Environmental Assessment

MOUNTAINTOP SENSOR INTEGRATION AND TEST PROGRAM

- Pacific Missile Range Facility-Makaha Ridge
- Pacific Missile Range Facility-Kokee
- Kokee Air Force Station

Kauai, Hawaii

December 1993

DEPARTMENT OF DEFENSE
DEPARTMENT OF THE NAVY

FINDING OF NO SIGNIFICANT IMPACT FOR THE MOUNTAINTOP SENSOR INTEGRATION AND TEST PROGRAM AT PACIFIC MISSILE RANGE FACILITY-MAKAHA RIDGE, PACIFIC MISSILE RANGE FACILITY - KOKEE, KOKEE AIR FORCE STATION, KAUAI, HAWAII

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 gives notice that an Environmental Assessment (EA) has been prepared and an Environmental Impact Statement is not being prepared for implementation of the Mountaintop Sensor Integration and Test Program (MSITP).

The purpose of MSITP is to evaluate the enhanced technology required for detection and tracking af targets by an airborne radar platform at long range. Thin testing is essential to military readiness of existing and future military operations world-wide. MSITP will enhance the Navy's ability to *detect* airborne targets.

The proposed action is a ground-baaed, test, and demonstration of airborne surveillance and communication technology associated with long-range detection and tracking of targets. This project is referred to as the Mountaintop Sensor Integration and Test Program and is sponsored by the Advanced Research Projects Agency. Three test sites have been chosen on the island of Kauai, Hawaii: the Pacific Missile Range Facility - Makaha Ridge (PMRF - Makaha Ridge); the Pacific Missile Range Facility - Kokee (PMRF - Kokee); and the Kokee Air Force Station (KAFS). The MSITP facility will be rotated among each *of* the three sites over a three year period, with no sites being used simultaneously. The action will incorporate two 45 foot long trailers housing a display and operations center, and a pedestal/antenna structure which holds the Radar Surveillance Technology Experimental Radar (RSTER) equipment, Antenna height will vary at each site. A 25 foot high auxiliary tower will be used to support assembly and surveillance *of* RSTER, Additionally, a linear patch antenna will be used in conjunction with the RSTER system. After the three year test is complete all equipment will be removed from the sites.

Three alternatives to the proposed action were considered. The no-action alternative was considered unaccaptabls because without the proposed MSITP testing the Department of Defense would be required to rely on the existing inadequate radar technology to track. advanced airborne targets among land and sea clutter. The alternative site an Mt. Haleakala, Maui was unaaceptablc bocause it lacks airborne targste for tracking, has no existing ranqe control, posed flight safety problems caused by commercial air traffic, proximity to ocean, and sea clutter. Three sites on Kauai were all considered acceptablo and were incorporated into the proposed action. Alternate technology would require a significant increase in flying hours and funding, and would have no appreciable environmental advantage,

No significant impacts to the environment are expected to occur due to the proposed action. All three sites on Kauai, Hawaii are in attainment for the six criteria pollutants, thus the Clean Air Act does not require a conformity determination for the proposed action. The proposed action is in compliance with the State Implementation Plan for meeting ambient air quality standards. The proposed action will only increase the personnel on the three sites by 5, thus having a negligible impact on traffic patterns surrounding each site. Temporary increase in vehicle and dust emissions will occur due to construction of the antenna. Dust will be controlled by watering any exposed soil. No significant increase in demand on the infrastructure of the three sites is anticipated. Existing utilities will be used for the MSITP set-up and operation. The Office of State Planning has concurred with the Navy that the proposed action is consistent with the Coastal Zone Management Act of Kauai, Hawaii.

A natural resource survey was conducted in December 1992 on all three proposed sites. The MSITP facility on PMRF - Makaha Ridge and PMRF Kokee will be located on existing paved surfaces. Site preparation at KAFS will include the removal of 6,000 square feet of introduced yellow ginger, grading the site, and possible construction of retaining walls and drainage facilities, but will have no significant impact on any native birds or mammals. Exterior lighting at all sites will be designed to deflect lighting downward to avoid possible disorientation of traveling birds. The effects of the electromagnetic fields, produced by the MSITP, on birds will be negligible since the power density of the RSTER (16 mW/cm^2) is well below the power levels known to affect birds (50 mW/cm^2). No federally or state listed endangered or threatened plants or animals will be impacted by the project.

No visual impacts are anticipated from the erection of the proposed MSITP and RSTER antenna, Construction of the pedestal/antenna unit will vary with each of the sites; 85 feet at PMRF - Makaha Ridge, 56 feet at PMRF - Kokee, and 52 feet at KAFS. However, these structures will be temporary and will not permanently affect the existing aesthetic value of the areas. There will be no significant hazards of electromagnetic radiation to personnel, fuel, or ordnance. No significant increases in noise are anticipated.

A cultural and historic survey of the sites was conducted in December 1992 which found no historic, cultural, or archaeological remains, The State Historic preservation Office of the Department of Land and Natural Resources concurred with the survey conclusion.

Based on information gathered during preparation of the EA, the Navy finds that the proposed Mountaintop Sensor Integration and Test Program on Kauai, Hawaii, will have no significant impact on the environment.

The EA addressing this action may be obtained from: Commander, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii 96860-7300 (Attn: Mr. Melvin Kaku, Code 23), telephone (808)471-9338, A limited number of copies of the EA are available to fill single copy requests.

14 March 1994
Date

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Environmental Assessment

MOUNTAINTOP SENSOR INTEGRATION AND TEST PROGRAM

Kauai, Hawaii

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Pacific Division
Naval Facilities Engineering Command

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ABSTRACT
ENVIRONMENTAL ASSESSMENT FOR THE MOUNTAINTOP SENSOR INTEGRATION AND TEST PROGRAM AT PACIFIC MISSILE RANGE FACILITY-MAKAHA RIDGE, PACIFIC MISSILE RANGE FACILITY-KOKEE, AND KOKEE AIR FORCE STATION KAUAI, HAWAII

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Coordinating Agency:	Pacific Division, Naval Facilities Engineering Command Pearl Harbor, Hawaii
Host Agency:	Pacific Missile Range Facility-Barking Sands Barking Sands, Kauai
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The Advanced Research Projects Agency (ARPA) in Washington, D.C., proposes a ground-based test and demonstration of airborne surveillance and communication technology and algorithms associated with long-range detection and tracking of advanced airborne targets by an airborne radar platform. The project is referred to as the Mountaintop Sensor Integration and Test Program (MSITP). The MSITP project had been proposed for three alternative sites located on the island of Kauai, Hawaii: the Pacific Missile Range Facility-Makaha Ridge (PMRF-Makaha Ridge); the Pacific Missile Range Facility-Kokee (PMRF-Kokee); and, the Kokee Air Force Station (KAFS). The MSITP Facility will be rotated among each of the three main sites over a three-year period. The sites will not be used simultaneously.

The primary physical components of the MSITP project include two 45-foot long trailers, which will house the display and operations center for the project, and an antenna/pedestal structure housing the radar equipment for the project. The primary radar equipment to be tested is designated the Radar Surveillance Technology Experimental Radar (RSTER). Secondary components of the project include: an auxiliary tower (approximately 25 feet high) to support assembly and checkout of the RSTER-90 antenna prior to lift and mounting on the primary RSTER tower (the RSTER-90 configuration would flip the RSTER antenna 90°); a linear patch antenna to be used in conjunction with the RSTER system; and, an ADS-18s antenna to be used in conjunction with the RSTER system.

No significant environmental impacts that cannot be mitigated are expected as a result of the proposed actions. There will be no visual impacts associated with the MSITP project at the PMRF-Kokee site; hazards of electromagnetic radiation (EMR) to helicopters which carry electroexplosive devices (EEDs) at PMRF-Makaha Ridge will be mitigated by adherence to safe operating distance requirements; hazards of electromagnetic interference (EMI) to facilities at PMRF-Makaha Ridge which affect range operations at PMRF-BS, and facilities at PMRF-Kokee operated by NASA, NOAA, and USNO, will be minimized by operating in specified frequency ranges, sector blanking and cooperative scheduling; disorientation of Newell's Shearwater, will be minimized by deflecting security lighting downward; and, the clearing of vegetation at KAFS will be limited to non-native species.

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GLOSSARY

AFWTR	Air Force Western Range
BL	Badlands Soils
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DARPA	Defense Advanced Research Projects Agency
EA	Environmental Assessment
EMI	Electromagnetic Interference
EMR	Electromagnetic Radiation
HERF	Hazards of Electromagnetic Radiation to Fuel
HERO	Hazards of Electromagnetic Radiation to Ordnance
HERP	Hazards of Electromagnetic Radiation to Personnel
ITCS	Integrated Target Control System
KAFS	Kokee Air Force Station
KGO	Kokee Geophysical Observatory
KSKE	Kokee Silty Loam Soil
kV	Kilovolt
kW	Kilowatt
MHz	Megaherz

GLOSSARY

MSITP	Mountaintop Sensor Integration and Test Program
MSL	Mean Sea Level
mW/cm^2	Milliwatts per Square Centimeter
NAMRL	Naval Aerospace Medical Research Laboratory
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NISE West	Naval Command, Control and Ocean Surveillance Center, ISE West Activity
NOAA	National Oceanic and Atmosperic Administration
PACMISRANFAC	Pacific Missile Range Facility, Barking Sands, Kauai, Hawaii
PHRI	Paul H. Rosendahl, Ph.D., Inc.
PMRF-BS	Pacific Missile Range Facility-Barking Sands
PMRF-Kokee	Pacific Missile Range Facility-Kokee
PMRF-Makaha Ridge	Pacific Missile Range Facility-Makaha Ridge
RPM	Revolutions per Minute
RSTER	Radar Surveillance Technology Experimental Radar
T&C	Telemetry and Control
UIC	Underground Injection Control
USNO	U.S. Naval Observatory
VLBI	Very Long Baseline Interferometry

EXECUTIVE SUMMARY

This environmental assessment (EA) has been prepared pursuant to the National Environmental Policy Act (NEPA). The EA addresses the potential environmental impacts of a proposed ground-based, test and demonstration of airborne surveillance and communication technology and algorithms associated with long-range detection and tracking of targets by an airborne radar platform. The project, sponsored by the Advanced Research Projects Agency (ARPA) in Washington, D.C., is referred to as the Mountaintop Sensor Integration and Test Program (MSITP).

Three sites have been selected as possible locations for this test: the Pacific Missile Range Facility-Makaha Ridge ("PMRF-Makaha Ridge"); the Pacific Missile Range Facility-Kokee ("PMRF-Kokee"); and, the Kokee Air Force Station ("KAFS"). All sites are located on the island of Kauai, Hawaii. The MSITP facility will be rotated among each of the three main sites over a three-year period. The sites will not be used simultaneoulsly.

The primary physical components of the MSITP project include two 45-foot long trailers, which will house the display and operations center for the project, and an pedestal/antenna structure housing the radar equipment for the project. The primary radar equipment to be tested is designated the Radar Surveillance Technology Experimental Radar (RSTER). The overall height of the pedestal/antenna unit will vary with each of the alternative sites: approximately 85, 56, and 52 feet above ground elevation at PMRF-Makaha Ridge, KAFS and PMRF-Kokee, respectively.

Secondary components of the project include:

an auxiliary tower (approximately 25 feet high) to support assembly and checkout of the RSTER-90 antenna prior to lift and mounting on the primary RSTER tower (the RSTER-90 configuration would flip the RSTER antenna 90°);

- a linear patch antenna to be used in conjunction with the RSTER system; and,

- an ADS-18s antenna to be used in conjunction with the RSTER system.

Flora/Fauna. Impacts associated with the proposed action were not found to be significant. Two of the three alternative sites have already been developed and paved (PMRF-Makaha Ridge and PMRF-Kokee). The third site, KAFS, is a vegetated area within Kokee State Park that is dominated by introduced or exotic plant species. No listed, candidate or proposed threatened and endangered flora and fauna species were

found, nor any plants or animals found considered rare and vulnerable. However, because of the likely presence of the Newell's Shearwater at PMRF-Makaha Ridge, which is federally listed as threatened, security lighting will be shielded downward to avoid disorienting the birds. As additional mitigation, security lighting will be minimized during the months of October and November when the young Newell's Shearwaters leave their mountain burrows to head out to sea.

In addition, although the KAFS site does not host any listed, candidate or proposed threatened and endangered species, an undisturbed portion of the site is dominated by native habitat characteristic of a diverse mesic forest. Should this portion of the site be utilized, design of the project will accommodate preservation of habitat for native plants and land birds. There is sufficient area on the disturbed portion of the site to accommodate the MSITP antenna/pedestal.

Coastal Zone Management Act. The Navy has determined that the proposed action is consistent with the State of Hawaii Coastal Zone Management goals and objectives, and has received a concurrence from the State of Hawaii Office of State Planning.

Historic, Cultural, and Archaeological Resources. The proposed action will have no adverse effect on historic, cultural or archaeological resources. An archaeological survey of the proposed sites revealed no historic or cultural resources. These findings supported a "no effect" determination under the provisions of 36 CFR Part 800, which was concurred with by the State Historic Preservation Officer.

Traffic. Because there will be only nominal additional employees associated with the project (five), there will be no noticeable impact on the surrounding road network.

Infrastructure/Utilities. Existing utility systems (wastewater, water, electricity) are capable of handling the minimal increase in demand associated with the proposed project. However, because of the unreliable nature of power supplied by Kauai Electric Company, emergency power through use of existing resources will be provided by PMRF on a non-interference basis to the proposed project in the event of power disruption.

Visual Resources. The visual impacts of the MSITP project would be minimal. The RSTER antenna would be visible for a distance of about 100 yards between the 14- and 15-mile marker of Highway 550 in Kokee State Park if located at the PMRF-Kokee site. However, because the existing visual environment in the vicinity already includes utility poles and an existing 30-foot antenna pedestal, visual impacts will not be significant. Moreover, the additional mechanical equipment attributable to the MSITP project (and visual impacts associated thereto) is temporary and will be removed within three years.

Electromagnetic Radiation (EMR), Electromagnetic Interference (EMI), Electromagnetic Compatibility (EMC). Hazards of electromagnetic radiation to personnel (HERP) and birds at all sites will be minimal due to the rotation of the RSTER during most operations and sector blanking. A pre-operational test of the proposed antenna will be conducted to validate the findings of an EMR modeling analysis that was conducted for the EA. In addition, warning lights and signs will be installed.

Hazards of electromagnetic radiation to fuel (HERF) is minimal at all sites because there are no hazardous fuel locations within the calculated HERF distance of the RSTER. The potential for electromagnetic interference (EMI) occurring to existing facilities at PMRF-Makaha Ridge is minimal since high powered radars are already operating at this site and the RSTER will use sector blanking. During the preparation of this EA it was determined that locating the MSITP project at Site 1 at PMRF-Makaha Ridge would interfere with PMRF-BS range operations, specifically the Integrated Target Control System (ITCS) Facility. Therefore, the MSITP project will be moved to a site (Site 1A) approximately 100 yards east of Site 1.

It was also determined during the preparation of this EA that EMI could affect existing or planned sensor and communications programs operated by the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Naval Observatory (USNO) if the MSITP project is located at PMRF-Kokee or KAFS (Sites 2 and 3, respectively). Such problems will be avoided through a combination of mitigation measures including cooperative scheduling among NASA, NOAA, and USNO, sector blanking in the direction of NASA, NOAA and USNO facilities, the use of harmonic filters, if necessary, the selection of a compatible frequency range in the proposed UHF operating band and the development of an operations planning document.

There are no ordnance sites or routes at either Makaha Ridge or PMRF-Kokee, and only small arms (percussion) ammunition at KAFS. Therefore, hazards or EMR to HERO for facilities at these sites are minimal. However, helicopters carrying electroexplosive devices (EEDs) do use the heliport at Makaha Ridge. The maximum calculated EMR at the heliport is below the HERO UNSAFE and SUSCEPTIBLE levels due to sector blanking of the radar. Helicopters with HERO UNSAFE or SUSCEPTIBLE ordnance on-board and flying within the RSTER operating sector should avoid flying within 7,352 and 2,548 feet of the RSTER site, respectively.

It is anticipated that problems associated with electromagnetic compatibility (EMC) will occur. To mitigate these potential impacts, the RSTER frequency hopping will be limited

- to certain frequency ranges and several frequencies will be locked out which could interfere with several Command Guidance and Command Destruct frequencies used for rocket and missile launches at PMRF-BS.

Chapter 1

Introduction

10 INTRODUCTION/SUMMARY

This environmental assessment (EA) is prepared pursuant to the National Environmental Policy Act (NEPA). The EA supports a proposed ground-based test and demonstration of airborne surveillance and communication technology and algorithms associated with long-range detection and tracking of advanced airborne targets by an airborne platform. The project is referred to as the Mountaintop Sensor Integration and Test Program (MSITP). The primary physical components of the program include two 45-foot long trailers, and an antenna/pedestal structure (hereinafter referred to as the "MSITP facility").

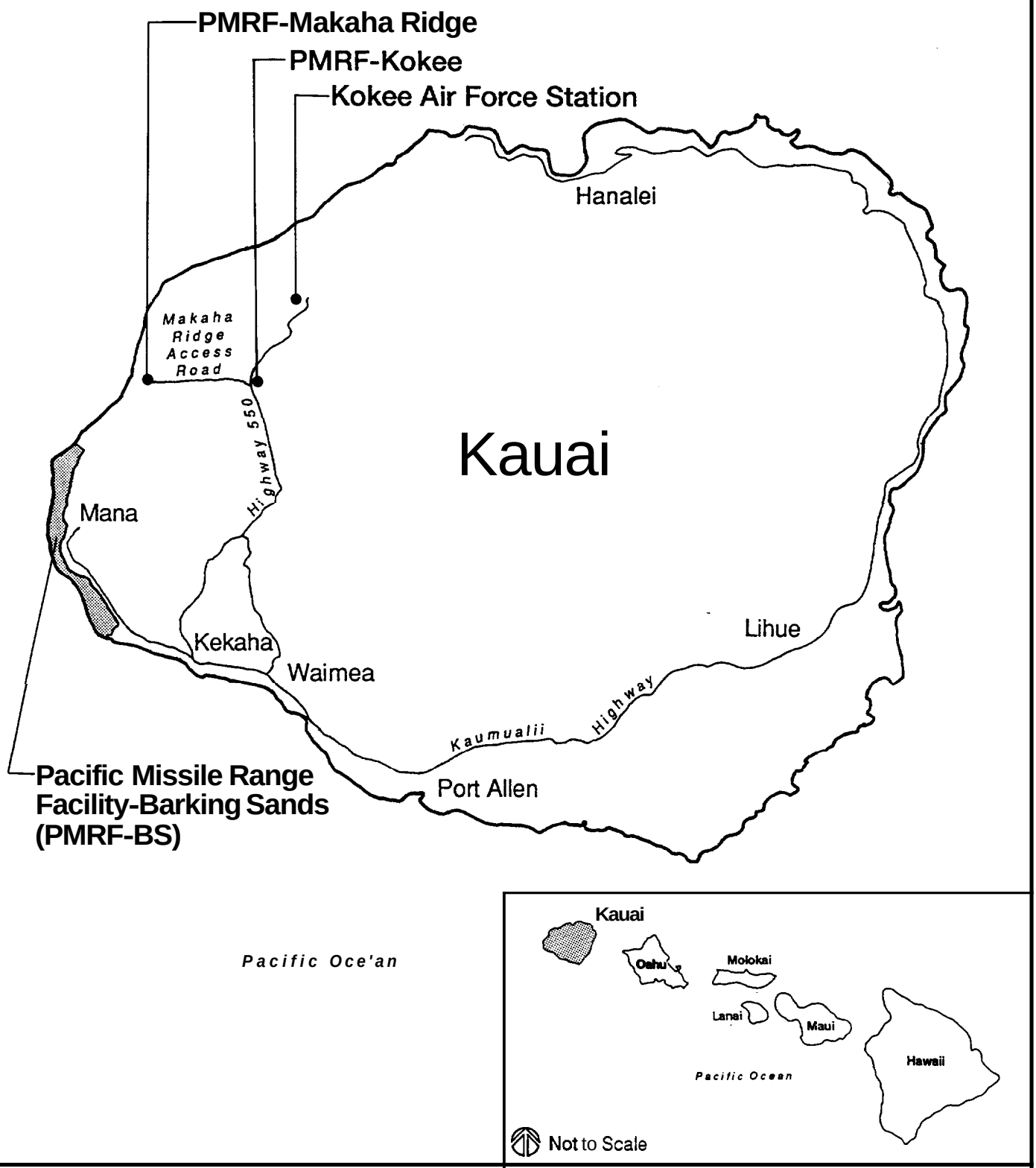
Three sites had been selected as possible locations for this test: the Pacific Missile Range Facility-Makaha Ridge ("PMRF-Makaha Ridge"); the Pacific Missile Range Facility-Kokee ("PMRF-Kokee"); and, the Kokee Air Force Station ("KAFS"). All sites are located on the island of Kauai, Hawaii (Figure 1). The MSITP Facility will be rotated among each of the three main sites over a three-year period. The sites will not be used simultaneously.

11 Project Description

The Advanced Research Projects Agency (ARPA) in Washington, D.C., sponsor of the MSITP project, requires a land-based capability to test different types of radars and communications equipment without the expense of flying. The United States Air Force, Rome Laboratory (Griffiss Air Force Base, New York) is managing the MSITP project for ARPA. The U.S. Navy is providing logistical and engineering support for the MSITP project.

Various radar models can be brought to the test facility for analysis without the requirement for flying. The MSITP project is designed to provide a signal environment consisting of targets, clutter, and noise levels representative of an operational airborne surveillance and tracking radar. The parameters which determined the final selection of the three sites on Kauai include:

- altitude;
- depression angle;
- near-in ground clutter;
- controlled air space;
- targets of opportunity;
- site preparation; and,
- environmental considerations.



General Location Map

Figure: 1

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

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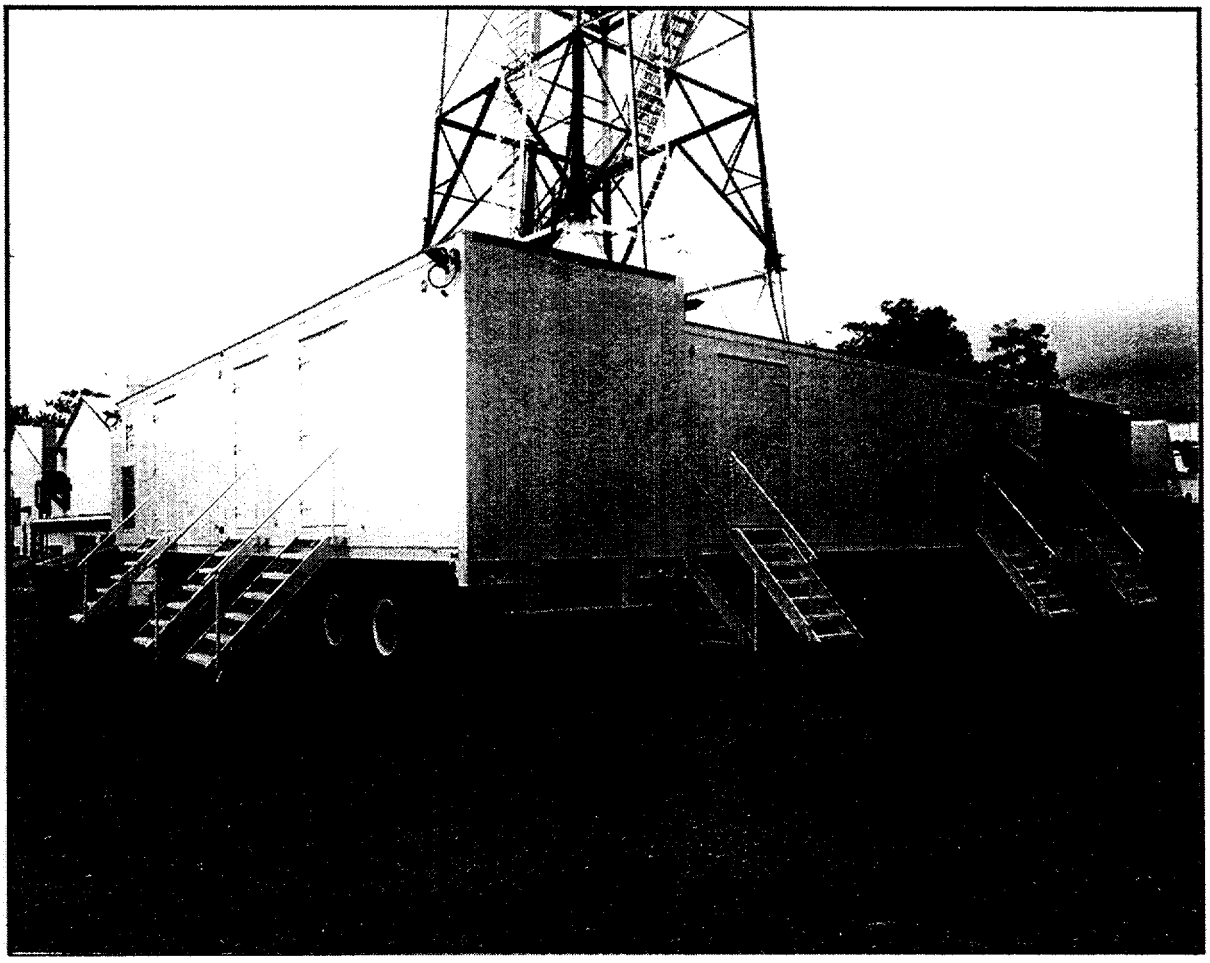
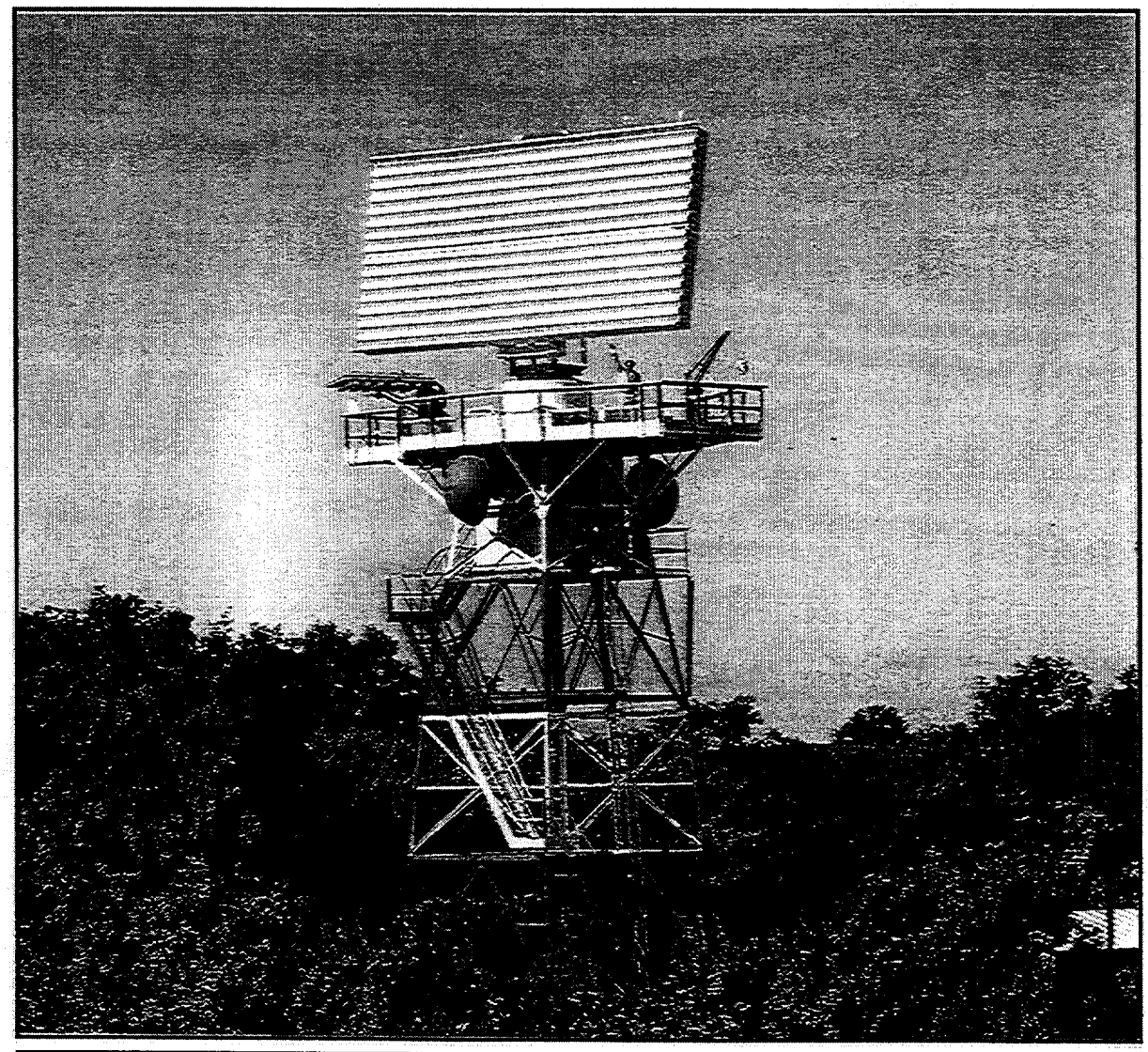
The primary radar equipment to be tested is designated the Radar Surveillance Technology Experimental Radar (RSTER). The RSTER is a long-range surveillance radar designed by MIT/Lincoln Labs (Lexington, Massachusetts), to provide surface ship detection and tracking capability against anti-shipping cruise missiles. The RSTER is "transportable" and self-contained. It consists of two 45-foot long trailers and an antenna/pedestal unit. One trailer houses the transmitter and the receiver signal processing equipment. The second trailer houses the display and operations center. Each trailer weighs 45,000 pounds, and can be transported by tractor. A typical two-trailer configuration is shown in Figure 2.



Typical Trailer Configuration Figure: 2

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

The antenna will be mounted on a steel tower or pedestal to be erected as part of the site preparation. The overall height of the pedestal/antenna unit will vary with each of the sites: 85 feet at PMRF-Makaha-Ridge; 56 feet at KAFS; and 52 feet at PMRF-Kokee. A typical antenna/pedestal unit with a RSTER attached is shown in Figure 3.



Typical Pedestal/Antenna Unit — Figure: 3

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

The antenna and pedestal are separate units, each weighing about 5,000 and 7,000 pounds, respectively. Prime power for operation of the system is 225 kilowatts (kW). The 16-foot (5 meter) by 32-foot (10 meter) antenna structure rotates at 5 revolutions per minute (rpm). Fixed 5.8" azimuth pencil beams are scanned in elevation using low power phase shifters. The 14 solid state amplifiers develop 600 watts each for a total of 8 kW average and 128 kW peak power at the transmitter output (input to the antenna is 4 kW average and 64 kW peak). The best antenna performance is provided across the 420 to 450 megaherz (MHz) band, although nearly the same performance is provided from 400 to 500 MHz.

In addition to the primary steel tower, an auxiliary tower, the "UNC" Tower, (approximately 25 feet high), will be located on site to support assembly and checkout of the RSTER-90 antenna prior to lift and mounting on the primary RSTER steel tower. The RSTER-90 antenna configuration would flip the RSTER antenna 90°.

The linear (patch 1) antenna to be used in conjunction with the RSTER system is an auxiliary array to be used at the same time as the RSTER antenna. Its purpose is to transmit successive pulses out of individual patch elements in the array. This movement of the phase center of the array has the effect of making the radar act as if it is moving with respect to the ground like an airborne radar. The array is about two feet high and 32 feet long and a few inches thick. The patches have a beam width of about 120 degrees. The positioning of this array is not as critical as the main RSTER array.

The ADS-18s antenna to be used in conjunction with the RSTER system is a new experimental upgrade antenna for the E2 radar system. For some tests, this antenna will take the place of the RSTER antenna and will be used with the RSTER transmitter. It will be in an enclosure which rotates but the antenna also has azimuth scanning capability to about +60 degrees. The array itself is a horizontal linear array with 18 elements. The array is about two feet high, 21 feet wide and six feet deep.

None of the sites would be operational simultaneously. When testing is completed at one site, the radar equipment and trailers will be moved to the next test site. It is anticipated that testing would be completed within three years after the first site is operational, at which time all sites will be returned to their existing condition. The MSITP project will employ about five personnel for three years on a full-time basis.

1.2 Alternatives Considered

Three alternatives to the proposed action were considered: a no-action alternative; alternate sites; and alternate technology. These alternatives were determined to be not

feasible for a variety of reasons, such as: absence of targets of opportunity; range control, flight safety; and, proximity to the ocean. Therefore these alternatives were dismissed from further consideration. These alternatives are discussed in more detail in Chapter 3.

1.3 Summary of Probable Impacts and Mitigation Measures

This section summarizes the probable impacts anticipated as the result of the construction of the MSITP project, and measures that can be used to mitigate these impacts, where appropriate.

Flora. A botanical assessment survey of the proposed sites revealed no listed, candidate, or proposed threatened and endangered species, nor are any of the plants considered rare and vulnerable. Although the KAFS site does not host any listed, candidate or proposed threatened and endangered species, the undisturbed portion of the site is dominated by native habitat characteristic of a diverse mesic forest. This portion of the site should remain intact to preserve habitat for native plants and land birds. There is sufficient area on the disturbed portion of the site to accommodate the MSITP antenna/pedestal (the trailers would be located on a separate portion of the KAFS, on an area already disturbed).

Fauna. An avifaunal and feral mammal survey of the sites revealed no listed, candidate or proposed threatened and endangered species. The Hawaiian Hoary bat, an endangered mammal has been placed at the KAFS site by anecdotal information. Construction of the MSITP project would not have a significant impact on the Hawaiian Hoary Bat.

Impacts from security lighting associated with the MSITP project at all sites could cause native birds to become disoriented and injure themselves. Security lighting shall be designed to be deflected downward to mitigate the potential for disorientation. Security lighting should be avoided during the months of October and November, when young Newell's Shearwaters leave their mountain burrows and head out to sea.

In addition, native vegetation at the KAFS site should be preserved to protect habitat for native land birds. There is sufficient area on the disturbed portion of the site to accommodate the MSITP antenna/pedestal (the trailers would be located on a separate portion of the KAFS, on an area already disturbed). No negative impacts are anticipated to native birds as the result of radar beams because the power density of the RSTER will be below the threshold to cause harm to birdlife and the radar will only be illuminated in an 80° arc in a westerly direction.

Electromagnetic Radiation (EMR). Hazards of electromagnetic radiation to personnel (HERP) and birds at all sites will be minimal due to the rotation of the RSTER during most operations and sector blanking. Hazards of electromagnetic radiation to fuel (HERF) is minimal at all sites because there are no hazardous fuel locations within the calculated HERF distance of the RSTER. The potential for electromagnetic interference (EMI) occurring to existing facilities at PMRF-Makaha Ridge is minimal since high powered radars are already operating at this site and the RSTER will use sector blanking. During the preparation of this EA it was determined that locating the MSITP project at Site 1 at PMRF-Makaha Ridge would interfere with PMRF-BS range operations, specifically the Integrated Target Control System (ITCS) Facility. The MSITP project will be moved to a site (Site 1A) approximately 100 yards east of Site 1.

There are no ordnance sites or routes at either Makaha Ridge or PMRF-Kokee, and only small arms (percussion) ammunition at KAFS. Therefore, hazards or EMR to HERO for facilities at these sites are minimal. However, helicopters carrying electroexplosive devices (EEDs) do use the heliport at Makaha Ridge. The maximum calculated EMR at the heliport is below the HERO UNSAFE and SUSCEPTIBLE levels due to sector blanking of the radar. Helicopters with HERO UNSAFE or SUSCEPTIBLE ordnance on-board and flying within the RSTER operating sector should avoid flying within 7,352 and 2,548 feet of the RSTER site, respectively.

It was also determined during the preparation of this EA that EMI could affect existing or planned sensor and communications programs operated by the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Naval Observatory (USNO) if the MSITP project is located at PMRF-Kokee or KAFS (Sites 2 and 3, respectively). Such problems can be avoided with a combination of mitigation measures including cooperative scheduling among NASA, NOAA, and USNO, sector blanking in the direction of NASA, NOAA and USNO facilities, the use of harmonic filters, if necessary, the selection of a compatible frequency range in the proposed UHF operating band and the development of an operations planning document.

Visual Resources. The existing 30-foot antenna pedestal at the PMRF-Kokee site (Site 2) is visible for a distance of about 100 yards between the 14- and 15-mile marker along Highway 550 travelling in a downhill direction. The RSTER antenna would add about 23 feet of mechanical equipment to the existing pedestal. However given the existing visual environment (the currently visible 30-foot antenna pedestal and prominent utility poles and lines along Highway 550), the impacts of the MSITP facility would be minimal. Additionally, there will be no known long-term visual aesthetic impacts due to the temporary (three years) nature of the MSITP project.

Archaeological, Cultural and Historic Resources. The Makaha Ridge Site 1A and the Kokee Air Force Station Site 3 underwent full archaeological inventory survey which consisted of 100% surface survey and limited shovel subsurface testing. No archaeological sites or cultural materials were identified during the survey. The Makaha Ridge Site 1 was not surveyed because the area was previously heavily developed and 'is completely paved with asphalt. The Kokee NASA station Parcel A site (Site 2) also was not surveyed because the area was previously heavily developed and has an existing concrete slab with an existing 30-foot tower on grade at the proposed site. There will be no ground disturbing activity at this site. In accordance with 36 CFR 800, the proposed construction and use of the MSITP radar facility will have "no effect" on any historic sites or cultural resources.

Chapter 2

Purpose and Need for Mountaintop Sensor Integration and Test Program

2.0 PURPOSE AND NEED FOR THE MOUNTAINTOP SENSOR INTEGRATION AND TEST PROGRAM

The purpose of the Mountaintop Sensor Integration and Test Program (MSITP) is to demonstrate the enhanced technology required for detection and tracking of targets by an airborne radar platform at long range. The testing of new radar systems is essential to the state of military readiness of existing and future operations world-wide. The MSITP is neither associated or planned to be used in the development or testing of any weapon systems intended for use in the Strategic Defense Initiative. The MSITP program has been designed to address the following issues:

Demonstrating the power aperture required to achieve detection of targets;

Demonstrating equipment stability and coherent processing techniques required for mission success;

Demonstrating the ability to establish tracks in the presence of hundreds of additional detections due to birds, insects, and other sources;

Demonstrating the ability to achieve required levels of cancellation in the airframe environment, which includes airframe interference, microphonics due to airframe flexure and vibration, airframe mean motion and random motion due to wind gusts and turbulence; and,

Collection of clutter measurement data for analysis and characterization in order to generate and validate computer models in support of enhanced signal processing technology.

A total of four sites were evaluated for the MSITP project. One site was on the island of Maui, and three sites were on the island of Kauai. Only the three sites on Kauai were considered to be viable alternative locations based on an analysis of locational criteria: (1) the Pacific Missile Range Facility-Kokee (PMRF-Kokee); (2) the Pacific Missile Range Facility-Makaha Ridge (PMRF-Makaha Ridge); and, (3) the Kokee Air Force Station (KAFS).

The screening to limit the alternative sites to Kauai was primarily based on three criteria: (1) the favorable environmental conditions at the three sites for the emulation of an airborne platform; (2) high terrain (up to 4,200 feet above mean sea level [MSL]) with steep dropoffs; and, (3) both land and sea clutter.

Kauai is the home of the U.S. Navy Pacific Missile Range Facility at Barking Sands (PMRF-BS). PMRF-BS has the facilities and equipment to provide on-site support and can launch low-flying airborne targets which can be used as test targets for the experiment. PMRF-BS also has a range control and flight safety capability and can collect target parameters (position, trajectory, speed, etc.) which can be used for the radar equipment test. PMRF-BS has three alternative test site locations for the UHF radar. The first site is at Makaha Ridge, the second site is at Kokee (the previous NASA Tracking and Control [T&C] site), and the third site is at the Kokee Air Force Station.

The Makaha Ridge site is located near the Kaulakahi Channel, which separates the Hawaiian islands of Kauai and Niihau, at the edge of a cliff at an elevation of about 1,500 feet above MSL. Due to the limited amount of near in-ground clutter interference, this site is an ideal location to test airframe wing interference effects on the UHF radar signal processing. Both the KAFS and the PMRF-Kokee sites are located at higher elevations (about 3,700 feet and 4,200 feet above MSL, respectively), thus supporting the desired emulation of an airborne platform.

Chapter 3

Alternatives Considered

3.0 ALTERNATIVES CONSIDERED

Three alternatives to the proposed action were considered and are discussed below: no-action; alternate sites; and, alternate technology.

3.1 No-Action Alternative

The no-action alternative would require the Department of Defense to rely on existing radar technology to track advanced airborne targets in the presence of land and sea clutter. The benefits associated with this alternative relate to the economic "savings" accrued from the deferment of public funds for the construction and operation of the MSITP facility.

Detriments of the no-action alternative include the inability of existing radar technologies to adequately provide sufficient tracking capability of advanced airborne targets. This shortcoming is the result of advanced airborne targets escaping detection of existing radar technology. Therefore, the over-all preparedness of Department of Defense operations world-wide would be decreased.

3.2 Alternate Site Alternative

The U.S. Air Force surveyed a total of four sites on the islands of Maui and Kauai, Hawaii as potential locations for the MSITP facility. Of these candidate sites, the Maui site at Mt. Haleakala was eliminated for reasons described below:

- the site lacks airborne targets for the radar to track;
- the site lacks range control to provide support for the project;
- flight safety is of concern due to the proximity of commercial air traffic;
- the site is not close to the ocean, thus making it difficult to test airframe wing interference effects, which is critical to the overall success of the experiment;
- because the site is not close to the ocean, it also lacks sea clutter, which is an essential environmental condition for the experiment (sea clutter is the description used for the appearance of ocean surface irregularities, including waves, on the radar system); and,

- the site lacks steep dropoffs in terrain, which is necessary to provide a clear background for the radar.

