FINAL ENVIRONMENTAL ASSESSMENT FOR INSTALLATION OF TRANSMITTER AND RECEIVING ANTENNAS FOR THE DIPLOMATIC TELECOMMUNICATIONS SERVICE REGIONAL RELAY FACILITY, GUAM, MARIANA ISLANDS

Prepared for:

U.S. Department of State
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Coordinating Agency:

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CHAPTER 1

SUMMARY AND INTRODUCTION

1.1 IDENTIFICATION OF DOCUMENT

This document is an Environmental Assessment for an administrative action.

1.2 TITLE OF ACTION

Installation of Transmission and Receiving Antennas for the Diplomatic Telecommunications Service (DTS) Regional Relay Facility (RRF) Guam, Mariana Islands

1.3 DESCRIPTION OF ACTION

Installation of 26 transmission antennas and 11 receiving antennas are proposed by the Department of State's Bureau of Diplomatic Security and Information Management for the establishment of a Diplomatic Telecommunications Service Regional Relay Facility in Guam. The facility will provide high frequency radio communications with embassies and consulates in the East Asian area and relays of messages to Washington, D.C. The receiving antennas will be located at the Naval Communications Area Master Station (NAVCAMS) Finegayan. The transmitting antennas will be located at the Navy's Radio Transmitting Facility (RTF) Barrigada. Existing and former antenna fields will be utilized at both sites.

1.4 SUMMARY OF ADVERSE IMPACTS AND MITIGATION ACTIONS

- Electromagnetic impacts on the use of medical equipment upon deployment at the Naval Fleet Hospital Storage Facility. Mitigative measures: Portions of the area to the east of the storage facility (currently identified as Galley/Mess and Public Works) must be restricted from the use of electromagnetically sensitive medical equipment. The State Department must monitor transmissions to ensure that no signals above 2 Volts/meter (V/m) exist in medical treatment areas.

- Impacts on ordnance highly susceptible to ignition by electromagnetic radiation (HERO UNSAFE) on the public roads north and west of the site. Mitigative measures: As military ordnance will continue, per existing Navy policy, to be transported only under HERO SAFE conditions, no further mitigation measures are necessary. There will be no hazard to any ordnance or explosive device properly transported under military or U.S. Department of Transportation guidelines. Administrative procedures will need to be put in place to ensure safety when handling HERO UNSAFE ordnance on the eastern portion of Naval Air Station Agana. In order to establish operating procedures, a comprehensive HERO Survey, updating the 1982 Survey, will be performed prior to installation of the new antennas, encompassing all radio frequency emitters and affected ordnance handling operations in the vicinity of NAS Agana. Upon installation of the State Department antennas and transmitters, additional field strength measurements will be taken to verify the actual conditions. A hard-wired "hot-line" will be established from NAS Agana to the transmitter control room to provide a 15-minute minimum

response to allow for a power reduction should an in-flight emergency landing situation involving aircraft with improperly configured HERO UNSAFE ordnance (hung ordnance) occur.

- Transmitter antenna heights would intrude above the inner horizontal surface at Naval Air Station (NAS) Agana. However, the proximity of Mount Barrigada, which intrudes the surface to a greater extent, to both the runways and the antenna sites is such that the antennas should pose no additional impacts or hazards to fixed-wing air traffic navigation. However, impacts to rotary-wing operations could occur. A waiver has been filed and approved by the Naval Air Systems Command and the Federal Aviation Administration. Mitigative measures: Antennas must be marked in accordance to regulations governing possible obstructions to navigation. Hazard lighting will be installed on Antennas 1, 4, 5, 9, 13, 16, and 18 (see Figure 3.4).

- The beams from some of the antennas would intersect NAS Agana's flight tracks. Field strengths at the flight tracks would range from 20-47 V/m. Mitigative measures: An initial determination of the impacts to aircraft electronic equipment and any explosive devices contained or transported on board has been made by the appropriate Navy authorities in Dahlgren, Virginia. The impacts to ordnance transport and handling identified by this study will be mitigated by Navy administrative actions, and will be published in the appropriate navigational manuals used for the naval air station.

- Possible minor impacts during construction; no mitigation actions required.

- Electrical interference would be caused by a metal fence surrounding land within RTF Barrigada ceded to the Government of Guam for use as a storm runoff collector. This fence must be replaced with one constructed from a non-conductive material, preferably plastic. This will be done in coordination with the Guam Department of Public Works and will be funded through the project.

1.5 SUMMARY OF ALTERNATIVES CONSIDERED

- No action
- Sites in the Continental United States
- Sites in Hawaii or Alaska
- Sites in the U.S. Trust Territory, Mariana Islands, Federated States of Micronesia
- Sites in Japan/other foreign territories
- Sites in Guam
- Exclusive satellite use

1.6 SIGNIFICANCE OF IMPACTS

The proposed action would not have any significant environmental or electromagnetic effects on personnel outside the perimeters of the RTF Barrigada Transmitter Site. Field strengths at the public roads would exceed criteria established for HERO UNSAFE. As per existing Navy policy, the transport of explosives sensitive to detonation through electromagnetic signals occurs only in a HERO SAFE configuration. Hence, no additional mitigation measures are necessary. Explosives properly configured for transportation under military or U.S. Department of Transportation guidelines would not be impacted by emissions. The Electromagnetic interference criteria for medical equipment would be exceeded over some portions of the tarmac to the east of

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GLOSSARY

AFB	Air Force Base
AGL	Above Ground Level
AICUZ	Air Installation Compatible Use Zone
ANSI	American National Standards Institute
AUW	Advanced Underwater Weapons
DoD	Department of Defense
DTS	Diplomatic Telecommunications Service
DRMO	Defense Reutilization and Marketing Office
ECP	Erosion Control Plan
EED	Electro-explosive devices
EMC/EMI	Electromagnetic Compatibility/Interference
EMR	Electromagnetic radiation
EPS	Emergency power supply
FAA	Federal Aviation Administration
GCMP	Guam Coastal Management Program
GEPA	Guam Environmental Protection Agency
GHz	Gigahertz
HERF	Hazards of Electromagnetic Radiation to Fuel
HERO	Hazards of Electromagnetic Radiation to Ordnance
HERP	Hazards of Electromagnetic Radiation to Personnel
HF	High Frequency

IWPS	Island-Wide Power System
KHz	Kilohertz
KV	Kilovolt
KW	Kilowatt
MHz	Megahertz
MSL	Mean sea level
NAS	Naval Air Station
NAVCAMS	Naval Communications Area Master Station
NAVSTA	Naval Station
NAVFACINST	Navy Facility Instruction
NEPA	National Environmental Policy Act
NSWC	Naval Surface Warfare Center
OPNAVINST	Operational Navy Instructions
PEL	Permissible exposure limit
PWC	Public Works Center
RF	Radio frequency
RFR	Radio frequency radiation
RLPA	Rotatable, log periodic antennas
RRF	Regional Relay Facility
RTF	Radio Transmitting Facility
SAR	Specific absorption rate
T-site	Transmitter site
TSP	Total suspended particulates
USDOT	U.S. Department of Transportation
V/m	Volts per meter
WESTPAC	Western Pacific
W/kg	Watts per kilogram

the Fleet Hospital Storage Facility, designated for use as Galley/Mess and Public Works, during periods of deployment . Careful coordination with the command having cognizance for that facility has ensured that no sensitive medical equipment would be deployed in those areas exceeding the EMI criteria. Due to the design of the project, no electromagnetic interference with consumer products would occur at the closest housing complexes located near Mt. Barrigada. A comprehensive HERO survey, updating the 1982 survey, will be performed prior to installation of the new antennas, encompassing all radio frequency emitters and affected ordnance handling operations in the vicinity of NAS Agana, in order to establish operating procedures. Upon installation of the State Department antennas and transmitters, additional field strength measurements will be taken to verify the actual conditions.

1.7 LIST OF AGENCIES CONTACTED

Federal

- U.S. Department of State
- U.S. Federal Aviation Administration
- U.S. Navy
  - Naval Electronic Systems Engineering Center
  - Naval Facilities Engineering Command, Pacific Division
  - Naval Communications Area Master Station
  - Naval Air Station Agana
  - Commander of the Navy for the Marianas (COMNAVMAR)
- U.S. Coast Guard, LORAN Transmitting Station
- U.S. Air Force
  - 27th Communications Squadron, Andersen AFB

Territory of Guam

- Department of Parks and Recreation
- Department of Agriculture, Division of Aquatic and Wildlife Resources
- Guam Environmental Protection Agency
- Department of Planning
- Guam Airport Authority
- Guam Power Authority

CHAPTER 2

PURPOSE AND NEED

2.1 BACKGROUND

The Department of State's Bureau of Diplomatic Security and Information Management is proposing to establish a DTS RRF in Guam. The RRF service currently provides high frequency radio and satellite communications support to U.S. embassies and consulates in the Pacific/East Asian area and relays messages to Washington via its Regional Relay Facility at Clark Air Base in the Philippines. The proposed new RRF will occur in conjunction with existing Navy communications facilities on Guam.

2.2 NEED FOR ACTION

The U.S. Department of State has decided to close the current RRF at Clark Air Base as soon as a suitable replacement facility can be established elsewhere. The need for the proposed action has been prompted by the following circumstances:

1. The State Department desires to reduce the size of its embassy staffs and to move regional activities to U.S. territory when and where possible;
2. The existing facilities in the Philippines are outdated and would require substantial upgrading to meet the current and projected demand for improved communications serves and to maintain the facility's compatibility with the remainder of the worldwide DTS network;
3. In accordance with applicable portions of Executive Order 12856 dated November 18, 1988 and National Security Decision Directive number 97, the U.S. State Department has determined that, where possible, critical DTS facilities should be located on U.S. soil in order to avoid foreign control and intervention in their operation during national security emergencies. Recent events in Monrovia, Liberia, which resulted in the loss of the DTS facilities due to the internal strife and civil war in that country, illustrate the vulnerability of locating sensitive diplomatic services on foreign soil. And,
4. Negotiations between the U.S. Government and the Government of the Philippines are currently underway to decide the future tenability of U.S. bases located in the Philippines. The increasing threat to the safety of U.S. personnel and their families assigned to the Philippines, including the area around Clark Air Base, has prompted the U.S. Department of State to declare the Philippines a "dangerous" post, qualifying employees assigned there for "danger pay."

The move of the RRF is made possible due to advances in technology, cost factors, and changes in communication systems which will allow for greater staff efficiency and increased technical capacity. These improved systems will allow shifting some of the workload from the current Philippines site to U.S. sites which will enable radio communications over greater distances. The use of High Frequency (HF) transmitters also will allow for adequate back-up to existing satellite transmissions, and will allow for primary transmission capabilities to those areas currently unable to be serviced by existing satellites.

The criteria used to evaluate various siting alternatives are listed in Section 3.1.

CHAPTER 3

ALTERNATIVES

3.1 INTRODUCTION

Detailed descriptions of the proposed action and reasonable alternatives are presented here. Some of the alternatives that were considered include no-action, siting the facility at another location, and using available satellite technology exclusively. When evaluating various siting alternatives for the new facilities, the following criteria were used:

1. The regional topography must allow the facility to transmit and receive without surface obstructions to existing Department of State stations. The facility must be able to communicate with existing satellites.

2. The facility must have the ability to support U.S. facilities located in the Far East and Pacific regions, with capabilities to reach points west of India.

3. The facility must be located on U.S. territory to minimize foreign control and intervention.

4. The facility must be located near suitable support facilities, such as housing and schools, for both stationed personnel and their dependents.

5. There must be adequate space available to site the facility, approximately 200 acres for a receiving site and 300 acres for a transmitting site, separated by a minimum of four to five miles, and as close to 15 miles as possible.

3.2 DESCRIPTION OF THE PROPOSED ACTION

3.2.1 General Site Description

Figures 3.1, 3.2, and 3.3 show the locations of the project and the property boundaries for NAVCAMS Finegayan and RTF Barrigada. NAVCAMS Finegayan is characterized by a cleared and mowed meadow containing existing receiver antenna arrays on gently sloping terrain. The western edge of the site is bounded by the Haputo Cliffs, while the northern, southern, and eastern edges of the site are contained within the NAVCAMS Finegayan base. The RTF Barrigada site consists of slightly more rugged terrain than does the site at NAVCAMS Finegayan, and is covered with opportunistic shrubs, grasses, and weeds. The site was once an active transmitter field which was dismantled circa 1975. The RTF Barrigada site is bordered to the east by degraded limestone forest and to the west by a Naval Hospital Storage Facility and by Guam Route 16. The northern edge of the site is bordered by Mount Barrigada and the southern border is contained within the RTF Barrigada base.

3.2.2 Transmitter Site, RTF Barrigada

The new RRF transmitter site is to be located in Building No. 51 at the RTF Barrigada Facility. This building is currently being used as a warehouse facility. Materials stored within Building 51 will be moved out prior to it being reconfigured as the new RRF transmitter site (T-

Site). The Navy will be responsible for the design, site preparation, and installation associated with the project.

The proposed transmitter site layout is shown in Figure 3.4. Twenty-six (26) antennas are to be installed and are numbered in the figure. A list and description of these antennas can be found in Table 3.1. These antennas will rest upon reinforced concrete pads. The antennas will be located in such a manner as to minimize the need for grading. In general, antenna heights will range between 120 feet to 210 feet and operate within the 3 MHz to 30 MHz range. Connections from Building 51 to the antennas will be through buried cable.

An approximately 2,000-square-foot generator building will be constructed adjacent to Building 51 to house two 750 KW Detroit Diesel emergency generators. The building site is currently part of the paved parking area. Construction of a 5,100-square-foot replacement warehouse in the vicinity of Building 51 is also proposed.

Table 3.1
Listing and Description of Transmitting Antennas
RTF Barrigada

Antenna	Number on Figure 3.4	Description
TCI527E-3-04 HLP	1, 5 to 13, 15, and 16	double curtain, clamped mode log periodic antennas
TCI524E-6-04 HLP	2 to 4 and 14	single curtain, clamped mode log periodic antennas
TCI527B-8-04 HLP	17 and 18	double curtain, log periodic antennas
Granger 3001-3L-4 Spira-cone	19,20, and 22	omni-directional gain antennas
TCI540-1-09	21	horizontally polarized, omni-directional, log periodic antenna
Hy-Gain LP-1002	23 and 24	rotatable, log periodic antennas (RLPA)
Granger 3004-70F-31	25 and 26	Spira-cone, omni-directional gain antennas

3.2.3 Receiver Site, NAVCAMS Finegayan

The new RRF receiver site will be located in a portion of the basement in Building No. 150 at the NAVCAMS Finegayan Facility and in the adjoining existing antenna field. The building is currently used as a receiving station. All Naval and Coast Guard functions will be moved out of this basement prior to it being reconfigured. The Navy will be responsible for the design, site preparation, and installation associated with the project.

The proposed Receiver Site layout is shown in Figure 3.5. Eleven (11) antennas are to be installed and are numbered in the figure. These antennas will rest upon reinforced concrete pads. The antennas will be located in such a manner as to minimize the need for grading. In general, antenna heights will range between 100 to 210 feet and operate within the 3 MHz to 30 MHz range. Two antenna will be housed in radome structures with radii of 15 feet and 30 feet. Connections from Building 150 to the antennas will be through buried cable. Antenna proposed for NAVCAMS Finegayan include:

- four (4) TCI 524-6-02 HLP log periodic antennas;
- one (1) TCI527E-3-02 HLP log periodic antenna;
- one (1) Hy-Gain 5002 RLP rotatable, log periodic antenna;
- one (1) CSA Loop Array TBD omni-directional antenna;
- one (1) Dipole TBD antenna; one (1) TVRO antenna;
- one (1) SC-7 antenna; and
- one (1) 3001-3L-31 spiral omni-directional antenna

An approximately 500-square-foot generator building will be constructed adjacent to Building 150. This building will house a 250 KW Detroit Diesel emergency generator. The ground upon which this generator building is to be constructed is currently part of the paved parking area.

3.3 THE NO-ACTION ALTERNATIVE

This alternative would require continuing the use of the outdated DTS facilities at at Clark Air Base in the Philippines. No antenna facilities would be constructed at either Finegayan or Barrigada.

Under this alternative, the U.S. Department of State would have to continue staffing at current levels and would need to expend additional "dangerous pay" funds to support those personnel in the Philippines. This alternative would require those personnel and their dependents to continue working in an environment which is becoming increasingly more hazardous to their safety. If the ongoing U.S. base negotiations result in a closure of Clark Air Base, the DTS facility would be more susceptible to foreign control or intervention, if the continued operation of the facility is permitted at all. The Department of State would also incur additional security costs if U.S. military security were withdrawn from the facility. Long term planning would require an additional outlay of capital to upgrade the current facility to meet current and projected demand for communications services and to maintain network compatibility.

Although this alternative does meet some of the selection criteria, it does not address the question of foreign control as stated in Executive Order 12656 and National Security Decision Directive, number 97. In fact, under this alternative, the DTS facilities would remain subject to control by a foreign government, thus adding extra security risks and hazards to continued operation. This alternative also would not meet the policy objectives of the Department of State to decrease the size of its overseas embassy staffs, nor would it help the Department of State to meet the ever increasing demand upon the existing diplomatic transmitting facilities.

Economically, this alternative appears least costly in the very short term. However, the threat to the safety of personnel, the substantial economic investment required to upgrade the facility, and the operational risk associated with a possible decision to draw down or close Clark Air Base, make the long-term cost/benefit ratio of this alternative less attractive. Also, the no-action alternative would not carry any additional economic benefits to the island of Guam.

3.4 ALTERNATIVE SITES

Several alternative sites for the facilities were considered. These included sites in the Continental United States, Hawaii and Alaska, the U.S. Trust Territory and Pacific Island Region,

and Japan. None of these sites adequately addressed all of the selection criteria. Exclusionary criteria were:

Continental U.S. -The transmission distance to be covered from the nearest point on the West Coast to the farthest posts in India is over 7,000 miles. Typically, high frequency radio transmitters bounce their signals between the ionosphere and the earth approximately every 1,500 miles. However, each bounce reduces the effectiveness and reliability of the signal. Standard distances for reliable service are generally considered to be from 3,000 to 4,000 miles, which would require two to three bounces. Above 4,000, the ability to guarantee reliable transmissions does not exist. Therefore, the physical limitations of distance removed the Continental U.S. from consideration.

Hawaii and Alaska - As with the Continental U.S., sites in these locations were also determined to be too far removed from the Far East region for effective transmission, as the number of bounces involved, coupled with the corresponding drop in power, would not guarantee transmission reliability. In addition, Alaska's proximity to the Magnetic North Pole produces problems as magnetic interference further reduces transmission reliability.

U.S. Trust Territory/Pacific Island Region, other Mariana Islands - The rugged topography of most Trust Territory islands does not allow for adequate beam visibility. High volcanic mountains and lack of flat terrain would block radio waves. The Trust Territory Islands are also hampered by the lack of necessary space to site such facilities. Approximately 200 acres are needed for a receiving site and 300 acres for a transmitting site, separated by a minimum of four to five miles, and as close to 15 miles as possible. Such amounts of undeveloped acreage are not present on the Trust Territory and other Pacific islands. In addition to this lack of sufficient available space for facilities, the lack of sufficient support services for personnel and dependents, such as adequate schools and housing, ruled out this alternative. Sites on Saipan and Tinian were also evaluated, but were also found to lack the necessary infrastructure and amenities, most notably schools, that the Department of State would have to provide for its personnel to meet its objectives of a desirable duty station. In addition to the lack of appropriate support infrastructure, sufficient space to locate the transmitting and receiving stations in the necessary configuration and separation is not available on other Northern Mariana islands.

Japan - Sites in Japan, or in other foreign countries, would not meet the criteria of limiting foreign control over U.S. facilities. In the interests of national security it is the objective of the Department of State to limit a foreign government's ability to compromise emergency capabilities.

Other Sites on Guam - Alternative sites on Guam included Northwest Field, other Air Force property, and privately held parcels. These alternatives were considered and not selected for various reasons; the most significant being the presence of significant critical habitat, the expense of private land procurement and the public opposition that would incur from condemnation of private land for government use, and operational shortcomings. Northwest Field, located at Andersen AFB, was not considered a viable alternative due to the environmental concerns surrounding the limestone forest critical habitat area. Public agency opposition from the Guam Department of Parks and Recreation, the Guam Department of Planning, and the Guam Department of Agriculture, Division of Aquatic and Wildlife Resources caused this site to be excluded from consideration due to the endangered species habitat. Further opposition to the disturbance of the forest habitat on the Northwest Field site would have been

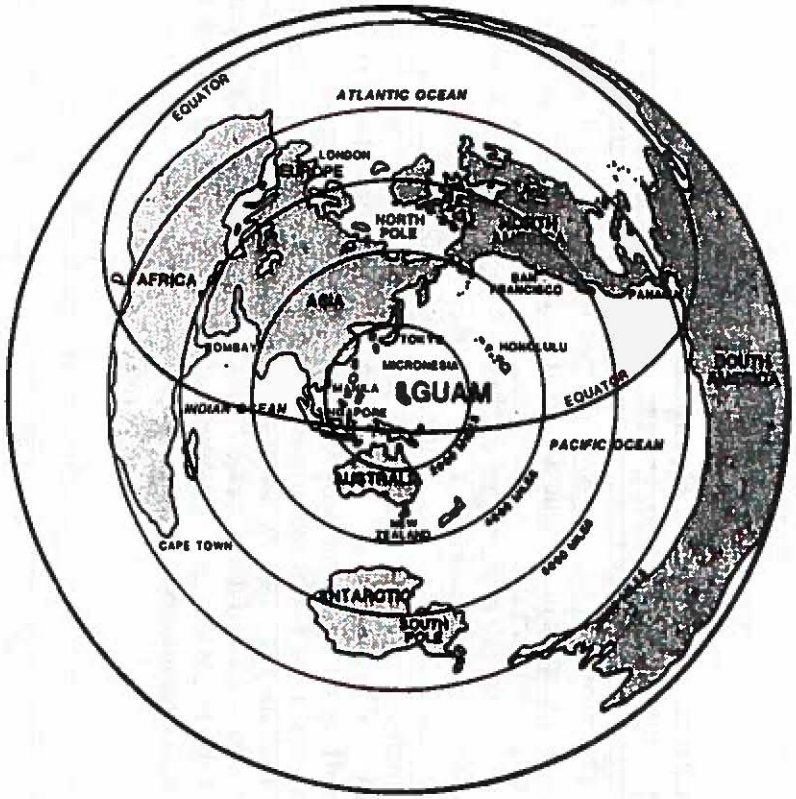
anticipated from environmental groups. In addition to the major environmental concerns that excluded this site, the distance from the receiving station at NAVCAMS Finegayan is less than the minimum required separation for the transmitting and receiving facilities. One further alternative examined was to place the receiving antennas at RTF Barrigada and the transmitting antennas at NAVCAMS Finegayan. However, this was not feasible from an operational point of view, as NAVCAMS Finegayan is currently a receiving station, and RTF Barrigada is currently a transmitting station. Placing transmitting antennas in close proximity to the receiving antennas would have disrupted the ability of the receivers to function. In addition to the Navy receivers, other receiving antennas at the north end of the island operated by the Air Force and Coast Guard would have been adversely impacted. Therefore, the alternative to switch the current operations of the two facilities was rejected.

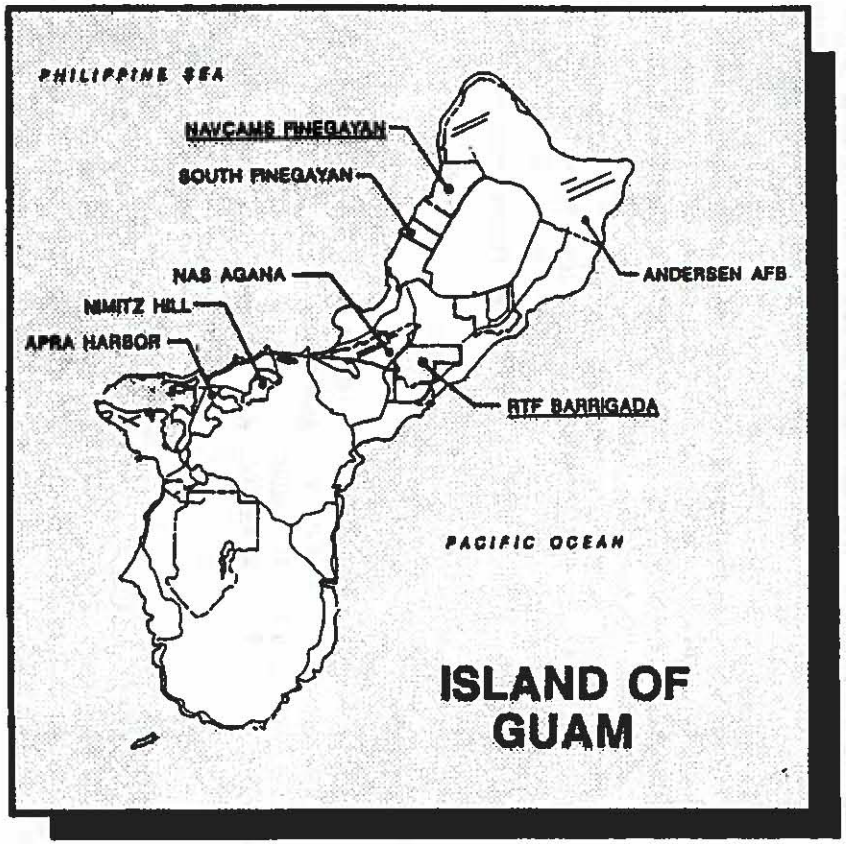
3.5 EXCLUSIVE SATELLITE USE

Under this alternative, the transmission and receiving of messages between Far East and Continental U.S. facilities would be handled exclusively by satellites. This alternative removes the constraints of topography on HF transmissions, the need for large land areas for the construction of antennas, and the need for dependent support facilities. However, exclusive reliance upon the satellite system would require more investment in satellites and satellite technologies. This alternative is deemed undesirable due to its removal of back-up capacities to existing satellites, which are subject to failure and not as easily defensible from destruction by outside forces. In addition, many areas of the Far East are outside of satellite transmission capabilities, either because of their geographic location, or because the ruling governments restrict the installation of satellite receiving or transmitting technology. Therefore, HF transmissions become the only viable alternative to reach diplomatic outposts in these regions.

3.6 SUMMARY

NAVCAMS Finegayan and RTF Barrigada on Guam are the only sites to meet the objectives of the Department of State and the criteria for selection. As existing U.S. facilities in a U.S. Territory, the sites do not contain the security threat of foreign control and are currently owned by the U.S. Government. The proposed project is consistent with existing uses of the selected sites by virtue of appearance, transmission frequency and output power. The project is essentially no different than existing communications facilities. The sites also provide the necessary 500 acres separated by approximately eight miles, well above the minimum separation criterion. The topography of Guam and its vicinity to the Far East region will facilitate communication with the target areas. Establishing a DTS facility on Guam will utilize new state-of-the-art systems and equipment which will allow the transfer of communications responsibilities from, and closure of, the DTS facility on Clark Air Base. The more modern equipment will be less manpower intensive, permitting a staffing reduction and consequent budgetary savings. Locating the facility on Guam will also provides a long-term solution to the need for a safe and secure working and living environment for both the DTS facility and its personnel and their families. This is consistent with the Department of State's objectives to locate critical communications systems on U.S. soil. Finally, Guam possesses the necessary infrastructure, schools, and available housing to meet the needs of both personnel and dependents.





