rates of lung cancer occurred in workers exposed to arsenic through inhalation. Increased rates of skin, liver, lung, bladder, and kidney cancer occurred in populations with elevated levels of arsenic in the drinking water (IRIS). Non-carcinogenic effects include effects to the skin, such as keratosis and hyperpigmentation.

Benzo(a)pyrene is classified as a B2 carcinogen. Studies of rodents have shown higher rates of forestomach tumors following ingestion, respiratory and upper digestive tract tumors following inhalation, and skin tumors following dermal application (IRIS).

Cadmium is considered a B1 carcinogen via inhalation (probable human carcinogen based on limited evidence in humans). This conclusion was reached based on a two-fold increase in lung cancer rates among smelter workers (IRIS). Following oral exposure by humans, abnormal amounts of protein appeared in urine, which is indicative of kidney damage.

In rats exposed to vanadium via the oral route, altered renal (kidney) function was observed. This effect is considered to be the most sensitive for vanadium exposure (U.S. Public Health Service, Agency for Toxic Substances and Disease Registry [ATSDR], 1992).

Lead can result in toxic effects on the nervous system, the cardiovascular system, and the kidneys. Severe lead toxicity is characterized by symptoms of irritability, short attention span, and loss of memory. Adverse effects from lead have been correlated

with blood-lead concentrations. USEPA applies a blood level of 10 micrograms per deciliter (µg/dL) as a basis for risk-based decision-making.

The toxicity values in **Table 2-4** were taken from USEPA's IRIS database where available. Other sources were consulted when no value was available on IRIS. At this time, toxicity values are not available for the dermal route of exposure. Instead, dermal toxicity values were extrapolated from oral values. An adjustment factor is sometimes applied, depending on how the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50 percent absorption via the ingestion route. Adjustments were made to the dermal reference doses (RfDs) for cadmium and vanadium.

TABLE 2-4

CANCER TOXICITY DATA SUMMARY
ANDERSEN AIR FORCE BASE, GUAM

Pathway: Ingestion, Dermal

Chemical of Concern	Oral Cancer Slope Factor	Dermal Cancer Slope Factor	Slope Factor Units	Weight of Evidence/Cancer Guideline Description	Source	Date
Aroclor 1254	2	2	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/17/07
Arsenic	1.5	1.5	$(mg/kg\text{-}day)^{-1}$	A	IRIS	2/17/07
Benzo(a)pyrene	7.3	7.3	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/17/07
Cadmium	NC	NC	NA	NC	NA	NA

Pathway: Inhalation

Chemical of Concern	Unit Risk Factor	Units	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date
Aroclor 1254	0.00057	$(\mu g/m^3)^{-1}$	2.0	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/17/07
Arsenic	0.0043	$(\mu g/m^3)^{-1}$	15.1	$(mg/kg\text{-}day)^{-1}$	A	IRIS	2/17/07
Benzo(a)pyrene	0.008	$(\mu g/m^3)^{-1}$	3.1	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/17/07
Cadmium	0.0018	$(\mu g/m^3)^{-1}$	6.3	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	2/17/07

Key
Weight of Evidence Classifications
A Known human carcinogen
B1 Probable human carcinogen; limited human data
B2 Probable human carcinogen; sufficient animal data
IRIS Integrated Risk Information System Database
NA Not applicable
mg/kg-day milligrams per kilogram per day
$\mu g/m^3$ micrograms per cubic meter
NC Not considered carcinogenic via the indicated exposure route

TABLE 2-5

NON-CANCER TOXICITY DATA SUMMARY
ANDERSEN AIR FORCE BASE, GUAM

Pathway: Ingestion, Dermal

Chemical of Concern	Chronic/ Subchronic	Oral RfD	Oral RfD Units	Dermal RfD	Dermal RfD Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ
Aroclor 1254	Chronic	0.00002	mg/kg-day	0.00002	mg/kg-day	Eyes, skin	300	IRIS	2/18/07
Arsenic	Chronic	0.0003	mg/kg-day	0.0003	mg/kg-day	Skin	3	IRIS	2/18/07
Cadmium	Chronic	0.0005	mg/kg-day	0.0000125	mg/kg-day	Kidneys	10	IRIS	2/18/07
Vanadium	Chronic	0.001	mg/kg-day	0.000026	mg/kg-day	Kidneys	100	HEAST	8/25/97

Pathway: Inhalation

Chemical of Concern	Chronic/ Subchronic	Inhalation RfC	Inhalation RfC Units	Inhalation RfD	Inhalation RfD Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfC/RfD: Target Organ	Dates
Aroclor 1254	Chronic	NA	NA	0.00002	mg/kg-day	Eyes, skin	300	IRIS	2/17/07
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA

Key

HEAST	Health Effects Assessment Tables (USEPA, 1997)
IRIS	Integrated Risk Information System database
mg/kg-day	milligrams per kilogram per day
NA	Not available or not applicable
RfC	Reference concentration
RfD	Reference dose

2.7.1.4 Risk Characterization

This section of the risk assessment combines the results of the exposure assessment with the toxicity criteria identified for the COCs. Carcinogenic risks and non-carcinogenic impacts for each COC are presented for all populations and media of interest, including both current and future land use settings. Cumulative risks for all relevant pathways and populations are also described. These risk estimates are summarized in **Tables 2-6 and 2-7**. The results of the human health risk assessment are interpreted within the context of the CERCLA acceptable risk range.

The major uncertainties affecting the risk assessment are also presented in this section, including uncertainties related to sampling and analysis, environmental fate and transport modeling, the use of default exposure assumptions, and those associated with the toxicity criteria.

For carcinogens, risks are generally expressed as the incremental probability of an individual's likelihood of developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

Risk = CDI x SF

Where:

Risk = a unitless probability (e.g., 2×10^{-5}) of an individual's likelihood of developing cancer

CDI = chronic daily intake averaged over 70 years (mg/kg-day)

SF = slope factor, expressed as $(mg/kg\text{-}day)^{-1}$.

These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). 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 such as genetics or smoking. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site-related exposure is 10^{-4} to 10^{-6}. Cancer risks below 1×10^{-6} are considered *de minimis;* cancer risks above 1×10^{-4} usually require remedial action.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., life-time) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a daily individual intake that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of site-related daily intake to the RfD is called a hazard quotient (HQ).

The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD

Where: CDI = chronic daily intake

RfD = reference dose

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

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 at a site 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 an individual may reasonably be exposed. An HI < 1 indicates that adverse effects are unlikely from additive exposure to site chemicals. An HI > 1 indicates that site-related exposures may present a risk to human health.

There are no toxicity values published by USEPA to quantify cancer or non-cancer risks from lead using the standard HHRA methodologies. According to USEPA guidance, lead is assessed through the use of the blood-lead model, which uses the average concentration of lead in soil. USEPA Region 9 has developed PRGs for lead: 400 mg/kg for residents and 800 mg/kg for industrial workers.

As discussed above, Sites 41 and 42 were evaluated on a screening basis, comparing constituent concentrations to PRGs and BTVs. Average lead concentrations in surface soil exceeded the residential PRG at Sites 41 and 42. For Site 41, the average lead concentration in surface soil also exceeded the industrial PRG.

At Site 43, the cancer risk for potential future residents exceeded 1×10^{-4} for both surface and subsurface soil (**Tables 2-6A** and **2-6B**). Aroclor 1254, arsenic, and benzo(a)pyrene were significant contributors to this risk estimate for surface soil; arsenic was the sole driver for subsurface soil. The total cancer risk for potential future residents exposed to surface soil constituents was estimated to equal 3×10^{-4}; for subsurface constituents, the cancer risk was calculated as 2×10^{-4}.

A hazard index of 18 was calculated for future child residents at Site 43 exposed to Aroclor 1254, arsenic, and cadmium in surface soil. This result indicates that non-carcinogenic effects cannot be ruled out. For subsurface soil, the hazard index was 6, based on the presence of arsenic and vanadium.

Average lead concentrations at Site 43 surface soil exceeded the residential screening level of 400 mg/kg. Consequently, lead is considered to pose a significant risk to potential future child residents.

Risks were also estimated for potential future industrial and construction worker exposure to surface and subsurface soil, respectively, at Site 43. For these receptors, the cancer risks were less than 1×10^{-4}, and the hazard indices were less than 1. In addition, average lead concentrations were less than industrial screening levels.

The risk estimates are derived from the underlying data, exposure assumptions, and toxicity assumptions. The soil sampling focused on locations where constituents were most likely to be present, which would result in an overestimate of the average concentration. Inhalation reference concentrations (RfCs) have not been derived for the COCs. Thus, the inhalation pathway was not quantified for non-carcinogenic effects.

A key assumption in the exposure assessment is the soil ingestion rate. The assumed soil ingestion rate for children ages 1-6 is based on data for children at 18 months. The children at the upper end of this age bracket would be expected to ingest much less soil than a toddler between the ages of 1 and 2. Furthermore, the soil ingestion rate assumes that all of the soil ingested is from the site, and that no activities take place elsewhere. To the extent that some of the soil ingestion is from locations other than the site, risks would be lower than estimated.

TABLE 2-6A

RISK CHARACTERIZATION SUMMARY – CARCINOGENS
ANDERSEN AIR FORCE BASE, GUAM

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

Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk			
			Ingestion	Inhalation	Dermal	Cumulative Risk
Site 43 Surface Soil	Site 43 Surface Soil	Aroclor 1254	4.6×10^{-5}	3.1×10^{-9}	2.0×10^{-5}	6.6×10^{-5}
		Arsenic	1.1×10^{-4}	7.2×10^{-8}	1.0×10^{-5}	1.2×10^{-4}
		Benzo(a)pyrene	1.1×10^{-4}	3.3×10^{-9}	4.7×10^{-5}	1.6×10^{-4}
		Cadmium	NC	6.5×10^{-8}	NC	6.5×10^{-8}
					Surface Soil Cancer Risk Total =	3.4×10^{-4}
					Total Risk =	3.4×10^{-4}

Key
NC Not carcinogenic by the indicated exposure route

TABLE 2-6B

RISK CHARACTERIZATION SUMMARY – CARCINOGENS
ANDERSEN AIR FORCE BASE, GUAM

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

Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk			
			Ingestion	Inhalation	Dermal	Cumulative Risk
Site 43 Subsurface Soil	Site 43 Subsurface Soil	Arsenic	1.5×10^{-4}	1.0×10^{-7}	1.4×10^{-5}	1.6×10^{-4}
		Cadmium	NC	4.5×10^{-9}	NC	4.5×10^{-9}
					Surface Soil Cancer Risk Total =	1.6×10^{-4}
					Total Risk =	1.6×10^{-4}

Key
NC Not carcinogenic by the indicated exposure route

TABLE 2-7A

RISK CHARACTERIZATION SUMMARY – NON-CARCINOGENS
ANDERSEN AIR FORCE BASE, GUAM

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

Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
				Ingestion	Inhalation	Dermal	Cumulative Hazard Index
Site 43 Surface Soil	Site 43 Surface Soil	Aroclor 1254	Eyes, Skin	9.3	NA	3.7	13
		Arsenic	Skin	1.9	NA	0.16	2.1
		Cadmium	Kidneys	2.5	NA	0.28	2.8
						Surface Soil Hazard Index Total =	18
						Receptor Hazard Index =	18

Key
NA No value available

TABLE 2-7B

RISK CHARACTERIZATION SUMMARY – NON-CARCINOGENS
ANDERSEN AIR FORCE BASE, GUAM

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

Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
				Ingestion	Inhalation	Dermal	Cumulative Hazard Index
Site 43 Subsurface Soil	Site 43 Subsurface Soil	Arsenic	Skin	2.7	NA	0.23	3.0
		Cadmium	Kidneys	0.17	NA	0.019	0.19
		Vanadium	Kidneys	2.9	NA	NA	2.9
						Surface Soil Hazard Index Total =	6.0
						Receptor Hazard Index =	6.0

Key
NA No value available

2.7.2 Summary of Ecological Risk Assessment

An ecological risk assessment (ERA) was not deemed necessary for Sites 41 and 42 because lead was the only COC at those sites. Lead contamination was not found to drive risks for ecological receptors. An ERA was deemed necessary for Site 43. This section summarizes the approaches and findings of the ERA at Site 43, which was performed at a screening level. The ERA did not find any unacceptable risks associated with chemicals present at Site 43.

2.7.2.1 Identification of Chemicals of Concern

The ERA identified surface soil as the critical medium of concern when evaluating the potential for ecological effects at Site 43. No constituents were identified as ecological COCs. The occurrence and distribution of contaminants of potential concern (COPCs) are summarized in **Tables 2-8A** and **2-8B** for soil invertebrates and plants, respectively.

Constituents were considered for inclusion as ecological COCs if the mean concentration exceeded the toxicological benchmark (i.e., the hazard quotient was greater than 1) and the maximum concentration exceeded the background threshold.

For soil invertebrates, zinc met this criterion. In addition, a screening benchmark was not available for PCBs. For plants, arsenic, lead, selenium, and zinc met this criterion. The actual determination that these constituents were not considered COCs is discussed in Section 2.7.2.4.

COPCs for avian species are arsenic, cadmium, chromium, copper, lead, selenium, vanadium, zinc, total PCBs, and total PAHs. The occurrence and distribution of these COPCs is summarized in **Tables 2-8A and 2-8B**. Exposure doses were calculated for avian species rather than comparing the soil concentrations directly to screening benchmarks. The results of this modeling are described in Section 2.7.2.2. No COCs were identified.

2.7.2.2 Exposure Assessment

This section describes the ecological setting on and near the site and types of habitat present, including any ecologically sensitive areas that have been identified. The key species at the site are identified, including any Federal or State designated rare, endangered, or threatened species. Complete exposure pathways and chemical-specific exposure point concentrations for each receptor of interest are also presented. The results of any field studies that have been conducted, as well as the assumptions, approaches, and results of any exposure modeling are presented.

A qualitative habitat and biota survey was performed at Site 43 in December 2006. Site 43 is a 35-acre site. Dominant vegetation was identified and the canopy cover was recorded. Animals were identified by direct observation and by sign (e.g., trails and scat).