3.3 Alternate Technology Alternative

An alternative technology was to retrofit an existing aircraft to test the radar system. Under this alternative of retrofitting an aircraft, the radar could only be tested during airborne operations, thus necessitating requirements for duplicative aircraft resources and a significant amount of flying hours. This alternative would require a substantial amount of funds for the aircraft fuel, maintenance, and operation of aircraft during the life of the program. Additionally if modifications to the radar equipment were required, it would be very costly to make those modifications to the aircraft relative to a land-based facility. Therefore, in consideration of the expenditure of aircraft fuel, discharges of gasses to the environment, the extensive maintenance requirements, and significant funding requirements, this technology alternative was rejected.

Chapter 4

Description of the Existing Environment

4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

The following sections describe the existing environment at each of the three sites proposed to host the MSITP project; PMRF-Makaha Ridge (Sites 1 and 1A); PMRF-Kokee (Site 2); and, KAFS (Site 3). Section 4.1 presents information common to each of the proposed sites.

4.1 Regional Setting

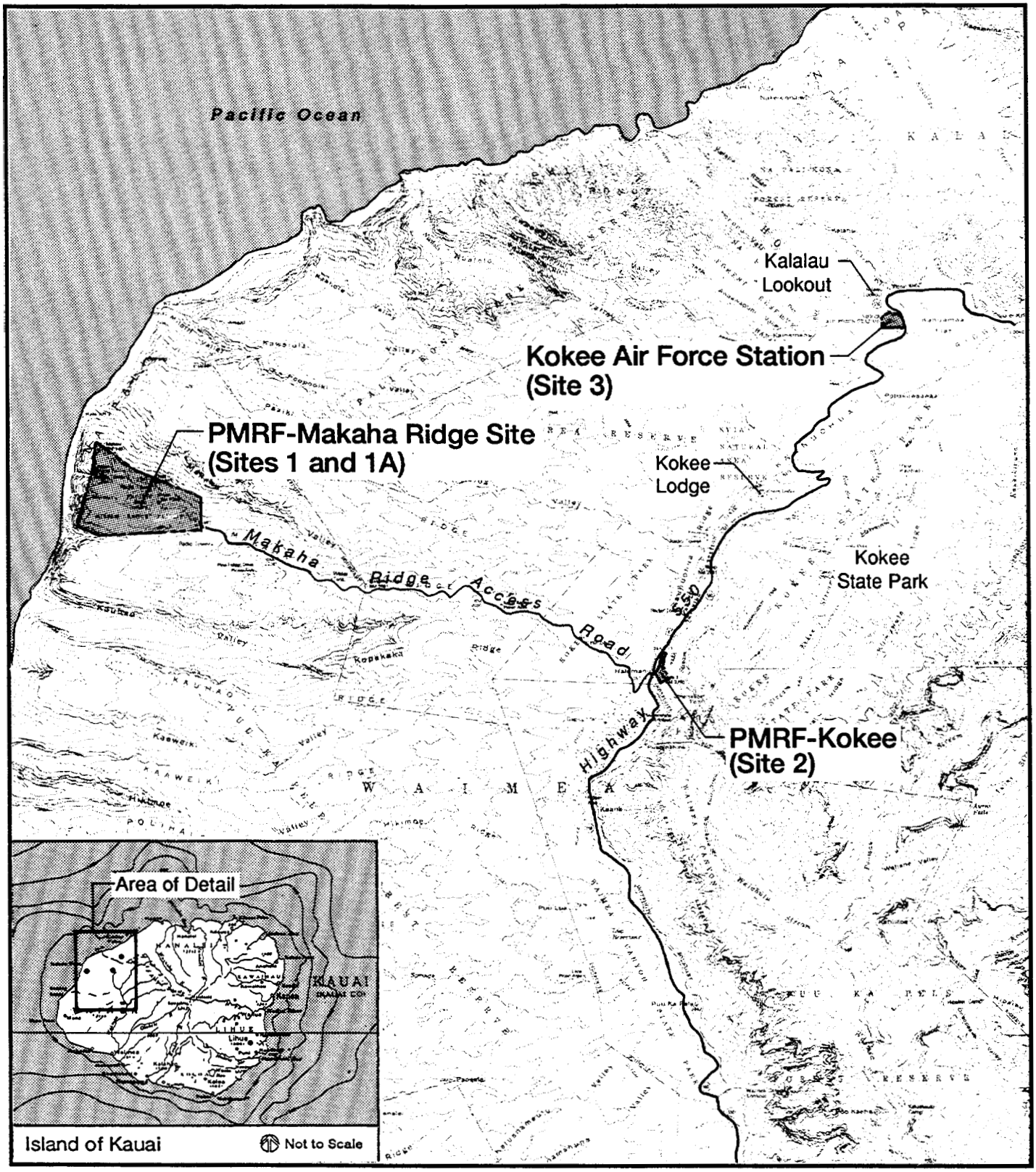
4.1.1 Location

Each of the three proposed sites for the MSITP project are located on the west side of the island of Kauai in the State of Hawaii. Two of the sites, (PMRF-Kokee and KAFS) are situated within Kokee State Park, which is owned by the State of Hawaii and managed by the Department of Land and Natural Resources, Division of State Parks (Figure 4). Kokee State Park is the home of the Waimea Canyon, which has been formed by the erosion of the great caldera that essentially formed the entire island of Kauai, and is one of the primary tourist destinations on Kauai. Many spectacular public viewing areas, including the Kalalau and Waimea Canyon Lookouts, are situated in the park, in addition to the Kokee Lodge and Museum. The main entry to Kokee State Park is via Kaumualii Highway and Waimea Town.

Waimea Town is the second largest town on the west side of Kauai, with a 1990 population of about 1,840 (State of Hawaii Data Book, 1991). Approximately three miles west of Waimea Town is Kekaha Town, with a 1990 population of about 3,506 (ibid). About three miles west of Kekaha is the Pacific Missile Range Facility-Barking Sands (PMRF-BS), which is the largest civilian employer in west Kauai, with a total of about 580 civilian employees (PACMISRANFAC HAWAREA Master Plan, 1990). PMRF-Makaha Ridge, which is located about seven miles north of PMRF-BS, is a secondary operations area for PMRF-BS. The site is situated at the seaward terminus of Makaha Ridge, a sea cliff fronting the channel between the islands of Niihau and Kauai.

4.1.2 Physiography/Topography

Kauai is the oldest and fourth largest of the eight main Hawaiian Islands. It is 33 miles long and 25 miles wide comprising about 555 square miles. The island began as a huge shield volcano similar to Mauna Loa on the island of Hawaii. The rocks of the volcano are of the Waimea Canyon volcanic series, which is further classified into the following units: the Na Pali formation; Olokele formation; Haupu formation; and, the Makaweli formation.



Regional Location Map

Figure: 4

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

0' 2500' 5000'

Makaha Ridge is part of the Na Pali formation, which dates from the Pliocene Period in geologic history. The formation consists of olivine basalt, basalt, and picrate basalt accumulated on the flanks of the Kauai shield volcano. Makaha Ridge is one of a series of ridges north of Barking Sands which descends from the central highlands directly to the sea. The terrain is steep and elevation changes abruptly. The elevation of the Operations Area on Makaha Ridge varies from about 1,460 feet to 1,850 feet above MSL. Elevations at PMRF-Kokee and KAFS are about 3,710 feet and 4,200 feet, respectively.

4.1.3 Climate

Generally speaking, Kauai has a mild, semi-tropical climate. Because of the marine influence and the prevailing northeast tradewinds, there is very little diurnal or seasonal variation in temperature. At PACMISRANFAC, long, dry, hot spells are common, especially during the summer months, and the mean annual temperature range is 70 degrees Fahrenheit to 78 degrees Fahrenheit. Mean annual rainfall is about 20 inches, with three-fourths of this amount falling during the period of October through March. At the upper end of the Makaha Ridge Access Road, at about 3,700 feet above MSL, rain and fog are nearly daily occurrences.

Because of the elevation of PMRF-Kokee and its proximity to Mt. Waialeale, one of the wettest locations in the world, the climate at PMRF-Kokee is markedly different from that of PMRF-Makaha Ridge. The mean annual rainfall in the area is about 66 inches (recorded over a 52-year period). Mean temperatures are much lower than Makaha Ridge, as should be expected, ranging from 51 degrees Fahrenheit to 68 degrees Fahrenheit.

The climate at KAFS is similar to the climate at PMRF-Kokee. The mean annual rainfall in the area is higher, about 90 inches, and mean temperatures are similar to the range experienced at PMRF-Kokee.

4.1.4 Flood Hazard

None of the proposed sites is subjected to any flood hazards.

4.1.5 Utilities

Sanitary Sewage System. Each of the proposed sites is serviced by cesspools and/or septic tank/leaching fields. These systems were installed prior to the adoption of State of Hawaii Public Health regulations for private wastewater treatment works and individual

wastewater systems. Historically, there have been no problems identified with the cesspools' operations. Therefore, the reliance on cesspools to partially dispose of sanitary wastewater is adequate since they are exempted from the requirements of Chapter 62 of the State of Hawaii Department of Health regulations (Yee, 1992).

Under Chapter 23 of the State of Hawaii Department of Health regulations, the State Underground Injection Control (UIC) program requires a permit and submission of data for sewage injection wells. However, as stated in the regulations, "non-residential waste disposal systems which receive solely sanitary wastes where the facility generates less than 1,000 [gallons per day] gpd" are excluded from the requirements of Chapter 23. Based on the per capita sewage flow generation criteria established by the State Public Health Service Publication No. 526, the 1,000 gpd translates to approximately 66 persons based on 15 gallons per capita per day per shift. Because no individual cesspool system at the station serves more than 66 persons per day (nor would it with the MSITP project), the permit and submission of data requirements of Chapter 23 are not applicable (ibid).

Electricity. All of the proposed sites obtain power from Kauai Electric Company's 12.5 kV feeder from the Waimea substation. In the case of PMRF-Kokee and KAFS, power is transmitted via a 12.5 kV line which parallels Highway 550, while power to PMRF-Makaha Ridge is transmitted via a 12.5 kV line that winds down the Makaha Ridge Access Road. Kauai Electric Company has indicated that service to all three sites can be provided (Appendix A).

Backup power is considered necessary for all areas because of the unreliable nature of electrical service provided by Kauai Electric Company.

4.1.6 Circulation

All of the proposed sites are reached via one of two routes off Kaumualii Highway, the main circulation route connecting west Kauai to Lihue. Highway 550, a State Highway, is the primary circulation route linking Kokee State Park to Kaumualii Highway and Waimea Town (Figure 1). Highway 550 has a posted speed limit of 25 miles per hour, with a paved width that varies between 18 and 20 feet. The second access route is via Kekaha Town on a County of Kauai road that intersects with the State Highway 550, about seven miles from Waimea Town.

PMRF-Makaha Ridge is reached by a paved two-lane access road, the Makaha Ridge Access Road, that connects to Highway 550 as a "T" intersection in the vicinity of the 14-mile marker on Highway 550. Driving distance between Waimea Town and the turnoff for the Makaha Ridge Access Road is about 14 miles. Driving distance to the

Makaha Ridge Complex from the intersection with Highway 550 is about four miles (Figure 4).

PMRF-Kokee is reached by Highway 550, and is located in the vicinity of its 14-mile marker. Ingress and egress to Parcel A is via an access road which branches off Highway 550 (Figure 4).

Similar to PMRF-Kokee, KAFS is also reached by Highway 550. KAFS is located in the vicinity of the 18-mile marker, about 1/4-mile below the Kalalau Lookout (Figure 4).

4.1.7 Historic, Cultural and Archaeological Sites

The Waimea-Kekaha region is noted for the richness of its historical and archaeological sites. The Waimea River valley, canyon and watershed, prominent natural features of the region, were important to Kauai's early Hawaiian people. The resources in the upper forests (sandalwood trees from which to make canoes and image logs, bird feathers, and other materials), were harvested to support coastal communities. Most of the known historic and archaeological features in the region have been identified in these coastal areas.

In conjunction with activities in the upland areas, it is likely that in addition to collecting resources, early Hawaiians built temporary shelters along trails and at sites where certain resources would have been collected regularly.

4.1.8 State of Hawaii Land Use Policies

State Land Use Law. The State of Hawaii Land Use Law is intended to preserve, protect and encourage the development of lands for those uses to which they are best suited. It directs the counties to integrate their land use controls with those of the State. All lands within the State have been placed in one of four land use districts by the State Land Use Commission in accordance with the 1961 State Land Use Law: urban, rural, agricultural and conservation. Each of the four proposed sites are within the State Conservation District.

Coastal Zone Management Act (CZMA). The **CZMA** program requires federal agencies to conduct activities directly affecting the coastal zone in a manner consistent, to the extent practicable, with a state's **CZMA** programs. In Hawaii, review for consistency is done by the State's **CZMA** lead agency (the Governor's Office of State Planning), on the basis of a consistency determination prepared by the Navy.

Lands which are considered federal enclaves, including those under lease to the Federal government (such as the proposed sites at PMRF-Makaha Ridge, PMRF-Kokee and KAFS), are excluded from a state's coastal zone. This does not exempt the federal government from complying with consistency review requirements, ensuring that any project does not affect the coastal zone.

4.1.9 Kauai County Land Use Policies

The major land use policy document for the County of Kauai, the General Plan, shows no designation for PMRF-Makaha Ridge, PMRF-Kokee or KAFS, as no maps have been adopted by the County which include the area. Likewise, there is no zoning designation for the three areas. However, even in the absence of such designations, the County of Kauai has no jurisdiction over the proposed sites, because they are situated within the State Conservation District (Mamaclay, December 1992).

4.2 Pacific Missile Range-Makaha Ridge (PMRF-Makaha Ridge)

4.2.1 Background

The Pacific Missile Range Facility (PACMISRANFAC) is located on the west side of the Island of Kauai and consists of six separate areas, including PMRF-Makaha Ridge. PMRF-Barking Sands (PMRF-BS), which is the primary site for PACMISRANFAC, consists of a long, narrow 2,046-acre site located on the Mana Plain, west of Kaumualii Highway, about 10 miles north of Waimea Town. It is bordered on the west by the Pacific Ocean and on all other sides by cultivated agriculture and undeveloped land.

The mission of PACMISRANFAC is to provide: (a) fully instrumented ranges; (b) operational and base support facilities for fleet underwater, surface, and air training exercises; and, (c) Navy operational and technical evaluation programs. In addition, the facility has assumed the mission of hosting other services and agencies requiring launch facilities in the central Pacific area.

PMRF-Makaha Ridge, a secondary operations area for PACMISRANFAC, is about seven miles north of Barking Sands. This 244-acre complex is located approximately at the 1,600-foot elevation of Makaha Ridge and is leased from the State of Hawaii (Figure 4). Its primary mission in support of PACMISRANFAC is to provide facilities for range operations at PMRF-BS.

4.2.2 Base Operations

All Navy-controlled land at Makaha Ridge is reserved for range operations. The complex consists of tracking radars, antennas, communications, electronic warfare simulation, target command control, telemetry facilities and a standby power plant (Figure 5). Other types of land uses are constrained by the terrain, hazard of electromagnetic radiation to personnel (HERP) and security considerations. Data, communications, and command control commands are sent to and from Barking Sands via a microwave system.

4.2.3 Site Description

PMRF-Makaha Ridge is located at the western terminus of the Makaha Ridge Access Road, approximately four miles from its intersection with Highway 550 in Kokee State Park. The access road is steeply sloped, winding through densely vegetated forest. Elevations range from about 1,850 feet above MSL at the upper reaches of the property to about 1,460 feet above MSL at the primary location for the MSITP facility at Makaha Ridge. The main complex has minimal vegetation and is covered with facilities to perform tasks associated with range operations.

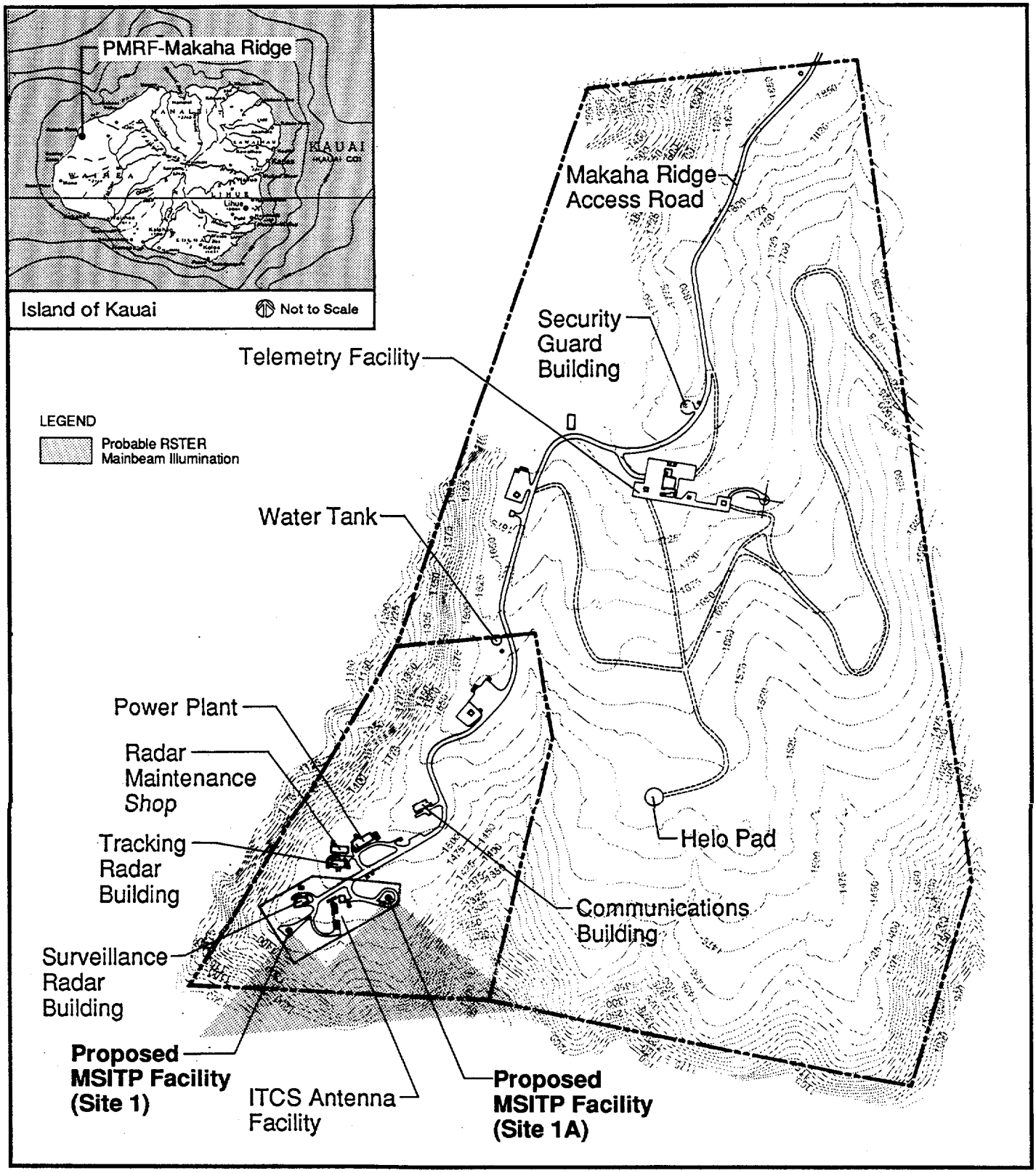
One of two locations for the MSITP facility at Makaha Ridge is situated at the western edge of the Makaha Ridge Complex, at the edge of a sea cliff (Site 1). This site has been leveled and paved with asphalt (Figure 6). The proximity of this site to the Integrated Target Control System (ITCS) Facility and the EMI operational impacts is of concern to range operations personnel at PMRF-BS. Site 1A is approximately 100 yards to the east and uphill of Site 1 (approximately 1,480 feet above sea level) and is now the preferred site at Makaha Ridge. This site has been leveled and paved adjacent to Building 744 (Figure 6).

4.2.4 Facility Loading

PMRF-Makaha Ridge employs 28 civilian personnel. All personnel are managed by a station contractor who administers the facilities at Makaha Ridge for PACMISRANFAC.

4.2.5 Soils

The general soils type that underlays PMRF-Makaha Ridge is in the Makaweli-Waiawa-Niu association. This association consists of deep, gently sloping to steep, well-drained soils that have a dominantly moderately fine textured or fine textured subsoil and shallow, steep and very steep, well-drained soils over basalt bedrock, on uplands. The most dominant soil type which underlays the two possible sites of the proposed MSITP facility



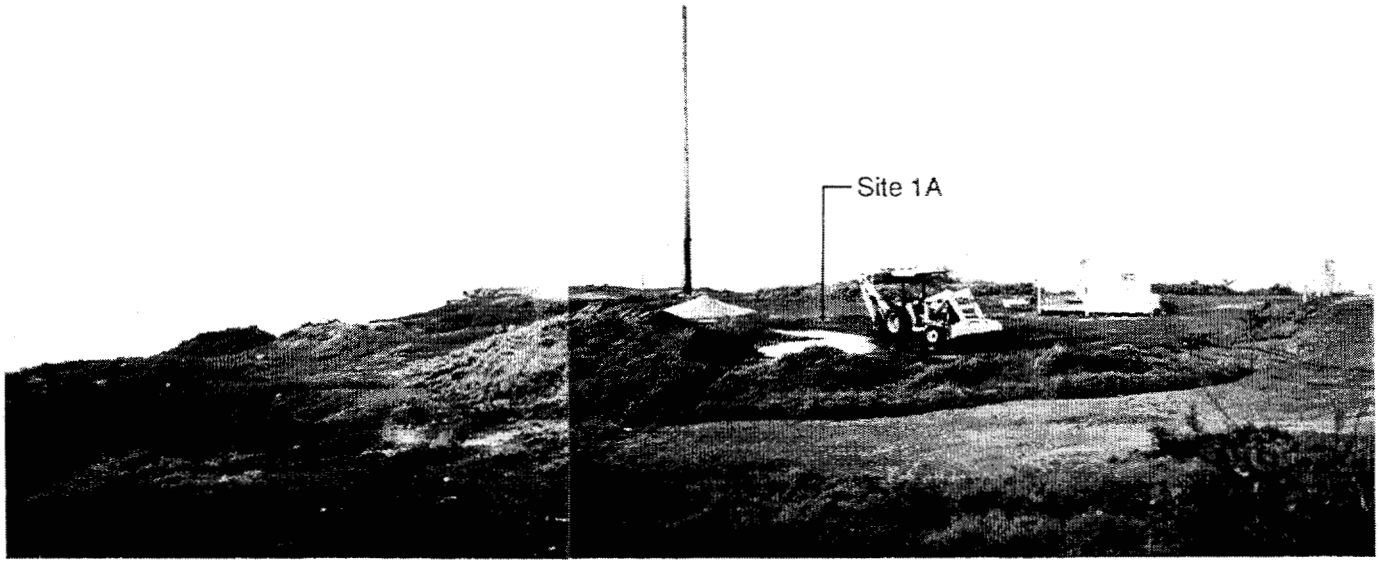
Area **Map**
PMRF-Makaha Ridge

Figure: 5

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

0' 300' 600'

View of Site 1 at PMRF-Makaha Ridge looking west.



View of Site 1A at Makaha Ridge looking south from access road.

Proposed MSITP Facility Sites at PMRF-Makaha Ridge — Figure: *6*

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

is Badlands (BL). This soil type is steep to very steep and nearly barren. Runoff is very rapid and geologic erosion is active. The soils forming material is generally soft or bad saprolite. The capability classification for this soil is subclass VIIIe, which indicates the soils are subject to very severe erosion if ground cover is removed. These areas are of very steep, shallow and rough mountainous land.

4.2.6 Utilities

Electricity. Two 600 kilowatt (kW), 480 volt diesel generators serve as the back-up electricity source for the Makaha Ridge Complex.

Potable Water System. Water is supplied to the Makaha Ridge Complex through a 4.5-mile long, two-inch pipeline connected to a State of Hawaii water main at Kokee. Three storage tanks totalling 76,000 gallons provide water storage for PMRF-Makaha Ridge.

All water purchased by the Navy is chlorinated before distribution. The quality of water obtained from all sources and distributed on-station is adequate. Monthly bacteriological analyses are conducted by the State Department of Health.

Sanitary Sewage System. There are two cesspools and one septic tank/leaching field system serving the Makaha Ridge Complex.

4.2.7 Flora

Char & Associates conducted a botanical assessment survey at PMRF-Makaha Ridge during December 1992. The complete survey is attached as Appendix B, and is summarized below as it pertains to the two sites at Makaha Ridge.

Site 1 at Makaha Ridge overlooks Makaha Valley and the ocean; Site 1A overlooks a smaller unnamed gulch. Well-maintained grassy lawns and landscape plantings are found on the relatively level areas around the existing buildings. On the surrounding lands, the ridge tops and valley walls consist of exposed rock and barren, weathered soil with the vegetation occumng as scattered pockets of plants, primarily on ledges. The vegetation on both the primary and the alternate sites is dominated by introduced or alien species, introduced to the Hawaiian Islands by humans after Western contact (1778). No listed, candidate, or proposed threatened and endangered flora species were found, nor any of the plants found considered rare and vulnerable.

Site 1. This site is located on an existing asphalt-paved area with a few concrete pads. Around the concrete pads are small patches of weedy herbs and grasses; these include

Natal redtop grass (Rhynchelytrum repens), partridge pea (Chamaecrista nictitans), three-flowered beggarweed (Desmodium triflorum), and crabgrass (Digitaria adscendens). Along the edges of the asphalt, pangola grass (Digitaria pentzii) forms dense, lumpy mats. Scattered through the pangola grass are plants of partridge pea and three-flowered beggarweed. Along the makai edge of the this site, where it drops off steeply to the ocean below, are a few shrubs of the native false sandalwood or naio (Myoporum sandwicense) and lantana (Lantana camara).

Site 1A. This site is located on a paved and leveled area. There are a few small, scattered tussocks of grasses, including Natal redtop and pitted beardgrass (Bothoriochloa pertusa), a handful of herbaceous species such as partridge pea and hi'aloa (Waltheria indica) and some low, windswept lantana shrubs on this site.

4.2.8 Fauna

Phillip Burner conducted an avifauna and feral mammal survey at Makaha Ridge in December 1992. The complete survey is attached as Appendix C, and is summarized below as it pertains to the two sites at Makaha Ridge.

A total of five bird species, including two endemic species, were identified at PMRF-Makaha Ridge. The two endemic species were the White-tailed Tropicbird (Phaethon lepturus) and the Pacific Golden Plover (Pluvialis fulva). The Golden Plover is a migratory native bird, which prefers open areas such as mud flats, fields and lawns. The White-tailed Tropicbird is a native seabird, and was observed flying along the cliff face at Makaha Ridge.

Newell's Shearwater (Puffinis newelli), which is federally listed as threatened, was not observed at Makaha Ridge, but may fly over the site as it goes back and forth between nesting burrows in the mountains and the open sea where it forages. Two native species which were not recorded but may likely be found in this area on an occasional basis are the Short-eared Owl (Asio flammeus sandwichensis) and the 'I'iwi (Vestiaria coccinea).

Three species of exotic (introduced) birds were observed at Makaha Ridge; the Spotted Dove (Streptopelia chinensis), the Zebra Dove (Geopelia striata), and the Common Myna (Acridotheres tristis). The exotic birds observed at PMRF-Makaha Ridge are typically found in this region of Kauai.

Although no evidence of rats or mice were noted, it is likely that these ubiquitous mammals inhabit the PMRF-Makaha Ridge area. Feral Goats (Capra hircus) were seen at Makaha Ridge.

4.2.9 Historic, Cultural and Archaeological Sites

Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted an inventory survey at PMRF-Makaha Ridge in December 1992. The complete survey is attached as Appendix D, and is summarized below as it pertains to the two sites at Makaha Ridge.

Site 1. At the time of the survey, the primary site at Makaha Ridge was paved. Therefore no prehistoric sites were expected at this site, and none were observed.

Site 1A. It was considered possible that trail systems with associated temporary shelters could be present in the vicinity of this site. Considering the steep slopes in the area, walls were also considered a possible site type for stabilizing soil. However, no sites were found at Site 1A at Makaha Ridge.

4.2.10 Operational Constraints

Due to the nature of the activities conducted at PMRF-Barking Sands, certain limitations, or constraints are placed on other base operations. This section briefly discusses constraints affecting PMRF-Makaha Ridge.

The electronic interplay between Barking Sands and Makaha Ridge is part of an extremely complex range control system required for target control, exercise data gathering and data transfer. Two components of this system, radars of various types and microwave channels, require land use considerations broader than their physical siting. In the case of microwave antennas, an unobstructed line-of-sight must be maintained between antennas. Radars also require an unobstructed path between the radar antenna and the object being tracked, otherwise referred to as "look angles." In the case of PMRF-BS, these look-angles are fairly fixed. Of critical concern is the relationship between the radar functions performed by range operations and the two launch facilities in the north area of PMRF-BS. Information is received from the launch "vehicles" before and after launch. It is essential that this line-of-sight remain unobstructed, as well as the area to the west of the launch sites, to allow clear tracking and information retrieval capability of the vehicles after launch.

4.3 Pacific Missile Range Facility-Kokee (PMRF-Kokee)

4.3.1 Background

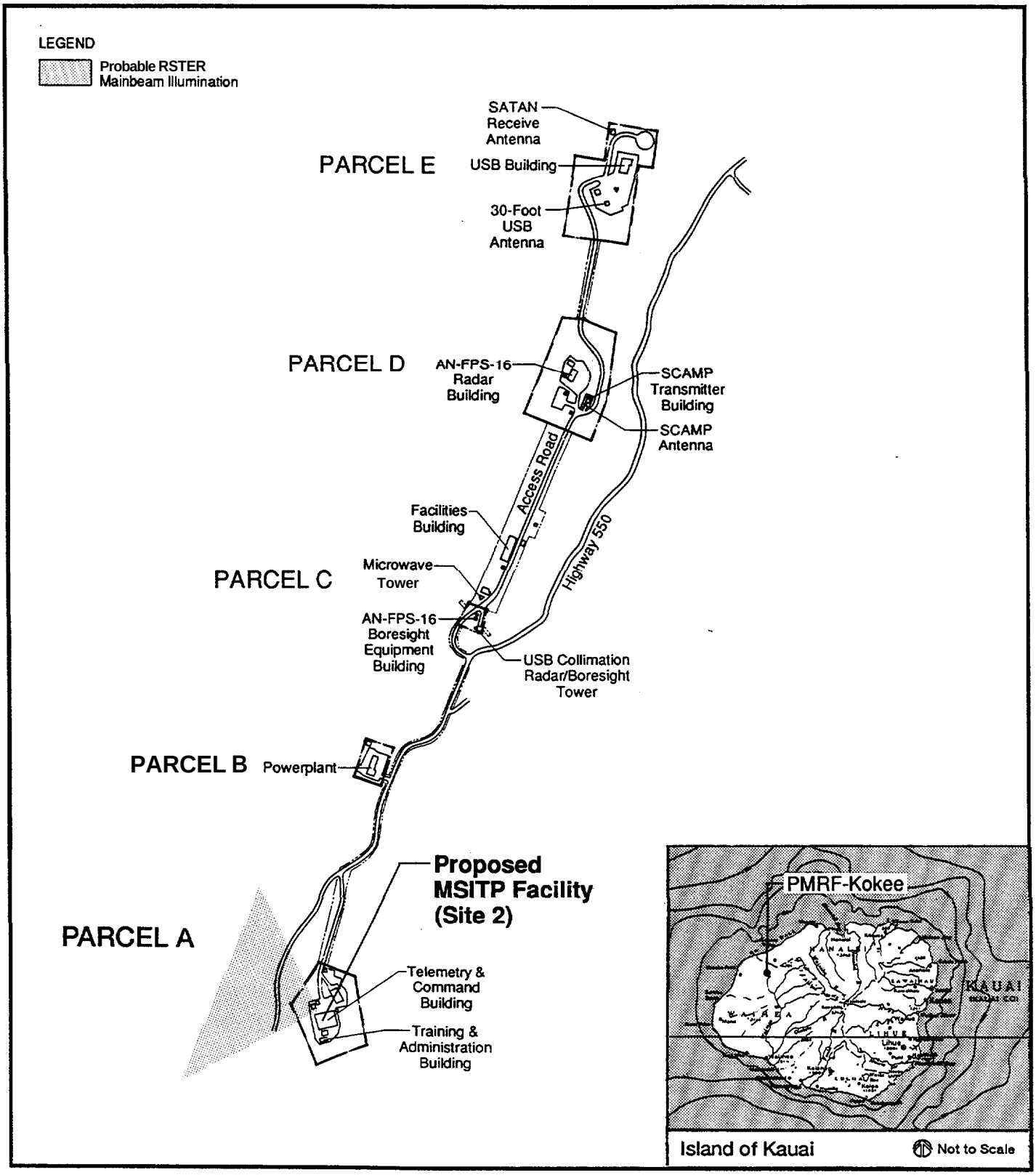
The buildings and structures of PMRF-Kokee, formerly referred to as the Kokee Park Tracking Station, have been under the ownership and management control of the Navy, the Air Force and the National Aeronautics and Space Administration (NASA), under a lease agreement with the State of Hawaii, which owns the land.

The site was constructed in 1960 by the Pacific Missile Range and was declared operational in time to support the first manned Mercury flight in April 1961. It continued to support manned space flight operations and some Air Force ballistics programs up through 1964. In 1965, by the direction of the Secretary of Defense, the Pacific Missile Range and associated facilities were split and transferred to the USAF with the terminal site at Kwajelein transferred to the United States Army. Kokee Park Tracking Station was part of the sites and assets transferred to the USAF. At that time, the USAF evaluated the tracking station's role as to its mission and decided that the major user was the NASA manned space flight program. Hence, the USAF transferred the operations and maintenance responsibility to NASA while still retaining control of the property. This continued until 1971 when the Air Force Western Range (AFWTR) saw no need to retain facility and equipment ownership and effected a transfer to NASA. In 1973, NASA subsequently transferred control of tracking radar (FPS-16) to the PMRF.

4.3.2 Site Description

PMRF-Kokee is made up of five parcels totalling 22.32 acres, located almost in a straight line, with the extremities of the site being slightly less than a mile apart (Figure 7). Parcel "A" (3.79 acres) is the southernmost site and houses the Telemetry and Command (T&C) Building, the Training and Administration Building and the Logistics Building. All the facilities at Parcel **A** are presently unoccupied. This is the parcel that will host the proposed MSITP project (Figure 8). Specifically, the MSITP antenna is proposed to be situated atop an existing 30-foot antenna tower, immediately to the north of the T&C Building (Figure 9). The trailers would be situated adjacent to the building on existing asphaltic pavement.

Parcel A (Site 2) is surrounded by a cyclone fence, and the area in the vicinity of the T&C Building has been graded and paved with asphalt (Figure 9). The ground elevation in the vicinity of the antenna tower is approximately 3,710 feet above MSL. Although some areas of Parcel "A" exhibit moderate slopes, the proposed location for the MSITP project is nearly level and paved.

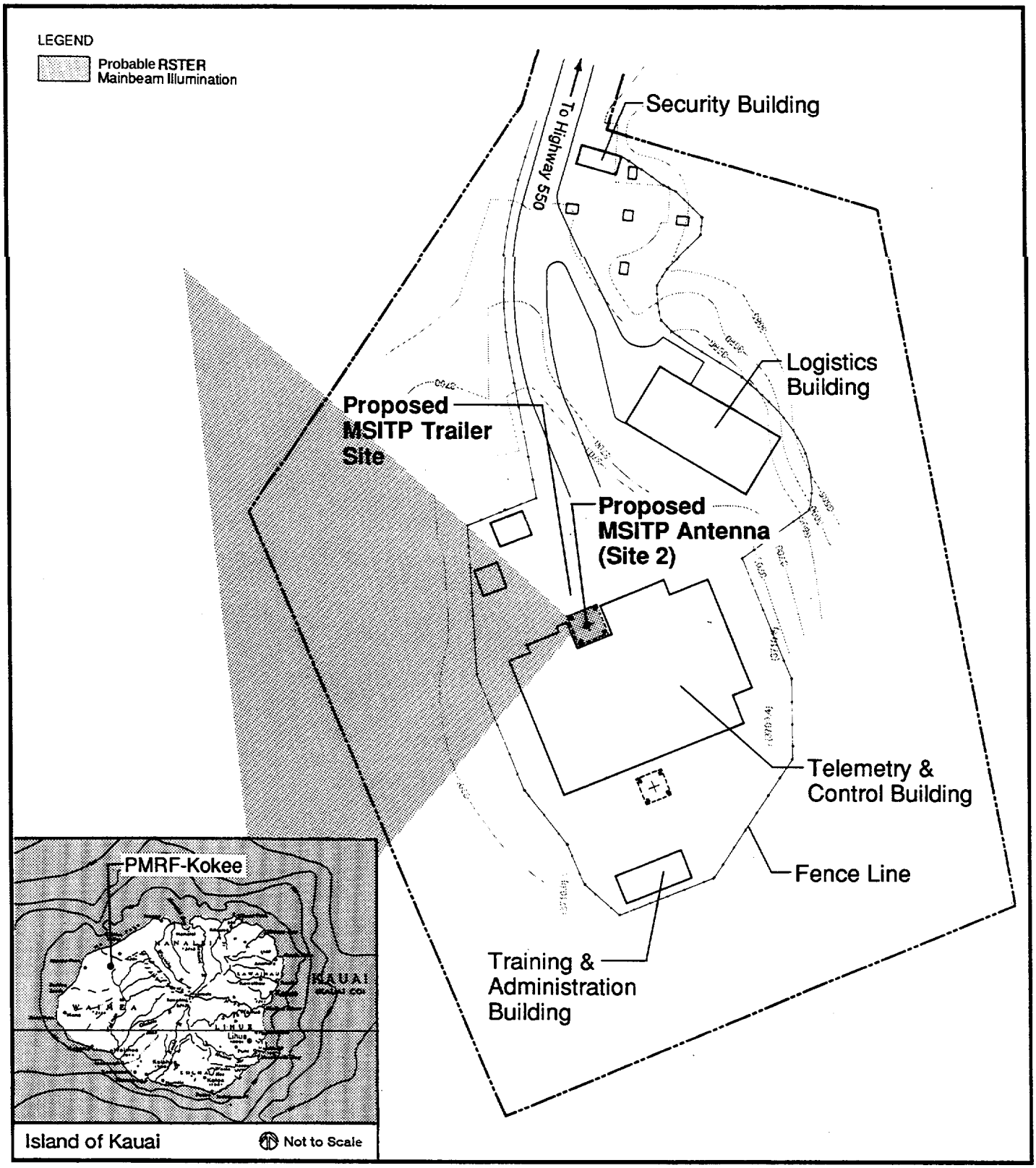


PMRF-Kokee Site Plan

Figure: 7

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

4000' 8000'



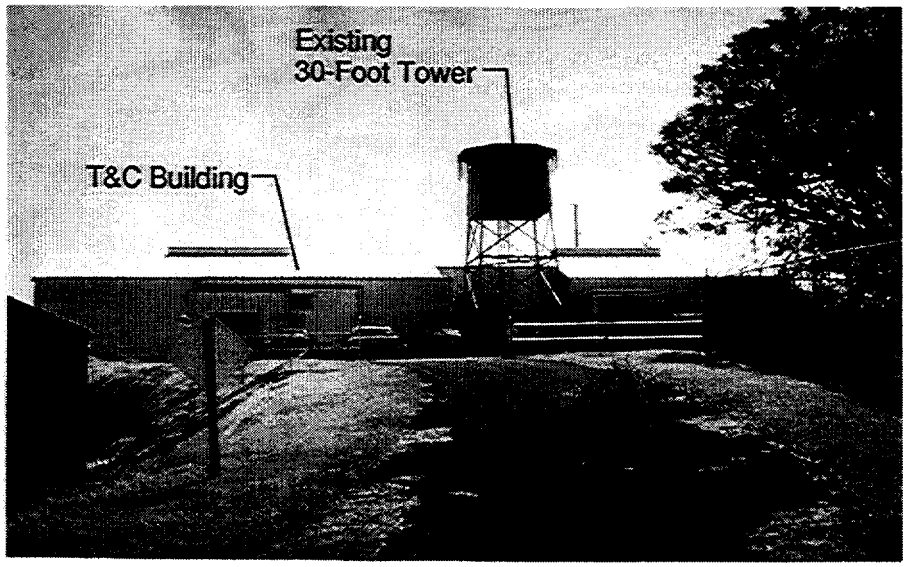
PMRF-Kokee
Parcel "A"

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

Figure: 8

0' 40' 80'

About 1,400 feet to the north, and across Highway 550, is Parcel "B" (1.11 acres), where a power plant and fuel storage area are located. Parcel "C" (0.38 acres), which is about 1,500 feet further north, includes the ANIFPS-16 Boresight Equipment Building, the Facilities Building, a microwave antenna and the USB collimation radar/boresight tower. Parcel "D" (5.33 acres) is further up-slope and contains the SCAMP Transmitter Building and SCAMP antenna and the AN/FPS-16 Radar Building. Nine hundred feet further north is Parcel "E" (5.27 acres), which houses the USB Building and antenna and the SATAN receive antenna in what is known as the Kokee Geophysical Observatory (KGO). Parcel "E" is also the site of the Very Long Baseline Interferometry (VLBI) facility which is operated by the U.S. Naval Observatory. The balance of the Kokee parcels (6.44 acres) are comprised of easements.



View of proposed MSITP site at PMRF-Kokee, looking south from access driveway.

