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Andersen Air Force Base

Yigo, Guam

CERCLIS #GU6571999519

Site Exposure Potential

Andersen Air Force Base, on Guam in the western Pacific, is about 6,000 km west of Hawaii and 2,500 km southeast of Japan (Figure 1). The base has operated since the 1940s and was used for military, logistical, and air support during the Korean and Vietnam wars. Today, it supports strategic air command operations. The main portion of the base occupies about 6,100 hectares on the northern portion of the 540-km^2 island and consists of the North Field, an operational airfield, and the Northwest Field, an inactive airfield. Andersen South and Harmon Annex are detached activities that occupy about 2,000 hectares south of the main portion of the base (Figure 1). There are 38 disposal sites within the main base and annex areas; 15 of these were addressed in the RI/FS because of the nature of contamination or potential for contaminant migration. Table 1 provides background information and summarizes disposal activities for each of these 15 sites. Materials disposed of include waste fuels, cleaning compounds, construction debris, organic chemicals, pesticides, and fertilizers (SAIC 1990; U.S. EPA 1991).

The topography of Northern Guam consists of a marine limestone plateau 90 to 180 m above sea level that overlies the volcanic island core. Sinkholes from 1 to 20 m deep, closed depressions,

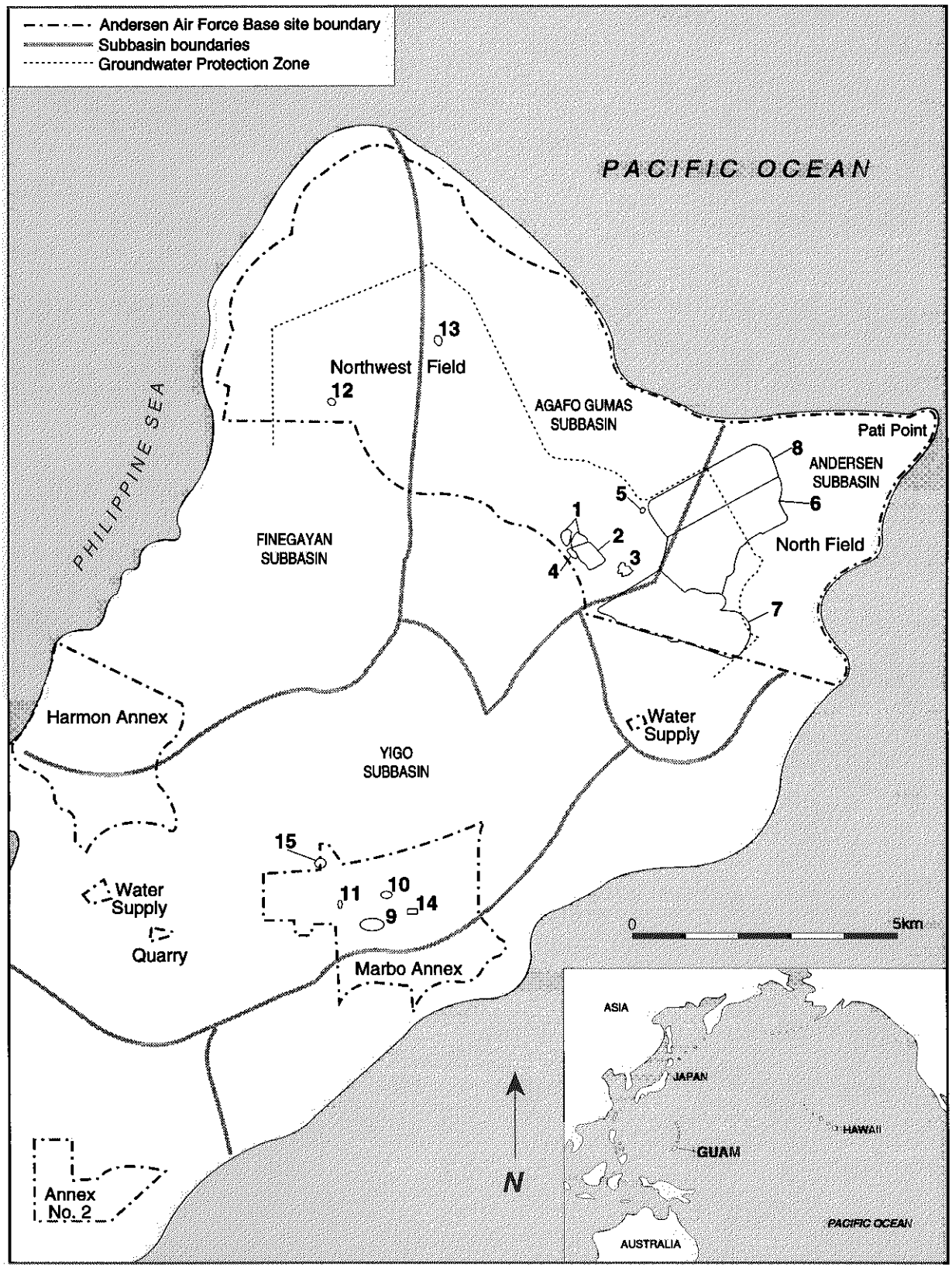

Figure 1. Andersen Air Force Base and sites 1 through 15 in the northern portion of Guam (SAIC 1990).