TABLE 2-8A

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF CONCERN FOR SOIL INVERTEBRATES ANDERSEN AIR FORCE BASE, GUAM

Chemical of Potential Concern	Concentration Detected (mg/kg)		Mean Concentration (mg/kg)	Background Concentration (mg/kg)	Screening Toxicity Value (mg/kg)	Screening Toxicity Value Source	HQ Value	COC Flag (Y or N)
	Min	Max						
Arsenic	5.5	116	40	62	60	ORNL	0.7	N
Cadmium	0.7	226	7.59	6.5	140	ESSL	0.1	N
Chromium	16.1	1050	273	1080	0.4	ORNL	683	N
Cobalt	0.74	16.35	5.54	29	1000	ORNL	0.006	N
Copper	2.9	207	43.4	72	60	ORNL	0.7	N
Lead	7	9390	615	166	1700	ESSL	0.4	N
Manganese	31.8	2030	664	5500	116	ORNL	6	N
Mercury	0.015	0.64	0.133	0.28	0.1	ORNL	1	N
Nickel	1.8	193	60.0	243	200	ORNL	0.3	N
Selenium	3.0	4.9	2.16	ND	70	ORNL	0.03	N
Silver	0.67	2.3	0.406	14.9	50	ORNL	0.008	N
Vanadium	2.1	202	59.5	206	20	ORNL	3	N
Zinc	11.3	853	165	111	100	ORNL	2	N
Total PCBs	0.56	31	16.2	ND	NA	NA	NA	N
Total PAHs	0.0045	83	0.615	ND	30	ORNL	0.02	N

Key:

COC Chemical of concern; constituent considered as a possible COC only if the HQ > 1 and the maximum is greater than the background threshold. Possible COCs were subjected to further qualitative evaluation.

ESSL Ecological Soil Screening Levels. United States Environmental Protection Agency, 2005. Office of Solid Waste and Emergency Response.

HQ Hazard quotient; calculated by dividing the mean concentration by the toxicity value

Max Maximum

Min Minimum

NA Not available or not applicable

ND Not detected

ORNL Efroymson, R.A., M.E. Will, and G.W. Suter II, 1997. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes: 1997 Revision. ES/ER/TM-126/R2. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

TABLE 2-8B

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF CONCERN FOR PLANTS
ANDERSEN AIR FORCE BASE, GUAM

Chemical of Potential Concern	Concentration Detected (mg/kg)		Mean Concentration (mg/kg)	Background Concentration (mg/kg)	Screening Toxicity Value (mg/kg)	Screening Toxicity Value Source	HQ Value	COC Flag (Y or N)
	Min	Max						
Arsenic	5.5	116	40	62	18	ESSL	2	N
Cadmium	0.7	226	7.59	6.5	32	ESSL	0.2	N
Chromium	16.1	1050	273	1080	1	ORNL	273	N
Cobalt	0.74	16.35	5.54	29	13	ESSL	0.4	N
Copper	2.9	207	43.4	72	100	ORNL	0.4	N
Lead	7	9390	615	166	120	ESSL	5	N
Manganese	31.8	2030	664	5500	500	ORNL	1	N
Mercury	0.015	0.64	0.133	0.28	0.3	ORNL	0.4	N
Nickel	1.8	193	60.0	243	30	ORNL	2	N
Selenium	3.0	4.9	2.16	ND	1	ORNL	2	N
Silver	0.67	2.3	0.406	14.9	560	ESSL	0.0007	N
Vanadium	2.1	202	59.5	206	2	ORNL	30	N
Zinc	11.3	853	165	111	50	ORNL	3	N
Total PCBs	0.56	31	16.2	ND	40	ORNL	0.4	N
Total PAHs	0.0045	83	0.615	ND	20	ORNL	0.3	N

Key:

COC Chemical of concern; constituent considered as a possible COC only if the HQ > 1 and the maximum is greater than the background threshold. Possible COCs were subjected to further qualitative evaluation.

ESSL Ecological Soil Screening Levels. United States Environmental Protection Agency, 2005. Office of Solid Waste and Emergency Response.

HQ Hazard quotient; calculated by dividing the mean concentration by the toxicity value

Max Maximum

Min Minimum

NA Not available or not applicable

ND Not detected

ORNL Efroymson, R.A., M.E. Will, and G.W. Suter II, 1997. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1997 Revision. ES/ER/TM-85/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Site 43 consists of a mixed shrub habitat and secondary growth limestone forest. These habitats include a mixture of grasses, vines, herbs, shrubs, and trees. Mammals identified in these habitats included feral pigs, deer, and dogs. Birds included the black drongo (*Dicrurus macrocerus*), black francolin (*Francolinus francolinus*), Eurasian tree sparrow (*Passer montanus*), Philippine turtle-dove (*Streptopeia bitorquata*), and yellow bittern (*Ixobrychus sinensis).* Numerous insects were observed including spiders, beetles, flies, mosquitoes, land snails, leafhoppers, bees, wasps, ants, crickets, moths, butterflies, dragonflies, praying mantis, and grasshoppers. Reptiles observed included the curious skink (*Carlia fusca*), gecko (*Gehyra mutilata*), blue-tailed skink (*Emoia caeruleocauda*), and monitor lizard (*Varanus indicus*). No rare, threatened, or endangered species were identified.

Receptors of concern (described in Section 2.7.2.3) included soil invertebrates, plants, and avian species. For soil invertebrates and plants, the only exposure pathway was direct contact/uptake with soil. Direct uptake (soil ingestion) also applies to birds. In addition, plants and soil invertebrates can take up chemical constituents from soil. Avian exposure can occur from consumption of these plants and invertebrates. To evaluate avian exposure, exposure doses were calculated based on soil ingestion and ingestion of biota.

Average surface soil concentrations were used as a starting point in estimating avian exposure doses. Bioaccumulation of constituents into food items was evaluated on a site-specific basis, utilizing bioaccumulation data for papaya (surrogate for plant food items) and monitor lizards (surrogate for reptile food items). All of the intake of soil and food was assumed to come from Site 43. **Tables 2-9A** and **2-9B** summarize avian exposure doses and hazard quotients.

2.7.2.3 Ecological Effects Assessment This section summarizes the assessment and measurement endpoints developed for Site 43.

The assessment endpoints for the Site 43 ERA included protection of plant communities, protection of soil invertebrate communities, and protection of birds. Protection in this context means no unacceptable adverse effects on growth, survival, or reproduction.

Measurement endpoints for the plant and soil invertebrate communities were background and ecotoxicological-based screening concentrations for the chemical constituents detected in soil. For avian receptors, the measurement endpoint was a comparison of calculated chemical doses in the diet of birds to toxicity reference values.

The receptors of concern evaluated by the avian measurement endpoint were the Mariana crow and the yellow bittern. The yellow bittern is the only non-marine or non-migratory bird species on Guam that is not considered endangered. The yellow bittern may forage in the habitat at Site 43. Its diet consists of geckos, snails, skinks, and insects.

The Mariana crow is a listed endangered species. While not observed in the habitat survey, this site could provide suitable habitat. The Mariana crow is an omnivore that feeds on insects, lizards, seeds, and occasionally on leaves, bark, and other birds' eggs.

Note that no mammalian receptors of concern were identified. Other than the Mariana fruit bat, all terrestrial mammals on Guam were introduced, and represent risks to native animals and plants. The Mariana fruit bat was not found at Site 43, nor is the habitat at this site appropriate for this species. Therefore, mammals have not been included in the ERA.

TABLE 2-9A

EXPOSURE DOSES AND HAZARD QUOTIENTS FOR THE MARIANA CROW
ANDERSEN AIR FORCE BASE, GUAM

Chemical of Potential Concern	Soil Concentration (mg/kg) (ww)	Plant Concentration (mg/kg) (ww)	Reptile Concentration (mg/kg) (ww)	Dose (mg/kg-day) (ww)	NOAEL (mg/kg-day)	NOAEL Source	NOAEL HQ	LOAEL (mg/kg-day)	LOAEL Source	LOAEL HQ
Arsenic	29.3	0.055	0.090	0.14	2.24	ESSL	0.06	22.4	ESSL	0.0006
Cadmium	5.6	0.000	0.227	0.047	1.47	ESSL	0.03	5.88	ESSL	0.008
Chromium	200.4	0.000	1.11	0.96	2.66	ESSL	0.4	15.6	ESSL	0.06
Copper	31.8	3.070	5.01	0.98	47	ORNL	0.02	61.7	ORNL	0.02
Lead	450.9	0.072	14.2	3.4	1.63	ESSL	2	16.3	ESSL	0.2
Selenium	1.6	0.180	0.180	0.044	0.5	ORNL	0.09	1	ORNL	0.04
Vanadium	43.6	0.300	0.196	0.24	0.344	ESSL	0.7	3.44	ESSL	0.07
Zinc	121.2	0.006	36.8	4.4	14.5	ORNL	0.3	131	ORNL	0.03
Total PCBs	11.9	0.033	0.033	0.057	0.18	ORNL	0.3	1.8	ORNL	0.03
Total PAHs	0.5	0.007	0.007	0.003	1	ORNL	0.003	10	ORNL	0.0003

Key:

ESSL Ecological Soil Screening Levels. United States Environmental Protection Agency, 2005. Office of Solid Waste and Emergency Response.
HQ Hazard quotient
LOAEL Lowest observed adverse effect level
NOAEL No observed adverse effect level
ORNL Sample, B.E., D.M. Opresko, and G.W. Suter II, 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee.
ww wet weight

TABLE 2-9B

EXPOSURE DOSES AND HAZARD QUOTIENTS FOR THE YELLOW BITTERN
ANDERSEN AIR FORCE BASE, GUAM

Chemical of Potential Concern	Soil Concentration (mg/kg) (ww)	Plant Concentration (mg/kg) (ww)	Reptile Concentration (mg/kg) (ww)	Dose (mg/kg-day) (ww)	NOAEL (mg/kg-day)	NOAEL Source	NOAEL HQ	LOAEL (mg/kg-day)	LOAEL Source	LOAEL HQ
Arsenic	29.3	0.055	0.090	0.176	2.24	ESSL	0.08	22.4	ESSL	0.008
Cadmium	5.6	0.000	0.227	0.088	1.47	ESSL	0.06	5.88	ESSL	0.01
Chromium	200.4	0.000	1.11	1.33	2.66	ESSL	0.50	15.6	ESSL	0.09
Copper	31.8	3.07	5.01	1.47	47	ORNL	0.03	61.7	ORNL	0.02
Lead	450.9	0.072	14.2	6.04	1.63	ESSL	4	16.3	ESSL	0.4
Selenium	1.6	0.18	0.180	0.06	0.5	ORNL	0.1	1	ORNL	0.06
Vanadium	43.6	0.30	0.196	0.28	0.344	ESSL	0.8	3.44	ESSL	0.08
Zinc	121.2	0.006	36.8	10.2	14.5	ORNL	0.7	131	ORNL	0.08
Total PCBs	11.9	0.033	0.033	0.07	0.18	ORNL	0.4	1.8	ORNL	0.04
Total PAHs	0.5	0.007	0.007	0.005	1	ORNL	0.005	10	ORNL	0.0005

Key:

ESSL Ecological Soil Screening Levels. United States Environmental Protection Agency, 2005. Office of Solid Waste and Emergency Response.
HQ Hazard quotient
LOAEL Lowest observed adverse effect level
NOAEL No observed adverse effect level
ORNL Sample, B.E., D.M. Opresko, and G.W. Suter II, 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee.
ww wet weight

2.7.2.4 Ecological Risk Characterization This section presents a brief summary of the environmental risks identified at the site, the basis for the risks, how the risks were determined, and COC concentrations that are expected to protect ecological receptors.

No COCs were identified for soil invertebrates or plants. Sustained, diverse native plant and invertebrate communities have been observed on site. These populations indicate that while some constituents exceeded their ecological benchmarks, any effects are localized to individual plants or animals, as opposed to being a population-based effect.

The screening benchmarks are derived from literature surveys that frequently focus on crop species (in the case of plants) and earthworms and other invertebrates that are not reflective of the composition of the soil invertebrate community on Guam. Toxicity studies frequently use conditions that increase metal availability (e.g., low pH). When multiple studies are available, the benchmarks will typically be reflective of the most sensitive species and conditions. Therefore, it is not surprising that there could be a thriving plant or invertebrate population in spite of exceeding the screening benchmarks.

No COCs were identified for birds. Avian hazard quotients were calculated based on both no-observed-adverse-effect level (NOAEL) and lowest-observed-adverse-effect level (LOAEL) benchmarks. The NOAEL HQ exceeded 1 for both the Mariana crow and the yellow bittern, with values of 2 and 4, respectively. All of the LOAEL HQs were less than 1. Given the relatively low NOAEL-based HQs for lead and the fact that the LOAEL HQs were less than 1, it is unlikely that population-wide effects would occur to avian species as a result of exposure to Site 43 constituents.

Key uncertainties in the ecological risk assessment include the following. While 162 samples were collected over the 35-acre site, the samples were from areas believed to have a high potential for chemical contamination. This sampling likely overestimates the actual constituent concentrations at the site.

Population effects will only result from constituents that are widely distributed. Elevated concentrations at isolated locations will only affect individuals. Lead is widespread at elevated concentrations, but other constituents are much more localized, and their potential for population-based effects is substantially reduced.

Toxicity values are based on tests using highly bioavailable forms of the constituent. The actual bioavailability of the constituent at the site, while assumed to be 100 percent, can be substantially less.

2.7.3 Basis for Action

The response action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants from this site which may present an imminent and substantial endangerment to public health or welfare. If no action is taken, there is an unacceptably high potential for cancer and non-cancer effects in the future.

2.8 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) provide a general description of what the cleanup will accomplish. These goals typically serve as the design basis for the remedial alternatives which will be presented in the next section. The RAOs described below were developed based on the currently and reasonably anticipated future land use, which may potentially include residential or industrial use as described in Section 2.6. These RAOs address the risks identified in the risk assessment by preventing current industrial (utility workers) and future residential exposures to contaminated surface soil.

Sites 41 and 42. At Sites 41 and 42, lead is the only COC identified for residential and industrial receptors in surface soil. The residential PRG of 400 mg/kg for lead was used for the RG, as it is protective for both future residents and current utility workers at those two sites. As lead exposure risk is assessed with a blood-level model that utilizes the

average concentration of lead in soil, the RAO will be to clean up the site so that the average concentration of lead in surface soil is below the RG.

The RAOs for Sites 41 and 42 are as follows:

Site 41 RAOs

- Prevent future resident and industrial/construction worker exposure to lead in surface soil by reducing the average concentration of lead across the site to below 400 mg/kg.

Site 42 RAOs

- Prevent future resident exposure to lead in surface soil by reducing the average concentration of lead across the site to below 400 mg/kg.

- Remove TPH-DRO contaminated surface soil that exceeds the Guam EPA action level (50 mg/kg).

Site 43. Five COCs were identified for residential receptors in surface soil at Site 43, including PAHs (benzo(a) pyrene, PCBs (Aroclor-1254), and metals (arsenic, cadmium, and lead).

The selected RGs listed below are based on previous studies conducted at Andersen AFB IRP sites, and have been agreed upon by the AF (previously the lead agency), the USEPA, and Guam EPA:

- benzo(a)pyrene (0.6 mg/kg);

- Aroclor-1254 (1 mg/kg);

- Arsenic (62 mg/kg)

- cadmium (37 mg/kg); and

- lead (400 mg/kg).

Because some metals occur naturally on Guam in relatively high concentrations, BTVs were calculated to establish the background concentration range of naturally occurring metals. The BTV was used for the RG for arsenic (62 mg/kg) in surface soil.

Two COCs, arsenic and vanadium, were identified for residential receptors in subsurface soil at Site 43. The BTVs for each of these metals were used for the RGs.