NORTH

Figure 3.1
GUAM DTS
NOT TO SCALE

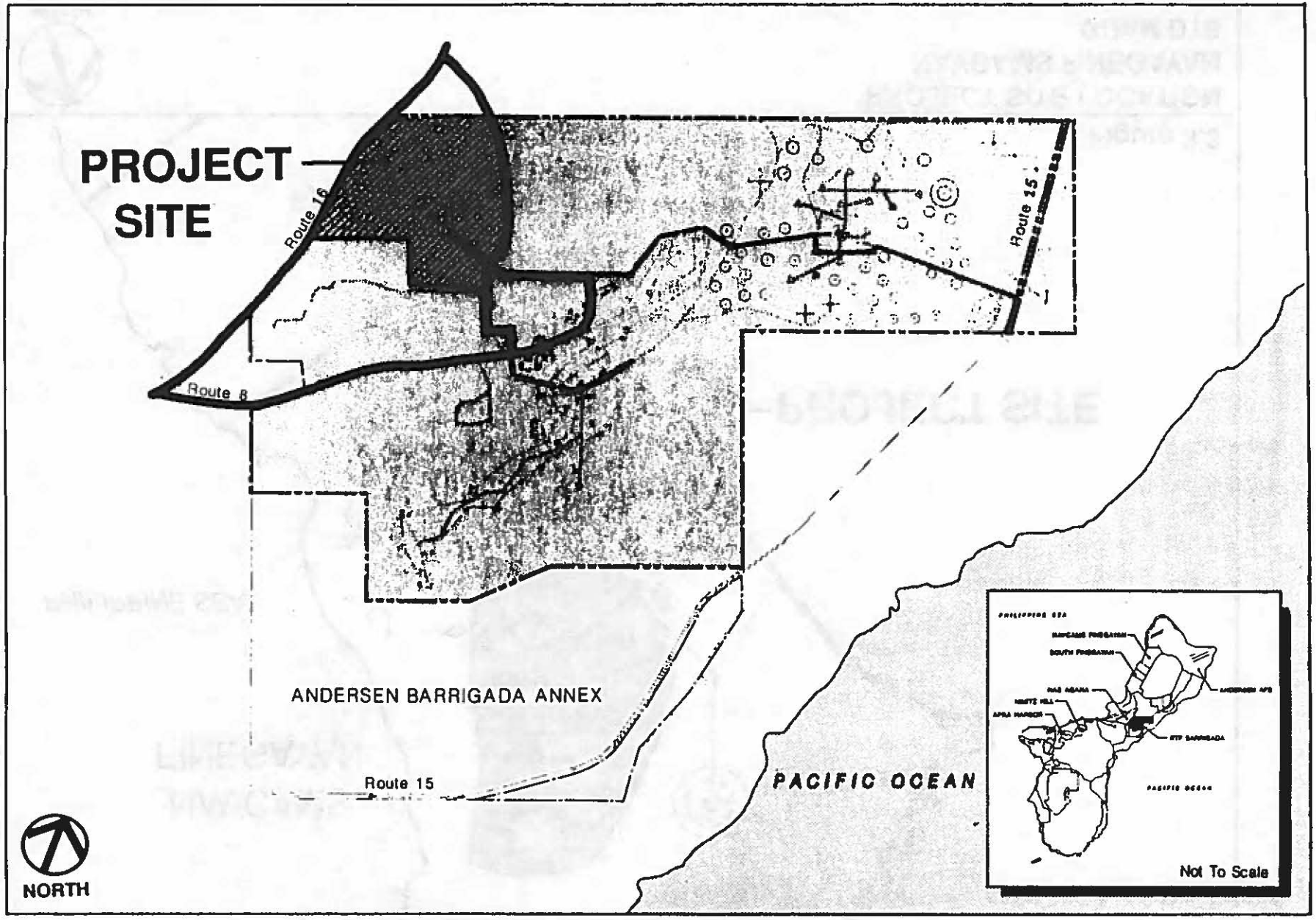


Figure 3.2
PROJECT SITE LOCATION
RTF BARRIGADA
GUAM DTS

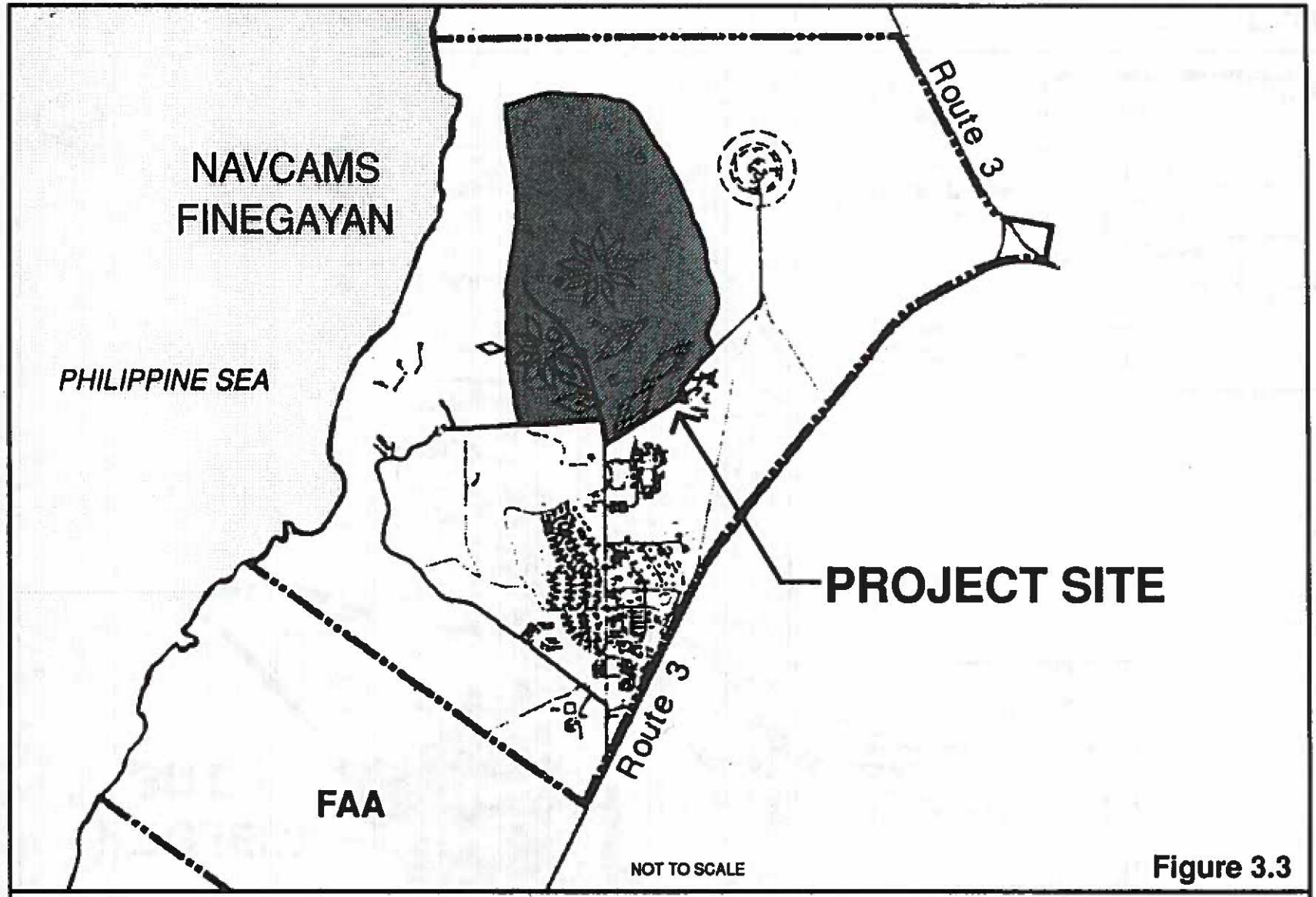


Figure 3.3

PROJECT SITE LOCATION
NAVCAMS FINEGAYAN
GUAM DTS

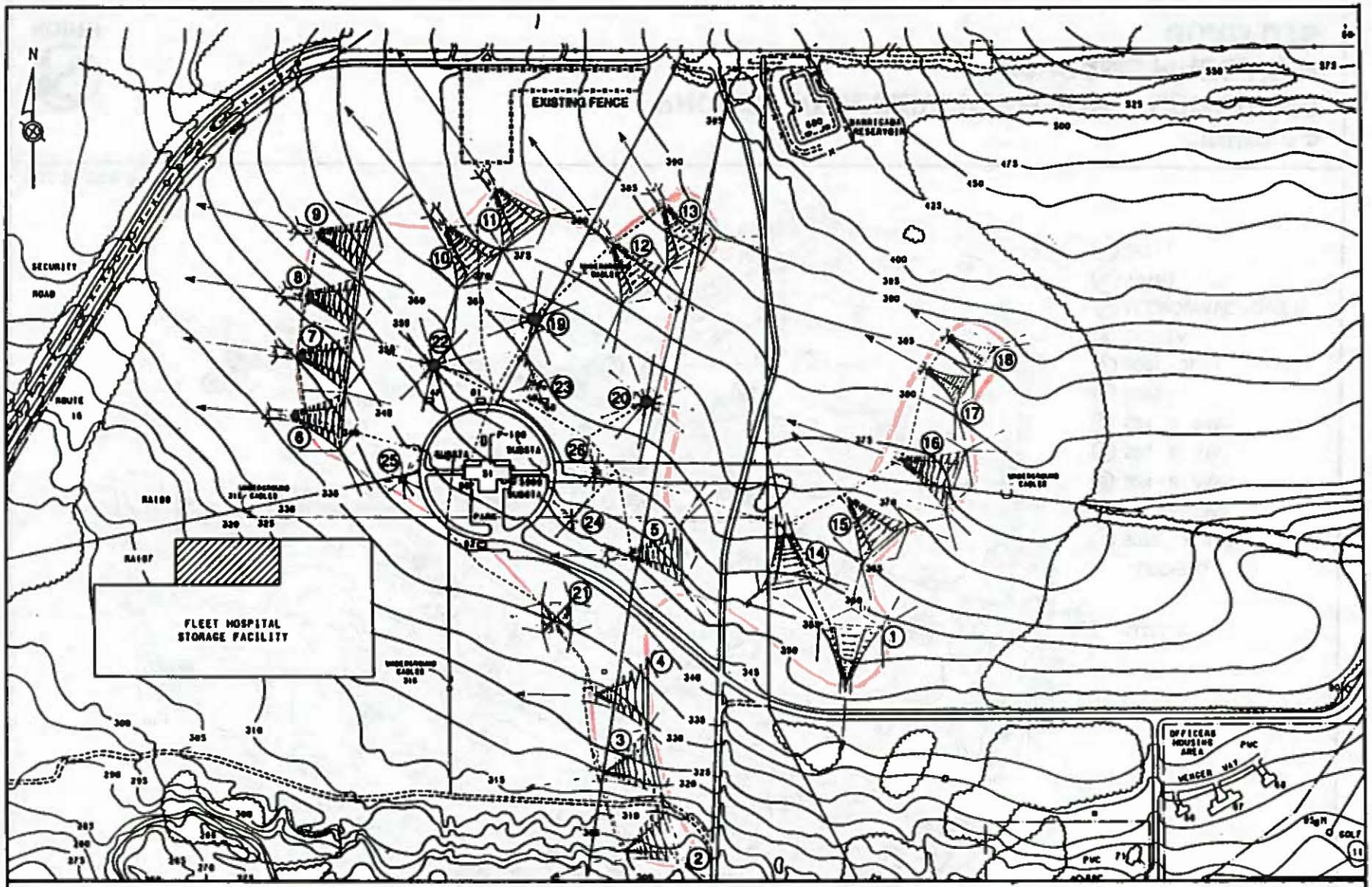


Figure 3.4

PROPOSED TRANSMITTING ANTENNA LOCATIONS
RTF BARRIGADA
GUAM DTS

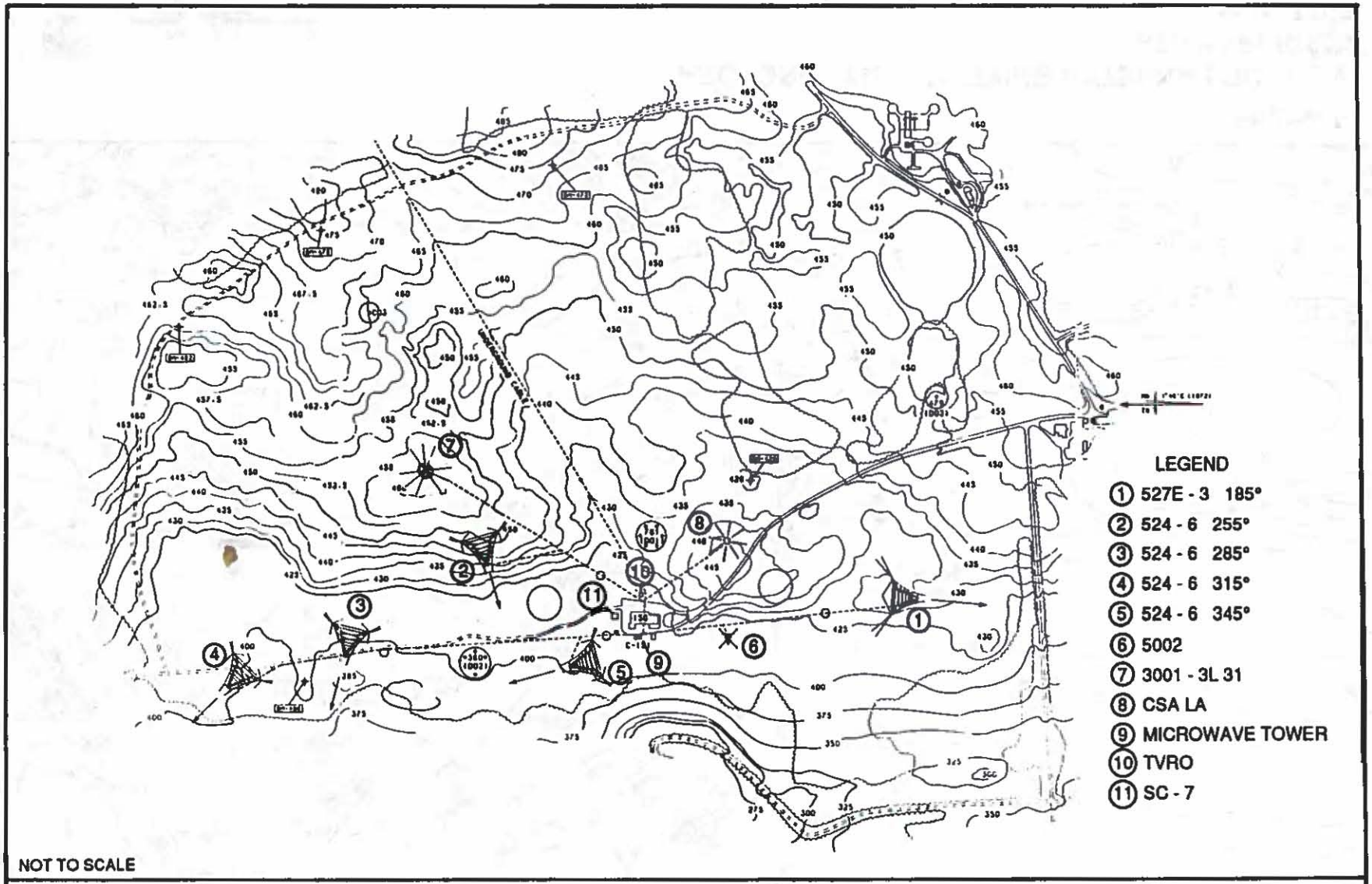


Figure 3.5
PROPOSED RECEIVING ANTENNA LOCATIONS
NAVCAMS FINEGAYAN
GUAM DTS

CHAPTER 4

EXISTING CONDITIONS

4.1 TOPOGRAPHY

Guam is the largest and southernmost of the Mariana Islands, a north-south chain of 15 islands located approximately 3,600 miles west of Hawaii and 1,400 miles south of Japan, at the boundary between the Pacific Ocean and the Philippine Sea. Guam is about 27 miles long and four to eight miles wide. The northern half of the island is a limestone plateau, 300 to 600 feet high with cliffs near the coast. It has alkaline soils with a substantial groundwater lens, but without perennial streams. The southern half of the island consists of hilly volcanic terrain with elevations up to 1,330 feet, acid volcanic soil, no groundwater lens, and numerous perennial streams. The central part of the island is a low-lying area less than 66 feet in elevation with a mixture of soil types.

NAVCAMS Finegayan is located on the northern limestone plateau of Guam. It is bordered to the west by a cliff which drops directly to sea level. Land within the boundary of Finegayan generally slopes north to south from an elevation of approximately 495 feet above mean sea level (MSL) at the northern end of the station, to approximately 355 feet above MSL at the southern boundary. The land within the station contains many surface irregularities, including numerous knobs, hills, and swales. Slopes for the study site are generally 0-5 percent with some slopes between 5-10 percent.

RTF Barrigada is located on the south-central portion of the northern plateau. Land on the station slopes from north to south. A portion of the northern boundary is on the slopes of Mount Barrigada at 600 feet above MSL. The remainder of the northern boundary ranges from approximately 375 to 460 feet above MSL. The southern boundary of the station is about 200 to 300 feet above MSL. Minor surface irregularities such as swales, knobs, knolls, and sinkholes are prevalent in areas which have not been graded.

4.2 GEOLOGY AND SOILS

The primary soil types at NAVCAMS Finegayan consist of "Guam cobbly clay loams" and "Guam-Urban land complex" located on rather level limestone plateaus. These are shallow, well drained soils well suited for grazing purposes, but poorly suited for commercial or subsistence farming or gardening. Their main limitations are their shallowness to bedrock.

The primary soil types at RTF Barrigada are "Pulantat clays" and "Pulantat-Kagman clays." These are shallow, well drained soils formed on limestone plateaus. Available water capacity is high. Therefore, these soils are especially well suited for commercial and subsistence farming or gardening.

The Pugua Fault, a major seismic fault, is located at NAVCAMS Finegayan. It extends from offshore at Urono Point through the cliff at Pugua, which is in the west-central part of the station, and ends in the Barrigada limestone plateau near Taguac, which is near the main entrance to the station.

4.3 CLIMATE

Because of Guam's low topography, variation in rainfall across the island is low. The east or windward coast of the island has a yearly average of 95 inches of rain, and the west coast has 80 inches. Afternoon temperatures are typically about 86 degrees F, and night time temperatures typically in the low 70s. Relative humidity ranges between 65 to 75 percent in the afternoon and 85 to 100 percent at night. Though temperature and humidity vary only slightly throughout the year, rainfall and wind conditions vary markedly.

There are two primary seasons and two secondary seasons on Guam. The primary seasons are the four-month-long dry season, from January through April, and the four-month-long wet season, from mid-July to mid-November. The secondary seasons separate the dry and wet seasons and are transitional in nature.

The dominant winds on Guam are the trade winds that blow from the east or northeast. The trade winds are strongest and most constant during the dry season, and windspeeds of 15 to 25 miles per hour are common.

4.4 HYDROLOGY AND WATER RESOURCES

Drainage systems at both Finegayan and Barrigada take advantage of the high soil porosity which is common to many limestone areas in northern and central Guam. By using sheet flow and unlined ditches to direct storm water to local area depressions, the water rapidly settles into the limestone below. Because of the high percolation rate and the ease of disposing of the water, flooding is not a major problem.

The aquifer lens in the northern part of the island is contained in thick sequences of porous limestone which were deposited on the submarine slopes of a volcanic mass. These massive formations are interlaced with pores and channels that easily transmit water from the surface into aquifers and finally into the ocean.

The northern lens consists of two basic types of aquifers: basal and parabasal. The Navy aquifers in Finegayan are of the basal type, in which fresh water floats on top of saline ocean water. Aquifers in Barrigada are parabasal types in which the fresh water overlies the volcanic formation.

Existing in the northwest sector of RTF Barrigada is a large sink hole which acts as a storm runoff collector (depicted on Fig. 3.4). The hole, and some land surrounding it, were ceded to the Government of Guam. Surrounding the area is a wire barrier fence, constructed to prevent people from falling accidently into the hole.

4.5 EXISTING LAND USE

4.5.1 NAVCAMS Finegayan

Land at NAVCAMS Finegayan is divided into two main functional areas that probably evolved from the need to protect radio receiving facilities from the encroachment of incompatible high-intensity development. The site is an active receiver area which occupies the northern part of the station and is generally used for antennas, radio receiving equipment buildings, satellite communication terminals, and other similar communication functions. The support area occupies the southern part of the station and is the administrative, personnel support, and operational center of the station.

NAVCAMS Finegayan is located in an area that is largely rural in character but is becoming increasingly urbanized as residential subdivisions continue to be developed in the area. The northern and southern boundaries of the station, except for a small portion in the northwest corner of the station, are bordered by Federal lands that are largely undeveloped and are anticipated to remain undeveloped. The western boundary of the station borders the Philippine Sea. The only civilian area immediately adjacent to the station is located on the southeastern boundary of the station. Recent developments in the area include a school and a 100-unit, Government of Guam sponsored, low-income housing development.

Most of the land in these areas is zoned for agriculture. Permissible uses in this zoning district include low and medium density residences, schools, churches, and other urban uses. Most of the civilian land adjacent to NAVCAMS Finegayan, except for a few pockets of urban use, have been designated for conservation. Many urban uses, such as residences and resort development, are permissible within the conservation district, but it is expected that the conservation classification will tend to maintain the existing low density of development.

4.5.2 RTF Barrigada

Land use at RTF Barrigada is dominated by a large antenna field in the eastern section of the station, which has developed around an active transmitter facility, Building 52. The central part of the station contains a golf course and a small built-up area that contains golf course facilities, playing fields, family housing, a fire station, a Guam Public Works Commission Branch Maintenance Facility, and a standby power plant and substation.

The site at RTF Barrigada was once an active transmitter field centering around Building 51 and stretches from the west, where RTF Barrigada borders Route 16, to the edge of the degraded limestone forest in the east, and from the station's northern boundary to a little used access road in the south. Antennas that once dotted the site were dismantled following the end of American involvement in the Vietnam conflict, circa 1975. The once cleared and mowed fields have been allowed to become overgrown with opportunistic weeds and shrubs.

Adjoining the site in the southwest corner is the Naval Hospital Storage Facility. The Facility consists of a large warehouse for storage of medical supplies and equipment, and a large pad, which in time of need would be transformed into a mobile field hospital.

RTF Barrigada is located in an area of growing civilian residential and commercial development. Much of this civilian development and the most rapidly developing areas are located on the western boundary of the station. Development in these areas is largely residential, except for substantial commercial development along two major highways, Routes 16 and 8, which pass through the area. Civilian land along the northern, eastern, and southern boundaries of the station are largely undeveloped or contain scattered agricultural uses.

Two major military installations partially border RTF Barrigada. Naval Air Station (NAS) Agana, which is the only Navy airfield on Guam, also serves as the Guam International Air Terminal. NAS Agana lies northwest of RTF Barrigada and is separated by Route 16. Land at NAS Agana lying closest to the station is largely undeveloped but contains a growing personnel support and recreation area that is slowly expanding toward RTF Barrigada.

Along the southern boundary of RTF Barrigada is the Andersen Air Force Base (AFB) Communications Annex, a radio transmitter operation similar to that at RTF Barrigada. Most of the land is used for antenna fields. These areas are outleased for cattle grazing. Land uses at the Andersen AFB Communications Annex are compatible with the RTF Barrigada transmitter operations.

4.6 FLORA

Field surveys were conducted by BioSystems Analysis, Inc. on July 15-16, 1987 in connection with the preparation of the *Natural Resources Survey for the U.S. Naval Communication Area Master Station, Guam* (Dept. of the Navy, 1989). Surveys were required to cover a minimum of 10% of the undeveloped land on Naval properties and to sample each major community type and unique community or habitat. Survey methods included general reconnaissance and 53 releve' plots. Verification of the vegetation listed on the sites was done by the preparers of this Environmental Assessment in September, 1990.

The NAVCAMS Finegayan site is located on land previously cleared of its natural vegetation. Flora in these cleared fields consists mainly of grass, which is constantly mowed. Secondary limestone forests surround portions of the site.

Much of RTF Barrigada has been developed, including a golf course, several buildings, and a number of mowed fields surrounding the project site. Once a cleared and mowed field, the project site is currently in a state of neglect. It is dominated by weeds with opportunistic small shrubs in thickets. Some of the species encountered include tangantangan (*Leucaena leucocephala*), *Cassia occidentalis*, wood-rose (*Operculina ventricosa*), *Ipomoea triloba* and Japanese morning glory (*Ipomea indica*), bitter melon (*Momordica charantia*), *Eupatorium odoratum*, and the grasses foxtail (*Pennisetum polystachyon*), wild cane (*Saccarum spontaneum*), *Panicum maximum*, and Johnson grass (*Sorghum halepense*). No species listed as threatened, endangered, or candidates for threatened or endangered status were identified on either site (Department of the Navy, 1989).

4.7 FAUNA

Bird surveys were conducted by BioSystems Analysis, Inc. in August, 1987 in connection with the preparation of the *Natural Resources Survey for the U.S. Naval Communication Area Master Station, Guam* (Dept. of the Navy, 1989). Initial surveys were performed by walking transects in a variety of habitats, with frequent stops to listen for birds. In addition to the initial surveys, the Variable Circular Plot technique was utilized, consisting of eight-minute counts by a stationary o server during which time all birds seen or heard were recorded. Survey techniques for mammals included walking transects on selected routes for presence of ungulate sign; night vehicle survey counts for ungulates using spotlights; incidental observations of wildlife; and habitat checks for amphibians and reptiles. All surveys were completed in August 1987.

Although Guam was once abundant with native avifauna, destruction caused by the brown tree snake has severely depleted bird stocks. Native species such as the Mariana crow (*Corvus kubaryl*), Micronesian kingfisher (*halcyon c. cinnamomina*), Micronesian starling (*Apolonis opaca guami*), Mariana fruit dove (*Ptilinipus roseicapilla*), Guam flycatcher (*myiagra freqcineti*), cardinal honeyeater (*Myzomela cardinalis saffordi*), bridled white-eye (*Zosterops c. conspicillata*), rufous fantail (*Rhipidura rufifrons uraniae*), and the white-throated ground dove (*Gallicolumba xanthonura*) were once found in the NAVCAMS Finegayan and RTF Barrigada areas. All but the Mariana crow, Micronesian kingfisher, and the Micronesian starling are presumed extinct.

Inasmuch as both project sites are located in either cleared open areas surrounding existing antennas or in fields once cleared of natural vegetation, they are not considered by the Guam Division of Aquatic and Wildlife to be good habitats for Guam's indigenous birds. Species that have been recorded in the vicinity of the project sites include: yellow bittern (*Ixobrychus sinensis*),

black francolin (*Francolinus francolinus*), rock dove (*Columba livia*), Philippine turtledove (*Streptopelia bitorquata*), Eurasian tree sparrow (*Passer montanus saturatus*), and the black drongo (*Dicrurus macrocercus*).

Mammals have also been known to traverse the open spaces surrounding the project sites. Animal signs associated with the Guam deer (*Cervus unicolor*) and feral pigs (*Sus scrofa*) have been noted, as well as those of small rodents. The brown tree snake and the monitor lizard (*Varanus indicus*) are the top reptile predators in the area. No species listed as threatened, endangered, or candidates for threatened or endangered status were identified on either site (Department of the Navy, 1989).

4.8 HISTORIC/ARCHAEOLOGICAL RESOURCES

In October 1990, an archaeological survey was conducted by Paul H. Rosendahl, Inc. on both the NAVCAMS Finegayan and RTF Barrigada sites (see Appendix A). No historic or archaeological resources were identified upon either of the sites.

4.9 NATURAL HAZARDS

Guam is located in an active seismic zone. There were 84 earthquakes with magnitudes of 6.0 or more on the Richter Scale between 1902 and 1976. A severe earthquake with magnitude 8.1 was recorded in 1902 that caused considerable damage. Due to the number and severity of earthquake occurrences, the island is designated in seismic probability zone 3.

Guam lies in a typhoon belt and is frequently impacted by heavy rains and winds that accompany these storms. Based on historical records an average of 1.4 typhoons per year pass within 120 nautical miles of Guam. There is a one in five chance that a typhoon will pass directly over the island in any particular year. High winds and heavy rains that accompany typhoons have caused heavy damage on Guam. Chances are slightly less than one in three that there will be one or more seriously destructive typhoons in any particular year.

4.10 VISUAL SETTING

The visual setting at NAVCAMS Finegayan is dominated by the existing antenna towers which dot the cleared and mowed meadow area. The antennas are variable in height up to 210 feet. The gently sloping terrain extends to the horizon to the north, east, and south, where degraded limestone forest areas visibly mark the boundaries of the site. The western horizon consists of the Philippine Sea. All land areas visible from the site are contained within the NAVCAMS Finegayan station boundaries.

RTF Barrigada consists of sloping terrain with views dominated by overgrown vegetation, abandoned remains from the former transmitting field, the Naval Hospital Storage Facility to the southwest, and Mount Barrigada to the north. Visible to the east are antenna towers at the existing transmitter site surrounding Building 52. Elevated views from atop Building 51 show that Naval Air Station Agana and Route 16 are visible from the site. Cover along the road and base boundaries effectively obscures views of the site.

4.11 INFRASTRUCTURE

Commercial electrical power for operational loads is provided to NAVCAMS Finegayan by the Island-Wide Power System (IWPS) 34.5 KV network through the Harmon Substation. Dual 13.8 KV overhead lines, owned by the Government of Guam, carry power from the Harmon Substation to the Finegayan Substation and standby power plant at NAVCAMS Finegayan, where it is distributed at 13.8 KV by underground lines to Building 309. The automatic standby units consist of diesel generators which provide emergency power three to five minutes after an outage.

Commercial power for RTF Barrigada is provided from the IWPS 34.5 KV network through the RTF Barrigada Substation. It is then distributed at 13.8 KV to RTF Barrigada, as well as NAS Agana and the Andersen AFB Communications Annex. Transmitter building Nos. 51 and 52 are supplied power from the substation by a dual underground 13.8 KV cable system.

Water for NAVCAMS Finegayan and RTF Barrigada is supplied by the Government of Guam water system, which carries water from the Almagosa Spring, Bona Spring, and Fena Watershed in Southern Guam. Water for the Finegayan area is routed through the 3 million gallon Barrigada reservoir to two reservoirs at NAVCAMS Finegayan. Distribution is by gravity from an elevated tank. Water to RTF Barrigada is drawn directly from the Barrigada reservoir.

Solid waste is collected by the Government of Guam and disposed of in the Public Works Center (PWC) Guam sanitary landfill at Naval Station (NAVSTA) GUAM. It is expected that the landfill will be able to accommodate all military solid waste disposal requirements on Guam for the next 20 years (NAVCAMS Master Plan, 1987).

NAVCAMS Finegayan is in the Government of Guam's northern sewage district. Sewage generated at the station, for the most part, is routed to a major interceptor which runs along Route 3. Sewage is being routed to the Northern District sewage treatment plant and outfall at Harmon for disposal.

Sewage treatment at RTF Barrigada is handled through separate septic tank and leaching fields.

NAVCAMS Finegayan is especially dependent on the transportation circulation system of Guam due to its distance from population centers and other Navy activities on the island. The on-station road system is relatively straight forward, with only one entrance to the station and a single main road (Bullard Avenue) traversing the communication center/support area.

RTF Barrigada has one main entrance road with a gate. This road is actually a continuation of Route 8, which terminates in the middle of RTF Barrigada at the small support complex. A secondary road continues through the small family housing area where it branches out to the two transmitter sites. Access to both Routes 15 and 16 is gained by proceeding past the two transmitter sites. Neither of these access points is controlled.

4.12 EXISTING FACILITIES

Located on the project site at NAVCAMS Finegayan is a receiver building (Building 150) with approximately 24,000 square feet of floor space. In addition to the receiver building, numerous antenna already exist in the project area. The project area at RTF Barrigada contains an existing transmitter station (Building 51) currently used as a warehouse.

CHAPTER 5

ENVIRONMENTAL CONSEQUENCES

5.1 CONSTRUCTION IMPACTS

Construction-related impacts are expected to be minimal. Excavation will be required to install individual concrete antenna pads approximately 28 square feet in size. Grading will be done only in those specific pad locations. Negligible amounts of soils would be removed. Excavated areas will be immediately filled. The clay soils at both NAVCAMS Finegayan and RTF Barrigada are porous and drain well. Erosion impacts would not be significant. No significant traffic, noise, or air quality impacts are anticipated during the construction period.

5.2 CHANGES IN TOPOGRAPHY

Installation of the antennas should result in little or no changes to existing landforms. Grading will be required in pad specific locations, but this will be minimal. Therefore, no special mitigative actions are recommended.

5.3 HYDROLOGY AND WATER RESOURCES IMPACTS

Neither NAVCAMS Finegayan nor RTF Barrigada contain any surface water bodies on site. No facilities are proposed that would affect the natural drainage pattern at either site. Given the high porosity of the soil types at both sites and the limited amount of ground disturbance, the project should have no effects upon hydrology, drainage, or water resources in the area.

Antennas at RTF Barrigada would not affect the sink hole in the northwestern corner of the site which currently functions as a storm runoff collector. However, the wire fence currently surrounding the area would produce electrical interference with elements of the TCI527 antennas (Numbers 10-13 on Fig. 3.4). To mitigate this interference, it is recommended that the wire fence be replaced with one made of a non-conductive material, preferably plastic. This would allow the fence to continue to prevent people from endangering themselves, while also eliminating any electrical interference.

5.4 FLORA IMPACTS

Installation of the transmitter antenna field at RTF Barrigada will require the clearing of vegetation at the site and its conversion to a grassy meadow. The site at NAVCAMS Finegayan is currently a grassy meadow. According to the NAVCAMS Natural Resources Survey, cited in Chapter Four, no plant species found upon the sites are officially listed as, proposed as, or candidates for threatened or endangered species status. Clearing of the overgrown brush thickets is not expected to have a significant negative impact upon botanical resources. Therefore, there are no botanical reasons to impose any restrictions, impediments, or conditions to the proposed project.

5.5 FAUNA IMPACTS

Neither the cleared meadow at NAVCAMS Finegayan nor the brush thickets at RTF Barrigada are considered quality habitats for avifauna or terrestrial fauna according to the NAVCAMS Natural Resources Survey and discussions with officials at the Guam Department of Agriculture, Division of Aquatic and Wildlife. Migratory birds sighted in the area are expected to relocate to less disturbed areas during construction, while introduced birds recorded in the area are often observed on construction sites. There has been no recorded evidence of adverse impacts to avifauna caused by either antenna towers or guy wires.

Clearing of brush at RTF Barrigada could result in the relocation of the small rodents associated with thickets, chiefly mice and rats, to adjoining areas. Conversion of the RTF Barrigada site from brush to meadow could have a positive impact upon the Guam deer by providing additional grazing area.

The proposed project is expected to have little or no impact upon the fauna according to the Electromagnetic Compatibility Report conducted by the U.S. Navy in December 1990 and contained in Appendix B. Birds flying through the main beam close to the transmitting antenna may become disoriented due to the magnetic fields. However, this would not be a permanent effect and would pass once the bird were to fly through or under the main beam. Hence, no mitigation measures are required.

5.6 HISTORIC/ARCHAEOLOGICAL RESOURCES IMPACTS

In October 1990, Paul H. Rosendahl, Inc. conducted an archaeological survey on the NAVCAMS Finegayan and the RTF Barrigada project locations (Appendix A). The field work was conducted October 16,17,19, and 22 by a crew of six. The project area received 100% survey coverage by pedestrian sweeps. Intervals between crew members on sweeps were 15-30 meters, depending on terrain and vegetation. No archaeological sites were identified within the project areas during the survey. The only cultural resources located were recent antenna-associated hardware and structural foundations. Other than archaeological monitoring of future earth moving, no further archaeological work would be required in the project areas.

5.7 VISUAL IMPACTS

The site at NAVCAMS Finegayan consists of an existing antenna field. The 11 proposed antenna would be interspersed among the existing structures. The site itself is not visible to neighboring residential areas, either military or civilian. Installation of these antenna should not have an impact upon the visual aesthetics of the site.

The current site at RTF Barrigada will be cleared of its overgrowth and reverted to a cleared meadow. Twenty-six (26) antenna are proposed for the area. Antennas over 200 feet will likely be visible from Route 16 if sited close to the road. Given the gentle sloping terrain of the site, the entire antenna field should be visible from the base housing areas. The extent to which an object is considered a visual obtrusion is subjective in nature and rests, in large part, on local standards and practices. To the extent that Guam's view planes are filled with similar structures, the small number of antennas visible to the civilian population should not be perceived as a significant impact. Therefore, no mitigation measures are required.

5.8 AIR QUALITY IMPACTS

Opportunities for impacts upon air quality in the region from this project are limited to two areas, construction and the use of the emergency power generators. Operation of the transmitting and receiving antennas themselves will produce no emissions.

The construction and installation phase will produce minimal amounts of dust due to excavation for the antenna pads. In addition, dust and pollen will be generated through the vegetation clearing process at RTF Barrigada. Neither excavation nor clearing are expected to produce significant impacts upon air quality. Hence, no extra mitigation measures beyond prudent construction and clearing techniques are required.

Use of the emergency power generators as part of the emergency power supply (EPS) will be limited to those times when electrical power from the substations to the transmitter and receiver buildings fails. At that point, the EPS system is expected to start up approximately 3 to 5 seconds after failure and remain in operation until the reestablishment of power from the substation. During the operation of the EPS, small amounts of diesel exhaust will be discharged into the atmosphere, made up of elements of carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_x), hydrocarbons (HC), and total suspended particulates (TSP). Given the expected limited operating time of these emergency power generators, the emissions associated with their use should produce no degradation of the ambient air quality and should have no significant impact.

5.9 ELECTROMAGNETIC/RADIO FREQUENCY INTERFERENCE IMPACTS

Electromagnetic and radio frequency interference effects were modelled and studied by the Naval Electronic Systems Engineering Center of Charleston, South Carolina. The full report is contained in Appendix B. The study looked at the effects of transmissions with respect to Hazards of Electromagnetic Radiation to Personnel (HERP); Hazards of Electromagnetic Radiation to Fuel (HERF); Hazards of Electromagnetic Radiation to Ordnance (HERO); and Electromagnetic Compatibility/Interference (EMC/EMI) on other communication facilities, consumer goods, medical equipment, and aircraft.

A HERO study has been performed by the Naval Surface Warfare Center (NSWC) Electromagnetic Effects Branch (Code H22) at Dahlgren, Virginia. The full report is contained in Appendix C. The study identified only minimal HERO Impacts. A comprehensive Hero survey, updating the 1982 survey will be performed encompassing all RF radiations in the vicinity of NAS Agana prior to installation of the new antennas in order to establish operating procedures.

5.9.1 HERP Impacts

Department of Defense Instruction 6055.11 addressed "Protection of Personnel from Exposure to radio Frequency radiation." Standards in this publication are based on American National Standard Institute standards (ANSI C95.1-1982) published in 1982. ANSI standards are based on "a consensus of those substantially concerned with its scope and revisions." Radio frequency radiation hazards were first addressed by ANSI in 1960, and updated in 1974 and 1982. The standard "prescribes recommended radiation protection guidelines to prevent biological injury from exposure to electromagnetic radiation (EMR)." These standards include occupational and non-occupational exposure to radiation in the frequency range 300 KHz to 100 GHz, but do not include "...the effects of various parameters such as modulation and long-term exposure...," for which insufficient information exists to substantiate further guidelines (ANSI C95.1-1982; Forward).

Within the scope of the Navy EMI/EMR study, Department of Defense Instruction 6055.11 limits with respect to Hazards of Electromagnetic Radiation to Personnel were used to provide guidance for the protection of personnel against non-ionizing radio-frequency radiation (RFR) in the frequency range from 10 KHz to 300 GHz. These provisions are applicable to all civilian and military personnel who may be exposed to RFR while at or in the vicinity of Navy shore establishments. Biological effects have been determined to be a function of the specific absorption rate (SAR) of radio frequency radiation, which depends on the frequency of the electric field and the size and configuration of the biological specimen. The threshold for adverse biological effect, in accordance with the ANSI standards, was established at an SAR of 4 watts per kilogram (W/kg), and, with a safety factor of 10 added, the accepted limit, known as the Permissible Exposure Limit (PEL), becomes 0.4 W/kg for the whole body, averaged over any six minute period. For the high frequency portion (30 MHz) of the RF spectrum, this occurs at an electrical field power density of 61.4 Volts/meter (V/m).