Table 1. Activities with potential contamination or contaminant migration and their associated wastes at the Andersen Air Force Base (SAIC 1990).

Activity	Size (ha.)	Types of Wastes	Hydrologic Subbasin	Disposal Methods
1 Landfill 1945-Present	8	Sanitary trash, waste POL, waste chemicals	Agafo Gumus	Area/pit fill
2 Landfill 1947-1974	16	Sanitary trash, waste POL, waste chemicals, waste solvents, pesticides, scrap metal, construction debris, UXO[2]	Agafo Gumus	Trench fill with burning
3 Waste Pile 1947-1977	3	Chemical/industrial wastes, sanitary trash, waste POL, pesticides, scrap metal, construction debris	Agafo Gumus	Area fill
4 Waste Pile	NA	Asphalt tar	Agafo Gumus	Drum disposal area; drums rusted, leaking
5 Fire Training Area 1958-1988	NA	Waste fuels, oils, and solvents	Agafo Gumus	Contaminated fuels burned during training exercises in unlined berm area
6 Stormwater Drainage System 1940s-Present	NA	Runoff from industrial shops may contain residue of sulfuric acid, ethylene glycol, aircraft-cleaning compound, alodine solution, chromic acid, paint stripper, detergent, boiler blowdown, pesticides, fertilizers	Andersen	Dry wells in natural low area to rapidly remove surface runoff; will collect surface contaminants from nearby areas
7 Stormwater Drainage System 1940s-Present	NA	Runoff from industrial shops containing residues of ethylene glycol, pesticides, fertilizers	Andersen	Dry wells in natural low area to rapidly remove surface runoff; will collect surface contaminants from nearby areas
8 Stormwater Drainage System 1940s-Present	NA	Runoff from industrial shops may contain residues of alodine solution, chromic acid, paint stripper, detergent, aircraft-cleaning compound, pesticides, fertilizers	Andersen Agafo Gumus	Dry wells in natural low area to rapidly remove surface runoff; will collect surface contaminants from nearby areas
9 Waste Pile 1945-1962	5	Sanitary trash, waste POL, solvents, scrap vehicles and equipment, construction debris, waste dry-cleaning fluids	Yigo	Area fill
10 Waste Pile	2	Construction debris	Yigo	Area fill
11 Waste Pile	0.8	Construction debris, auto bodies	Yigo	Area fill, trench fill
12 Chemical Disposal 1952-1956	NA	Sanitary trash, waste oils, solvents	Finegayan	Area fill
13 Landfill 1966	0.8	Sanitary trash, construction debris	Agafo Gumus	Trench
14 Former Marbo Laundry Facility	NA	Halogenated hydrocarbons	Yigo	NA
15 Borrow Pit	2	organic chemicals	Yigo	NA

NA: Not available.

and solution caverns are the primary features of the terrain. Due to the highly porous limestone and extremely permeable soils, there is no surface water on the site, which is bordered by the Pacific Ocean. The Northern Guam lens aquifer underlying the base supplies drinking water to at least 50 percent of the population and is recharged by rainwater. Depth to water in the 150- to 240-m freshwater lens varies with sea level changes, tidal fluctuations, and seasonal fluctuations. Because of the aquifer's importance to the surrounding population, EPA designated a groundwater protection zone in 1986 to preserve and protect resources. Over half of the base lies in this protection zone (SAIC 1990; U.S. EPA 1991).

The Pacific Ocean is downgradient and near hazardous substance sources on the base. Groundwater is the only pathway for contaminant migration off-site near the base. The karst features provide quarry locations and dump sites for refuse by the base. There are several disposal areas within 300 m of the intertidal zone (U.S. EPA 1991). Given the topography, it is likely that groundwater discharges to the ocean. Areas of concern at the base overlie four of the six groundwater subbasins on Guam. The Finegayan, Agafo Gumus, Andersen, and Yigo subbasins are separated by hydrologic divides. Contaminants associated with groundwater are not expected to cross subbasin boundaries. The Air Force Installation Restoration Program indicated that groundwater flow in the four subbasins is as follows: west towards the Pacific Ocean in the Finagayan Subbasin, north towards the Pacific Ocean in the Agafo Gumus Subbasin, north and northeast towards the Pacific Ocean in the Andersen Subbasin, and south-southwest towards the Pacific Ocean in the Yigo Subbasin (SAIC 1990).