Proposed MSITP Facility Site at PMRF-Kokee **Figure: 9**

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

4.3.3 Facility Loading

As discussed above, Parcel A is unoccupied and presently, no personnel are assigned to its facilities.

4.3.4 Soils

Soils which underlay PMRF-Kokee are of the Kokee series, characterized as well-drained soils on the uplands of the island of Kauai. They have been developed in material weathered from basic igneous rock, probably mixed with volcanic ash. They vary from gently sloping to very steep soils and are found between 3,400 feet and 4,200 feet elevation. The specific soils type found at PMRF-Kokee is the Kokee Silty Loam (KSKE). The permeability of this soil is moderately rapid, runoff is medium and the erosion hazard is slight to moderate. This soil is used primarily for water supply, wildlife habitat and woodland. It is generally unsuited for cultivation.

4.3.5 Utilities

Electricity. *A* backup powerplant at Parcel "B", consisting of five diesel generators with a total capacity of 1,950 kW, provides backup power for the entire station.

Potable Water System. Water is brought to PMRF-Kokee by PMRF-BS personnel and stored.

Sanitary Sewage System. All existing buildings rely on individual cesspool systems for sewage disposal. Cesspools servicing Parcel A are located west of the Telemetry and Control Building.

4.3.6 Flora

Char & Associates conducted a botanical assessment survey at PMRF-Kokee in December 1992. The complete survey is attached as Appendix B and is summarized below as it pertains to PMRF-Kokee. The buildings at Parcel A are presently unoccupied. The proposed MSITP antenna would be placed on top of an existing 30-foot tower. The area under the tower, as well as around the T&C Building, is asphaltic concrete. The nearest vegetation is found in a small planter box, about 20 feet west of the tower. The box supports a weedy mixture of plants such as prickly Florida blackberry (Rubus argutus), sowthistle (Sonchus oleraceus), daisy fleabane (Erigeron karvinskianus), yellow foxtail (Seteria gracilis), and smooth cat's ear (Hypochoeris glabra).

The vegetation on the site is dominated by introduced or alien species, introduced to the Hawaiian Islands by humans after Western contact (1778). No listed, candidate, or proposed threatened and endangered flora species were found, nor any of the plants found considered rare and vulnerable.

4.3.7 Fauna

Phillip Bruner conducted an avifauna and feral mammal survey at PMRF-Kokee in December 1992. The complete survey is attached as Appendix C, and is summarized below as it pertains to PMRF-Kokee.

The site is surrounded by forested areas which are a mixture of exotic species and some native trees and shrubs. Two native bird species were observed at PMRF-Kokee; the Pacific Golden Plover (Pluvialis fulva) and the Common Amakihi (Hemignathus virens). The Pacific Golden Plover is a native migratory bird that prefers open areas such as mud flats, fields and lawns. The Amakahi is a native land bird. Neither of these birds are endangered or threatened.

Three species of exotic birds were observed at PMRF-Kokee: the Feral Chicken (Gallus gallus); the Common Myna (Acridotheres tristis); and, the Japanese White-eye (Zosterops japonicus). These exotic birds are typical of those found in the region. In addition to these exotic species, the following birds may also occur at PMRF-Kokee: the Barn Owl (Tyto alba); the White-rumped Shama (Copsychus malabaricus); the Japanese Bush-warbler (Cettia diphone); and the Eurasian Skylark (Alauda arvensis).

No evidence of rats or mice were noted at the facility, but these ubiquitous mammals likely do occur on or near the site. There was evidence of feral pigs outside the fenceline. Black-tailed Deer (Odocoileus henionus) occur in the Kokee area, but were not recorded on the survey.

4.3.8 Historic, Cultural and Archaeological Sites

PHRI conducted an inventory survey at PMRF-Kokee in December 1992. The complete survey is attached as Appendix D. At the time of the survey, the site at PMRF-Kokee was paved. No historic, cultural or archaeological features were observed.

4.4 Kokee Air Force Station (KAFS)

4.4.1 Background

The buildings and structures of KAFS are located on an 8.45-acre parcel at the end of Highway 550 in Kokee State Park and have been under the management and control of the USAF since 1965 (Figure 4). The land is owned by the State of Hawaii and leased to the USAF. This aircraft control and warning station provides 24-hour radar air surveillance information to the Hawaii Regional Operational Control Center and is operated by the Hawaii Air National Guard (HIANG).

4.4.2 Site Description

The portion of the 8.45-acre parcel that houses KAFS is surrounded by a security fence and has been improved with roadways, utilities and buildings. Major facilities at KAFS include two radar domes (FPS-20 and FPS-6), an Operations Building, a Generator Building, a Supply Building, Motor Pool and dormitories (hutments) (Figure 10). The dormitories are used primarily by HIANG personnel on active duty during the summer months.

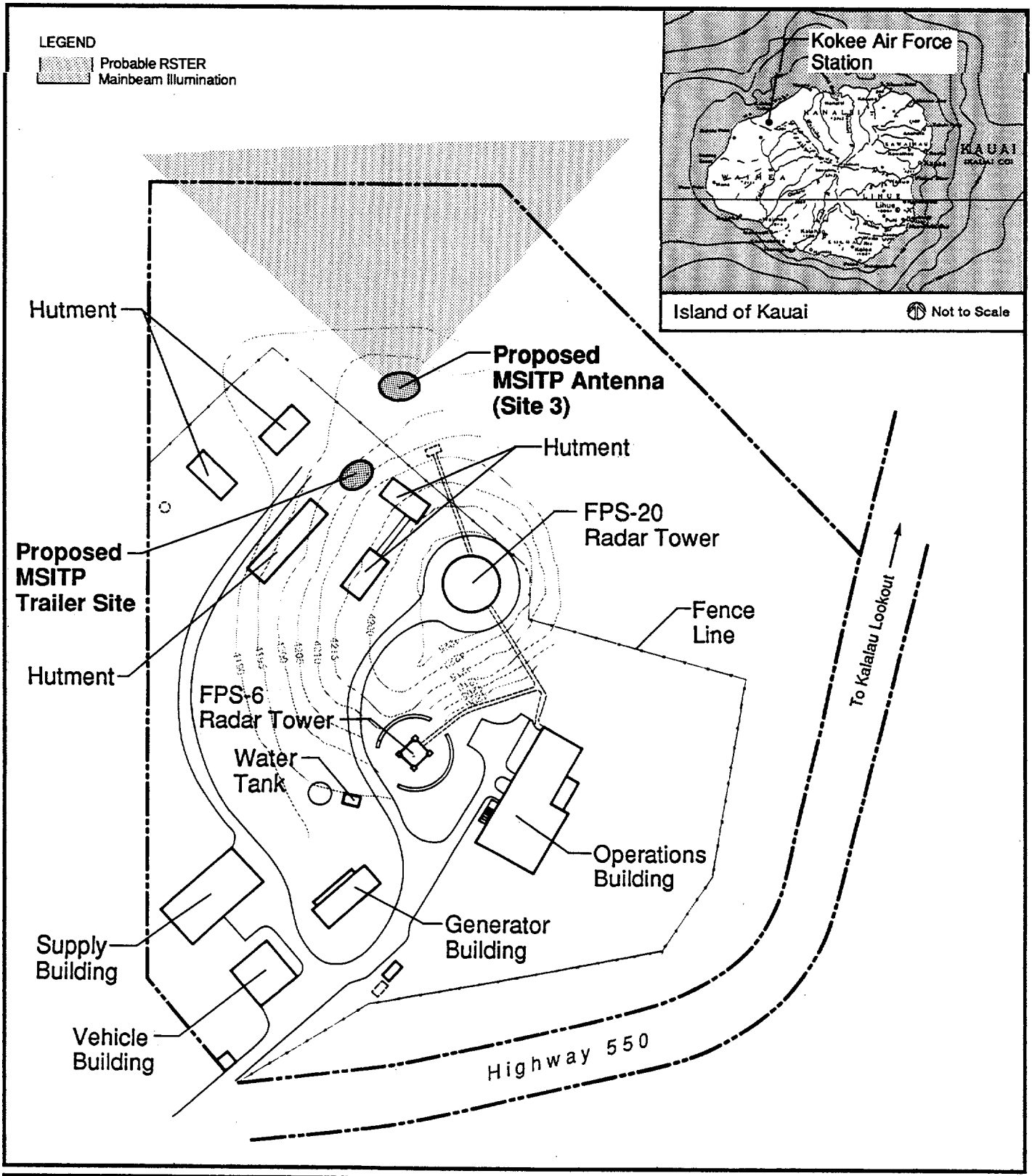
The area inside the fence line is generally characterized by modest slopes with most of the vegetation cleared to accommodate the facilities for KAFS. The proposed MSITP antenna/pedestal location (Site 3) is outside the fence line, west of Radar Dome FPS-20, in an area that is densely vegetated, at an elevation of about 4,220 feet above MSL (Figure 11). The trailers would be parked on the existing paved area within the fence line. This area is fairly level, although the slope increases significantly immediately west of the proposed site.

4.4.3 Facility Loading

KAFS employs 67 people, with full-time, day-to-day operational requirements of 37 people. Staffing is assigned on a 24-hour rotational basis, and all personnel are members of HIANG.

4.4.4 Soils

The soils which underlay KAFS are Kokee silty clay loam (KSKE). This soil is part of the Kokee Series which consist of well-drained soils on uplands on the island of Kauai. These soils developed in material weathered from igneous rock, probably mixed with ash. Kokee Silty clay loam soil is characterized by moderately rapid permeability, medium

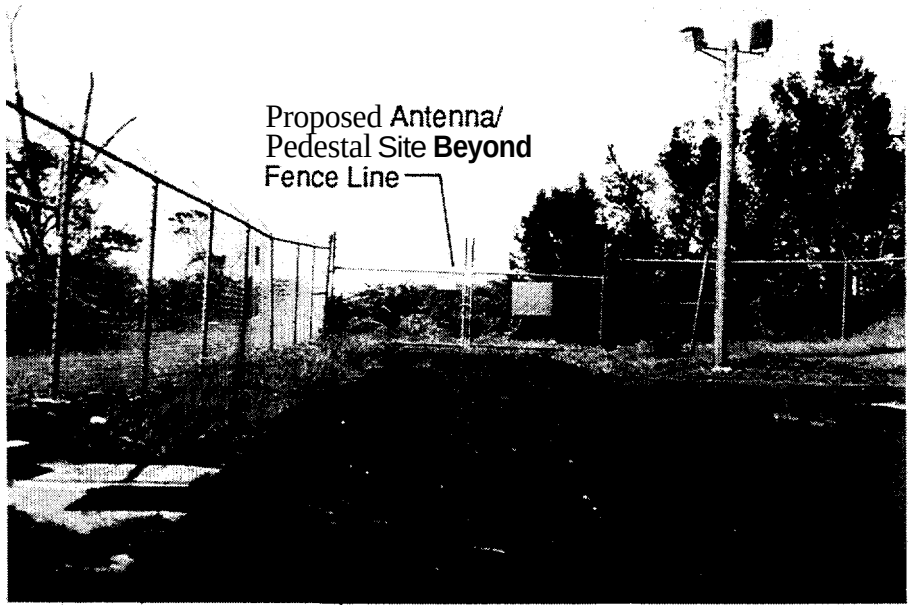


Area Map
Kokee Air Force Station

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

Figure: 10

0' 60' 120'



View of Kokee Air Force Station site, looking west beyond fence line.

Proposed MSITP Facility Site at Kokee Air Force Station **Figure: 11**

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

runoff and slight to moderate erosion hazard. It is used for water supply, wildlife habitat and woodland and is generally unsuited for cultivation.

4.4.5 Utilities

Electricity. There is a back-up generating plant on the station, with a total capacity of 800 kW.

Potable Water System. Water is supplied to the station by an off-site well maintained by USAF, located about 114-mile from KAFS. Water is transmitted to the station via a two-inch water line that is connected to a 50,000 gallon water tank which supplies water to all the station facilities. All drinking water on the station is chlorinated.

Sanitary Sewage System. All existing buildings use a sewage septic tank, which is located west of the FPS-20 Radar Dome or a cesspool, which is located south of the dormitories.

4.4.6 Flora

Char & Associates conducted a botanical assessment survey at KAFS in December 1992. The complete survey is attached as Appendix B, and is summarized below as it pertains to the proposed KAFS site.

The site is the most densely vegetated of the proposed sites. It appears to have been cleared at least once and is now overgrown with yellow ginger (Hedychium flavescens), which forms a thick, rhizomatous mat, and a few clumps of hardy fuchsia or earring flower (Fuchsia magellanica); both are introduced or alien species. Analysis of infrared photography indicates that the upper portion of the ginger patch and other nearby introduced species comprise approximately 10,000 square feet in the vicinity of the proposed site. Where the ginger patch abuts the KAFS fenceline, there is a large pile of tree branches and lawn trimmings as well as a number of other introduced species such as velvet grass (Holchus lanatus), montbretia (Crocosmia X Crocasmiiflora), smooth cat's ear, pangola grass, and prickly Florida blackberry.

With the exception of a small thicket of firetree (Myrica faya), a noxious introduced species, and a few plum trees (Prunus cerasifera X salicina), the forest surrounding the ginger patch is composed primarily of native species characteristic of a diverse mesic forest. These include trees of 'ohi'a (Metrosideros polymorpha), koa (Acacia koa), and 'ohe (Tetraplasandra sp.); and smaller trees and shrubs of kopiko (Psychotria sp.) kawa'u (Ilex anomala), two species of kolea (Myrsine spp.), mokihana (Pelea anisata), and manono (Hedyotis terminalis). One small plant of the native mint, (Stenogyne purpurea) occurs in this forest. Ground cover and epiphytic ferns include ho'i'o (Diplazium sandwichianum), uluhe (Dicranaoperis linearis), 'ekaha (Elaphoglossum hirtum), and kolokolo (Grammitis tenella). Plants of pa'iniu (Astelia agyrocoma) and 'uki'uki (Dianella sandwicensis) form low, rounded tufts.

No listed, candidate, or proposed threatened and endangered flora species were found, nor any of the plants found considered rare and vulnerable.

4.4.7 Fauna

Phillip Bruner conducted a avifauna and feral mammal survey at KAFS in December 1992. The complete survey is attached as Appendix C, and is summarized below as it pertains to KAFS.

As discussed above, the KAFS site contains a mixture of native and introduced plants, which comprises the best habitat of the three sites, and consequently the greatest number and diversity of native birds occurs there. Four native land birds were observed: 'Elepaio (Chasiempis sandwichensis); Anianiau (Hemignathus parvus); Common Amakihi (Hemignathus virens); and, Apapane (Himatione sanguinea). None of these birds are endangered or threatened. The only native species which were not recorded but may likely be found in the area on an occasional basis are the Short-eared Owl (Asio flammeus sandwichensis) and the 'I'iwi (Vestiaria coccinea).

Although not observed during the survey, anecdotal information places the Newell's Shearwater (Puffinus newelli), a native seabird, at the KAFS site. An injured Newell's Shearwater that had flown into the fence surrounding the site was discovered at KAFS. The bird was subsequently turned over to State of Hawaii wildlife authorities. The endangered Dark-rumped Petrel (Pterodroma phaeopygia) are known to nest in the high elevation forest near the KAFS site, although none were observed during the survey.

Four exotic species were observed at KAFS: the Common Myna (Acridotheres tristis); the Northern Cardinal (Cardinalis cardinalis); the Hwamei (Garrulax canorus); and the Japanese White-eye (Zosterops japonicus).

Additional anecdotal information indicates that the native and endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus) has been commonly observed at KAFS. As many as nine individual bats at one time have been observed foraging for insects around the KAFS site. In addition, evidence of feral pigs was abundant in the vicinity of KAFS. Black-tailed Deer occur in the Kokee area, but were not recorded in the vicinity of KAFS during the survey.

4.4.8 Historic, Cultural and Archaeological Sites

PHRI conducted an inventory survey at KAFS in December 1992. The complete inventory survey is attached as Appendix D, and is summarized below as it pertains to KAFS. On the basis of the inventory survey, which included test excavations, the geology at KAFS was found to be primarily comprised of back-fill soil, most probably from previous construction of the facility. Beneath the approximate two-foot layer of

back-fill soil is eroding bedrock. No cultural material of any kind was observed. The lack of cultural material could be the result of development activity in the area or the complete absence of sites, which is highly likely the most probable reason since the site terrain does have existing steep slopes and very little soil for agriculture.

Chapter 5

Environmental Consequences

5.0 ENVIRONMENTAL CONSEQUENCES

This Chapter analyzes the environmental issues associated with the proposed action.

5.1 Direct Effects and Their Significance

5.1.1 Traffic Impact

A previous analysis of traffic patterns affecting Highway 550 was conducted for the Navy by Parsons Brinckerhoff Quade & Douglas in 1990 for the VLBI project. This analysis indicated that Highway 550 is influenced by a pattern of higher mid-day peak hour traffic volume than the traditional morning and evening peak hours (AM peak hour trips were measured at 58, PM trips at 141, and mid-day trips at 205). This higher mid-day peak is primarily due to tourist-oriented traffic visiting the Waimea Canyon Lookout and the Kalalau Lookout. The proposed project, however, is expected to generate few, if any, mid-day trips. Approximately five personnel are anticipated to be working at this project who will be driving to the three sites during the morning and late afternoon hours. Traffic impacts to Highway 550 would therefore be negligible during the mid-day peak hour.

5.1.2 Flora

As discussed in previous Sections 4.2.7, 4.3.6, and 4.4.6, Char & Associates conducted a botanical assessment survey of the alternative MSITP facility sites in December 1992. The vegetation in the vicinity of Sites 1 and 1A (Makaha Ridge) and Site 2 (PMRF-Kokee), although sparse, is dominated by introduced or alien species. Otherwise, these sites are paved. On the KAFS site (Site 3), introduced yellow ginger forms a dense patch on a previously disturbed portion of the site, while an adjoining undisturbed portion is covered by a native, diverse mesic forest. No listed, candidate, or proposed threatened and endangered flora species were found, nor any of the plants found considered rare and vulnerable.

Construction of the proposed MSITP project on either of the PMRF-Makaha Ridge sites (Sites 1 and 1A) or the PMRF-Kokee site (Site 2) would not have a negative impact to botanical resources. The plants found on the sites are almost exclusively introduced species. These plants occur throughout the islands in similar environmental habitats.

Although the KAFS site does not host any listed, candidate or proposed threatened and endangered flora species, the undisturbed portion of the site is dominated by native

habitat. Destruction of this habitat would result in the loss of additional individual native plants and would further reduce habitat for native land birds (see Section 5.1.3).

5.1.3 Fauna

There are two aspects to the possible impact of the MSITP project on the fauna at the proposed alternative sites; one is related to the possible loss of habitat for native species during construction of the facility, and the second is related to the operation of the facility after it has been installed.

Construction Period. As discussed in previous Sections 4.2.8, 4.3.7, and 4.4.7, Phillip Bruner conducted an avifauna and feral mammal survey of the proposed MSITP project sites in December 1992. Mr. Bruner's survey primarily addresses the construction period impacts of the MSITP project.

PMRF-Makaha Ridge. The two Makaha Ridge sites are of the least concern to native birds, primarily because of their barren terrain and lack of suitable habitat. Neither of the two species of native birds observed at Makaha Ridge (the White-tailed Tropicbird and the Pacific Golden Plover) are endangered or threatened. For this reason, development of the MSITP facility at Makaha Ridge would not result in a loss of habitat for native birds. The Newell's Shearwater, a native seabird, may fly over the Makaha Ridge area as it goes back and forth between nesting burrows in the mountains and the open sea where it forages. It is possible that any night-lighting of the MSITP facility could cause disorientation, and subsequently cause an accident in flight.

PMRF-Kokee. Two native birds were observed at the PMRF-Kokee site (the Pacific Golden Plover and the Common Amakihi). Neither of these birds are endangered or threatened. No native mammals were observed at this site, and because the proposed MSITP antenna would be located atop an existing antenna tower, there would be no additional loss of habitat for native species.

KAFS. The KAFS site contains a mixture of native and introduced plants and comprises the best habitat of the proposed sites. Consequently, the greatest number and diversity of native birds occurs there. None of the four native birds observed at the KAFS site ('Elepaio, Anianiau, Common Amakihi, Apapane) is endangered or threatened. The Newell's Shearwater has been observed in the area and the endangered Dark-rumped Petrel is known to nest in the high elevation forest near the KAFS site.

Although none of the observed native bird species at KAFS are threatened or endangered, the removal of native trees, which are used extensively by native birds, would eliminate

potential habitat for these species. Also, similar to the Makaha Ridge sites, the placement of security lighting for the proposed MSITP project could disorient any Newell's Shearwater which frequent the area.

Operational Period. The second possible impact on fauna associated with the proposed MSITP project could occur as the direct result of the operation of the radar equipment. Based on research conducted by the Naval Aerospace Medical Research Laboratory in Pensacola, Florida (NAMRL), the impacts of radar on birds is measured as a function of the power density output of the radar equipment, measured in milliwatts per square centimeter (mW/cm^2). The following discussion is the result of information provided by John de Lorge, Ph.d., at NAMRL and included in Appendix E.

Effects on birds of brief exposures (less than 60 seconds) at power levels of 50 mW/cm^2 or less are not permanent. Lethal effects begin to occur when exposures exceed 100 mW/cm^2 for greater than 20 minutes. Higher densities for shorter periods of time are not lethal. However, some birds begin showing stress effects after exposure for 30 seconds at 25 mW/cm^2.

Birds normally exposed to electromagnetic fields in free flight do not evidence any deviation in flight patterns nor do birds nesting/roosting near large radar facilities show avoidance or attraction to enhanced radiation fields. It is highly unlikely that any bird would approach the radar antenna near enough to create power absorption at hazardous thermal levels. Nor is it likely that they would nest in fields where thermal levels were high enough to produce biological effects.

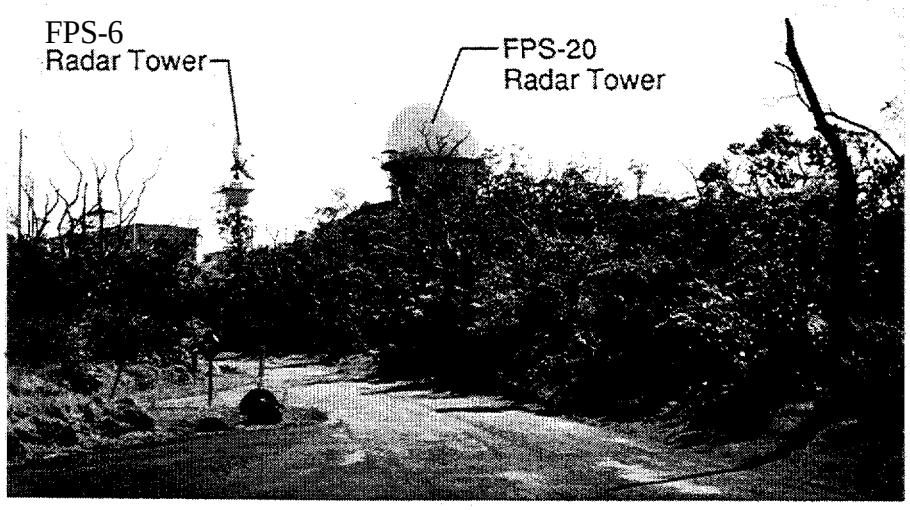
The power density for the RSTER has been measured at 16 mW/cm^2 out to 20 feet away from the radar unit. Ten (10) feet and 100 feet below the RSTER the power density drops to 0.1 mW/cm^2 and 5 mW/cm^2, respectively (Lynch, December 1992). These power densities, in consideration of the information provided by John de Lorge, Ph.D. at NAMRL, are well below those required to produce negative effects on birds. Furthermore, the RSTER is normally a rotating radar while in operation and non-essential sectors will be blanked out, thereby further reducing the time frame of exposure to any radar beams and minimizing harmful effects to free flying birds.

5.1.4 Visual Resources

The MSITP antenna/pedestal will be a maximum of approximately 85 feet in height and will resemble other radar facilities in appearance and shape. Since the PMRF-Kokee and KAFS sites are located within the boundaries of Kokee State Park, it is important to consider the visual environment within the park.

Highway 550. Highway 550, which provides access to both facilities from **Kaumualii** Highway, extends about 18 miles to the Kalalau Lookout and is characterized as a winding road that is flanked by dense stands of trees, especially at higher elevations. Visibility is often restricted, not only by the vegetation, but also by extreme changes in topography. Formal public lookouts offering spectacular vistas within **Kokee** State Park are the Waimea Canyon Lookout, the Pu'u **Hinahina** Lookout, the Kalalau Lookout and the Pu'u O **Kila** Lookout. The general ambience of the drive through the park is one of lush foliage with occasional glimpses of Waimea Canyon. Throughout this drive, which terminates at approximately the 18-mile marker at the Kalalau Lookout, overhead electrical wires and utility poles parallel the roadway. There are other reminders of the built environment. At approximately the 9-mile marker, there is a microwave dish antenna that is approximately 100-feet high and is clearly visible as it is approached from a downhill direction.

KAFS. Just before reaching the Kalalau Lookout at the 18-mile marker, the KAFS maintains a radar facility which is visible from Highway 550 as one approaches the lookout, and from the parking area for the Kalalau Lookout (Figure 12).



View of KAFS, looking west, from Kalalau Lookout parking lot.

Existing Visual Environment; Kalalau Lookout Parking Lot **Figure: 12**

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

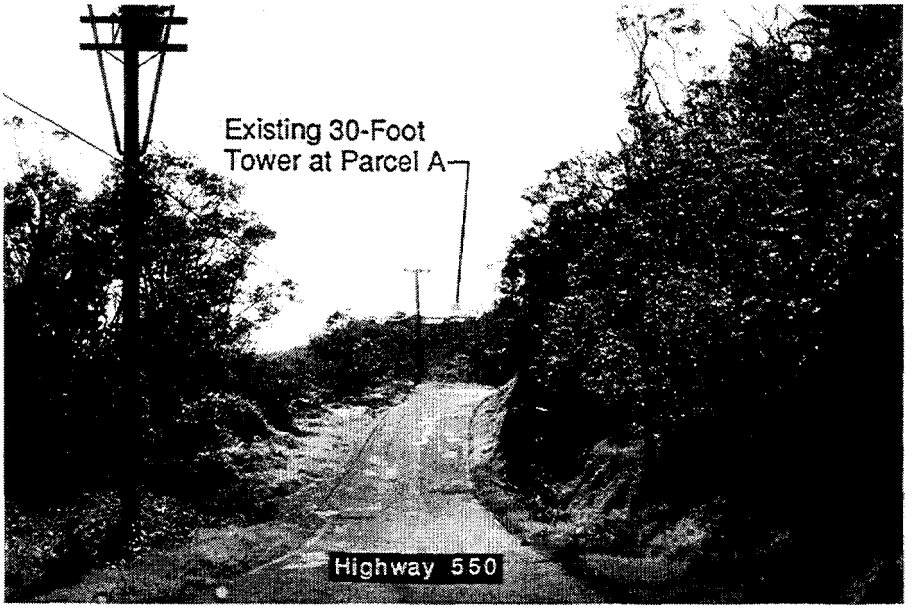
PMRF-Kokee. Between the 14- and the 15-mile-marker, two antennae, one an 85-foot collimation tower for the USB receiving dish at the Kokee Geophysical Observatory (KGO) and the second, a 190-foot microwave antenna operated for PMRF-BS, are clearly visible as they extend beyond the tree line. No other structures of the PMRF-Kokee site are visible from the highway as one travels uphill, including those at Parcel A.

On the drive back toward Waimea, the USB receiving dish antenna is only occasionally visible through the trees between the 15- and 16-mile markers, as it extends above the tree line. It is most visible on the downhill approach to the Kokee Lodge for a lineal distance of about 100 yards. In addition, the VLBI Radio Telescope, now under construction at KGO, is also visible along this portion of Highway 550. None of the facilities at PMRF-Kokee are visible from the Waimea Canyon, Pu'u Hinahina, Kalalau or Pu'u O Kila Lookouts within Kokee State Park.

After proceeding past the Kokee Lodge, the next visible development is the existing antenna pedestal at Parcel A of PMRF-Kokee; the proposed site for the MSITP project. The pedestal is visible for a length of about 100 yards along Highway 550 between the 14- and 15-mile marker, travelling in a downhill direction. This antenna pedestal protrudes above the tree line. The RSTER radar equipment will add about 23 feet of mechanical equipment to the pedestal, thereby increasing its visibility. It should be noted that existing electric utility poles and lines are also prominent visual features of the landscape along this stretch of Highway 550 (Figure 13).

PMRF-Makaha Ridge. PMRF-Makaha Ridge, unlike the PMRF-Kokee and KAFS sites, is not visible from public highways. Consequently, there will be no visual impact associated with the project at PMRF-Makaha Ridge, with the possible exception of views from the ocean. Elevations at the proposed sites on Makaha Ridge are approximately 1,500 feet above MSL. Both sites at Makaha Ridge are located near the western edge of a sea cliff and therefore, the antenna/pedestal unit will only be visible from the ocean. However, because Makaha Ridge is already extensively developed with other radar and communications antennae, visual impacts to watercraft will be minimal.

The overall impact of the proposed MSITP project must be assessed in context with the regional and local physical environment. For the most part, Parcel A at PMRF-Kokee cannot be seen from Highway 550 because of the relationship between topography, vegetation and sight lines. Only brief glimpses of the proposed facility will be possible from an approximate 100-yard stretch along Highway 550, between the 15- and 14-mile markers, as one drives downhill. The proposed site at KAFS is behind an existing radar



Downhill view along Highway 550, between 14- and 15- mile marker. Exisiting 30-foot tower at PMRF-Kokee Parcel A is visible in the distance.

Existing Visual Environment Along Highway 550 Figure: **13**

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

facility (FPS-20) and knoll. The site is not visible from public viewpoints and the MSITP facility will not be visible after installation. In the case of PMRF-Kokee, it is important to remember the project is temporary; testing will be completed within three years, after which the facility will be dismantled.

5.1.5 Locational and Physical Site Conditions

Sites 1 and 1A at Makaha Ridge and Site 2 at PMRF-Kokee, have been leveled and paved. The construction of the MSITP facility at these alternative sites will have minimal impacts on the physical environment.

The KAFS site is covered with dense foliage, with many native plant species. The installation of the MSITP facility at this site will require some site preparation: the removal of about 6,000 square feet of vegetation and the grading of the site; the possible construction of retaining walls and drainage facilities; and, the installation of utility cables from the antenna to the trailers inside the existing fenceline.

5.1.6 Electromagnetic Radiation (EMR)

The Naval Command, Control and Ocean Surveillance Center In-Service Engineering West Activity (NISE WEST HAWAII) conducted an electromagnetic radiation (EMR) hazard review and an electromagnetic compatibility (EMC) study of the RSTER as it pertained to the proposed alternative MSITP project sites. The studies considered hazards of electromagnetic radiation to personnel, fuel, and ordnance (HERP, HERF, and HERO, respectively), electromagnetic interference (EMI) to electronic equipment and the electromagnetic compatibility of the RSTER to existing facilities. The full reviews conducted by NISE WEST HAWAII are attached as Appendix F, and summarized below.

HERP. Hazards of electromagnetic radiation to personnel (HERP) is the result of tissue heating by radio frequency (RF) energy. Hazard levels are a result of RF energy averaged over any six-minute period. HERP could be caused during operation of the RSTER, but only during mainbeam illumination by a stationary antenna. The possibility of a HERP incident occurring during operation of the RSTER is minimal since the antennas will be rotating and non-essential areas will be sector blanked.

HEW is predicted at Site 1A at Makaha Ridge, and Sites 2 and 3 (PMRF-Kokee and KAFS, respectively) for operation of the RSTER90 antenna even with transmissions limited to the 225° to 315° azimuth sector due to the lower height of the antenna.

HERF. Hazards of electromagnetic radiation to fuel (HERF) is the ignition of fuel vapors by arcing or ignition of fuel in contact with RF heated metal in intense RF fields. There are no fuel locations within the calculated HERF distance of the systems' antennae and therefore HERF will be minimal.

HERO. There are no ordnance sites or routes at PMRF-Kokee and Makaha Ridge, and only small arms (percussion) ammunition at KAFS. Therefore, hazards or EMR to HERO for facilities at these sites are minimal. However, helicopters carrying electroexplosive devices (EEDs) do use the heliport at Makaha Ridge. The maximum calculated EMR at the heliport is below the HERO UNSAFE and SUSCEPTIBLE levels due to sector blanking of the radar. There is concern about the EMR hazards to these materials should the helicopters fly within the operating sector of the RSTER.

EMI. The potential for electromagnetic interference (EMI) occumng at PMRF-Makaha Ridge is minimal since high powered radars are already operating at this site and the RSTER will use sector blanking (away from existing facilities). However, the possibility of EMI at any of the three sites cannot be ruled out entirely. This is especially important, because, as described in Section 4.1.4, the electronic interplay between PMRF-Barking Sands and PMRF-Makaha Ridge is part of an extremely complex range control system required for target control, exercise data gathering and data transfer. During the preparation of this EA, joint discussions between personnel at PMRF-Barking Sands and Rome Laboratory determined that Site 1 at Makaha-Ridge would probably compromise range operations at PMRF-Barking Sands and a decision was made to move the MSITP project to Site 1A at Makaha Ridge.

It was also determined during the preparation of this EA that EMI could affect existing or planned sensor and communications programs located at the Kokee Geophysical Observatory (KGO), operated by NASA, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Naval Observatory (USNO) if the MSITP project is located at PMRF-Kokee or KAFS (Sites 2 and 3, respectively) (Appendix G).

However, on the basis of mitigaton measures and cooperative management procedures as outlined in Section 5.9, NASA concurs with the project as discussed in their letter found in Appendix G.

EMC. The RSTER transmitter is capable of operating from 400 to 500 MHz in 1 MHz increments in its frequency hopping mode. Co-channel interference is predicted to numerous existing users in the 400 to 420 MHz and 450 to 470 MHz ranges. In the 420 to 449 MHz range, co-channel interference is predicted for several Command Guidance and Command Destruct frequencies used for rocket and missile launches at PMRF-BS.

Co-channel interference is predicted to affect RSTER operations at all sites from the broadband noise transmission across the 425-445 MHz range from the AN/ALT-41 at PMRF-Makaha Ridge or from some aircraft at PMRF-BS during exercises. It is also anticipated that a path blockage problem could exist for the Integrated Target Control System (ITCS) at PMRF-Makaha Ridge due to the RSTER antenna. As discussed previously, the decision to move the MSITP project to Site 1A at Makaha Ridge will eliminate this conflict. Pre-operational tests will confirm this finding. Additionally, mitigation measures and cooperative management procedures as outlined in NASA's letter, Appendix G, will minimize any effects to their programs.

5.1.7 Noise Impact

The existing noise quality of PMRF-Makaha Ridge, PMRF-Kokee and KAFS is predominantly influenced by motor vehicular traffic movement along both Highway 550 and the Makaha Ridge Access Road, and other factors such as wind moving through the trees. Because of the location of the sites relative to existing roads, and the amount of vegetative buffering at the PMRF-Kokee and KAFS sites, noise from motor vehicular traffic is not pronounced. Impacts to noise quality will be generated by vehicular movements to and from the MSITP project during construction activities and by employees travelling to and from work. Because of the anticipated short period of construction and the small number vehicles that will be added to the traffic flow by the five operational employees, it is expected that adverse impacts to the noise quality of any of the proposed sites will be minimal.

5.1.8 Socio-Economic Impact

In the short-term, construction related employment will be provided while the MSITP facility is being built. Additionally, it is anticipated that five full-time positions will be created to manage and operate the MSITP facility. These jobs will be terminated once the project is completed, about three years after testing begins. Because of the relative size of the construction project and the small number of jobs that will be created by the operation of the facility, socio-economic impacts associated with the proposed project are expected to be minimal.

5.1.9 Historic, Cultural and Archaeological Sites

Paul H. Rosendahl, Inc. (PHRI) conducted an archaeological inventory survey of the proposed sites in December 1992. The complete report prepared by PHRI is attached as Appendix D. No historic, cultural or archaeological remains were discovered at any of the sites during the inventory survey. Consequently, there will be no impact on archaeological, cultural or historic sites.

5.1.10 Air Quality

Air quality in the vicinity of the alternative sites is affected by a number of sources, including: agricultural activities, such as sugar cane burning; vehicular emissions; and diesel-powered generators.

The principal source of short-term air quality impact will be construction activity. Site preparation and earth moving will create particulate emissions, as will actual construction

activity. For construction-related fugitive dust, adequate dust control measures should be employed during construction. Dust control can be accomplished through frequent watering of exposed soil.

Long-term air quality will be affected by the increased number of vehicles occupied by employees of the MSITP project travelling to and from work for three years only. However, because only five additional employees are anticipated for the project, this impact will be negligible.

5.1.11 Infrastructure/Utilities

As described in previous Sections 4.1.9 and 4.2.8 and 4.3.8, infrastructure and utility service to the alternative sites appears adequate. These systems should be sufficient for the MSITP project and five additional employees anticipated for the MSITP facility, who will increase demand in a negligible manner. However, if electrical power from the public utility is interrupted, it is possible that back-up power serving each of the three proposed sites (PMRF-Makaha Ridge, PMRF-Kokee and Kokee Air Force Station) may not be sufficient to accommodate the MSITP project if operational activities at the proposed sites are in progress.

Impacts of construction-related activities on these systems will also be negligible, due to the short-term duration of construction.

5.1.12 Soils

Sites 1 and 1A at Makaha Ridge and Site 2 at PMRF-Kokee have been leveled and paved. No impacts to soils are expected at these sites. Site 3 at KAFS, is fairly level and surrounded by vegetation. No impacts to soils are expected at this site either.

5.1.13 Hazardous Waste Management

There are no known hazardous wastes on the three sites and the proposed project will not generate hazardous wastes.

5.2 Indirect Effects and Their Significance

The scope of the proposed action is rather small, adding only five employees to the labor force, thereby consuming limited resources and placing minimal demands on existing infrastructure (water, electricity, sewage, transportation). Therefore, the proposed action

will not induce changes to the population base, growth profiles or expansions of necessary infrastructure systems.

5.3 Possible Conflicts Between the Proposed Action and the Objectives of Federal, State and Local Land Use Policies, Plans and Controls

5.3.1 Department of Defense

The analysis contained in this EA has shown that the location of the MSITP project at Site 1 at PMRF-Makaha Ridge could affect range operations at PMRF-BS. In order to sustain high levels of range operations performance at PMRF-BS, the MSITP project will be located at Site 1A at Makaha Ridge.

5.3.2 Hawaii Coastal Zone Management (CZM) Program

The National Coastal Zone Management Act of 1972 (P.L. 92-583), as amended (P.L. 94-730) requires Federal agencies to conduct their planning, management, development, and regulatory activities in a manner consistent with the State of Hawaii's CZM programs. The "coastal zone" of Hawaii includes all non-federal property within the state, including offshore islands and the submerged lands and waters extending seaward to a distance of three nautical miles. The Office of State Planning (OSP), as the lead agency of the CZM program, is responsible for conducting federal consistency review for federal activities.

The review to establish consistency with CZM policies as stated in E.O. 78-37, is conducted as specified in 15 CFR Part 930. Although the proposed action is within a federal enclave, it contains a "spillover" effect into the coastal zone (radar beams from the radar test systems). The Navy has determined that the proposed MSITP project is consistent with the goals and objectives of the Coastal Zone Management Program and a concurrence has been received from OSP. A copy of the consistency form and response is contained in Appendix H.

5.3.3 National Historic Preservation Act

The MSITP 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 avoid or mitigate adverse effects. Section 106 applies not

only to those properties that meet specified eligibility criteria. This could include properties that have not been listed and even those that have not been discovered, especially in the case of archaeological resources.

In Hawaii, Section 106 review is carried out by the Department of Land and Natural Resources. No historic, cultural or archaeological resources were discovered during the preparation of this environmental assessment. The absence of such resources provides the basis for the "no effect" determination which was concurred with the State Historic Preservation Office (SHPO) of the Department of Land and Natural Resources.

5.3.4 State of Hawaii Land Use Policies

As discussed in Section 4.0, all the alternative sites are located within the State Conservation District. The decision issued by the United States District Court for the District of Hawaii in Sierra Club v. Cheney, State of Hawaii v. Cheney, Civ. No. 90-761 DAE, determined that the federal government is not required to comply with the State's Conservation District Use permitting process. However, compliance with all applicable State requirements will be achieved.

5.3.5 Kauai County Land Use Policies

The County of Kauai has no recognized land use policy for the alternative sites, as adopted General Plan maps have not been developed for those areas. In addition, there is no County zoning designation assigned to the sites. This is because the State Land Use designation for the sites is Conservation, and the County of Kauai relinquishes jurisdiction of the lands to the State of Hawaii. As such, the proposed MSITP project does not impact County of Kauai land use policies (Mamaclay, December 1992).

5.4 The Environmental Effects of Alternatives Including the Proposed Action

Except for the "no-action" alternative, all of the proposed alternatives would have some impacts. It is possible that selection of one of the alternate sites identified in Section 3.2 could result in electromagnetic interference to existing facilities in the area, disturb historic, cultural or archaeological sites, or require the installation of additional utilities or infrastructure.

The selection of the alternate technology alternative described in Section 3.3 is reliant on the use of aircraft to test the RSTER. This alternative would significantly increase the consumption of fossil fuels because aircraft would need to spend thousands of hours

airborne to achieve the same results as the MSITP project, thereby contributing impacts to ambient noise quality and ambient air quality.

5.5 Energy Requirements and Conservation Potential of Various Alternatives and Mitigation Measures

It is expected that the MSITP facility will require about 300 kW of prime power. In addition to these operational energy requirements, the facility would expend fossil fuels during the construction period for the operation of heavy equipment and transportation of construction workers and materials to the job site.