Criteria for exposure to EMR were determined by ANSI without prejudgment by a committee of trained biological scientists, which considered a select list of research reports on the subject. In the consideration of this committee "whole body SAR's below 4 W/kg were not by consensus associated with effects that demonstrably constituted a hazard...." To ensure a wide margin of safety, an order of magnitude reduction in the permissible whole body average SAR to 0.4 W/kg was invoked (Ibid, p. 13).

In the EMI/EMR study for the proposed project, electric fields for each transmitting antenna were determined for an average power level of 20 KW at three frequencies within its specified range. Electric field outputs were analyzed to determine worst case conditions among the frequencies utilized. Heights of 3.1 feet (1m), 6.6 feet (2m), 13.1 feet (4m), and 26.2 feet (8m) were looked at. For the directional antennas, both front and back limits were determined. Maximum hazard distances were found to occur at 30 MHz at a height of 6.6 feet. The distances from which access should be restricted for each antenna are compared in Table 5.1. There will be no electric fields exceeding HERP standards radiated beyond the perimeter of the transmitter site. For all antennas, access beneath the antenna curtains should be restricted in any case.

The ANSI standards are presently in the process of being revised, and are expected to be published in 1991. The new standards are expected to reduce the maximum permissible field strength exposure for voltage across the frequency spectrum by roughly half. This, in effect, would increase the distances from the transmitters at which the HERP limits would be encountered. The Naval electronic Systems Engineering Center also evaluated field strengths using the proposed ANSI standards to ensure that the antenna field design would meets the future proposed criteria. Results are shown in Table 5.2. Although distances from the front of the first elements increased under the proposed ANSI standards, the hazard areas would still be well within the boundaries of the RTF Barrigada site. Electromagnetic distances considered a hazard to personnel under the proposed ANSI standards are shown graphically in Figure 5.1.

5.9.2 HERF Impacts

Hazards of Electromagnetic Radiation to Fuel refers to the possibility of accidentally igniting fuel vapors by radio frequency induced arcs during fuel handling operations in close proximity to high power transmitting antennas. The minimal separation distance for antennas radiating 250 watts and under is 50 feet (15 m). The power density corresponds to an electric field strength of 5.76 V/m.

Table 5.1
Maximum HERP Hazard Distances for Transmitting Antenna Under Current ANSI Standards
30 Mhz at Height of 6.6 feet (2m)

Antenna	Side Distance from Center Line	Front Distance from First Element
TCI527	33 ft.	106.0 ft.
TCI524	43 ft.	154.0 ft.
TCI527B	52.5 ft.	102.0 ft.
TCI540	30.2 ft.	30.2 ft.
Granger 3001	30.2 ft.	30.2 ft.
Granger 3004	30.2 ft.	30.2 ft.
LP-1002	121.1 ft.	121.1 ft.

Table 5.2
Comparison of HERP Hazard Distance Using Current and Proposed ANSI Standards for Transmitting Antenna
30 Mhz at Height of 6.6 feet (2m), distances from front element only

Antenna	Old ANSI Standards (1982)	New ANSI Standards (1991)
TCI527	106.0 ft.	143.0 ft.
TCI524	154.0 ft.	260.0 ft.
TCI527B	102.0 ft.	143.0 ft.
TCI540	30.2 ft.	117.0 ft.
Grangers	30.2 ft.	117.0 ft.
LP-1002	121.1 ft.	240.5 ft.

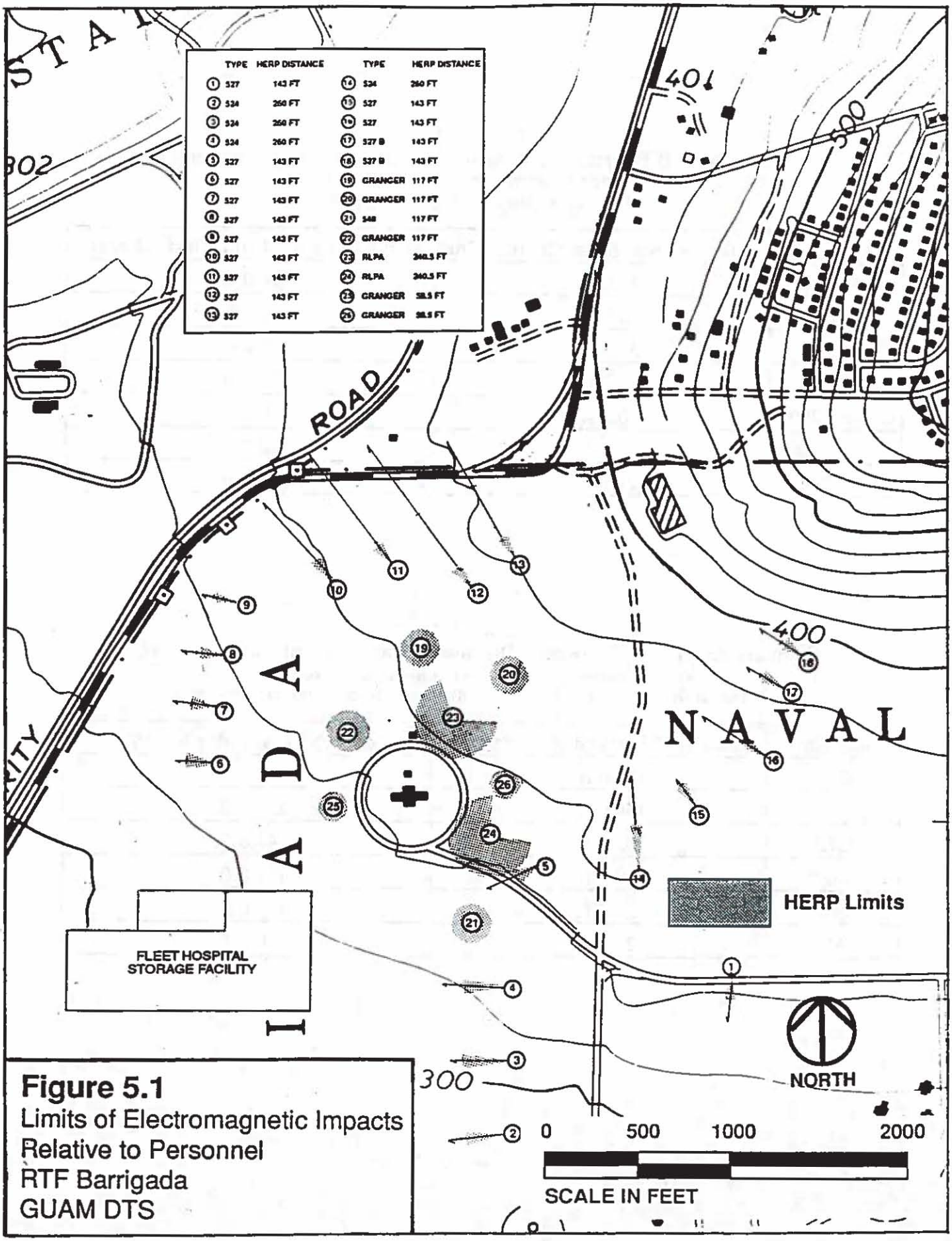


Figure 5.1
Limits of Electromagnetic Impacts Relative to Personnel
RTF Barrigada
GUAM DTS

The study showed that the maximum distance at which the electric field strength at a height of 6.6 feet fell to 5.76 V/m in front of the antenna. The maximum frontal distance occurred at 30 MHz. The results of the analysis are shown in Table 5.3. No volatile fuels should be handled within the maximum hazard distances. Diesel fuel is not considered a volatile fuel below a temperature of 125 degrees Fahrenheit (51.7 degrees Celsius). The sole identified use of volatile fuel is on the east tarmac of the Fleet Hospital Storage Facility when the hospital is deployed. Based on the distances and corresponding field strengths, the entire tarmac is safe for volatile fuel handling. Therefore, there will be no HERF impacts at the Fleet Hospital Storage Facility.

Table 5.3
Maximum HERF Hazard Distances for Transmitting Antenna
30 Mhz at Height of 6.6 feet (2m)

Antenna	Rear Distance from Tower Base	Front Distance from First Element
TCI527	72.2 ft.	492.1 ft.
TCI524	98.4 ft.	610.2 ft.
TCI527B	26.2 ft.	393.7 ft.
TCI540	360.9 ft.	360.9 ft.
Granger 3001	360.9 ft.	360.9 ft.
Granger 3004	360.9 ft.	360.9 ft.
LP-1002	583.0 ft.	583.0 ft.

5.9.3 HERO Impacts

Hazards of Electromagnetic Radiation to Ordnance refers to the possibility of ignition of electro-explosive devices (EED) due to the presence of radio frequency fields. Three classifications pertinent to HERO for ordnance have been established. These classifications are based upon the degree of susceptibility to radio frequency emissions. Items that are negligibly susceptible and require no RF environmental restrictions during all phases of normal employment are classified HERO SAFE. Items that are moderately susceptible and require moderate RF environmental restrictions during one or more phases of employment are classified HERO SUSCEPTIBLE. Items that are highly susceptible and require severe restriction for some or all phases of employment are classified as HERO UNSAFE.

5.9.3.1 Ground-Level Impacts

Results of ground-level modelling were examined to determine the distance at which the electric field strength measured at 6.6 feet above ground fell to the value delineated by NAVSEA OP-3565. The results are shown in Tables 5.4 and 5.5.

No ordnance is expected on the transmitter site at Barrigada. The limits for HERO SUSCEPTIBLE for all antennas are within the transmitter site. Antennas 9,11,12, and 13 listed on Fig. 3.4 (TCI527 antennas), which are located closer than 2,707 feet from the site boundaries, create electromagnetic fields over the limit values for HERO UNSAFE beyond the transmitter site boundary, extending across the perimeter road to the west and north (see Fig. 3.4). As military

Table 5.4
Maximum HERO SUSCEPTIBLE Distances for Transmitting Antenna
Variable Frequencies at Height of 6.6 feet (2m)

Antenna	Rear Distance from Tower Base	Front Distance from First Element
TCI527	326.4 ft.	605.0 ft.
TCI524	236.9 ft.	626.7 ft.
TCI527B	172.0 ft.	431.8 ft.
TCI540	449.5 ft.	449.5 ft.
Granger 3001	449.5 ft.	449.5 ft.
Granger 3004	449.5 ft.	449.5 ft.
LP-1002	734.9 ft.	734.9 ft.

Table 5.5
Maximum HERO UNSAFE Distances for Transmitting Antenna
Variable Frequencies at Height of 6.6 feet (2m)

Antenna	Rear Distance from Tower Base	Front Distance from First Element
TCI527	1378.0 ft.	2707.0 ft.
TCI524	1411.0 ft.	3386.0 ft.
TCI527B	778.0 ft.	2188.0 ft.
TCI540	2034.0 ft.	2034.0 ft.
Granger 3001	2034.0 ft.	2034.0 ft.
Granger 3004	2034.0 ft.	2034.0 ft.
LP-1002	3199.0 ft.	3199.0 ft.

ordnance is not transported in a HERO UNSAFE configuration per existing Navy regulations, no safety hazard would exist. Additionally, civilian transport of electro-explosive devices properly configured to U.S. Department of Transportation guidelines (foil packaged and electrically shunted) would not be affected.

The most easterly buildings at the airport complex will also be subjected to electric fields. Results of the HERO analysis indicate that fields will be less than the HERO SUSCEPTIBLE criterion of 2 V/m. However, one should expect field strengths which marginally exceed the HERO UNSAFE criterion of 0.2 V/m at the Advanced Underwater Weapons (AUW) Compound, near the torpedo magazines and on the ordnance transportation route. The AUW Compound is utilized for ordnance assembly where HERO "untested" components are assembled. Such components are HERO UNSAFE ordnance to which the 0.2 V/m criterion applies. However, the analysis did not include those intrinsic shielding properties of the AUW building and the torpedo magazines. Past experience has suggested that instrumented tests performed inside the buildings will demonstrate that the field strengths would be lower than criteria, and, therefore, safe. The areas on NAS Agana in which sensitive ordnance handling occur are located as points 1,2,3, and 4

on Figure 5.4. Results of modeling of antenna field strengths relevant to these areas found that the 0.2 V/m threshold would occur no closer than:

- 290 feet east of the engine test pad (#3),
- 556 feet east of hangar #2,
- 895 feet east of the hot pad (#4); and,
- 1,138 feet east of hangar #1.

In all cases, the modeled strengths were based on a total power output of 250 kw, about 18 percent higher than the planned output for the tranmitting facility.

The NSWC in Dahlgren, Virginia has been contacted for an evaluation of the situation regarding impacts to ordnance and a HERO study has been performed. The full report is contained in Appendix C. The study identified only minimal HERO impacts and concluded that these impacts could be mitigated through Navy administrative actions. A comprehensive HERO Survey updating the 1982 Survey will be performed, encompassing all radio frequency emitters and affected ordnance handling operations in the vicinity of NAS Agana prior to installation of the new antennas, in order to establish operating procedures. Upon installation of the State Department antennas and transmitters, additional field strength measurements will be taken to verify the actual conditions.

5.9.3.2 Aircraft Impacts

Although unusual, it is possible that aircraft carrying HERO SUSCEPTIBLE ordnance could operate out of NAS Agana. One such occurence would be in the event of an emergency landing of carrier aircraft with "hung ordnance," ordnance in a HERO UNSAFE configuration. Sky wave propagation profiles indicate that "main beam" irradiation would occur as aircraft traverse electromagnetic fields. Results of the HERO analysis, with respect to fixed-wing military aircraft lanes at NAS Agana, indicate that field strength levels from 20-36 V/m would be present during fly-throughs in the main beam from antennas 10 through 13. Aircraft, such as the P-3, S-3, F/A-18, and the F-14, would penetrate the main beam created by the antennas when exiting runways 06R and 06L and during flight in air lanes 06R-I, 06R-H, 06L-I, and 06L-H. These field intensity levels, although above the general HERO criterion for HERO SUSCEPTIBLE ordnance, would not affect electric cartridges internal to the aircraft or most externally loaded stores. However, on rare occasions, it may be deemed necessary to fly through the RTF Barrigada RF envelope with HERO SUSCEPTIBLE ordnance that has a susceptibility criterion less than the field strength levels created by the antennas. The following HERO SUSCEPTIBLE ordnance separation distances shown in Table 5.6 would apply to "in-flight" ordnance.

The data in Table 5.6 apply to ordnance that has not been certified by Naval Air Systems Command, but as an interim measure shall be treated as HERO SUSCEPTIBLE ordnance. For example, according to the NAS Agana ordnance list, flight operations could be conducted with training missiles ATM-7F and ATM-7E. Options would include grounding the ordnance or reducing the transmitter power at RTF Barrigada.

Results of the HERO analysis with respect to rotary-wing military aircraft lanes at NAS Agana indicate that field strength levels in excess of 100 V/m would occur in the main beam envelopes from antennas 5 through 9 when these aircraft utilized air lanes 06R-N, 06R-P, and pattern E2-A. This field strength level would exceed the HERO SUSCEPTIBLE criterion for H-46 aircraft while carrying external stores such as the magnetic anomaly detector (MAD) cable cutter (NALC M161), or when uncontainerized ordnance is transferred for vertical replenishment. Additionally, other helicopters, such as the SH-2, SH-3, and SH-60, would have internal electric cartridges (NALC M161 rescue hoist cable cutter) and external stores, such as bomb racks, marine

location markers, and sonobouys, all of which carry a susceptibility criterion of 100 V/m or less. Alternatives would include reducing transmitted power or rerouting the aircraft from the aforementioned flight paths onto other flight paths. A hard-wired "hot-line" will be established from NAS Agana to the transmitter control room as a further mitigation measure to provide a 15-minute minimum response allowing for a power reduction should an in-flight emergency landing situation involving aircraft with improperly configured HERO UNSAFE ordnance (hung ordnance) occur.

Table 5.6
HERO SUSCEPTIBLE Ordnance Separation Distances for Transmitting Antenna
("in-flight" ordnance)

Antenna	Distance from Tower Base
TCI527	8507.0 ft.
TCI524	7582.0 ft.
TCI527B	7157.0 ft.
TCI540	2849.0 ft.
Granger 3001	2849.0 ft.
Granger 3004	1425.0 ft.
LP-1002	4025.0 ft.

5.9.4 EMC/EMI Impacts

Electromagnetic Compatibility/Electromagnetic Interference analysis was done to investigate the potential electromagnetic interference associated with the reactivated Barrigada transmitter site on communications, consumer products, and air traffic.

5.9.4.1 Communications

Interference with other communication sites by the Barrigada transmitter antennas will be minimal. The nearest site is the Andersen AFB Communications Annex, which is some 1.5 miles (2.5k) away at a bearing of 180 degrees from the nearest RLPA antenna. The electric field strength caused by the RLPA, the antenna most likely to cause interference at this location, will be just under 200 millivolts/meter (mV/m) at a height of 39.4 feet (12m). Unless the Andersen Annex is attempting to receive another station near or on the same frequency being transmitted from the Barrigada antenna, there will be no interference. In addition, there is a U.S. Coast Guard LORAN transmitter station located in the vicinity of the RTF Barrigada site. This station transmits at 100 khz with a power output of 600 kw. As the frequency band of this station is different than that proposed for the State Department project, no electromagnetic interaction would occur. As the proposed transmitters would not operate in the VHF range, they would not impact the Guam Airport Authority's transmitter on Mount Barrigada. Also, sector cutouts restricting transmission towards Mount Barrigada would eliminate the chance for interference with communications equipment located in the area.

Electrical transmission lines in the area are 13.8 KV. Transmissions from the proposed project would cause no interference with the lines, nor would the lines cause any interference with the transmissions.

Given the many transmitting antennas on Guam which operate in excess of 10 kw, there will be a need to coordinate the project with the Joint Frequency Management Office for Guam NAVCAMS. Although there is no fixed limit for transmission antennas per se, the frequency management process does provide for establishment of an operating range for all emitters. The current frequency allotment for the project established a power level of 10 kw continuous and 40 kw in emergencies. The Department of State will request a modification to the frequency allotment to establish the power level at 20 kw continuous.

5.9.4.2 Consumer Products

Manufacturers of consumer equipment have no imposed electromagnetic susceptibility requirement, but most manufacturers have assumed a limit of 1 V/m for their products, including TV sets, VCRs, radios, etc. Electric fields of 2.37 V/m have been known to completely distort video signals to VCRs. For this analysis, 1 V/m was set as a limit for consumer products. Table 5.7 shows the EMI hazard distances at a height of 6.6 feet.

The housing complex and other proposed projects on the southwest side of Mt. Barrigada would be in the main beam of both RLPA when the antennas are oriented at a bearing of 47 degrees. The distance of the complexes from the closest RLPA antenna is approximately 2,624 feet (800m). The electric field levels from this antenna would range up to 5.6 V/m at the housing complex. Electric fields from the more distant RLPA antenna, located approximately 2,950 feet (900m) away, would range up to 5 V/m.

To mitigate any potential interference with consumer products in the housing area, greater cutouts will be implemented for the RLPA antennas to restrict transmission over radii affecting the area. For the antenna closest to the housing complex a cutout of 98 degrees will be established, from 358 to 96 degrees, to ensure that interference does not occur. For the RLPA antenna farthest from the complex, a sector cutout of 93 degrees, from 353.5 to 86.5 degrees, will be established. These sector cutouts would be maintained by a combination of hardware, physical barriers which would restrict the turning movements of the antennas from those arcs, and software, algorithms programmed into the transmitting software which would restrict radio transmissions over those arcs. Maintenance of these prohibited transmitting areas will ensure that no electrical interference occurs to consumer products within the neighboring housing complex. Areas over which the RLPA antennas will not transmit are shown in Figure 5.2. Modeling encorporating these mitigation measures showed that under a "worst-case" scenario, with both RLPA antennas oriented at 350 degrees, the maximum field strength at these housing complexes would be 0.5 V/m.

Table 5.7
Maximum Product Hazard Distances for Transmitting Antenna
1 V/m at Height of 6.6 feet (2m)

Antenna	Rear Distance from Tower Base	Front Distance from First Element
TCI527	459.0 ft.	1230.0 ft.
TCI524	337.0 ft.	1505.0 ft.
TCI527B	55.0 ft.	971.0 ft.
TCI540	1213.0 ft.	1213.0 ft.
Granger 3001	1213.0 ft.	1213.0 ft.
Granger 3004	1213.0 ft.	1213.0 ft.
LP-1002	1417.0 ft.	1417.0 ft.

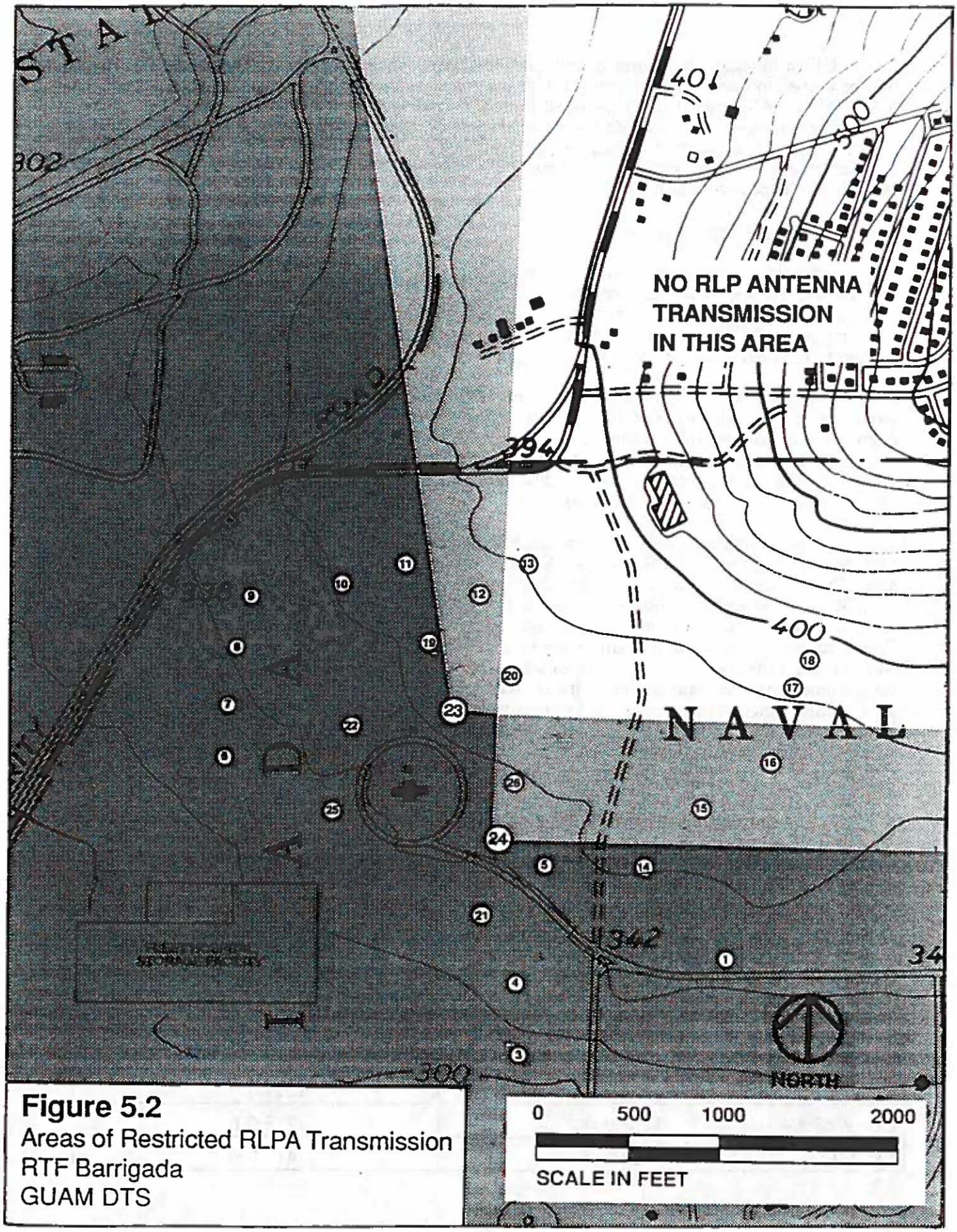


Figure 5.2
Areas of Restricted RLPA Transmission
RTF Barrigada
GUAM DTS

Areas proposed for future development to the north of the site (A and B on Figure 5.4) may experience some radio and TV interference in certain circumstances at elevations 30 to 40 feet above ground level. Under a "worst-case" scenario, with both RLPA antennas oriented at 350 degrees, the field strengths at the proposed commercial development (B on Figure 5.4) was 0.9 V/m at 6 feet above ground level (AGL) and 3.6 V/m at 30 feet AGL. Any interference encountered with selected consumer products can be readily mitigated using inexpensive, readily available filters on the devices. As proposed commercial zoning for the proposed development sites limits building heights to 30 feet, it is not anticipated that other mitigation measures will be necessary. The field strengths for area A on Figure 5.4 did not reach 1 V/m.

5.9.4.3 Aircraft

Equipment and systems installed aboard military aircraft, including associated ground support equipment, must meet a minimum electric field susceptibility level of 20 V/m (MIL-STD-461C Class A1). The EMI impact on commercial aircraft for equipment internal to the aircraft has been considered by the EMI subcommittee of the Federal Aviation Administration (FAA). They believe that aircraft internal electronics were designed to an EMI threshold of approximately 2 V/m. Taking into account the RF shielding characteristics of the aircraft's metal skin, it is felt that an external exposure level up to 100 V/m would not upset the avionics and controls of older commercial aircraft. These predictions are based on estimates of the aircraft's intrinsic shielding effects. Future standards will establish a bench test level of 200 V/m for new commercial aircraft. Since electronic equipment on civil aircraft is enclosed within a metal skin, a susceptibility level of 10 V/m was conservatively assumed in the EMI study. Results of analyses to determine the ground-level hazard distance for 10 V/m are shown in Table 5.8.

Both the RLPAs and the TCI527s may subject several buildings at the east end of the airport complex to electric fields of 1 V/m at heights of 26 to 40 feet (8-12m). At lower heights the buildings would be exposed to fields below 1 V/m. No adverse effect is anticipated from this exposure.

Another potential problem considered was the electric field that a landing aircraft could be subjected to. The worst case is offered by the RLPA (antenna no. 23). When this antenna is positioned at approximately 335 degrees, the beam would be directly pointed at a spot some 975 feet (300m) beyond the northeast end of the runway. The antenna would be 3,937 feet (1.2 km) from the intersect point with a line extended from the end of the runway. At this position, the center of the main beam of the antenna would be 318 feet (97m) above ground. Incoming aircraft would contact the beam at approximately 43 feet (13m) above ground. At that height the electric field would be less than 1 V/m. Therefore, landing aircraft would not be subjected to levels greater than the selected 10 V/m. Also, the RTF Barrigada HF field strengths within the specific air patterns, glideslope lanes, and takeoff routes indicate that the external levels would be below the 100 V/m allowed by the FAA EMI Sub-committee.

Currently a portion of the existing H-46 flight track for NAS Agana would also fall within the beam capabilities of two TCI524 antennas (Nos. 9 and 10 on Fig. 3.4). Antenna 9 would be located approximately 600 feet (185m) from a portion of the flight track located in the far northwestern corner of the RTF Barrigada site. Antenna 10 would be approximately 702 feet (216m) from this point. At the point where the antenna beam would cross the flight path, the distance above ground at which the field strength would be 10 V/m (at 30 MHz) would be 422.5 feet (130m) for antenna 9 and 390 feet (120m) for antenna 10. Field strengths would increase closer to the ground and would reach a peak of 47 V/m at 130 feet (40m) above ground for antenna 9 and 33 V/m at 162.5 feet (50m) above ground for antenna 10 (see Fig. 5.3). The EMI limit for military aircraft, as presented in MIL-HDBK-235, is 300 V/m. Calculated field strengths from RTF Barrigada would not exceed this in any of the normal air patterns at NAS Agana.

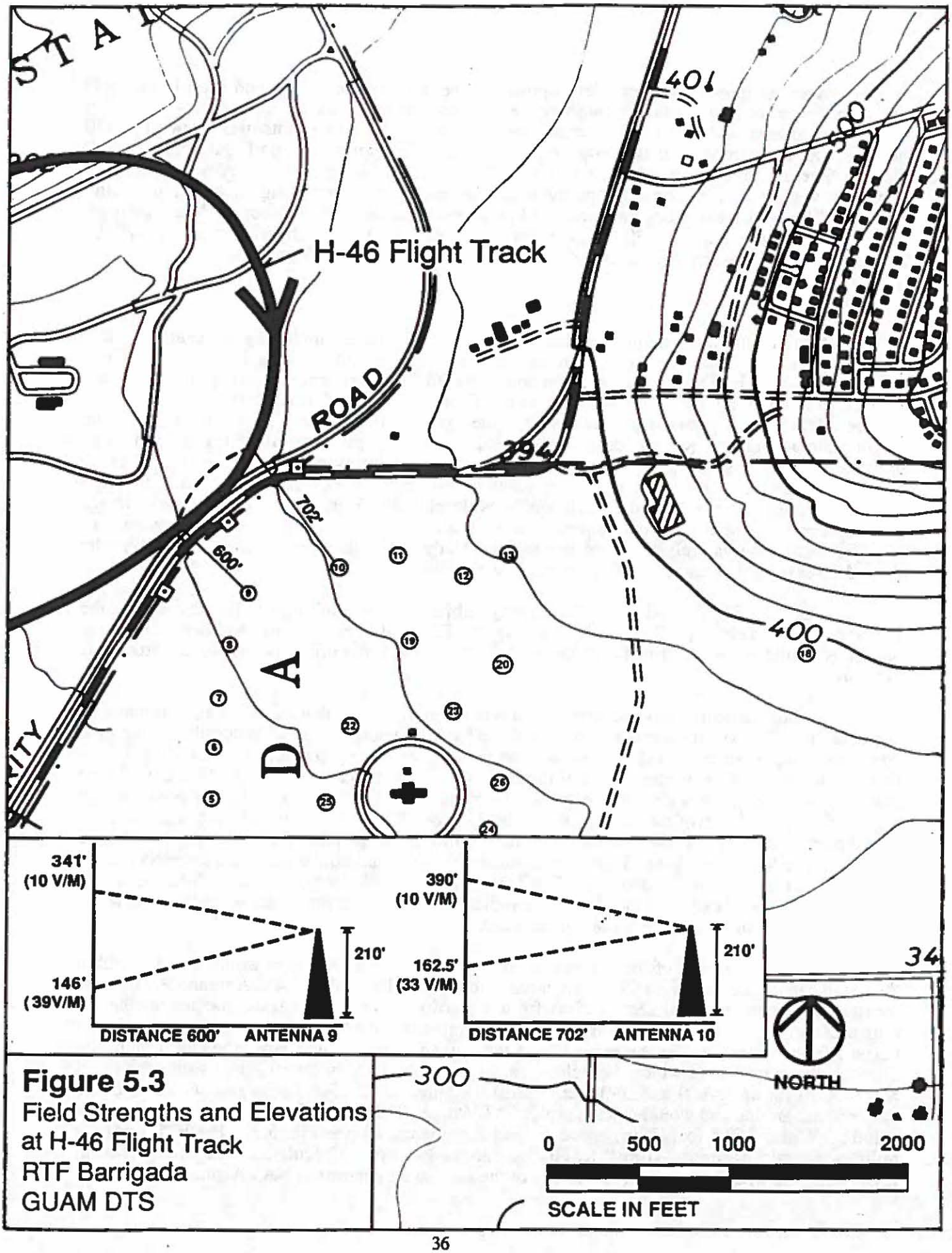


Figure 5.3
Field Strengths and Elevations
at H-46 Flight Track
RTF Barrigada
GUAM DTS

Table 5.8
Maximum Aircraft Hazard Distances for Transmitting Antenna
10 V/m at Height of 6.6 feet (2m)

Antenna	Rear Distance from Tower Base	Front Distance from First Element
TCI527	66.0 ft.	377.0 ft.
TCI524	within antenna perimeter	456.0 ft.
TCI527B	within antenna perimeter	318.0 ft.
TCI540	262.0 ft.	262.0 ft.
Granger 3001	262.0 ft.	262.0 ft.
Granger 3004	262.0 ft.	262.0 ft.
LP-1002	436.0 ft.	436.0 ft.

5.9.5 Impacts on the Naval Fleet Hospital Storage Facility

The Fleet Hospital Storage Facility is a repository for portable/mobile hospital units. When necessity requires deployment of this equipment for the care of casualties, hospital tents and equipment would be arranged around the storage facility. Although the tarmac is beyond the personnel hazard distances for the closest antennas, conflicts between the use of this facility and the siting of the transmitting antennas could occur in areas where electronic equipment, such as heart monitors and life support systems, is used for patient care.

Electromagnetic Compatibility for Medical Devices Standards suggest a minimum radiated electric field susceptibility of 2 V/m. At this minimum susceptibility level, a portion of the east tarmac is excluded from use due to radiation from the nearest TCI524 and RLPA antennas. antenna No. 4 (TCI524) would have an electric field intensity over 2 V/m extending approximately 50 feet (15m) into the southeast corner of the tarmac. Antenna No. 3 and 4 were analyzed together at 30 MHz with a power of 20 KW to each. Because of reinforcement/interference effects, the field strength on the tarmac from these antennas operating together was no greater than that from antenna No. 4 alone.

Antenna No. 24 (RLPA) would exceed 2 V/m over an area extending 200 feet (61m) into the tarmac along the northern boundary and lessening in extent as one proceeds south. During deployment, the Fleet Hospital would not set up medical facilities on the eastern 200 feet (61m) of the tarmac. This area is designated as Galley/Mess and Public Works, and is reserved for dining and motor pool facilities. The field strength on the eastern portion of the tarmac would not prohibit this use.

5.10 NOISE IMPACTS

Operation of the transmitting and receiving antennas will produce no audible noise. Noise associated with construction will be limited in duration, and given the distance of the sites to the nearest facilities or residential areas, will produce no impacts. Operation of the emergency power generators will produce some noise, but will be contained within concrete generator buildings which will minimize the impact. Hence, no mitigation measures are required.