NOAA Trust Habitats and Species

Habitats of concern to NOAA include surface water, bottom substrates, and fringe reef habitats associated with approximately 29 km of coastline on the northern end of Guam. The majority of the coastline is bordered by fringing reef. Seaward portions of reef flats typically consist of well-developed algal (*Porolithon*) ridges intersected and undercut by numerous surge channels. There are lagoons measuring up to 1 m deep at mean low tide between the reefs and the beaches. Much of the habitat within the lagoons is a sandy substrate that supports extensive stands of seagrasses (*Halodule uninnervis*) and functions to consolidate bottom sediments. Portions of the lagoons have no seagrasses and commonly contain various corals and thin areas of sand. Outside of the fringe reefs, bottom substrates are typically hard-bottomed, consolidated limestone with scattered staghorn (*Acropora*) and coral (*Pocillopora*) populations. The outer reef slope of Guam drops off steeply (DAF 1992).

As many as 841 fish species have been recorded in the marine habitat surrounding Guam. Near the site, reef habitats support diverse, abundant populations of NOAA trust resources (Table 2).

The majority of these species are resident to the reef habitat and occur during sensitive live stages. Fish fauna include a variety of trophic types, including herbivores, omnivores, carnivores, and some planktivores. Species commonly occurring near the site include squirrelfish, grouper, jack, snapper, emperor, sweetlip, goatfish, rudderfish, wrasse, parrotfish, surgeonfish, and rabbitfish (DAF 1992). Surface water surrounding the northern side of the island near the site is an important source area for reseeding Guam's central and southern reefs with larvae and juveniles of fish and invertebrates (DAF 1992; Davis personal communication 1992).

The federally threatened green sea turtle (*Chelonia mydas*) actively nests along the beaches surrounding the site. Although the Hawksbill sea turtle (*Erectmocheyls imbricata*), a federally endangered species, is also thought to nest on these beaches, this behavior is undocumented (DAF 1992; Davis personal communication 1992).

There are no known commercial and recreational fisheries close to the base, although commercial trolling fisheries are a major economic source for Guam. Five species comprise the usual catch: wahoo, skipjack tuna, mahi mahi, yellowfin tuna, and blue marlin. About 225,000 metric tons of fish were harvested between October 1985 and September 1986. In 1987, the economic value of fish species harvested from both offshore and onshore fisheries exceeded $1.6 million (U.S. EPA 1991). The base has recently proposed that approximately 5.5 km of coastline around Pati Point be designated as a protected Marine Resources Preserve (DAF 1992).

Table 2. Selected NOAA trust fish and invertebrates that use the reef habitat near Andersen Air Force Base, Guam (DAF 1992).

Species		Habitat Use		Fisheries	
Common Name	Scientific Name	Nursery Ground	Adult Forage	Comm. Fishery	Recr. Fishery
Surgeonfish	*Acanthurids*	♦	♦	♦	♦
Cardinalfish	*Apagonids*	♦	♦		
Triggerfish	*Balistids*	♦	♦		
Blenny	*Blennies*	♦	♦		
Jack	*Carangids*	♦	♦	♦	♦
Butterflyfish	*Chaetodontids*	♦	♦		
Goby	*Gobiids*	♦	♦		
Sweetlips	*Haemulids*	♦	♦	♦	♦
Squirrelfish	*Holocentrids*	♦	♦	♦	♦
Rudderfish	*Kyphosids*	♦	♦	♦	♦
Wrasse	*Labrids*	♦	♦	♦	♦
Emperor	*Lethrinids*	♦	♦	♦	♦
Snapper	*Lutjanids*	♦	♦	♦	♦
Filefish	*Monacanthids*	♦	♦		
Goatfish	*Mullids*	♦	♦	♦	♦
Angelfish	*Pomacanthids*	♦	♦		
Damselfish	*Pomacentrids*	♦	♦		
Parrotfish	*Scaridae* spp.	♦	♦	♦	♦
Grouper	*Serranids*	♦	♦	♦	♦
Rabbitfish	*Siganids*	♦	♦	♦	♦
Puffer	*Tetradontids*	♦	♦		

Site-Related Contamination

Trace elements and pesticides are the contaminants of primary concern to NOAA. Data collected during preliminary site investigations indicate that soils and groundwater contain elevated concentrations of contaminants at many of the 15 waste sites sampled at the base (SAIC 1990). The maximum concentrations of trace elements detected in soils and groundwater and their respective screening criteria are presented in Table 3 (Lindsay 1979; U.S. EPA 1991).