5.6 Irretrievable and Irreversible Resource Commitments

It is unavoidable that the operation of the MSITP project will require the use of fossil fuels to provide the electricity for the radar operations and the control facilities which will support the antenna. Fossil fuels will also be committed to transportation requirements for the personnel who will operate the facility, and to manufacture and transport the components of the antenna to the project location. In addition, approximately 6,000 square feet of paved surface would be required at the KAFS site (Site 3).

Except for the paved improvements at PMRF-Makaha Ridge, all facilities and equipment would be removed at the end of the three-year test period.

5.7 Short-Term Use Versus Long-Term Productivity

The most obvious result of the installation of the MSITP facility will be the installation of a radar antenna that is dedicated to the development of new radar and communications equipment without the expense of flying the equipment. Not only will the proposed action result in the development of new radar technology, it will do so at a fraction of the fossil fuel expenditure that would have been required if the tests were conducted airborne.

In addition, there are long-term benefits to be derived by the development of new radar technologies with the short-term use of Kauai facilities.

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

As discussed in Section 5.1.4, the MSITP project will have potential impacts to visual resources when in use at the PMRF-Kokee site (Site 2). However this impact must be considered in the context of the existing built environment. Presently, a 30-foot antenna

tower at PMRF-Kokee is visible for about 100 yards while driving downhill between the 15- and 14-mile marker along Highway 550. It is not expected that the location of the MSITP antenna atop this existing tower will significantly alter the existing visual environment because of the presence of similar facilities in the same location.

5.9 Means of Mitigating Potentially Adverse Effects

This EA has identified four potential impacts that could cause adverse effects as the result of the installation of the MSITP facility: (1) the potential loss of native vegetation at KAFS; (2) the potential disorientation of native birds such as the Newell's Shearwater due to security lighting; (3) the potential for EMR in the form of HERP at KAFS and PMRF-Kokee and EMI at all three sites; and (4) the potential impact to visual resources affected by the PMRF-Kokee site.

1. Potential loss of native vegetation. The concrete pad for the MSITP antenna/pedestal will require about 6,000 square feet of land area. The KAFS site (Site 3) is the only site that has native vegetation, and it is recommended that this vegetation not be disturbed. Analysis of infrared aerial photography of the site, (dated 4 October 1992), by Char & Associates indicates that the yellow ginger patch, which is in the middle of the site, comprises approximately 10,000 square feet of land area (Char, 1993) and thus could easily accommodate the antenna pedestal. According to Char & Associates, this area can be disturbed, since this plant species, and others in the immediate vicinity, including the fire tree, are introduced species.

It is recommended that any site preparation include retention of the native vegetation surrounding the yellow ginger and fire trees, and after the test of the RSTER has been completed, the antenna pad be removed and replanted with native vegetation similar to the adjoining forest area by the operational activity.

2. Potential disorientation of native birds. As discussed by Phil Bruner (Appendix B), any security lighting associated with the MSITP facility could attract native birds such as the Newell's Shearwater, and cause disorientation and possible injury. The U.S Fish and Wildlife Service (USFWS) and the State Department of Land and Natural Resources recommend that any security lighting be designed to deflect the lighting downward. The USFWS recommends that lights not be used at all during the months of October and November when young Newell's Shearwaters leave their mountain burrows to head out to sea.

3. Potential impacts of EMR, EMI and EMC. Transmissions from the RSTER can cause HERP, but only during mainbeam illumination by a stationary antenna. The

possibility of a HERP incident is minimal since the RSTER will normally be rotating and non-essential areas will be blanked out. As a precaution the following actions are recommended by NISE WEST HAWAII:

ensure that the RSTER will not be able to transmit in sector blanked areas while the radar antenna is stopped;

install a red flashing warning light that is readily visible to all personnel in the surrounding area that is activated whenever the RSTER, or other radar systems associated with the MSITP facility, are transmitting;

- conduct a pre-operational HERP survey to ensure that EMR levels in all accessible areas immediately below the RSTER antenna are below the HERP criteria. If hazardous levels are recorded, then these areas should be secured by a personnel barrier while the RSTER is operating;,

install HERP warning signs at the entrances to the RSTER areas;

- the antenna should be pointed at 270" azimuth and 0" elevation angle or higher during transmissions from the "UNC" tower at Site 1A;

the antenna should be pointed at an elevation of -5° or higher during transmissions of the RSTER-90 at PMRF-Kokee (Site 2); and,

the antenna should be pointed an elevation angle of -1.5" or higher during transmissions of the RSTER 90 at KAFS (Site 3).

The potential for EMI occurring at Site 1 at Makaha Ridge is minimal since none are now experienced from existing high-powered radar. Sector blanking should also reduce the potential of EMI occumng. However, the possibility of EMI cannot be ruled out at any of the three sites. If the MSITP project is located at either PMRF-Kokee or KAFS, EMI could occur at the Kokee Geophysical Observatory, affecting the operations of NASA, NOAA, and USNO. To mitigate possible impacts, the following recommendations are offered by NISE WEST HAWAII:

temporarily suspend operations if it is suspected that EMI is interfering with PMRF-Makaha Ridge or KAFS operations;

require Rome Laboratory to correct or fund efforts to correct any EMI-related problems, including the relocation of the MSITP facility at PMRF-Makaha Ridge to Site 1A;

avoid flying aircraft within 571 feet of the RSTER site.

cooperative scheduling among all activities;

selection of a compatible frequency range in the proposed UHF operating band; and,

prior to planning installation of the RSTER radar at either the PMRF-Kokee or KAFS sites, an operations planning document should be submitted for approval to the Kokee NASA Site Manager in order to preclude possible interference with existing or planned NASA, NOAA, and USNO sensor and communications programs. NASA should be consulted prior to any RSTER operations at either of these sites.

On the basis of these recommendations, NASA has found the MSITP project acceptable and has recommended the following additional mitigation measure (Appendix G):

sector blanking in the direction of NASA, NOAA and USNO facilities; and,

use of harmonic filters in the RSTER transmitter (if measurements demonstrate the need).

It is predicted that problems associated with electromagnetic compatiblity (EMC) will occur across several MHz ranges. To mitigate these potential impacts, NISE WEST HAWAII recommends the following actions be taken:

due to predicted co-channel interference in the 400 to 420 MHz and 450 to 470 MHz ranges, RSTER frequency hopping should be limited to the frequency ranges of 420 to 449 MHz and 470 to 500 MHz.

due to predicted co-channel interference for several Command Guidance and Command Destruct frequencies used for rocket and missile launches at PMRF-BS, several frequencies (listed in Table 3 of Appendix F) should be locked out for corresponding launches. It is also recommended that the Instrumentation Control Center in PMRF-BS range operations review and approve RSTER test schedules and test frequencies.

if co-channel interference is experienced by RSTER operations from the AN/ALT-41 at PMRF-Makaha Ridge or from aircraft exercises, then RSTER operations should be assigned to remaining frequency ranges (provided frequency assignment is granted).

Periodically, helicopters carrying electroexplosive devices (EEDs) use the heliport at Makaha Ridge. The maximum calculated EMR at the heliport is below the HERO UNSAFE and SUSCEPTIBLE levels due to sector blanking. However, there is concern about helicopters with EEDs flying within the RSTER operating sector. Therefore, it is recommended that helicopters with HERO UNSAFE or SUSCEPTIBLE ordnance on-board avoid flying within 7,352 feet and 2,548 feet of the RSTER site, respectively.

4. Visual resources. The installation of the MSITP antenna at the PMRF-Kokee site would add approximately 23 feet of mechanical equipment to the existing 30-foot antenna tower. This additional mechanical equipment will increase the visibility of the antenna tower along about 100 yards of Highway 550, between the 15- and 14-mile markers travelling in a downhill direction, although its impacts will be minimal due to the nature of the existing built environment and the temporary nature of the project (about three years). The temporary nature of the project is, in itself, a mitigation measure.

5.10 Cumulative Impacts

The completion of this project will temporarily increase demand on existing infrastructure systems at PMRF-Makaha Ridge, PMRF-Kokee and KAFS. However, the increases will be minimal and are not expected to tax the existing capacities of those systems. Otherwise, the proposed project will add to the built environment for a period of approximately three years which, as discussed above, is not expected to create a significant impact.

5.11 Additional Approvals Needed

No additional approvals are required for the MSITP project.

Chapter 6

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Chapter 7

List of Preparers

7.0 LIST OF PREPARERS

The EA was prepared for the Advanced Research Projects Agency of the Department of Defense by Helber Hastert & Fee, Planners under the direction of Pacific Division Naval Facilities Engineering Command (PACDIV). The following list identifies individuals and organizations involved in the preparation of the Draft EA and their respective contributions.

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Archaeological Reconnaissance	Paul H. Rosendahl, Ph.D., Inc. (Archaeological/historical/culture resource management studies and services) Paul H. Rosendahl, Ph.D. Ph.D. Anthropology

Appendices

A. Letter of Electric Service Verification (Kauai Electric Company)

CITIZENS UTILITIES
KAUAI ELECTRIC DIVISION
P.O. BOX 530 • LIHUE, KAUAI, HAWAII 96766-0530

November 16, 1993

In reply refer to:
File #93-9-103AM

Department of the Navy
Pacific Missile Range Facility
P.O. Box 128
Kekaha, HI 96752

Attention: Lt. W.B. Wilhem, CEC, U.S. Navy

Dear Sir:

We have reviewed your letter dated October 7, 1993 regarding increase load at PMRF Makaha Ridge site, Kokee Site or HANG 150 Facility and have the following comments:

A. Our electrical distribution system in the Kokee area is sufficient to handle your increase load. For the purposes of this discussion, our electrical distribution system is defined as the Substation at Pukapele and the lines that extend from it up to the primary metering point or, for secondary metered facilities, up to the high voltage side of Kauai Electric's transformers.

B. In the event transformer capacity becomes questionable, Kauai Electric must review the existing and projected load on the transformer. If replacement of transformer is necessary, Kauai Electric will upgrade the existing transformer in accordance with Rule 13 of our tariffs.

If you have any further questions, please contact our Staff Engineer, Mr. Michael Yamane at 246-4366.

Very truly yours,

ALTON H. MIYAMOTO
Manger, Engineering

AHM:fen

cc: Ms. Christine Nonaka

\MY\93-0080.LTR

Appendices

B. Botanical Survey Assessment (Char & Associates)

CHAR & ASSOCIATES
Botanical/Environmental Consultants
4471 Puu Panini Ave.
Honolulu, Hawaii 96816
(808) 734-7828

21 December 1992

BOTANICAL ASSESSMENT SURVEY
MOUNTAINTOP SENSOR INTEGRATION AND TESTING PROGRAM
KOKE'E, ISLAND OF KAUA'I

INTRODUCTION

Three potential sites at Koke'e, Kaua'i, have been selected for the proposed mountaintop sensor integration and test program facility. These sites are: Pacific Missile Range Facility (PMRF)-Makaha Ridge; Koke'e Air Force Station (Hawai'i Air National Guard or HIANG site); and PMRF-Koke'e (former NASA Tracking Station). All three sites are easily accessed from Highway 550, the main road into Koke'e State Park.

Field studies to assess the botanical resources found on the three sites were conducted on 02 December 1992. The primary objectives of the survey were to provide a general description of the vegetation and to search for threatened and endangered plants which might occur on the three sites.

DESCRIPTION OF THE VEGETATION

Following is a general description of the vegetation found on each of the three sites. The plant names used follow Wagner et al. (1990) for the flowering plants and Lamoureux (1984) for the ferns.

PMRF-Makaha Ridge

Two areas were surveyed for the Makaha Ridge site. The primary site overlooks Makaha Valley and the ocean; the alternate site is located about 100 yards south of the preferred site and overlooks a smaller, unnamed gulch. Well-maintained grassy lawns and landscape plantings are found on the relatively level areas around the existing buildings. On the surrounding lands, the ridge tops and valley walls consist of exposed rock and barren, weathered soil with the vegetation occurring as scattered pockets of plants, primarily on ledges.

Primary site: This site is located on an existing asphalt-paved area with a few concrete pads. Around the concrete pads are small patches of weedy herbs and grasses; these include Natal redtop grass (Rhynchelytrum repens), partridge pea (Chamaecrista nictitans), three-flowered beggarweed (Desmodium triflorum), and crabgrass (Digitaria adscendens). Along the edges of the asphalt, pangola grass (Digitaria pentzii) forms dense, lumpy mats. Scattered through the pangola grass are plants of partridge pea and three-flowered beggarweed. Along the makai edge of the preferred site, where it drops off steeply to the ocean below, are a few shrubs of the native false sandalwood or naio (Myoporum sandwicense) and lantana (Lantana camara).

Alternate site: This site is located on mostly barren, exposed soil. There are a few, small, scattered tussocks of grasses -- Natal redtop and pitted beardgrass (Bothriochloa pertusa); a handful of herbaceous species such as partridge pea and hi'aloa (Waltheria indica); and some low, windswept lantana shrubs on this site.

PMRF-Koke'e

The former NASA Tracking Station is unoccupied. The proposed project will be placed on top of an existing metal tower, located adjacent to the Telemetry and Control (T&C) building. The area under the tower, as well as around the T&C building, is asphalt paving. The nearest vegetation is found in a small planter box, about 20 ft. to the west of the tower. The box supports a weedy mixture of plants such as prickly Florida blackberry (Rubus argutus), sowthistle (Sonchus oleraceus), daisy fleabane (Erigeron karvinskianus), yellow foxtail (Setaria gracilis), and smooth cat's ear (Hypochoeris glabra).

Koke'e Air Force Station/HIANG

This is the most densely vegetated of the three sites. It appears to have been cleared at least once and is now overgrown with yellow ginger (Hedychium flavescens), which forms a thick, rhizomatous mat, and a few clumps of hardy fuschia or earring flower (Fuschia magellanica); both are introduced or alien species. Where the ginger patch abuts the HIANG fence, there is a large pile of tree branches and lawn trimmings as well as a number of other introduced species such as velvet grass (Holchus lanatus), montbretia (Crocosmia X crocosmiiflora), smooth cat's ear, pangola grass, and prickly Florida blackberry. With the exception of a small thicket of firetree (Myrica faya), a noxious introduced species, and a few plum trees (Prunus cerasifera X salicina), the forest surrounding the ginger patch is composed primarily of native species. These include trees of 'ohi'a (Metrosideros polymorpha), koa (Acacia koa), and 'ohe (Tetraplasandra sp.); and smaller trees and shrubs of kopiko (Psychotria sp.), kawa'u (Ilex anomala), two species of kolea (Myrsine spp.), mokihana (Pelea anisata), and manono (Hedyotis

terminalis). One small plant of the native mint, Stenogyne purpurea, occurs in this forest. Ground cover and epiphytic ferns include ho'i'o (Diplazium sandwichianum), uluhe (Dicranopteris linearis), Dryopteris sp., 'ekaha (Elaphoglossum hirtum), and kolokolo (Grammitis tenella). Plants of pa'iniu (Astelia agyrocoma) and 'uki'uki (Dianella sandwicensis) form low, rounded tufts. Native birds such as the 'Apapane (Himatione sanguinea) and 'Elepaio (Chasiempis sandwichensis) were observed at this site; the 'Apapane even visiting the brillant magenta and purple fuschia flowers for nectar.

DISCUSSION

The vegetation on two of the sites, PMRF-Makaha and PMRF-Koke'e, although sparse, is dominated by introduced or alien species. These are plants which were introduced to the Hawaiian Islands by humans after Western contact (1778). On the HIANG site, the introduced yellow ginger forms a dense patch on the disturbed portion, while the adjoining undisturbed portion is covered by a native, diverse mesic forest. None of the plants found on the three sites are officially listed, candidate, or proposed threatened and endangered species (U.S. Fish and Wildlife Service 1989, 1990); nor are any of the plants considered rare and vulnerable (Wagner et al. 1990).

Placement of the proposed project on the PMRF-Makaha Ridge or PMRF-Koke'e site would not cause a significant negative impact to the botanical resources. The plants found on the site are almost exclusively introduced species; these plants occur throughout the islands in similar environmental habitats. The alternate area at Makaha Ridge will need to be landscaped to prevent further soil erosion.

The HIANG site is not recommended unless all of the project can

placed only within the disturbed, yellow ginger-dominated portion of the site. The surrounding, native-dominated forest should not be disturbed.

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Appendices

C. Faunal Survey (Phillip Bruner)

FIELD SURVEY OF THE AVIFAUNA AND FERAL MAMMALS FOR A PROPOSED MOUNTAINTOP SENSOR TESTING AND INTEGRATION PROJECT ENVIRONMENTAL ASSESSMENT, KAUAI

Prepared for

Helber Hastert and Fee

by

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14 December 1992

INTRODUCTION

The purpose of this report is to summarize the findings of a one day (1 December 1992) bird and mammal field survey for a Mountain-top Sensor Testing and Integration Environmental Assessment Project on Kauai (see Fig. 1 for actual location of sites surveyed). Also included are references to pertinent literature as well as unpublished faunal reports from similar habitat elsewhere on Kauai.

The objectives of the field survey were to:

1- Document what bird and mammal species occur on or near the proposed sites.

2- Provide some baseline data on the relative abundance of each species.

3- Determine the presence or likely occurrence of any native fauna particularly any that are considered "Endangered" or "Threatened".

4- Determine if these sites contain any special or unique habitats that if lost or altered by development might result in a significant negative impact on the fauna in this region of the island.

GENERAL SITE DESCRIPTION

Three separate sites were investigated on this faunal survey. Figures One, Two and Three show their location and indicate where faunal census stations were taken. The Kokea Air Force Station (Hawaii Air National Guard or "HIANG") site contains a mixture of native and introduced plants. The property slopes down into a forest which is largely composed of native trees. An existing radar facility occurs nearby. The PMRF - Kokee (former NASA Tracking Station or Kokee Site) is located on an existing facility. The vegetation around the perimeter fence is a mixture of exotic trees such as Silk Oak and some native trees and shrubs. The third site at Makaha Ridge has two separate areas approximately 100 yards apart. These two sites are essentially barren soil and pavement.

Weather during the field survey was overcast and relatively calm. Light passing showers occured during the morning hours of the visit. Damage to the forest from the recent hurricane (Iniki) was most noticeable around the PMRF - Kokee site.

STUDY METHODS

A walk-through of each site was made in order to view a representative sample of the available habitats. Field observations were made with binoculars and by listening for vocalizations. These observations were

concentrated during the peak bird activity periods of early morning and late afternoon. Attention was also paid to the presence of tracks and scats as indicators of bird and mammal activity.

At various locations, during the walk-through, census (count) stations were established where all birds seen or heard over a period of eight minutes were tallied. Any unusual observations of birds made between these census stations were also recorded. These data provide the basis for the relative abundance estimates given in this report (Table 1). Published and unpublished reports of birds known from similar habitat elsewhere on Kauai were also consulted in order to acquire a more complete picture of the possible species that might occur in the area (Pratt et al. 1987; Hawaii Audubon Society 1989; Bruner 1990). Observations of feral mammals were limited to visual sightings and evidence in the form of scats and tracks. No attempts were made to trap mammals in order to obtain data on their relative abundance and distribution.

Scientific names used in this report follow those given in Hawaii's Birds (Hawaii Audubon Society 1989); A field guide to the birds of Hawaii and Tropical Pacific (Pratt et al. 1987) and Mammals species of the World (Honacki et al. 1982).

RESULTS AND DISCUSSION

Resident Endemic (Native) Land Birds:

Table One lists the native birds recorded at each proposed project site. The HIANG site contained the greatest number and diversity of native birds. This is understandable given the more diversified forest habitat at this location. Four native land birds were observed: 'Elepaio (Chasiempis sandwichensis), Anianiau (Hemignathus parvus), Common Amakihi (Hemignathus virens) and Apapane (Himatione sanguinea). None of these birds are endangered. Table 1 shows their relative abundance at each survey location. The only native species which were not recorded but may likely be found in the area on an occasional basis are: Short-eared Owl (Asio flammeus sandwichensis) and 'I'iwi (Vestiaria coccinea).

Migratory Indigenous (Native) Birds:

One Pacific Golden Plover (Pluvialis fulva) was observed at the PMRF site and three were recorded near the Makaha Ridge sites. Plover prefer open areas such as mud flats, fields and lawns. Johnson et al. (1981, 1989) have shown plover are extremely site-faithful (returning each year to the same spot and maintaining this behavior throughout their lifetime). Plover also establish foraging territories which they defend vigorously. Such behavior makes it possible to acquire a fairly good estimate of the abundance of plover in any one area. These populations likewise remain relatively stable over many years.

Resident Endemic and Indigenous (Native) Waterbirds:

None of the three sites contain habitat that would be attractive to waterbirds. No native waterbirds were recorded on the survey.

Resident Indigenous (Native) Seabirds:

Two White-tailed Tropicbirds (Phaethon lepturus) were seen flying along the cliff face at Makaha Ridge. Newell's Shearwater (Puffinus newelli) may fly over these three sites as it goes back and forth between its nesting burrow in the mountains and the open sea where it forages. Mike Ferguson (security guard at HIANG) reported (pers. comm.) finding an injured Newell's Shearwater that had flown into the fence surrounding the site. The bird was subsequently turned over to State Wildlife authorities. The endangered Dark-rumped Petrel (Pterodroma phaeopygia) are known to nest in high elevation forest near HIANG (Tom Telfer DLNR, pers. comm.).

Exotic. (Introduced) Birds:

Table One notes which exotic species were recorded during the survey at each of the three proposed project locations along their with their relative abundance. Data from surveys in similar habitat elsewhere (Pratt et al. 1987; Hawaii Audubon Society 1989; and Bruner 1990) suggest the following birds may also occur on or near these sites: Barn Owl (Tyto alba), White-rumped Shama (Copsychus malabaricus), Japanese Bush-warbler (Cettia diphone) and Eurasian Skylark (Alauda arvensis).

Feral Mammals:

No evidence of rats or mice were noted but these ubiquitous mammals likely do occur on or near these properties. No trapping was conducted in order to access the relative abundance of mammals at this site. Feral Goats (Capra hircus) were seen at the Makaha Ridge sites and evidence of feral pigs (Sus scrofa) was abundant around the HIANG and PMRF sites. Black-tailed Deer (Odocoileus henionus) occur in the Kokee area but were not recorded on the survey.

The endemic and endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus) does occur on Kauai (Tomich 1986; Kepler and Scott 1990). No bats were observed on this survey, however, both Mike Ferguson (security guard) and CMSGT Mel Kawahi reported (pers. comm.) that bats were commonly seen on the HIANG site. Ferguson has seen as many as nine individual bats at one time foraging for insects around the HIANG Facility.

CONCLUSIONS

A brief field survey can at best provide only a limited perspective of the wildlife present in any given area. Not all species will necessarily be observed and information on their use of the site must be sketched together from brief observations, available literature and unpublished reports. The number of species and the relative abundance of each species may vary throughout the year to changing

food resources and reproductive success. Species sometimes prosper for a time only to later disappear or become a less significant part of the ecosystem (Williams 1987; Moulton et al. 1990). Thus only long term studies can provide a comprehensive view of the bird and mammal populations in a particular area. Nevertheless, some general conclusions related to birds and mammals at these sites can be made:

1- The native birds recorded on the survey were those species which would be expected given the types of habitat available. The HANG site contains the best habitat and consequently the greatest number and diversity of native birds. The survey of the Makaha Ridge location recorded only the native Pacific Golden Plover and the White-tailed Tropicbird. Newell's Shearwater has been found at the HANG site.

2- The exotic birds recorded on the survey were also those typically found in this region of Kauai. No unusual observations were made reguarding exotic birds.

3- Feral mammals included pigs and goats. Other species of introduced mammals may also occur in the region. No Hawaiian Hoary Bats were seen but they apparently do occur regularly at HANG based on reports from personnel working at the facility.

RECOMMENDATIONS

The following comments are recommendations I make or suggestions gathered from conservations I had with USFWS, National Marine Fisheries and DLNR (State of Hawaii):

1- I would advise against the removal of any native trees especially Ohia. This tree is used extensively by native birds. The removal of non-native vegetation would not be a problem and in fact should be encouraged. The Makaha Ridge site would probably be of least concern to native birds.

2- William Kramer of USFWS suggested that security lighting should be designed to deflect the light downwards. This could perhaps lessen the impact such fixtures would have on birds like shearwaters which are often drawn to lights and subsequently become either disoriented or fall victims of power lines, cars, or predators such as cats and dogs. Mr. Kramer also noted that it would be important to not use lights during the months of October and November when young shearwaters leave their mountain burrows to head out to sea.

3- Tom Telfer (District Biologist DLNR) responded (pers. comm.) that minimizing the lights was a good idea and that the Makaha Ridge site would be less

likely to present a problem for birds. Tom also noted that the endangered Dark-rumped Petrel, a seabird that nests at high elevation, is known to occur near HIANG and thus this site may be the least desirable location for the proposed project.

4- Neither Telfer nor Kramer expressed any specific concerns over the possible effects, if any, that radar might have on birds and bats in the immediate area of the proposed facility. Indeed the fact that radar facilities allready exist on these sites without any reported faunal problems suggests that this may not be a serious concern. The strength of the radar and the duration of exposure are probably the major determinants as to whether or not radar poses a difficulty for birds and bats.

5- Gene Nitta of the National Marine Fisheries was called and he stated that the project would not be expected to have any impact on the species his agency is charged to regulate.

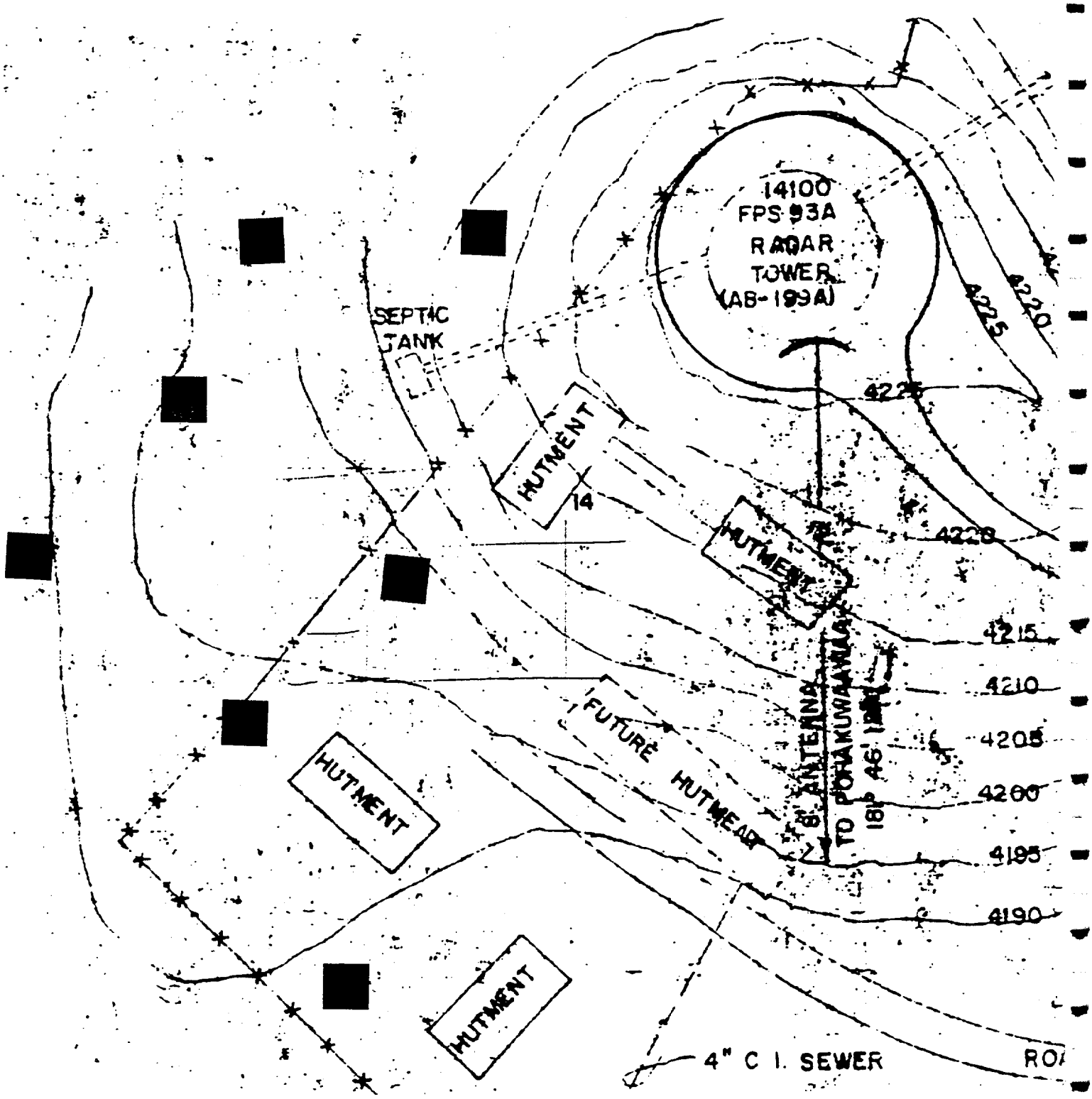

Fig. 1. Location of the HIANG Site with faunal census stations shown as solid squares.

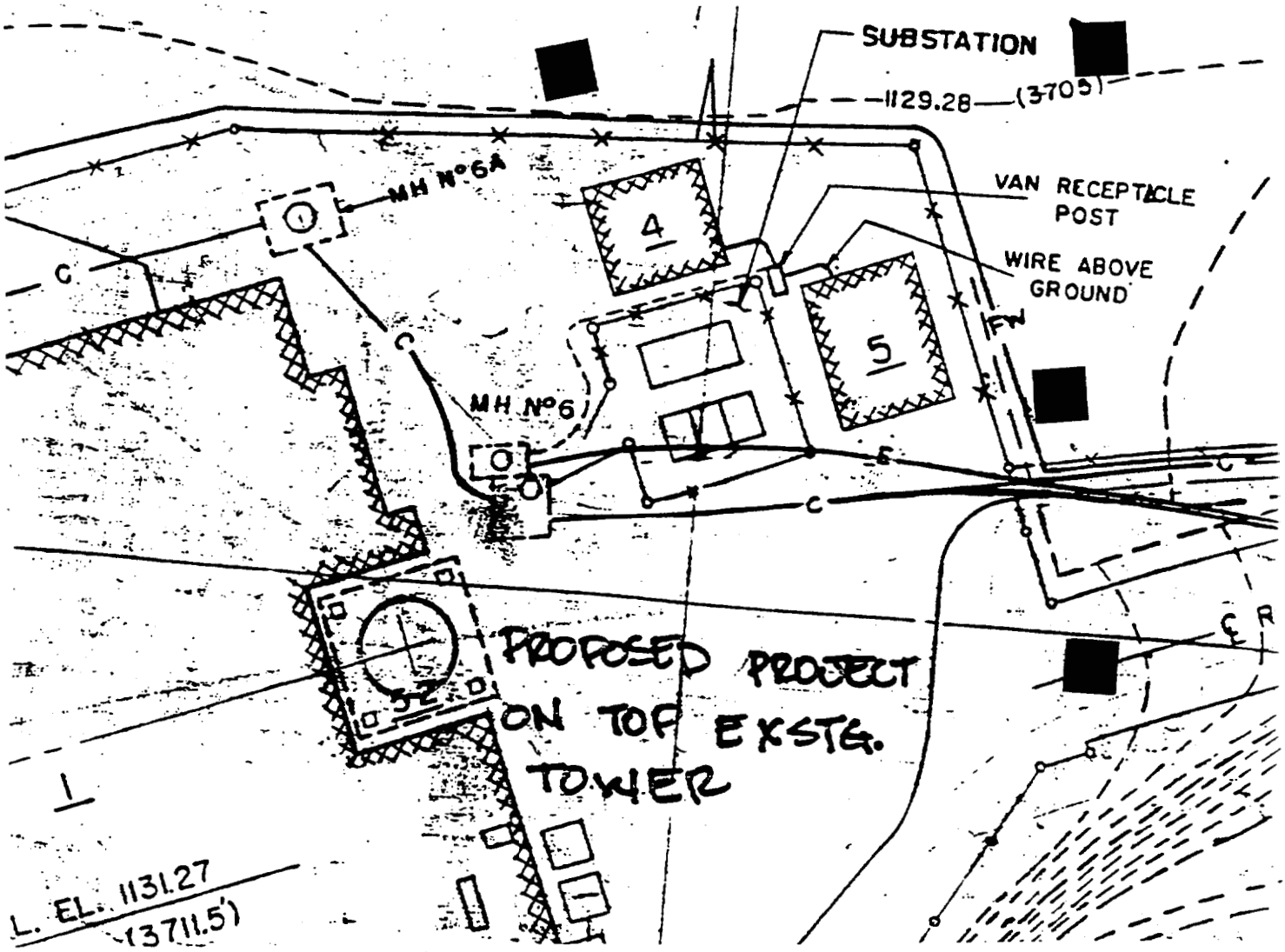

Fig. 2. Location of PMRF - Kokee Site with faunal census stations shown a solid squares.

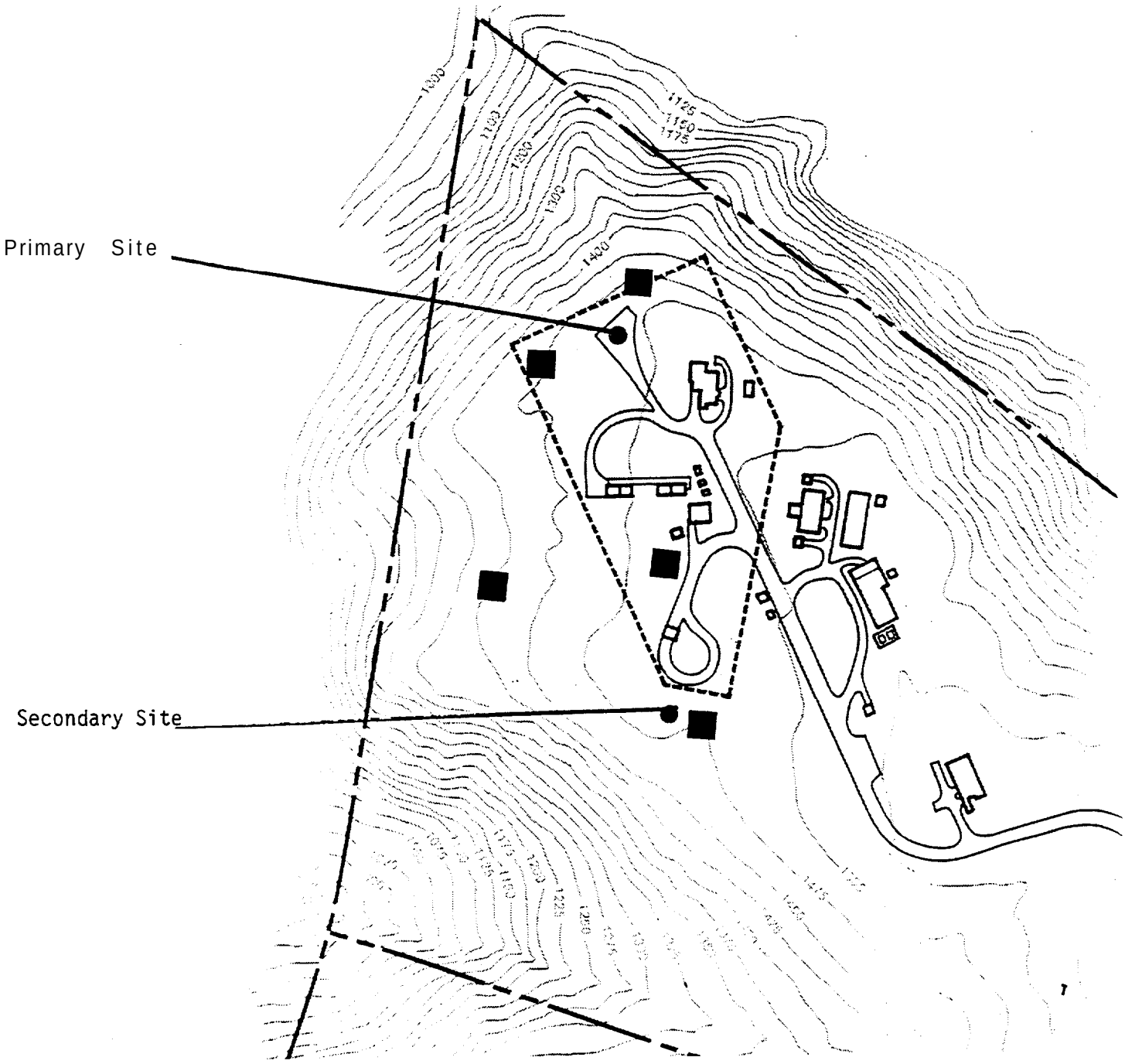

Fig. 3. Location of the Makaha Ridge sites with faunal census stations shown as solid squares.

TABLE 1

Native and introduced birds recorded at three locations proposed for a Mountaintop Sensor Testing and Integration Project, Kauai.

	COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE*		
			HTANG	PMRF Kokee	Makaha Ridge
Native species	White-tailed Tropicbird	Phaethon lepturus	-	-	R = 2
	Pacific Golden Plover	Pluvialis fulva	-	R = 1	R = 3
	Elepaio	Chasiempis sandwichensis	U = 2	-	-
	Anianiau	Hemignathus parvus	R = 2	-	-
	Common Amakihi	Hemignathus virens	U = 3	U = 4	-
	Apapane	Himatione sanguinea	C = 6	-	-
Introduced species	Feral Chicken	Gallus gallus	-	R = 4	-
	Spotted Dove	Streptopelia chinensis	-	-	R = 2
	Zebra Dove	Geopelia striata	-	-	C = 6
	Common Myna	Acridotheres tristis	C = 6	R = 2	R = 2
	Northern Cardinal	Cardinalis cardinalis	R = 2	-	-
	Hwamei	Garrulax canorus	R = 1	-	-
	Japanese White-eye	Zosterops japonicus	C = 7	C = 8	-

* (see page 14 for key to symbols)

KEY TO TABLE 1

Relative abundance = number of times observed during survey or average number on eight minute counts.

A = abundant (ave. 10+)

C = common (ave. 5-10)

U = uncommon (ave. less than 5)

R = recorded (seen or heard at times other than on 8 min. counts. number which follows is the total number seen or heard over the duration of the survey).

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Appendices

D. Archaeological Inventory Survey (Paul H. Rosendahl, Inc.)

Report 1306-091093

Archaeological Inventory Survey Mountaintop Sensor Integration and Test Program Project Area

Land of Waimea
Waimea District, Island of Kauai

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Report 1306-091093

Archaeological Inventory Survey Mountaintop Sensor Integration and Test Program Project Area

Land of Waimea
Waimea District, Island of Kauai
(TMK:4-1-2-01:6; 4-1-4-01:13; 4-5-9-01:16)

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SUMMARY

At the request of Mr. Scott Ezer of Helber Hastert & Fee, Planners, on behalf of his client, the United States Navy (USN), Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted an archaeological inventory survey of the Mountaintop Sensor Integration and Test Program project area, located in the Land of Waimea, District of Waimea, Island of Kauai (TMK:4-1-2-01:6; 4-1-4-01:13; 4-5-9-01:16). The project area consists of four alternative sites. Two of the sites are within the Pacific Missile Range - Makaha Ridge Facility. One site is in the Kokee Air Force Station (HIANG), and the fourth site is in the Pacific Missile Range - Kokee Station (former NASA tracking station). The overall objective of the inventory survey was to provide information sufficient for compliance with federal historic preservation statutes.

The inventory survey was conducted December 1 and 2, 1993. During the survey field work, no archaeological sites were identified. The field work included placing shovel tests in the Pacific Missile Range - Makaha Ridge Facility Alternative Site and the Kokee Air Force Station. During the subsurface testing no significant cultural materials were identified. Based on the negative findings of the current work, no further archaeological work is recommended for the project area.

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INTRODUCTION

BACKGROUND

At the request of Mr. Scott Ezer of Helber Hastert & Fee, Planners, on behalf of his client, the United States Navy (USN), Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted an archaeological inventory survey of the Mountaintop Sensor Integration and Test Program project area, located in the Land of Waimea, District of Waimea, Island of Kauai (TMK: 4-1-2-01:6; 4-1-4-01:13; 4-5-9-01:16) (Contract No. N62742-92-D-0031). The project area consists of four alternative sites. Two of the sites are within the Pacific Missile Range - Makaha Ridge Facility. One site is in the Kokee Air Force Station (HIANG), and the fourth site is in the Pacific Missile Range - Kokee Station (former NASA tracking station) (Figures 1-4). The overall objective of the inventory survey was to provide information sufficient for compliance with federal historic preservation statutes.

The inventory survey was conducted December 1 and 2, 1992 by Project Supervisor Amy Dunn, assisted by Field Archaeologist Sheryl Dowden. The work was conducted under the overall direction of Principal Archaeologist Dr. Paul H. Rosendahl. Approximately 16 labor-hours were required to complete the field work.

SCOPE OF WORK

The basic purpose of the inventory survey was to identify all sites and features of potential archaeological significance present within the project area. An inventory survey comprises an initial level of archaeological investigation. Basically, it determines the presence or absence of archaeological resources and, if present, indicates their general nature and variety, and their general distribution and density. Finally, it permits a general significance assessment of the archaeological resources, and facilitates formulation of realistic recommendations and estimates for such further work as might be necessary. Such work could include further collection involving detailed recording of sites and features, and selected limited excavations; and possibly 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 further data collection and/or other mitigation work that might be necessary or appropriate.