5.11 HAZARDOUS WASTE MANAGEMENT IMPACTS

Renovation of Building 51 at RTF Barrigada will require the removal of six electrical transformers. Of these transformers, five have been tested for contamination from polychlorinated biphenyls (PCB). Three transformers were found to be PCB contaminated, containing PCB levels of 300 ppm, 630 ppm, and 1560 ppm. Two transformers were found to contain no PCB. The remaining transformer, although not tested, must be treated as PCB contaminated in accordance with the Toxic Substance Control Act of 1976.

The Department of Defense (DoD) has designated the Defense Logistics Agency (DLA) as the responsible agency within the DoD for disposal of hazardous materials, with the exception of certain categories of materials such as radioactive wastes, which are specifically designated for DoD component disposal. Hazardous wastes are disposed of through the DLA's local Defense Reutilization and Marketing Office (DRMO). Proper disposal of hazardous material is the responsibility of the Naval activity which generates, uses, or stores it. Each Navy Area Coordinator must develop an Area Oil and Hazardous Substance Pollution Contingency Plan under the Navy's Environmental and Natural Resources Program Manual, OPNAVINST 5090.1A. This contingency plan must provide guidelines and specify responsibilities for the control and cleanup of oil and hazardous substance spills.

On Guam, removal and disposal of Naval PCB-contaminated material are covered under the Naval Public Works Center Oil and Hazardous Waste Management and Spill Contingency Plan, PWC 5090.5B (25 January 1990) and 40CFR761. Removal and transport of the transformers would occur in accordance with these plans and regulations. The transformers would be disposed of at an authorized hazardous waste disposal site on the Continental U.S. Accidental release of hazardous substances in reportable quantities would be reported immediately to the Navy On-Scene Coordinator by telephone as required by Naval spill contingency plans.

Except for the removal and disposal of the six transformers, the installation and operation of the transmitting and receiving antennas will produce no wastes identified as hazardous.

5.12 TRAFFIC IMPACTS

Operation of the transmitting and receiving antennas will increase personnel by approximately 40 people. However, as this work force will be split between both the NAVCAMS Finegayan and RTF Barrigada sites, and split further again by shift, there should be no significant impact to either station's circulation system, parking arrangements, or to the adjoining civilian transportation system. Additional peak hour traffic in the NAVCAMS Finegayan vicinity should amount to no more than 10 vehicles, and in the RTF Barrigada vicinity no more than 3 vehicles. No mitigation measures are required.

5.13 SOCIOECONOMIC IMPACTS

Installation and operation of the transmitter and receiver antennas will increase personnel stationed on Guam by approximately 40 people plus any dependents. Given the recent reassignment of a large number of personnel from Guam associated with the former B-52 squadron, housing is available. The small number of dependents is not expected to have any impact upon Guam support services, such as schools. The increase in personnel associated with this project is expected to have an overall positive impact upon the economic condition of Guam due to increased local spending. Approximately a dozen personnel from NAVCAMS Finegayan receiver building may need to be reassigned to other sites on the NAVCAMS Finegayan station. This is not seen as presenting a significant problem. As the overall socioeconomic impacts are positive, no mitigation measures are required.

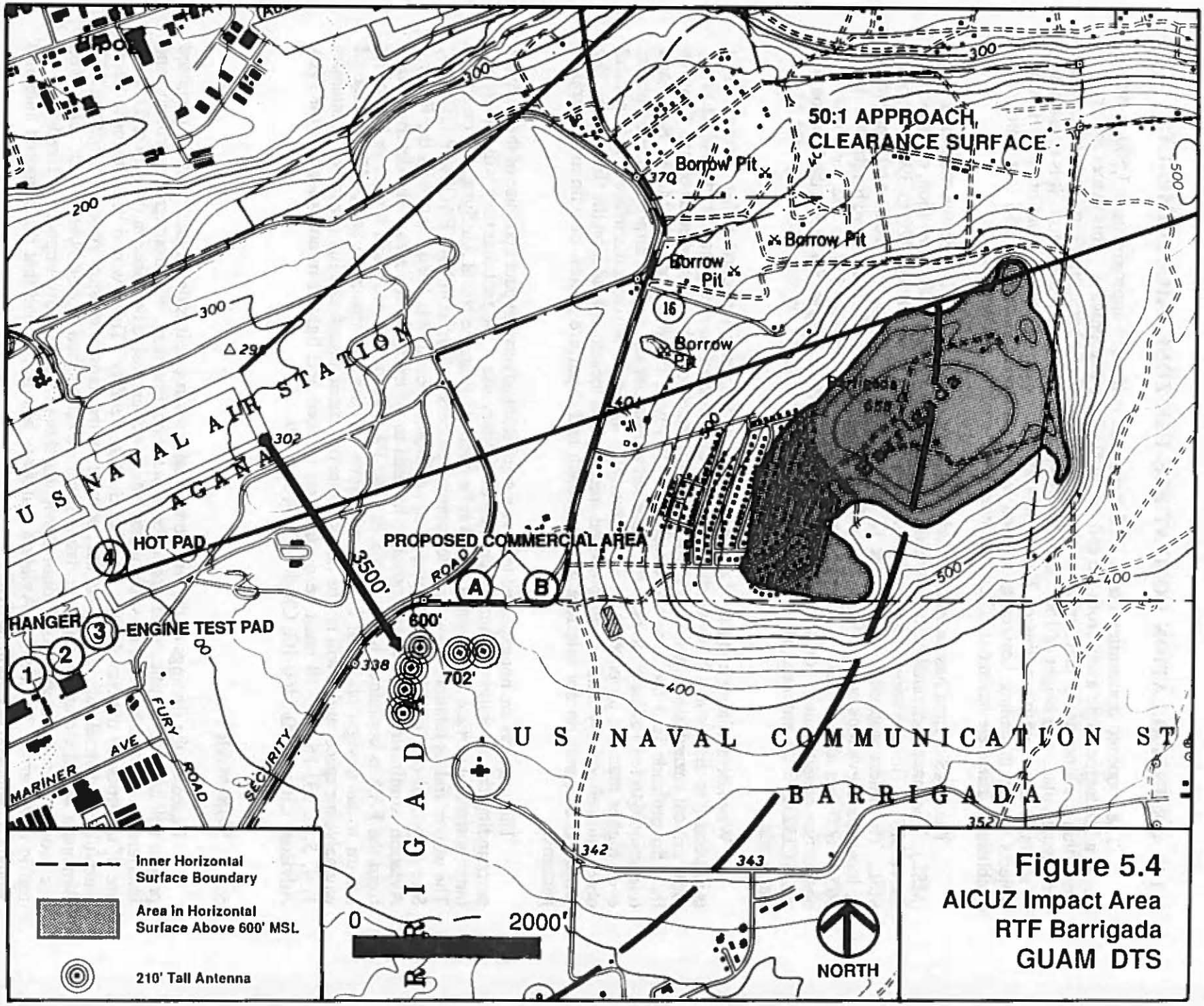


Figure 5.4
AICUZ Impact Area
RTF Barrigada
GUAM DTS

5.14 AIR INSTALLATION COMPATIBLE USE ZONE (AICUZ) IMPACTS

The proposed transmitter site at RTF Barrigada is located approximately 3,500 to 4,000 feet at a 90 degree angle away from the end of the NAS Agana runways. This places the project site within the inner horizontal surface of the airfield. This inner horizontal surface consists of an oval shaped plane at a height of 150 feet above the established airfield elevation. It is constructed by scribing an arc with a radius of 7,500 feet about the centerline at each end of each runway. Objects within this inner horizontal surface which would be taller than 150 feet above the established airfield elevation could be considered an obstruction to navigation.

The NAS Agana has an established airfield elevation of 298 feet above mean sea level (MSL). The inner horizontal surface would exist up to 150 feet above this elevation, or at 448 feet above MSL. The elevation at the proposed transmitter site ranges from 320 to 390 feet above MSL. The tallest proposed elements, the 12 TCI527E-3-04 antennas, are 210 feet tall and would be located at elevations ranging from 355 to 390 feet above MSL. Their effective heights would be 565 to 600 feet above MSL. This would place them approximately 117 to 152 feet above the obstruction height limit imposed by the inner horizontal surface. Figure 5.4 shows the location of the TCI527E-3-04 antennas in relation to the inner horizontal surface boundary and Mount Barrigada.

When determining impacts of an object violating the inner horizontal surface restrictions, it is important to distinguish between the object as an obstruction to navigation, or the object as the more critical hazard to navigation. Certainly, the antennas could be considered as obstructions, as they do protrude into the airspace envelope. However, the proximity of Mount Barrigada (elevation 646 feet) adjacent to both the proposed transmitter site and the airport places an object even higher than the proposed antennas directly in the inner horizontal surface. This natural obstruction effectively shadows the proposed antenna field located behind it on the flight path. The proposed antennas do not interfere with approach and departure routes, or with airport traffic patterns.

The antennas are not expected to have a significant adverse impact upon use of the airspace surrounding the air station, either for civilian or military use. The fact that they will violate the inner horizontal surface requires that a waiver be obtained from the Naval Air Systems Command. The waiver and its relationship to the site approval process is defined in NAVFACINST 11010.57, Site Approval of Naval Shore Facilities. In addition, a permit has been filed with the Federal Aviation Administration to assess possible hazards to air traffic in the area. The determination from the FAA is contained in Appendix E. The FAA found the proposed towers to be "of no hazard to air navigation," that is, they will have no adverse impact on safe, efficient use of navigable air space, and it will not be necessary to obstruction mark and light each one. Antennas 1, 4, 5, 6, 13, 16, and 18 must be obstruction marked and lighted in accordance with FAA Advisory Circular 70/7460-1G, Chapters 3, 4, 5, and 9.

5.15 SUMMARY

Based on the findings of this environmental assessment, it is determined that the proposed project will have no significant adverse effects on the environment. Electromagnetic radiation and interference due to transmission would restrict the use of explosive ordnance in the area and restrict use of a portion of the Naval Fleet Hospital Storage Facility. There would be no electric fields harmful to personnel radiated beyond the perimeter of the transmitter site. Antenna heights at RTF Barrigada would violate the inner horizontal surface established around NAS Agana. However, the proximity and elevation of Mount Barrigada should remove any impacts to fixed-wing air traffic in the area. The Federal Aviation Authority has determined that the proposed antennas would constitute no hazard to navigation.

5.15.1 Direct and Indirect Effects and Their Significance

The following effects have been identified:

- Temporary construction impacts - insignificant
- Geological impacts - insignificant
- Biological impacts - insignificant
- Historic/Archaeological impacts - insignificant
- Infrastructure impacts - insignificant
- Environmental impacts - insignificant
- Socioeconomic impacts - insignificant
- HERP impacts - insignificant beyond site perimeters
- HERO impacts - further testing and modification of flight procedures for some categories of air operations.
- HERF - no anticipated impacts
- EMC/EMI - restricts use of electronic medical equipment on a portion of Fleet Hospital Storage Facility east tarmac. No consumer product impacts anticipated if mitigation measures followed. Electrical interference caused by an existing wire fence would require its replacement with a fence constructed of a non-conductive material, preferably plastic.
- Aircraft impacts - The Federal Aviation Administration has made a "no-hazard" determination and recommended obstruction lighting for several towers (see Appendix E). Appropriate Navy authorities in Dahlgren, Virginia and at NAS Agana must determine if any EMI impacts to the H-46 Flight Track exist .

5.15.2 Possible Conflicts between Proposed Action and the Objectives of Federal and Territorial Land Use Policies, Plans and Controls

5.15.2.1 National Environmental Policy Act

This document has been prepared in compliance with the National Environmental Policy Act (NEPA) of 1972, and the Council of Environmental Quality Regulations.

5.15.2.2 National Historic Preservation Act

The project is being carried out in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR 800 (implementing regulations). Section 106 requires Federal agencies to consider the effects of their actions on historic properties. The review process is designed to identify and evaluate historic properties, to assess the effects of the proposed action on the properties, and, if applicable, to find ways to mitigate adverse effects. Section 106 applies not only to those properties listed on the National Register of Historic Places,

but also to properties that meet specified eligibility criteria. This could include properties that have not been listed and even those that have not yet been discovered, especially in the case of archaeology. In Guam, Section 106 review is carried out by the Department of Parks and Recreation. Coordination between the U.S. Navy, Pacific Division and the Department of Parks and Recreation took place in September 1990. Results of the archaeological reports will be forwarded to the Department of Parks and Recreation for review.

5.15.2.3 Federal Aviation Administration (FAA)

In accordance with Section 307 of the Federal Aviation Act of 1958, Federal Aviation Regulations, Part 77, and Advisory Circulars No. 70/7460-2H, and 70/7460-1G, any person who proposes to erect or alter an object that may affect the navigable airspace must submit a notice to the Administrator of the Federal Aviation Administration if that object would be:

1. Of a height more than 200 feet above ground level at its location.

2. Within 20,000 feet of an airport with at least one runway more than 3,200 feet in length and would exceed one foot in height for each 100 feet horizontally from the nearest point of the nearest runway.

3. Within 5,000 feet of a heliport listed in the "Airport Directory" or operated by a Federal military agency and would exceed one foot in height for each 25 feet, horizontally from the nearest landing and takeoff area of the heliport.

4. A traverse way which would exceed at least one of the standards listed in items 1 to 3 above, after its height is adjusted upward 17 feet for an interstate highway, 15 feet for any other public roadway, 10 feet (or the height of the highest mobile object that would normally traverse the road if higher) for a private road, or an amount equal to the height of the highest mobile objects that would traverse a waterway or any other thoroughfare not previously mentioned.

5. On an airport.

6. When requested by the FAA.

Notice requirement applies to the proposed construction or alteration of any structure (building, tower, roadway, overhead wires and their supporting structures, etc.), including any construction equipment employed.

Notification has been filed with the Manager, Airspace and Procedures Branch. The FAA has determined in an April 1991 Finding of No Hazard that although the proposed construction would exceed FAA standards, an thus constitue an obstruction to air navigation, it would not be necessary to obstruction mark and light each one. Antennas 1, 4, 5, 6, 13, 16, and 18 must be obstruction marked and lighted in accordance with FAA Advisory Circular 70/7460-1G, Chapters 3, 4, 5, and 9.

5.15.2.4 Guam Coastal Management Program

A Guam Coastal Management Program (GCMP) Consistency Certification is being filed in compliance with the National Coastal Zone Management Act of 1972 (P.L. 92-583), as amended (P.L. 94-370). This law requires Federal agencies to conduct their planning, management, development, and regulatory activities in a manner consistent with the Government of Guam's CMP programs. The "coastal zone" of Guam includes all non-federal property within the

Territory, including offshore islands and the submerged lands and waters extending seaward to a distance of three (3) nautical miles. The Bureau of Planning, as the lead agency of the GCMP, is responsible for conducting federal consistency review for the following:

1. Federal activities
2. Activities requiring a federal license or permit
3. Federal assistance to local governments

The review to establish consistency with GCMP policies as stated in E.O. 78-37, is conducted as specified in 15 CFR Part 930. The proposed action is consistent with the objectives and policies of the Guam Coastal Management Program, as shown in the completed GCMP assessment contained in Appendix C.

5.15.2.5 Guam Environmental Protection Agency

Under the Air Pollution Control Act, Title 10, Chapter 49, Guam Code Annotated, and the Air Pollution Control Standards and Regulations, any facility which may emit pollutants into the atmosphere is required to have an Air Pollution Source Construction and Operating Permit, issued by the Guam Environmental Protection Agency (GEPA). This permit assures that facilities are built in a manner which keeps airborne emissions at a reduced level and within permissible limits, as established by Guam's Air Quality Standards. Types of facilities which need a construction permit include: laundries; incinerators and other similar facilities; as well as any facilities that burn petroleum products such as stand-by generators, boilers and compressors. Once an air pollution source facility is constructed, it must have an Air Pollution Source Operating Permit before start-up of operations.

Under the Water Pollution Control Act, Title 10, Chapter 47, Guam Code Annotated and the Soil Erosion and Sedimentation Control Regulations of 1985, projects which include grading and clearing must submit an Erosion Control Plan (ECP) to ensure erosion and sedimentation control. Review and approval of the ECP is done by GEPA.

Erosion Control Plans are a requirement of most land grading and clearing permits, which are issued by the Building Official, Department of Public Works. Such a plan must accompany the permit application and must be prepared in compliance with the promulgated Soil Erosion and Sedimentation Control Regulations.

Permits under the Guam Environmental Protection Agency jurisdiction would be required for this project due to the proposed use of emergency backup uninterruptible power sources with diesel powered electrical generators. The antenna sites are located above ground water protection zones. If underground storage tanks are utilized, these tanks would be regulated in accordance with 40CFR 280. Above ground tanks, if used, would be regulated under 40CFR 112, and would have lined containment. Above ground fuel tanks connected with the generators will be included within the existing NAVCAMS Spill Prevention Control and Countermeasures Plan prior to installation.

5.15.2.6 NAVCAMS WESTPAC Master Plan

Under the Master Plan for the Naval Communications Area Master Station, Western Pacific, Guam, approved by the Department of the Navy in 1987, the project site land use at both NAVCAMS Finegayan and RTF Barrigada is designated as "Operational." Neither site infringes upon land designated as "Constrained." Land utilization designations for both areas under the

Master Plan are listed as present or future "Built-Up Areas." Hence, the projects are in compliance with the NAVCAMS WESTPAC Master Plan.

5.15.3 Environmental Effects of Alternatives

No significant adverse effects are expected as a result of the construction or operation of the two antenna facilities. Minor construction-related impacts may occur, but these would be temporary. The socioeconomic impact would be positive to the extent that it would add resources to the Guam economy. Mitigation measures will lessen the electromagnetic radiation and interference impacts.

5.15.4 Energy Requirements and Conservation Potential of Alternatives

Energy requirements would be lowest for the no-action alternative and highest for those alternatives requiring greater transmitting distances, such as sites in the Continental United States, Hawaii, or Alaska. The highest energy consumption would be associated with the exclusive-use-of-satellites alternative due to the possible need for additional satellite launchings. For the proposed alternative, energy requirements would be relatively minor during the construction phase. During operation, the main building transformer at RTF Barrigada will have the capacity to handle 1,500 KVA service. Energy requirements of less than 250 KVA are expected at NAVCAMS Finegayan.

5.15.5 Irreversible and Irretrievable Commitments of Resources

Installation of the antennas would involve the irretrievable loss of fiscal resources, as well as labor and materials expended during construction. Land at RTF Barrigada currently in an unused state would be lost to future alternative uses; however, this loss is neither irreversible nor irretrievable. Facilities currently in use at both stations will be lost for their present uses, but this loss is neither irreversible or irretrievable. Use of electronic medical equipment upon a portion of the Naval Fleet Hospital Storage Facility east tarmac would be restricted.

5.15.6 Relationship Between Local Short-Term Use and Long-Term Productivity

Currently the site at NAVCAMS Finegayan is an active receiver antenna field. Installation of the proposed antennas will not result in any changes to the current situation.

The transmitter site at RTF Barrigada is a former transmitter antenna field. Since its dismantling in the mid-1970s the site has been inactive and not maintained. It is currently in an unproductive state. Installation of the antenna fields will restore the site to its previous productive use. Although productivity would increase at the site, one could expect a small loss of anticipated productivity due to the restricted use of medical equipment upon a portion of the east tarmac at the Fleet Hospital Storage Facility.

5.15.7 Urban Quality, Historic/Cultural Resources, and Design of the Built Environment

Since the proposed antenna project will occur among existing and former antenna fields, the addition of more antennas will not be in conflict with the surrounding urban design or built environment. Surveys have determined that there are no historic or cultural resources on the sites.

5.15.8 Means of Mitigating Potentially Adverse Effects

To mitigate any potential interference with consumer products in the housing area located near the site, greater cutouts (areas of prohibited transmission) will be implemented for the RLPA antennas. For the RLPA antenna closest to the housing complex, the restricted transmission radius will be increased to 98 degrees, from 358 to 96 degrees, to ensure that interference does not occur. For the RLPA antenna farthest from the complex, a sector cutout of 93 degrees will be implemented, from 353.5 to 86.5 degrees. Inexpensive filters for consumer products are readily available should any interference occur to individual consumer products located on the higher floors of future proposed developments adjoining the RTF Barrigada site.

Areas exceeding the Permissible Exposure Limit should be marked with warning signs bearing the Radio Frequency radiation Hazard Symbol in accordance with ANSI C95.1-1982. In areas where radio frequency radiation exceeds 10 times the PEL, fencing and warning lights are recommended to prohibit unauthorized entry during periods of transmission.

Transportation of ordnance must always occur in a HERO SAFE condition around the RTF Barrigada site. Sensitive aircraft recording instruments should be checked at proscribed intervals. If this is done at the airport in Guam, it should be done in a building farthest from the antenna site.

Impacts associated with construction and grading can be mitigated by using accepted construction procedures.

Impacts on the Naval Fleet Hospital Storage Facility would restrict usage of electrically sensitive equipment in a portion of the east tarmac area of the facility. Affected areas of the tarmac may be utilized under their currently designated use as Galley/Mess and Public Works, for which there is no EMR impact.

A determination of the specific ordnance items impacted by HERO SUSCEPTIBLE and HERO UNSAFE criteria on each flight track will be necessary from the Naval Air Systems Command and the Naval Surface Warfare Center. Antennas at RTF Barrigada would need to be marked in accordance to FAA and Navy regulations. Mitigation may include limiting the transmission power output of the offending antennas or limiting the use of certain flight tracks by aircraft carrying unsafe or susceptible ordnance. A hard-wired "hot-line" will be established from NAS Agana to the transmitter control room to provide a 15-minute minimum response to allow for a power reduction should an in-flight emergency landing situation involving aircraft with improperly configured HERO UNSAFE ordnance (hung ordnance) occur.

Coordination with the Guam Department of Public Works must occur to replace the existing wire fence in the northwester corner of RTF Barrigada with a fence constructed of a non-conductive material, preferably plastic. This would be done to prevent any electrical interference from the existing fence. Replacement work would be funded through the project.

5.15.9 Cumulative Impacts

Installation of the receiving antennas would not affect current projects at NAVCAMS Finegayan. Several impacts have been identified on RTF Barrigada due to the nature of the transmitting station and other base activities. These would include:

- Displacement of equipment currently warehoused in Building 51 and the unavailability of Building 51 as a storage facility. Additional proposed warehousing adjacent to Building 51 would mitigate this impact.

- Restricted use of electronic equipment upon a portion of the Naval Fleet Hospital Storage Facility east tarmac.

- Restricted use of HERO UNSAFE ordnance around the perimeter of the site.

- Restrictions of helicopter traffic around NAS Agana due to antenna heights and possible EMR impacts. No impacts are foreseen to fixed-wing aircraft patterns due to the proximity of the site to Mount Barrigada.

- Replacement of an existing wire fence in the northwest corner of site with a fence constructed of a non-conductive material, preferably plastic.

5.15.10 Adverse Environmental Effects Which Cannot be Avoided/Unresolved Issues

Public roads to the west and north, as well as a portion of the airport complex, would be subject to fields above the HERO UNSAFE limits. Transport of electro-explosive devices (EED) by military personnel is always in a HERO SAFE condition per existing Navy regulations. Hence, there would be no additional highway risk. Transportation of EEDs by civilians in accordance with USDOT guidelines would also pose no additional highway risk.

HERO impacts to aircraft carrying ordnance not yet HERO certified cannot be determined at this time. In addition, the particular ordnance items impacted on each flight track need to be determined so that appropriate mitigation measures can be developed. a comprehensive HERO survey, updating the 1982 survey, would be performed, encompassing all RF radiations in the vicinity of NAS Agana prior to installation of the new antennas in order to establish operating procedures.

Field strengths which marginally exceed the HERO UNSAFE ordnance criterion of 0.2 V/m may occur at the Advanced Underwater Weapons Compound. Upon installation of the antennas, further field strength measurements should be taken to verify the actual conditions at this site and other impact areas.

The effect of the TCI524s and RLPA antennas on medical electronic equipment used upon deployment of stations around the Fleet Hospital Storage Facility would restrict the use of such equipment upon a small portion of the tarmac to the east of the storage facility. However, the designation of the area is as Galley/Mess and Public Works, with the planned use of this area of the tarmac being as parking space for the motor pool and as sites for the dining and mess tents. The transmitting antennas would have no adverse impacts upon these planned uses.

The transmitter antenna heights at RTF Barrigada would violate the inner horizontal surface established around Naval Air Station Agana. However, the proximity of Mount Barrigada to both the runways and the antenna sites should remove the impacts of the antennas on fixed-wing air traffic navigation. A waiver must be obtained from the Naval Air Systems Command and a determination from the FAA has been obtained relating to the potential hazard to fixed-wing air traffic. The FAA issued a Finding of No Hazard determinination in April of 1991. As per their finding, antennas 1, 4, 5, 6, 13, 16, and 18 must be obstruction marked and lighted in accordance with FAA Advisory Circular 70/7460-1G, Chapters 3, 4, 5, and 9.

FINAL ENVIRONMENTAL ASSESSMENT FOR INSTALLATION OF TRANSMITTER AND RECEIVING ANTENNAS FOR THE DIPLOMATIC TELECOMMUNICATIONS SERVICE REGIONAL RELAY FACILITY, GUAM, MARIANA ISLANDS

Lead Agency: Department of State
Bureau of Diplomatic Security and Information Management

Coordinating Agency: Pacific Division, Naval Facilities Engineering Command
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Abstract: The United States Department of State's Bureau of Diplomatic Security and Information Management proposes to install 26 transmission antennas and 11 receiving antennas for the establishment of a Diplomatic Telecommunications Service (DTS) Regional Relay Facility in Guam. The facility will provide high frequency radio communications with embassies and consulates in the East Asian area and relays of messages to Washington, D.C. This effort, when complete, will replace functions now performed at Clark Air Base in the Philippines, allowing assigned State Department personnel to live and work in a safe environment on U.S. soil. The receiving antennas will be located at the Naval Communications Area Master Station at Finegayan. The transmitting antennas will be located at the Navy's Radio Transmitting Facility at Barrigada. Existing and former antenna fields will be utilized at both sites.

Alternatives to the proposed action include no action, location at alternative sites, and exclusive use of satellite systems.

No significant adverse environmental impacts are expected as a result of the installation of the antennas. Impacts were initially identified for the Naval Fleet Hospital Storage Facility area, but have been resolved by reconfiguration of the antenna field. Specifically, the eastern-most portion of the deployment tarmac, scheduled for use as the Public Works motor pool and Galley dining/mess tent area, cannot be used for sensitive electronic medical equipment. There would be no impact, however, since the antennas would not affect the planned motor pool and dining/mess uses.

Roads to the north and west of the transmitter site would be subjected to EMR field strengths exceeding the HERO UNSAFE criteria. Field strengths would be below all other HERO criteria. By regulation, ordnance is not transported in HERO UNSAFE conditions, so there would be no adverse impact in this regard. Civilian transportation of properly configured explosives per U.S. Department of Transportation guidelines would also not be affected. Field strengths may marginally exceed HERO UNSAFE criterion at the Advanced Underwater Weapons compound. The Navy must prepare a comprehensive HERO Survey (a routine action) and publish procedures to eliminate any hazardous conditions from arising, prior to State Department operations at RTF Barrigada. Upon installation of the antennas, additional field strength measurements should be taken to verify the actual conditions.

Portions of flight tracks for NAS Agana will cross the beams of some of the antennas. Impacts relative to explosive devices contained or transported by both fixed-wing and rotary aircraft employing these flight tracks have been determined to be acceptable by the appropriate Navy authorities in Dahlgren, Virginia. The potential impacts pertain to particular aircraft and to specific ordnance and can be mitigated under a plan of management actions that will be developed by Navy authorities in Dahlgren in coordination with Navy and State Department officials. One such mitigation measure will be the establishment of a hard-wired "hot-line" from NAS Agana to the transmitter control room to provide a 15-minute minimum response to allow for a power reduction should an in-flight emergency landing situation involving aircraft with improperly configured HERO UNSAFE ordnance (hung ordnance) occur.

The limits of EMR fields that would pose hazards to personnel under Navy and American National Standards Institute (ANSI) criteria are contained entirely within the boundaries of RTF Barrigada and do not impact any areas now occupied.

Transmitter antenna heights would violate the ideal inner horizontal surface for Naval Air Station Agana. However, the proximity and height of Mount Barrigada to both the runways and the transmitter site should make additional impacts to navigational approach paths from the antennas unlikely for fixed-wing aircraft. The antennas are not screened by Mount Barrigada for rotary-wing operations, the potential impacts of which have been determined by the Federal Aviation Administration. The FAA will require hazard lighting on selected antennas in accordance with FAA Advisory Circular 70/7460-1G, Chapters 3,4,5, and 9.

A metal fence surrounding a small parcel of land contained within RTF Barrigada and used by the Government of Guam under an easement from the Navy, will be replaced with a fence constructed of non-conductive material. This replacement will be funded through the project.

CHAPTER 6

LIST OF PREPARERS

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CHAPTER 7

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APPENDIX A

ARCHAEOLOGICAL SURVEY

Report 908-113090

Archaeological Inventory Survey
DTS Facility: Barrigada and Finegayan Sites

Dededo and Barrigada Municipalities
Territory of Guam

PHRI

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Report 908-113090

Archaeological Inventory Survey
DTS Facility: Barrigada and Finegayan Sites

Dededo and Barrigada Municipalities
Territory of Guam

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SUMMARY

At the request of Ms. Sue Rutka of Belt, Collins, & Associates, Inc., Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted an archaeological inventory survey of the approximately 514-acre DTS Facility project areas, situated in Barrigada, Barrigada Municipality, and Finegayan, Dededo Municipality, Territory of Guam. The overall objective of the survey was to provide information appropriate to and sufficient for satisfying the cultural resources inventory requirements of the Guam Historic Preservation Office (GHPO).

No sites were identified within the project area during the survey. The only cultural resources located were recent antenna-associated hardware and structural foundations. Other than archaeological monitoring of future earth moving, no further archaeological work is required in the project area.

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INTRODUCTION

BACKGROUND

At the request of Ms. Sue Rutka of Belt, Collins, & Associates, Inc., Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted an archaeological inventory survey of the approximately 514-acre DTS Facility Barrigada and Finegayan project areas, situated in Barrigada, Barrigada Municipality, and Finegayan, Dededo Municipality, Territory of Guam. The overall objective of the survey was to provide information appropriate to and sufficient for satisfying the cultural resources inventory requirements of the Guam Historic Preservation Office (GHPO).

The field work portion of the survey was conducted on October 16, 17, 19, and 22, 1990, by a crew of six, under the supervision of Supervisory Field Archaeologist Bradley J. Dilli, B.A., Supervisory Archaeologist Roderick S. Brown, M.A., and under the overall direction of Senior Archaeologist Dr. Alan E. Haun. Crew members included Crew Chief David E. Highness, B.S. and Field Archaeologists Mark Donham, David Dillon, Neil Rhodes, Jeff Johnston, and Bert Meigs. Approximately 20 labor-hours were expended in conducting the field work portion of the survey.

This report constitutes the final report for the present project. It includes project objectives and a Scope of Work. It describes field methods and findings. Because no archaeological remains were identified, no general significance assessments were assigned, and no general treatments were recommended.

SCOPE OF WORK

The basic purpose of the survey was to identify—to discover and locate on available maps—all sites and features of potential archaeological significance within the specified project area. An *inventory* survey is an initial level of archaeological investigation and is extensive rather than intensive in scope. An inventory survey is conducted with the primary aim of determining the presence or absence of archaeological resources within a specified project area. A survey of this type indicates both the general nature and the variety of archaeological remains present, and the general distribution and density of such remains. It permits a general significance assessment of the archaeological resources, and facilitates formulation of realistic recommendations and estimates for any further work that might be necessary or appropriate. Such work could include *intensive survey*—data collection involving detailed recording of sites and features, and selected test excavations. It might also include subsequent *mitigation*—data recovery research excavations, construction monitoring, interpretive planning and development, and/or preservation of sites and features with significant scientific research, interpretive, and/or cultural values.

The basic objectives of the present survey were fourfold: (a) to identify (find and locate) all sites and site complexes present within the project area, (b) to evaluate the potential general significance of all identified archaeological remains, (c) to determine the possible impacts of proposed development upon the identified remains, and (d) to define the general scope of any subsequent data collection and/or mitigation work that might be necessary or appropriate.

Based on a review of available background literature, and on familiarity with the current requirements of review authorities, the following specific tasks were determined to constitute an adequate and appropriate scope of work for the proposed survey:

1. Review available background archaeological and historical literature relevant to the immediate project area;

2. Conduct a 100% coverage surface survey of the entire project area, with emphasis upon (a) identification and collection of any portable cultural remains (e.g., artifacts, midden, or human bones), and (b) identification and evaluation of any subsurface cultural deposits that might be visible in any existing exposures (e.g., erosional faces and drainage channels);

3. Conduct shovel tests at identified sites to determine the presence/absence and general nature of subsurface deposits; and

4. Analyze background and field data, and prepare appropriate reports.

PROJECT AREA DESCRIPTION

Guam has been subdivided into geologic blocks by Tracey et al. (1959). Using this scheme, the limestone plateau of north Guam, on which the project area is situated, comprises the Machanao and Barrigada Blocks. The main geologic component of both blocks is the Mariana Limestone Formation. This formation has two members. The main member, which is not named, constitutes most of the Northern

Plateau and the northerly Machanao Block. The present project area is situated within this geographic region. The southern portion of the plateau constitutes the Barrigada Block and is composed of the Agana argillaceous member.

The plateau is a virtually flat platform of reef-associated limestone that through tectonic activity has been lifted above sea level and tilted slightly to the southwest. Soil on the plateau is characterized by a thin mantle of Guam clay, or by scattered pockets of this clay in depressions within the limestone. Guam clay is a red, granular, friable clay that constitutes the most extensive soil unit on Guam.