- arsenic (62 mg/kg); and

- vanadium (206 mg/kg)

In addition to the COCs at Site 43, ACM was identified in Areas A and B. There are no established RGs for ACM, which generally requires 100% removal and appropriate disposal at a hazardous waste facility.

Site 43 RAOs are as follows:

- Prevent future residential exposures to Aroclor 1254, arsenic, benzo(a)pyrene, cadmium and lead in surface soil at concentrations greater than the RG.

- Prevent future residential exposures to arsenic and vanadium in subsurface soil at concentrations greater than the RGs.

- Remove TPH-DRO contaminated surface soil that exceeds the Guam EPA action level (50 mg/kg).

- Prevent future residential exposures to ACM.

2.9 DESCRIPTION OF ALTERNATIVES

The remedial alternatives considered for Sites 41, 42, and 43 were presented in the *Final Feasibility Study Report for MARBO Annex IRP Sites 41, 42, and 43* (EA, 2009a). However, one of the alternatives for Site 41 (*Industrial Land Use Controls; Soil Removal*) was deleted from the list of alternatives following further evaluation during development and review of the Proposed Plan. The *Industrial Land Use Controls; Soil Removal* alternative for Site 41 was determined to be more costly than the *Soil Removal (Unrestricted Land Use)* alternative, and would require the use of long-term Land Use Controls (LUCs). The remaining alternatives are summarized in **Tables 2-10A** through **2-10C** below.

TABLE 2-10A

SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR SITE 41
ANDERSEN AIR FORCE BASE, GUAM

Alternative Designation	Alternative Description
1	No Action
2	Land Use Controls with Engineering Controls
3	Soil Removal (Unrestricted Land Use)

TABLE 2-10B

SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR SITE 42
ANDERSEN AIR FORCE BASE, GUAM

Alternative Designation	Alternative Description
1	No Action
2	Land Use Controls with Engineering Controls
3	Soil Removal (Unrestricted Land Use)

TABLE 2-10C

SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR SITE 43
ANDERSEN AIR FORCE BASE, GUAM

Alternative Designation	Alternative Description
1	No Action
2	Land Use Controls with Engineering Controls and ACM Removal
3	Soil Removal (Unrestricted Land Use)

Each alternative evaluated is described in more detail in the following sections including: remedy components, common elements and distinguishing features, and expected outcomes.

2.9.1 Description of Remedy Components

Three alternatives each were developed to address contamination at Sites 41, 42 and 43. This section provides a summary overview of the components of those alternatives.

Site 41 Alternatives

Alternative 1 – No Action

- No action to clean up contaminated soil
- No LUCs or engineering controls

Alternative 2 - Land Use Controls (LUCs) with Engineering Controls

- LUCs - The USN would enact LUCs through amendments to the Base General Plan (BGP) to ensure the continued protection of human health and the environment. Because the average concentration of lead in soil at Site 41 exceeds the industrial PRGs (800 mg/kg), the LUCs would restrict both residential and industrial activities at the site. The full scope of the LUCs would be presented in a Land Use Control Management Plan (LUCMP). As a protective measure, the USN would notify nearby residents about the site status through fact sheets in order to prevent disturbance of site soil. Any land use change to residential or industrial use would require additional remediation and risk assessment prior to development. The USN, in conjunction with the USEPA and Guam EPA, would conduct five-year reviews to ensure that the LUCs are effective in the future in protecting human health and the environment. Five-year

reviews would be conducted until the site is deemed suitable for unlimited use and unrestricted exposure.

- Restricted access and development - Development of the property for industrial or residential use would be restricted, and access by residential receptors and utility workers also would be restricted.

- Engineering Controls – The USN would implement engineering controls (e.g. fencing and signage) to restrict access.

Alternative 3 – Soil Removal – Unrestricted Land Use

- Soil excavation and removal to meet RGs - Approximately 540 lcy of COC-impacted surface soil would be excavated for offsite disposal. Field screening sampling and confirmation sampling would be employed to ensure removal of all soil containing COCs above RGs.

Site 42

Alternative 1 – No Action

- No action to clean up contaminated soil

- No LUCs or engineering controls

Alternative 2 – Land Use Controls with Engineering Controls

- LUCs - The USN would enact LUCs through amendments to the Base General Plan to ensure the continued protection of human health and the environment. Land use would be restricted to industrial use. As a protective measure, the USN would notify nearby residents about the site status through fact sheets in

order to prevent disturbance of site soil. Five-year reviews would be conducted until the site is deemed suitable for unlimited use and unrestricted exposure.

- Restricted access and development - Development of the property for residential use would be restricted, and access by residential receptors also would be restricted.

- Engineering Controls – The USN would implement engineering controls (e.g. fencing and signage) to restrict access.

Alternative 3 – Soil Removal – Unrestricted Land Use

- Soil excavation and removal to meet RGs - Approximately 30 lcy of COC-impacted surface soil would be excavated for offsite disposal. In addition, relatively small quantities (less than 2 lcy) of contaminated soil identified beneath the former UST piping (at approximately 1 foot bgs) would be removed. Field screening sampling and confirmation sampling would be employed to ensure removal of all soil containing COCs above RGs.

Site 43

Alternative 1 – No Action

- No action to clean up contaminated soil

- No LUCs or engineering controls

Alternative 2 – Land Use Controls with Engineering Controls and ACM Removal

- LUCs - The USN would enact LUCs with engineering controls (e.g., fencing) through amendments to the Base General Plan to ensure the continued protection of human health and the environment. Land use would be restricted to

industrial use. As a protective measure, the USN would notify nearby residents about the site status through fact sheets in order to prevent disturbance of site soil. Five-year reviews would be conducted until the site is deemed suitable for unlimited use and unrestricted exposure.

- Removal of ACM - ACM detected at Areas A and B would be removed and disposed of at a TSCA-approved disposal facility.

- Restricted access and development - Development of the property for residential use would be restricted, and access by residential receptors also would be restricted.

- Engineering Controls – The USN would implement engineering controls (e.g. fencing and signage) to restrict access.

Alternative 3 – Soil Removal – Unrestricted Land Use

- Soil excavation and removal (including ACM) to meet RGs - Approximately 890 lcy of COC-impacted surface and subsurface soil would be excavated for offsite disposal. In addition, relatively small quantities (less than 2 lcy) of contaminated soil identified beneath the former UST piping (at approximately 1 foot bgs) would be removed. Field screening sampling and confirmation sampling would be employed to ensure removal of all soil containing COCs above RGs. In addition, ACM detected at Areas A and B would be removed and disposed of at a TSCA-approved disposal facility.

2.9.2 Common Elements and Distinguishing Features of Each Alternative

A summary of the elements common to each alternative and features that distinguish one alternative from another is presented in **Table 2-11**. Since the alternatives for the three sites overlap, the discussion is alternative-specific, and not site-specific and

covers all three discreet alternatives, namely: 1) *No Action*; 2) *Land Use Controls with Engineering Controls*; and 3) *Soil Removal (Unrestricted Land Use).*

2.9.3 Expected Outcome of Each Alternative

A summary of the outcomes of each alternative is presented in **Table 2-12.**

2.10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

In accordance with the NCP, the alternatives for Sites 41, 42, and 43 were evaluated using the nine criteria described in Section 121(b) of CERCLA and the NCP §300.430(f)(5)(i). These criteria are classified as threshold criteria, balancing criteria, and modifying criteria.

Threshold criteria are standards that an alternative must meet to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—the alternative must meet them or it is unacceptable. The following are classified as threshold criteria:

- Overall protection of human health and the environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

TABLE 2-11 (Page 1 of 2)

COMMON ELEMENTS AND DISTINGUISHING FEATURES OF ALTERNATIVES
ANDERSEN AIR FORCE BASE, GUAM

Remedial Alternative Description	Alternative (No Action)	Alternative – LUCs with Engineering Controls	Alternative - Soil Removal (Unrestricted Land Use)
Number of years over which cost is projected	N/A - No costs associated with this alternative	30	30
Key Applicable or Relevant and Appropriate Requirements (ARARs) associated with alternative	N/A	16 USC 1531; 50 CFR 200, 402; 33 CFR 320 to 330; 40 CFR 61; 5 Guam Code Annotated (GCA), Chapter 63; 21 GCA, Chapter 76; SWMA, 10 GCA, Chapter 51	16 USC 1531; 50 CFR 200, 402; 33 CFR 320 to 330; 40 CFR 261, 263, 268; 40 CFR 50, 100-199; 29 CFR 1900 through 1910; 40 CFR 61; WPCA 10 GCA, Chapter 47; 5 GCA Chapter 63, 76; SWMA, 10 GCA, Chapter 51
Long-term reliability of remedy	N/A - No action is taken	COC-impacted soil would remain on site, but LUCs would prevent exposure	COC-impacted surface and shallow-subsurface soil above RGs, including ACM at Site 43, would be removed from the sites and disposed of at appropriate off-Base facilities. Lead-impacted soil at 16 feet bgs beneath the former UST at Site 42, and TPH-DRO-impacted soil at 10 feet bgs beneath the former USTs at Site 43 would be left in place as it does not pose an exposure risk.
Quantity of untreated waste and treatment residuals to be disposed off-site or managed on-site in a containment system and the degree of hazard remaining in such material	An estimated 1460 lcy of COC-impacted soil would be left on site at Sites 41, 42, and 43 and would pose an unacceptable risk to human health	An estimated 1460 lcy of COC-impacted soil would be left on site at Sites 41, 42, and 43; LUCs and engineering controls would prevent potential future exposure.	COC-impacted soil above RGs, and all ACM at Site 43, would be removed and disposed offsite. Contamination identified at depth at Sites 42 and 43 (16 feet bgs and 10 feet bgs, respectively) does not pose a risk to human health or the environment due to depth and relative immobility in the karst environment.

TABLE 2-11 (Page 2 of 2)

COMMON ELEMENTS AND DISTINGUISHING FEATURES OF ALTERNATIVES
ANDERSEN AIR FORCE BASE, GUAM

Remedial Alternative Description	Alternative (No Action)	Alternative – LUCs with Engineering Controls	Alternative - Soil Removal (Unrestricted Land Use)
Estimated time for design and construction	N/A	12 to 18 months	12 to 18 months
Estimated time to reach remediation goals	Not achieved	Remediation goals not achieved; however, LUCs effective Immediately upon action	Immediate upon action
Estimated total present worth	N/A	Site 41 - $0.23 mil Site 42-$0.11 mil Site 43 - $0.28 mil	Site 41 – 0.34 mil Site 42 – 0.17 mil Site 43 – 0.53 mil
Discount rate	7%	7%	

ACM – asbestos-containing material
ARAR – Applicable or Relevant and Appropriate Requirements
bgs – below ground surface
CFR – Code of Federal Regulations
COC – contaminant of concern
GCA – Guam Code Annotated
LUCs – Land Use Controls
Mil - million
N/A – Not applicable
RG – remedial goal
SWMA – Solid Waste Management Act
TPH-DRO – total petroleum hydrocarbons – diesel range organics
UST – underground storage tank
WPCA – Water Pollution Control Act

TABLE 2-12 (Page 1 of 3)

EXPECTED OUTCOME OF EACH ALTERNATIVE
ANDERSEN AIR FORCE BASE, GUAM

Site 41	Alternative 1 – No Action	Alternative 2 – LUCs with Engineering Controls	Alternative 3 – Soil Removal (Unrestricted Land Use)
Available uses of land upon achieving cleanup levels	Cleanup would not be achieved because COC-impacted soil would remain on site indefinitely	Cleanup would not be achieved because COC-impacted soil would remain on site indefinitely. Residential and industrial land use would be restricted.	COC-impacted soil would be removed from the site to reduce average COC concentrations to below the RG. Land use would be unrestricted.
Time frame to achieve available land use	N/A. Contamination would remain on site indefinitely	Residential and industrial land use would be restricted indefinitely because contamination above RGs (and industrial PRGs) would remain on site indefinitely.	Residential and industrial land use would be available immediately upon remedial action
Available uses of groundwater upon achieving cleanup levels	N/A - Groundwater cleanup is being addressed under the Basewide Groundwater Monitoring Program	N/A - Groundwater cleanup is being addressed under the Basewide Groundwater Monitoring Program	N/A - Groundwater cleanup is being addressed under the Basewide Groundwater Monitoring Program
Time frame to achieve available groundwater use	N/A	N/A	N/A
Other impacts or benefits associated with alternative	Exposure to COC-contaminated soil may occur	Increased security (and costs) would be needed to prevent local population from trespassing onto the site	There would be no need for institutional controls or engineering controls

TABLE 2-12 (Page 2 of 3)

EXPECTED OUTCOME OF EACH ALTERNATIVE
ANDERSEN AIR FORCE BASE, GUAM

Site 42	Alternative 1 - No Action	Alternative 2 – LUCs with Engineering Controls	Alternative 3 - Soil Removal (Unrestricted Land Use)
Available uses of land upon achieving cleanup levels	Cleanup would not be achieved because COC-impacted soil would remain on site indefinitely	Cleanup would not be achieved. Land use would be restricted to industrial use only. Residential use would be prohibited.	COC-impacted soil would be removed from the site to reduce average concentrations across the site to below the RG. Land use would be unrestricted.
Time frame to achieve available land use	N/A. Contamination would remain on site indefinitely	Industrial land use would be available immediately upon action. Residential use would be prohibited.	Immediately upon remedial action
Available uses of groundwater upon achieving cleanup levels	N/A - Groundwater cleanup is being addressed under the Basewide Groundwater Monitoring Program	N/A - Groundwater cleanup is being addressed under the Basewide Groundwater Monitoring Program	N/A - Groundwater cleanup is being addressed under the Basewide Groundwater Monitoring Program
Time frame to achieve available groundwater use	N/A	N/A	N/A
Other impacts or benefits associated with alternative	Exposure to COC-contaminated soil may occur	Increased security (and costs) would be needed to prevent local population from trespassing onto the site	There would be no need for institutional controls or engineering controls

TABLE 2-12 (Page 3 of 3)

EXPECTED OUTCOME OF EACH ALTERNATIVE
ANDERSEN AIR FORCE BASE, GUAM

Site 43	Alternative 1 - No Action	Alternative 2 – LUCs with Engineering Controls and ACM Removal	Alternative 3 - Soil Removal (Unrestricted Land Use)
Available uses of land upon achieving cleanup levels	Cleanup would not be achieved because COC-impacted soil would remain on site indefinitely	Land use would be restricted to industrial use only. Residential use would be prohibited.	COC-impacted soil above respective RGs, including all ACM, would be removed and disposed offsite. Land use would be unrestricted.
Time frame to achieve available land use	N/A. COC-impacted soil would remain on site indefinitely.	Industrial land use would be available immediately upon action. Residential use would be prohibited.	Immediately upon remedial action
Available uses of groundwater upon achieving cleanup levels	N/A - Groundwater cleanup is being addressed under the Basewide Groundwater Monitoring Program	N/A - Groundwater cleanup is being addressed under the Basewide Groundwater Monitoring Program	N/A - Groundwater cleanup is being addressed under the Basewide Groundwater Monitoring Program
Time frame to achieve available groundwater use	N/A	N/A	N/A
Other impacts or benefits associated with alternative	Exposure to COC-impacted soil may occur	Increased security (and costs) would be needed to prevent local population from trespassing onto the site	There would be no need for institutional controls or engineering controls

ACM – asbestos-containing material
COC – contaminant of concern
N/A – Not applicable
PRG – preliminary remediation goal
RG – remedial goal

Balancing criteria weigh the tradeoffs between alternatives. These criteria represent the standards upon which the detailed evaluation and comparative analysis of alternatives are based. In general, a high rating on one criterion can offset a low rating on another balancing criterion. Five of the nine criteria are considered balancing criteria:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Modifying criteria are as follows:

- Community acceptance
- Territory (Guam) acceptance

This section summarizes how well each alternative satisfies each evaluation criterion and indicates how it compares to the other alternatives under consideration.