Based on a review of readily available background literature, on basic familiarity with the project area and extensive familiarity with the current requirements of review authorities; and based on discussions with Mr. Scott Ezer of Helber, Hastert & Fee, Planners, the following tasks were determined to constitute an adequate scope of work for the proposed inventory survey:

1. Conduct archaeological and limited historical documentary background research involving review and evaluation of readily available archaeological and historical literature, historic documents and records, and cartographic sources relevant to the immediate project area;

2. Conduct 100%-coverage pedestrian sweeps within two of the four alternative sites (HIANG and Makaha Alternative Sites);

3. Conduct limited subsurface testing of the HIANG and Makaha Alternative Sites to (a) determine the presence or absence (and general distribution) of potentially significant buried cultural features or deposits, and (b) obtain suitable samples for age determination analyses; and

4. Analyze field and historical research data, and prepare appropriate reports.

The inventory survey was carried out in accordance with the standards for inventory-level survey recommended by the Department of Land and Natural Resources - State Historic Preservation Division (DLNR-SHPD). The significance of the archaeological remains identified in the project area was assessed in terms of (a) the National Register criteria contained in the *Code* of Federal Regulations (36 CFR Part 60); (b) the criteria for evaluation of traditional cultural values prepared by the National Advisory Council on Historic Preservation; and (c) PHRI Cultural Resource Management (CRM) value modes. The DLNR-SHPD and the Hawaii County Planning Depariment (HCPD) both use the first two criteria to evaluate eligibility for both the Hawaii State and National Registers of Historic Places.

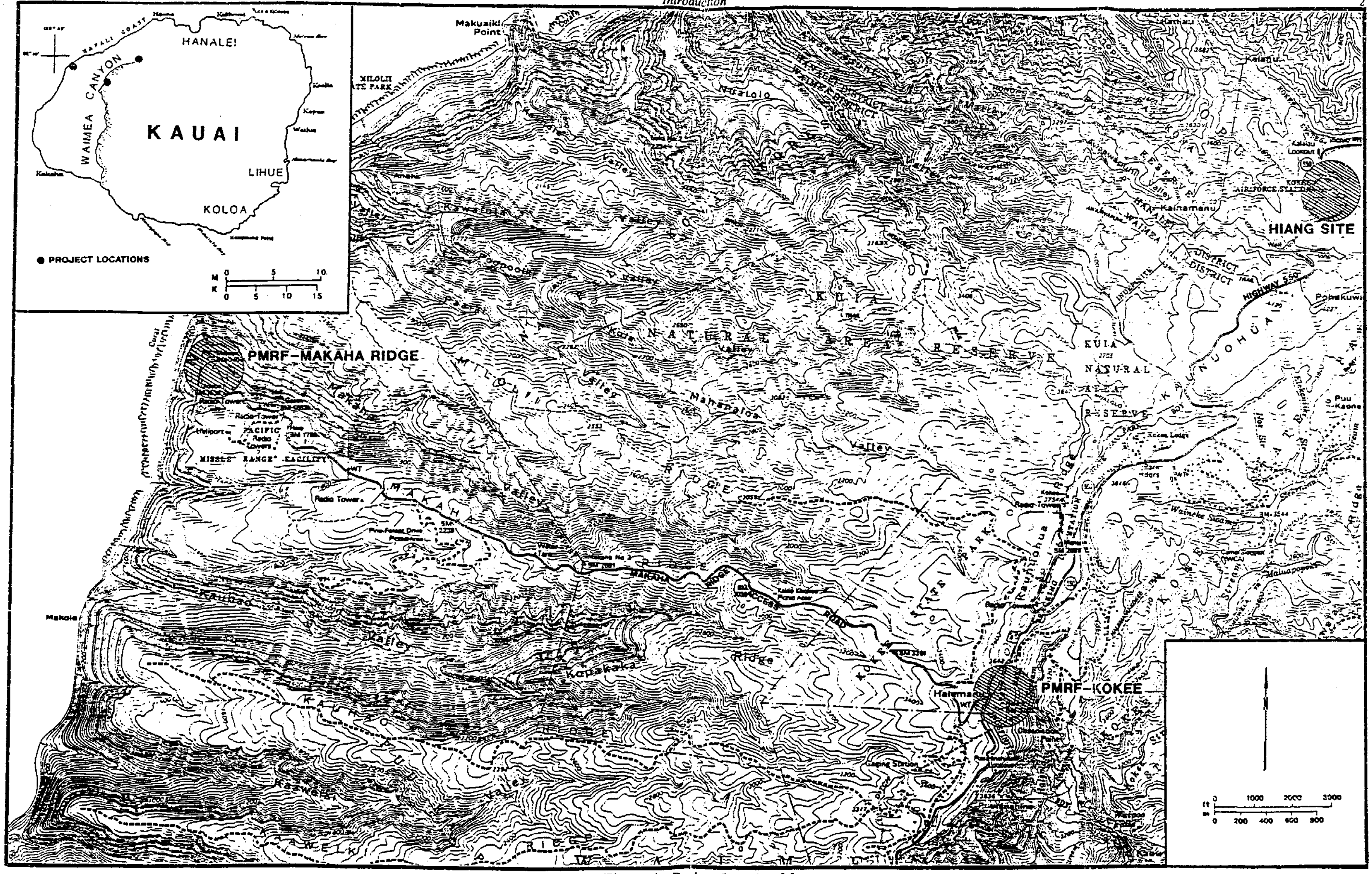

Figure 1. Project Location Map

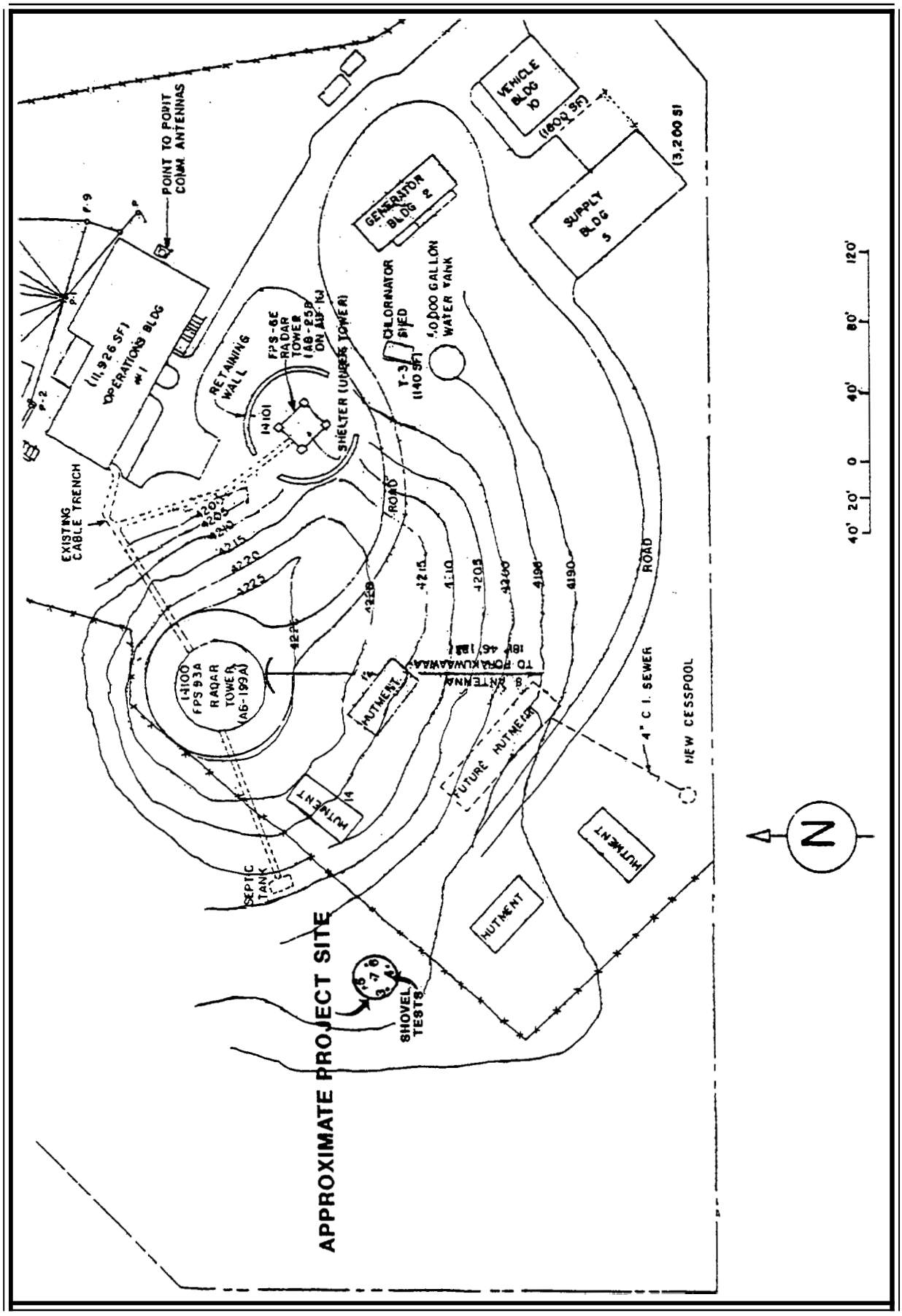

Figure 2. Kokee Air Force Station (HIANG)

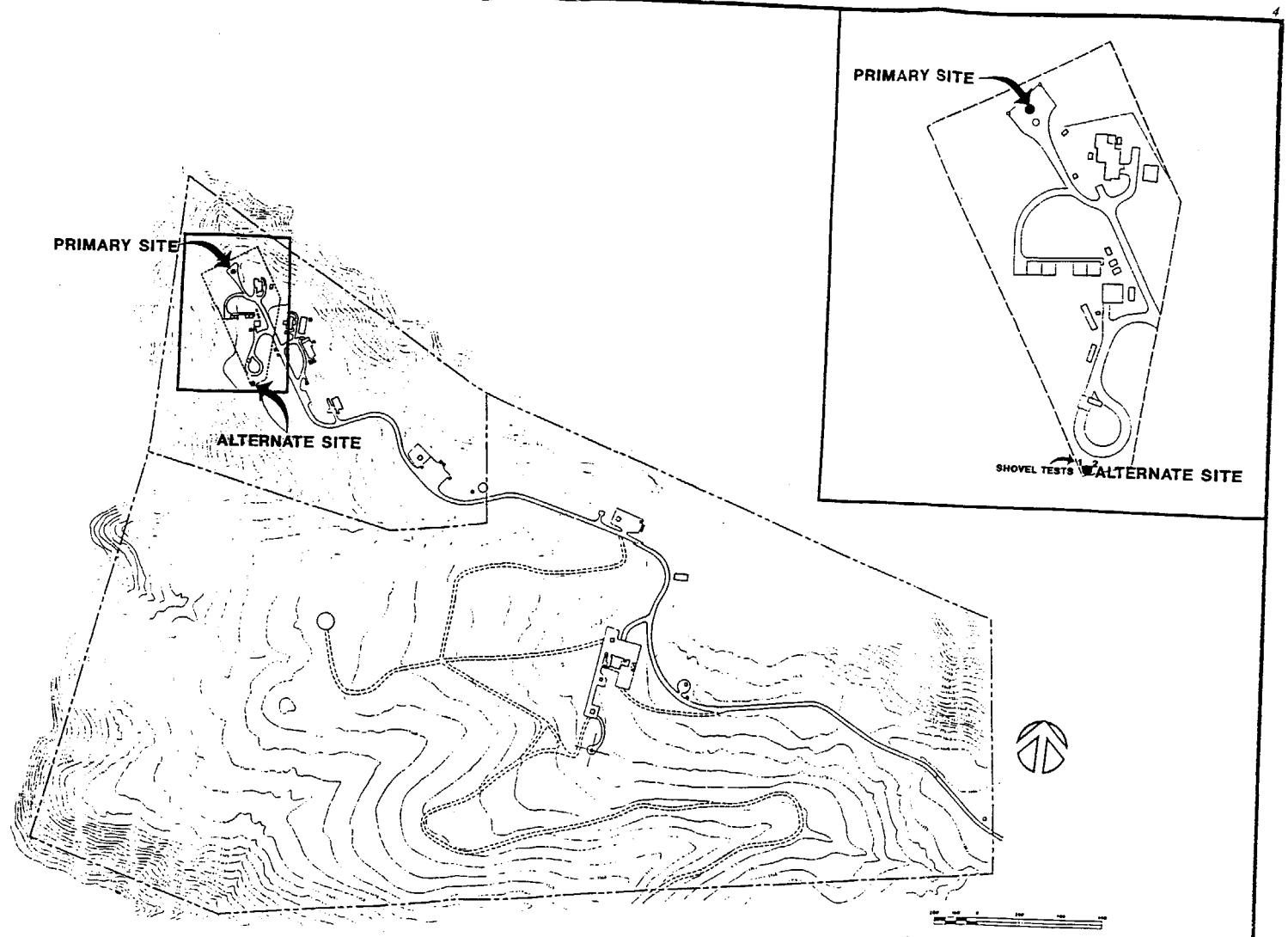

Figure 3. Pacific Missile Range - Makaha Ridge Facility

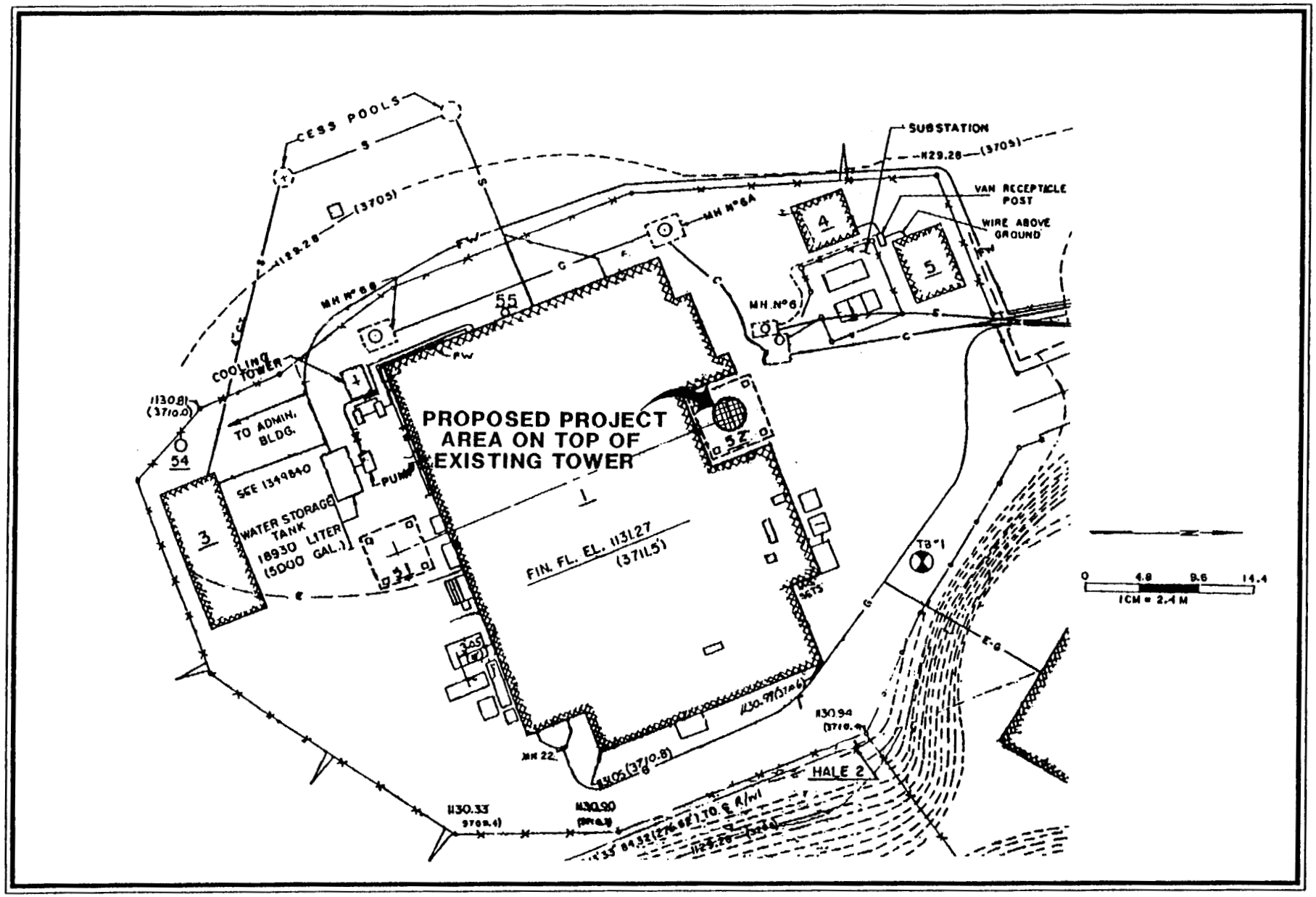

Figure 4. PMRF-Kokee Station (Former NASA Tracking Statiori)

PROJECT AREA DESCRIPTION

The project area's four alternative sites are described in detail in the following.

The Pacific Missile Range - Makaha Ridge **Facility.** This facility is **near** the 14-mile marker on Highway 550 **at** an elevation of about 1,400 ft above **sea level.** Within the facility **are** two sites—The Primary **and The** Alternative. The sites are at the edge of a very steep cliff, within **100 yards of each other. The** Primary site is 25 by 25 feet and contains a trailer, an **antenna,** and a concrete pad. The Alternative site is **also** 25 by 25 feet; within **this** site, on the ground, are two **reinforcement bars placed 20** ft apart. The **bars may** have **been placed to mark the** boundaries of the alternative site.

There is no vegetation **at** the two sites. The wind velocity in **the** vicinity of the sites can go as high **as** 18 knots **during the** summer. Rainfall in the vicinity is 30-50 inches per year. The mean **annual** temperature is about 70-80 degrees F **(Armstrong 1983:62,63). The** site areas appear to be highly eroded. There are large decomposing boulders in the area. **The** soil in the area consists of eroded and decomposing bedrock with a high clay content.

Kokee Air Force Station (HIANG). This station is located near the **18-mile** marker, about **1/4-mile** before the Kalalau Lookout, **at** an elevation of about 4,100 feet **AMSL.** The **station** contains one alternative site. The site is in the northwest corner of the station, c. 20 ft northwest of the **fenceline/gate.** The site measures 30 by 30 feet.

The surface of the alternative **site appears to be** composed of **backfill from** the **construction** of **the** present facility. The **terrain** at the site is level, except for **the** west edge, which drops steeply toward the ocean. The soil **at** the site consists of Kokee silty clay loam (0-35% slopes) **representing the** Kokee series **"...of well-drained** soils on uplands on the island of Kauai. These soils developed in material weathered **from** basic igneous rock, probably mixed with volcanic ash" (Foote et al. **1972:71).** Rainfall in the vicinity of the site is 50-75 inches per year, and **the** mean **annual temperature** is about 60-70 degrees F **(Armstrong 1983:62,64).** Vegetation at the site consists of *uluhe* (*Dicranopteris* ***linearis*** Burm.), fuschia **(*Fuschia* spp.), ohia (*Metrosideros*** sp.), white ginger (*Hedychium coronarium* **Koenig), blackberry** (*Rubus lucidus* **Rydb.),** and exotic grasses eight feet tall.

Kokee Station (former **NASA** Tracking **Station).** This station **is** just mauka of the **14-mile** marker on Highway 550, at an elevation of about 4,000 ft **AMSL.** The site is about 10 feet by 10 feet and consists of a concrete pad atop a tower. **Vegetation in** the vicinity of the site consists **of lawn** *grass.* The rainfall, mean **annual temperature,** and soil **type** at **the** site are the **same** as **at** the HIANG site described above.

PREVIOUS ARCHAEOLOGICAL RESEARCH

Numerous archaeological **and cultural** resources studies have been conducted in the **Kona** District of Kaua'i, in areas located between, **and** including **Mahā'ulepū** in the south and **Polihale** in **the** north. Most of these studies have focused on the **shore** line (***kahakai***) and coastal to inland plains (***ko kula kahakai*** and ***ko kula uka***); environmental zones **which** coincide with **the** areas **of highest traditional Hawaiian use.** The studies in **the Waimea region,** possibly **the** largest **and northernmost** ahupua'a (traditional land **unit)** of **Kona, Kaua'i,** have **also** primarily **focused** upon the lowland zones.

Because it was the **practice** of ancient Hawaiians to establish land divisions (***ahupua'a***) which would allow native tenants access to **natural** resources extending **from** the ocean to **the** mountain ridges, several of the studies done for the Waimea region have included some references to **the** upland areas around the proposed project areas. Table 1 includes **a list** of previous research reports reviewed for this study, and **also** includes **references** to the upland area of **Waimea,** which today is generally called **Kōke'e.** Of **these studies, only** one **(Kikuchi** 1982) was within the immediate vicinity of the current project area **Kikuchi** reported on a **natural** rock formation situated mid-way between the primary and alternative sites at the **Mākaha** Ridge Facility. **One** other site, a ***heiau*** (temple) **named Kaunu'aiea** (Bennett 1931, Site **22),** was **reportedly** once situated near the **Halemanu** area of upland **Kōke'e.** This ***heiau*** **may have been near** the **alternative** PMRF **Kōke'e** site (Figure 1.**).** The remaining sites described below are several miles away **from** the current project areas.

In October of 1982 William **Kikuchi** was asked to investigate a rock formation on **Mākaha** Ridge at **approximately** the 1,500 foot elevation within **the Mākaha** facility area It was **Kikuchi's determination** that the rock **formation was natural,** and that there was no physical evidence **of prehistoric** or historic significance (letter, W. Kikuchi to J. Zink **October** 17, 1982).

The initial surveys of cultural **resources** in **the** Waimea area were conducted by Thomas Thrum (1907) and Wendell

Table 1.

SUMMARY OF PREVIOUS ARCHAEOLOGICAL RESEARCH IN VICINITY OF PROJECT AREA

Year	Author(s)	Type of Report	Ahupua'a	Zone
1907	Thrum	Articles	Waimea	Coastal-Upland
1931	Bennett	Surveys	Waimea	Coastal-Upland
1974	Ching	Survey	Waimea	coastal-Upland
1978	Ching	Reconnaissance Survey	Waimea	Upland
1982	Barrera	Archaeological Investigation	Waimea	Upland
1982	Yent	Archaeological Reconnaissance	Waimea	Upland
1982	Kikuchi	Archaeological Investigation	Waimea	Upland
1992	Flores and Kaohi (draft)	Hawaiian Cultural and Historical survey	Waimea	Coastal-Upland
1993	McMahon	Archaeological Reconnaissance	Waimea	Upland
1993	Chaffee and Spear (draft)	Inventory Survey	Waimea	Upland
1993	Flores	Memo addressing EA	Waimea	Upland
1993	Yent and Carpenter	Field Check of Archaeological Site	Waimea	Uplands

Bennett (1931). Thrum's "List of Heiaus," recorded the existence of (a) a small shrine named Kaunu'aiea*, reportedly situated in the upper Miloli'i forests (c. 3600 foot elevation) on the ridge of Kaunuohua (1907:40); and (b) Ahuloulu*'At [the] foot of Puukapele crater cone" (ibid.) Pu'ukapele is approximately 3,600 feet above sea level overlooking both the Mānā-Kekaha region and Waimea Canyon, and is in an area which was once noted for its' rich native forests. Thrum's description of Ahuloulu states:

A series of three platforms, irregular in shape, largest being 60x50 feet. Four feet above is a walled enclosure 12x30 feet, its walls badly dilapidated. Credited to King Ola (1907:40).

In 1931, Bennett conducted an archaeological survey of Kaua'i, and he presented further documentation on the sites reported by Thrum above. In Bennett's texts, Kaunu'aiea became "Kaumuaiea" (Site 22) which was

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* *Ka-unu-'aiea may be literally translated as "The 'aiea (lex) tree altar." An unu is a small altar-shrine which was dedicated to Lono, and in which prayers could be offered for rains and abundant crops, etc. Figuratively, 'ai-ea can mean "to eat or have life," thus this site name could be translated as "The altar of life or where life is obtained" (cf. Stokes and Dye 1991:189 and Pukui and Elbert 1975:344).*

\# *Ahu-loulu may be translated as "Loulu [Pritchardia - fan palm] shrine." During times of famine and drought, etc., the Heiau loulu-temples which had structures thatched with lulu leaves, were built and prayers were offered within them to bring an end to the afflictions and promote abundance. The temples were of a chiefly class and were not casually placed (Handy 1972:385 and Stokes and Dye 1991:31, 32. and 188).*

situated on the ridge of "Kaumuohua" [Kaunuohua]. Bennett states:

> In the forest above Halemanu is a small clearing known as Kaumuaiea. Here there are a few stones in a rough line, but not forming a platform or definite outline. Thrum describes this heiau as a *small* shrine and says that no platform remains to indicate its location (Bennett 1931: 104).

At Pu'ukapele Bennett numbered the features as Sites 19, 20, and 21. The sites included the *heiau* (temple) of Ahuloulu and house sites with associated features (1931:104). The three sites (19-21) identified by Bennett, were combined into one complex (Site 50-30-01-19) by the Hawai'i Historic Places Review Board in 1981 (McMahon 1993:10-11).

In 1974, Francis Ching Jr., of Archaeological Research Center Hawai'i (ARCH) and a crew conducted a survey of Kaua'i sites for the State of Hawai'i. His field notes confirmed the continued existence of Bennett's sites 19 and 20, and believed that Site 21 was still present, but due to dense vegetation, was unable to confirm the condition of the site.

Ching described Ahuloulu (Site 19) as being in good to excellent condition, and as "the only heiau found to date in the Kokee area although others are reported" (Ching 1974). Ching did additional work below Pu'ukapele, on the Waimea Canyon side in 1978 as part of an EIS for the proposed Waimea Canyon Mule Tours. Situated at Kukui, an area overlooking and descending into Waimea Canyon, the proposed trail would have ranged in elevation from 2,900 feet to approximately 600 feet. No Hawaiian archaeological sites were located during this survey (two letters from F. Ching to A. Mederios, dated November 28, 1978).

William Barrera Jr. of Chiniago Inc., inspected a right-of-way of the Kitano Hydroelectric Project in February of 1982. The corridor was approximately 2,400 feet in length and 300 feet wide between the c. 3,000 to 2,200 foot elevation, below Pu'ukapele, towards the Waimea Canyon rim. "No cultural, historical or archaeological materials of any kind were found" (Barren 1982).

Martha Yent, staff archaeologist with the Division of State Parks, DLNR conducted a survey of limited areas within the Kōke'e and Waimea State Parks, and the upper Mānā-Kekaha area in 1982. This study was done in association with potential development of a hydropower system proposed by Kekaha Sugar Co. (Amfac) and the State Department of Land and Natural Resources. The survey area included Kawaikōi (at c. 3,600 foot elevation); a Kaunuohua Ridge site (at c. 3,800 foot elevation); a Waiakoali Stream site (at c. 3,400 foot elevation); the existing upper Waimea irrigation ditch system along Mōhihi (at c. 3,600 foot elevation), the Kitano and Pu'ulua reservoirs, including portions of the Kōke'e Ditch system (at varying elevations between c. 3,600 to 2,200 k t); and the Mānā-Kekaha area between Pu'u'ōpae and Pūlehu (at elevations between c. 1,800 to 20 feet above sea level).

Yent notes that a thorough survey was "hampered" *in* areas by dense vegetation (Yent 1982:7), but she states:

> *As* best as *can* be determined from maps and described location, the recorded archaeological sites are not in the immediate area of proposed construction. Also, no archaeological sites or features were located in the area observed... (Yent 1982:8).

In July of 1990, Walker and Rosendahl (1990) conducted an archaeological inventory survey at the Pacific Missile Range Facility - Barking Sands (PMRF-BS) and the Kōke'e Park Geophysical Observatory (KPGO). They identified a low modern retaining wall outside the fenced compound at KPGO, which appeared to function as an erosion control barrier set in-place to stabilize the soil embankment. No other surface, or cultural remains were identified at the other six sites within the PMRF-BS or KPGO project areas.

In January 1992, Hawaiian Studies specialist E. Kalani Flores and Waimea native and historian Aletha G. Kaohi presented a draft of a Hawaiian Cultural & Historical Survey of Nohili, Mana, Kona District, Island of Kaua'i, State of Hawai'i (the survey is *still* in draft form, and is not available). The report was prepared for Advanced Sciences, Inc., for the proposed EDX project at the Pacific Missile Range Facility (PMRF) at Nōhili-Mānā. The overall goal of the survey was to compile a comprehensive resource with which to document traditional Hawaiian cultural values, religious beliefs, practices of spiritual significance, regional use of natural resources, the occurrences of Hawaiian sites, and record the knowledge of living informants as related to past practices and the changes which have affected traditional life styles in the Kona region.

A part of the Flores and Kaohi study provides documentation pertaining to the upland region and forests of Waimea, including the Pu'ukapele - Ahuloulu (described above), and Pu'u'ōpae and Pu'umoi localities (Flores and Kaohi 1992:45-46, 50-51, 72-74, 97-98, 101, 146-147, 213,

and 216). The authors express concern that:

> *pohaku* (stones) have not been properly documented as significant archaeological features in past and recent surveys. Especially unique and unusual naturally-shaped *pohaku*, ranging in size from a small rock which would fit in the palm of your hand to the size of a boulder as large as a house... (ibid 1992:46).

In the report are also documented various examples of the spiritual importance of *pōhaku*, and narratives describing past occurrences including how *pōhaku* have been named and cared for by human guardians, and/or have served as traditional landmarks of various functions, including navigational, burial, trail, and land boundary, etc. (ibid. 1992:46). Additionally, the authors cite references from W.H. Rice's "Hawaiian Legends" (1923), which describe an *imu* which was built for Kaua'i's chief Ola in the uplands between Kalalau and Waimea. The place where this *imu* was built is called Kapuahi-a-Ola (The sacred fire of Ola) (Flores and Kaohi 1992:101).

DLNR-SHPD Archaeologist Nancy McMahon *conducted* an archaeological survey along ridge roads in the Kōke'e uplands in 1993. The survey area included the Mākaha portion of the current project area and covered an area from Mākaha in the north to Nohomalu in the south along the plateau ridge, extending inland to Kaunu'aiea - Halemanu in the north to an area just above Kukui overlooking Waimea Canyon in the south. While describing traditional access to and use of the upland resources, McMahon cites a letter from R. Gahran (Kaua'i Museum) to F. Ching Jr. (ARCH 1978) in which he quotes Kaua'i Museum Historian, C. Stauder: "...Hawaiians probably constructed temporary camp sites but little remains of these features" (McMahon April 1993:10). In summarizing her report, McMahon comments on the possibility of sites existing, but due to vegetaiion and various recent uses of the region, "no historic sites were found in the areas surveyed" (ibid. 1993:17).

In May of 1993, D. Chaffee and R. Spear of Applied Planning Services conducted an inventory survey of a *small* (50x50) land parcel at the Waimea Canyon Lookout. "No cultural remains of any sort were discovered in the project area" (1993:9).

In June of 1993, E. Kalani Flores (cited above) sent a memo to A. Kyono, Forester (DLNR-DFW, Kaua'i) regarding an Environmental Assessment involving Kōke'e lands. In the correspondence, Flores cited the significance of Kōke'e and the region's importance in religious and spiritual beliefs and practices of the Hawaiian people. He also noted that areas of the upland forest between Hale' ie'ie and Kaluanamaulu were known as "the 'Canoe Factory' where logs were roughly shaped and partially completed into canoes before being taken down to the Mānā coastal plain through gulches such as Niu Valley" (June 7, 1993:1). Flores also expressed concern about the significance of rock formations, identifying several in the Pu'ukapele area as examples of important cultural resources (ibid.).

One additional study has been completed in the uplands of Waimea. In July 1993, State Parks archaeologists Martha Yent and Alan Carpenter reported on the locating of a site (Site # 50-30-06–707) near the Waimea Canyon Overlook. Their descriptions states:

> The site, as observed, consists of a single row of stones defining three sides of a flat, open area atop a ridge. The stone outline, as observed, measured approximately 3 meters by 5 meters. However the surrounding level area is considerably larger, and the observed stone outline may represent only a small division of a larger complex, parts of which could be obscured by downed vegetation. Some stone concentrations were noted in the vicinity and warrant further investigation. This site *appears* similar to, though smaller than, the described house sites at Puu Ka Pele. This site likely represents a temporary habitation feature, although the possibility of it being a *canoe* manufacturing site, in light of the previously mentioned oral account, should not be ruled out (Yent and Carpenter 1993:4).

SUMMARY OF HISTORICAL DOCUMENTARY RESEARCH

PHRI Historical Researcher Kepa Maly, conducted historical research for the current project (see Appendix A). A brief summary of his work is presented here.

Maly reports that the Waimea river valley, canyon, and watershed-prominent natural features of the region—were important to Kauai's people. The resources in the upper forests—sandalwood, trees from which to make canoes and image logs, bird feathers, and other materials—were harvested to support the *coastal* communities.

The legends of the *menehune* abound in the Waimea area The *menehune* were industrious people who dwelt in remote areas and accomplished great deeds in short periods of time. The *menehune* are said to have constructed the *Kiki-a-Ola* in the upland region above Pu'ukapele, towards Kokee. This was a water course constructed throughout the mountain region.

Historic accounts identify Waimea as one of the island's two major government seats during the early historic period. Historic accounts for Waimea in Maly include a review of the Indices of Awards made by the Board of Commissioners to Quiet Land Titles. The 1929 Indices of Awards list no references to land use in the upland region of Waimea including the current project area During the LCA awards (c. 1848-1853) less than 30,000 acres of land were awarded to native tenants as *kuleana* lands island wide. In the case of this mountainous region, permanent habitation would have been unlikely.

Welch (1990a) notes that after 1929 the Indices list 116 awardees within the *ahupua*'a of Waimea (Indices 1929 1:151-176). Part II of the Indices indicate the *ahupua'a* of Waimea is among those lands decreed "private lands of His Majesty Kamehameha III, to have and to hold to himself, his heirs and successor, forever, and said lands shall be regulated and disposed of according to his royal will and pleasure subject only to the rights of tenants" (Indices 1929 2:28).

Kamehameha 111 surrendered a large portion of his reserved lands to the Government of Hawaii in the Great Mahele (Land Division of 1848) and settled the Crown's commutation payment to the Government of Hawaii. Unlike his chiefs and *konohiki* who had participated in the Mahele of 1848, it was not necessary for the Crown to obtain an award for these lands from the Land Commission (Chinen 1974:27).

SETTLEMENT PATTERNS

Current research indicates that the earliest settlers of the Hawaiian Island came from central East Polynesia The Marquesas Islands are noted as being the most probable point of origin. Initial settlement of the Hawaiian Archipelago is believed to have occurred along the wetter and more fertile windward coastlines of the larger islands, where "conditions were optimal for marine and terrestrial exploitation along lines followed previously in Eastern Polynesia" (Green 1980:1). Kirch (1985) notes that the windward environments of the islands offered an attractive and ecologically optimal setting for early Polynesian settlers. Welch (1990a) concludes that colonization parties from the eastern Polynesian archipelago are thought to be responsible for the settlement of Hawai'i by 300 AD, based on an early radiocarbon date of 350 AD (McMahon 1990) for the Hā'ena area of northwestern Kaua'i.

Though the current project area lies in the upland forested region (wao *nahele*) of Waimea, an area which was not traditionally favored for long-term habitation, there are traditional and historic accounts which document human activities in the region in ancient times. Sites in the uplands were visited for ceremonial functions as those which reportedly occurred at Kaunu'aiea - Halemanu, Kapuahi-a-Ola, and Ahuloulu, etc. Important pathways provided both cross island and resource access as with Ke-alapi'i-a-ka-menehune and the trails of Honopū, Nu'alolo, and Miloli'i. Additionally, harvesting took place. Forest resources included wood for canoe making and other carved wooden items, feathers for ornaments, and medicinal items. Archaeological features at Pu'ukapele, Waimea Canyon Overlook, and Halemanu confirm traditional use of the upland region as well.

As noted earlier in this report, researchers are reminded by Hawaiian informants that *cultural* resources are more than architectural features. Place names (same of which are specifically mentioned in oral traditions), natural features, and accounts of spiritual phenomena are also important cultural resources and valued by the Hawaiian people. Flores and Kaohi (1992) document that unique and unusual naturally shaped *pōhaku* (stones) have many levels of importance, (including religious significance, and serving as markers for navigational practices, burial functions, and trail and land *boundary* markers, etc.) (Flores and Kaohi 1992:46).

Implications for the Project Area

Based on the previous achaeological and historical research, it was thought possible that some evidence of past use might be present in the project area These uses could have included sites of religious significance, trails, temporary shelters, and/or evidence of resource harvesting. Due to the fact that much of the area has already been substantially altered by construction work, it is unlikely that little if any cultural resources remain. Concrete pads are already in place at the Mākaha Ridge Facility (Primary Site) and the PMRF-Kōke'e site. The Alternative site at the Mākaha Ridge Facility and the HIANG site are also within the immediate vicinity of existing facilities and it is unlikely that any cultural features will be found.

FIELD METHODS AND PROCEDURES

Two field personnel conducted 100% surface surveys at the HIANG Site Area and the Makaha Ridge Alternative Site. No surveys were conducted at the other two sites as they already had concrete pads over them. The HIANG site was surveyed by way of three pedestrian sweeps - two within the site area and one around the sides and back of the site area. Crew members maintained transect intervals of 7.0 m. Survey transects were flagged with blue-and-white striped flagging tape to insure complete coverage. Ground visibility at the sites was very poor due to thick white ginger and blackberry bushes. Shovel tests were placed at both sites in order to test the sites for subsurface deposits. Photographs were taken at each site area using 35mm black-and-white film (PHRI Temp. Roll Number 1306).

FINDINGS

The surface survey and the subsurface testing yielded no cultural remains of any kind (see Table 2 for a summary of subsurface testing). The terrain of the HIANG site was found to comprise backfill-soil from the previous construction of the government facility. Underneath the soil was eroding bedrock.

The terrain at the Makaha Ridge Alternative Site was found to comprise decomposing bedrock with a high clay content. The entire site area was heavily eroded, and there were large, decomposing boulders throughout the area

Table 2.

SUMMARY OF SHOVEL TESTS

Site Area	Shovel Test No.	Size (m)	Max. Depth (m below surface)	Layer	Cultural Material
Makaha (Alt.)	1	030 x 0.30	0.20	I	None
Makaha (Alt.)	2	030 x 0.30	0.18	I	None
HIANG	3	0.30 x 030	0.25	I	None
			0.30	11	None
HIANG	4	030 x 0.27	0.17	I	None
			0.22	11	None
HIANG	5	0.37 x 030	0.12	I	None
			0.34	II	None
			0.44	III	None
HIANG	6	0.57 x 035	0.23	I	None
			0.48	II	None
			0.60	III	None
HIANG	7	035 x 037	0.15	I	None
			0.56	II	None
			0.61	III	None

CONCLUSION

The previous archaeological research for this project had indicated there might be trails or temporary shelters within the study areas, but none were found during the current project, In fact, no significant cultural material of any kind was identified during the current work. This may be due to the development in the area; presently, the area is being used for the development of military complexes. The lack of cultural material may also mean there never were any sites in the area This is highly likely because the steep slopes and the lack of soil in the areas are not suited for agriculture.

Sites identified during this project were to be assessed using the National Register criteria for evaluation, as outlined in the Code of Federal Regulations (36 CFR Part 60). However, no sites were identified during this project. Based on the negative findings, no further work is recommended for the project area

The evaluations presented within this final report have been based on inventory-level investigations. There is always the possibility, however remote, that potentially significant subsurface cultural remains will be encountered in the project area during the course of future development. In such situations, archaeological consultation should be sought immediately.

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APPENDIX A

HISTORICAL DOCUMENTARY RESEARCH

by Kepa Maly

THE LEGENDARY SETTING

The *moku o l o b* (district [literally: interior island]) of Kona, Kaua'i is the largest of five major districts on the island. Prominent features in the district include the Waimea river valley, canyon, and watershed—important places in prehistoric times.

Waimea, with its flowing water and valley walls adorned with glowing buds of sandalwood, was traditionally described with the saying:

> Nani wale o Waimea i ka wai 'ula 'iliahi
>
> So beautiful is Waimea of the waters that glow red like the sandalwood buds.
>
> (R. Kekahu 1975, and J.R Wichman 1986; pers. comm.)

There are few legendary resources available for the vicinity of the project area. This is to be expected because of the locations of the project areas in mountainous areas. The current project areas lie along the slopes of Koke'e (to bend or wind, as of a path). In Hawaiian tradition, the upper cloud covered *kuahiwi* (mountainous slopes), such as at Koke'e were considered the realm of spirits and gods; as such, they were not a fitting place for the endeavors of man.

One legend concerns the journey of Hi'iaka-i-ka-poli-o-Pele (Hi'iaka) who was the youngest sister of the volcano goddess Pele. This legend was published in the Hawaiian Newspaper *Ka Hoku o Hawai'i* (September 18,1924 to July 17,1928). The legend is much like Nathaniel Emerson's 1915 version of the story of "Pele and Hi'iaka," but contains many place names, narrative accounts, and *chants* differing from Emerson's version. The *Ka Hoku o Hawai'i* version has yet to be translated in its entirety. The following excerpts from the legend are from a draft PHRI manuscript (Maly, in prep).