The present project area consists of two irregular parcels: the approximately 309-acre Barrigada Transmitter site in Barrigada Municipality, and the approximately 204-acre Finegayan Receiver site, located on the Naval Communications station, Finegayan, Dededo Municipality (Figures 1 and 2). Average elevation of the Barrigada project area is approximately 320 to 400 feet above mean sea level (AMSL) and at the Finegayan parcel, 400 to 440 feet AMSL. Vegetation at the project area is dominated by a dense cover of secondary growth, which limits ground visibility. This growth includes grasses such as swordgrass (*Miscanthus floridulus* [Labill.] Warburg ex. Schum. & Lauterb.) and elephant grass (*Pennisetum purpureum* [Schumacher], Beskr. Guin.), and vines such as wait-a-bit (*Caesalpinia major* [Medic.] Dandy & Exell), and *tangan-tangan* (*Leucaena glauca* L. [Benth.]), *pago* (*Hibiscus tiliaceus* L.), and limon-china (*Triphasia trifolia* (Burm. f.). Occasional stands of Northern Plateau Limestone forest growth were also noted surrounding the periphery of the Finegayan project area. Limestone forest species noted were pandanus (*Pandanus fragrans* Gaud.), *ifil* (*Intsia bijuga* [Colebr.] O.Kuntze), false rattan (*Flagellaria indica* L.), and cycad (*Cycas circinalis* L.).

The surface of the two parcels has been extensively disturbed by activities related to past and present military installations. The Barrigada parcel has had extensive surface treatments (i.e. cutting and filling) and contains the remains of many past military antennae installations. The Finegayan parcel has also been extensively graded and contains many operational antennae.

HISTORICAL OVERVIEW

The Spanish were the first Europeans to arrive in the Marianas. For more than 250 years they used Umatac and Agana, on Guam, as replenishment stations for Manila Galleons carrying silver, gold, and other cargo from Acapulco to Manila. The Spanish established governorships in the Marianas. Quiroga was notable among the governors; between 1680 and 1683, in response to serious, episodic native uprisings, he ordered all natives to settle in seven parish villages: Hagatna (Agana), Pago, Juapsan (Jinapsan), Juarahan (Inarajan), Merizo, Humatag (Umatac), and Agat. All other native settlements were destroyed. At Quiroga's order, churches were erected at Jinapsan, Pago, Umatac, Agat, and Inarajan.

The Spanish presence totally disrupted the native Chamorro culture. Diseases introduced by the Spanish decimated Guam's native population, which fell from an estimated 100,000 people at contact, to barely over 3,000 in 1710. The Spanish imported Chinese, Filipinos, Japanese, and other Pacific Islanders to compensate for this dramatic reduction of the Chamorro labor force, upon which they depended.

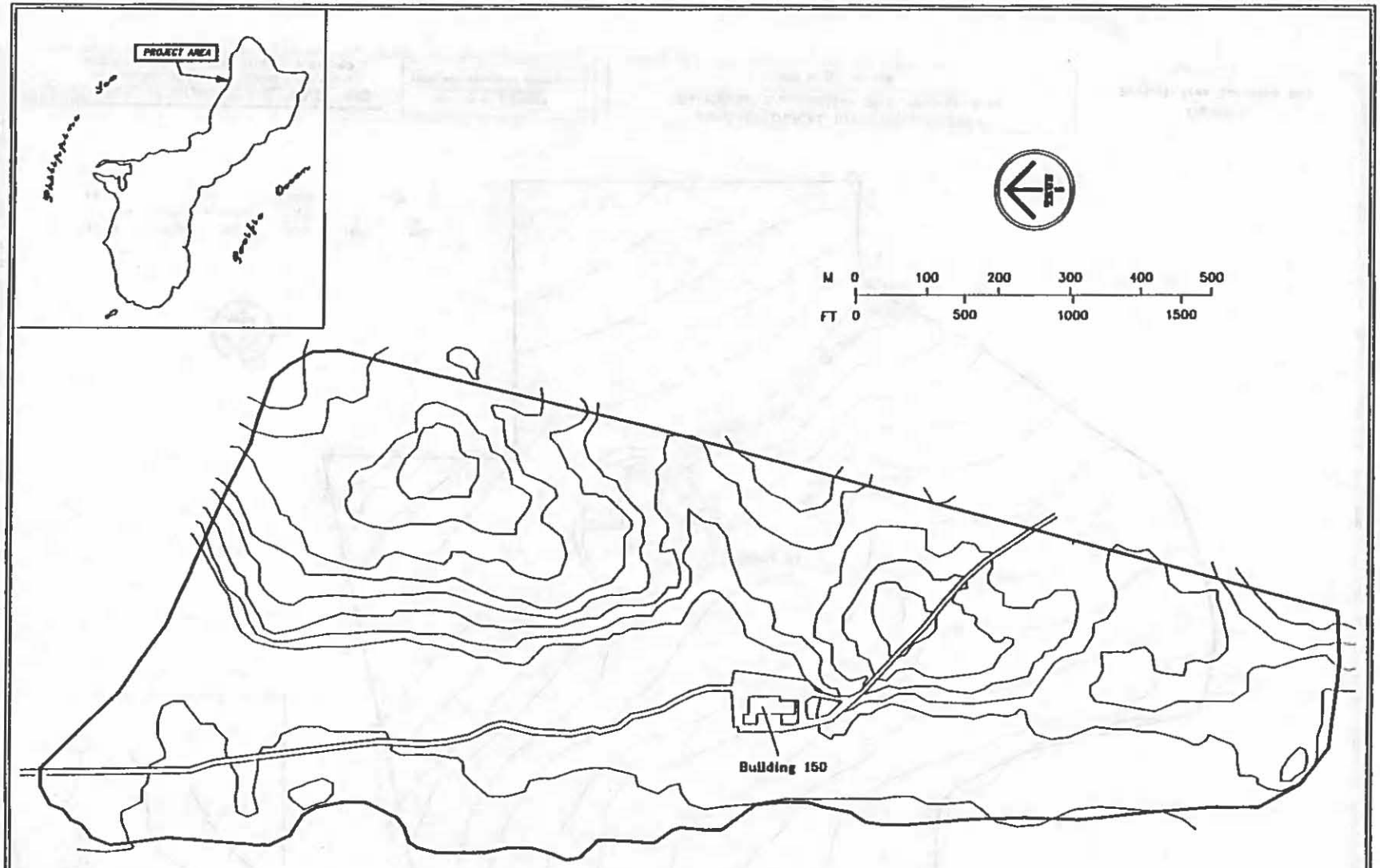
The influx of immigrants diluted the original Chamorro culture. By the eighteenth century, the population of the Marianas was an admixture of peoples from throughout the southwest Pacific (Carano and Sanchez 1964).

By 1824, Guam's native population had increased to about 5,920—concentrated in Agana, Umatac, Agat, Merizo, Pago, and Inarajan (Carano and Sanchez 1964). In 1856, disaster struck again: a smallpox epidemic reduced the native population by more than half (3,644 deaths). In response to the epidemic, hospitals were established at Agat, Umatac, Merizo, Pago, and Inarajan.

Spanish control on Guam ended when the United States assumed control in 1899. The American administration improved roads and utilities until the island fell to the Japanese in 1941. Tumon was the landing site of the Japanese invasion force, and the Japanese subsequently fortified it, and Agana, to repel counter-invasion by the Allies. The Japanese occupation and fortification modified Guam substantially. The United States recaptured the island in August 1944. During the Allied invasion, Agana was completely destroyed by naval artillery and aerial bombardment. The town was reconstructed soon after the war and currently serves as the island's governmental and commercial center.

PREVIOUS ARCHAEOLOGICAL WORK - GENERAL

Under the aegis of B.P. Bishop Museum in Honolulu, Hans G. Hornbostel conducted the first serious archaeological investigations in the Mariana Islands. Hornbostel's work remains largely unpublished; however, in 1932, Laura



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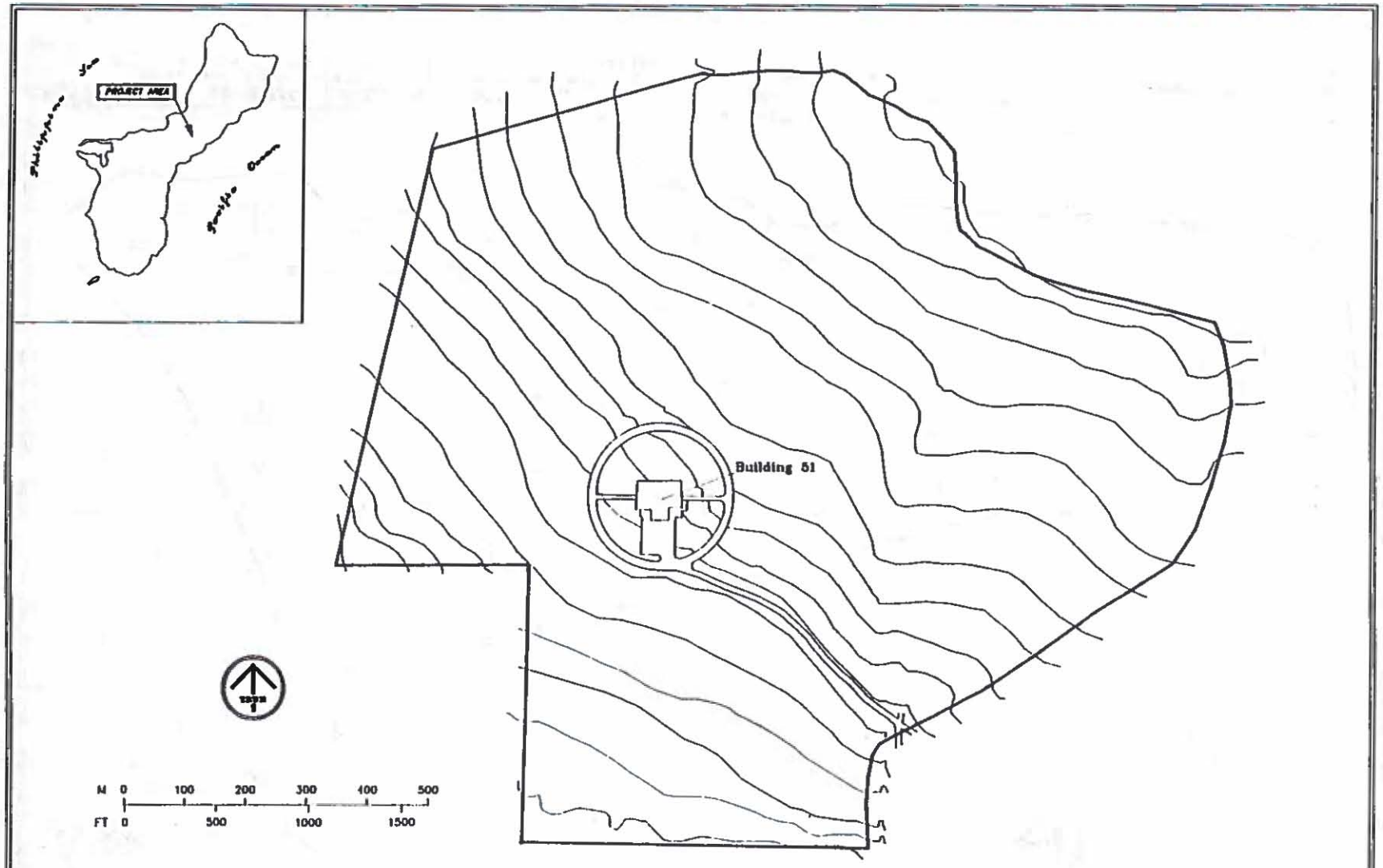
ARCHAEOLOGICAL INVENTORY SURVEY
Finegayan Receiver Site Project Area
PHRI Project 90-908

Figure 1.
Project Area Location Map



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ARCHAEOLOGICAL INVENTORY SURVEY
Barrigada Transmitter Site Project Area
PHRI Project 90-008

Figure 2.
Project Area Location Map

Thompson published an analysis of some of Hornbostel's records and collections (Thompson 1932). Prior to the end of WWII, Hornbostel's work, Thompson's 1932 report, and a work on *latte* sets by Thompson (1940) constituted the entire body of formal archaeological literature concerning the prehistory of Guam.

Immediately after the war, Douglas Osborne (1947) published the results of his efforts to reconstruct *latte* sets in Gognga Cove and the results of his cursory examinations of other portions of the island. Osborne's work was primarily descriptive, but he did attempt (unsuccessfully) to discern differences between inland and coastal sites, ceramic materials, and characteristics of *latte*. Aware that the available data was limited, Osborne made no attempt to establish a prehistoric chronology.

The temporal framework within which archaeological interpretations are made today was formulated by Alexander Spoehr (1957). Spoehr's work on Rota, Saipan, and Tinian incorporated the radiocarbon dating method and enabled him to describe two archaeological manifestations of Chamorro prehistory—the Pre-Latte Phase (BC 1500 to AD 800-1000), and the Latte Phase (c. AD 1000-1200 to European colonization). These two phases are distinguished by differences in associated portable remains (particularly ceramics) and by the inclusion, or lack of, monumental architectural features, called *latte* sets, that are associated exclusively with more recent archaeological sites.

Until recently, most archaeological research after Spoehr has focused on the geographic origins of the Chamorro people and on enhancing descriptive Chamorro culture history (Takayama and Egami 1971). More recent research has focused on (a) refining the methods by which temporal variation in the archaeological record can be perceived and quantified (Athens 1986), (b) the discernment of environmental factors (Graves and Moore 1985), and (c) the explanation of diachronic differences in the archaeological record in terms of the evolution of Chamorro culture.

Several researchers have recently attempted to discover patterning in the various features present in archaeological deposits on Guam. Their aim has been to discern the areal relationships between the structural and functional entities within prehistoric Chamorro settlements. Bath's 1986 excavations at Matapang, during the San Vitores Road Project, and Butler's work on the north coast of the island of Rota (Butler 1988) are examples of preliminary attempts to define the basic structural units within prehistoric Chamorro settlements. But with the exception of *latte* sets, not a single architectural feature has been completely exposed.

In recent years, Guam has undergone rapid development. As a result, there has been a substantial increase in archaeological information concerning the island. Archaeological investigations in the coastal regions of Guam as a whole have increased over the last few years, due to commercial development related to the Japanese tourist trade. Hotel construction and the construction of attendant support facilities—utilities, nightclubs, golf courses, shops, and specialty establishments—have resulted in a proliferation of survey and excavation projects. The projects have been mandated by federal and territorial environmental protection regulations and are funded by the project developers.

As a result of these studies, hypotheses concerning the development of Chamorro culture are being formulated and tested. The emerging picture is one of small Pre-Latte Phase coastal populations adapted to collecting marine resources in the coastal lagoons, and later, Latte Phase populations, adapted to agriculture and making greater use of inland areas. The earliest inhabitants made thin-walled pottery that was tempered with calcareous sand, fishing equipment, shell and stone tools, and shell ornaments. In addition, they appear to have made greater use of bivalves than gastropods. Graves and Moore (1985) indicate that in comparison with the upper levels, the lower levels of sites with a Pre-Latte component contain a higher ratio of bivalves to gastropods.

Pre-Latte sites are characterized by deep and ephemeral soil horizons that contain a higher percentage of bivalve remains than Latte Phase sites. They are also characterized by thin and narrow-rimmed pottery, and by the absence of *latte* and mortars (Butler 1988, Bath 1986). Latte deposits are characterized by surface or near-surface organic-rich soils containing abundant thick-walled, wide-rimmed pottery, and by relatively abundant gastropod remains. Mortars and *latte* stones (sometimes fallen and sometimes erect) are often found on the surfaces of these sites. Human burials are usually found within and near *latte* sets. The association of these burials with the presumed high status architecture suggests that the burials are the remains of high status individuals.

A Transitional Phase between the Pre-Latte and Latte Phases (c. AD 1-AD 1000) has been postulated, but it has not been well defined. During the proposed Transitional Phase, the population increased and expanded seaward and inland. There was an increased dependence on large pelagic fish

(Moore 1983), and ceramic vessels increased in size and evolved into "a relatively homogeneous ceramic assemblage" (Graves and Moore 1985).

During the Latte Phase, structures built on compound stone foundation posts (*latte*) became common. *Latte* occur in sets of parallel rows of four, five, six, and seven pairs. These sets are found most frequently in coastal zones, in association with human burials, large and thick wide-rimmed sherds, and midden in which the shellfish *Strombus gibberulus gibbosus* predominates.

Little is known about the Pre-Latte Phase population, and there is no conclusive evidence concerning the origins of Guam's first inhabitants. Details of their societal organization are not discernible from the limited data available. The earliest recorded archeological site on Guam, at Ypao Beach, in the Tumon Bay area, dates to 3000 BP (Territorial Archaeology Laboratory 1982). A questionable date of BC 4395-3800 was derived from a sample taken by Bath during the San Vitores Road Project (Bath 1986). From Ypao Beach, there was probably a population expansion towards Gognga Beach and shoreward. In the Latte Phase all the lowland area between the reefs and the inland cliffs appears to have been occupied.

The distribution of recorded and otherwise known Latte Phase habitation sites suggests that these sites occur more frequently and contain more substantial deposits in the coastal plains "in the land sea interface" (Kurashina 1986). Whether these distributions reflect the actual distributions of Latte Phase sites remains to be demonstrated, since there has never been a representative survey of the island. Only a relative few inland Latte Phase sites have been found. As Reinman has suggested "[l]arge areas of the island remain unsurveyed and there is little doubt that considerably more sites remain..."(Reinman 1977).

Latte Phase sites are much more conspicuous and more likely to be discovered than Pre-Latte sites. They often include the remains of large stone *latte* sets, which are noticeable even in dense jungle. They were also occupied later in time, and as a result, are found in higher strata. Thus they are more likely to be exposed on the surface. Whether these characteristics explain the preponderance of Latte Phase sites, or whether they are actually more abundant, is open to question. For whatever reason, the fact remains that Pre-Latte sites constitute but a small fraction of the recorded sites on Guam.

Latte sets have been most commonly interpreted as the remains of the foundations of high status residences, or infrequently, as purely ceremonial structural remnants. Archaeological investigations at Latte Phase sites have usually focused on the exposure of the areas within and adjacent to the *latte* sets themselves (Osborne 1947, Reinman 1966, Takayama and Intoh 1976) at the expense of the identification of presumed nearby lower status residences and the portions of the sites that were devoted to other activities. As a result, less is known of the intra-site distribution within Latte Phase sites than of their inter-site variability. Very little is known concerning intra-site variability of Pre-Latte sites. As Graves and Moore (1985) have stated "...we know virtually nothing about early prehistoric organization over a period... that spans at least 2,000 years."

PREVIOUS ARCHAEOLOGICAL WORK - PROJECT AREA AND VICINITY

Several researchers have studied sites in the general vicinity of the project area and sites situated in similar topographic settings, that is, sites in the interior uplands of Guam's Northern Plateau. Hornbostel produced a map of Guam depicting *latte* sites and *latte* density within the sites (IN Reed 1952; Map 1). The map shows dense clusters of *latte* on the northern plateau near Mataguac Spring, Mount Santa Rosa, Mangilao, and a series of four clusters extending from the southwest flank of Mt. Barrigada to the Chochoga-Toto area, east of Agana, an area now largely occupied by the Naval Air Station.

In 1945-46, Osborne (1947) visited all of the sites shown on Hornbostel's map, except the ones at Mangilao and probably those in the vicinity of the Naval Air Station. It is evident from Osborne's descriptions that major portions of these sites had been destroyed since Hornbostel visited them in the 1920s. Osborne reported an eight-stone *latte* set at Toto Village and a destroyed set at the 5th Depot Officer's Country (exact location unknown). These are probably remnants of the southernmost cluster identified by Hornbostel, a cluster that was subsequently destroyed by construction of the Naval Air Station at Agana. Osborne reported a site east of Yigo, which consisted of an extensive scatter of pottery sherds. Osborne also recorded two *latte* sets at Mogfog, southeast of Dededo; one at Maina, west of Agana; and several destroyed sets at Agana Heights.

Osborne's (1947) extensive but cursory examination of sites throughout Guam led him to conclude that, compared to coastal sites, the "archaeologically most complex, largest and spectacular sites are inland" (1947:49). Osborne cites as examples the site at Mogfog and the southern Guam interior sites of Acapulco, Chandija, Mepo, Pulantat, and San Isidre.

Osborne interpreted the presence of inland sites as evidence that the population had grown to a size that necessitated the use of inland food sources. He speculated that the apparent lack of midden at inland sites was either because erosion had removed the midden, or because inland sites were occupied late, and therefore not long enough for significant accumulation of midden. According to Osborne, the latter possibility is the more likely explanation. A third possibility mentioned by Osborne is that inland sites may have functioned as religious or ceremonial centers that were "visited but not extensively inhabited" (1947:49). Finally, Osborne suggests that the Spanish presence on Guam may have played a role. He speculates the Spanish may have destroyed most of the large coastal *latte* settlements and thereby left archaeologists with a false impression of the relative sizes and significance of inland versus coastal settlements. Alternatively, the appearance of inland settlements might represent an attempt by coastal dwelling groups to "escape the religious and social domain of the Spanish" (1947:49).

Reed (1952) surveyed sites on Guam in 1952 and reported that the *latte* sets at Maina and Toto Village had been destroyed. He described the remnants of at least four *latte* sets at the Agana Heights site (12-stone, 10-stone, 2 unknown), with associated pottery sherds, midden deposits, and basalt mortars. Reed reported a large site at Maimai immediately west of Mangilao. This site may correspond to a portion of the Mangilao *latte* cluster on Hornbostel's map. The site comprises at least four *latte* sets (six-stone, ten-stone, and two eight-stone sets) associated with an extensive area of shallow midden deposits, and a surface scatter of potsherds and marine shell. Reed noted that a large *latte* site at Dededo was destroyed during air field construction in 1946.

In the mid-1960s Reinman (1977) conducted surveys and excavations throughout the island. He identified a total of 138 sites, 37 in the north half of the island and 101 in the south. He subdivided these areal groupings on the basis of topographic setting: coastal plain, southeast coastal limestone plateau, interior river valley, and upland interior. In the north, all sites, except one each from river valley and interior upland contexts, were situated on the coastal plain. In the south, 43 sites were identified on the coastal plain, 11 on the southeast coastal plateau centering on the town of Malojloj, 18 in the river valleys, and 29 in the uplands. Reinman's northern interior sites include a large, badly disturbed site containing at least four *latte* sets at Mataguac Hill (MaGY-11), and a single *latte* set associated with a surface scatter of pottery at Agana Heights (MaGAH-1). It is unclear which of these two sites was categorized as a river valley site by Reinman.

According to Reinman, interior upland sites on Guam are typically situated on grassy knolls, forested ridges, and at the heads of small drainages. Reinman characterized interior upland sites as frequently consisting of numerous *latte* structures. He found that artifacts associated with these sites—pottery, mortars, and stone tools—were generally sparsely scattered over the surfaces of sites, and that the sites were rarely associated with midden deposits. Reinman also noted that interior upland sites contrasted with sites in coastal areas and with interior river valleys. The most important difference was that midden deposits and artifacts were scarce at the upland sites. Reinman interpreted the interior upland sites as small to large villages at which occupation was "either very late, infrequent (seasonal) or both" (1977:19).

At the South Finegayan Navy housing area, Birkedal and McCarty (1972) recorded and excavated a ten-stone *latte* set with associated with shallow deposits: pottery sherds, a shell adze fragment, and fire-cracked basalt and limestone. The site, called the NCS Latte Site, was dated to the Latte Phase (based on ceramic analysis and a single radiocarbon date). The site is interpreted as a habitation that was occupied, presumably on a permanent basis, for a "short term" of less than one-hundred years (1972:8).

In 1981, the Territorial Archaeological Laboratory recorded three *latte* sets at Chochogo, east of Agana. A 10-stone *latte* set at the c. 3.0 hectare site, which formerly included more than four *latte* sets, was subsequently excavated in 1985 by Cordy and Allen (1986). Remains recovered in 1985 included pottery sherds, shell and ceramic beads, a basalt pounder, a basalt abrader, chert flakes, and marine shell midden. The site is interpreted as a permanent Latte Phase habitation site.

Kurashina and Sinoto (1984) conducted a survey of a 776-acre parcel in Mangilao Municipality, east of Asbeco. The survey did not identify any sites. The absence of sites is attributed to extensive disturbance connected with ranching and military activities.

Moore (1987) conducted a survey of a 260-acre parcel near Asdonlucas, in southeastern Dededo Municipality. The

survey located one site in a limestone forest. The site included two stone platforms, a probable deposit, a surface artifact scatter composed of five to six pottery sherds, a shell adze, and a basalt boulder mortar. The site is interpreted as a Latte Phase habitation.

Kurashina et al. (1987) conducted surveys of four areas on the northwestern portion of the Northern Plateau, east of Urunao Point and Falcona Beach. The surveys covered a total of approximately 905 acres and identified 17 prehistoric sites. The sites are composed of small surface scatters of two to twenty sherds and two isolated artifacts. Based on ceramic analysis, the sites are interpreted as Latte Phase. The denser distribution of sites near the cliff at the edge of the plateau is interpreted as a possible indication that the land was controlled and/or utilized by occupants of the large adjacent coastal sites. The absence of *latte*, lack of subsurface deposits, and the limited nature of the portable remains are cited as indications that the sites were not permanent settlements, and as evidence of the marginal nature of Northern Plateau limestone forest land use.

PHRI conducted an archaeological inventory survey of an approximately 205-acre parcel east of Dededo (Brown, Dilli, and Haun 1989). The survey identified one prehistoric pottery scatter (66-04-0311), which was interpreted as a prehistoric habitation site. Analysis of pottery collected from the site places it in the Latte Phase. The limited quantity of material at the site is interpreted as indicating that habitation activity was short-term. The habitation activity may have been incidental to such activities as water procurement, plant food or industrial material gathering/processing, hunting, gardening, and/or other as yet unknown activities. PHRI undertook mitigation of site 66-04-0311 in July of 1990 (Brown, Highness, and Haun 1990), and the final report is in preparation.

Brown, Dilli, and Haun conducted archaeological inventory surveys of (a) an approximately 50-acre parcel southeast of Potts Junction (1990a), and (b) of an approximately 18-acre parcel on Ypao Road, in Tamuning (1990c). The surveys did not identify any prehistoric sites. The lack of sites is attributed to previous disturbance and/or to the fact that much of the surface is exposed limestone bedrock.

PHRI conducted an archaeological inventory survey of an approximately 200-acre parcel west of Dededo (Haun 1989a). The survey identified one prehistoric pottery scatter. The site is interpreted as a prehistoric temporary habitation site. Analysis of pottery collected from the site places it the early Latte Phase, c. AD 800-1000. The analysis further determined that between seven and eleven vessels were represented by the 31 sherds collected from a three square-meter area of the site.

Haun (1989b) conducted an archaeological inventory survey of an approximately 200-acre parcel at Northwest Field, Anderson Air Force Base. The survey did not identify any prehistoric sites. The lack of sites was attributed to extensive previous disturbance connected with the construction of the air field.

PHRI conducted an archaeological inventory survey of an approximately 200-acre parcel extending between Northwest Field and the Naval Communications Area Master Station (Haun 1988). The survey identified seven pottery scatters and two isolated artifacts. Ceramic analysis indicated a probable Latte Phase age for use of the sites. The sites are interpreted as temporary habitation sites occupied in conjunction with the exploitation of upland resources. The sites were probably used by people who lived permanently at the coast.

As part of the above project (Haun 1988) PHRI also conducted archaeological field inspections of portions of two other parcels: an approximately 200-acre parcel in Yigo Municipality, on the northern plateau between Mt. Machanao and Pajon Point, and of portions of an approximately 200-acre parcel at Harmon Annex, in Dededo Municipality. The Yigo inspection identified two small pottery scatters presumed to have been used by occupants of the large coastal site at Jinapsan Beach. The Harmon Annex inspection did not identify any prehistoric sites, presumably because the area had been extensively disturbed.

PHRI subsequently conducted an archaeological inventory of a second approximately 200-acre parcel at Harmon Annex. No prehistoric sites were identified (Haun, Brown, and Dilli 1990). As before, the absence of prehistoric remains was attributed to extensive disturbance.

Brown and Haun (1989) conducted an archaeological inventory survey of an approximately 25-acre parcel near Mataquac Spring. The survey did not identify any prehistoric sites. The lack of sites is attributed to previous disturbance.

PHRI conducted a survey of an approximately 65-acre parcel along the tributary of the Choat River, in Chalan Pago-Ordot Municipality (Brown, Dilli, and Haun 1990c). During the survey five prehistoric sites were identified. These included three lithic scatters, one relatively intact *latte* site (one to two sets), and a disturbed *latte* set. Subsurface deposits at the intact Latte Phase site indicated an occupation

Table 1.

SUMMARY OF NORTHERN PLATEAU SITES

Site No.	Dist. to Coast (km)	Elevation (AMSL) (m)	Area (hect)	Sherd Density (/sq m)	Comments
PHRI Sites					
460-1	1.2	146	0.0038	4.0000	10 cm deposit
-2	1.1	146	0.0100	3.0000	no deposit
-3	1.2	155	0.0225	6.0000	15 cm deposit
-4	1.1	155	0.0150	0.0667	no deposit
-5	1.1	155	0.0150	3.0000	no deposit
-7	1.0	155	0.0920	53.0000	15-20 cm deposit; shell adze
-9	1.0	150	0.0025	2.0000	no deposit
532-1	0.5	113	0.0035	4.0000	no deposit
706-1	7.0	70	0.09	———	sherds and lithics
-2	7.0	70	1.34	———	sherds and lithics
-3	7.0	72	0.18	———	sherds and lithics
-4	7.0	46	0.017	———	two *latte* sets
-6	7.0	60	0.06	———	disturbed *latte* set
742-1	4.5	119	0.0049	7.0000	no deposit
Average	3.41	115	0.1326	9.1185	
Kurashina et al. (1987) Sites*					
T-1	2.0	165	0.0005	2.3913	11 sherds; no deposit
-2	1.4	170	0.0132	0.0227	3 sherds; no deposit
-3	1.6	165	0.0030	0.1200	3 sherds; no deposit
-5	0.7	145	0.0528	0.0133	3 sherds; no deposit
-6	0.6	145	0.0004	1.7500	7 sherds; no deposit
-7	0.6	145	0.1200	0.0250	7 sherds; no deposit
-8	0.6	143	0.0113	0.1416	16 sherds; no deposit
-9	0.4	143	0.0024	0.8334	20 sherds; no deposit
-10	0.4	140	0.0016	0.2500	4 sherds; no deposit
-12	0.4	140	0.0049	0.0408	2 sherds; no deposit
-13	0.3	140	0.0100	0.0700	7 sherds; no deposit
-14	0.4	137	0.0099	0.1414	14 sherds; no deposit
-15	1.2	170	0.0009	0.3334	3 sherds; no deposit
-16	0.6	147	0.0140	0.4286	6 sherds; no deposit
-17	0.5	147	0.0450	0.0156	7 sherds; no deposit
Average	0.7533	150	0.0194	0.4385	

* Sites consisting of single potsherds (T-4 and T-11) have been omitted.
Note: "—" = missing or unavailable data

Table 1. (cont.)

Site No.	Dist. to Coast (km)	Elevation (AMSL) (m)	Area (hect)	Sherd Density (/sq m)	Comments
Other Sites					
66-08-0141	1.3	98	0.5360	———	NCS Latte Site; shell adze, deposit; (Birkedal & McCarty 1972)
MaGMa-2	1.75	49	———	———	Agana Heights; 6+*latte*, deposit (Reed 1952, Osborne 1947)
MaGY-11	4.0	122	———	———	Mataguac Hill; 4+ *latte* sets (Reinman 1977)
Maina	1.25	85	———	———	one *latte* set; deposit (Osborne 1947)
Maimai	2.25	30	———	———	four+ *latte* sets; Reed (1952)
5th Service Depot Officer's Country	—	—	———	———	Large *latte* set; location uncertain- east Agana area (Osborne 1947)
Chochogo	5.0	12	3.1000	———	4+ *latte* sets
Toto Village	3.0	60	———	———	8-stone *latte* set; destroyed; (Osborne 1947; Reed 1952)
Mogfog	3.0	86	———	———	2 *latte*; destroyed; (Osborne 1947; Reed 1952)
T-1	0.5	171	0.4464	0.0014	pottery (6) shell adze (Asdonlucas) mortar, stone platforms, deposit (Moore et al. 1988)
East Yigo	—	—	———	———	Pottery scatter, E. Yigo (Osborne 1947, Reed 1952)
Mt. Santa Rosa	—	—	———	———	Dense *latte* cluster (Hornbostel map IN Reed 1952)
Dededo	—	—	———	———	Large Latte site at Dededo destroyed by airfield construct.
SW Mount Barrigada	—	—	———	———	Dense *latte* cluster (Hornbostel map IN Reed 1952)
Naval Air Station (2 sites)	—	—	———	———	Dense *latte* clusters (Hornbostel map IN Reed 1952)
Average	2.5	79	1.3561	0.0014	
Overall Avg.	2.9	163	0.2825	6.7118	(4.2756)

of considerable duration, and the ceramic sherds and flaked lithics at the site suggested that a variety of activities occurred there. The lithic scatters in the area were interpreted as an indication of stone tool production and tool use. The lithic material at the sites included tool-quality aphanitic silicas that ranged from cream-colored to deep red and brown. The material was probably derived from outcrops of similar materials found on the ridges surrounding the present project area.

To date, the above-mentioned studies of Northern Plateau interior upland areas of Guam have identified a total of at least 43 sites (Table 1). Data for some of the sites are unavailable or missing, because they were destroyed. Site elevation ranges from 12 m to 170 m AMSL, with an average of 163 m AMSL. The sites are situated between 0.4 km and 4.5 km from the coast, with an average distance of 2.5 km. *Latte* sets are found at 36% (15) of Northern Plateau interior upland sites. Approximately half of the *latte* sites are characterized by one to two *latte* sets. The other *latte* sites apparently had four or more *latte* sets. The remaining sites lack *latte* remains and consist of surface scatters of pottery and other non-ceramic artifacts.

Pottery sherds, predominately characterized by Latte Phase attributes, are found on the surfaces of nearly all Northern Plateau interior upland sites. Sherd density ranges from 0.0014 to 53 sherds per square meter, with an average density of 6.7118 sherds per square meter (4.2756 sherds per square meter if the unusually high value from PHRI Site 460-7 is omitted). These size data are skewed by the low densities recorded by Kurashina et al. (1987), which average one sherd per 26 square meters. In contrast, the sites identified by PHRI average 9.1185 sherds per square meter (3.6667 sherds per square meter if the large value is omitted). Stone tools and mortars are uncommon at the sites. Shell adzes are also rare, but they are more common than stone tools. Marine shell midden is rare, and subsurface deposits tend to be thin and to contain little cultural material.