2.10.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

All of the alternatives, except the *No Action* alternative, are protective of human health and the environment by eliminating, reducing, or controlling risks posed by the site through LUCs, engineering controls, or removal of soil contaminants.

The protectiveness of each alternative is described below. Since the alternatives for the three sites overlap, the discussion is alternative-specific, and not site-specific and covers all three discreet alternatives, namely: *No Action*; *Land Use Controls with Engineering Controls*; and *Soil Removal (Unrestricted Land Use).*

No Action – The No Action alternative would not be protective of human health or the environment because the identified unacceptable risks associated with the COCs in surface soil would not be addressed.

Land Use Controls with Engineering Controls – The *LUCs with Engineering Controls* alternative would be protective of human health by preventing exposure to COC-contaminated soil above RGs. The LUCs would impose restrictions on both residential and industrial uses of the property at Site 41 where average lead concentrations exceed industrial PRGs. The LUCs would also restrict use of the property at Sites 42 and 43 to industrial use only. Under this alternative, the USN would implement engineering controls (e.g. fencing and signage) to restrict access and prevent potential future contact with contaminated soil.

Soil Removal (Unrestricted Land Use) – This alternative would be protective of human health and the environment by removing soil with contamination exceeding the respective RGs, thus eliminating the exposure pathway.

The *No Action* alternative is not protective of human health or the environment. The *Land Use Controls with Engineering Controls* alternative would be protective because it would place restrictions on access and future land use. The *Soil Removal (Unrestricted*

Land Use) alternative would provide the most protectiveness because COC-impacted soil above the respective RGs at all three sites would be removed under this alternative.

2.10.2 Compliance with Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA and NCP §300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State/Territory environmental or facility citing laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State/Territory environmental or facility citing laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site (relevant) that their use is well-suited (appropriate) to the particular site. Only those Territorial (Guam) standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for invoking a waiver. A detailed analysis of compliance with ARARs is presented in Section 2.13.2.

The *Land Use Controls with Engineering Controls* alternative (which, with respect to Site 43, also involves the removal of ACM) and the *Soil Removal (Unrestricted Land Use)* alternative would both comply with ARARs. A summary of the key ARARs that apply to each of the two alternatives is set forth in **Table 2-11**. A more detailed discussion of the ARARs for the selected remedy is presented in Section 2.12.1, Section 2.13.2, and **Table 2-16**.

2.10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

The *No Action* alternative would not be effective in the long term because identified risks associated with COCs in soil would remain on site indefinitely.

The *Land Use Controls with Engineering Controls* alternative would be effective in the long term for mitigating the identified potential risks to future residents. Although COC-impacted soil above RGs at all three sites would remain on site indefinitely, the LUCs and engineering controls would prevent potential future exposure of the COCs to residents.

The *Soil Removal (Unrestricted Land Use)* alternative would be effective in the long term for mitigating the identified potential risks for future residents and current utility

workers at all three sites through removal of COC-impacted soil to reduce average COC concentrations to below RGs.

2.10.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

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

The *Land Use Controls with Engineering Controls* alternative would not reduce the toxicity, mobility, or volume of contaminated soil through treatment.

The *Soil Removal (Unrestricted Land Use)* alternative would reduce the toxicity, mobility, and volume of COC-impacted soil through excavation and offsite disposal. Excavated soil that exceeds Toxicity Characteristic Leachate Procedure (TCLP) thresholds would be treated prior to disposal.

2.10.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

The *No 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 *Land Use Controls with Engineering Controls* alternative could be quickly implemented (i.e., within one year) and would be effective for achieving RAOs in the short term. Exposure risks to the community and site workers would be mitigated with engineering controls and/or personal protective equipment.

The *Soil Removal (Unrestricted Land Use)* alternative could be quickly implemented (i.e., within one year) and would be effective for achieving RAOs in the short term. Exposure risks to the community and site workers would be mitigated with engineering controls and/or personal protective equipment.

2.10.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

The *No Action* alternative requires minimal technical or administrative effort. However, the alternative is not considered implementable because the RAOs would not be achieved.

The *Land Use Controls with Engineering Controls* alternative could be readily implemented because the LUCs can be established via modifications to the existing BGP and because the required equipment and services to maintain the LUCs and to conduct five-year reviews are readily available. The administrative feasibility of implementing the alternative would be relatively simple, as there would be minimal coordination of resources and materials, with the exception of implementation of engineering controls (e.g., fence installation). However, maintaining the fence and signs may be difficult and costly as the sites are located within the MARBO Annex

which is isolated from the Main Base and has minimal security to prevent vandalism and trespassing.

The *Soil Removal (Unrestricted Land Use)* alternative could be readily implemented as the alternative would utilize standard excavation and disposal equipment and procedures established during past remedial projects at Andersen AFB.

2.10.7 Cost

The estimated present worth costs for the alternatives are summarized in **Table 2-13**.

TABLE 2-13

MATRIX OF COST AND EFFECTIVENESS DATA FOR SITES 41, 42, AND 43 ANDERSEN AIR FORCE BASE, GUAM

Site ID	Total Present Worth Costs for Each Alternative		
	Alternative – No Action	Alternative – LUCs with Engineering Controls	Alternative –Soil Removal (Unrestricted Use)
41	$0.0 Mil	0.23 Mil	0.34 Mil
42	$0.0 Mil	0.11 Mil	0.17 Mil
43	$0.0 Mil	0.28 Mil	0.53 Mil

2.10.8 Territory (Guam) Acceptance

The Territory of Guam has expressed its support for the Soil Removal (Unrestricted Use) Alternative. The Territory of Guam does not support the other alternatives because they do not meet some of the nine NCP evaluation criteria, particularly with respect to protectiveness and reduction of toxicity, mobility, or volume of contaminants.

2.10.9 Community Acceptance

Based on the verbal comments received during the Proposed Plan public meeting, the *Soil Removal (Unrestricted Land Use)* alternative is acceptable to the public.

2.11 PRINCIPAL THREAT WASTES

The NCP expects that treatment that reduces the toxicity, mobility, or volume of the principal threat wastes will be used to the extent practicable. The principal threat concept refers to the source materials at a CERCLA site considered to be highly toxic or highly mobile that generally cannot be reliably controlled in place or present a significant risk to human health or the environment should exposure occur. A source material is material that contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to groundwater or air, or that acts as a source for direct exposure. This section lists the principal threat wastes at Sites 41, 42, and 43 and discusses how each remedial alternative would address them.

The ACM identified at Site 43 constitutes a principal threat waste by definition because it is considered to be highly toxic and highly mobile if released into the atmosphere. In addition, ACM generally cannot be reliably controlled in place if it is released into the environment, and presents a significant risk to human health should exposure occur. The *No Action* alternative would not address treatment, containment, or removal of ACM. Both the *Land Use Controls with Engineering Controls and ACM Removal* alternative and the *Soil Removal (Unrestricted Land Use)* alternative would eliminate the risk posed by the ACM by removing and disposing of the ACM at an approved hazardous waste facility.

The COC-impacted soil at Sites 41, 42, and 43 is considered a non-principal threat waste because the major COCs are metals (particularly lead) that are relatively immobile in the alkaline conditions of the limestone formations at the three sites. There

are no toxicity values published by USEPA to quantify cancer risks from lead using the standard HHRA methodologies. However, the human health risks associated with the COC-impacted soils justify remedial action to protect human health and the environment. In addition, COCs generally cannot be reliably controlled in place due to the difficulty associated with preventing trespassers from accessing the MARBO Annex, and therefore pose a significant risk to human health should exposure occur.

2.12 SELECTED REMEDY

The selected remedy for Sites 41, 42, and 43 is *Soil Removal (Unrestricted Land Use).* This remedy was selected based upon its ability to protect human health and the environment and cost effectiveness. This section describes the selected remedy and also provides specific performance measures for the selected remedy. The primary indicator of remedial action performance will be satisfying the RAOs for Sites 41, 42, and 43 and protecting human health and the environment. Performance measures are defined herein as the RAOs (see Section 2.8 – Remedial Action Objectives) plus the required actions to achieve the objectives, as defined in this section. It is anticipated that successful implementation, operation, maintenance, and completion of the performance measures will achieve a protective and legally compliant remedy for Sites 41, 42, and 43.

The selected remedy is based on the detailed evaluation of remedial alternatives presented in the *Final Feasibility Study Report for MARBO Annex IRP Sites 41, 42, and 43* EA, 2009a). It is expected that this remedy will remain in effect and be protective of human health and the environment.

The USN is responsible for implementing, maintaining, and monitoring the remedial action identified herein for the duration of the remedy selected in this ROD. The USN will exercise this responsibility in accordance with CERCLA and the NCP. Approval by

the USEPA and Guam EPA is required for any modification of the remedy inconsistent with the objectives of this ROD.

2.12.1 Summary of the Rationale for the Selected Remedy

The selected remedy for Sites 41, 42, and 43 is Alternative 3 for each site (i.e., *Soil Removal [Unrestricted Land Use]*). The USN, Andersen AFB, the USEPA, and Guam EPA believe that the selected remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The selected remedy is expected to satisfy the following statutory requirements of CERCLA § 121(b):

Threshold criteria

- Protection of human health and the environment
- Compliance with ARARs

Balancing criteria

- Long-term effectiveness and permanence
- Toxicity, mobility or volume reduction through treatment
- Short-term effectiveness
- Implementability
- Cost

Modifying criteria

- Territory (Guam) acceptance
- Community acceptance

The selected remedy for Sites 41, 42, and 43 protects human health and the environment through excavation and removal of COC-impacted soil, thus eliminating potential future human exposure or impacts to the environment. Although the LUCs with Engineering Controls alternative would also prevent potential exposure to COC-impacted soil through implementation of land use controls and engineering controls (e.g., fencing and signs), the USN may have difficulty preventing trespassers from accessing the sites because the MARBO Annex has minimal security. Therefore, this alternative would be costly and would not effectively eliminate potential future exposure. The selected remedy will not pose any unacceptable short term risks, and proper health and safety procedures will be implemented during soil excavation and removal. Engineering controls and other measures will be used to control any dust emissions that may be generated during the excavation process.

The selected remedy complies with all applicable ARARs as described below. Compliance with ARARs is discussed in more detail in Section 2.13.2.

Chemical-Specific ARARs - The selected remedy complies with chemical-specific ARARs and criteria to be considered (TBCs). Chemical-specific ARARs include 40 CFR 61 National Emission Standard for Asbestos (removal will be conducted in a manner to ensure there will be no visible emissions from the sites); TBCs include USEPA Region IX Preliminary PRGs to screen and establish RGs.

Territory (Guam) Location-specific ARARs - The selected remedy complies with Territory (Guam) Location-specific ARARs, specifically the Guam Wellhead Protection Program. The selected remedial alternative complies with this ARAR because

excavation and disposal of impacted soil would be conducted in a manner to prevent potential impacts to groundwater quality.

Territory (Guam) Action-specific ARARs - The selected remedy complies with Territory (Guam) Action-specific ARARs include the following: 21 GCA, Chapter 76, as soil excavation activities would avoid impacts to any historical objects that may be identified at the sites; and the SWMA, 10 GCA, Chapter 51 regarding disposal of non-hazardous waste to the Andersen AFB consolidation unit.

The selected remedy will achieve long-term effectiveness because soil impacted with COCs above RGs will be excavated and disposed of, including small areas of shallow (less than one foot bgs) contaminated soil beneath the former UST piping at Sites 42 and 43. Remaining contaminated soil at depth (lead at 16 feet bgs at Site 42 and TPH-DRO at 10 feet bgs at Site 43) does not pose an exposure risk to human health because it is too deep to result in potential exposure, and does not appear to be impacting the underlying aquifer based on historical and on-going groundwater monitoring at the MARBO Annex.

The selected remedy will achieve reduction in toxicity, mobility, and volume through excavation and removal of COC-impacted soil above RGs. The other alternatives would not achieve reduction in toxicity, mobility, and volume because COC-impacted soil above the RGs would remain on site indefinitely. The selected remedy is also readily implementable as it would utilize standard excavation and disposal equipment and procedures established during past remedial projects at Andersen AFB.

The selected remedy is acceptable to the Territory of Guam because it removes the potential for future human exposure to COC-impacted soil and places no restrictions on future land use. The other alternatives would not be acceptable to the Territory of Guam because COC-impacted soil above the RGs would remain on site indefinitely and

would place restrictions on future land use. Community acceptance of the selected remedy is currently being evaluated.

Although the cost of the selected remedy is higher than that of other alternatives (e.g., Land Use Controls with Engineering Controls), the selected remedy would permanently remove COC-impacted soil with concentrations above the RGs from the site and allow for unrestricted land use.

Remedial Action Objectives (RAOs). Remedial action objectives were developed to identify the specific goals for adequately reducing risks identified at Sites 41, 42, and 43. The RAOs included developing RGs, which are proposed cleanup levels determined to be protective of human health and the environment (i.e. acceptable COC concentrations). RAOs are presented in Section 2.8, and are summarized below for each of the three sites.

Site 41 RAOs

- Prevent future resident and transient industrial/utility worker exposure to lead in surface soil by reducing the average concentration of lead across the site to below 400 mg/kg.

Site 42 RAOs

- Prevent future resident exposure to lead in surface soil by reducing the average concentration of lead across the site to below 400 mg/kg.

- Remove TPH-DRO contaminated surface soil that exceeds the Guam EPA action level (50 mg/kg).

Site 43 RAOs

- Prevent future residential exposures to Aroclor 1254, arsenic, benzo(a)pyrene, cadmium and lead in surface soil at concentrations greater than the RG.

- Prevent future residential exposures to arsenic and vanadium in subsurface soil at concentrations greater than the RGs.

- Remove TPH-DRO contaminated surface soil that exceeds the Guam EPA action level (50 mg/kg).

- Prevent future residential exposures to ACM.