> The goddess Hi'iaka journeyed from Hawai'i Island to Kaua'i to fetch the chief Lohiau-ipo (Lohiau) from Ha'ena and return with him to Pele's domain at Kilauea, Hawai'i. Upon arriving on Kaua'i, Hi'iaka found that Lohiau had died and she restored him to life. Following the ceremonies of purification and celebrations of Lohiau's return to life, Hi'iaka, her companions Wahine'oma'o and Pa'uopala'a, and Lohiau prepared a canoe and made ready to depart from Ha'ena to return to the island of Hawai'i.
>
> "...Pa`uopala`a was positioned in the canoe as the steers-woman, and Wahine`oma`o was lead paddler, with Lohiau between them. Hi'iaka then told them that they were to travel by sea along the cliffs; while I travel overland. Lohiau will direct you along the coastline and when the time is right, I will join you.
>
> Upon completing her explanation, Hi'iaka grasped the stem of the canoe. She then instructed them to prepare their paddles, and head straight towards the breaking waves saying, "Once you are beyond the waves, turn to the windward (Napali) side of the island." Hi'iaka then pushed the canoe towards the breaking waves and it smoothly crossed the waters. They moved so swiftly that the strongest canoe paddlers were unable to keep up with them. Once the canoe was beyond the wave crest of Ha'ena, Hi'iaka then turned and bid aloha to the chiefs and people who were gathered along the shore..." (10/19/1926)
>
> "...The path of Lohiau, Wahine'oma'o, and Pa'uopala'a took them along the cliffs of Kalalau, and on towards Miloli`i and the cliff of Kamaile. As the canoe surged forward upon the swelling waves, Lohiau's thoughts returned to the *hala* (pandanus) groves of Ha`ena and Naue by the sea. He thought with longing of his sister Kahuanui and best friend Kaukahiapa`oa (Pa`oa), and of the chiefs and people of his beloved land.
>
> The canoe moved forward carried by the wind which blew from the beloved land, and the travelers passed the famous hill of 'Aneki [Miloli'i] from which the fire brands are flown. Now while Lohiau ma* were thus traveling, Hi'iaka-ka-wahine-po'ai-moku (Hi'iaka, the woman who encircled the islands) was traveling along the steep cliffs. When she reached the heights of Honopuaialoha (Honopu), she looked upon the beauty of the cliffs and Kalalau, Hi'iaka offered a chant in praise of the beauty of the land:

* *ma - a Hawaiian word meaning companion or associates.*

O Kalalau pali 'a'ala ho'i e
Ke ake 'ia a'e la e ka wahine
'A'ala ka pali i ka laua'e
O Honopu i Waialoha
Aloha 'oe la

O Kalalau of the fragrant cliffs
Greatly desired by the woman
Cliffs made fragrant by the laua'e fern
Which grows at Honopu, at Waialoha
Greetings to you

Completing her offering, she then continued on her journey overland and saw the dwelling place of Honopu ma. Hi'iaka then thought affectionately of her companion Wahine'oma'o who was with Lohiau ma on the canoe, and recalled all of the adventures they'd shared on their journey to fetch Lohiau. Hi'iaka then offered a chant of aloha to her companion, describing this region which she traveled alone:

A Honopu wau i Waialoha
O ku'u wai lele hunahuna
Wai ma'awe i ka pali
O ku'u wai hana 'apu lau-ki
A ke kupa la i hana a ha'alele
Ha'alele i Honoipu i Waiakua
Kanaka 'ole la e ka hoa e
A'ohe hoa la

I am at Honopu, at Waialoha
My misty waterfall
Narrow water path on the cliff
My water which is placed in a ti leaf cup
Cup made by the natives and then discarded
Leaving Honoipu at Waiakua
Where no one is found as a traveling companion
Indeed there is no companion to be found

Hi'iaka then continued her journey along the path, which is set across the mountain This was a wild region of dense forest growth where one met with dual formed beings which tried to hinder one's joumey, but these beings and the steep cliffs were effortlessly passed by Hi'iaka. Hi'iaka then reached a high point along the cliff overlooking Mana where she saw "the 4,000, the 40,000" ghost-gods which dwelt in the region.

[The narrative continues describing how Hi'iaka overcomes the multitude of ghosts with her lightning skirt Pa'u-o-pala'e, and thus the region was rid of these beings.]

When Hi'iaka destroyed the gods of Mana, the canoe of Lohiau ma drew to the shore, and at ke one kani o Nohili (the resonant sands of Nohili), Hi'iaka joined once again with her companions. From that time on, it has been said that the reason the sands ring out is because of the wailing of the ghosts which Hi'iaka destroyed; the sound is that of the wailing ghosts of Mana (10/26/1926).

Another legend concerning the upland region identifies Pu'u-ka-Pele (The Pele, or eruption hill) as a site at which the goddess Pele tried to make her home when she first came to the Hawaiian Islands. As narrated in the legend of Ka-Miki:

> When Pele came to Hawai'i from Tahiti Pakapaka-ua, she first sought out a home for her family on Ka moku ka'ili la (The island which snatches the sun), also called Kamawaelualani, or Kawili; it is Kaua'i ka mokupuni kihapai pua (the Garden island). Pele dug a couple homes for herself and her family on Kaua'i, they were Ka'inapele (Procession of Pele [eruptions]) at Pu'uopapa'i (Hill of striking), and Leleiwi (Bone altar) at Pu'ukapele. Pele-Honuamea then moved to the island of O'ahu-a-Lua...(12/16/1915).

Another legend identifies the upland region as the haunt of the *menehune*. These were industrious people who reportedly accomplished great deeds in short periods of time, and lived in isolated, remote areas. The water course of the great Waimea chief Ola, Kiki-a-Ola (now called the Menehune Ditch), and Kipapa-a-Ola (the paved path of Ola), which crossed the mountain region from Waimea to Hanalei, are among the great accomplishments attributed to these people.

The account of the construction of Kiki-a-Ola, refers to the upland region above Pu'ukapele, towards Koke'e. When the *menehune* completed the water course, they were given the customary offering of 'opae (fresh water shrimp) as food, and once satisfied, the menehune returned to the uplands before the rising of the sun. Having accomplished their task and their bellies full, the *menehune* hummed on their way to the mountains. Because the *menehune* were so numerous, the rumble of their humming was heard all the way to Kawainui, O'ahu, and this event was the source of the saying:

> Wawa ka menehune i Pu'ukapele ma Kaua'i, puoho ka manu o ka loko o Kawainui ma Ko'olaupoko, O'ahu!

---

* *Honopu ma - Honopu (literally: Conch Bay) and companions; indicates that the land area was named for a particular individual.*

> The rumbling of the voices of the menehune at Pu'ukapele, Kaua'i, startled the birds at the pond of Kawainui at Ko'olaupoko, O'ahu! (Thrum p. 21)

The writings of turn-of-the-century foreigners greatly embellished accounts of the menehune, giving them magical qualities. Many menehune tales have taken on European characteristics. Thomas Thrum, compiler of Hawaiian legends, history, and practices, referred to the menehune as "brownies, fairies, and a mythical class of gnomes or dwarfs..." (1910, pp 10-12).

Early Historical References

Legendary and historic accounts identify Waimea as one of two major seats of government for the island in early historic times (the other being Wailua in the Puna district). The role of Waimea at the time of Captain James Cook's landing (January 20, 1778), and subsequently, during the rule of Kaumuali'i, the last independent birthright ruler of the island (c. 1796 through 1821; Joesting 1984:58,96) attest to the value of the Waimea region during this period.

The legend of Hi'iaka cited above, documents traditional use of trails in the uplands of the Koke'e region. In Archaeology of Kaua'i, Bennett discusses early historic uses of the trail systems. Commenting on a precarious ladder-trail which rises along a sheer cliff out of Nu'alolo and associated trails, he states, "The trails seem to have been freely used by the natives" (Bennett p.6). In the following paragraph, Bennett identifies several trail systems. Along Kaua'i's northern shores, in valleys which mark the Napali region, were small but viable communities that shared these trails with communities in the Waimea-Mana area. Archaeological features that have been identified with these communities include house sites, terraces, and agricultural features, ceremonial sites, and trails.

Aside from this ladder there was the landing and trail at Honopu point, also a steep ascent, the Kamaile trail into Nu'alolo from above, and the trail from Nu'alolo to Honopu, which, though high, is passable. There is another trail reported from Kalalau into Honopu... The trail leading from Koke'e in the mountains to Kalalau was in use at the time of the famous leper, Ko'olau [1893]. In the other direction William Goodwin of Waimea bas made his way from the Nu'alolo flats to Miloli'i, and the route from Miloli'i to Polihale has been used many times, though it involves swimming. There is a trail also from Koke'e to Miloli'i. A famous trail led from Waimea up the valley, or up through Koke'e, ov a the Alaka'i swamps [Kiki-a-Ola]... There were doubtless many other trails which lessened the degree of isolation. (ibid p 7)

One traditional description of the precarious nature of the trails leading from the Napali side communities to the Koke'e uplands is recorded in the legendary account of Ka-Miki (1992 PHRI manuscript in prep), as translated from the Hawaiian language newspaper Ka Hoku o Hawai'i. The saying warns travelers not to be careless while ascending or descending the trails lest one be:

> Ua pau kuhihewa i ka hakalewa o Nu'alolo, i ke ahi lele o
> Kamaile, i ka lele pua-o lele me ka 'auhau welo i Makua-iki...
>
> Killed like one who travels the precipitous cliff trail of Nu'alolo, falling like the fire brands of Kamaile, or the flying fire darts, which are the fluttering tribute of Makua-iki. (8/3/1916)

The legend of Ka-Miki provides us with one other reference to the forests of the Waimea-Koke'e region, and the harvesting of certain choice woods from this area Having been challenged to a war club fighting contest, Ka-Miki claimed:

> I have no club, my only weapon is my hands, but I have learned to use the war club from my club fighting teacher, I have used green hau spears, stripped like the maile [*Alyxia olivaeformis*], I have used clubs made of the uhiuhi [Mewneuron *kauaiensis*] and the koai'e [Acacia *koaia*], the resonant clubs made of the resilient kauila [Alphitonia ponderosa] trees which grow at Pu'ukapele, my expertise covers all manner of war club fighting...(2/24/1916).

The forests of Pu'ukapele and surrounding areas was famous as a harvesting place in ancient times, and the harvesting continued through the mid to late 1800s. Until recently, an old canoe which had belonged to Prince Jonah Kuhio was exhibited at the old Hanama'ulu Post Office building. This canoe is said to have been made from the last log harvested from the Pu'ukapele forest region before the forest was mostly destroyed by fire and grazing (J.R. Wichman, pers. comm. 1986).

In Native Planters (1972, pp 397-402), E.S.C. Handy describes use of the trails and the forests of the Waimea-Koke'e region:

> On the heights of the west canyon wall and at the extreme northern tip (now a United States Coast and Geodetic Survey station) there is another jutting

promontory, artificially flattened and with enough stone remains to indicate an ancient enclosure of considerable dimensions, with smaller terraced levels below, away from the canyon rim. It is thought to have once been a fort, since it offers a clear view in all directions from Waimea and Olokele Canyons to the summit of Wai'ale'ale, and would have been an excellent spot for fire or torch signaling. Below it is a grassy glade enclosing an old house foundation (paepae), probably a place of refuge for those using the overland trail into the forest and all to Kalalau or the Alaka'i Swamp. Oldtimers know the spot as Hale (House), which would indicate a halfway house for travelers.. ..This site is just above the junction of the Koke'e road and the present road leading to Hale Manu (Bird Dwelling), where the pioneer Valdermir Knudsen built his mountain retreat... (Handy:1972: 399).

Handy goes on to describe the diversity of the forest region stating:

> This extensive forest which covers Halemanu, Koke'e, and in fact the whole upland region of the west canyon rim at altitudes from 3,000 to 4,000 feet, deserves a fuller description... Quite obviously the ancient forest has dwindled. There are still numerous 'ohi'a stumps measuring 4 feet in diameter, mute evidence of the widespread felling of these giants for temple images long ago. The 'ohi'a-lehua is a tree which lives to great age, and it seems likely that cattle, goats, and wild hogs ranged in these uplands, and ranchers began (since 1800) to seek out this durable wood for use as fence posts... Still today, there are many living trees more than 100 feet high.
>
> Another characteristic growth along forest trails today is the tall bare stalk (maximum 40 feet) of the hahalua (a lobelia variety restricted to Kaua'i) with its broad crown of long fluted leaves fluttering in the wind. Its milky juice may here have been used as bird lime in snaring, as was the milky juice of the lobelia 'oha kepau in other areas. The somewhat similar-looking but distinct halapepe is also found growing here. The loulu, the native palm, still survives in some areas of the forest even up to 4,000 feet elevation, although it is now rendered almost extinct because rats eat the seed of the fruit (hawane) after the birds have feasted on the outer flesh. Natives used to eat the unripe seed, and the fanlike leaves were used for thatch (Neal 1948:85-87).
>
> There are still occasional sandalwood trees found here where anciently there were so many... (Handy:1972:400)

Handy goes on to identify several other common forest plants—*kauila*, maile, hoi *kuahiwi*, 'iliau, ha'iwale, *po*'olanui, *ko'oko*'olau, *koki'o ke'oke'o*, *'uki*, *popolo*, *pukiawe*, 'ala'a, kalia, *ho'awa*, uhiuhi, *mokihana*, and numerous other species. *All* of these plants were used in ancient Hawai'i (ibid:400-401).

LAND TENURE: A SUMMARY OF LAND USE PATTERNS

The Indices of Awards did not yield any information pertaining to land use in the project area at the time of the LCA action (c. 1848–1855). In fact, less than 30,000 acres of land were awarded to native tenants as *kuleana* lands island wide. To claim any land the claimant had to testify he occupied the land. In the case of this mountainous region, permanent occupation of the land would have been unlikely.

As discussed earlier, people did travel through the region, and forest resources were collected. It is likely that hale papa'i (temporary shelters) would have been established along trails and at sites where *certain* resources would have been collected regularly.

By the late 1800's Koke'e had become a favorite retreat for many of the foreign families who came to settle on Kaua'i, as the coolness of the forest was a reprieve from the humid lowlands. This use of the Koke'e region continues today, with the State of Hawai'i controlling most all of the house lot leases, and has been the source of many changes to the native environment Families retreating to the natural beauty of Koke'e introduced black berries, fuchsia, tritonia, passion fiuit, guavas, ginger, and numerous other exotic plants, along with feral pigs, goats and other animals. These introductions have irreparably damaged the native ecosystems. Harvesting of *maile*, *mokihana* and other plants takes place in the area, and regeneration of these plants is difficult due to the fact that the native ecosystem has already been severely altered and the plants cannot compete with the exotic species.

Military use of the region, from the shore to the present proposed project sites, is summarized in Clark's Beaches of *Kaua'i and* Ni*'ihau*, from which the following is taken:

> The Pacific Missile Range Facility, a multipurpose naval installation, is located on the shoreline of the Mana Coastal Plain. Many local residents simply *call* the site PMR[F]. The

Pacific Missile Range Facility is one of the foremost centers in the world for the detection of aircraft or vessels. With its highly sophisticated computer centers and electronic equipment, the facility can detect underwater activities and estimate depth, range, and bearing of a ship, submarine, or any other marine vessel. Listening devices on the ocean floor in the Underwater Range offshore of the facility can pinpoint within 10 to 15 bet a vessel's location within an area of 1,000 square miles. Radar units on base, at Makaha Ridge and at Koke'e, allow detection of surface ships and aircraft over 17,000 square miles of ocean.

Radio Station WWVH is also located within the facility. This high-frequency station is one of two in the United States operated by the U.S. Department of Commerce. It broadcasts time signals to trans-Pacific ships and aircraft.

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Appendices

E. Radar Impacts to Birdlife Summary (Johnde Lorge, Ph.d)

MICROWAVES AND BIRDS

John de Lorge, Ph.D.
Naval Aerospace Medical Research Laboratory
Pensacola, Florida

1. Following our Phoncon of 12/18 I made a survey of the literature on birds and microwave effects. Perhaps the following information will be of use to you.

2. A moderate amount of research concerning avian species and microwave bioeffects has been conducted. Most of this work was with chickens and the Japanese quail (eggs). However recent work includes other birds such as blue jays and budgerigars.

3. Much research in this area utilized 2.45 GHz frequencies and power densities at 1 mW/cm^2 and greater. Exposures tended to be with birds in restricted areas not free flying. In general, it was found that power densities greater than 10 mW/cm^2 would probably alter behavior due to thermal effects and as power densities increased so did the behavioral effect. Similarly, when eggs were irradiated for long periods of time and exceeded internal temperatures above 37° hatchability was reduced and abnormalities increased.

4. Several generalizations from these studies can be arrived at. Wild birds can perceive microwave irradiation at 10mW/cm^2 and higher. As time in the irradiation increases at power densities greater than 1mW/cm^2 so does the biological effect. Effects of brief exposures (less than 60 sec) at power levels of 50 mW/cm^2 or less are not permanent. Lethal effects begin to occur when exposures exceed 100mW/cm^2 for greater than 20 minutes. Higher densities for shorter periods of time are not lethal. However some birds begin showing stress effects after 30 second exposures at 25mW/cm^2. No thermoregulatory stress is observed at 10mW/cm^2 or less. Molting is successful even after continuous exposures of 18 weeks at levels of 1, 10 and 25 mW/cm^2.

5 It seems safe to say that exposures of 5 min duration at levels of 25 mW/cm^2 or less will not impair a parrot. However, exposures of 50mW/cm^2 or greater could disturb flight and might discourage a bird from leaving the exposure area or land in the exposure area. Birds normally exposed to radars in free flight do not evidence any deviation in flight patterns nor do birds nesting/roosting near large radar facilities show avoidance or attraction to enhanced radiation fields. It is highly unlikely that a parrot or any bird would approach the radar antenna near enough to create power absorption at hazardous thermal levels. Nor is it likely that they would nest in fields where thermal levels were high enough to produce biological effects.

6. The known effects of microwave exposure consist of hyperthermia, cataratogenesis, warm sensation and pain and burns; all at high intensities greater than 50 mW/cm^2 for extended periods of time. Other effects at moderate intensities (1 to 50 mW/cm^2) are a moderate warming, oligospermia (similar to hot bath decreasing sperm count), aggravating existing dermatitis, reversible stress response, reversible behavior response, and hearing of microwave pulses. Other effect. have been reported at levels less than lmW/cm^2 but these reports are inconclusive and contradictory. The same can be said about long term, chronic and low intensity exposures. In regard to low level effects, all reports indicate that these are reversible.

Appendices

F. Electromagnetic Radiation Assessment Electromagnetic Compatibility Survey (NISE WEST HAWAII)

DEPARTMENT OF THE NAVY
NAVAL COMMAND, CONTROL AND OCEAN SURVEILLANCE CENTER
ISE WEST ACTIVITY
BOX 130
PEARL HARBOR, HAWAII 96860-5170

REFER TO
2000
Ser 322SK/ 491
04 JUN 1993

From: Officer in Charge, Naval Command, Control and Ocean Surveillance Center ISE West Activity
To: Commander, Pacific Division, Naval Facilities Engineering Command (Attn: Code 23)

Subj: ELECTROMAGNETIC RADIATION (EMR) HAZARDS REVIEW FOR THE ROME LABORATORY UHF RADAR SURVEILLANCE TECHNOLOGY EXPERIMENTAL RADAR (RSTER) TESTING AT PACIFIC MISSILE RANGE FACILITY (PMRF), KAUAI, HAWAII (E3 PROGRAM TASK NO. E92-H029)

Ref: (a) PACNAVFACENGCOM ltr Ser 23/5225 of 13 August 92 (NOTAL)
(b) NISE WEST HAWAII ltr Ser 322SK/1220 of 2 November 1992 (NOTAL)
(c) PHONCON NAVSURFWARCENDIV Dahlgren (D. Vaught)/NISE WEST HAWAII (S. Kobashigawa) of 2 June 1993
(d) PHONCON PMRF (F. Bran)/NISE WEST HAWAII (S. Kobashigawa) of 20 October 1992
(e) PHONCON 154 ACW FQ (LTCOL Nitta)/NISE WEST HAWAII (S. Kobashigawa) of 20 October 1992

Encl: (1) Technical Report of the EMR Hazards Review for the Rome Laboratory UHF RSTER Testing at PMRF, Kauai, Hawaii

1. As tasked by reference (a), reference (b) provided the original EMR hazards review of the Rome Laboratory RSTER testing portion of the Mountaintop Sensor Integration and Test Program (MSITP) at the Pacific Missile Range Facility on Kauai, Hawaii. Due to numerous changes in the RSTER testing, reference (b) is no longer valid and is superseded by this review. Copies of reference (b) should be discarded.

2. The RSTER tests will be conducted by Rome Laboratory personnel and contractors at four sites; the cliff and alternate sites at the PMRF Makaha Ridge Facility (MRF), Parcel "A" (formerly known as the NASA Telemetry and Control (T&C) site) at the PMRF Kokee Park Instrumentation Station (KPIS), and the Hawaii Air National Guard (HIANG) Kokee Air Force Station (AFS). We considered hazards of EMR to personnel, fuel, and ordnance (HERP, HERF, and HERO respectively) and electromagnetic interference (EMI) to electronic equipment. Enclosure (1) provides a detailed analysis.

3. Based on the results of our analyses, site approval for the installation of the RSTER and the fixed linear array transmitter and antenna systems is granted with regard to HERP, HERF, and EMI to electronic equipment provided that the calculated separation distances listed in Tables 4 through 8 of enclosure (1) and the recommendations in Paragraph 5 are observed.

HERO was considered in the analysis. As advised by reference (c), since all ordnance sites and routes are at least 5 miles away from any RSTER site and well beyond the calculated HERO UNSAFE (and UNRELIABLE) and SUSCEPTIBLE safe separation distances, a site approval with regards to HERO is not required. Helicopters with HERO UNSAFE or SUSCEPTIBLE ordnance on-board should remain beyond the separation distances specified in Paragraph 5 from

the RSTER sites, when flying within the RSTER operational sector of 225" to 315".

4. The proposed project will install and operate the RSTER and a fixed linear array transmitting system at four sites. The RSTER operates in the 400 to 500 MHz frequency range with peak and average power outputs of 64 kW and 4 kW, respectively. The fixed linear array uses a spare high power RSTER amplifier as its transmitter and its transmission is identical to the RSTER's except its peak and average power is 600 and 37.5 watts, respectively.

a. The RSTER system will be using two antennas interchangeably during the course of the testing, the AEGIS Adjunct planar phased array (the normal RSTER antenna) and a ADS-18s linear phased array. Additionally, the AEGIS Adjunct antenna will be operated in a 90° rotated configuration referred to as the RSTER90. The RSTER and ADS-18s antennas will be rotating during normal operations whereas the RSTER90 and the Patch 1 (the fixed linear array antenna, also known as the IDPCA) will be stationary. Mainbeam transmissions at all sites will be limited to a 225° to 315° azimuth sector.

b. Operation of these transmitting systems is part of a UHF radar experiment lasting from April 1994 (radar installation start date) to August 1995 (test completion date).

5. Conclusions and Recommendations:

a. HERP:

(1) RSTER (Normal Configuration) and ADS-18s: Our analysis indicates that transmissions from both antennas can cause HERP but only during mainbeam illumination by a stationary antenna. The possibility of a HERP incident occurring is minimal since both antennas will be rotating and non-essential areas sector blanked. Recommend ensuring that the RSTER will not transmit in the sector blanked areas should the antennas accidentally stop rotating.

(2) RSTER90: HERP is predicted at the MRF alternate site for transmissions from the "UND" tower (a 8 meter (25 foot) test tower), and the two Kokee sites even with transmissions limited to the 225° to 315" azimuth sector due to the lower height of the antenna. In addition to the sector blanking, we recommend that:

(a) MRF Alternate Site: The antenna be pointed at 270° azimuth and a 0° elevation angle or higher during transmissions from the "UND" tower.

(b) KPIS Parcel "A" Site: The antenna be pointed at an elevation angle of -5° or higher during transmissions.

(c) Kokee AFS Site: The antenna be pointed at an elevation angle of -1.5" or higher during transmissions.

(d) Restrictions on the minimum elevation angles of the RSTER90 antenna may be relaxed if an on-site HERP survey shows that no HERP will exist at ground level during transmissions at lower elevation angles.

(3) Fixed Linear Array Radar Transmitting System: At the MRF alternate site where the antenna will be mounted on a 1.2 meter (4 foot high) pad, a personnel barricade should be installed around the antenna pad two meters away from the edges of the antenna to prevent personnel from touching the antenna and preclude HERP.

(4) Furthermore, we recommend:

(a) Installing a red flashing warning light that is readily visible to all personnel in the surrounding area and is activated during transmissions by the RSTER and/or the fixed linear array radar transmitting system.

(b) Conducting a HERP survey to ensure that EMR levels in all accessible areas around the RSTER antennas are below the HERP criteria. If hazardous levels are recorded, then these areas should be secured by a personnel barrier while the RSTER is operating.

(c) Installing HERP warning signs at the entrances to the RSTER areas.

b. HERF: No HERF is predicted since all fuel facilities are beyond the calculated HERF safe separation distances.

c. HERO: There are no ordnance sites or routes at the PKIS and MRF, and only small arms (percussion) ammunition at the Kokee AFS as advised by references (d) and (e), respectively. Analysis was limited to electroexplosive devices (EED's) on board helicopters using the helicopter pad at the MRF. The maximum calculated EMR at the heliport is below the HERO UNSAFE and SUSCEPTIBLE levels due to sector blanking. Helicopters with HERO UNSAFE or SUSCEPTIBLE ordnance on-board and flying within the RSTER operating sector should avoid flying within 2240.8 meters (7,352 feet) and 776.6 meters (2,548 feet) of the RSTER site, respectively.

d. MIL-STD-461D Radiated Susceptibility (RS)103 EMI:

(1) Aircraft: Aircraft should avoid flying within 174 meters (571 feet) of the RSTER site to avoid flying in electric (E)-fields exceeding the RS103 criteria for aircraft.

(2) Ground Electronic Equipment: Our analysis predicts that EMI will be caused by the EMR levels exceeding the RS103 levels. The potential for EMI occurring at both the MRF and Kokee AFS are minimal since none are experienced now from the existing high powered radars. Sector blanking at these two sites will also reduce the potential of EMI occurring. The antenna heights at Parcel "A" at KPIS should aid in reducing the potential for EMI at that site. However, since the possibility of EMI cannot be ruled out entirely, the following conditions should be included in the site agreement with Rome Laboratory:

(a) The RSTER and/or the fixed linear array radar transmitting system transmissions will be temporarily suspended if it is suspected that their emissions are interfering with PMRF or HIANG exercises.

SUBJ: EMR HAZARDS REVIEW FOR THE ROME LABORATORY UHF RSTER TESTING AT PMRF, KAUAI, HAWAII; E3 PROGRAM TASK NO. E92-H029

(b) Rome Laboratory will correct or fund efforts to correct any RSTER and/or fixed linear array system related EMI problems that are disrupting PMRF or HIANG day-to-day operations.

6. For PMRF Code 7031; please route this report to Codes 7322, 7325, and 7333.

7. Our point of contact is S.Kobashigawa, DSN(315) 471-1976 or COMM(808) 471-1976.

D.K.L. LEE
By direction

Copy to:
Rome Laboratory OCDR(Joe Massoud)
COMNAVFACENGCOM(Code 200)
COMSPAWARSYSCOM(Code 224-3A2)
NAVELEXCEN Charleston(Code 222)
PACMISRANFAC(Code 7031)
COMNAVSEASYSCOM(Code 665)
NAVSURFWARCENDIV Dahlgren(Code F52)

TECHNICAL REPORT

ELECTROMAGNETIC RADIATION HAZARDS REVIEW FOR THE ROME LABORATORY UHF RADAR SURVEILLANCE TECHNOLOGY EXPERIMENTAL RADAR (RSTER) TESTING AT PACIFIC MISSILE RANGE FACILITY, KAUAI, HAWAII (E3 PROGRAM TASK NO E92-H029)

JUNE 1993

Naval Command, Control and Ocean Surveillance Center ISE West Activity
Pearl Harbor, Hawaii 96860-5170

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ILLUSTRATIONS

3. The antenna tower at Kokee AFS will be located 27.4 meters (90 feet) from the equipment vans.

4. An existing 9.1 meter (30 foot) tower at Parcel "A" will be used as the antenna tower.

5. An ADS-18s antenna will be used during the test interchangeably along with the RSTER (AEGIS Adjunct) antenna.

6. The RSTER antenna will be operated in a 90" rotated configuration known as the RSTER90. See Figure 5.

7. A fourth site, the alternate site at the MRF, will be used for RSTER testing.

8. At all sites, radar transmissions will be limited to azimuths between 225" and 315".

C. RSTER Equipment Description: Table 1 lists the RSTER parameters. A brief description of the RSTER follows.

1. The RSTER transmitter and receiver are installed in a 13.7 meter (45 foot) long van and the radar signal processing system in another. Preliminary plans for installing the RSTER antennas are:

a. MRF Cliff Site: On a tower 4.6 meters (15 feet) above ground level (AGL).

b. MRF Alternate Site: The RSTER and ADS-18S will be mounted on a tower where the top of the RSTER antenna will not exceed 25.9 meters (85 feet). Additionally, the RSTER90 will be assembled on the "UND" tower, a 7.6 meter (25 foot) tower, and tested prior to being mounted on the main tower. See Figure 6 for a site layout.

c. KPIS Parcel "A" Site: On an existing 9.2 meter (30 foot) tower.

d. Kokee AFS Site: On a tower where the top of the antenna will not exceed 16.2 meters (53 feet). Based on the dimensions of the RSTER antenna assembly, it is assumed that the tower will be 9.2 meters (30 feet) high. See Figure 7.

2. The RSTER is capable of transmitting on 1 MHz increments from 400 to 500 MHz in a fixed frequency or frequency hopping format. The transmission is a chirped (linear frequency modulated) pulse 100 microseconds long repeated 625 times per second. The peak output power is 64 kilowatts (kW) and the average power is 4 kW at the antenna input.

3. The RSTER system uses the 10 meter (32.8 feet) by 5 meter (16.4 feet), planar phased array AEGIS Adjunct antenna. Its minimum elevation angle is -10". The antenna rotates at 5 revolutions per minute (rpm) in its normal configuration but will not rotate in the RSTER90 configuration. Although the mainbeam can be made to electronically scan vertically, tests on Kauai will be conducted without vertical scanning.

4. An ADS-18S linear array antenna (normally mounted in a 7.3 meter (24 foot) diameter dome on a E2C air surveillance aircraft) will be used interchangeably with the AEGIS Adjunct antenna. Its minimum elevation angle is -10". Since the antenna will be mounted on the AEGIS Adjunct pedestal, it will also rotate at 5 rpm. The array is 0.6 meters (2 feet) high and 6.4 meters (21 feet) wide. See Table 2 for details.

D. The fixed linear array radar transmitting system consists of an SD1568HI transmitter and a PATCH 1 (IDPCA), linear array antenna. The transmitter is actually one of the RSTER's spare high power linear amplifiers. The linear array transmissions will be identical to those of the RSTER but at a lower peak power level of 600 watts and average power of 37.5 watts. See Table 3 for details.

1. The PATCH 1 antenna is about 2.4 meters (8 feet) high and 9.8 meters (32 feet) wide. Preliminary plans call for installing the antenna two feet below the RSTER antenna at all sites except at the MRF alternate site where it will be installed on a 1.2 meter (4 feet) high pad. The linear array antenna will be stationary and pointed between azimuths of 225" to 315".

III. ELECTROMAGNETIC RADIATION HAZARDS

A. HERP: HERP is the result of tissue heating by radio frequency (RF) energy. The hazard levels are promulgated by OPNAVINST 5100.23B CH-3, Navy Occupational Safety and Health (NAVOSH) Program Manual, Chapter 22 dated 28 July 1987 and are a result of RF energy averaged over any six minute period. The personnel exposure limit (PEL) for the RSTER operating frequency range is 1.26 mW/cm^2. The PEL for radars operating next to the RSTER sites is 10 mW/cm^2.

B. HERF: HERF is the ignition of fuel vapor by arcing or ignition of fuel in contact with RF heated metal in intense RF fields. These fuels include AVGAS, MOGAS, JP-4 and kerosene. Diesel fuel is not vulnerable to RF arcs due to its low vapor pressure at room temperatures. The RF hazard energy levels are promulgated by NAVSEA OP 3565 Volume I Fifth revision, Electromagnetic Radiation Hazards (Hazards to Personnel. Fuel and Other Flammable Material} dated 15 July 1982. The HERF criteria is 5.77 V/m for lower communication frequencies and 5 watts/cm^2 for radar and microwave frequencies. Additionally, as cited in OP 3565 Volume I, the minimum recommended separation distance at shore sites is 15 meters (50 feet) for transmitters 250 watts or less and 60 meters (200 feet) for transmitters radiating more than 250 watts. The HERF criteria which requires the greatest separation distance is used in this analysis.

C. HERO: HERO results from the absorption of electromagnetic energy by the firing circuitry of EED's. The EED's may be accidentally initiated or their performance degraded by exposure to RF environments. Items that are susceptible and require moderate RF environmental restrictions are classified as HERO SUSCEPTIBLE ordnance. HERO UNRELIABLE and HERO UNSAFE ordnance include ordnance items which by being in a state of assembly, disassembly, or otherwise subjected to unauthorized conditions or operations, may be degraded in performance (HERO UNRELIABLE), or may be

accidentally ignited or detonated (HERO UNSAFE) when exposed to an RF environment. The maximum allowable RF environment which these two classifications of ordnance may be exposed to are prescribed in NAVSEA OP 3565, ***Electromagnetic Radiation Hazards (Hazards to Ordnance),*** Vol II, Part One, Sixth Revision dated 15 July 1989. The HERO criteria for the RSTER frequencies are as follows:

1. HERO UNSAFE/UNRELIABLE: 3.88 V/m
2. HERO SUSCEPTIBLE: 11.2 V/m

D. MIL-STD-461D ELECTRONIC EQUIPMENT SUSCEPTIBILITY: Electronic equipment and subsystems are susceptible to RF fields. To avoid malfunction or performance degradation, these equipments should be built to MIL-STD-461D radiated susceptibility (RS)103 requirements. Per MIL-STD-461D, ***Requirements for the Control of Electromagnetic Interference Emission and Susceptibility*** dated 11 January 1993, the following types of equipment with their maximum susceptibility limits should not experience EMI in the radiated electric (E) fields generated by the RSTER transmissions.

1. Aircraft: 200 V/m
2. Ground: 10 V/m

IV. RADHAZ ANALYSIS

Equipment data specified in Tables 1 through 3 were used to calculate minimum safe separation distances under free space (i.e., worst case) conditions. The minimum safe separation distance is the distance between the RSTER antennas and where their RF signals are equal to the exposure limit.

V. RESULTS

A. RADHAZ: The calculated minimum safe separation distances are listed in Tables 4 through 8. The separation distances are based on maximum output power and no system losses.

1. HERP

a. RSTER System (Normal Configuration): HERP is predicted at the Kokee AFS and the two MRF sites where the slope of the land places occupied areas within the 122.7 meter (402 feet) safe separation distance for RSTER antenna mainbeam exposure, see Table 4. However, the HERP will be minimal due to the rotation of the RSTER antenna and sector blanking. At the KPIS Parcel "A" site, the height of the antenna will place the mainbeam above any occupied area within the hazard area.

(1) Rotating Antenna: Since the RSTER antenna will be normally rotating when transmitting, NAVSEA 0P-3565 Volume I, specifies that the transmitted power can be reduced by a ratio of twice the RSTER horizontal beamwidth (6°) to the total angle scanned in a rotation

(360°) when computing the HERP distance. Based on this formula, the safe separation distance for mainbeam illumination is 22.4 meters (73.5 feet) from the rotating RSTER antenna.

(2) Sector Blanking: Additionally, sector blanking will be employed at all sites so that the occupied areas will not be radiated by the RSTER mainbeam. Figures 2 through 4 show the areas of mainbeam illumination for sector blanking from 315° through 0" and to 225°.

b. ADS-18s Configuration: HERP is also predicted at the Kokee AFS and the two MRF sites where the slope of the land places occupied areas within the 54.8 meter (180 feet) safe separation distance for mainbeam exposure, see Table 5. Similar to the RSTER, the HERP will be minimal due to the rotation of the antenna (which will reduce the separation distance to 11.3 meters (37 feet)) and sector blanking.

c. RSTER90: The RSTER90 will not be rotating and the base of the antenna will be 17.25 feet lower than the normal RSTER configuration. See Figure 7. Even when limiting transmissions to the prescribed 225° to 315" azimuth sector, HERP is still predicted.

(1) MRF Alternate Site (When Mounted on the "UND" Tower): The RSTER90 may cause HERP when operated at low elevation angles. At the lowest elevation angle of -10°, illumination by the mainbeam at a 2.1 meters (7 feet) height AGL occurs at 9.75 meters (32 feet) from the antenna. When the RSTER90 is pointed due West at an elevation angle of 0o, no HERP is predicted.

(2) KPIS Parcel "A" Site: When the RSTER90 is operating at low elevation angles, HERP will exist at ground level within the compound and immediately beyond the compound fence. At the minimum elevation angle of -10°, the mainbeam will drop below a 2.1 meter (7 feet) height AGL at 18 meters (59 feet) from the antenna. See Figure 7. However, if the RSTER90 minimum elevation angle is above -5°, no HERP will exist at ground level since the ground elevation falls off rapidly beyond the compound and the mainbeam will never drop below a height of 3.1 meters (10 feet) AGL within the safe separation distance.

(3) Kokee AFS Site: When the RSTER90 is operating at low elevation angles, HERP will exist at ground level within 18 meters (59 feet) of the antenna (at the minimum elevation angle of -10"). However, if the RSTER90 minimum elevation angle is kept above -1.5°, no HERP will exist at ground level since the mainbeam will reach a height of 2.1 meters (7 feet) AGL at 125 meters (410 feet) from the antenna which is beyond the safe separation distance.

d. Fixed Linear Array Radar Transmitting System: No HERP should occur at all sites except at the MRF alternate site since the antenna is elevated beyond the safe separation distance (see Table 6). At the MRF alternate site where the antenna will be mounted on a 1.2 meter (4 foot) high pad, HERP will exist immediately in front of the antenna.

e. HERP Due to Existing Radars: Tables 7 and 8 lists the safe separation distances from the existing radars at the MRF and Kokee

AFS sites, respectively. No HERP is predicted at the MRF cliff site and the Kokee AFS site since the nearby radars' antennas are normally rotating and the RSTER structures are beyond the safe separation distances for the rotating antennas.

(1) MRF Alternate Site: The two AN/FPQ-10's near the MRF alternate site are tracking radars that can transmit in one direction for long periods depending on their target's movement. HERP was originally predicted for workers on the RSTER main and "UND" towers since both fall within the 100.5 meter (330 feet) safe separation distance. However, during the HERP survey of 2 June 1993 we were advised that the AN/FPQ-10s' peak output power has been reduced from 1 MW to 150 kW on one and 100 kW on the other due to parts replacement problems. PMRF Code 7322 (Mr. R. Miller) advised that the proper parts would not be available to PMRF for at least another three years and will not impact the RSTER testing. Based on the present AN/FPQ-10s' output powers no HERP is predicted. Measurements were conducted to verify that EMR levels would be below the HERP criteria.

(2) AN/FPQ-10 Testing: Mainbeam measurements made 25.6 meters (84 feet) from one AN/FPQ-10 on the adjacent AN/FPQ-10 radar tower. A 1.5 mW/cm^2 power density was recorded with the radar operating at 80 kW (normal operating power), 640 pulses per second, and a 1 microsecond pulse width (maximum pulse width). If the radar was operated at 150 kW, the power density should rise to 2.8 mW/cm^2. The levels at the RSTER towers should be well below 10 mW/cm^2 criteria since the RSTER towers will be at least 60 meters (200 feet) from the closest AN/FPQ-10.

2. HERF: There are no hazardous fuel sites within the calculated HERF separation distances (the maximum distance is 8 meters (26 feet)) of RSTER antennas. The nearest fuel sites are 152 meters (499 feet) at MRF cliff site, 36 meters (120 feet) at the MRF alternate site, 305 meters (1000 feet) at KPIS site, and 146 meters (480 feet) at Kokee AFS. All fuel sites except for the MOGAS storage tank (Building 733) at the MRF alternate site are beyond the minimum recommended separation distance of 60 meters (200 feet). See Figure 2.

3. HERO: Helicopters landing at the helicopter pad at the MRF helicopter pad will only be exposed to sidelobe RSTER emissions due to the sector blanking of the RSTER emissions. The pad is located beyond the sidelobe safe separation distances for HERO UNSAFE and SUSCEPTIBLE ordnance. See Figure 2 for the location of the helicopter pad and Tables 4 through 6 for the calculated safe separation distances.

4. MIL-STD-461D: ELECTRONIC EQUIPMENT SUSCEPTIBILITY:

a. Aircraft: Aircraft flying in the RSTER operational sector within 174 meters (571 feet) of the RSTER site will be subjected to E-field levels exceeding the 200 V/m RS103 criteria for aircraft. Since the MRF helicopter pad is located 356.6 meters (1170 feet) from the closest RSTER site (alternate site) no EMI is predicted for helicopters using the pad.

b. Ground: EMI to electronic equipment is predicted

since many existing structures are within the RS103 calculated safe separation distances for ground equipment.

(1) The potential for EMI occurring at Kokee AFS and MRF is minimal since high powered radars are already operating at these sites, the RSTER and ADS-18S will use sector blanking, and the fixed linear array and RSTER90 antennas will be pointed away from existing structures.

(2) EMI at the KPIS site will be minimized since the height of the antennas will prevent mainbeam illumination of surrounding structures.

VI. Conclusions and Recommendations:

A. HERP

1. RSTER (Normal Configuration) and ADS-18S: Our analysis indicates that transmissions from the both antennas can cause HERP but only during mainbeam illumination by a stationary antenna. The possibility of a HERP incident occurring is minimal since both antennas will be rotating and non-essential areas will be sector blanked. Recommend verifying that the RSTER and ADS-18S will not be able to transmit in sector blanked areas should the antennas accidentally stop rotating.

2. RSTER90: HERP is predicted at the MRF alternate site for transmissions from the "UND" tower, and the two Kokee sites even with transmissions limited to the 225" to 315° azimuth sector due to the lower height of the antenna. In addition to sector blanking, we recommend that:

a. MRF Alternate Site: The antenna be pointed at 270" azimuth and a 0° elevation angle or higher during transmissions from the "UND" tower.

b. KPIS Parcel "A" Site: The antenna be pointed at an elevation angle of -5° or higher during transmissions.

c. Kokee AFS Site: The antenna be pointed at an elevation angle of -1.5 ° or higher during transmissions.

d. Restrictions on the minimum elevation angles of the RSTER90 antenna may be relaxed if an on-site HERP survey shows that no HERP will exist at ground level during transmissions at lower elevation angles.