In terms of size, using the smallest rectangular area which would include the entire site, interior upland sites of the Northern Plateau range from 0.0004 hectares to 3.1 hectares, with an average size of 0.2825 hectares (0.1297 hectares if the high value for the Chochogo Site is omitted). These size data primarily are derived from non-*latte* sites and from *latte* sites with only one or two *latte* sets. No size data are available for the larger sites noted by Hombostle, Osborne, and Reed. These sites apparently have been destroyed; however, based on Hornbostel's map, they must have been one or more hectares in extent.

Previous researchers (Kurashina and Sinoto 1984:10) have estimated a site-density of one site per 24 square miles (6,216 hectares) for the northern limestone plateau interior; however, this estimate was based on the limited data available at that time. Table 2 summarizes site-density and other pertinent data from archaeological surveys of 17 separate parcels on the flat portions of the Northern Plateau. Within individual parcels density ranges from no sites, to one site, per two hectares. Taken as a whole, the data yield a site-density of one site per 43 hectares. These data are skewed by prior disturbance of portions of most of the survey areas. An attempt was made to control for this by classifying and quantifying vegetation type as either secondary-growth or limestone forest vegetation. Areas characterized by limestone forest are presumed to have been undisturbed by earth-moving Assuming that most, if not all, identified sites occur in areas supporting the latter vegetation type, a density of one site per 6.7 hectares results. It should be noted that this figure is primarily based on surveys of areas near cliffs, at the edges of the northern limestone plateau.

Based largely upon surface evidence, Northern Plateau interior upland sites appear to be primarily Latte Phase. The sites are interpreted as semi-permanent to permanent habitation sites when *latte* are present, and as short-term to temporary habitation sites when they are not. It is presumed the habitation function assigned to the latter sites was incidental to some other, as yet unknown, activity, such as gardening or natural resource exploitation (i.e., collecting plant food or industrial materials, hunting, procuring water, etc.).

In terms of distribution, non-*latte* sites of the Northern Plateau appear to cluster near the cliffs above areas where there were large coastal settlements (Kurashina et al. 1987). Northern Plateau *latte* sites are found on the dissected southwestern portion of the plateau, in the "waist" of the island between Agana, Barrigada, and Pago Bay. Eight to nine, of the total of fifteen *latte* sites, are found there. Elsewhere, on the northern flat-lying parts of the plateau, *latte* and non-*latte* sites appear to be concentrated along major fault zones, including the Tamuning-Yigo, Machanao, and Mount Santa Rosa faults. Water, both from springs, and ponded after rains, is more readily available in these areas, compared to the surrounding terrain of the Northern Plateau. The drainage patterns associated with these faults tend to build up alluvial soils, which may have been used for agriculture.

Table 2.

SUMMARY OF NORTHERN PLATEAU SURVEY RESULTS

Survey Area	Survey Area Location	Elevation AMSL (meters)	Veg.* Type	No. Sites	Hect. Site	Survey Cvrg.	Reference
81	S. Central	avg. 120	90% SND/10% LSF	1	81	100%	Brown et al. (1989)
20	N. Central	avg. 137	100% SND	0	0	100%	Brown et al. (1990a)
7	SW. Coastal	21-27	100% SND w/ CLTGNS	0	0	100%	Brown et al. (1990b)
81	Central W. Coastal	98-116	95% SND/5% LSF	1	81	100%	Haun (1989a)
81	NW Coastal	avg. 152	100% SND	0	0	100%	Haun (1989b)
81	NW Coastal	128-158	80% SND/20% LSF	7	12	100%	Haun (1988)
24 (81)*	Central W. Coastal	79-110	100% SND	0	0	30%	Haun (1988)
16 (81)	Northern tip	61-152	50% SND/50% LSF	2	8	20%	Haun (1988)
111	W. Central	79-98	100% SND w/ CLTGNS	0	0	100%	Haun et al. (1990)
10	Central	149-157	100% SND	0	0	100%	Brown and Haun (1989)
314	SE Coastal	avg. 85	100% SND	0	0	100%	Kurashina & Sinoto(1984)
100	NW Coastal	146-159	80% SND/20% LSF	3	33	100%	Kurashina et al. (1987)
12 (122)	NW Coastal	146-183	80% SND/20% LSF	1	12	10%	Kurashina et al. (1987)
98	NW Coastal	122-159	40% SND/60% LSF	4	25	100%	Kurashina et al. (1987)
15 (49)	NW Coastal	110-159	30% SND/70% LSF	7	2	30%	Kurashina et al. (1987)
105	Central E Coastal	171-183	SND/LSF	1	105	?	Moore et al. (1988)

* Vegetation Type: SND=secondary, LSF=limestone forest, CLTGNS=cultigens (breadfruit, coconut, betel nut palm, etc.)

* Total size of project area given in parentheses if area was sampled

FIELD METHODS AND PROCEDURES

Field methods and procedures for the project followed those outlined in the Scope of Work. The field work was conducted October 16, 17, 19, and 22, by a crew of six, under the supervision of Supervisory Field Archaeologist Bradley J. Dilli, B.A., and Supervisory Archaeologist Roderick S. Brown, M.A. Dr. Alan E. Haun provided overall direction for the project. Crew members included Crew Chief David E. Highness, B.S., and Field Archaeologists Mark Donham, David Dillon, Neil Rhodes, Jeff Johnston, and Bert Meigs. The project area received 100% survey coverage by pedestrian sweeps. Intervals between crew members on sweeps were 15-30 meters, depending on terrain and vegetation. Transect lines were marked using striped flagging tape.

Had archaeological features been encountered, all crew members were to have been notified and the transect halted. Features were to have been flagged with flagging tape. Then, the approximate locations of all features were to have been marked on available maps and briefly described in a notebook before the transect sweeping continued. After completion of the survey work, tagged sites were to have been recorded in detail. Because no archaeological features were located at the project area, these procedures were not necessary.

FINDINGS

No archaeological features or artifacts were located in the survey area during the current survey. The lack of sites is presumed to be due to extensive grading and other activities associated with military use of the area.

CONCLUSION

DISCUSSION

The entire surface of the project area appears to have been extensively disturbed. Hills have been lowered and depressions have been filled. Nevertheless, areas of apparently undisturbed Northern Plateau Limestone Forest exist along portions of the periphery of the Finegayan parcel. This is indicate by indigenous plant species growing in the forest and the associated exposed limestone bedrock topography. The periphery of the forest area was checked carefully for archaeological remains, but none were located.

GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

General significance assessment was not necessary for this project, because no archaeological sites were located. But because heavy vegetation limited ground-surface visibility in the project area, and may have obscured cultural remains, monitoring of all construction-related ground disturbance is recommended.

It should be noted that the evaluations and recommendations presented within this final report have been based primarily on a 100% surface inventory survey of the project area, and are thus subject to the limitations of such surveys. There is always the possibility, however remote, that potentially significant, unidentified surface and subsurface cultural remains will be encountered in the course of future archaeological investigations or subsequent development activities. In such situations, archaeological consultation should be sought immediately.

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APPROVAL PAGE

Archaeological Inventory Survey
DTS Facility: Barrigada and Finegayan Sites

Submitted: _____
for Paul H. Rosendahl, Ph. D. Inc.

Position: Supervisory Archaeologist

Date: December 14, 1990

Approved: _____

Representing: _____

Position: _____

Date: _____

Approved: _____

Representing: _____

Position: _____

Date: _____

DEPARTMENT OF DEFENSE
DEPARTMENT OF THE NAVY

DEPARTMENT OF STATE
BUREAU OF DIPLOMATIC SECURITY
AND INFORMATION MANAGEMENT

FINDING OF NO SIGNIFICANT IMPACT FOR INSTALLATION AND OPERATION OF A DIPLOMATIC TELECOMMUNICATIONS SERVICE REGIONAL RELAY FACILITY FOR USE BY THE DEPARTMENT OF STATE DIPLOMATIC TELECOMMUNICATIONS SERVICE AT NAVAL COMMUNICATIONS AREA MASTER STATION, WESTERN PACIFIC, GUAM, MARIANA ISLANDS

Pursuant to Council on Environmental Quality Regulations (40 CFR Parts 1500-1508) implementing procedural provisions of the National Environmental Policy Act, the Department of the Navy and the Department of State give notice that an Environmental Assessment (EA) has been prepared and an Environmental Impact Statement is not being prepared for the construction and operation of a Diplomatic Telecommunications Service Regional Relay Facility (RRF) at the Naval Radio Transmitting Facility (RTF) Barrigada, and Naval Communications Area Master Station (NAVCAMS) Finegayan, Guam.

The proposed action involves the construction of 26 transmitting antennas at RTF Barrigada and 11 receiving antennas at NAVCAMS Finegayan. Building 51 at RTF Barrigada, which currently serves as a warehouse, will be modified to serve as a transmitter facility. Also, a 5,000 square feet replacement warehouse and a 2,000 square feet building will be constructed near building 51 to house two 750 kilowatt emergency diesel generators. The receiver facility will be located in a portion of Building 150 at NAVCAMS Finegayan. Antennas will rest on reinforced concrete pads; antenna heights will range from 100 to 210 feet. Buried cables will connect the transmitter antennas to the transmitter facility, and the receiver antennas to the receiver facility. The RRF will operate within the 3 megahertz (MHz) to 30 MHz range.

The Department of State has decided to close its RRF near Clark Air Base, Philippines, as soon as a suitable replacement facility can be established elsewhere. This action is the result of the desire of the Department of State to reduce the size of its embassy staff and recognition that existing facilities in the Philippines are outdated and would require substantial upgrading to meet current and projected demand for improved communications service. In addition, in accordance with Executive Order 12856 of November 18, 1988, and National Security Decision Directive number 97, the Department of State has determined that, where possible, RRF facilities should be located on U.S. soil in order to avoid foreign control and intervention in their operation during national security emergencies. The Department of State has declared the Philippines to be a post qualifying for danger

pay. The proposed action will replace functions now performed at Clark Air Base in the Philippines. That facility will be closed and the personnel and functions transferred to Guam allowing assigned Department personnel to live and work on U.S. soil.

Alternatives considered include no action, expanded use of satellite based systems, and construction of an RRF on Guam, or at other sites. The no action alternative would continue the use of the RRF at Clark Air Base in the Philippines. Under this alternative, Department of State personnel would continue to be exposed to the threats inherent in a foreign environment. Long term usage of the facility would require an additional outlay of funds to upgrade the current facilty. For these reasons, the no action alternative is unacceptable. Exclusive reliance on a satellite system would require increased investment in satellites and satellite technology. However, many host governments in the RRF area of coverage restrict the installation of satellite receiving or transmitting facilities; therefore, high frequency transmissions are the only viable means to reach many diplomatic outposts. Sites considered for the Philippines replacement RRF included the continental United States, Hawaii, Alaska, islands in the U.S. Trust Territories of the Pacific Island Region, and Guam. Signals from high frequency radio transmitters typically bounce between the ionosphere and the earth every 1,500 miles. Each bounce, though, reduces the effectiveness and reliability of the signal; signal reliability seriously degrades after 3,000 to 4,000 miles. Placement of RRF facilities in the continental United States, Alaska or Hawaii would require broadcasting radio signals over distances that exceed the reliability distance. While several of the Trust Territory Islands possess technically viable sites, they do not possess the necessary infrastructure or community support facilities to support Department of State employees and their dependants that would be associated with the proposed RRF. Thus, only Guam meets all siting criteria. Several site combinations on Guam were evaluated and the selected alternative sites have the least environmental impact while meeting operational requirements. The chosen sites have been, or still are, used for similar communication functions, and are already in government ownership.

Impacts associated with the proposed action are not significant. The proposed site at RTF Barrigada is an inactive transmitting facility which currently supports a fleet hospital storage facility. This relatively level area supports ruderal weeds and brush thickets. The proposed site at NAVCAMS Finegayan is an active communications facility; vegetation is limited to maintained grassy areas. No wetlands are present at either site. Grading at both sites will be limited to concrete pad construction; an erosion control plan will be prepared and coordinated with the Guam Environmental Protection Agency (GEPA) prior to construction. The U.S. Fish and Wildlife Service has

concurred that the proposed action will not impact federally protected endangered species or endangered species habitat.

The proposed action will not impact cultural, historic or archeological resources listed or determined eligible for listing on the National Register of Historic Places.

Proposed antennas at RTF Barrigada will be visible from Route 16; however, these antennas are over 640 feet from Route 16. While the antennas will be visible from privately owned housing on Mt. Barrigada, this housing area is about 0.4 miles from the proposed site. In addition, this housing area is topographically higher than the top of the highest tower; the proposed towers blend in the viewscape with other existing towers on RTF Barrigada. Proposed towers at NAVCAMS Finegayan blend with other existing towers on the site. Viewscapes at both sites will not be significantly affected by the construction of the proposed towers.

The use of the emergency power generators, which will be installed as part of the proposed action, will be limited to those times when electrical power to the transmitter and receiver buildings fail. Given the expected limited operating time of these generators, emissions associated with their use will not significantly degrade ambient air quality. Permits for their use will be obtained from GEPA prior to construction of the proposed action.

Biological effects, including human health, from electromagnetic radiation (EMR) is a function of the frequency of the radio wave and the size of the organism. American National Standards Institute (ANSI) recommendations, which have been adopted by the Navy, include exposure rates for those frequencies that would be used by the proposed RRF facility. Based on these ANSI standards, areas that would exceed permissible exposure limits from EMR are well within Navy land; no areas off Navy land would be exposed to EMR beyond permissible exposure limits. Areas on Navy land that would exceed permissible exposure limits will be marked with warning signs and fencing to prohibit unauthorized entry during transmission periods.

Electromagnetic compatibility and interference analysis conducted for the RRF revealed a potential for the proposed transmitters to interfere with consumer electronic devices (e.g., televisions, VCRs, radios). To prevent any potential interference, the proposed facility has been designed to not transmit in the direction of the nearby housing area on Mt. Barrigada, or in the direction of planned development. This design will ensure that transmitting operations will not interfere with the use of consumer electronic devices.

Electromagnetic interference criteria for sensitive medical equipment will be exceeded on some parts of the Fleet Hospital Storage Facility grounds on the RTF Barrigada site. However, the affected area is designated for support functions, not medical treatment. Therefore, the transmitter facility will not impact the Navy Fleet Hospital function.

Electromagnetic signal levels from the proposed transmitters will not pose any danger to moderately sensitive electro-explosive devices off Navy property. Areas on public roads adjacent to the proposed transmitter site will exceed the limits for highly sensitive electro-explosive ordnance. However, U.S. Department of Transportation (DOT) regulations prohibit transportation of explosives sensitive to detonation through electromagnetic signals; civilian explosives properly configured for transportation under DOT guidelines (i.e., foil packaged and electrically shunted) would not be affected in any manner by transmitter emissions.

The Federal Aviation Administration (FAA) conducted a study of the navigational and radio signal affects of the project on civil aviation. The FAA determined that the proposed action would have no adverse impact on safe and efficient air navigation to existing, or planned, public use aeronautical facilities.

Renovation of Building 51 at RTF Barrigada will require the removal of four electrical transformers contaminated with PCB. These transformers will be removed, transported, and disposed on the continental U.S. in compliance with the Toxic Substance Control Act.

The Navy has determined that the proposed action conforms to the maximum extent practicable with the Guam Coastal Zone Management Plan. The Guam Department of Planning concurs with this determination.

Based on information gathered during preparation of the EA, the Navy and the Department of State find that construction and operation of a Diplomatic Telecommunications Service Regional Relay Facility at Naval Radio Transmitting Facility Barrigada, and Naval Communications Area Master Station Finegayan, Guam, will not significantly impact the environment.

The EA is on file and may be reviewed by interested parties at the place of origin: Commanding Officer, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, HI 96860, Attn: Mr. Mel Kaku, Code 23 (telephone (808) 471-3088); or at the Department of State Diplomatic Telecommunications Service Representative, C/O Commander, Naval Forces Marianas, PO Box 28 (DTS), FPO San Francisco, CA 96630 (INTERISLAND), telephone

(671) 344-6287. A limited number of copies of the EA are available to fill single copy requests.

5/7/91
Date

Thomas J. Peeling
Special Assistant for Environmental Planning
Shore Facilities Division
Deputy Chief of Naval Operations
(Logistics)

5/9/91
Date

Joseph Hazewski
Director of Foreign Operations
Bureau of Diplomatic Security
U.S. Department of State

APPENDIX B

ELECTROMAGNETIC COMPATIBILITY STUDY
DECEMBER 1990

DEPARTMENT OF THE NAVY
NAVAL ELECTRONIC SYSTEMS
ENGINEERING CENTER, CHARLESTON
4600 MARRIOTT DRIVE
NORTH CHARLESTON, S.C. 29418-6504

IN REPLY REFER TO

Ser 222LV/116
26 DEC 1990

From: Commanding Officer, Naval Electronic Systems Engineering Center, Charleston, SC
To: Commanding Officer, Naval Facilities Engineering Command, Code 052, 200 Stovall Street, Alexandria,VA 22332-2300

Subj TRANSMITTAL OF THEORETICAL ELECTROMAGNETIC COMPATIBILITY STUDY FINAL REPORT FOR THE REACTIVATED BARRIGADA TRANSMITTER SITE, GUAM (E3 PROGRAM TASK NO. E90203-C145)

Ref: (a) TELCON Wayne Burke, NAVFACENGCOM/Louis Valoppi, NAVELEXCEN CHASN of 3 Jun 1990
(b) Funding Document No. N6276690WROOA32 dtd 7 Sep 1990, OICC Guam to NAVELEXCEN CHASN

Encl: (1) Subject Report

1. As requested by reference (a) and in accordance with reference (b), NAVELEXCEN CHASN conducted a theoretical electromagnetic compatibility study to determine potential radio frequency (RF) hazards and interference (EMI) problems associated with the reactivation of the NAVCOMSTA transmitter site at Barrigada, Guam. Concerns were with Hazards of Electromagnetic Radiation to Personnel (HERP), Hazards of Electromagnetic Radiation to Fuel (HERF), Hazards of Electromagnetic Radiation to Ordnance (HERO) and possible electromagnetic interference (EMI) to military or civilian electronic equipment in the area. The analyses were based on the electric field outputs of the Numerical Electromagnetics Code 3 (NEC3) developed by Lawrence Livermore Laboratory.

2. Theoretical analyses of electromagnetic fields from the antennas to be installed indicated that hazardous levels of radiation for HERP and HERF will not be projected beyond the boundaries of the transmitter site. There are no hazards within the site as presently configured as long as standard established safety and operating restrictions are observed.

3. Electric fields propagating beyond the perimeters of the transmitter site can exceed the limits specified in NAVSEA OP 3565 for HERO. NAVSWC Dahlgren, Va. (Code H22) should be contacted for evaluation of potential HERO problems.

Subj: TRANSMITTAL OF THEORETICAL ELECTROMAGNETIC COMPATIBILITY STUDY FINAL REPORT FOR THE REACTIVATED BARRIGADA TRANSMITTER SITE, GUAM (E3 PROGRAM TASK NO. E90303-C145))

4. A major EMI problem was discovered with the original layout of the transmitter site which would have had a severe impact on the deployment of medical electronics onto the tarmac of the Fleet Hospital Storage Facility, co-located on the site. Relocation of several antennas resulted in elimination of this problem.

5. Possible EMI to a housing complex to the north of the transmitter site can be eliminated by increasing the planned 90 degree sector cutouts for the rotatable log periodic antennas (RLPA) by a maximum of 7 degrees.

6. Several buildings at the east perimeter of NAVAIRSTA, Agana may experience EMI if commercial or MIL-STD-461C Class B electronic equipment is installed above the first floor.

7. Results of NEC3 runs upon which these conclusions are based will be maintained at NAVELEXCEN CHASN and will be made available upon request.

8. NAVELEXCEN CHASN point of contact is Louis M. Valoppi, Autovon 563-2030 Ext 4959 or Commercial (803) 745-4959.

ROBERT M. BYRNES
By direction

Copy to:
OICC NAVFACENGCOM Marianas
PACNAVFACENGCOM Pearl Harbor, HI
COMSPARWARSYSCOM (Code 32142)

NAVAL ELECTRONIC SYSTEMS ENGINEERING CENTER

CHARLESTON, SOUTH CAROLINA

THEORETICAL ELECTROMAGNETIC COMPATIBILITY STUDY FINAL REPORT,

Reactivated Barrigada Transmitter Site, Guam

E3 TASK NUMBER E90203-C145

NAVAL ELECTRONIC SYSTEMS ENGINEERING CENTER

CHARLESTON, SOUTH CAROLINA

REACTIVATED BARRIGADA TRANSMITTER SITE, GUAM
THEORETICAL ELECTROMAGNETIC COMPATIBILITY STUDY
FINAL REPORT
E^3 Task Number E90203-C145

Report Date:
20 December 1990

Prepared by: Louis M. Valoppi
Louis M. Valoppi
ELECTRONICS ENGINEER

Reviewed by: Robert M. Byrnes
Robert M. Byrnes
SUPERVISORY ELECTRONICS ENGINEER,
SOFTWARE AND E^3 ENGINEERING DIVISION

ABSTRACT

A theoretical Electromagnetic Compatibility study was performed under the Navy Shore Electromagnetic Environmental Effects (E3) program, Task No. E90203-C145, to identify potential hazard and interference problems with the reactivated Transmitter Site at Barrigada, Guam, Marianas Islands. Primary concerns were Hazards of Electromagnetic Radiation to Personnel (HERP), Hazards of Electromagnetic Radiation to Fuel (HERF), Hazards of Electromagnetic Radiation to Ordnance (HERO) and possible Electromagnetic Interference (EMI) to either military or civilian electronic equipment in the area.

Theoretical analyses performed indicated that no HERP or HERF hazards exist with the Transmitter Site as presently configured as long as standard established safety and operating restrictions are observed.

Electric fields propagating beyond the perimeter of the Transmitter Site are greater than the maximums specified in NAVSEA OP 3565 Vol II for HERO. NAVSWC Dahlgren, Va. (Code H22) should be contacted for evaluation of potential HERO problems.

Medical electronics planned for deployment onto the tarmac of the Fleet Hospital Storage Facility were subject to Electromagnetic Interference from several nearby antennas. The originally proposed site layout would have prevented usage of medical electronics on about 70 percent of the deployment tarmac. However, in the final configuration with several of the antennas in the southest area of the field relocated, this potential problem has been resolved. The housing complex southwest of Mt. Barrigada (north of the transmitter site) could suffer interference from the Transmitting Site. Proposed sector blanking of the RLPA antennas will prevent EMI to the housing complex. EMI to several buildings at the east end of the airport depends on the height above ground at which the susceptible equipment is used; ground floor usage presents no problem.

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1.0 INTRODUCTION

A theoretical Electromagnetic Compatibility study was performed under the Shore Electromagnetic Environmental Effects (E3) program, Task No. E90203-C145, to identify potential hazard and interference problems with the reactivated Transmitter Site at Barrigada, Guam, Marianas Islands. Primary concerns were Hazards of Electromagnetic Radiation to Personnel (HERP), Hazards of Electromagnetic Radiation to Fuel(HERF), Hazards of Electromagnetic Radiation to Ordnance (HERO) and possible interference to either military or civilian electronic equipment in the area.

The originally proposed Transmitter Site layout is shown in Figure 1. The redesigned site, based on our original analysis is shown in Figure 2. Both show twenty six (26) antennas to be installed and each antenna is numbered in the figures. Antenna numbers 1, 5 to 13, 15 and 16 are TCI527E-3-04 HLP double curtain, clamped mode log periodic antennas. Numbers 2 to 4 and 14 are TCI524E-6-04 HLP single curtain, clamped mode log periodic antennas. Numbers 17 and 18 are TCI527B-8-04 HLP double curtain log periodic antennas. Numbers 19, 20, and 22 are Granger 3001-3L-4 Spira-cone antennas, numbers 25 and 26 are Granger 3004-70F-31 Spira-cones and number 21 is a TCI540-1-09, all of which are omni-directional gain antennas. Numbers 23 and 24 are Hy-Gain LP-1002 rotatable log periodic antennas (RLPA).

TCI provided antenna geometries for the 527, 527B, 524 and 540 antennas, permitting NAVELEXCEN Charleston to model the antennas using the Numerical Electromagnetics Code (NEC3) program. The data provided is not included as part of this report since it is proprietary to TCI and its further dissemination is not warranted. The spira-cone antennas are not compatible with the NEC3 program due to wires being too near one another. However, the radiation from the Granger 3001 is comparable to that for the TCI540 and results for that antenna were used in the following analyses. Since the Granger 3004 is rated at only 5KW, its fields will be approximately one half of those for the TCI540. The RLPA was modelled using data already in hand, raising the height to 100 ft. above ground.

The criteria utilized to accomplish the HERP objectives of the study are contained in DOD 6055.11. This document provides guidance for the protection of personnel against non-ionizing radio frequency (RF) radiation in the frequency range from 10 KHz to 300 GHz. The criteria utilized to accomplish the HERF objectives of the study are contained in NAVSEA OP 3565 Vol I. This document addresses the possibility of igniting fuel vapors by RF induced arcs during fuel handling operations in close proximity to a high power transmitting antenna. The criteria utilized to accomplish the HERO objectives of the study are contained in NAVSEA OP 3565 Vol II. This document addresses the precautions and procedures for handling, transporting and storing electrically initiated ordnance when the possibility of exposure to RF environments exists. The criteria utilized to accomplish the EMI objectives of the study are contained in MIL-STD-461C and

MDS-201-0004. These documents detail the levels of RF exposures to which various classes of electronic equipment must be tested without degradation of function.

2.0 ANALYSIS

To theoretically determine the electric field intensities for a given transmitter/antenna system, the antenna is modelled, fed with the appropriate power, and the NEC3 program then calculates the radiation pattern and near and far electric fields. For the antennas considered here, their configuration and size required changes to the NEC3 program to expand the number of segments to 2100 and, for the TCI527B, increase the number of transmission lines allowed to 60. Since double precision must be used to prevent roundoff errors when such large arrays are filled and factored, many of the programs and data files on the HP835 had to be removed to allow the program to run to completion. For example, the first run of the TCI527 ran out of disk space after a 35 hour run time.

Modelling an antenna required reformatting the supplied data to NEC3 input card images. Once the model was completed, it was transferred to the IGUANA program on a PC compatible computer for inspection of the antenna geometry with magnification factor necessary to determine that all wire interconnect points were free from overlaps and misses. For double curtain antennas this was done for each curtain individually prior to combining them to create one model. The model was run for each of three frequencies, one at its high limit , one at the low limit and another near its geometrical mean. The Sommerfeld/Norton ground option was used since this includes both space and surface waves when calculating the near electric fields. Ground parameters were set at conductivity of 0.0275 mhos/meter and a relative dielectric constant of 15. These values are expected for the Guam wet season. During the dry season conductivity will be lower, resulting in lower electric fields near the ground. Therefore, the wet season value gives more conservative levels (higher) of electric field strength.

When these runs were made, the program was instructed to produce a Numerical Green's Function (NGF) file to prevent the necessity to generate and factor the interaction matrix each time the program was run at a particular frequency. This procedure was repeated until the program produced satisfactory results as determined by checking geometry output, currents along wires and at junctions, and radiation patterns compatible with provided data sheets. Once the proper model was finalized, the antenna excitation required for an input power of 20 KW was determined based on the program calculated antenna input impedance. Card images delineating points at which electric fields were to be calculated were entered along with the geometry deck and a final run was made for that frequency. Electric fields were calculated out to 10 kilometers (km) in front of the antennas and 2 km behind in 100 meter steps. Ten meter steps were used for distances of 1 km in front and 0.2 km behind the antenna. These were calculated at heights of 1, 2, 4 and 8 meters. In addition a one meter step in both the x and y directions at a height of 2 meters was utilized to precisely determine location of exclusion areas about the antenna for HERP purposes. NEC3 program

outputs for radiation patterns and electric fields for the various antennas are given in the appendices.

The above procedure resulted in proper models for all antennas except the TCI540. For some reason (not ascertained due to lack of time) this antenna could not be modelled to pass the checks described above. It was originally simulated by placing one-fourth of the wires making up the antenna into one quadrant (x,y) reflecting it into another (x,-y) and then reflecting it across the xz plane into the two remaining quadrants (-x,y and -x,-y). Attempting to excite the antenna in accordance with the data supplied by TCI resulted in erratic performance. A week was spent in an attempt to determine where the problem lie but to no avail. It was decided that instead of trying to model the antenna by generating wires in all four quadrants, it would be simpler to simulate the antenna by 4 halfwave elements in a loop configuration, using two such loops spaced at the distance above ground and distance between the two loops consistent with the distances for the active regions of the the two curtains of the actual antenna. This was done at two frequencies, 3.6 and 30 MHz. Results were consistent with TCI's supplied data sheets; therefore, this model was used to determine electric fields.

3.0 HERP ANALYSIS RATIONALE AND ASSUMPTIONS

One of the objectives of the study was to determine the distances from an antenna at which the electric fields are in compliance with the guidelines of DOD 6055.11. These guidelines address limits with respect to Hazards of Electromagnetic Radiation to Personnel (HERP) and are intended to provide guidance for the protection of personnel against non-ionizing radio-frequency radiation (RFR) in the frequency range from 10 KHz to 300 GHz. Its provisions are applicable to all civilian and military personnel who may be exposed to RFR while at or in the vicinity of Navy shore establishments. Biological effects have been determined to be a function of the specific absorption rate (SAR) which depends on the frequency of the electric field and the size and configuration of the biological specimen. The threshold for adverse biological effect is at present established at an SAR of 4 watts per kilogram (W/kg), and, with a safely factor of 10 added, the accepted limit is 0.4 W/kg for the whole body, averaged over any six minute period. For the high frequency portion (3 to 30 MHz) of the RF spectrum this results in a power density (in milliwatts per square centimeter (mW/cm^2)) of 900 divided by the square of the frequency (900/f^2). At 30 MHz this equates to 1 mW/cm^2 or 61.4 Volts/meter (V/m) while at 3 MHz the value rises to 100 mW/cm^2 or 614 V/m.

3.1 HERP STUDY ANALYSIS RESULTS

The electric fields for each antenna were determined for an average power level of 20 KW at three frequencies (two for the TCI540) within its specified range. The electric field outputs (see appendices) were analyzed to determine worst case conditions among the frequencies utilized. For the directional antennas (the RLPA excepted) both front and back limits were determined. The results of this analysis are presented below for each antenna:

3.1.1 TCI527 ANTENNA

The TCI527 was modelled at three frequencies; 30 MHz, 14 MHz and 6.5 MHz. The corresponding electric field limits for HERP are 61.4 V/m, 131.6 V/m and 283.4 V/m. Electric fields were calculated at 1, 2, 4 and 8 meters above ground. The 2 meter height electric field is used as the determining factor in consideration for marking and/or fencing around the antenna to define the unsafe area. The maximum hazard distances occurred at 30 MHz. These were at 32.4 meters (106 feet) in front of the first element of the antenna and 27 meters (88 feet) behind the first element which is located under the antenna curtains. The shape of the hazardous area is elliptical and extends to 10 meters (33 feet) on either side of the antenna centerline. The coordinates of the ellipse are as follows:

Distance from Center Line	Distance from First Element
0 m (0 ft)	32.4 m (106 ft)
2 m (6.6 ft)	31.9 m (104.7 ft)
4 m (13.1 ft)	30.5 m (100 ft)
6 m (19.7 ft)	28.5 m (93.5 ft)
8 m (26.2 ft)	24.3 m (79.7 ft)
10 m (32.8 ft)	-3.0 m (-9.8 ft)

The 10 meter line should be extended from the last coordinate until it intersects the projected edge of the antenna curtains. Access beneath the antenna curtains should be restricted in any case.

3.1.2 TCI524 ANTENNA

The TCI524 was modelled at three frequencies; 30 MHz, 12.25 MHZ and 5 MHz. The corresponding electric field limits for HERP are 61.4 V/m, 150.4 V/m and 368.4 V/m. Electric fields were calculated at 1, 2, 4 and 8 meters above ground. The 2 meter height electric field is used as the determining factor for marking and/or fencing around the antenna to define the unsafe area. Again the maximum hazard distances occurred at 30 MHz. These were at 47 meters (154 ft) in front of the first element of the antenna and 28 meters (92 ft) behind the first element which is located under the antenna curtain. The shape of the hazardous area is elliptical and extends to 13 meters (43 feet) on either side of the antenna centerline. The coordinates of the ellipse are as follows:

Distance from Center Line	Distance from First Element
0 m (0 ft)	47 m (154 ft)
2 m (6.6 ft)	47 m (154 ft)
4 m (13.1 ft)	46 m (151 ft)
6 m (19.7 ft)	45 m (148 ft)
8 m (26.2 ft)	43 m (141 ft)
10 m (32.8 ft)	41 m (134 ft)

12 m (39.4 ft)	36 m (118 ft)
13 m (42.7 ft)	32 m (105 ft)

The 13 meter line should be extended from the last coordinate until it intersects the projected edge of the antenna curtain. Access beneath the antenna curtain should be restricted in any case.

3.1.3 TCI527B ANTENNA

The TCI527B antenna was modelled as was the TCI527, Section 3.1.1 above. Frequencies, electric field limits and height above ground for electric field calculations are as described therein. Again the worst case hazard distances for HERP occurred at a frequency of 30 MHz. The hazard distance to the front of the first element of the antenna was 31 meters (102 ft) while that to the rear was 7 meters (23 ft) behind the first element. The hazardous area is elliptical in shape and extends 16 meters to either side of the antenna center line. The coordinates for the hazard area are as follows:

Distance from Center Line	Distance from First Element
0 m (0 ft)	31 m (102 ft)
2 m (6.6 ft)	31 m (102 ft)
4 m (13.3 ft)	30.5 m (100 ft)
6 m (19.7 ft)	29.8 m (97.8 ft)
8 m (26.2 ft)	28.9 m (94.8 ft)
10 m (32.8 ft)	27.4 m (89.9 ft)
12 m (39.4 ft)	25.5 m (83.7 ft)
14 m (45.9 ft)	22.7 m (74.5 ft)
16 m (52.5 ft)	17.1 m (56.1 ft)

The 16 meter line should be extended from the last coordinate until it intersects the projected edge of the antenna curtains. Access beneath the antenna curtains should be restricted in any case.