2.12.2 Description of the Selected Remedy

The selected remedy for Sites 41, 42, and 43 is *Soil Removal (Unrestricted Land Use)*. This remedy includes excavation and disposal of COC-impacted soil at all three sites as follows:

- Excavation and disposal of approximately 540 lcy of COC-impacted surface soil (to one foot bgs) containing COCs above the RG at Site 41;

- Excavation and disposal of approximately 30 lcy of surface soil (to one foot bgs) containing COCs above RG at Site 42, including removal of TPH-DRO-impacted soil beneath the former UST piping.

- Excavation and disposal of approximately 890 lcy of surface (to one foot bgs) and subsurface (to eight feet bgs) soil containing COCs above RGs at Site 43 in Areas A, B, C, and D, including TPH-DRO-impacted soil beneath the former UST piping. Prior to excavation, surface soil sampling will be conducted to further define the extent of soil to be excavated. In addition, approximately 22 square

feet of ACM observed in Areas A and B in the form of transite, floor tiles, mastic, paint-coating materials, and residue, will be excavated and disposed of at an approved disposal facility.

The areas to be excavated are depicted in **Figures 2-10 through 2-15**, and are based on soil sample results presented in the RI report (EA 2009b). The excavated soil will be managed based on TCLP soil samples to be collected from the stockpile prior to transportation. Non-hazardous waste will be placed in the Andersen AFB consolidation unit for management. Hazardous waste will be shipped off island for disposal at a RCRA-regulated facility. Field screening samples and confirmation samples will be collected after soil removal to confirm that the average concentration of COCs in surface soil across the site is less than the respective RGs. There are no known site-specific factors that may impact remediation activities.

The USN, Andersen AFB, the USEPA, and Guam EPA believe that the selected remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The selected remedy satisfies statutory requirements of CERCLA § 121(b).

The selected remedy will be protective of human health by eliminating exposure of industrial and residential receptors to COC-impacted soil above RGs. This is consistent with the USN's future land use at the sites since no restrictions would be necessary.

It is important to note that the remedy may change somewhat as a result of the remedial design and construction processes. Changes, if they occur, to the remedy as described in this ROD will be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences (ESD), or ROD amendment.

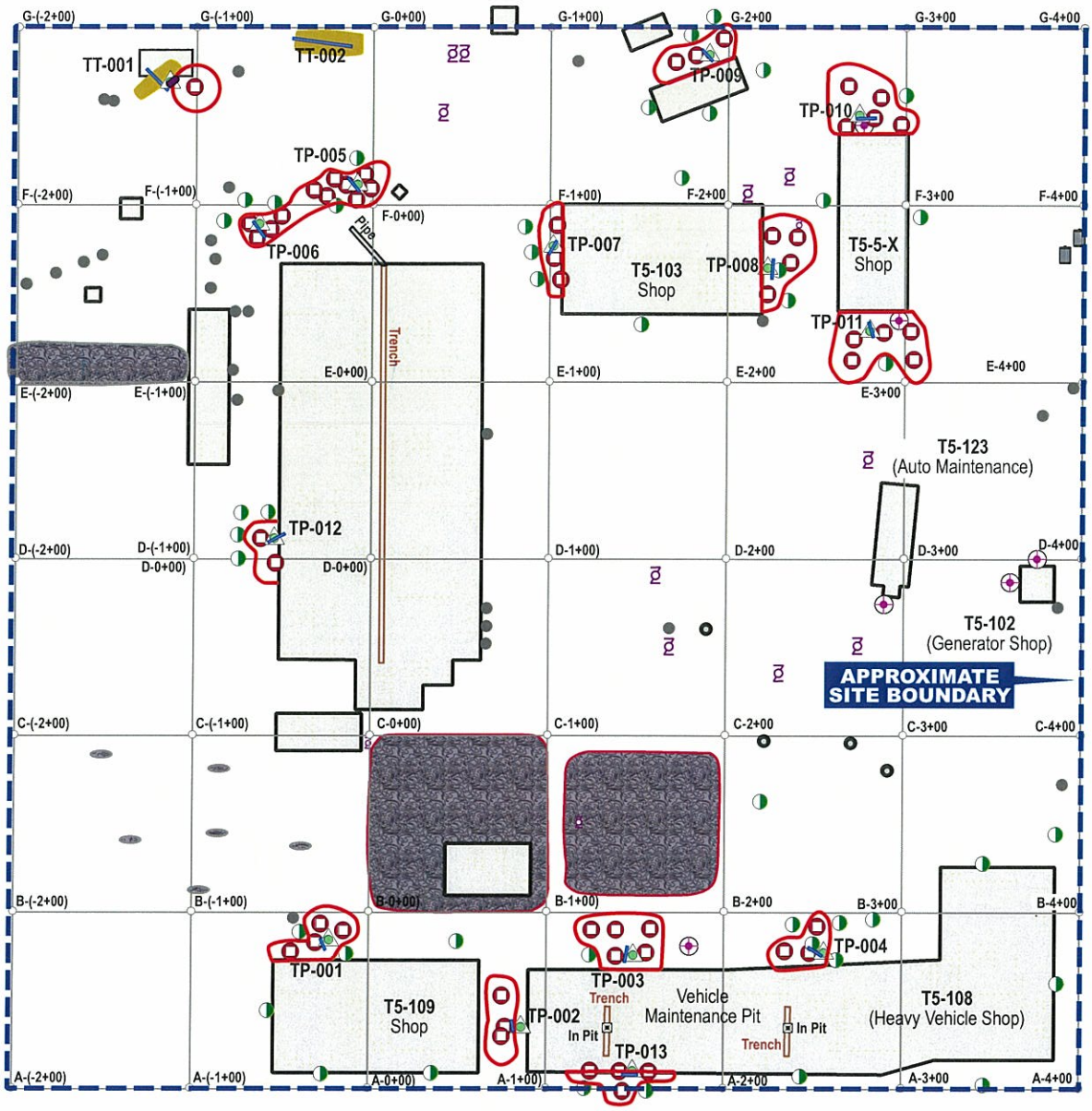
2.12.3 Summary of Estimated Remedy Costs

A summary of the estimated remedy costs (EA, 2009a) at Sites 41, 42, and 43 is presented in **Tables 2-14A**, **2-14B** and **2-14C**, respectively. The tables only present capital costs because there are no O&M costs associated with the selected remedy.

The total estimated cost of the remedy for all three sites is $1,030,000. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the selected remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedy. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. The cost estimate as presented for each site is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.12.4 Expected Outcomes of Selected Remedy

The selected remedy will remove surface and shallow subsurface COC-impacted soil exceeding RGs at all three sites, thereby eliminating potential future exposure to COC-impacted soil. Additionally, future land use at the sites will be unrestricted. Although none of the contaminants identified in surface and shallow subsurface soil have been detected in the underlying groundwater in concentrations above the MCLs, excavation and removal of the COC-impacted soil will eliminate any potential future impacts to groundwater quality.



EXPLANATION

- Proposed cleanup area
- Proposed tar/asphalt cleanup 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
- Aspalt debris area
- Mounded area
- Wooden utility poles on the ground
- Existing wooden utility pole
- Concrete pad
- Existing trench

N
W E
S

0 50 100

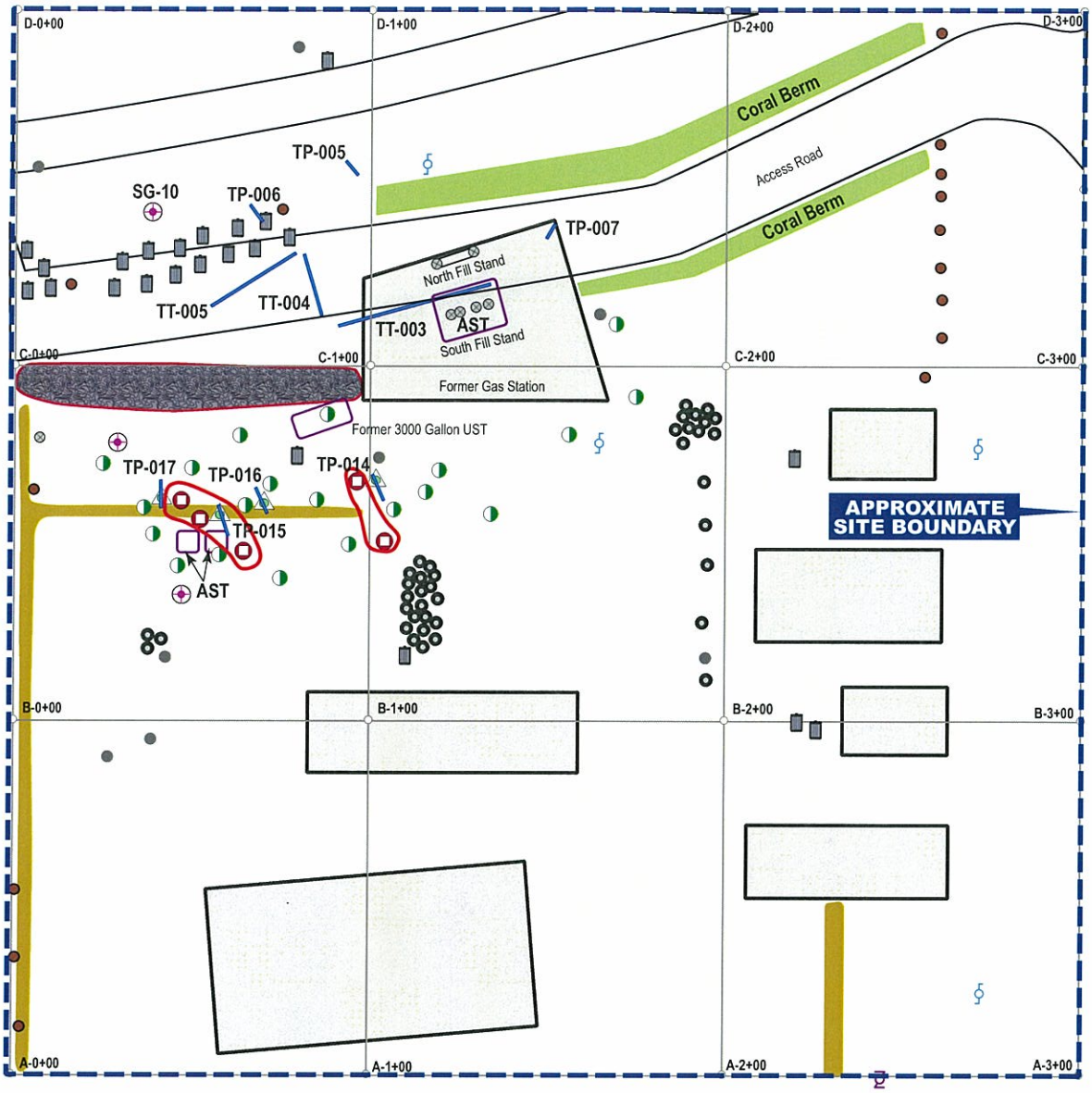
Scale in Feet

ANDERSEN AIR FORCE BASE
GUAM

Site 41
Proposed Cleanup Areas
MARBO Annex

FIGURE 2-10

FILE Fig 2-10 MARBO Site 41 Cleanup Areas.ai 12/03/08



EXPLANATION

- Proposed cleanup area
- Proposed tar/asphalt cleanup 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 compostie 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