Soil samples from all six sites in the Agafo Gumus subbasin were contaminated with trace elements. Maximum concentrations of arsenic, cadmium, chromium, copper, lead, nickel, silver, and lead were above the average U.S. soil concentrations for these elements. Groundwater samples from the Agafo Gumus subbasin contained concentrations of cadmium, chromium, copper, silver, and zinc that exceeded marine AWQC by at least a factor of ten. Groundwater from Site 5, the fire training area, contained dieldrin (0.13 µg/l) at a concentration that exceeded the screening guideline (0.019 µg/l) by an order of magnitude. DDT was detected in one groundwater sample (0.14 µg/l) at a concentration exceeding its AWQC (0.001 µg/l). However, DDT was not detected in a duplicate sample collected from the same well, and it was concluded that the detection was a false positive.

Soil samples were not collected from the Andersen subbasin. The sites of concern are three stormwater drainage wells that receive runoff from 15 different shops in the area. Groundwater samples were collected from both installed and pre-existing wells at these sites. Nickel and silver concentrations exceeded AWQC for these elements by more than ten times. High concentrations of dieldrin (0.12 µg/l) were detected in samples collected from two different wells.

There were high concentrations of arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc in soils at most of the five sites in the Yigo subbasin, with maximum concentrations of these trace elements exceeding their respective screening criteria by several orders of magnitude. Two soil samples from Site 14, the former laundry facility, contained semi-quantified concentrations of PCBs (20 and 50 mg/kg, respectively). These results are considered semi-quantified because they were detected while performing a test for semi-volatile organics that is not specifically calibrated for PCBs. Groundwater samples collected from the Yigo subbasin contained concentrations of lead, nickel, and zinc that exceeded their respective marine AWQC. DDT and DDD were detected in groundwater samples collected north of Site 11 at concentrations of 1.3 µg/l and 0.23 µg/l, respectively, well above the marine AWQC for DDT of 0.001 µg/l.

The chemical disposal site in the Finegayan subbasin, Site 12, contained concentrations of trace elements in the soils that exceeded the screening criteria for all of the elements listed in Table 3. Groundwater samples were not collected directly at the disposal site but from areal wells

within the subbasin. Concentrations of copper, lead, nickel, and zinc in groundwater samples exceeded their respective marine AWQC.

Summary

The base is surrounded by fringing coral reef systems that support a rich, diverse flora and fauna. Coral polyps depend on sunlight and can only grow in nearshore, relatively shallow waters. Additionally, federally threatened green sea turtles nest along beaches surrounding the base. Groundwater at the base is contaminated with trace metals, PCBs, and pesticides. The karst, limestone geology of the region provides a rapid groundwater pathway for contaminant transfer to the coast. These persistent contaminants may enter the nearshore coastal zone, which is the only area delicate coral reef ecosystems can grow and develop, and threaten sensitive life stages of reef inhabitants. The reefs surrounding Andersen are also vital because they are a source of larvae

Table 3. Maximum concentrations of trace elements in soil and groundwater at the site.

Soil (mg/kg)	Agafo Gumus Subbasin	Andersen Subasin	Yigo Subbasin	Finegayan Subbasin	Average U.S. Soil[1]
Trace Elements					
Arsenic	31	NT	50	44	5
Cadmium	17	NT	93	26	0.06
Chromium	1,200	NT	750	210	100
Copper	2,700	NT	2,300	21,000	30
Lead	1,000	NT	15,700	4,300	10
Nickel	100	NT	230	84	40
Silver	74	NT	1.6	55	0.05
Zinc	1,400	NT	10,000	22,000	50
Groundwater (µg/l)					AWQC[2] (µg/l)
Trace Elements					
Arsenic	ND	2	NT	2	36
Cadmium	330	NT	NT	NT	9.3
Chromium	4,500	NT	NT	40	50
Copper	120	20	NT	120	2.9
Lead	77	22	70	45	8.5
Nickel	ND	150	200	70	8.3
Silver	20	20	NT	NT	0.92
Zinc	3,100	160	130	160	86

1: Lindsay (1979)
2: Ambient water quality criteria for the protection of aquatic organisms. Marine chronic criteria presented (U.S. EPA 1986).
ND: Not detected.
NA: Not available.
NT: Not tested.

and juveniles for propagating and reseeding Guam's central and southern reefs.

References

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