3. Fixed Linear Array Radar Transmitting System: At the MRF alternate site, a personnel barricade should be installed around the antenna tower two meters away to prevent personnel from touching the antenna and HERP.

4. Furthermore, we recommend:

a. Installing a red flashing warning light that is readily visible to all personnel in the surrounding area and is activated whenever the RSTER and/or the fixed linear array radar transmitting system are/is transmitting.

b. Conducting a HERP survey to ensure that EMR levels in all accessible areas around the RSTER antennas are below the HERP criteria. If hazardous levels are recorded, then these areas should be secured by a personnel barrier while the RSTER is operating.

c. Installing HERP warning signs at the entrances to the RSTER areas. Suggested HERP warning signs are shown by Figure 8.

d. Silencing transmitters during maintenance of antennas.

B. HERF: No HERF is predicted at any site. The MRF alternate site does not meet the 60 meter recommended separation from the MOGAS storage tank (Building 733) due to land constraints. Site safety will not be compromised by the failure to meet the recommended separation distance since no HERF is predicted even with mainbeam exposure and the tank will only receive sidelobe and backlobe emissions.

C. HERO: The calculated EMR at the helicopter pad is below the HERO UNSAFE and SUSCEPTIBLE levels due to sector blanking. As advised by NAVSURFWARCENDIV Dahlgren Code F52 (Mr. Dennis Vaught), helicopters with HERO UNSAFE or SUSCEPTIBLE ordnance on-board should avoid flying within 2240.8 meters (7,352 feet) and 776.6 meters (2,548 feet), respectively, of the RSTER site when flying in the RSTER operational sector.

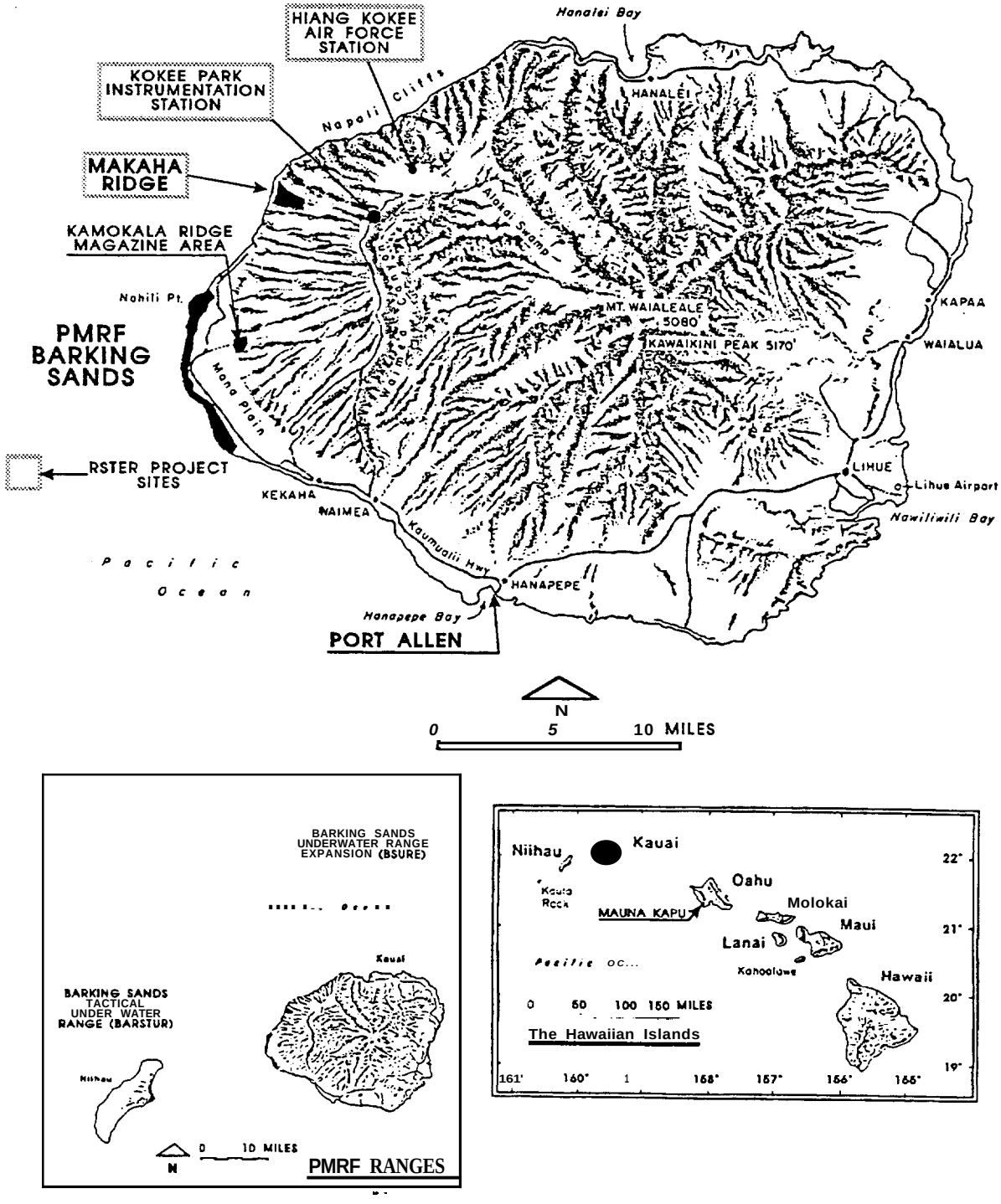
D. MIL-STD-461D RS103 EMI:

1. Aircraft: Aircraft should avoid flying within 174 meters (571 feet) of the RSTER site.

2. Ground Electronic Equipment: Our analysis predicts that EMI will be caused by the EMR levels exceeding the RS103 levels. The potential for EMI occurring at both the Kokee AFS and MRF are minimal since no EMI is experienced from existing high powered radars. Sector blanking at these two sites will also reduce the potential for EMI. The antenna heights at Parcel "A" at KPIS should aid in reducing the potential for EMI at that site. However, since the possibility of EMI cannot be ruled out entirely, the following conditions should be included in the site agreement with Rome Laboratory:

a. RSTER and/or fixed linear array radar transmitting system transmissions will be temporarily suspended if it is suspected that their emissions are interfering with PMRF or HIANG exercises.

b. Rome Laboratory will correct or fund efforts to correct any RSTER and/or fixed linear array system related EMI problems that are disrupting PMRF or HIANG day-to-day operations.



LOCATION MAP
ISLAND OF KAUAI

Figure 1. Map of Kauai Showing the Prcposed RSTER Sites

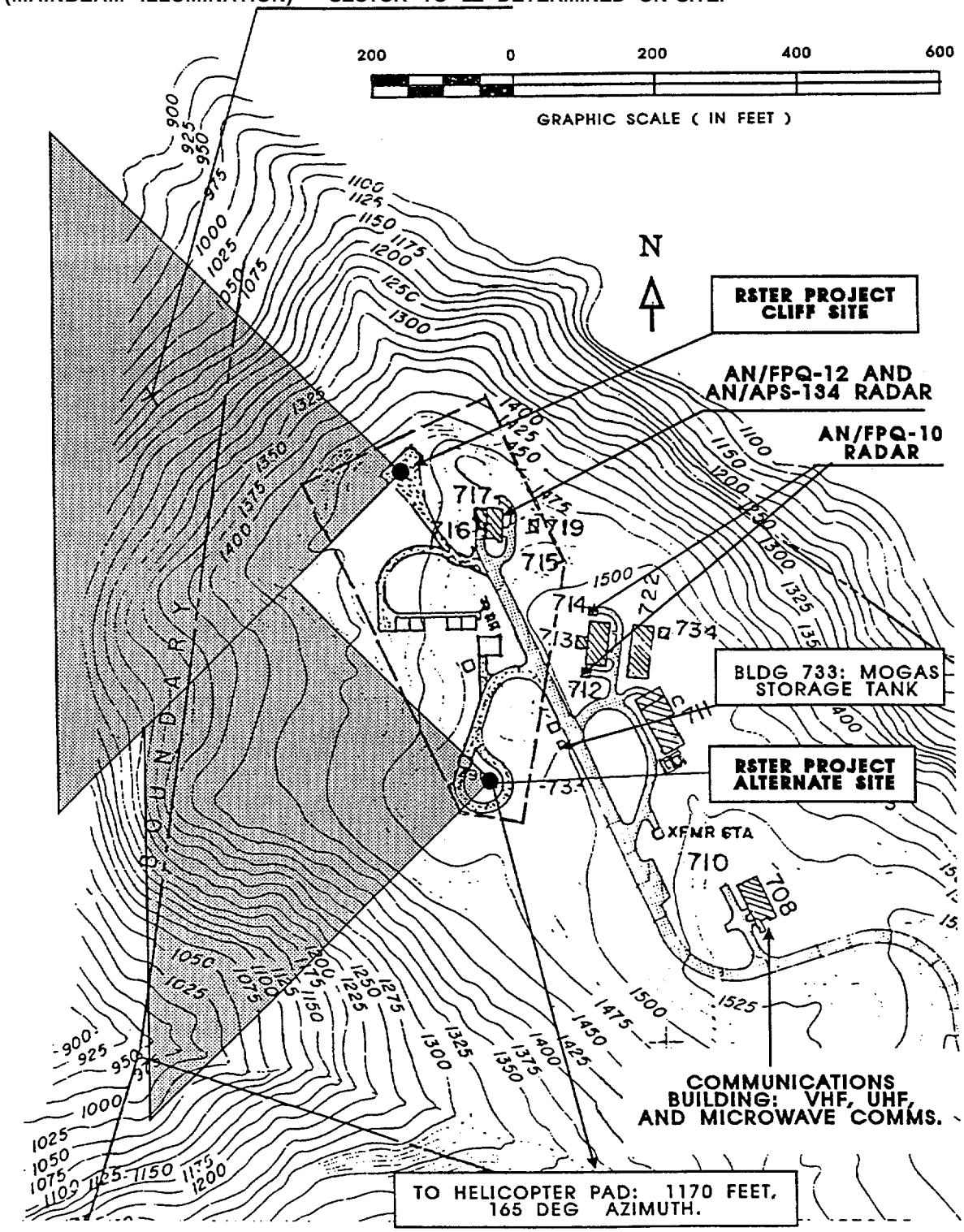


Figure 2. Partial Layout of the Makaha Ridge Facility Showing the RSTER Antenna Locations

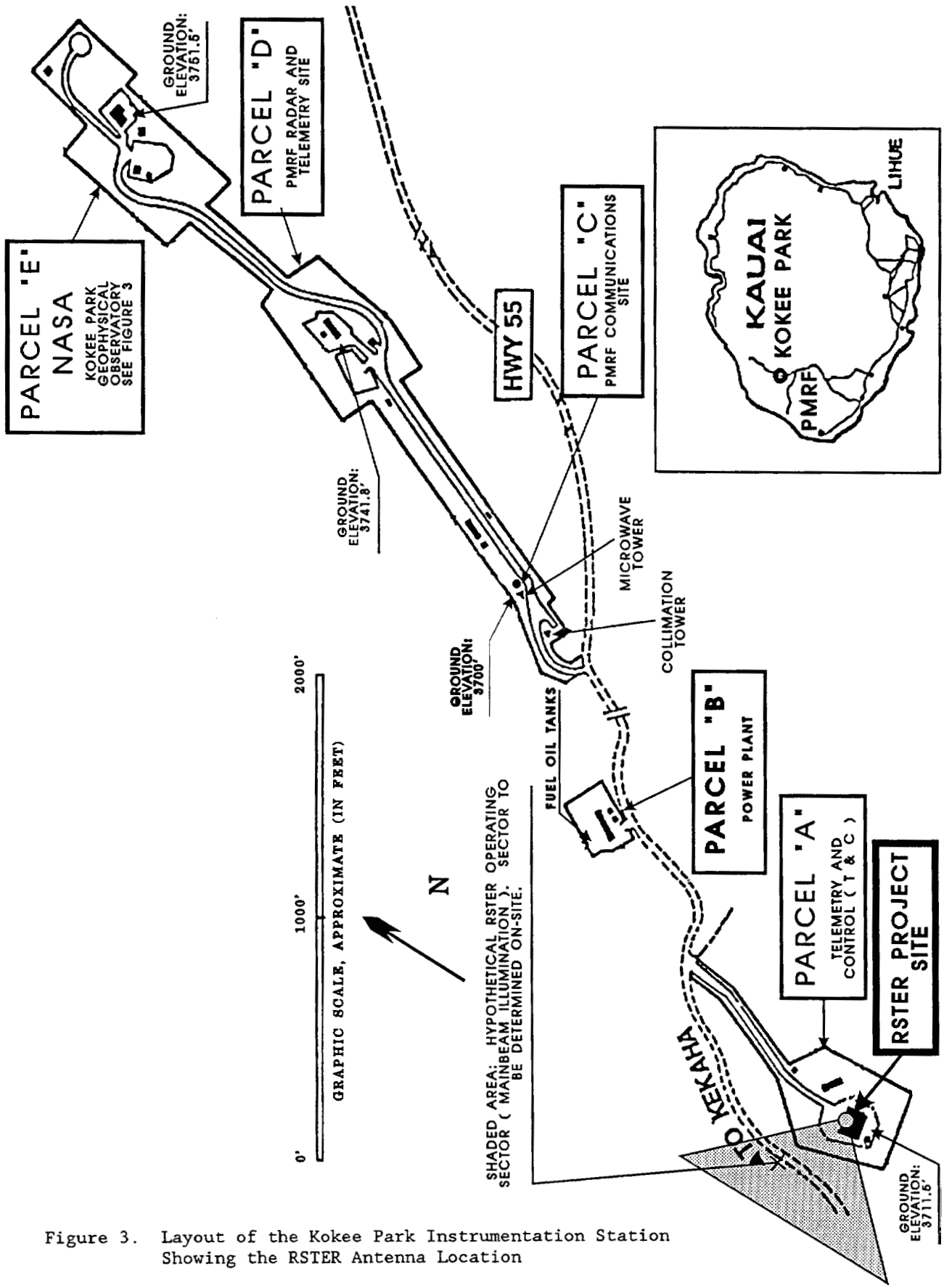


Figure 3. Layout of the Kokee Park Instrumentation Station Showing the RSTER Antenna Location

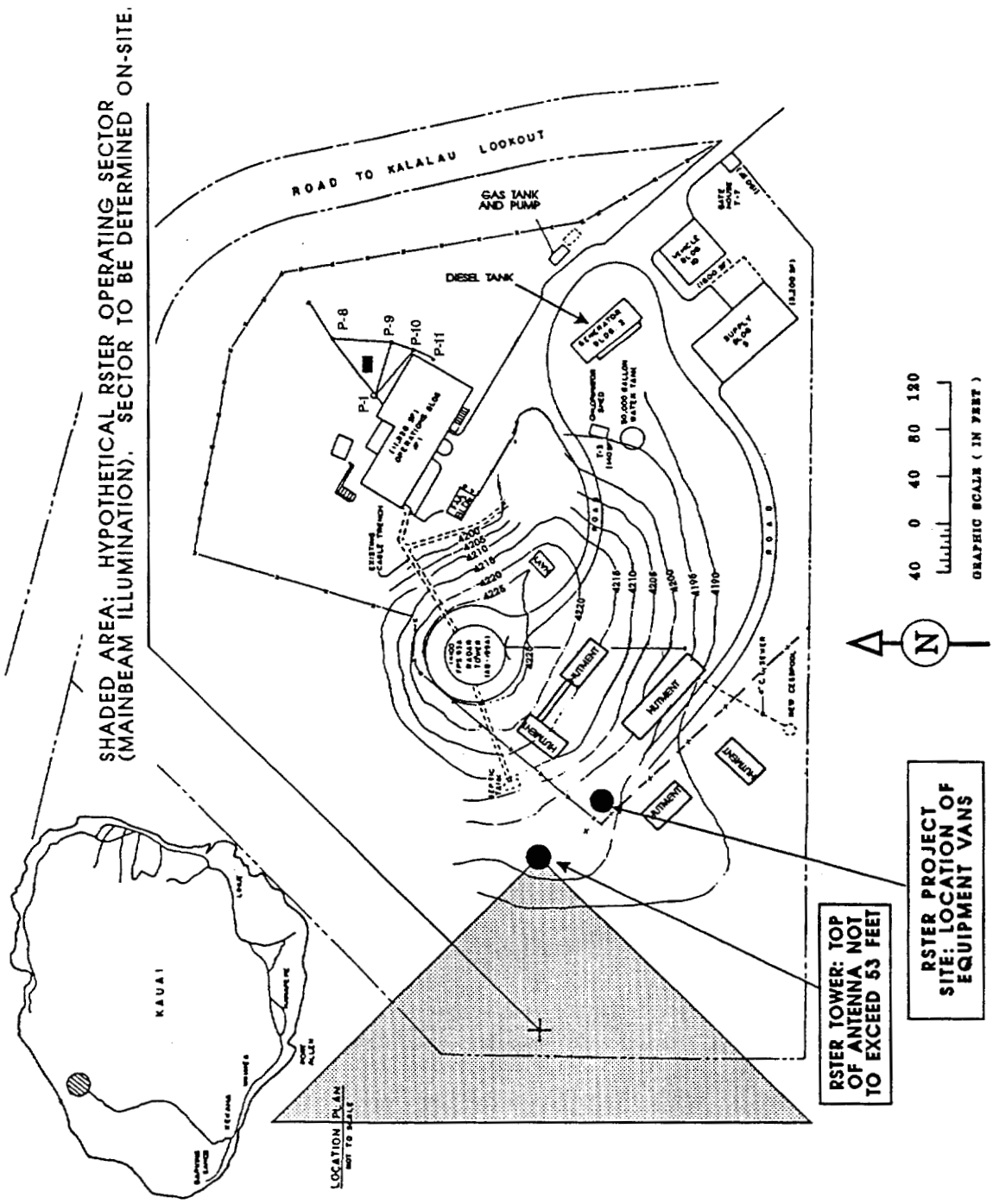


Figure 4. Layout of the HIANG Kokee Air Force Station Showing the RSTER Antenna Location

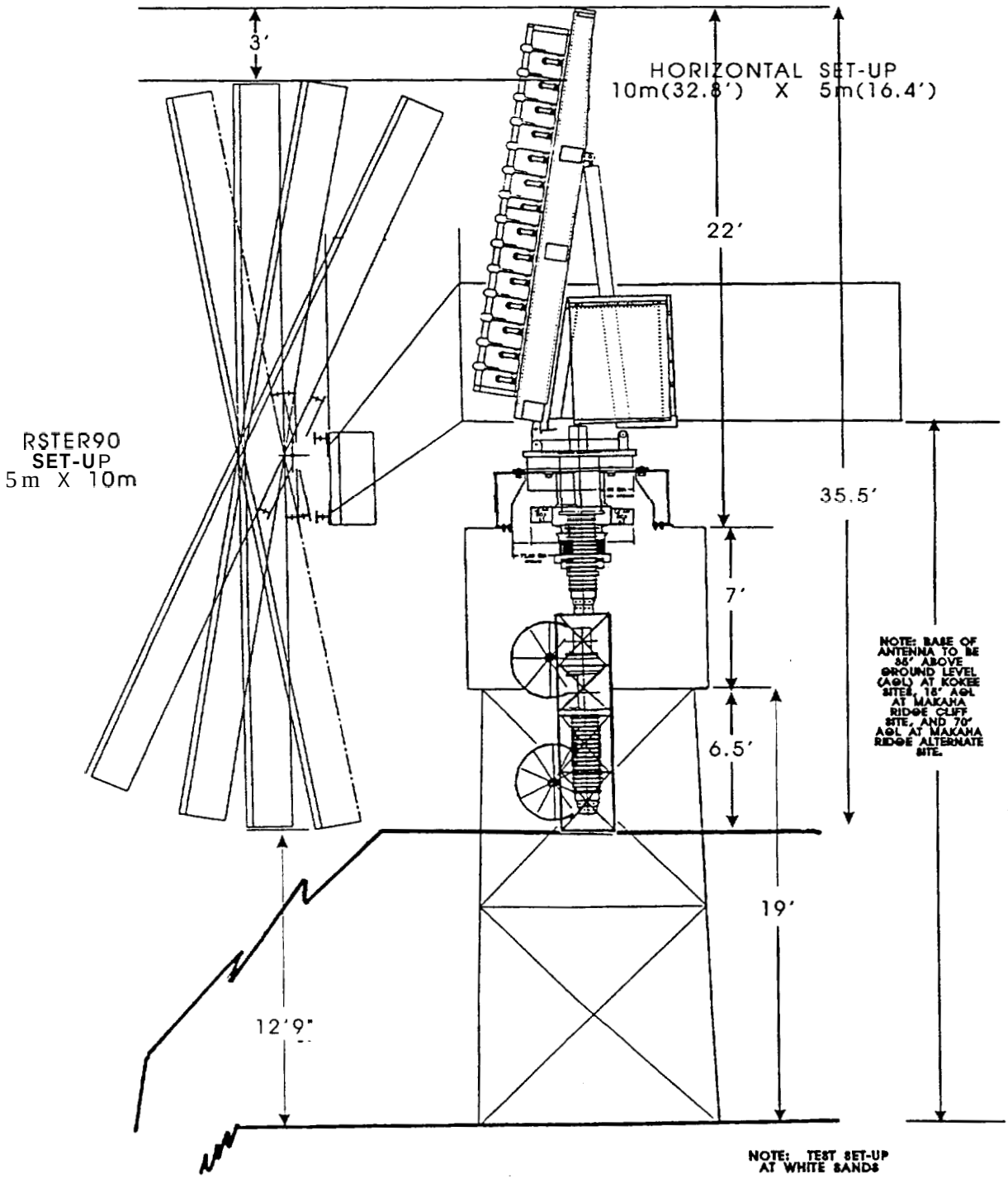


Figure 5. Sketch of the AEGIS Adjunct Antenna

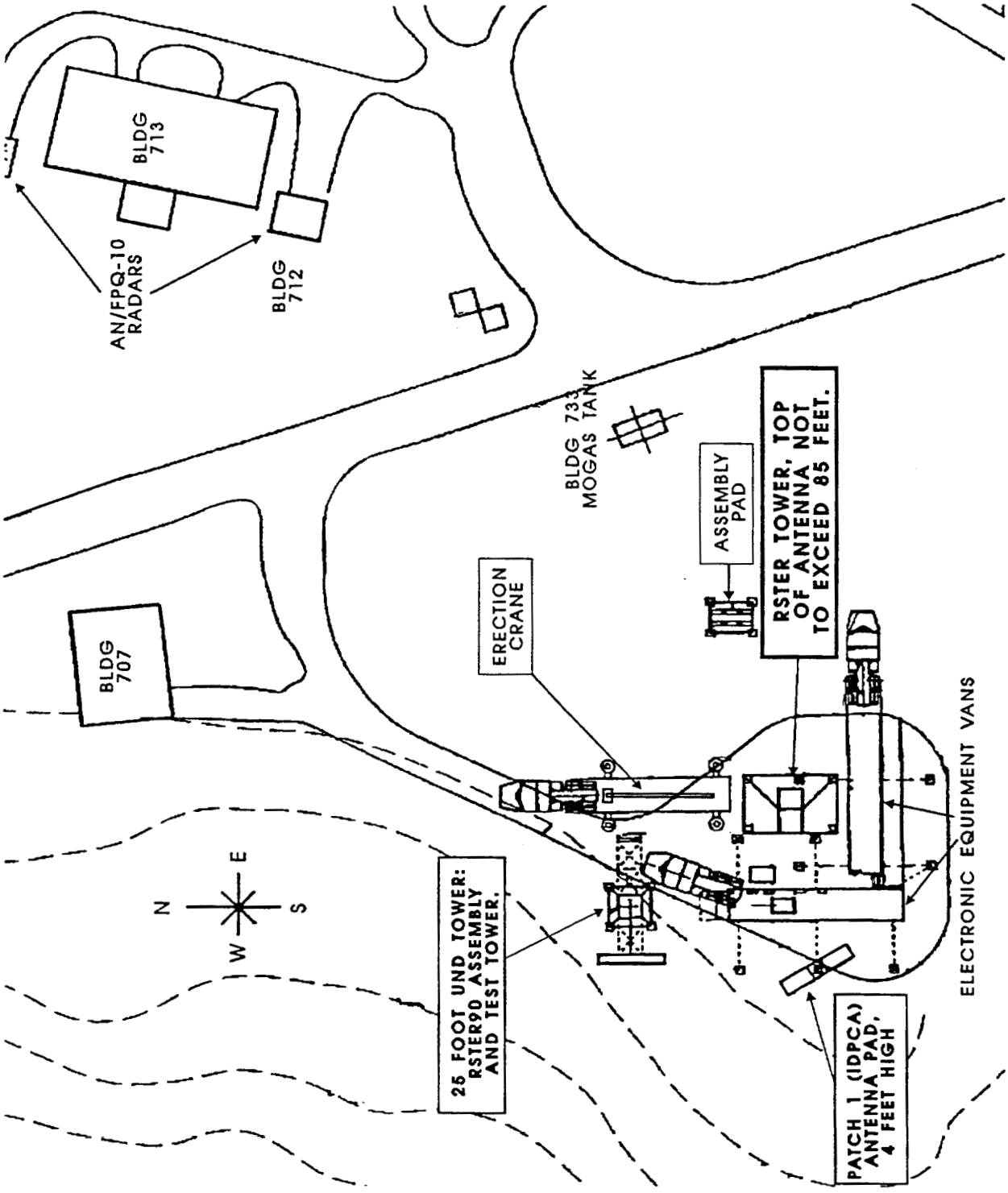


Figure 6. Layout of the Alternate RSTER Site at the Makaha Ridge Facility

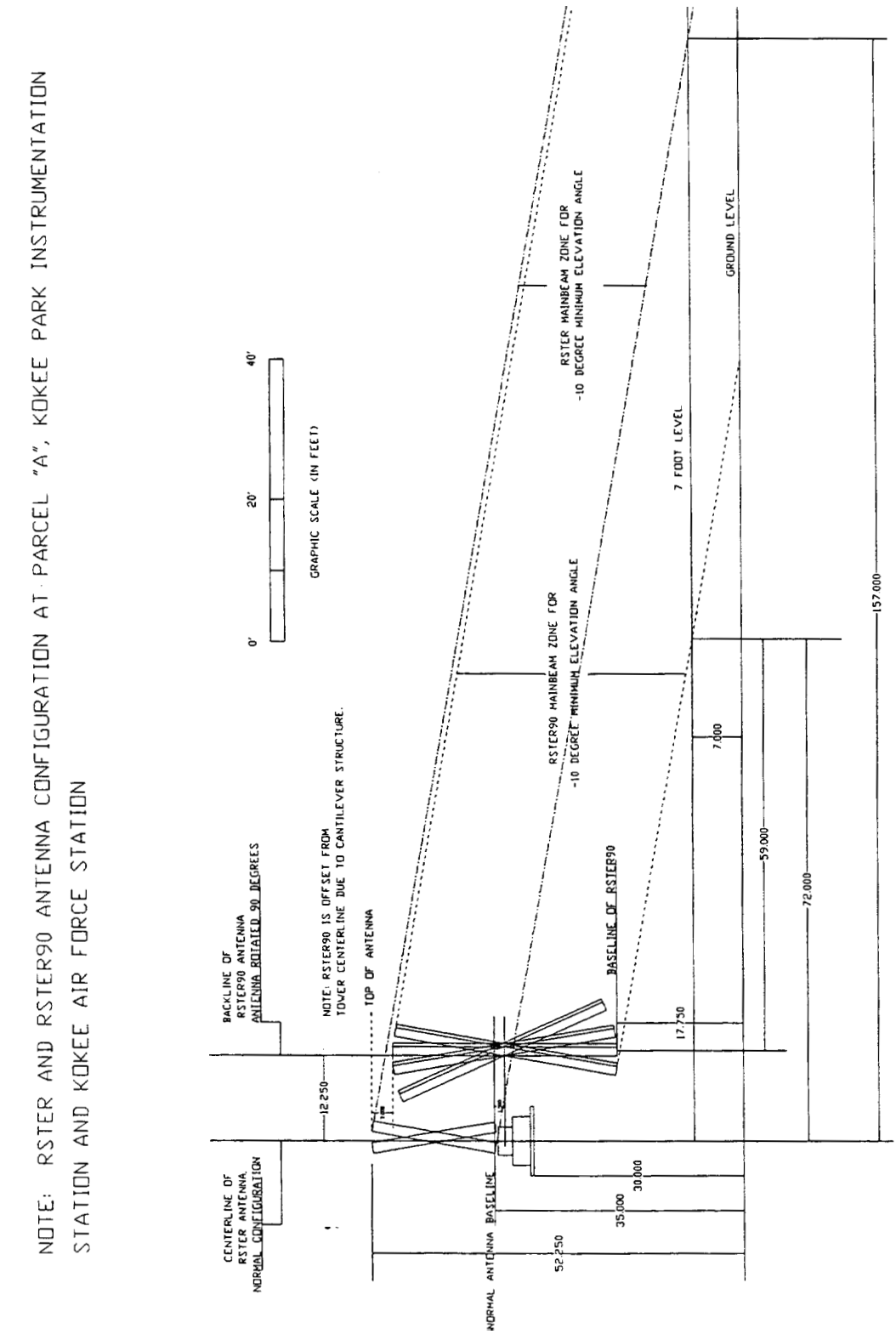
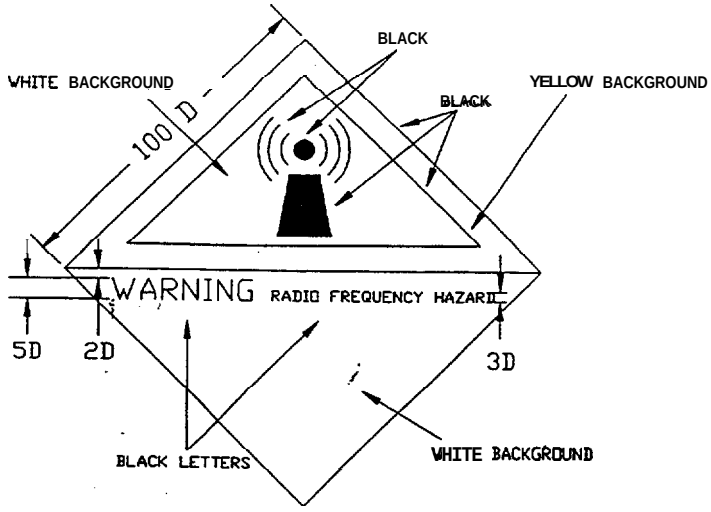


Figure 7. Sketch Showing the RSTER Tower Layout for the Two Kokee Sites



'KEEP MOVING' **sign**

'BEYOND THIS POINT' **sign**

'RF BURN' **sign**

Figure 8. Radio Frequency Hazard Warning Signs for Personnel

Transmitter	RSTER
Transmit Frequency	400 - 500 MHz
Receive Frequency	400 - 500 MHz
Transmit Power (Peak)	64,000 watts
Transmit Power (Average)	4,000 watts
Pulse Width	100 microseconds
Pulse Repetition Frequency	625 pulses per second
Antenna	AEGIS Adjunct (Planar Phased Array)
Gain	28 dBi
Antenna Size	10 m x 5 m (32.8 ft x 16.4 ft)
Maximum Sidelobe Gain	-15 dBi
Backlobe Gain	-15 dBi
Minimum elevation angle for the antenna	-10"
Azimuth angles of the antenna	225° - 315'

Table 1. RSTER Equipment Specifications

Antenna	ADS-18s Linear Phased Array
Gain	21 dBi
Antenna Size	6.4 m x 0.6 m (21 ft x 2 ft)
Maximum Sidelobe Gain	-19 dBi
Backlobe Gain	-4 dBi
Minimum elevation angle for the antenna	-10°
Azimuth angles of the antenna	225° - 315"

Table 2. ADS-18s Antenna Specifications

Transmitter	SD1568HI
Transmit Frequency	400 · 500 MHz
Receive Frequency	Transmit Only
Transmit Power (Peak)	600 watts
Transmit Power (Average)	37.5 watts
Pulse Width	100 microseconds
Pulse Repetition Frequency	625 pulses per second
Antenna	Patch 1 (IDPCA) Linear Array
Gain	5 dBi
Antenna Size	9.8 m x 2.4 m (32 ft x 8 ft)
Maximum Sidelobe Gain	-10 dBi
Backlobe Gain	-10 dBi
Minimum elevation angle for the antenna	-10"
Azimuth angles of the antenna	225" - 315"

Table 3. Fixed Linear Array Radar Transmitting System Specifications

	RSTER Separation Distances	
	Main Beam	Sidelobes and Backlobe
HERP, ANTENNA STATIONARY	122.7 m (402 ft)	1 m (3.3 ft)
HERP, ANTENNA ROTATING	22.4 m (73.5 ft)	N/A
HERF, CALCULATED*	8 m (26.3 ft)	N/A
HERO UNRELIABLE/UNSAFE	2240.8 m (7352 ft)	15.9 m (52 ft)
HERO SUSCEPTIBLE	776.6 m (2548 ft)	7 m (23 ft)
MIL-STD-461D Aircraft	174 m (571 ft)	1.2 m (3.9 ft)
MIL-STD-461D Ground	3480.6 m (11,419 ft)	24.6 m (81 ft)

* Note: Per OP 3565 Volume I, the recommended HERF separation distance for transmitters radiating more than 250 watts is 60 meters (200 feet).

Table 4. Calculated Safe Separation Distances from the RSTER Antenna

	ADS-18s Separation Distances	
	Main Beam	Sidelobes and Backlobe
HERP, ANTENNA STATIONARY	54.8 m (180 ft)	3.1 m (10 ft)
HERP, ANTENNA ROTATING	11.3 m (37 ft)	N/A
HERF, CALCULATED*	3.6 m (12 ft)	N/A
HERO UNRELIABLE/UNSAFE	1000.9 m (3284 ft)	56.3 m (1847 ft)
HERO SUSCEPTIBLE	346.9 m (1138 ft)	19.5 m (64 ft)
MIL-STD-461D Aircraft	77.7 m (255 ft)	4.4 m (14 ft)
MIL-STD-461D Ground	1554.7 m (5101 ft)	87.4 m (287 ft)

Table 5. Calculated Safe Separation Distances from the ADS-18S Antenna

	Fixed Linear Array Radar Transmitting System Separation Distances	
	Main Beam	Sidelobes and Backlobe
HERP	1 m (3.3 ft)	1 m (3.3 ft)
HERF, CALCULATED**	0.6 m (2 ft)	N/A
HERO UNRELIABLE/UNSAFE	15.4 m (51 ft)	7 m (23 ft)
HERO SUSCEPTIBLE	7 m (23 ft)	7 m (23 ft)
MIL-STD-461D Aircraft	1.2 m (3.9 ft)	0.2 m (0.7 ft)
MIL-STD-461D Ground	23.9 m (78 ft)	4.2 m (14 ft)

** Note: Per OP 3565 Volume I, the recommended separation distance for transmitters of 250 watts or less is 15 meters (50 feet).

Table 6. Calculated Safe Separation Distances from the Fixed Linear Array Antenna

	AN/APS-134 Separation Distances	
	Main Beam	Sidelobes and Backlobe
HERP, ANTENNA STATIONARY	16.6 m (54 ft)	N/A
HERP, ANTENNA ROTATING	1.9 m (6.3 ft)	N/A

	AN/FPQ-12 Separation Distances	
	Main Beam	Sidelobes and Backlobe
HERP, ANTENNA STATIONARY	112.4 m (368 ft)	N/A
HERP, ANTENNA ROTATING	11.5 m (38 ft)	N/A

	AN/FPS-10 Separation Distances (Stationary Antenna)	
	Main Beam	Sidelobes and Backlobe
HERP, 1 MWATT OUTPUT	100.5 m (330 ft)	N/A
HERP, 150 kWATT OUTPUT	39.0 m (128 ft)	N/A

Table 7. Calculated HERP Safe Separation Distances from Nearby Radars at Makaha Ridge

	AN/FPS-93A Separation Distances	
	Main Beam	Sidelobes and Backlobe
HERP, ANTENNA STATIONARY	109.4 m (359 ft)	N/A
HERP, ANTENNA ROTATING	9.3 m (31 ft)	N/A

Table 8. Calculated HERP Safe Separation Distances from the AN/FPS-93A Radar at Kokee AFS

DEPARTMENT OF THE NAVY
NAVAL COMMAND.CONTROL AND OCEAN SURVEILLANCE CENTER
ISE WEST ACTIVITY
BOX 130
PEARL HARBOR.HAWAII 96860-5170

REFER TO 4900
Ser 322SK/490
04 JUN 1993

From: Officer in Charge, Naval Command, Control and Ocean Surveillance Center ISE West Activity
To: Commander, Pacific Division, Naval Facilities Engineering Command (Attn: Code 23)

Subj: AMENDMENT TO THE ELECTROMAGNETIC COMPATIBILITY(EMC) STUDY FOR THE ROME LABORATORY UHF RADAR SURVEILLANCE TECHNOLOGY EXPERIMENTAL RADAR(RSTER) TESTING AT PACIFIC MISSILE RANGE FACILITY(PMRF), KAUAI, HAWAII(E3 PROGRAM TASK NO. E92-H029)

Ref: (a) NISE WEST HAWAII ltr Ser 322SK/50 of 21 Jan 1993
(b) NISE WEST HAWAII ltr Ser 322SK/1220 of 2 Nov 1992
(c) NISE WEST HAWAII ltr Ser 322SK/491 of 4 Jun 1993

Encl: (1) Proposed RSTER Antenna Locations at Makaha Ridge

1. Reference(a) forwarded our original EMC study of the Rome Laboratory UHF Radar Surveillance Technology Experimental Radar(RSTER) testing portion of the Mountaintop Sensor Integration and Test Program(MSITP) at the Pacific Missile Range Facility on Kauai, Hawaii. This addendum discusses EMC impact of operating the RSTER at the alternate site at the PMRF Makaha Ridge Facility. See enclosure(1) for the location of the alternate site.

2. The study for the alternate site showed that the EMC impact of the RSTER will be essentially the same as that for the original Makaha Ridge site. All conclusions and recommendations applicable to the original site are applicable to the alternate site with one exception. The RSTER antenna will not be blocking the Integrated Target Control System(ITCS) or the AN/FPQ-12 coverage of the PMRF test range to the west of Kauai.

3. Reference(b), the electromagnetic radiation(EMR) hazard review referred to in reference(a), has been superseded by reference(c).

4. Attach this letter to reference(a).

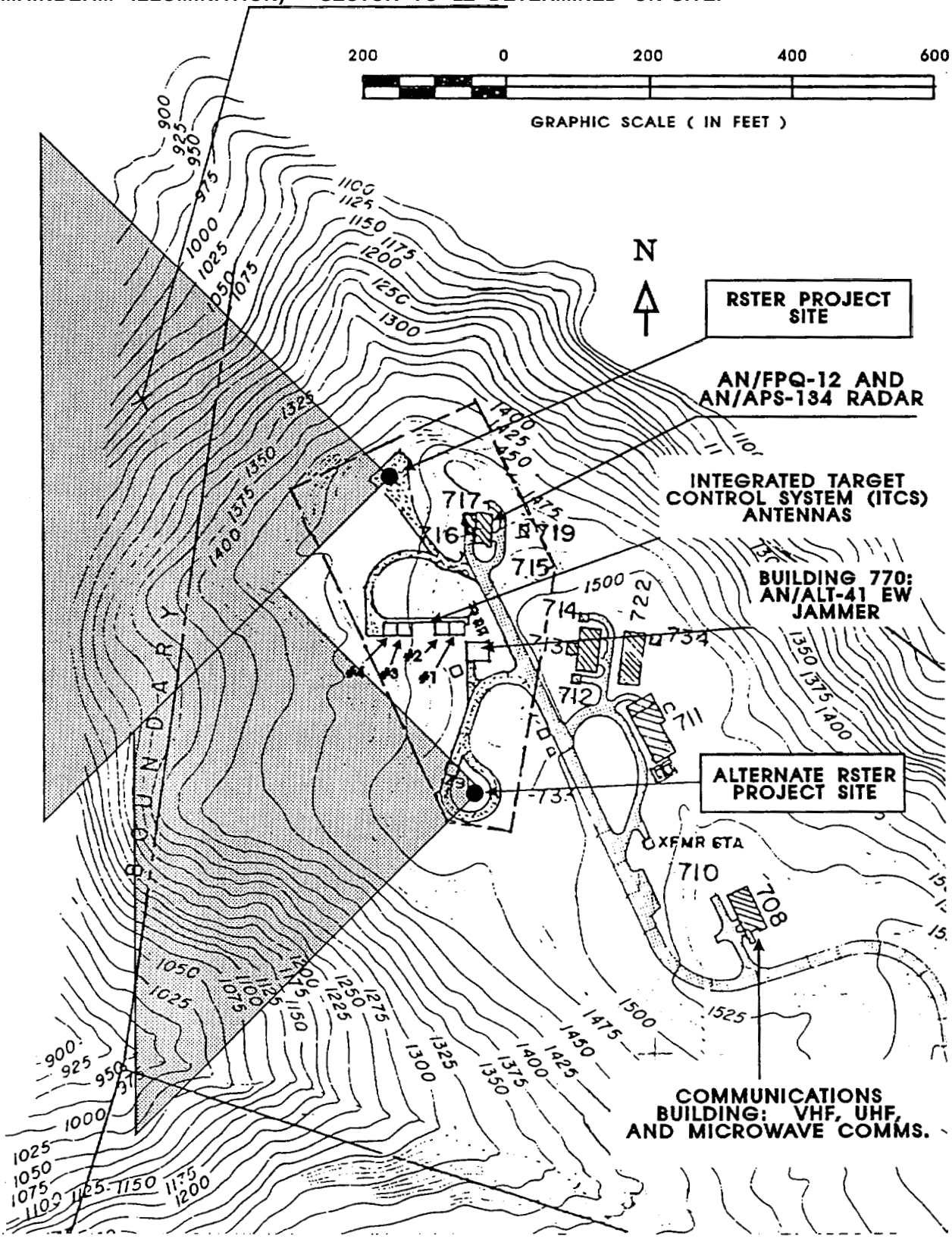
5. For PMRF Code 7031; please route this letter to Codes 7322, 7325, and 7333.