3.1.4 TCI540 and GRANGER SPIRA-CONE ANTENNAS

These antennas could not be directly modelled by the NEC3 program. The TCI540 due to unresolved problems in setting up the antenna geometry and the Spira-cone because the wires are too close to one another for NEC3 to handle properly. A simulation utilizing loops at the heights of the antenna active region was determined to give the gain, takeoff angle and lobe width as given in the manufacturers literature. The simulated antenna was modelled at two frequencies, 30 and 3.6 MHz. The corresponding hazard limits are 61.4 and 511.7 V/m. As for the other antennas above, the governing frequency for HERP was 30 MHz. Since the antenna is essentially omni-directional, the hazardous area is a circle of 9.2 meters (30.2 feet) radius with the center located at the antenna center.

3.1.5 HYGAIN RLPA ANTENNA

The RLPA antenna geometry was based on an antenna previously modelled for which data was available. The antenna was specified at the same gain as the Hy-gain model. Since the antenna is fully rotatable and may be deployed in any direction, the hazardous area will correspond to a circle with radius equal to the worst case maximum hazard distance in front of the antenna. The worst case distance occurs at a frequency of 30 MHz. The maximum hazard distance in this case is 36.9 meters (121.1 feet) at a height of 2 meters (6.6 feet) above ground.

4.0 HERF ANALYSIS RATIONALE AND ASSUMPTIONS

NAVSEA OP-3565 addresses the Hazards of Electromagnetic Radiation to Fuel (HERF) and the possibility of accidentally igniting fuel vapors by RF induced arcs during fuel handling operations in close proximity to high power transmitting antennas. Guidance provided in that document states that for transmitting antennas radiating more than 250 watts, the separation from a fuel handling or fueling area should be such that the power density in the fueling area is no greater than would exist at a distance of 15 meters (50 feet) from a monopole antenna radiating 250 watts. However, even for 250 watts and under, minimal separation distance is 15 meters (50 feet). The power density given above corresponds to an electric field strength of 5.76 V/m.

4.1 HERF ANALYSIS RESULTS

The modelling described in Section 3 for each of the antenna types provided electric field values for distances to 10 kilometers from the antenna in all cases and for distances to 2 kilometers to the rear of the antenna for the fixed directional antennas. The output was perused to determine the distance at which the electric field strength at 2 meters (6.6 feet) fell to 5.76 V/m in front of the antenna and, where necessary, to the rear of the antenna. For the fixed directional antennas the maximum frontal distance occurred at 30 MHz while the maximum rearward distance occurred at the specified low frequency for that particular antenna. The results are tabulated below.

	HERF Distance To Antenna Front From First Element	HERF Distance To Antenna Rear From Tower Base
TCI527	150 m (492.1 ft)	22 m (72.2 ft)
TCI524	186 m (610.2 ft)	30 m (98.4 ft)
TCI527B	120 m (393.7 ft)	8 m (26.2 ft)
TCI540 & Spira-cone	110 m (360.9 ft) from antenna center	
RLPA	178 m (583 ft) from tower center	

No volatile fuels should be handled within the above distances from the antennas. Diesel fuel is not considered a volatile fuel below a temperature of 125 degrees Fahrenheit (51.7 degrees Celsius). Since the sole identified use of volatile fuel is on the east 61 meters (200 feet) of the Fleet Hospital Storage Facility when

the hospital is deployed (see Section 6,1,3 below), that area was analyzed to determine if any antenna could radiate an electric field of 5.76 V/m into the area. Based on the above given distances, and using one half of the TCI540 & Spira-cone distances for the Granger 3004s as mentioned in the introduction, the whole tarmac, not only the eastern 61 meters (200 feet), is safe for volatile fuel handling.

5.0 HERO ANALYSIS RATIONALE AND ASSUMPTIONS

NAVSEA OP-3565 addresses the Hazards of Electromagnetic Radiation to Ordnance (HERO) and the possibility of ignition of electro-explosive devices (EED) due to the presence of radio frequency fields. Guidance provided in this document is intended to prescribe operating procedures and precautions to prevent premature initiation of EEDs. Three classifications pertinent to HERO for ordnance have been established. These classifications are based upon the degree of susceptibility in accordance with the criteria of MIL-STD 1385. Items that are negligibly susceptible and require no RF environmental restrictions during all phases of normal employment are classified HERO SAFE ORDNANCE. Items that are moderately susceptible and require moderate RF environmental restrictions during one or more phases of employment are classified HERO SUSCEPTIBLE ORDNANCE. Items that are highly susceptible and require severe restriction for some or all phases of employment are classified as HERO UNSAFE ORDNANCE.

The intent of this section of the report is to provide electric field intensity data that indicate the minimum safe separation distances for HERO SUSCEPTIBLE and HERO UNSAFE ordnance based on the electric field limits contained in NAVSEA OP-3565. The identification of possible HERO SUSCEPTIBLE or HERO UNSAFE areas by this report does not constitute the final HERO assessment and recommendation. NAVSEA Code 652 is the approving authority for all HERO safety and any changes in handling procedures. NAVSWC Dahlgren, Va. (Code H22) should be contacted for evaluation of any potential HERO problem identified in this report. Their recommendations will be forwarded to NAVSEA Code 652 for final approval. Upon approval NAVSEA will forward final recommendations to the site for use in preparation of the local EMCON bill.

5.1 HERO ANALYSIS RESULTS

The modelling described in Section 3 for each of the antenna types provided electric field values for distances to 10 kilometers from the antenna in all cases and for distances 2 kilometers to the rear of the antenna for the fixed directional antennas. The output was perused to determine the distance at which the electric field strength at 2 meters above ground fell to the value delineated by NAVSEA OP-3565 for the two classifications. A height of two meters was selected since work on, and transportation of, ordnance occurs below that height. The limit for HERO UNSAFE remains constant at 0.2 V/m over the 2 to 30 MHz frequency range. The limit for HERO SUSCEPTIBLE decreases from 100 V/m to 2 V/m over the frequency range from 1 to 3.68 MHz. The limit then remains constant at 2

V/m up to 10 MHz. From 10 to 30 MHz, the limit increases from 2 V/m to 3.85 V/m. The results are tabulated below:

HERO SUSCEPTIBLE

	HERO Distance To Antenna Front From First Element	HERO Distance To Antenna Rear From Tower Base
TCI527	184.4 m (605.0 ft)	99.5 m (326.4 ft)
TCI524	191.0 m (626.7 ft)	72.2 m (236.9 ft)
TCI527B	131.6 m (431.8 ft)	52.4 m (172.0 ft)
TCI540 & Spira-cone	137.0 m (449.5 ft) from antenna center	
RLPA	224.0 m (734.9 ft) from tower center	

HERO UNSAFE

	HERO Distance To Antenna Front From First Element	HERO Distance To Antenna Rear From Tower Base
TCI527	825 m (2707 ft)	420 m (1378 ft)
TCI524	1032 m (3386 ft)	430 m (1411 ft)
TCI527B	667 m (2188 ft)	237 m (778 ft)
TCI540 & Spira-cone	620 m (2034 ft) from antenna center	
RLPA	975 m (3199 ft) from tower center	

No ordnance is expected on the transmitter site at Barrigada. The limits for HERO SUSCEPTIBLE are within the transmitter site except for antennas 9, 11, 12 and 13 (all TCI527s) which are not located at least 184.4 meters (605 feet) from the site boundaries and, therefore, have electric fields over the limit values for HERO SUSCEPTIBLE at the perimeter road (see Figure 3) to the west and north. Obviously, the electric fields for these antennas will also exceed the HERO UNSAFE limits at the road and beyond. In fact, most of the antennas exceed the HERO UNSAFE limits at the transmitter site perimeter. The most easterly buildings at the airport complex (see Figure 3) will also be subjected to electric fields of 0.2 V/m and above. The housing complex directly southwest of Mt. Barrigada will be subjected to electric fields higher than the HERO SUSCEPTIBLE and HERO UNSAFE limits (see Section 6 below) from the RLPA antennas.

In summation then, the roads directly to the south, west and north as well as a portion of the airport complex and the housing complex to the northeast of the transmitter site are subject to fields above the HERO UNSAFE limits. The roads to the west and north are also subjected to fields above the HERO SUSCEPTIBLE limit. The housing complex will also be subject to fields above the HERO SUSCEPTIBLE limit. However, the sector cutouts proposed to resolve possible interference problems at the housing complex (see Section 6, below) will bring electric fields below the HERO SUSCEPTIBLE limit. NAVSWC Dahlgren, Va.

(Code H22) should be contacted for evaluation and recommendation of action to be taken.

6.0 EMC/EMI ANALYSIS RATIONALE AND ASSUMPTIONS

An Electromagnetic Compatibility/Electromagnetic Interference analysis was done to investigate the potential electromagnetic interference associated with the reactivated Barrigada Transmitter Site. The manufacturers of consumer equipment have no imposed electromagnetic susceptibility requirement but most responsible manufacturers have assumed a limit of 1 V/m for their electronic products, including TV sets, VCRs, AM and/or FM radios, etc. However, there may be older consumer products or those from manufacturers who have not accepted the self-imposed limits located in the vicinity of the transmitter site. This type of equipment has provided problems for the Navy in the past. One such study four years ago of such a reported problem outside continental US resulted in instrumented measurement of electric fields causing interference to VCRs outside a Navy Transmitter Site. At a frequency of 6.3 MHz, vertically polarized electric fields of 0.76 V/m caused moderate interference to a VCR while 2.37 V/m caused severe interference, completely distorting the video. The audio was unaffected. Tests were made from 3 to 12 MHz on Navy assigned frequencies at power outputs of 1 KW and 7 KW to a inverted cone monopole (gain approximately 4.5 db). At electric fields from 2.51 to 9.44 V/m, frequencies above 6.3 MHz resulted in no distortion while those below gave slight distortion. Since fields from this transmitter site are different from those in the above study in that they are horizontally polarized, for this analysis 1 V/m will be used as a limit for consumer products since this value is now the de facto standard.

According to MDS-201-0004 Electromagnetic Compatibility Standard for Medical Devices. October 1, 1979, the suggested standard for minimum radiated electric field susceptibility is 2 V/m (given therein as 126 db microvolts/meter). Military electronic medical equipment may be specified as either Class A3, Equipment and Subsystems Installed in Ground Facilities, or Class B, Ancillary or Support Equipment and Subsystems Installed in Non-Critical Ground Areas under the classification guidelines of MIL-STD-461C. If the former, the standard for minimum radiated electric field susceptibility level is 10 V/m, if the latter, the susceptibility level is set at 1 V/m. In the latter case, the susceptibility level will be at the commonly accepted civilian level of MDS-201-0004, or 2 V/m.

Equipment and Systems Installed Aboard Aircraft, Including Associated Ground Support Equipment (MIL-STD-461C Class A1) must meet a minimum electric field susceptibility level of 20 V/m, except if installed on non-metallic aircraft, non-metallic structures on metallic aircraft, or externally mounted on metallic aircraft, then the minimum level is 200 V/m. A check with the Federal Aviation Administration revealed that a standard for the civil aviation community is now being developed. Since electronic equipment on civil aircraft is enclosed within an metal skin, a susceptibility level of 10 V/m is assumed for this analysis.

6.1 EMC/EMI ANALYSIS RESULTS

The modelling described in Section 3 for each of the antenna types provided electric field values for distances to 10 kilometers from the antenna in all cases and for distances 2 kilometers to the rear of the antenna for the fixed directional antennas. The output was perused to determine the distances from the antennas at which the electric field strength fell to values of 10, 2 and 1 V/m. These distances at a height of 2 meters are given below:

	To Antenna Front From First Element	To Antenna Rear From Tower Base
10 Volts/meter		
TCI527	115 m (377 ft)	20 m (66 ft)
TCI524	139 m (456 ft)	Under curtain
TCI527B	97 m (318 ft)	Under curtain
TCI540 & Spira-cone	80 m (262 ft) from antenna center	
RLPA	133 m (436 ft) from tower center	
2 Volts/meter		
TCI527	265 m (869 ft)	69 m (226 ft)
TCI524	329 m (1079 ft)	53 m (174 ft)
TCI527B	207 m (679 ft)	8 m (26 ft)
TCI540 & Spira-cone	200 m (656 ft) from antenna center	
RLPA	321 m (1053 ft) from tower center	
1 Volt/meter		
TCI527	375 m (1230 ft)	140 m (459 ft)
TCI524	459 m (1505 ft)	103 m (337 ft)
TCI527B	296 m (971 ft)	17 m (55 ft)
TCI540 & Spira-cone	370 m (1213 ft) from antenna center	
RLPA	432 m (1417 ft) from tower center	

6.1.1 COMMUNICATIONS AND ROTHR

Interference with other communication sites by the Barrigada Transmitter Site will be minimal. The nearest site is the Andersen AFB Communications Annex which is some 2.5 kilometers (1.55 miles) at an bearing of approximately 180 degrees from the number 24 RLPA, the antenna most likely to cause interference. The electric field strength caused by the RLPA at this distance will be just under 200 millivolts/meter (mV/m) at a height of 12 meters above ground. Unless the Andersen Annex is attempting to receive another station near or on the same frequency being transmitted from the Barrigada Transmitter Site, there will be no interference. NAVCOMMSTA Finegayan is approximately 12 kilometers distant on a bearing of 13 degrees. The electric field from the RLPA is

again the highest expected at this distance and is below 15 mV/m at a height of 12 meters, based on a value of 27 mV/m at 6.25 kilometers, the largest distance calculated for the RLPA. As described in Section 6.1.2 below, sector cutouts will prevent the RLPAs from transmitting in this direction.

NAVELEXCEN Charleston has performed noise and spectrum occupancy instrumented surveys for two proposed ROTHR receive sites on Guam, one at Andersen AFB, Harmon Annex, and the other at Andersen AFB, Northwest Field. the Harmon Annex site is some 6.9 kilometers from the Barrigada Transmitter Site at a bearing of 3 degrees. At 8 meters above ground, the RLPA will produce an electric field strength of less than 18 mV/m at Harmon Annex, while antenna number 14, a TCI524, will produce 17 mV/m. In any case, the levels are not high enough to produce degradation of electronic equipment. However, ROTHR will not be able to utilize frequencies and modulation bandwidths assigned to the Barrigada Transmitter Site therefore spectrum occupancy will be greater than that measured during the prior instrumented surveys. The Northwest Field site is some 16 kilometers from the Barrigada Transmitter Site on a bearing of 13 degrees. Electric fields were not calculated to this distance, however the highest field at a height of 8 meters, at a distance of 10 kilometers, was 8 mV/m. At Northwest Field the value will probably be half that. Interference problems are not anticipated. Again, as mentioned in 6.1.2 below, the RLPAs will be prevented from transmitting in either of these directions by sector cutouts.

6.1.2 EMI - CONSUMER PRODUCTS

The housing complex on the southwest side of Mt. Barrigada (see Figure 3) will be in the main beam of either RLPA when the antenna is oriented at a bearing of 47 degrees for antenna No 23 or 40 degrees for antenna No 24. The distance of the complex from RLPA No. 23 is approximately 800 meters (2624 feet) and the complex spans an angle of 35 degrees. The electric field levels from this antenna will range up to 5.6 V/m at the housing complex. The antenna beamwidth at the 3 db points is 59 degrees. Since approximately 15 db of reduction in electric field strength is needed to bring this level down to 1 V/m, 2 degrees should be added to each side, making the interference beamwidth of the antenna 63 degrees. Added to the 35 degree span angle, this corresponds to 98 degrees of rotation over which the antenna may cause interference. A 90 degree cutout was previously planned for this antenna, from bearings of 0 to 90 degrees. This sector cutout should be extended to 98 degrees, from 358 to 96 degrees to ensure interference does not occur.

The distance of the housing complex from the relocated RLPA No. 24 is approximately 900 meters (2950 feet) at a bearing of 40 degrees. The complex spans an angle of 30 degrees when seen from this RLPA's new location. The electric field levels for this antenna may range to 5 V/m at the complex. To bring this down to 1 V/m requires a 14 db reduction in field strength. Keeping the antenna beamwidth of 63 degrees discussed above, this antenna requires a sector cutout of 93 degrees from 353.5 to 86.5 degrees. This sector cutout again is larger than originally planned and somewhat larger than that obtained for the original

planned position for this antenna, which was only 87 degrees. Moving the antenna closer to the housing complex increased the angular span encompassed by the complex.

6.1.3 EMI - FLEET HOSPITAL STORAGE FACILITY

The Fleet Hospital Storage Facility is a repository for portable/mobile hospital units. When necessity requires deployment of this equipment for the care of casualties, hospital tents and equipment will be arranged on the tarmac to the south and east of the repository. The tarmac is outside the personnel hazard zones of all antennas; however, a further consideration is the use of electronic equipment in patient care. As mentioned in Section 6.0 above, the susceptibility level of this equipment may range from 2V/m to 10V/m. Conversation with the command with cognizance over the Fleet Hospital Storage Facility has determined that the limit is 2V/m. At a minimum susceptibility level of 2 V/m a large portion of the tarmac was excluded from use due to radiation from antennas No. 3 and 4 (TCI524s) and antenna No. 24 (RLPA) in their original locations (Figure 1.).

In their new locations (Figure 2.) these antennas will project fields greater than 2V/m onto the eastern section of the tarmac although not to the extent they did in their original positions. Antenna No. 4 (TCI524) will have an electric field intensity over 2V/m extending approximately 15 meters (50 feet) into the southeast corner of the tarmac. Antenna No. 3 and 4 were analyzed together at 30 MHz with a power of 20 KW to each. Because of reinforcement/interference effects, the fields on the tarmac from these antennas operating together were no greater than those from antenna No. 4 alone.

Antenna No. 24 (RLPA) will exceed 2V/m over an area extending 61 meters (200 feet) into the tarmac along the northern boundary and lessening in extent as one proceeds south. The western boundary of this area of electric field of 2V/m or higher is an arc of a circle centered on the tower of antenna No. 24.

During deployment, the Fleet Hospital will not set up medical facilities on the eastern 61 meters (200 feet) of the tarmac. This area is reserved for galley and Public Works functions. Since the 2V/m electric fields extend no farther than 61 meters (200 feet) into the tarmac, any medical electronic equipment deployed will not be subject to fields higher than their minimum susceptibility level with the antennas located as in Figure 2.

6.1.4 EMI - AIRPORT

Both the RLPAs (antennas No. 23 and 24) and the TCI527s (antennas No. 5 and 6) may subject several buildings at the east end of the airport complex to electric fields of 1 V/m at heights of 8 to 12 meters (26 to 40 feet). At lower heights the buildings will be exposed to fields below 1 V/m. Since the height of these buildings are not known, there may actually be no problem at all.

Another potential problem considered was the electric field that a landing aircraft may be subjected to. Worse case is offered by the RLPA (antenna No. 23). When it is positioned at approximately 335 degrees, the beam is directly pointed at a point some 300 meters beyond the northeast end of the runway. The antenna is 1.2 kilometers (3937 feet) from the intersect point with a line extended from the end of the runway. At this position the center of the main beam of the antenna is 97 meters (318 feet) above ground. The lower 3 db point of the main beam will be 44 meters above ground. The aircraft will be approximately 13 meters (43 feet) above ground if coming in at a 3.25 degree ILS angle. The aircraft can be three times as high and still be below the main beam of the antenna. The center main beam electric field is 3.8 V/m and the lower 3 db point field is 2.7 V/m. At 12 meters (40 feet) the electric field is less than 1 V/m based on the 1 V/m distance being 1022 meters (3353 feet). Therefore, landing aircraft will not be subjected to levels greater than the selected 10 V/m.

7.0 CONCLUSIONS

As with any transmitter site installation in or near populated areas, the Barrigada Transmitter Site may present potential EMC/EMI problems. These anticipated problems were investigated here using the NEC3 program to numerically compute electric fields for the antennas involved. It should be mentioned that every effort was made to ensure that conclusions drawn would err on the conservative side.

There will be no electric fields harmful to personnel radiated beyond the perimeter of the transmitter site. HERP distances have been given for each antenna type so that hazardous areas may be identified. HERP, therefore, is not a problem. The frequency range under consideration here is below that which which would cause detrimental heating effects to small animals of the type found on Guam. Since they are far less resonant at these frequencies than humans would be (i.e. their SAR is lower), harming of animal life is not an area of concern. However, birds flying through the main beam close to any antenna have been observed to become disoriented due to the magnetic fields effecting their magnetic sensors. The magnitude of the effect has not been quantified but seems to depend on frequency, the type of bird and the power density of the beam and is independent of antenna type. The effect is not permanent and will pass once the bird exits the main beam.

There are potential HERO problems due to the electric field level at the roads on the north, south and west of the transmitter site. This will typically not effect military transportation since EEDs are always transported in a HERO SAFE condition if procedures are followed. However, transportation of EEDs by construction workers or hobbyists (e.g. model rocket squibs) must be addressed. Commercial civil aircraft must have the squibs which fire their cockpit recorders checked at proscribed intervals. If this is done (not typically) at the airport in Guam, it should be done in a building close to the runway and not at any of the buildings to the far east of the airport complex. Naval Air Station ordnance should be handled as in the preceding sentence. For precise procedural direction, contact NAVSWC Dahlgren, Va.

There are no anticipated HERF problems since the only use of volatile fuel will be on the eastern 61 meters (200 feet) of the Fleet Hospital Storage Facility tarmac in the galley/Public Works area, and that area is not subject to electric fields above the limits of NAVSEA OP-3565.

There are EMC/EMI problems especially associated with the RLPA antennas due to their very low take off angle. The prime area of concern is the housing complex on the southwest side of Mt. Barrigada. This can be resolved by slightly revising the sector cutouts for the RLPAs as described above. The effect of the TCI524s (antennas No. 3 and 4) as well as an RLPA (No 24) on medical electronic equipment used upon deployment of stations on the tarmac of the Fleet Hospital Storage Facility will prevent use of the eastern 61 meters (200 feet) of the area due to susceptibility limits of medical electronics. However, this is not a problem since this area will be used for galley and Public Works functions.

Antenna Field Layout-Original
Barrigada, Guam, MI

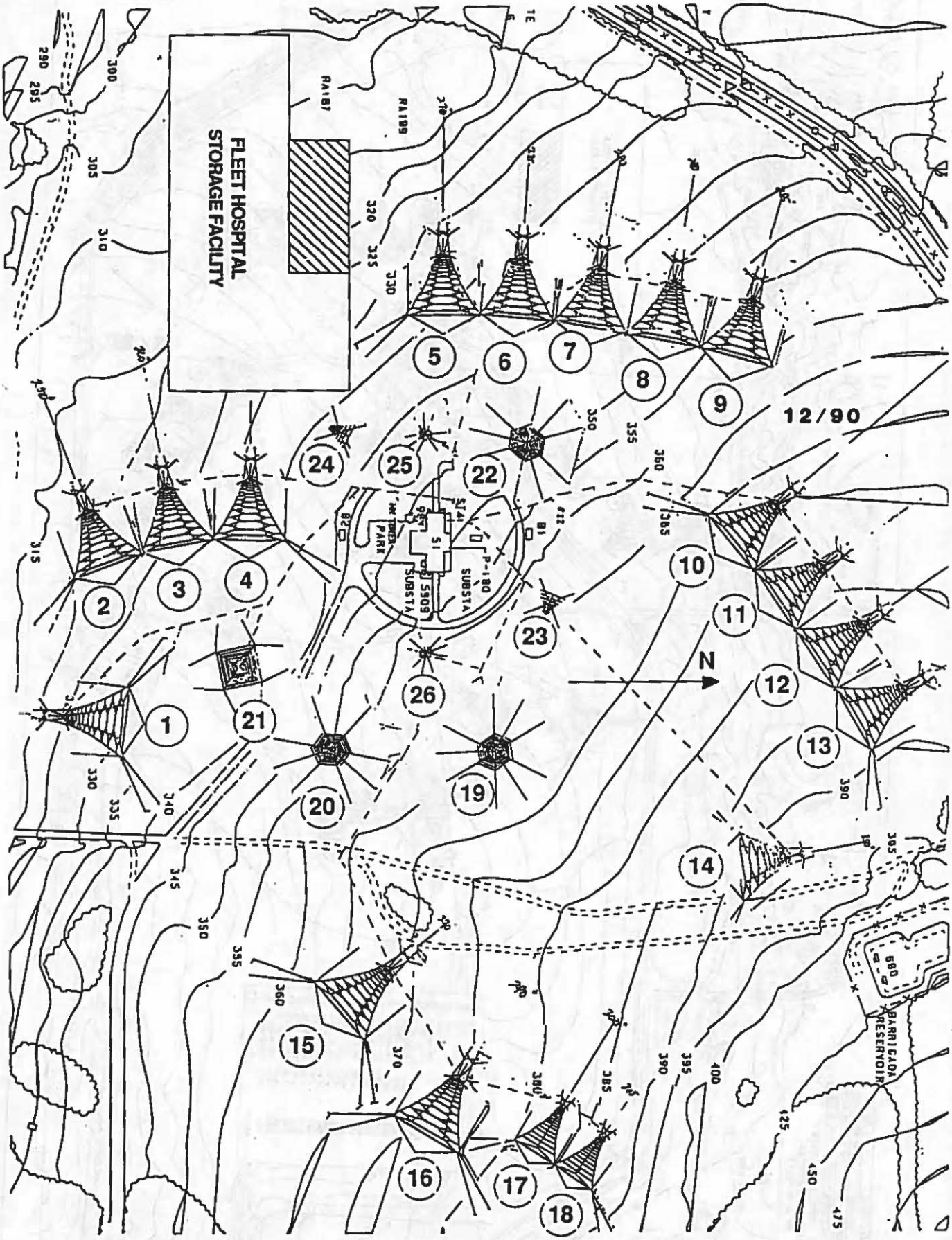

Figure 1

Antenna Field Layout-Revised
Barrigada, Guam, MI

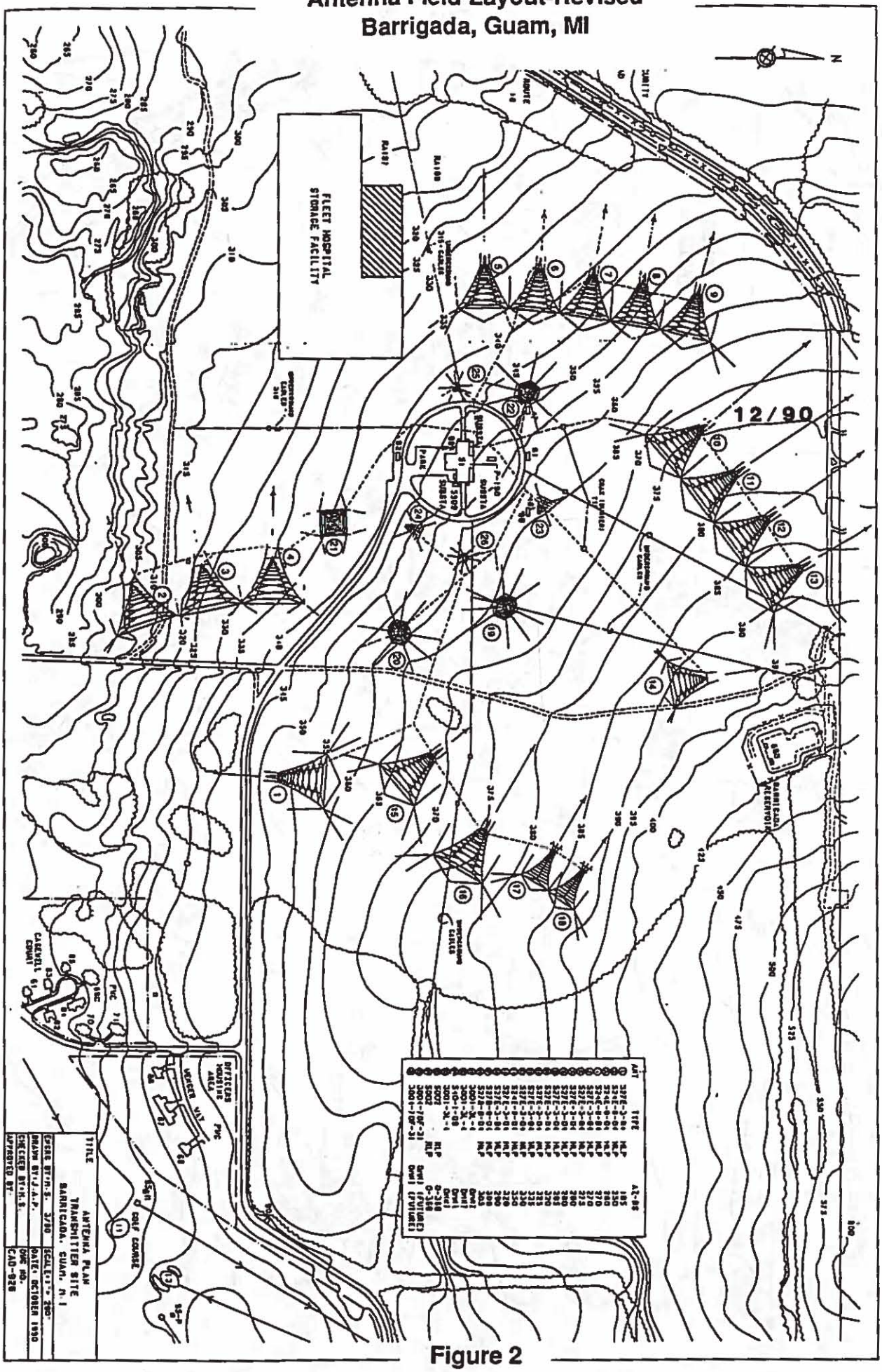

Figure 2

Map - Transmitter Site and Immediate Area

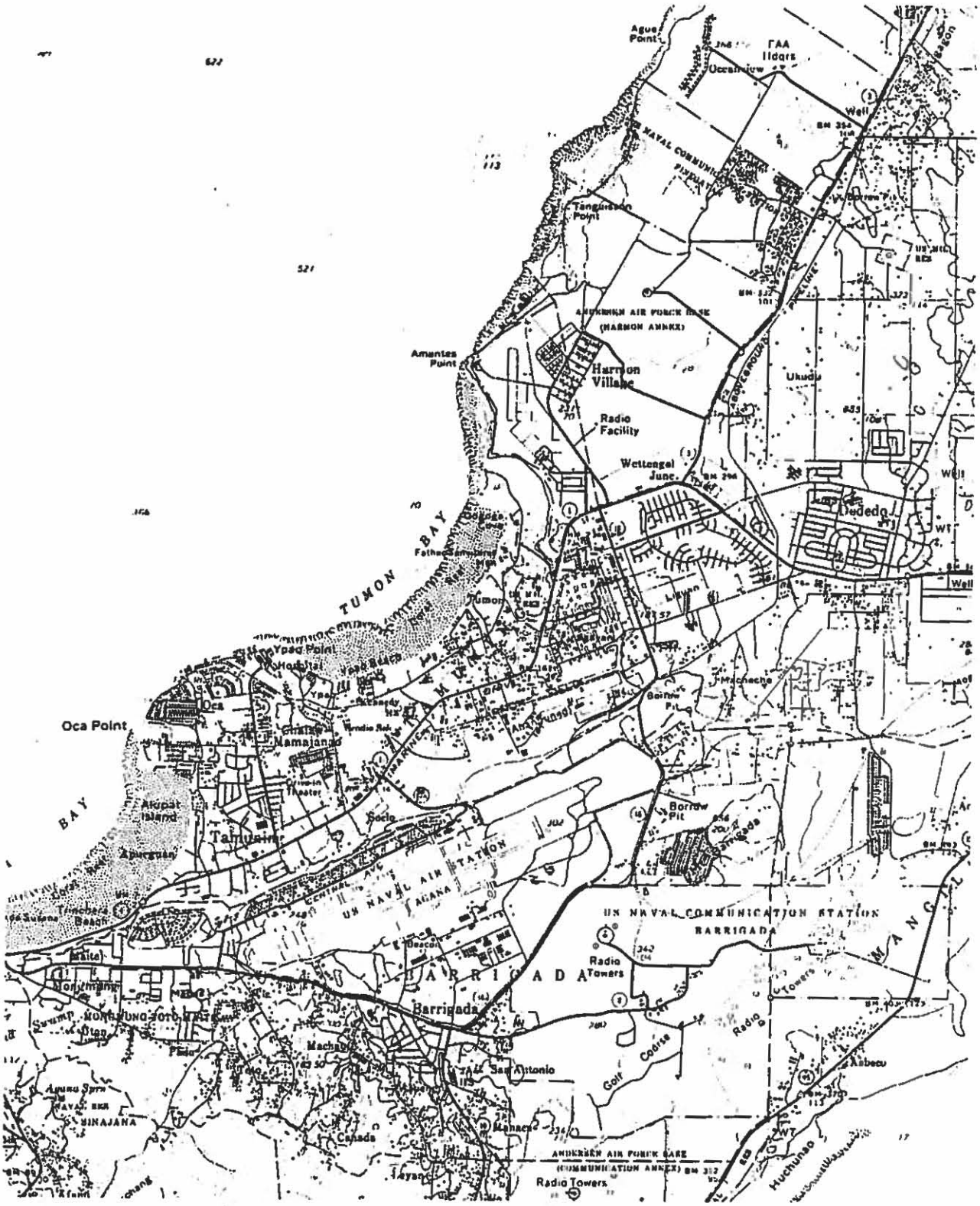

Figure 3

APPENDIX C

HERO STUDY

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IN REPLY REFER TO
8020
H22-DEV/CCD

From: Commander, Naval Surface Warfare Center
To: Commander, Naval Sea Systems Command (SEA-665)

Subj: HERO ANALYSIS FOR SITE APPROVAL OF INSTALLATION OF TRANSMITTING AND RECEIVING ANTENNAS FOR THE DIPLOMATIC TELECOMMUNICATIONS SERVICE RELAY FACILITY, PROJECT FB-29, GUAM, MARIANAS ISLANDS

Ref: (a) PACNAVFACENGCOM ltr 11010.31 Ser 203B/962 of 4 Feb 91
(b) NAVSEA OP 3565/NAVAIR 16-1-529/NAVELEX 0967-LP-624-6010, ELECTROMAGNETIC RADIATION HAZARDS (HAZARDS TO ORDNANCE), Volume II, Revision 6 of 15 Jul 89
(c) NAVELEXSYSENGCEN Theoretical Compatibility Study; Final Report for Reactivated Barragada Transmitter Site, Guam of 26 Dec 90
(d) PHONCON NAVSWC (Code H22) D. Vaught/FAA J. Treacey of 24 Jan 89

Encl: (1) HERO/EMI Analysis for Guam, Marianas Islands, Project to Install Telecommunications Service Relay Facility, Project FB-29

1. This letter, sent in response to reference (a), addresses the issue of Hazards of Electromagnetic Radiation to Ordnance (HERO) as a potential by-product of the Diplomatic Service's proposed Telecommunications Relay Facility to be located on the island of Guam. This facility, part of the Diplomatic Telecommunications Service, will provide high frequency (HF) communications with embassies and consulates in the East Asia area. The HERO analysis is focused on Naval Air Station (NAS), Agana, which shares a common border with the Radio Transmitter Facility (RTF) (Barragada), on which the Telecommunications Relay Facility antennas will be located. In addition to the HERO comments, some insight is offered with respect to the potential for electromagnetic interference (EMI) to commercial and military aircraft. Enclosure (1) provides results and conclusions germane to this analysis. Reference (b) is our authority for the included recommendations.