N
W E
S

0 50
Scale in Feet

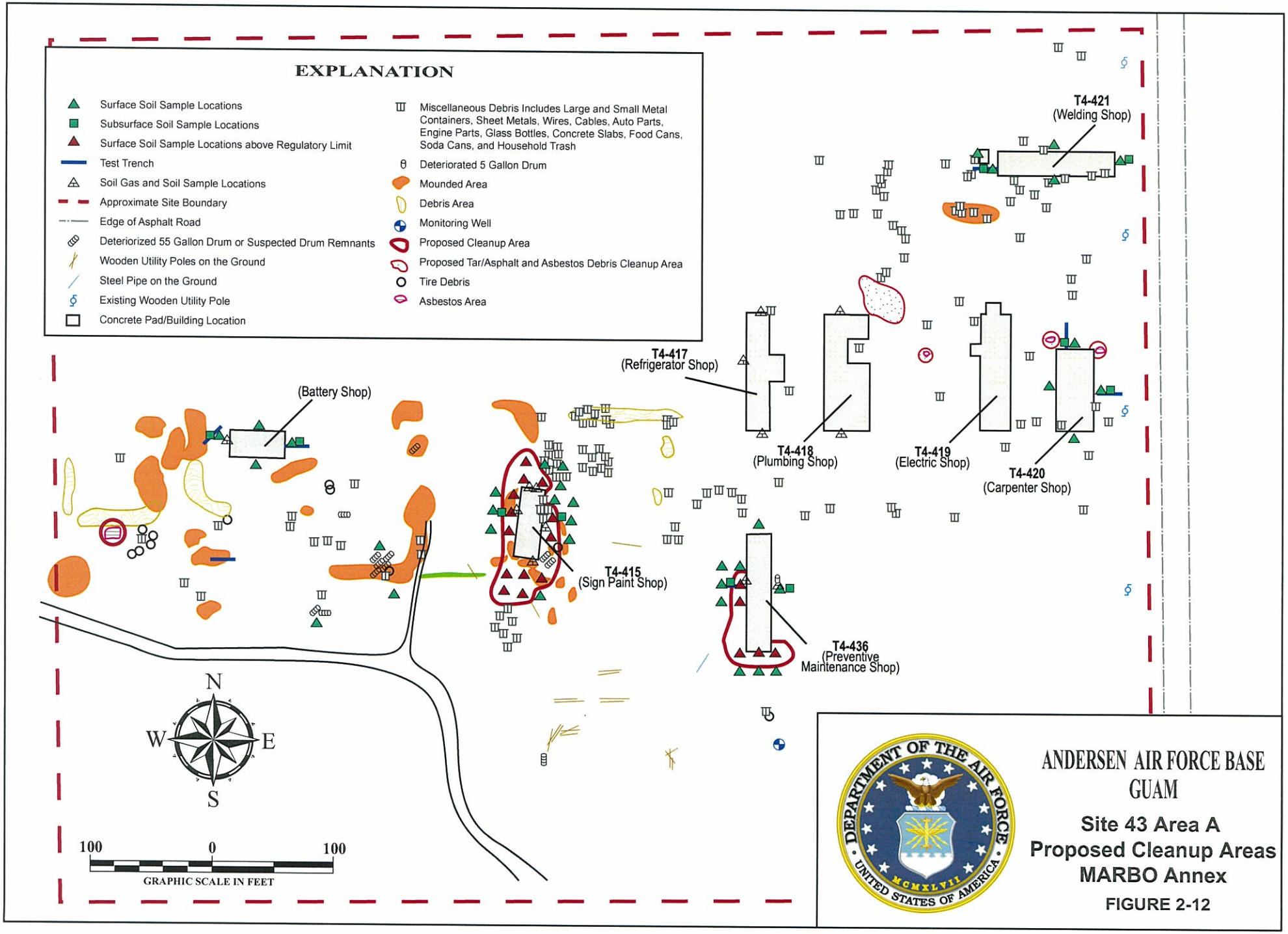
ANDERSEN AIR FORCE BASE
GUAM

Site 42
Proposed Cleanup Areas
MARBO Annex

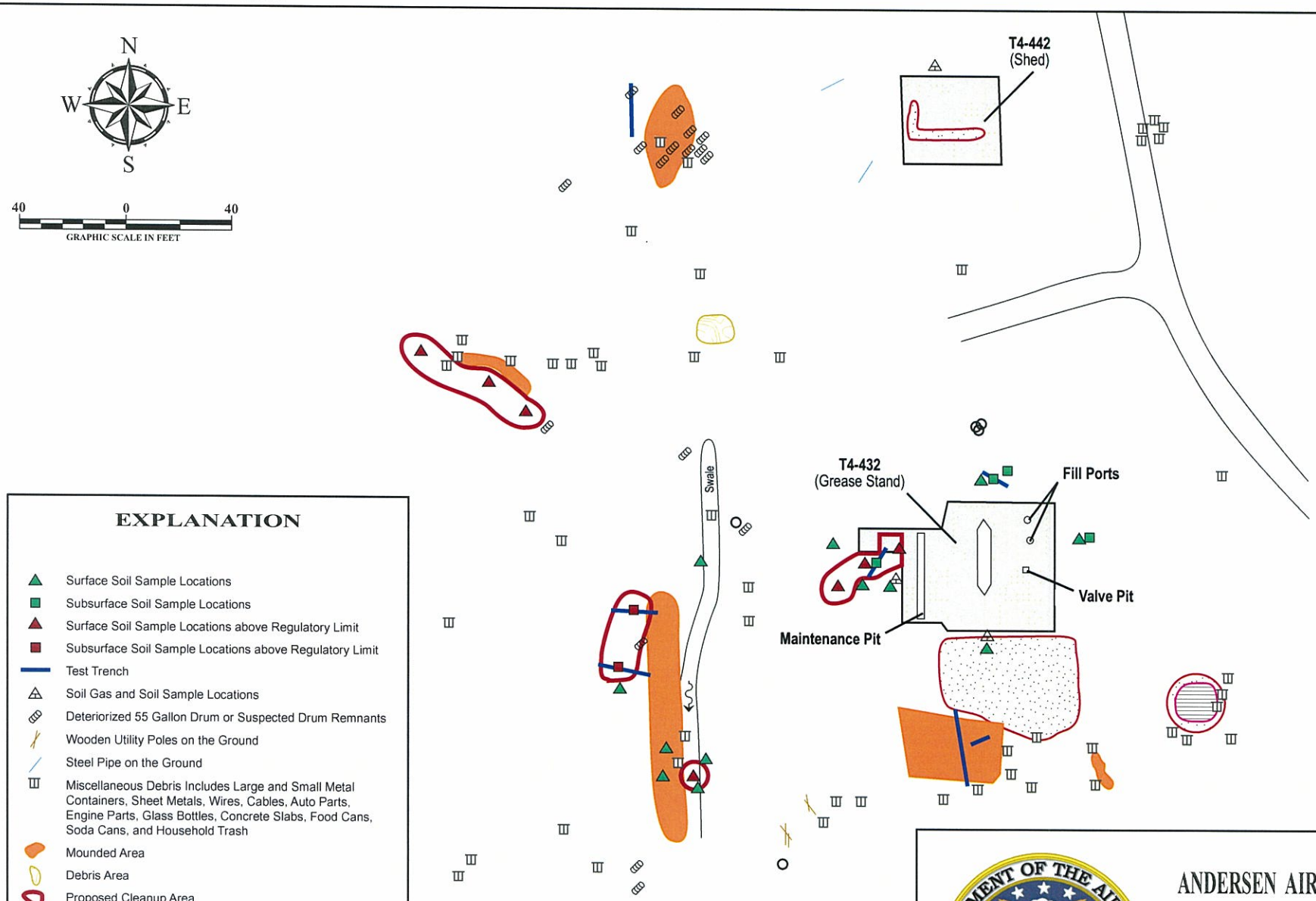
FIGURE 2-11

FILE Fig 2-11 MARBO Site 42 Cleanup Areas.ai 12/03/08

Fig2-12_Area-A_Site43 Cleanup Areas.ai



FILE Fig2-13_Area-B_Site43 Cleanup Areas.ai 12/03/08

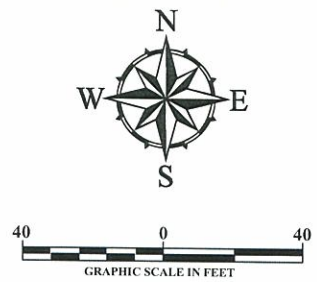


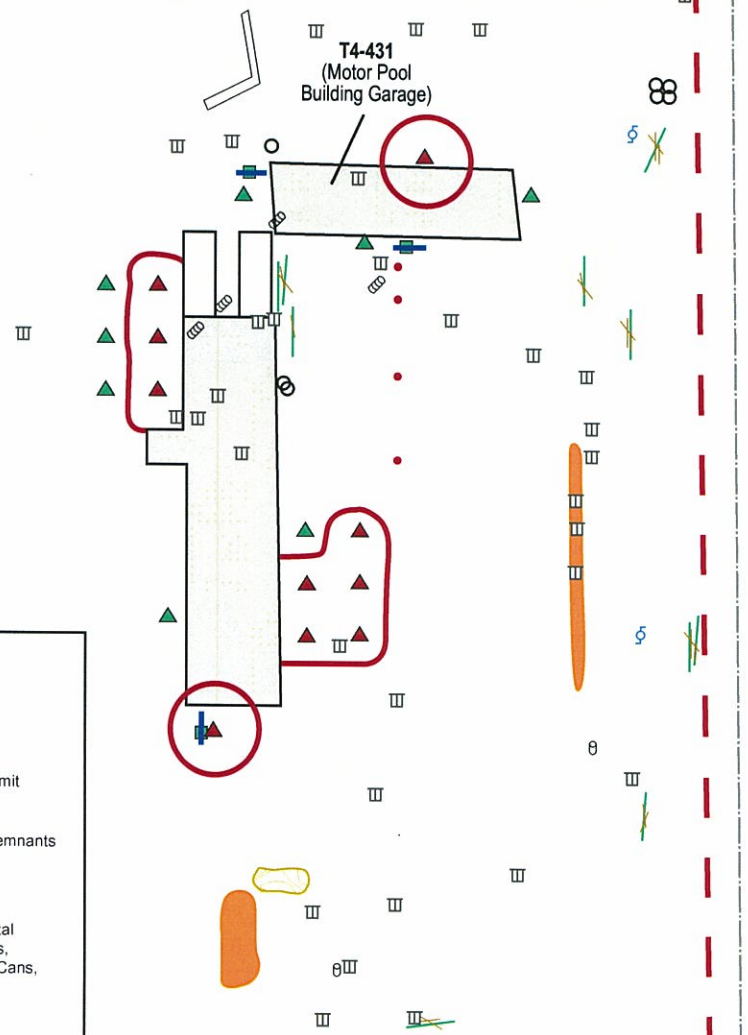
ANDERSEN AIR FORCE BASE
GUAM

Site 43 Area B
Proposed Cleanup Areas
MARBO Annex

FIGURE 2-13

FILE Fig2-14_Area-C_Site43 Cleanup Areas.ai 12/03/08





EXPLANATION

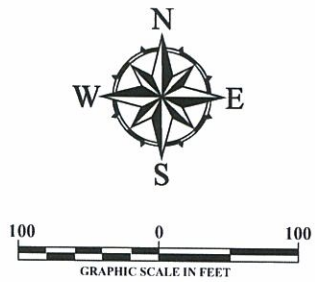
- Surface Soil Sample Locations
- Subsurface Soil Sample Locations
- Surface Soil Sample Locations above Regulatory Limit
- Test Trench
- Deteriorized 55 Gallon Drum or Suspected Drum Remnants
- Wooden Utility Poles on the Ground
- Steel Pipe on the Ground
- Miscellaneous Debris Includes Large and Small 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
- Proposed Cleanup Area
- Tire Debris
- Fence Posts
- PVC Pipe on the Ground
- Concrete Pad/Building Location

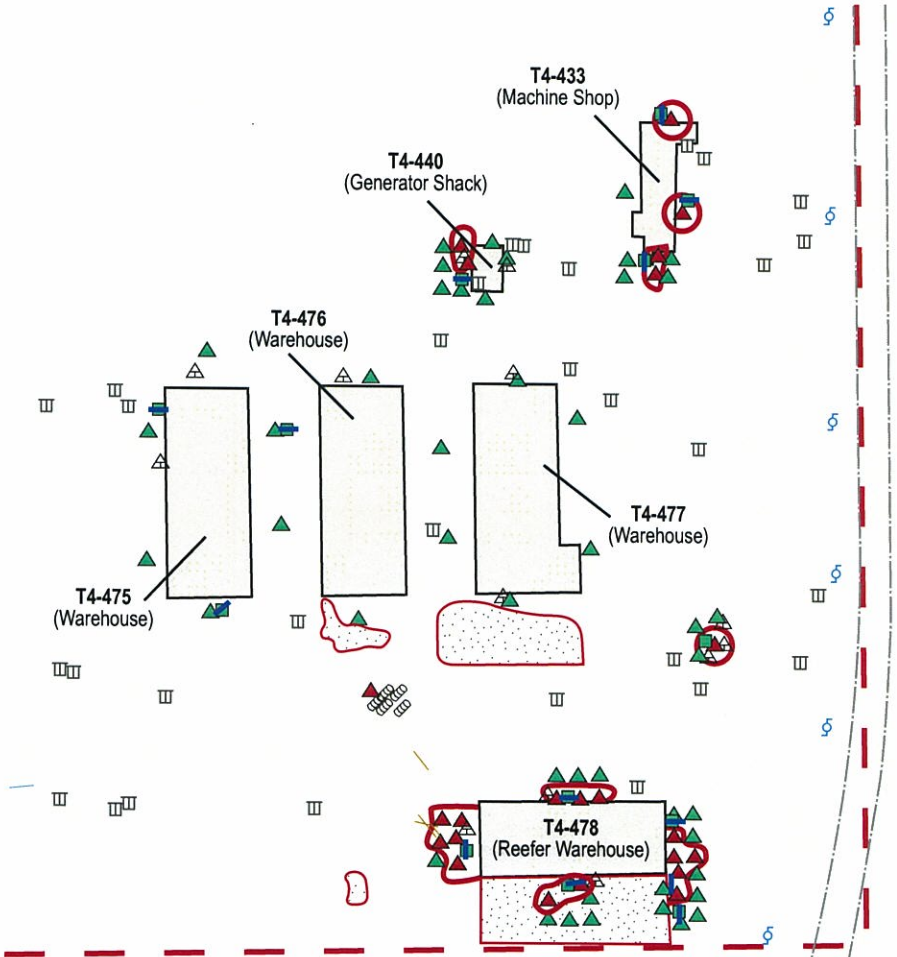
ANDERSEN AIR FORCE BASE
GUAM

Site 43 Area C
Proposed Cleanup Areas
MARBO Annex

FIGURE 2-14

FILE Fig2-15_Area-D_Site43 Cleanup Areas.ai 12/03/08





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
- Deteriorized 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
- Proposed Cleanup Area
- Proposed Tar/Asphalt and Debris Cleanup Area
- Tire Debris
- Concrete Pad/Building Location

ANDERSEN AIR FORCE BASE
GUAM

Site 43 Area D
Proposed Cleanup Areas
MARBO Annex

FIGURE 2-15

TABLE 2-14A (Page 1 of 2)

COST ESTIMATE SUMMARY FOR SITE 41 – CAPITAL COSTS
FOR SELECTED REMEDY COMPONENT
ANDERSEN AIR FORCE BASE, GUAM

Site	Description Work Plan Preparation (labor, ODCs, production, applicable taxes)	Quantity	Unit	Unit Cost	Cost
	Labor hours[1]	288	Hour	$72.90	$21,000
	Reproduction, shipping, per diem, travel (ODCs)	1	Lump Sum	$6,000	$6,000
	15% Markup on ODCs				$900
	4% Guam Tax				$1,080
	Subtotal[2]				**$29,000**
	Capital Cost - Clear, Grub, and Pre-survey				
	Labor hours[1]	64	Hour	$86.25	$5,520
	Reproduction, shipping, per diem, travel	1	Lump Sum	$2,000	$2,000
	Surveyors and Laborers to Clear (vendor quote)	1.5	Week	$8,000	$12,000
	15% Markup on ODCs				$2,100
	4% Guam Tax				$781
	Subtotal[2]				**$21,700**
	Excavation and Removal (540 Lcy of Soil)				
	Labor hours[1]	560	Hour	$93.92	$52,600
	Reproduction, shipping, per diem, travel (ODCs)	5	Week	$3,000	$15,000
	Mob-demob (contractor)	2	Task	$600	$1,200
	Trackhoe/Dozer Rental	25	Day	$800	$20,000
	Drag Line with Clam Shell Bucket	25	Day	$1,650	$41,250
	Rolloff Bins	12	Each	$2,200	$26,400
	Dump Trucks and Drivers	25	Day	$450	$11,250
	Steam/Water Truck	25	Day	$1,100	$27,500
	Transport/dispose non-hazardous waste at consolidation unit (98%)	529	Loose Cubic Yard	$10	$5,290
	Transport/dispose hazardous waste off island (0.2%)	1	Loose Cubic Yard	$2,000	$2,000
	TSP Treated non-hazardous waste (1.8%)	22	Loose Cubic Yard	$220	$4,840
	Reseeding/revegetation	11,160	Square Feet	$0.50	$5,580
	Clean Backfill	270	Loose Cubic Yard	$26	$7,020
	15% Markup on ODCs				$25,111
	4% Guam Tax				$6,697
	Subtotal[2]				**$251,700**

TABLE 2-14A (Page 2 of 2)

COST ESTIMATE SUMMARY FOR SITE 41 – CAPITAL COSTS
FOR SELECTED REMEDY COMPONENT
ANDERSEN AIR FORCE BASE, GUAM

Site	Description Work Plan Preparation (labor, ODCs, production, applicable taxes)	Quantity	Unit	Unit Cost	Cost[2]
	Capital Cost – Confirmatory Samples and Closure Report				
	Labor hours[1]	128	Hour	$81.56	$10,440
	Survey Confirmatory Samples	1	Week	$4,500	$4,500
	Reproduction, per diem, etc (ODCs).	1	Lump Sum	$6,500	$6,500
	Analytical Costs	100	Sample	$30	$3,000
	Sampling and Shipment Costs	1	Task	$5,000	$5,000
	15% Markup on ODCs, analytical, shipping, etc				$4,416
	4% Guam Tax				$1,178
	Subtotal[2]				**35,100**
Total Capital Cost[2]					**$337,500**

[1] – Labor hour rates represent averaged values for various professional labor rates and disciplines
[2] – Costs are rounded to the nearest $100.
ODCs – Other direct costs

TABLE 2-14B (Page 1 of 2)

COST ESTIMATE SUMMARY FOR SITE 42 – CAPITAL COSTS FOR SELECTED REMEDY COMPONENT ANDERSEN AIR FORCE BASE, GUAM

Site	Description Work Plan Preparation (labor, ODCs, production, applicable taxes)	Quantity	Unit	Unit Cost	Cost[2]
	Labor hours[1]	288	Hour	$72.90	$21,000
	Reproduction, shipping, per diem, travel (ODC)	1	Lump Sum	$6,000	$6,000
	15% Markup on ODC				$900
	4% Guam Tax				$1,080
	Subtotal[2]				**$29,000**
	Capital Cost - Clear, Grub, and Pre-survey				
	Labor hours[1]	64	Hour	$86.25	$5,520
	Reproduction, shipping, per diem, travel	1	Lump Sum	$2,000	$2,000
	Surveyors and Laborers to Clear (vendor quote)	1.5	Week	$8,000	$12,000
	15% Markup on ODCs				$2,100
	4% Guam Tax				$781
	Subtotal[2]				**$21,700**
	Excavation and Removal (30 Lcy of Soil)				
	Labor hours[1]	240	Hour	$81.16	$19,480
	Reproduction, shipping, per diem, travel (ODC)	5	Week	$3,000	$15,000
	Mob-demob (contractor)	2	Task	$600	$1,200
	Trackhoe/Dozer Rental	25	Day	$800	$4,000
	Drag Line with Clam Shell Bucket	25	Day	$1,650	$8,250
	Rolloff Bins	12	Each	$2,200	$26,400
	Dump Trucks and Drivers	5	Day	$450	$2,250
	Steam/Water Truck	5	Day	$1,100	$5,500
	Transport/dispose non-hazardous waste at consolidation unit (98%)	29	Loose Cubic Yd	$10	$290
	Transport/dispose hazardous waste off island (0.2%)	0.1	Loose Cubic Yd	$2,000	$200
	TSP Treated non-hazardous waste (1.8%)	1	Loose Cubic Yd	$220	$220
	Reseeding/revegetation	450	Square Feet	$0.50	$225
	Clean Backfill	1	Loose Cubic Yd	$26	$26

TABLE 2-14B (Page 2 of 2)

COST ESTIMATE SUMMARY FOR SITE 42 – CAPITAL COSTS
FOR SELECTED REMEDY COMPONENT
ANDERSEN AIR FORCE BASE, GUAM

Site	Description Work Plan Preparation (labor, ODCs, production, applicable taxes)	Quantity	Unit	Unit Cost	Cost[2]
	15% Markup on ODC				$7,728
	4% Guam Tax				$2,061
	Subtotal[2]				**$80,800**
	Capital Cost – Confirmatory Samples and Closure Report				
	Labor hours[1]	128	Hour	$81.56	$10,440
	Survey Confirmatory Samples	1	Week	$4,500	$4,500
	Reproduction, per diem, etc.	1	Lump Sum	$6,500	$6,500
	Analytical Costs	50	Sample	$30	$1,500
	Sampling and Shipment Costs	1	Task	$5,000	$5,000
	15% Markup on ODCs, analytical, shipping, etc				$4,191
	4% Guam Tax				$1,118
	Subtotal[2]				**33,300**
Total Capital Cost[2]					**$164,800**

[1] – Labor hour rates represent averaged values for various professional labor rates and disciplines
[2] – Costs are rounded to the nearest $100.
ODCs – Other direct costs

TABLE 2-14C (Page 1 of 2)

COST ESTIMATE SUMMARY FOR SITE 43 – CAPITAL COSTS
FOR SELECTED REMEDY COMPONENT
ANDERSEN AIR FORCE BASE, GUAM

Site	Description	Quantity	Unit	Unit Cost	Cost[2]
	Work Plan Preparation (labor, ODCs, production, applicable taxes)				
	Labor hours[1]	288	Hour	$72.90	$21,000
	Reproduction, shipping, per diem, travel (ODCs)	1	Lump Sum	$6,000	$6,000
	15% Markup on ODCs				$900
	4% Guam Tax				$1,080
	Subtotal[2]				**$29,000**
	Capital Cost - Clear, Grub, & Pre-survey				
	Labor hours[1]	64	Hour	$86.25	$5,520
	Reproduction, shipping, per diem, travel (ODCs)	1	Lump Sum	$2,000	$2,000
	Surveyors and Laborers to Clear (vendor quote)	1.5	Week	$8,000	$12,000
	15% Markup on ODCs and Survey				$2,100
	4% Guam Tax				$781
	Subtotal[2]				**$21,700**
	Excavation and Removal (540 Lcy of Soil)				
	Labor hours[1]	560	Hour	$93.92	$52,600
	Reproduction, shipping, per diem, travel	5	Week	$3,000	$15,000
	Mob-demob (contractor)	2	Task	$600	$1,200
	Trackhoe/Dozer Rental	25	Day	$800	$20,000
	Drag Line with Clam Shell Bucket	25	Day	$1,650	$41,250
	Asphalt and Asbestos Removal	1	Lump Sum	$35,000	$35,000
	Rolloff Bins	12	Each	$2,200	$26,400
	Laborers	2	Hour	$15	$30
	Dump Trucks and Drivers	25	Day	$450	$11,250
	Steam/Water Truck	25	Day	$1,100	$27,500
	Transport/dispose non-hazardous waste at consolidation unit (98%)	872	Loose Cubic Yd	$10	$8,720
	Transport/dispose hazardous waste off island (0.2%)	2	Loose Cubic Yd	$2,000	$4,000
	TSP Treated non-hazardous waste (1.8%)	36	Loose Cubic Yd	$220	$7,920
	Reseeding/revegetation	13,050	Square Feet	$0.50	$6,525
	Clean Backfill	16	Loose Cubic Yd	$26	$416
	15% Markup on ODCs				$30,705
	4% Guam Tax				$8,188
	Subtotal[2]				**$296,700**

TABLE 2-14C (Page 2 of 2)

COST ESTIMATE SUMMARY FOR SITE 43 – CAPITAL COSTS
FOR SELECTED REMEDY COMPONENT
ANDERSEN AIR FORCE BASE, GUAM

Site	Description	Quantity	Unit	Unit Cost	Cost[2]
	Capital Cost – Confirmatory Samples and Closure Report				
	Labor hours[1]	128	Hour	$81.56	$10,440
	Survey Confirmatory Samples	1	Week	$4,500	$4,500
	Reproduction, per diem, etc.	1	Lump Sum	$6,500	$6,500
	Analytical Costs	250	Sample	$500	$125,000
	Sampling and Shipment Costs	1	Task	$5,000	$5,000
	15% Markup on ODC				$22,716
	4% Guam Tax				$6,058
	Subtotal[2]				**180,300**
Total Capital Cost[2]					**$527,700**

[1] – Labor hour rates represent averaged values for various professional labor rates and disciplines
[2] – Costs are rounded to the nearest $100.
ODCs – Other direct costs

The cleanup level for carcinogens is set equal to 1 x 10^{-5} for a potential future resident unless background levels are higher or unless there is another more restrictive requirement. The target cancer risk is within EPA's generally acceptable risk range of 10^{-4} to 10^{-6}. The value of 1 x 10^{-5} is protective, while still being considerably less than the risk from naturally occurring concentrations of metals at the site; i.e., it will not lead to a significant increase in risk (see **Table 2-15C** for arsenic). The cleanup level for non-carcinogens is a hazard quotient of 1, unless background levels are higher or unless there is another more restrictive requirement.

The cleanup criterion for benzo(a)pyrene of 0.6 mg/kg meets the carcinogenic criterion and the cleanup level for cadmium meets the non-carcinogenic criterion. Arsenic and vanadium cleanup levels of 62 and 206 mg/kg, respectively, have been set equal to their background levels. The cleanup criterion for arsenic results in a cancer risk greater than 1 x 10^{-5} and a hazard quotient greater than 1; the vanadium cleanup

criterion also results in a hazard quotient greater than 1. However, the risks at these cleanup levels will be comparable to the surrounding soil unaffected by releases of hazardous constituents. The cleanup level for Aroclor 1254 of 1 mg/kg is the residential cleanup standard for PCBs under TSCA. The lead cleanup level of 400 mg/kg corresponds to 95 percent of children having a blood lead level (BLL) less than 10 µg/dl. Cleanup levels for COCs at Sites 41, 42, and 43 are presented in **Tables 2-15A**, **2-15B**, and **2-15C**, respectively.

TABLE 2-15A

CLEANUP LEVELS FOR CHEMICALS OF CONCERN AT SITE 41
ANDERSEN AIR FORCE BASE, GUAM

Media: Surface Soil
Site Area: Site 41
Available Use: Residential
Controls to Ensure Restricted Use (if applicable): None

Chemical of Concern	Cleanup Level	Basis for Cleanup Level	Risk at Cleanup Level
Lead	400 mg/kg	Residential PRG	BLL=10 µg/dl

Key:
BLL 95th percentile blood lead level
PRG Preliminary remediation goal

TABLE 2-15B

CLEANUP LEVELS FOR CHEMICALS OF CONCERN AT SITE 42
ANDERSEN AIR FORCE BASE, GUAM

Media: Surface Soil
Site Area: Site 42
Available Use: Residential
Controls to Ensure Restricted Use (if applicable): None

Chemical of Concern	Cleanup Level	Basis for Cleanup Level	Risk at Cleanup Level
Lead	400 mg/kg	Residential PRG	BLL=10 µg/dl

Key:
BLL 95th percentile blood lead level
PRG Preliminary remediation goal

TABLE 2-15C

CLEANUP LEVELS FOR CHEMICALS OF CONCERN AT SITE 43
ANDERSEN AIR FORCE BASE, GUAM

Media: Surface and Subsurface Soil
Site Area: Site 43
Available Use: Residential
Controls to Ensure Restricted Use (if applicable): None

Chemical of Concern	Cleanup Level	Basis for Cleanup Level	Risk at Cleanup Level
Benzo(a)pyrene	0.6 mg/kg	Residential PRG	CR=1E-05
Aroclor-1254	1 mg/kg	Residential PRG	CR=5E-06; HQ=0.9
Cadmium	37 mg/kg	Residential PRG	HQ=1
Lead	400 mg/kg	Residential PRG	BLL=10 µg/dl
Arsenic	62 mg/kg	Soil BTV	CR=1E-04; HQ=3
Vanadium	206 mg/kg	Soil BTV	HQ=3

Key:
BLL 95th percentile blood lead level
BTV Background threshold value
CR Cancer risk
HQ Hazard quotient
PRG Preliminary remediation goal

2.13 STATUTORY DETERMINATIONS

Under CERCLA §121 (as required by NCP §300.430(f)(5)(ii)), the lead agency must select a remedy that is protective of human health and the environment, complies with ARARs, is cost-effective, and uses permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes: 1) a preference for remedies that employ treatment which permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element; and 2) a bias against offsite disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

2.13.1 Protection of Human Health and the Environment

The selected remedy (Soil Removal [Unrestricted Land Use]) will protect human health and the environment by removing soil that exceeds protective ARARs. By removing the impacted soil, the risk level from residential or industrial exposure to COC-impacted soil becomes acceptable. In addition, the implementation of the selected remedy will not pose unacceptable short-term risks or cross-media impacts.

2.13.2 Compliance with ARARs

Remedial actions must comply with both Federal and State ARARs. ARARs are legally applicable or relevant and appropriate requirements, standards, criteria, or limitations of Federal and State environmental laws and regulations.

ARARs fall into three categories: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs are health-based or risk-management-based numbers that provide concentration limits for the occurrence of a chemical in the environment. Location-specific ARARs restrict activities in certain sensitive environments. Action-specific ARARs are activity-based or technology-based, and typically control remedial activities that generate hazardous wastes (such as with those covered under the RCRA). Offsite shipment, treatment and disposal of excavated contaminated soil invoke action-specific ARARs. Criteria to be considered, or TBCs, are non-promulgated advisories or guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. However, in many circumstances, TBCs are considered along with ARARs.

The selected remedy complies with the chemical-specific, location-specific, and action-specific ARARs. The implementation of the remedy is required to meet the substantive portions of these requirements and is exempt from administrative requirements such as permitting and notifications. **Table 2-16** summarizes the ARARs for the selected

remedy at Sites 41, 42, and 43, and describes how the selected remedy addresses each one.

2.13.3 Cost Effectiveness

In the judgment of the USN, and the AF (as the previous lead agency), the selected remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness" (40 CFR 300.430[f][1][ii][D]). This determination was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfy the threshold criteria (that is, is protective of human health and the environment and ARAR-compliant).

Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination: long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness. Overall effectiveness was then compared to costs to determine cost-effectiveness. The overall effectiveness of the selected remedy for Sites 41, 42, and 43 was demonstrated in the comparative analysis of alternatives (Section 2.10 – Summary of Comparative Analysis of Alternatives) and is summarized in **Tables 2-17A through 2-17C** following. The estimated present worth cost of the selected remedy (in 2009 dollars) is $1,030,000.

TABLE 2-16 (Page 1 of 4)

DESCRIPTION OF ARARS AND TBCs FOR SELECTED REMEDY FOR SITES 41, 42, AND 43
ANDERSEN AIR FORCE BASE, GUAM

Type	Authority	Medium	Requirement	Synopsis of Requirement	Action to be Taken to Attain Requirement
Chemical-Specific TBC	Federal Regulatory Requirement	Soil	USEPA Region IX Preliminary PRGs to screen and establish RGs	Establishes health-based concentration goals for chemicals in environmental media	Removal will mitigate unacceptable risk for future residential and industrial scenarios associated with site soil.
Chemical-Specific ARAR	Federal Regulatory Requirement	Soil	40 CFR 61, Subpart M; National Emission Standard for Asbestos (61.150)	Establishes standards for removal, packaging, or transportation of asbestos-containing material	Removal will be conducted in a manner to ensure that there will be no visible emissions to the outside air from the site, as may be achieved through use of a dust control agent.
Action-Specific ARAR	Federal Regulatory Requirement	Soil	Resource Conservation and Recovery Act (RCRA) regulations for identification of Hazardous Waste 40 CFR 261, Transport of Hazardous Waste 40 CFR 263, and for Land Disposal Restrictions (LDRs) and landfills	Establishes guidelines for identification and transport of hazardous waste, and requirements for disposal	Excavated material will be tested for hazardous waste characteristics (ignitability, reactivity, corrosivity, or toxicity). Hazardous waste will be handled, stored, and transported in accordance with RCRA.
Action-Specific ARAR	Federal Regulatory Requirement	Soil	40 CFR 268 Land Disposal Restrictions ("Land Ban")	Identifies hazardous wastes that are restricted from land disposal; provides guidelines for treatment of hazardous waste prior to disposal	Any soil classified as hazardous waste which is to be disposed offsite will be treated as necessary to meet LDR treatment standards.