2. The results of the analysis, in the interest of clarity, have been divided into the general areas of "ground" effects and "air" effects. In general, the calculated field strength on the ground has been found to be proportionately low when compared to that calculated at altitudes typically used by military and commercial aircraft. This is explained below.

3. Sample field strengths calculated for the ground areas, which encompass the NAS Advanced Underwater Weapons Compound and the torpedo magazines, indicate levels will be slightly above that considered safe for exposure of the "worst-case" categories of ordnance (HERO UNSAFE ORDNANCE). Reference (c) was determined to be a more realistic interpretation of ground wave propagation and was adopted for this analysis. However, it is expected that this finding, if confirmed by instrumented testing, will have

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no practical consequences. Inasmuch as the buildings in which HERO UNSAFE ORDNANCE is handled and stored have a discrete, even though small, level of radio frequency shielding, the resulting fields produced inside the buildings should be of an acceptable level.

4. Field strength levels to which military and commercial aircraft will be exposed while approaching and taking off are calculated to be orders of magnitude above that alluded to above with respect to ground areas. However, the results of the investigation, which include HERO and EMI, are disparate. Commercial aircraft, limited to authorized flight lanes, will not be subject to EMI or HERO. Reference (d) provided confirmation of Federal Aviation Administration guidelines concerning commercial aircraft used in this analysis. Moreover, military aircraft, limited to authorized flight lanes, will not be subjected to EMI. However, there will be HERO impacts to be avoided.

5. Changes to air traffic patterns may be necessary to avoid HERO to certain impulse cartridges aboard rotary-wing aircraft (helicopters). This is derived from results of calculations indicating high field strength in lanes 06R-N, 06R-P and E2-A. In addition, certain training/exercise missiles carried by fixed-wing aircraft have not been HERO certified. This is being addressed by the cognizant program offices and the Naval Surface Warfare Center (NAVSWC). It is noted that only limited types of aircraft and ordnance are affected and that various options may be available to control this potential problem. During the coming months, we will be conducting instrumented tests and analyses to add refinement to the recommendations furnished to the various commands involved.

6. NAVSWC recommends HERO approval. Prior to activation of the RTF transmitters, arrangements must be made, including funding, for a HERO survey. The objective of the survey is to provide "real" data to determine the final power output levels [emission controls (EMCON)] consistent with HERO safety, and reliability of communications. The Center's point of contact for these matters is Dennis Vaught, Code H22, DSN 249-8594 or commercial (703) 663-8594.

Copy to:
CNO (OP 092K)
COMNAVAIRSYSCOM (AIR-5161G)

Subj: HERO ANALYSIS FOR SITE APPROVAL OF INSTALLATION OF TRANSMITTING AND RECEIVING ANTENNAS FOR THE DIPLOMATIC TELECOMMUNICATIONS SERVICE RELAY FACILITY, PROJECT FB-29, GUAM, MARIANAS ISLANDS

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8020
H22-DEV/CCD

HERO/EMI ANALYSIS FOR GUAM, MARIANAS ISLANDS, PROJECT TO INSTALL TELECOMMUNICATIONS SERVICE RELAY FACILITY, PROJECT FB-29

FEBRUARY 1991

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encl (1)

DRAFT

HERO/EMI ANALYSIS FOR GUAM, MARIANAS ISLANDS, PROJECT TO INSTALL TELECOMMUNICATIONS SERVICE RELAY FACILITY, PROJECT FB-29

Ref: (a) PACNAVFACENGCOM ltr 11010.31 Ser 203B/962 of 4 Feb 91
(b) NAVSEA OP 3565/NAVAIR 16-1-529/NAVELEX 0967-LP-624-6010, ELECTROMAGNETIC RADIATION HAZARDS (HAZARDS TO ORDNANCE), Volume II, Revision 6 of 15 Jul 89
(c) NAVELEXSYSENGCEN Theoretical Compatibility Study; Final Report for Reactivated Barragada Transmitter Site, Guam of 26 Dec 90
(d) CNO (OP 092K) HERO mtg of 26 Feb 91

1. This analysis responds to reference (a), concerning the installation of a Diplomatic Telecommunications Service Relay Facility at Barragada, Guam, Marianas Islands. This analysis addresses not only the Hazards of Electromagnetic Radiation to Ordnance (HERO) concerns with regard to Navy ordnance evolutions on the ground and ordnance carried by military aircraft at Naval Air Station (NAS), Agana, but also radio frequency (RF) environmental levels in the Barragada housing area, which is adjacent to the antenna field. In addition to the HERO analysis, judgments concerning the electromagnetic interference (EMI) impact to military and commercial aircraft, which utilize NAS Agana, are offered.

2. The proposed high frequency (HF) transmitter site will be located at the Radio Transmitter Facility (RTF), Barragada, approximately 3500 feet from the end of the NAS Agana runways. The following describes the antenna specifications:

Antenna	Type	Gain (dBi)	Frequency (MHz)
TCI Model 527E (12) each	Horizontal log periodic	16.5-18.2	6.2-30
TCI Model 527B (2) each	Horizontal log periodic	15	6.2-30
TCI Model 524E (4) each	Horizontal log periodic	15.5-16	5-30
TCI Model 540 (1) each	Omnidirectional log periodic	7-10.5	3.6-30
Granger 3001-3L-4 (1) each	Omnidirectional spiracone	7	2-30
Granger 3004-70F-31 (2) each	Omnidirectional spiracone	7	2-30
Hy-Gain LP-1002 (2) each	Rotatable log periodic	10-13.5	6-40

[Figure 1 illustrates the RTF Barragada antenna configuration, Barragada housing area and ordnance locations at NAS Agana.] The transmitter system will consist of 12 Harris transmitter units; two (20000 watts), six (10000 watts), four (5000 watts). All of the antennas are capable of a full 20000-watt power output, except the Granger 3004-70F-31 antennas, which are only rated for 5000 watts.

3. The method used in reference (c) was determined to be a more realistic interpretation for ground wave modeling in the near- and far-electric fields, and was adopted for this analysis in lieu of the equations presented in reference (b). This approach resulted in "worst-case" numbers; network and structural losses from the antenna were considered to be negligible, with a 100 percent operating efficiency. Also considered were the superimposed electromagnetic fields produced by multiple antennas or transmitters.

4. There are two basic ways in which electromagnetic energy propagates from a transmitting antenna; by ground wave and by sky wave. The following represent the minimum required separation distances at ground level between the specified antennas and HERO classified ordnance (as indicated, these calculated distances are based on a ground propagation model):

Antenna Type	HERO UNSAFE ORDNANCE Separation Distance (m)	HERO SUSCEPTIBLE ORDNANCE Separation Distance (m)
TCI 527E	825 (2707 ft)	184.4 (605 ft)
TCI 527B	667 (2188 ft)	131.6 (431.8 ft)
TCI 524E	1032 (3386 ft)	191 (626.7 ft)
TCI 540	620 (2034 ft)	137 (449.5 ft)
Granger 3001-3L-4	620 (2034 ft)	137 (449.5 ft)
Granger 3004-70F-31	620 (2034 ft)	137 (449.5 ft)
HY-Gain LP 1002	975 (3199 ft)	224 (734.9)

5. Results of the HERO analysis indicate that fields within NAS Agana ordnance areas will be less than the HERO SUSCEPTIBLE ORDNANCE criterion of 2 V/m. However, one should expect field strengths which marginally exceed the HERO UNSAFE ORDNANCE criterion of 0.2 V/m in the Advanced Underwater Weapons (AUW) Compound, near the torpedo magazines and on the ordnance transportation route. The AUW Compound is utilized for ordnance assembly where HERO "untested" components are assembled. Such components are HERO UNSAFE ORDNANCE and the 0.2 V/m criterion applies. However, this analysis does not include those intrinsic shielding properties of the AUW building and the torpedo magazines. Past experience suggests that instrumented

tests performed inside the buildings will demonstrate that the field strengths are lower than criteria (hence, safe). [Figure 2 illustrates the HF ground wave propagation from RTF Barragada to NAS Agana.]

6. With regard to the field strength levels created in the Barragada housing area, the stationary log periodic antennas cannot propagate significant radiation levels within the Barragada housing area. The rotatable log periodic antennas will have cutouts installed to avoid this area. Calculations for the omnidirectional antennas present similar results; e.g., HF field strength levels are below 0.2 V/m. Neither HERO nor Hazards of Electromagnetic Radiation to Personnel (HERP) will be a concern in the housing area.

7. Although unusual, it is possible that aircraft carrying HERO UNSAFE or HERO SUSCEPTIBLE ORDNANCE could operate out of NAS Agana. Sky wave propagation profiles indicate that "main beam" irradiation will occur as aircraft traverse electromagnetic fields. Results of the HERO analysis, with respect to fixed-wing military aircraft lanes at NAS Agana, indicate that field strength levels from 20 to 36 V/m will be present during fly-throughs in the main beam from antennas 10 through 13. Aircraft, such as P-3, S-3, F/A-18 and F-14, will penetrate the main beam created by these antennas when exiting runways 06R and 06L and during flight in air lanes 06R-I, 06R-H, 06L-I and 06L-H. [Refer to Figure 3 for fixed-wing air lanes and RF contours.] These field intensity levels, although above the general HERO criterion for HERO SUSCEPTIBLE ORDNANCE, will not affect electric cartridges internal to the aircraft or most externally loaded stores. However, on rare occasions, it may be deemed necessary to fly through the RTF Barragada RF envelope with HERO SUSCEPTIBLE ORDNANCE that has a susceptibility criterion less than the field strength levels created by the antennas. The following HERO SUSCEPTIBLE ORDNANCE separation distances apply to "in-flight" ordnance:

Antenna Type	HERO SUSCEPTIBLE ORDNANCE Separation Distance (m)
TCI 527E	2590 (8507 ft)
TCI 527B	2179 (7157 ft)
TCI 524E	2308 (7582 ft)
TCI 540	867 (2849 ft)
Granger 3001-3L-4	867 (2849 ft)
Granger 3004-70F-31	434 (1425 ft)
HY-Gain LP 1002	1225 (4025 ft)

These data were compiled using the equations presented in reference (b) and apply to ordnance that has not been certified by Naval Air Systems Command, but as an interim measure shall be treated as HERO SUSCEPTIBLE ORDNANCE. For example, according to the NAS Agana ordnance list, flight operations can be conducted with training missiles ATM-7F and -7E. Options could include grounding the ordnance or reduction of transmitter power at RTF Barragada, but it is expected that this ordnance will eventually be HERO certified, at least for in-flight conditions.

8. Results of the HERO analysis, with respect to rotary-wing military aircraft lanes at NAS Agana, indicate that field strength levels in excess of 100 V/m will occur in the main beam envelopes from antennas 5-9, while aircraft are flying air lanes 06R-N, 06R-P and pattern E2-A. [Figure 4 illustrates the NAS Agana rotary-wing air routes and RF contours.] This field strength level will exceed the HERO susceptibility criterion for H-46 aircraft while carrying external stores such as the magnetic anomaly detector (MAD) cable cutter (NALC M161) or when uncontainerized ordnance is transferred for vertical replenishment (VERTREP). Additionally, other helicopters, such as the SH-2, SH-3 and SH-60, will have internal electric cartridges (NALC M161, rescue hoist cable cutter) and external stores, such as bomb racks, marine location markers and sonobuoys, all of which carry a susceptibility criterion of 100 V/m or less. Alternatives include reduction of transmitted power or rerouting the aircraft from the aforementioned flight paths onto other flight paths.

9. The EMI impact on older commercial aircraft for electronic equipment internal to the fuselage has been considered by the EMI subcommittee of the Federal Aviation Administration (FAA). They state that aircraft internal electronics were designed to an EMI threshold of approximately 1 to 2 V/m [reference (d)]. Taking into account the RF shielding characteristics of the aircraft's metal skin, we estimate that an exposure level up to 100 V/m external will not upset the avionics and controls of older commercial aircraft. These predictions are based on estimates of the aircraft intrinsic RF shielding. Future standards will establish a bench test level of 200 V/m for new commercial aircraft. RTF Barragada HF field strengths within the specific air patterns, glideslope lanes and takeoff routes indicate the levels will be below 100 V/m. The EMI limit for military aircraft, as presented in MIL-HDBK-235, is 200 V/m. Calculated field strengths from RTF Barragada will not exceed this in any of the normal air patterns at NAS Agana.

APPENDIX D

GUAM COASTAL MANAGEMENT PROGRAM CONSISTENCY REPORT

GUAM COASTAL MANAGEMENT PROGRAM
ASSESSMENT FORMAT

DATE OF APPLICATION: April 10, 1991

NAME OF APPLICATION: U.S. Navy - Pacific Division Facilities Engineering Command

ADDRESS: Pearl Harbor, Hawaii 96860-7300

TELEPHONE NO. Mr. Gordon Ishikawa, Code 231 (808) 471-9338

TITLE OF PROPOSED PROJECT: Installation of Transmitter and Receiving Antennas for the Diplomatic Telecommunications System Regional Relay Facility, Guam, Mariana Islands

COMPLETE FOLLOWING PAGES

FOR BUREAU OF PLANNING ONLY:

DATE APPLICATION RECEIVED: _____

OCRM NOTIFIED: _____ **LIC. AGENCY NOTIFIED:** _____

APPLICANT NOTIFIED: _____ **PUBLIC NOTICE GIVEN:** _____

OTHER AGENCY REVIEW REQUESTED: _____

_____

_____

DETERMINATION: ( ) **CONSISTENT** ( ) **NON-CONSISTENT** ( ) **FURTHER INFORMATION REQUESTED**

OCRM NOTIFIED: _____ **LIC. AGENCY NOTIFIED:** _____

APPLICANT NOTIFIED: _____

ACTION LOG:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

DATE REVIEW COMPLETED: _____

GUAM COASTAL MANAGEMENT PROGRAM
ASSESSMENT FORMAT

DEVELOPMENT POLICIES (DP):

1. Shore Area Development

Intent: To insure environment and aesthetic compatibility of shore area land uses.

Policy: Only those uses shall be located within the Seashore Reserve which:

- enhance, are compatible with or do not generally detract from the surrounding coastal area's aesthetic and environmental quality and beach accessibility; or
- can demonstrate dependence on such a location and the lack of feasible alternative sites.

Discussion:

Sites do not fall within seashore reserves. Proposed use is compatible with existing use as antenna fields. See Chapter 4 of the EA for discussion on alternatives.

2. Urban Development

Intent: To cluster high impact uses such that coherent community design, function, infrastructure support and environmental compatibility are assured.

Policy: Commercial, multi-family, industrial and resort-hotel zone uses and uses requiring high levels of support facilities shall be concentrated within urban districts as outlined on the Land Use Districting Map.

Discussion:

Areas are part of current defense installations serving as antenna facilities.

DP 3. Rural Development

Intent: To provide a development pattern compatible with environmental and infrastructure support suitability and which can permit traditional lifestyle patterns to continue to the extent practicable .

Policy: Rural districts shall be designated in which only low density residential and agricultural uses will be acceptable. Minimum lot size for these uses should be one-half acre until adequate infrastructure including functional sewering is provided.

Discussion:

No rural or agricultural areas will be affected. The use is contained within existing military facilities.

4. Major Facility Siting

Intent: To include the national interest in analyzing the siting proposals for major utilities, fuel and transport facilities.

Policy: In evaluating the consistency of proposed major facilities with the goals, policies, and standards of the Comprehensive Development and Coastal Management Plans, the Territory shall recognize the national interest in the siting of such facilities including those associated with electric power production and transmission, petroleum refining and transmission, port and air installations, solid waste disposal, sewage treatment, and major reservoir sites.

Discussion:

It is in the national interest to site sensitive diplomatic transmitting and receiving facilities on U.S. territory. See Chapter 2 of the EA for project purpose.

DP 5. Hazardous Areas

Intent: Development in hazardous areas will be governed by the degree of hazard and the land use regulations.

Policy: Identified hazardous lands, including floodplains, erosion-prone areas, air installations, crash and sound zones and major fault lines shall be developed only to the extent that such development does not pose unreasonable risks to the health, safety or welfare of the people of Guam, and complies with the land use regulations.

Discussion:

Sites are not considered hazardous.

6. Housing

Intent: To promote efficient community design placed where the resources can support it.

Policy: The government shall encourage efficient design of residential areas, restrict such development in areas highly susceptible to natural and man-made hazards, and recognize the limitations of the island's resources to support historical patterns of residential development.

Discussion:

Proposed action is not residential. No impact on current housing is expected.

DP 7. Transportation

Intent: To provide transportation systems while protecting potentially impacted resources.

Policy: The Territory shall develop an efficient and safe transportation system, while limiting adverse environmental impacts on primary aquifers, beaches, estuaries and other coastal resources.

Discussion:

No impact on transportation services is expected.

8. Erosion and Siltation

Intent: To control development where erosion and siltation damage is likely to occur.

Policy: Development shall be limited in areas of 15% or greater slope by requiring strict compliance with erosion, sedimentation, and land use districting guidelines, as well as other related land use standards for such areas.

Discussion:

Minor grading will be restricted to antenna pad areas. No erosion or siltation damage is anticipated.

RESOURCES POLICIES (RP):

1. Air Quality

Intent: To control activities to insure good air quality.

Policy: All activities and uses shall comply with all local air pollution regulations and all appropriate Federal air quality standards in order to ensure the maintenance of Guam's relatively high air quality.

Discussion:

Operation of emergency electrical generators is not anticipated to have any impact upon air quality.

2. Water Quality

Intent: To control activities that may degrade Guam's drinking, recreational, and ecologically sensitive waters.

Policy: Safe drinking water shall be assured and aquatic recreation sites shall be protected through the regulation of uses and discharges that pose a pollution threat to Guam's waters, particularly in estuarine, reef and aquifer areas.

Discussion:

No impact on water quality is expected.

RP 3. Fragile Areas

Intent: To protect significant cultural areas, and natural marine and terrestrial wildlife and plant habitats.

Policy: Development in the following types of fragile areas shall be regulated to protect their unique character.

- historical and archaeological sites
- wildlife habitats
- pristine marine and terrestrial communities
- limestone forests
- mangrove stands and other wetlands

Discussion:

Action is proposed for existing or former antenna sites. Areas do not contain any archaeological sites, sensitive habitats, limestone forests, or wetlands.

4. Living Marine Resources

Intent: To protect marine resources in Guam's waters.

Policy: All living resources within the territorial waters of Guam, particularly corals and fish, shall be protected from over harvesting and, in the case of marine mammals, from any taking whatsoever.

Discussion:

Action will have no impact upon living marine resources.

RP 5. Visual Quality

Intent: To protect the quality of Guam's natural scenic beauty.

Policy: Preservation and enhancement of, and respect for the 's scenic resources shall be encouraged through increased enforcement of and compliance with sign, litter, zoning, subdivision, building and related land use laws. Visually objectionable uses shall be located to the maximum extent practicable so as not to degrade significant views from scenic overlooks, highways and trails.

Discussion:

Action will occur amongst existing antenna fields and military installations. No scenic overlooks or significant views will be affected.

6. Recreation Areas

Intent: To encourage environmentally compatible recreational development.

Policy: The Government of Guam shall encourage development of varied types of recreational facilities located and maintained so as to be compatible with the surrounding environment and land uses, adequately serve community centers and urban areas and protect beaches and such passive recreational areas as wildlife and marine conservation areas, scenic overlooks, parks and historical sites.

Discussion:

Action will not impact recreation areas.

RP 7. Public Access

Intent: To ensure the right of public access.

Policy: The public's right of unrestricted access shall be ensured to all non-federally owned beach areas and all Territorial recreation areas, parks, scenic overlooks, designated conservation areas and their public lands; and agreements shall be encouraged with the owners of private and federal property for the provision of releasable access to and use of resources of public nature located on such land.

Discussion:

Action will occur on federal military installations. No non-federally owned beach areas, territorial recreation areas, parks, etc. will be impacted.

8. Agricultural Lands

Intent: To stop urban types of development on agricultural land.

Policy: Critical agricultural land shall be preserved and maintained for agricultural use.

Discussion:

Land involved is not in agricultural use or designation.

FEDERAL CONSISTENCY
SUPPLEMENTAL INFORMATION FORM

Date: April 10, 1991

Project/Activity Title or Description: Construction of Diplomatic Telecommunications Service on NAVCAMS Finegayan and RTF Barrigada

Location: RTF Barrigada, NAVCAMS Finegayan

Other applicable area(s) affected, if appropriate: _____

Est. Start Date: June 1991 Est. Duration: February 92 (9 months)

APPLICANT

Name & Title: Gordon Ishikawa - Code 231

Agency/Organization: Pacific Division, Naval Facilities Engineering Command

Address: Pearl Harbor, Hawaii

_____ Zip: 96860-7300

Telephone No. during business hours:

A/C ( ) (808) 471-9338

A/C ( ) _____

AGENT

Name & Title: Susan S. Rutka, Senior Planner

Agency/Organization: Belt Collins & Associates

Address: 680 Ala Moana Boulevard, Suite 200, Honolulu, Hawaii 96813

_____ Zip: _____

Telephone No. during business hours:

A/C ( ) (808) 521-5361

A/C ( ) _____

APPENDIX E

FEDERAL AVIATION AUTHORITY DETERMINATION OF NO HAZARD TO AIR NAVIGATION

US Department of Transportation
Federal Aviation Administration

FAA, Airspace & Procedures, AWP-530
P.O. Box 92007, WWPC
Los Angeles, CA 90009

IN REPLY REFER TO
AERONAUTICAL STUDY
NO. 91-AWP-0266-OE
THRU
91-AWP-0279-OE

DETERMINATION OF NO HAZARD TO AIR NAVIGATION

SPONSOR	Department of State Diplomatic Security Information Management /SO/TO Washington, D.C. 20520-2810 Project Officer, Michael A. Brennan	CONSTRUCTION LOCATION PLACE NAME AGANA, GUAM LATITUDE: 13-28-38 LONGITUDE: 144-48-55	
CONSTRUCTION PROPOSED	DESCRIPTION 26 HF Antennas 3-30 MHz .2MW	HEIGHT (IN FEET) ABOVE GROUND: Max 210 ABOVE MSL: Max 609	

An aeronautical study of the proposed construction described above has been completed under the provisions of Part 77 of the Federal Aviation Regulations. Based on the study it is found that the construction would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the construction would not be a hazard to air navigation provided the following conditions are met.

Conditions:

Any future change in frequency, radiated power or antenna characteristics shall be filed as notice to the FAA on Form 7460-1

Supplemental notice of construction is required any time the project is abandoned (use the enclosed FAA form), or

- ☐ At least 48 hours before the start of construction (use the enclosed FAA form).
- ☒ Within five days after the construction reaches its greatest height (use the enclosed FAA form)

This determination expires on Novemeber 15, 1992 unless:

(a) extended, revised or terminated by the issuing office;
(b) the construction is subject to the licensing authority of the Federal Communications Commission and an application for a construction permit is made to the FCC on or before the above expiration date. In such case the determination expires on the date prescribed by the FCC for completion of construction, or on the date the FCC denies the application.

NOTE: Request for extension of the effective period of this determination must be postmarked or delivered to the issuing office at least 15 days prior to the expiration date.

This determination is subject to review if an interested party files a petition on or before May 5, 1991. In the event a petition for review is filed, it should be submitted in triplicate to the Manager, Flight Information and Obstructions Branch, AAT-210, Federal Aviation Administration, Washington, D.C. 20591 and contain a full statement of the basis upon which it is made.

This determination becomes final on May 15, 1991 unless a petition for review is timely filed, in which case the determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review.

An account of the study findings, aeronautical objections, if any, registered with the FAA during the study, and the basis for the FAA's decision in this matter will be found on the following page(s).

If the structure is subject to the licensing authority of the FCC, a copy of this determination will be sent to that Agency.

This determination, issued in accordance with FAA Part 77, concerns the effect of this proposal on the safe and efficient use of the navigable airspace by aircraft and does not relieve the sponsor of any compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

Continued

SIGNED for Sabra W. Kaulia TITLE Manager, System Management Branch

ISSUED IN Hawthorne, CA ON April 5, 1991

THE PROPOSED ANTENNA TOWERS WOULD BE LOCATED BETWEEN 3450 FEET AND 6800 FEET SOUTHEAST OF THE APPROACH END OF RUNWAY 24R OF THE NAVAL AIR STATION AGANA GUAM. THE PROPOSED TOWERS HAVE BEEN IDENTIFIED AS OBSTRUCTIONS BY EXCEEDING THE STANDARDS OF FEDERAL AVIATION REGULATIONS (FAR) PART 77, SUBPART C, AS FOLLOWS:

77.23 (A) (2) BY 10 FEET, A HEIGHT GREATER THAN 200 FEET ABOVE GROUND LEVEL WITHIN 3 NAUTICAL MILES OF THE AIRPORT REFERENCE POINT OF THE NAVAL AIR STATION AGANA GUAM.

77.23(A) (5) BY 8 TO 162 FEET, A HEIGHT EXCEEDING THE INNER HORIZONTAL SURFACE 150 FEET ABOVE AIRPORT ELEVATION (297') WITHIN A 7500 FOOT RADIUS OF THE NAVAL AIR STATION AGANA GUAM.

THE AERONAUTICAL STUDY CONDUCTED BY THE FEDERAL AVIATION ADMINISTRATION (FAA) FOUND THE PROPOSAL WOULD HAVE NO ADVERSE IMPACT ON ARRIVAL, DEPARTURE, OR ENROUTE PROCEDURES FOR AIRCRAFT OPERATING UNDER VISUAL OR INSTRUMENT FLIGHT RULES. THE STUDY ALSO FOUND THERE WOULD BE NO IMPACT TO EXISTING OR PLANNED PUBLIC USE AERONAUTICAL FACILITIES.

THE PROPOSED TOWERS WOULD BE LOCATED WITHIN AN AREA WHICH HAS PREVIOUSLY BEEN DESIGNATED AS AN ANTENNA FARM AREA. THEY ARE ALSO LOCATED ADJACENT TO THE BASE OF MOUNT BARRIGADA WHICH HAS AN OVERALL HEIGHT GREATER THAN ANY OF THE PROPOSED TOWERS. THE PROPOSED TOWERS WOULD HAVE NO GREATER IMPACT ON AERONAUTICAL OPERATIONS THAN THE EXISTING TERRAIN AND WAS THEREFORE NOT CIRCULARIZED TO THE PUBLIC FOR COMMENT.

ALTHOUGH THE PROPOSED TOWERS HAVE BEEN IDENTIFIED AS OBSTRUCTIONS, THE STUDY RESULTS CONCLUDE THE PROPOSALS WOULD HAVE NO ADVERSE AFFECT ON THE SAFE AND EFFICIENT USE OF NAVIGABLE AIRSPACE AND WOULD NOT BE A HAZARD TO AIR NAVIGATION.

ALTHOUGH EACH OF THE TOWERS HAVE BEEN IDENTIFIED AS OBSTRUCTIONS, THE STUDY CONCLUDES THAT IT IS NOT NECESSARY TO OBSTRUCTION MARK AND LIGHT EACH ONE. IT IS RECOMMENDED THAT TOWERS NUMBER 1, 4, 5, 9, 13, 16, AND 18 BE OBSTRUCTION MARKED AND LIGHTED IN ACCORDANCE WITH FAA ADVISORY CIRCULAR 70/7460-1G CHAPTERS 3,4,5,& 9.

THIS DETERMINATION DOES NOT INCLUDE TEMPORARY CONSTRUCTION EQUIPMENT, SUCH AS CRANES OR DERRICKS WHICH MEET THE FILING REQUIREMENTS OF FAR PART 77. SUCH EQUIPMENT REQUIRES NOTIFICATION TO THE FAA ON FORM 7460-1 FOR AERONAUTICAL STUDY.

DO NOT REMOVE CARBONS

Form Approved OMB No. 2120-0001

Department of Transportation
Federal Aviation Administration

NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION

Aeronautical Study Number: 91-AWP-280-OE

Nature of Proposal

Type	B. Class	C. Work Schedule Dates
☒ New Construction	☒ Permanent	Beginning 4/1/91
☐ Alteration	☐ Temporary (Duration _____ months)	End 9/1/92

1. Name and address of individual, company, corporation, etc. proposing the construction or alteration. (Number, Street, City, State and Zip Code)

202 647-4219
Area code Telephone Number

Department of State
Diplomatic Security
Information Management/SO/TO
Washington, DC 20520-2810
Project Officer: Michael A. Brennan

Name, address and telephone number of proponent's representative if different than 3 above.

SAIC
3705 Cordova Place (703) 591-5755
Fairfax, VA. 22031 Attn: M. Strong

2. Complete Description of Structure

A. Include effective radiated power and assigned frequency of all existing, proposed or modified AM, FM, or TV broadcast stations utilizing this structure.

B. Include size and configuration of power transmission lines and their supporting towers in the vicinity of FAA facilities and public airports.

C. Include information showing site orientation, dimensions, and construction materials of the proposed structure.

Structure is TCI model 527E-3 HLP antenna.

A. 0 Power (Receiving)

B. Coax will be buried in ground

C. See attached drawing.
Ant. #1

(If more space is required, continue on a separate sheet.)

Location of Structure

Finegayan, Guam ANDERSAFB

A. Coordinates (nearest second)	B. Nearest City or Town, and State	C. Name of nearest airport, heliport, flightpark, or seaplane base	5. Height and Elevation (Complete to the nearest foot)	
13° 34' 57"	Agana, Guam, M.I.	Guam International	A. Elevation of site above mean sea level	427
144° 50' 21"	(1) Distance to 4B: 9 Miles	(1) Distance from structure to nearest point of nearest runway 5 7-25	B. Height of Structure including all appurtenances and lighting (if any) above ground, or water if so situated	210'
Datum	(2) Direction to 4B	(2) Direction from structure to airport Southwest EAST	C. Overall height above mean sea level (A + B)	637

Description of location of site with respect to highways, streets, airports, prominent terrain features, existing structures, etc. Attach a U.S. Geological Survey quadrangle map or equivalent showing the relationship of construction site to nearest airport(s). (If more space is required, continue on a separate sheet of paper and attach to this notice.)

See attached map and site drawing, CAD-928A, December 1990.

This is required by Part 77 of the Federal Aviation Regulations (14 C.F.R. Part 77) pursuant to Section 1101 of the Federal Aviation Act of 1958, as amended (49 U.S.C. 1101). Persons who knowingly and willingly violate the Notice requirements of Part 77 are subject to a fine (criminal penalty) of not more than $500 for the first offense and not more than $1,000 for subsequent offenses, pursuant to Section 902(a) of the Federal Aviation Act of 1958, as amended (49 U.S.C. 1472(a)).

I HEREBY CERTIFY that all of the above statements made by me are true, complete, and correct to the best of my knowledge. In addition, I agree to obstruction mark and/or light the structure in accordance with established marking & lighting standards if necessary.

Date	Typed Name/Title of Person Filing Notice	Signature
2/28/91	Myron E. Strong	

FAA USE ONLY — FAA will either return this form or issue a separate acknowledgement.

Proposal: ANY FUTURE CHANGE IN FREQUENCY, RADIATED POWER OR ANTENNA CHARACTERISTICS SHALL BE FILED AS NOTICE TO THE FAA ON FORM 7460-1.

Does not require a notice to FAA.

Is not identified by any standard of FAR, Part 77, Subpart C, and would not be a hazard to air navigation.

Is identified as an obstruction under the standards of FAR, Part 77, Subpart C, but would not be a hazard to air navigation.

Should be obstruction ☒ marked ☐ lighted per FAA Advisory Circular 70/7460-1, Chapter(s) 3, 4, 5 & 9

Obstruction marking and lighting are not necessary.

Remarks:

Supplemental Notice of Construction FAA Form 7460-2 is required any time the project is abandoned, or:

☐ At least 48 hours before the start of construction.

☐ Within five days after the construction reaches its greatest height.

This determination expires on Oct 2, 1992 unless:

(a) extended, revised or terminated by the issuing office;

(b) the construction is subject to the licensing authority of the Federal Communications Commission and an application for a construction permit is made to the FCC on or before the above expiration date. In such case the determination expires on the date prescribed by the FCC for completion of construction, or on the date the FCC denies the application.

NOTE: Request for extension of the effective period of this determination must be postmarked or delivered to the issuing office at least 15 days prior to the expiration date.

If the structure is subject to the licensing authority of the FCC, a copy of this determination will be sent to that Agency.

Signature	Date
	April 2, 1991

7460-1 (8-85)

DO NOT REMOVE CARBONS