TABLE 2-16 (Page 2 of 4)

DESCRIPTION OF ARARS AND TBCs FOR SELECTED REMEDY FOR SITES 41, 42, AND 43
ANDERSEN AIR FORCE BASE, GUAM

Type	Authority	Medium	Requirement	Synopsis of Requirement	Action to be Taken to Attain Requirement
Action-Specific ARAR	Federal Regulatory Requirement	Ambient Air	Clean Air Act (CAA) 40 CFR 50	Permits and regulates air emissions if considered a major source	CERCLA 121(E) exempts onsite activities from obtaining air permits. Air emissions at the site are not a major source. However, an air monitoring plan will be established and dust control measures will be implemented to mitigate fugitive emissions during site excavation activities.
Action-Specific ARAR	Federal Regulatory Requirement	Soil	Hazardous Materials Transportation Act (HMTA) 40 CFR 100-199	Establishes guidelines for handling, storage, and transportation of hazardous waste	If removal action involves offsite transport of hazardous waste, handling, storage, and transportation will comply with HMTA and Department of Transportation (DOT) regulations.
Action-Specific ARAR	Federal Regulatory Requirement	Coastal waters	Coastal Zone Management Act	Requires activities conducted within the coastal zone or near coastal areas to be conducted in a manner consistent with the Coastal Zone Management Act	There is no watershed basin for the Northern Limestone Plateau due to the relatively high porosity of the limestone. Therefore there would be no impact to coastal water from soil erosion occurring at the site.
Location-Specific ARAR	Federal Regulatory Requirement	Soil	Endangered Species Act 16 USC 1531 and 50 CFR 200, 402; Fish and Wildlife Coordination Act (16 USC 661); 33 CFR 320 to 330	Establishes guidelines for conserving and protecting endangered or threatened species if action threatens critical habitat	Listed endangered species have not been observed on the site. The removal plan will be assessed to ensure that there is no adverse impact to potential roosting, nesting, or foraging habitat of endangered species.

TABLE 2-16 (Page 3 of 4)

DESCRIPTION OF ARARS AND TBCs FOR SELECTED REMEDY FOR SITES 41, 42, AND 43
ANDERSEN AIR FORCE BASE, GUAM

Type	Authority	Medium	Requirement	Synopsis of Requirement	Action to be Taken to Attain Requirement
Location-Specific ARAR	Federal Regulatory Requirement	Soil	16 USC Section 469, 36 CFR 65, 40 CFR 6.301(b)	Provides guidelines for action to recover and preserve artifacts if in an area where action may cause irreparable harm, loss, or destruction of significant artifacts	Will consult with Territory of Guam and National Register of Historic Places if necessary.
Location-Specific ARAR	Territorial (Guam) Regulatory Requirement	Soil, Groundwater	Guam Wellhead Protection Program	Protects groundwater in wells/wellfields that supply drinking water. Regulates permitting of production and monitoring wells, and contractor licensing	Excavation and disposal of impacted soil will be conducted in a manner to avoid potential impacts to groundwater quality. No production wells are located within 1,500 feet of Sites 41, 42, and 43.
Location-Specific ARAR	Territorial (Guam) Regulatory Requirement	Soil	5 Guam Code Annotated, Chapter 63	Lists endangered and threatened species; regulates fish and wildlife	Listed endangered species have not been observed on the site. The removal plan will be assessed to ensure that there is no adverse impact to potential roosting, nesting, or foraging habitat of endangered species.
Action-Specific ARAR	Territorial (Guam) Regulatory Requirement	Marine waters	Water Pollution Control Act, 10 Guam Code Annotated, Chapter 47	Provides guidelines for eliminating and/or preventing pollution to surface waters and groundwater	Soil excavation activities would be conducted in a manner to prevent surface erosion of soil to nearby marine waters. There are no surface streams due to the relatively high porosity of the limestone.
Action-Specific ARAR	Territorial (Guam) Regulatory Requirement	Coastal waters	Coastal Zone Management Act of 1972 (P.O. 92-583, et al.)	Provides guidelines for eliminating and/or preventing pollution to marine waters	There is no watershed basin for the Northern Limestone Plateau due to the relatively high porosity of the limestone. Therefore there would be no impact to coastal water from soil erosion occurring at the site.

TABLE 2-16 (Page 4 of 4)

DESCRIPTION OF ARARS AND TBCs FOR SELECTED REMEDY FOR SITES 41, 42, AND 43
ANDERSEN AIR FORCE BASE, GUAM

Key:
ARARs – Applicable and Relevant and Appropriate Requirements
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
CFR – Code of Federal Regulations
DOT – Department of Transportation
HMTA – Hazardous Materials Transportation Act
LDR – Land Disposal Restrictions
PRGs – Preliminary Remediation Goals
RCRA – Resource Conservation and Recovery Act
RGs – Remediation Goals
TBC – To be considered
USEPA – United States Environmental Protection Agency

TABLE 2-17A

COST AND EFFECTIVENESS SUMMARY FOR SITE 41
ANDERSEN AIR FORCE BASE, GUAM

Alternative	Present-Worth Cost	Incremental Cost (if applicable)	Long-Term Effectiveness and Permanence	Reduction of TMV Through Treatment	Short-Term Effectiveness
1 – No Action	$0	N/A	Not Achieved	Not Achieved	Not Achieved
2 – Land Use Controls with Engineering Controls	$230,500	Yes (LUCs, five-year reviews, etc)	Achieved upon implementation	Not Achieved	Achieved upon implementation
3 – Soil Removal (Unrestricted Land Use)	$337,500	N/A	Achieved upon implementation	Achieved through removal of COC-impacted soil exceeding RGs, and treatment if necessary prior to disposal	Achieved upon implementation

Cost Effectiveness Summary:

- Alternative 1 is not cost effective because it is not protective of human health or the environment, and is not ARAR- compliant.
- While Alternative 2 is considered to be cost effective, Alternative 3 provides a potentially greater return on investment by eliminating COC-impacted soil above RGs, and requires no LUCs.

Key:

ARAR – Applicable or Relevant and Appropriate Requirement

COC – Contaminant of Concern

LUC – Land Use Controls

N/A – Not applicable

TMV – Toxicity, mobility, and volume

RG – Remediation goal

TABLE 2-17B

COST AND EFFECTIVENESS SUMMARY FOR SITE 42
ANDERSEN AIR FORCE BASE, GUAM

Alternative	Present-Worth Cost	Incremental Cost (if applicable)	Long-Term Effectiveness and Permanence	Reduction of TMV Through Treatment	Short-Term Effectiveness
1 – No Action	$0	N/A	Not Achieved	Not Achieved	Not Achieved
2 – Land Use Controls with Engineering Controls	$104,900	Yes (LUCs, five-year reviews, etc)	Achieved upon implementation	Not Achieved	Achieved upon implementation
3 – Soil Removal (Unrestricted Land Use)	$164,800	N/A	Achieved upon implementation	Achieved through removal of COC-impacted soil exceeding RGs, and treatment if necessary prior to disposal	Achieved upon implementation

Cost Effectiveness Summary:

- Alternative 1 is not cost effective because it is not protective of human health or the environment, and is not ARAR- compliant.
- Alternative 2 is not considered to be cost effective because Alternative 3 provides complete removal of all COC-impacted soil above RGs for a marginally higher cost.

Key:

ARAR – Applicable or Relevant and Appropriate Requirement

COC – Contaminant of Concern

LUC – Land Use Controls

N/A – Not applicable

TMV – Toxicity, mobility, and volume

RG – Remediation goal

TABLE 2-17C

COST AND EFFECTIVENESS SUMMARY FOR SITE 43
ANDERSEN AIR FORCE BASE, GUAM

Alternative	Present-Worth Cost	Incremental Cost (if applicable)	Long-Term Effectiveness and Permanence	Reduction of TMV Through Treatment	Short-Term Effectiveness
1 – No Action	$0	N/A	Not Achieved	Not Achieved	Not Achieved
2 – Land Use Controls with Engineering Controls and ACM Removal	$275,900	Yes (LUCs, five-year reviews, etc)	Achieved upon implementation	Not Achieved	Achieved upon implementation
3 – Soil Removal (Unrestricted Land Use)	$527,700	N/A	Achieved upon implementation	Achieved through removal of COC-impacted soil exceeding RGs, and treatment if necessary prior to disposal	Achieved upon implementation

Cost Effectiveness Summary:

- Alternative 1 is not cost effective because it is not protective of human health or the environment, and is not ARAR- compliant.
- Alternative 2 is not considered to be cost effective because Alternative 3 provides complete removal of all COC-impacted soil above RGs and does not require long-term LUCs.

Key:

ARAR – Applicable or Relevant and Appropriate Requirement

COC – Contaminant of Concern

LUC – Land Use Controls

N/A – Not applicable

TMV – Toxicity, mobility, and volume

RG – Remediation goal

2.13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies

Evaluation of the alternatives indicates that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner at the site. Of those alternatives that are protective of human health and the environment and comply with ARARs, the USN considers the selected remedy to provide the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against offsite treatment and disposal, and considering Territory of Guam and community acceptance. The selected remedy manages the potential risks to human health and the environment by removing COC-impacted soil exceeding regulatory cleanup levels from the site.

2.13.5 Preference for Treatment as a Principal Element

The selected remedy for Sites 41, 42, and 43 does not satisfy CERCLA's statutory preference for treatment as a principal element of the remedy [CERCLA Section 121(b)] 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.

2.13.6 Five-Year Review Requirements

Pursuant to CERCLA §121(c) and NCP §300.430(f)(5)(iii)(C), because the selected remedy will not result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will not be required within five years after initiation of the remedial action to verify that the remedy is, or will be, protective of human health and the environment.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

Based on comments received by the AF during the public review period and public meeting for the Proposed Plan, it was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

3.0 RESPONSIVENESS SUMMARY

This section provides a summary of the public comments regarding the Proposed Plan for remedial action at Sites 41, 42, and 43, MARBO Annex, Andersen AFB, Guam. At the time of the public review period, the AF (previously the lead agency) had selected Soil Removal (Unrestricted Land Use) as the preferred alternative for the three sites.

The public review and comment period ran from 14 April 2009 through 14 May 2009. During this period, no written comments were received from the public. In addition, no request for extension of the public comment period was received. A public meeting was held on 30 April 2009 to present details of the Proposed Plan and to solicit public comment and input. Based upon the verbal comments received at the meeting, the AF's Proposed Plan was accepted by the public. A list of attendees at the public meeting is included as **Attachment 1.**

3.1 STAKEHOLDER COMMENTS AND LEAD AGENCY RESPONSES

The only members of the public in attendance at the public meeting are also members of the Andersen AFB Restoration Advisory Board (RAB). General questions and comments received by members of the RAB during the presentation at the meeting, along with AF (previously the lead agency) responses are listed below and are also presented verbatim in a transcript of the proceedings of the meeting, which is included as **Attachment 2.**

Mr. Kasperbauer requested an explanation of the reference to risk as it pertains to future residents and industrial workers. Mr. Agar explained that the EPA has established risk screening levels for different categories of potential receptors (e.g., residents, industrial workers). Contamination in soil that exceeds those respective risk screening levels is determined to pose a risk to receptors in that category. Mr. Agar also explained that the risk calculations take into consideration exposure routes (inhalation, dermal contact, ingestion, etc) when determining the actual risk.

4.0 REFERENCES

Barrett, Harris & Associates, 1982. Summary Report Northern Guam Lens Study. December 1982.

DAWR (Department of Aquatic and Wildlife Resources), 1988. Checklist of terrestrial vertebrates and selected terrestrial invertebrates of Guam.

EA Engineering, Science, and Technology (EA), 2009a. Final Feasibility Study Report for MARBO Annex IRP Sites 41, 42, and 43, Andersen AFB, Guam. February, 2009.

EA, 2009b. Final Remedial Investigation Report for MARBO Annex IRP Sites 41, 42, and 43, Andersen AFB, Guam. February 2009.

EA, 2009c. Draft Record of Decision Amendment for MARBO Annex OU, Andersen AFB, Guam. February 2009.

EA, 2008. Draft Closure Report for Underground Storage Tank Removal at Facility 2598 and Decommissioning Report for Underground Storage Tank Removal at IRP Site 42 and IRP Site 43, Andersen AFB, Guam. September 2008.

EA, 2007. Fall 2006 Groundwater Monitoring Report, Andersen Air Force Base, Guam. June 2007.

EA, 1998a. Final Phase II Environmental Baseline Survey for MARBO Annex Part II, Andersen AFB, Guam. October 1998.

EA, 1998b. Technical Memorandum on Long-Term Groundwater Monitoring at MARBO. February 1998.

EA, 1995. Groundwater Monitoring Plan, Andersen AFB, Guam. October 1995.

Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. ES/ER/TM-126/R2. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

ICF (ICF Technology, Inc.), 1997. Analysis of Background Threshold Values for Andersen Air Force Base, Guam. February 1997.

ICF (ICF Technology, Inc.), 1995. Installation Restoration Program (IRP) Groundwater Dye Trace Program and Well Cluster Proposal for Landfill Area, Andersen Air Force Base, Guam. February 1995.

Mink, John F., 1976. Groundwater Resources of Guam: Occurrence and Development, Technical Report No. 1, Water Resources Research Center, University of Guam, September 1976, 275pp.

Sample. B. E., D. M. Opresko, and G. W. Suter II, 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Lockheed Martin Energy Systems, Inc.

Stearns, H.T., 1937. Geology and Water Resources of the Island of Guam, Mariana Islands. U.S. Navy Manuscript Report.

Tracey, J.I., Schlanger, S. O., Stark, J.T., Doan, D.B., and May, H.G., 1964. General Geology of Guam: U.S.G.S. Prof. Paper 403-A.

USAF (United States Air Force), 1994. Environmental Baseline Surveys in Real Estate Transactions. Air Force Instruction 32-7066. April.

USEPA (United States Environmental Protection Agency), 1993. Federal Facility Agreement Under CERCLA Section 120. Administrative Docket Number:93-17. Air Force Base, Guam. 30 March.

USEPA, 1997. Exposure Factors Handbook, Volumes I, II, and III. Report No.EPA/600/P-95/002Fa-c. Office of Health and Environmental Assessment, Washington, D.C. August 1997.

USEPA, 2005. Ecological Soil Screening Levels. OSWER Directive No. 9285.7. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response (OSWER). February - March 2005.

USGS (United States Geological Survey), 1978. Topographical Map of Guam, Mariana Islands.

U.S. Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR), 1992. Toxicological Profile for Vanadium and Compounds, July 1992.

Ward, Porter E., Hoffard, Stuart H., and Davis, Dan A., 1965. Geology and Hydrology of Guam, Mariana Islands, U.S. Geol. Survey Prof. Paper 403-H, 28pp.