6. Our point of contact is S.Kobashigawa, DSN(315) 471-1976 or COMM(808) 471-1976.

D.K.L. LEE
By direction

Copy to:
PACMISRANFAC(Code 7031)
COMNAVFACENGCOM(Code 200)
COMSPAWARSYSCOM(Code 224-3A2)
NAVELEXCEN Charleston(Code 222)
ROME Laboratories(Code OCDR, Mr. J. Massoud)

SHADED AREA: HYPOTHETICAL RSTER OPERATING SECTOR
(MAINBEAM ILLUMINATION) SECTOR TO BE DETERMINED ON-SITE.



Enclosure (1) Proposed RSTER Antenna Locations at Makaha Ridge

ENCL (1) TO NISE WEST HAWAII
LTR SER 322SK/490
OF 04 JUN 1993

FILE

DEPARTMENT OF THE NAVY
NAVAL COMMAND. CONTROL AND OCEAN SURVEILLANCE CENTER
ISE WEST ACTIVITY
BOX 130
PEARL HARBOR. HAWAII 96860-5170

EMI/EMC
REFER TO

2000
Ser 322SK/- 50
21 JAN 1993

From: Officer in Charge, Naval Command, Control and Ocean Surveillance Center ISE West Activity
To: Commander, Pacific Division, Naval Facilities Engineering Command (Attn: Code 23)

Subj: ELECTROMAGNETIC COMPATIBILITY (EMC) STUDY FOR THE ROME LABORATORY UHF RADAR SURVEILLANCE TECHNOLOGY EXPERIMENTAL RADAR (RSTER) TESTING AT PACIFIC MISSILE RANGE FACILITY (PMRF), KAUAI, HAWAII (E3 PROGRAM TASK NO. E92-H029)

Ref: (a) PACNAVFACENGCOM ltr Ser 23/5225 of 13 August 92 (NOTAL)
(b) NISE WEST ACT ltr Ser 322SK/1220 of 2 Nov 1992 (NOTAL)
(c) Rome Laboratory OCDR FAX of 23 October 1992 (NOTAL)
(d) Rome Laboratory OCDR FAX of 16 December 1992 (NOTAL)

offline
Encl: (1) Technical Report of the EMC Study for the Rome Laboratory UHF RSTER Testing at PMRF, Kauai, Hawaii

1. As requested by reference (a), NISE West Hawaii conducted an EMC study of the Rome Laboratory UHF Radar Surveillance Technology Experimental Radar (RSTER) testing portion of the Mountaintop Sensor Integration and Test Program (MSITP) at the Pacific Missile Range Facility on Kauai, Hawaii. The RSTER tests will be conducted at three sites; the Hawaii Air National Guard (HIANG) Kokee Air Force Station (AFS), Parcel "A" (formerly known as the NASA Telemetry and Control (T&C) site) at the PMRF Kokee Park Instrumentation Station (KPIS), and the PMRF Makaha Ridge Facility (MRF). The purpose of the EMC study is to determine if the RSTER will cause electromagnetic interference (EMI) to existing RF users and vice versa.

a. Reference (a) also tasked NISE West Hawaii to conduct an electromagnetic radiation (EMR) hazard review of the UHF RSTER testing. The results of the EMR hazards review was provided by reference (b).

b. As advised by reference (c), the L-Band radar is no longer part of the of the MSITP project. However, a fixed linear array radar transmitting system will also be installed on the RSTER tower.

c. Reference (d) advised that an ADS-18s antenna will also be used during RSTER testing. RSTER tests will be conducted first with the AEGIS Adjunct antenna (normally used by RSTER system) then later with the ADS-18s.

d. The preliminary schedule calls for radar installation to begin in April 1994, check-out completed by July 1994, tests completed by August 1995, and the radar removed by November 1995.

2. The RSTER transmitter is capable of operating from 400 to 500 MHz in 1 MHz increments in its frequency hopping mode. Any number of frequencies can be locked out of the frequency set to avoid EMI problems. The RSTER

322SKWPS1\ mac\ PMRF\ MSITP\ E92H029EMI,ETR,TOC,RPT

transmitted frequency is chirped (linearly varied from the start frequency to a frequency 1 MHz lower during its 100 microsecond pulse period).

3. The results of the EMC study are as follow:

a. Co-channel interference is predicted to numerous existing users in the 400 to 420 MHz and 450 to 470 MHz range. Due to predicted co-channel interference to existing users, recommend that the RSTER frequency hop list be limited to the frequency ranges of 420 to 449 MHz and 470 to 500 MHz.

b. In the 420 to 449 MHz range, co-channel interference is predicted for several Command Guidance (CG) and Command Destruct (CD) frequencies used for rocket and missile launches at PMRF. Recommend that the group of frequencies listed in enclosure (1) be locked out for corresponding launches. Also recommend that an administrative procedure be established to allow the Instrumentation Control Center (ICC) in PMRF Range Operations to review and approve the RSTER schedule of tests and test frequencies. Any daily change in test plans should be coordinated with the ICC. Additional information on missile and rocket CG and CD frequencies is available from PMRF Code 7333 (Mr. M. Eichten).

c. Co-channel interference is predicted to RSTER operations at all three sites from the broadband noise transmission across the 425 to 445 MHz band from the AN/ALT-41 at Makaha Ridge or DLQ-3 pods mounted on the PMRF RC-12F aircraft during AN/SPS-40 EW exercises. If the jammers make the 425 to 445 MHz frequency range unusable, recommend that the RSTER operate in the remaining frequency ranges (provided frequency assignment is granted). Jamming exercises are normally conducted once every two weeks for four hours. EW exercise schedules are available from PMRF Code 7332 (Mr. Ed Butrovich).

d. Minimal interference is predicted to existing RF users due to RSTER 2ND and 3RD harmonics and spurious emissions. Additionally, the probability of interference occurring is minimized since the RSTER frequency is constantly changing due to hopping and chirping. The hopping and chirping of the RSTER frequency also makes interference due to intermodulation products improbable.

e. A path blockage problem for the Integrated Target Control System (ITCS), AN/FPQ-12 and AN/APS-134 radars is anticipated at Makaha Ridge due to the large size of the RSTER AEGIS Adjunct antenna. The ITCS signals control the target drones launched by PMRF and the radars ensure range safety during fleet exercises coordinated and monitored by PMRF. Further investigations are being conducted to determine the extent of the problem and means to minimize the blockage. Final resolution should be coordinated with PMRF Code 7322 (Mr. J. Roberts and Mr. R. Miller).

f. If not already done, recommend that a request for frequency assignment be completed and submitted to NCTAMS EASTPAC via the PMRF frequency coordinator (Mr. Jim Bulloch, Code 7325).

4. The EMC study results indicate that site approval granted with regards to EMI by reference (b) is still applicable provided that the

recommendations in Paragraph 3 of this report are also followed. Additionally, as cited in reference (b), the following conditions should be included in the site agreement with Rome Laboratory:

a. RSTER and/or fixed linear array system transmissions will be temporarily suspended if it is suspected that their EMR is interfering with PMRF or HIANG exercises.

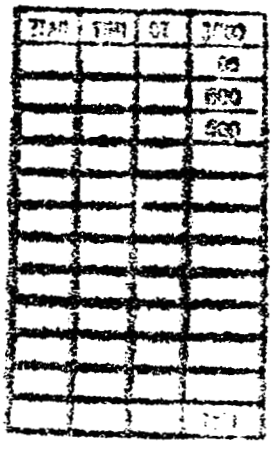
b. Rome Laboratory will correct or fund efforts to correct any RSTER and/or fixed linear array system related EMI problems that are disrupting PMRF or HIANG day-to-day operations.

5. Our point of contact is S.Kobashigawa, DSN (315) 471-1976 or COMM (808) 471-1976.

D.K.L. LEE
By direction

Copy to:
PACMISRANFAC (Codes 7320, 7322, 7324, 7325, 7330, 7331, 7332, and 7333)
COMNAVFACENGCOM (Code 200)
COMSPAWARSYSCOM (Code 224-3A2)
NAVELEXCEN Charleston (Code 222)
ROME Laboratories (Code OCDR, Mr. J. Massoud)

3225K



TECHNICAL REPORT

ELECTROMAGNETIC COMPATIBILITY STUDY FOR THE ROME LABORATORY UHF RADAR SURVEILLANCE TECHNOLOGY EXPERIMENTAL RADAR (RSTER) TESTING AT PACIFIC MISSILE RANGE FACILITY, KAUAI, HAWAII (E3 PROGRAM TASK NO E92-H029)

JANUARY 1993

Survey Personnel: Steve Kobashigawa
Staci Okino

Naval Command, Control and Ocean Surveillance
Center ISE West Activity
Pearl Harbor, Hawaii 96860-5170

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I. INTRODUCTION

A. Objective: The purpose of this study is to determine if the proposed UHF RSTER tests conducted by Rome Laboratories will be electromagnetically compatible with the current RF users on Kauai. Transmissions could begin as early as April 1994 (radar installation start date) and will halt after August 1995 (test completion date).

B. BACKGROUND: The UHF RSTER tests are one part of the Rome Laboratory Mountaintop Sensor Integration Test Program (MSITP) Project being conducted at the Pacific Missile Range Facility (PMRF) and Hawaii Air National Guard (HIANG) Kokee Air Force Station (AFS). NISE West Hawaii was tasked by PACNAVFACENGCOM letter Serial 23/5225 of 13 August 1992 to conduct Radiation Hazard (RADHAZ) and EMC studies for the UHF RSTER tests. The RADHAZ study was completed earlier and forwarded by NISE West Activity letter Serial 322SK/1220 of 2 November 1992.

II. UHF RSTER PROJECT DESCRIPTION

A. The RSTER is being developed by MIT Lincoln Laboratory to provide low level radar coverage over water. Of special interest in the tests will be the ability of the radar to minimize the effect of sea clutter. Three sites selected for the RSTER on Kauai all have the required over-the-water look angle for the test. Two of the three sites are controlled by PMRF. These are Parcel "A" (formerly known as the NASA Telemetry and Control (T&C) site) at the Kokee Park Instrumentation Station (KPIS) and the Makaha Ridge Facility (MRF). The third site is at the HIANG Kokee AFS. See Figure 1 for the location of the proposed RSTER sites on Kauai and Figures 2 through 4 for the RSTER location at each site.

B. The initial test configuration provided by PACNAVFACENGCOM letter Serial 239/4313 of 2 July 1992, included the RSTER and a L-band radar. We were later advised by Rome Laboratory (Code OCDR) FAX of 23 October 1992 that the L-band radar would not be included in the test. Instead, a fixed linear array radar transmitter would be installed on the RSTER antenna tower. Then Rome Laboratory FAX of 16 December 1992 advised that a ADS-18s will also be used during the test along with the original AEGIS Adjunct antenna. The antennas will be swapped during the course of the tests.

C. RSTER Equipment Description: Table 1 lists the RSTER parameters. A brief description of the RSTER follows.

1. The RSTER transmitter and receiver are installed in one 45 foot van and the radar signal processing system in another. Preliminary plans call for installing the RSTER antenna on a tower 4.6 meters (15 feet) above ground level (AGL) at Makaha Ridge and 12.2 meters (40 feet) AGL at the two Kokee sites.

2. The RSTER is capable of transmitting on 1 MHz increments from 400 to 500 MHz in a fixed frequency or frequency hopping format. The transmission is a chirped (linear frequency modulated) pulse 100 microseconds long repeated 625 times per second. The peak output power is 64 kilowatts (kW) and the average power is 4 kW at the antenna input.

a. During frequency hopping, the RSTER remains at one frequency for 50 milliseconds. The RSTER system can notch out any number of frequencies in its 400 to 500 MHz band to minimize EMC problems.

b. As a chirped radar, the frequency of transmission is linearly varied, from the starting frequency to a frequency 1 MHz lower, from the start to the end of the 100 microsecond pulse.

3. The RSTER system uses the 10 meter (32.8 feet) by 5 meter (16.4 feet), phased array AEGIS Adjunct antenna. The antenna may be mounted in two configurations as shown on Figure 5. The mainbeam gain is +28 decibels isotropic (dBi) with sidelobes below -15 dBi. Being a surface search antenna, its minimum elevation angle is -10°. The antenna rotates at 5 revolutions per minute (rpm). Although the mainbeam can be made to scan vertically, tests on Kauai will be conducted without vertical scanning.

4. An ADS-18s linear array antenna (normally mounted in a 7.3 meter (24 foot) diameter dome on a E2C air surveillance aircraft) will also be used during the RSTER tests. The mainbeam gain is 21 dBi with peak sidelobes below -19 dBi and a backlobe of -4 dBi. Since the antenna will be mounted on the AEGIS Adjunct pedestal, it will also rotate at 5 rpm. The array is 0.6 meters (2 feet) high, 6.4 meters (21 feet) wide, and 1.8 meters (6 feet) deep.

D. The fixed linear array system consists of an SD1568HI radar transmitter and a PATCH 1, linear antenna. The transmitter is actually one of the RSTER spare high power linear amplifiers. The linear array transmissions will be identical to those of the RSTER but at a lower peak power level of 600 watts.

1. The PATCH 1 antenna is about 0.6 meters (2 feet) high and 9.8 meters (32 feet) wide and 0.2 meters (.6 feet) deep. It has a mainbeam gain of 5 dBi with peak sidelobes below -10 dBi. Preliminary plans call for installing the antenna on the RSTER antenna tower 2.4 meters (8 feet) AGL at Makaha Ridge and 10.1 meters (33 feet) AGL at the two Kokee sites. Unlike the RSTER antenna, the linear array antenna will be fixed and pointed due West (270°). However, the azimuth of the antenna will be varied from 190° to 350° during the course of the tests.

III. EXISTING SYSTEMS

A. PMRF: PMRF along with other military craft on exercise in the operations area west of Kauai constitutes the largest group of RF users. Figure 6 shows the numerous types of exercises that PMRF coordinates, conducts, and monitors. A brief description of each of these that may be impacted by the RSTER transmissions follow:

1. Missile and small rocket launches are conducted from the Department of Energy (DOE) and PMRF launch complexes both located at the north end of the PMRF Barking Sands base. See Figure 1. The DOE complex, also referred to as the Sandia complex, is managed by Sandia National Laboratories personnel. The following data was collected during meetings with Sandia (Mr. L. Gillette and Mr. A. Lopez), NAVAIRWARCENWPNDIV Code PO3B08 (Ms. I. Hoffer), and PMRF (Mr. M. Eichten and Mr. E. Eichholz) personnel.

a. BQM-34S and MQM-74A Target Drones: The drones serve as targets for anti-aircraft weapons aboard ships and aircraft and are the most frequently launched vehicles. The drones are controlled by the Integrated Target Control System (ITCS) whose transmitter and receiver (AN/TSW-10) are located at Makaha Ridge. The ITCS transmissions are in the *4200* to *4500* MHz frequency range. Although no EMI is anticipated, the proposed RSTER site at Makaha Ridge may create a path blockage problem.

b. Vandals: Vandals serve as targets for anti-missile exercises. Command Guidance and Command Destruct (CG and CD) signals at 437 and 441 MHz are used during Vandal launches.

c. STARS and ODES: The STARS and ODES missiles will be used for atmospheric testing starting in 1993 and ending in *2003.* Four launches are planned per year. The *407* MHz CD signal will be used during the missile launches as well as a 431 MHz relay signal from Kokee Communications (COMMS) (located on KPIS Parcel "C") to an in-flight P-3 aircraft.

(1) The STARS and ODES missiles will be assembled and checked out at the Sandia complex during a one month process. During this time frame, on-air tests will be conducted using the *407* MHz frequency approximately 4 times a week for several hours at a time.

d. Small Rockets: Frequencies used for other rockets including the AQM-37, HARPOON, and TOMAHAWK are 408, 409, 423, and *425* MHz.

e. Transmitter Sites: The CG and CD transmitters are located in the SANDIA operations building and the Kokee COMMS building. SANDIA's transmitting antennas are mounted on the roof of the building. Kokee COMMS antennas are mounted near the top of a 200 foot tower adjacent to the building. For the STARS and ODES launches, a P3 aircraft stationed down range will also be transmitting the CD signal relayed from Kokee COMMS.

2. Electronic Warfare Testing: PMRF conducts numerous EW training exercises for shipboard radars. The only shipboard radar in the *400* to 500

MHz band that PMRF presently works with is the AN/SPS-40. An AN/ALT-41 broadband jammer which transmits 100 watts of broadband noise over the 425 to 445 MHz range simultaneously is normally used in the training exercise. The WALT-41 transmitter is located in Building 770 at Makaha Ridge, see Figure 4. A B-band DQL-3 jammer mounted in a wing pod of PMRF RC-12F aircraft is occasionally used to jam the AN/SPS-40 radar. AN/SPS-40 exercises are conducted approximately once every two weeks and requires four to six hours to complete.

B. Co-site Communications:

1. KPIS: Parcel "A" only houses fiber optic and telephone cable terminations. However, Kokee COMMS houses numerous VHF, UHF, and microwave communications equipment. Antennas for the RF equipment are mounted on a 200 foot tower next to the building.

2. Makaha Ridge Facility: Building 708 at Makaha Ridge houses the VHF, UHF, and microwave communications. Antennas for the RF equipment are mounted on 90 foot poles next to the building.

3. Kokee AFS: There are four areas where VHF and UHF communications equipment are housed. The HIANG radio room, located in the Operations Building, has the greatest amount of equipment including microwave communications equipment. FAA radio equipment are housed in a small building. Both PMRF and Fleet Air Control and Surveillance Facility (FACSFAC) have separate vans for their equipment. The HIANG, FAA, and PMRF antennas are mounted at various levels on 90 foot wooden poles in the antenna field. The FACSFAC antennas are mounted on the roof of the equipment van.

IV. EMC ANALYSIS OF THE IMPACT OF RSTER TO EXISTING RF USERS

A. Co-channel and Adjacent Interference: The requested frequency band of 400 to 500 MHz has been separated into four bands due the nature of their assignments.

1. 400 to 420 MHz: This band has numerous assigned usages that are primarily government or scientifically related. Table 2 lists present frequency assignments from the Enhanced Frequency Resource Records System (EFRRS) data base managed by JFMO PAC. The list includes only frequency assignments of users on the island of Kauai and users with statewide assignments. At the low end of the band are several earth-to-space transmissions used for geological measurements. Numerous other assignments including missile guidance and mobile communications are included in this range. Although the UHF radar experiment calls for transmissions primarily to the west of Kauai, the side and backlobes will interfere with users on western Kauai. The interference may range from a nuisance background noise for non-encrypted voice communications to total disruption of data or encrypted transmissions. The RSTER should not transmit in this band due to the potential for interference.

2. 420 to 449 MHz: This band is primarily assigned for DOD use. As can be seen from Table 2, the only assignments in this band are for PMRF applications in missile or rocket control. Blocks of frequencies surrounding these frequencies should be excluded from the RSTER hop set to preclude interfering with these signals. As cited in the J/F-12 5952 of 25 March 1985, the -60 db emission bandwidth of the RSTER is 3 MHz. Table 3 lists the frequencies that should be locked out for the various launches.

3. 450 to 470 MHz: The 450 MHz slot is reserved for satellite transmissions. The remainder of the band, controlled by FCC, is reserved primarily for public safety, transportation and utilities communications, as well as commercial applications. A search of FCC files shows numerous assignments in this band for Kauai and statewide coverage. The RSTER should not transmit in this band due to the potential for interference.

4. 470 to 500 MHz: This band, controlled by FCC, is primarily reserved for commercial UHF TV Channels 14 through 18. None of these channels are used on Kauai. On Oahu, Channel 14 (KWHE-14) is the only channel in service among the five. KWHE-14 station personnel advised that they have never heard of someone on Kauai receiving their broadcast. Discussions with Kauai residents confirmed KWHE-14's report.

a. On-site tests at the KPIS Parcel "A" showed that KWHE-14 signals from Oahu could not be detected using a test system capable of detecting levels as low as 23 dBuV/m (dB microvolt per meter). KWHE-14's effective radiated power (ERP) is 75 kW and one of its two primary antenna lobes is aimed in the direction of Kauai. Since the maximum RSTER ERP in the direction of Oahu will be 25 kW, the RSTER signal should be below 23 dBuV/m on Oahu. No interference is predicted to KWHE-14 reception on Oahu since the minimal FCC TV standard is 66 dBuV/m (Grade B reception).

B. Harmonic Interference Analysis

1. The second harmonic frequency range for a 400 to 500 MHz operating range will be 800 to 1000 MHz. The primary assignments for this range are UHF TV Channel 69 (800-806 MHz), FCC controlled fixed and mobile services (806 to 960 MHz), and aeronautical radionavigation (960 to 1215 MHz). If the RSTER frequency range is limited to frequencies in the 420 to 449 MHz and 470 to 500 MHz range, no harmonics should be generated below 840 MHz and from 898 to 940 MHz. The 960 to 1000 MHz aeronautical radionavigation band is not in use on Kauai.

a. Of primary concern in the 840 to 960 MHz band is the impact to cellular telephone service. The cellular telephone (remote) receive band is from 869 to 893 MHz.

(1) Table 4 shows the calculated receive signal levels (RSL's) using the second harmonic levels provided in the J/F-12 for the RSTER and using antenna gains from the ECAC-CR-83-117 report dated April 1984 (see Appendix A). The calculated RSL's of 30.4 and 23.4 dBuV (dB microvolt) for mainbeam RSTER illumination within 0.5 miles of the AEGIS Adjunct and ADS-18s antennas, respectively, will be detectable by cellular

phones. Due to sector blanking, mainbeam illumination of areas accessible to the general public will be limited to roadways immediately to the west of the KPIS Parcel "A" site and adjacent to the Kokee AFS. The difference in levels is due to the fact that the AEGIS Adjunct antenna has the same polarization and the ADS-18s is cross polarized from the cellular antennas.

(2) The mass majority of cellular service will be exposed to sidelode and backlobe emissions. The calculated RSL's of -8.9 and -19.6 dBuV within 0.5 miles of the AEGIS Adjunct and ADS-18S, respectively, will be just above and below the -13 dBuV (-120 dB milliwatts(dBm)) noise floor of most cellular phones. The calculated RSL's within 1 mile of the RSTER antennas will be below the -13 dBuV noise floor of the cellular phones.

(3) The potential for interference is very low since the RSTER fundamental frequency is constantly changing due to frequency hopping and chirping, thus limiting time that any interfering harmonic will be transmitted.

2. Third harmonic RSTER emissions will fall within the 1250 to 1350 MHz frequency band of the AN/FPS-93A radar operated Kokee AFS. Table 4 shows the calculated RSL's using the third harmonic levels provided in the J/F-12 for the RSTER and antenna gains provided by the ECAC-CR-83-117 report (see Appendix A). The AN/FPS-93A reception will be from its sidelobes since the RSTER will be located below the AN/FPS-93A's mainbeam. The calculated RSL's are -112.6 and -124.1 dBm for sidelobe and backlobe illumination by the RSTER AEGIS Adjunct and ADS-18s antennas, respectively. Although the AN/FPS-93A's noise floor level is not available, noise floors of other military L-band radars are approximately -108 dBm. Due to system noise, the minimum display threshold levels are typically 16 dB higher than the radar's noise floor. Since the RSTER's third harmonic RSL's will not exceed the estimated -92 dBm display threshold level, it should not interfere with the AN/FPS-93A radar.

C. Spurious Emissions

1. Numerous AN/GRR-24 and AN/GRC-171 UHF receivers operating in the 200 to 400 MHz range at all three sites are potential victims of RSTER spurious emissions. UHF receivers at all three sites will be exposed to sidelobe and backlobe emissions when the RSTER is operated at their sites. Additionally, the Makaha Ridge site will be exposed to mainbeam illumination when the RSTER is operated at the two Kokee sites. Table 5 shows the calculated RSL's using the spurious emission levels provided in the J/F-12 for the RSTER and using antenna gains provided by the ECAC-CR-83-117 report (see Appendix A).

a. Although the antennas mounted on the FACSFAC communications van will be the closest to the RSTER at the Kokee AFS, the majority of the communication antennas are located on wooden poles 113 meters (370 feet) away. The calculated RSL's are -99.7 dBm and -103.5 dBm from the AEGIS Adjunct and ADS-18s antennas, respectively, for these antennas. Although the RSTER RSL's may be above the noise level of the receivers, they are below the minimum -97.5 dBm squelch level of the receivers. The results are

similar for Makaha Ridge and Kokee COMMS except that the RSL's will be lower since the RSTER will be further separated from the UHF antennas.

b. The calculated RSTER RSL's at the Makaha Ridge UHF receiver front ends are -114.2 dBm and -141.2 dBm from the AEGIS Adjunct and ADS-18S, respectively, for the case of mainbeam illumination when the RSTER is located at the two Kokee sites. The calculated RSTER RSL's are anticipated to be below the noise levels of the UHF receivers.

c. As advised by the Rome Laboratory OCDR FAX of 5 January 1993 Rome Laboratory has not experienced any transmitter spurious emissions related problems while operating the RSTER at any time.

D. Intermodulation Analysis: No intermodulation analysis was conducted since the probability of intermodulation products being generated is low due to the changing RSTER frequency as it chirps and hops through numerous frequencies.

E. Path Blockage: The RSTER antenna may create a path blockage problem for the AN/FPQ-12 and AN/APS-134 radars and the ITCS at Makaha Ridge due to the close proximity of RSTER antenna to the other antennas. The path blockage calculations are based on the assumption that the RSTER antenna is mounted in its standard 10 meter wide by 5 meter high configuration with the bottom edge of the antenna 451.1 meters (1480 feet) above mean sea level (AMSL).

1. Both the AN/FPQ-12 and AN/APS-134 radar antennas are located on the roof of Building 715 at Makaha Ridge. The feed point of the AN/FPQ-12 antenna is 462 meters (1516 feet) AMSL. The calculated blockage for the AN/FPQ-12 will be from azimuths 285" to 301°, and from elevation angles -17.5" to -9.4° (see Figure 7). The AN/APS-134 blockage will be very similar to that for the AN/FPQ-12.

2. There are four ITCS antennas numbering from No. 27C601 through No. 27C604. The feed point of the highest and most frequently used antenna, No. 27C601, is 458.4 meters (1503.9 feet) AMSL. The feed point of the lowest and least used antenna, No. 27C604, is 450.2 meters (1476.9 feet) AMSL. The remaining two antennas are located between Nos. 27C601 and 27C604. The calculated blockage for antenna No. 27C601 will be from azimuths 344" to 352°, and from elevation angles -5.7" to -1.8" (see Figure 8). The calculated blockage for antenna No. 27C604 will be from azimuths 356° to 4°, and from elevation angles 0.8° to 5.1".

V. EMC ANALYSIS OF THE IMPACT OF EXISTING RF USERS TO RSTER

A. Co-channel Interference: The primary sources of co-channel interference will be the CG and CD signals used in conjunction with missile and rocket launches and the AN/SPS-40 EW exercises.

1. The interference due to the CG and CD signals will be eliminated when the band of frequencies surrounding the CG and CD signals are locked

out of the RSTER frequency hop set.

2. Interference from the AN/SPS-40 should be almost minimal due to the distance separation, the rotation of both RSTER and AN/SPS-40 mainbeams, and the frequency hopping of the RSTER.

3. The AN/ALT-41 jammer used for AN/SPS-40 EW exercises is predicted to cause interference to the RSTER from 425 to 445 MHz range since it is simultaneously broadcasting noise across the entire band. Table 6 shows the calculated AN/ALT-41 RSL's when the RSTER is operated at Makaha Ridge and at the two Kokee sites. Although not shown by calculations, similar interference is anticipated from the B-band DLQ-3 jammer mounted on the PMRF RC-12F aircraft. Like the AN/ALT-41, the DLQ-3 also transmits 100 watts of broadband noise.

a. At Makaha Ridge, the RSTER will be located in the mainbeam of the AN/ALT-41. RSTER reception will be limited to sidelobe and backlobe pick-up. The calculated AN/ALT-41 RSL's are -16.3 and -25.3 dBm for the AEGIS Adjunct and ADS-18s antennas, respectively. The AN/ALT-41 RSL's exceed the RSTER display threshold level of -110 dBm estimated from the -126 dBm noise floor of the RSTER receiver.

b. At the two Kokee sites, the RSTER will be located in the backlobe of the AN/ALT-41. RSTER reception will be mainbeam and sidelobe pick-up. The calculated AN/ALT-41 RSL's are -35.2 and -62.2 dBm for the AEGIS Adjunct and ADS-18s antennas, respectively, for mainbeam pick-up. For sidelobe pick-up, the calculated RSL's drop to -78.2 and -87.2 dBm for the AEGIS Adjunct and ADS-18s antennas, respectively. All levels exceed the estimated RSTER display threshold of -110 dBm.

B. High Powered Radars: At both the Makaha Ridge and Kokee AFS sites, the RSTER will be operated in close proximity to high powered radars. The closest radar at Makaha Ridge will be the AN/FPQ-12 surface search radar 42.7 meters (140 feet) from the RSTER. The AN/FPS-93A at Kokee AFS will be located 51.8 meters (170 feet) from the RSTER. The projected E-field levels that RSTER equipment will be subjected to are 77.3 V/m from the AN/FPQ-12 and 105.3 V/m from the AN/FPS-93A radars, see Table 7. These E-field levels exceed the 10 V/m MIL-STD-461C radiated susceptibility requirement for Class A3 electronic equipment (ground fixed and mobile equipment). However, since the equipment will be installed in metallic vans no EMI problems are anticipated. The metallic vans should provide the 20 dB of attenuation required to reduce the E-field levels to below 10 V/m.

V. CONCLUSIONS AND RECOMMENDATIONS

A. Due to predicted co-channel interference to existing users, recommend that the RSTER frequency hop list be limited to the frequency ranges of 420 to 449 MHz and 470 to 500 MHz.

B. To avoid predicted co-channel interference to rocket and missile launches, recommend that the group of frequencies listed on Table 3 be locked out for corresponding launches. Most lock-outs will be limited to

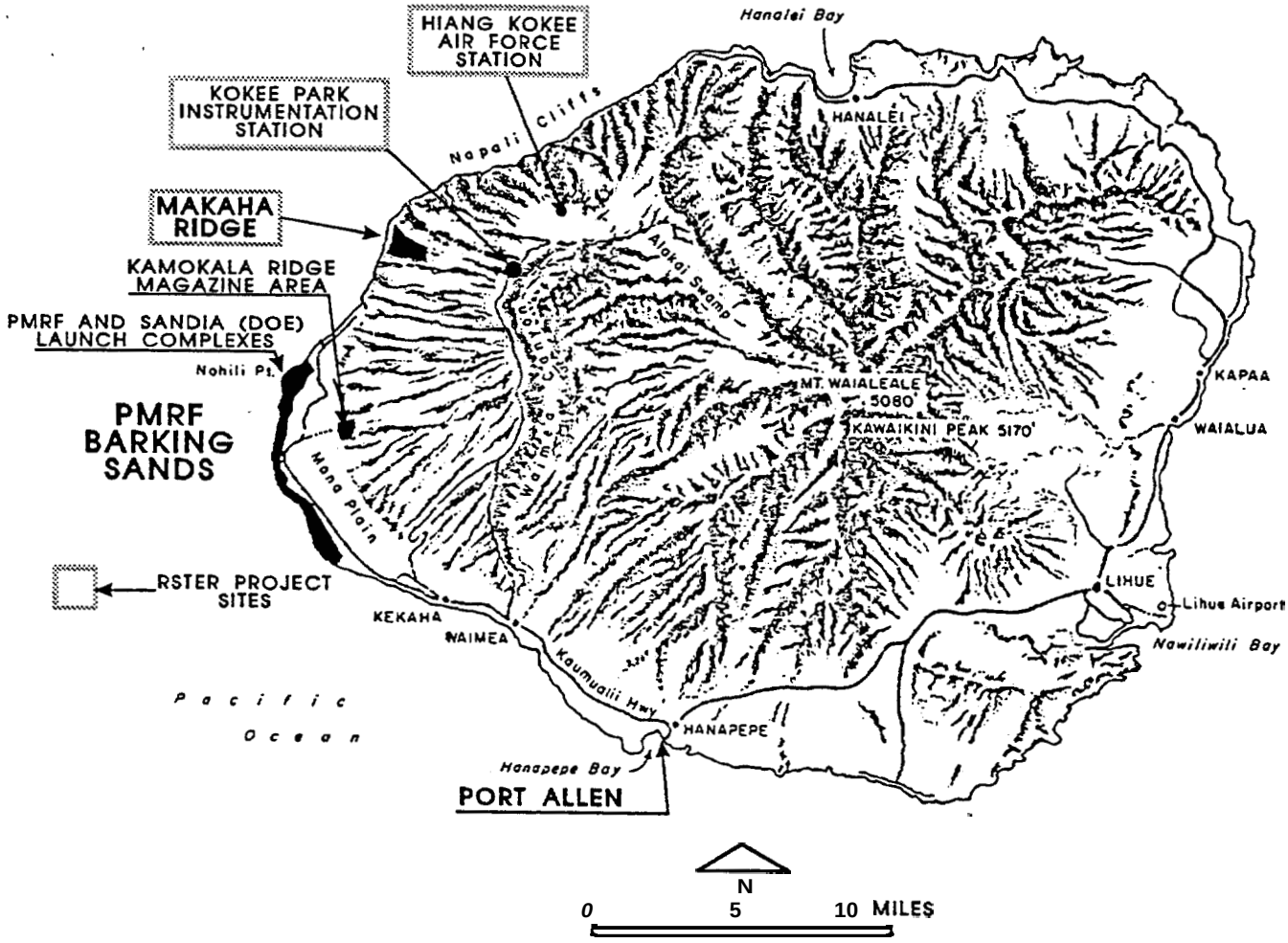
days of launches. However, launches involving STARS and ODES missiles may require month long lock-outs to accommodate the missile assembly and check-out phase. Recommend that an administrative procedure be established to allow the PMRF Instrumentation Control Center (ICC) to review and approve the RSTER schedule of tests and test frequencies. Any daily change in test plans should be coordinated with the ICC.

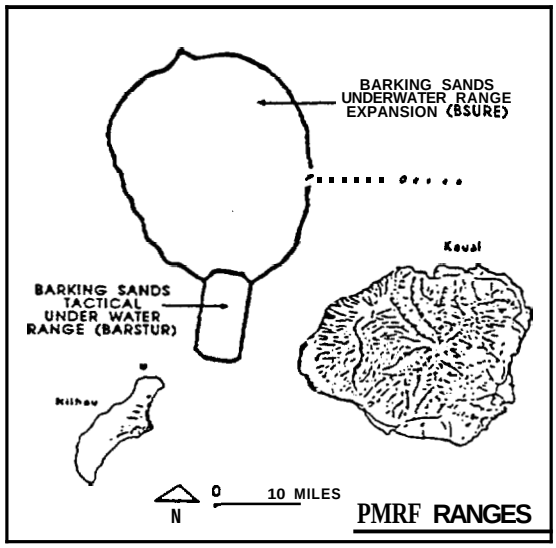
C. Co-channel interference is predicted to RSTER operations at all three sites from the broadband noise transmission across the 425 to 445 MHz band from the AN/ALT-41 at Makaha Ridge or a DLQ-3 pod mounted on the PMRF RC-12F aircraft during AN/SPS-40 EW exercises. If the jammers make the 425 to 445 MHz frequency range unusable, recommend that the RSTER operate in the remaining frequency ranges. Jamming exercises are normally conducted once every two weeks for four to six hours. EW exercise schedules are available from PMRF Code 7332 (Mr. E. Butrovich).

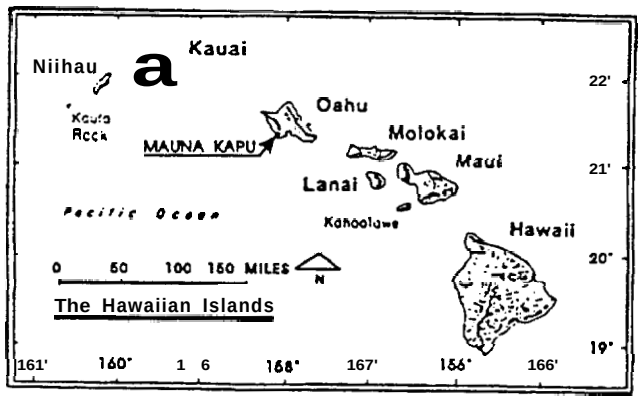
D. Minimal interference is predicted to existing RF users due to RSTER 2ND and 3RD harmonic and spurious emissions. The probability of interference occurring is further minimized since the RSTER frequency is constantly changing due to hopping and chirping. The hopping and chirping of the RSTER frequency also makes interference due to intermodulation products improbable.

E. A potential path blockage problem for the ITCS, AN/FPQ-12 and AN/APS-134 radars is anticipated at Makaha Ridge due to the large size of the RSTER AEGIS Adjunct antenna. The ITCS signals control the target drones launched by PMRF and the radars cited are surface search radars used for range safety. Further investigations are being conducted to determine the extent of the problem and means to minimize the blockage.

F. If not already done, recommend that a request for frequency assignment be completed and submitted via the PMRF frequency manager (Mr. J. Bulloch, Code 7325) to NCTAMS EASTPAC.







LOCATION MAP

ISLAND OF KAUAI

Figure 1. Map of Kauai Showing the Proposed RSTER Sites

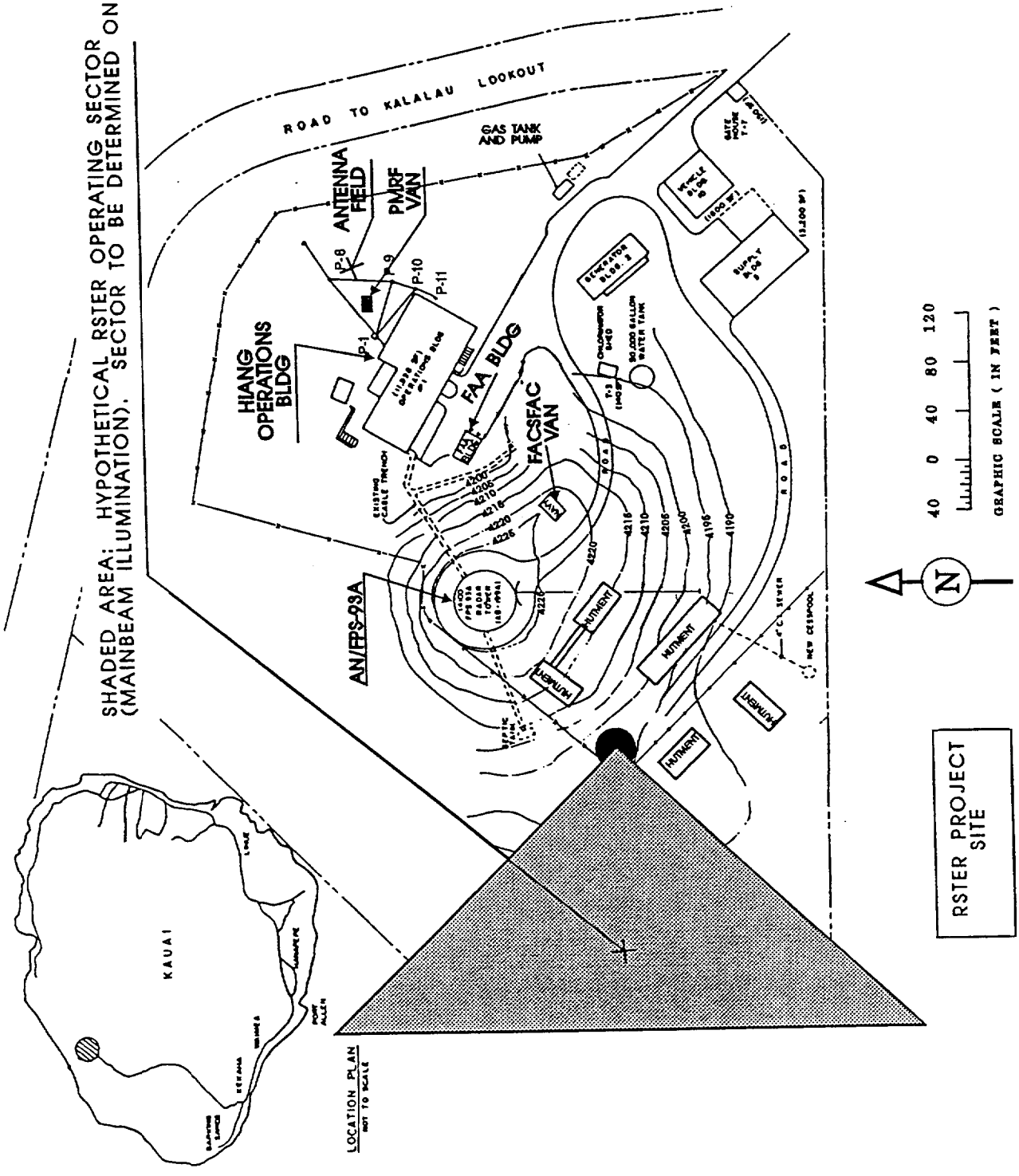


Figure 2 Layout of the HIANG Kokee Air Force Station Showing the RSTER Antenna Location

Figure 3. Layout of the Kokee Park Instrumentation Station Showing the RSTER Antenna Location

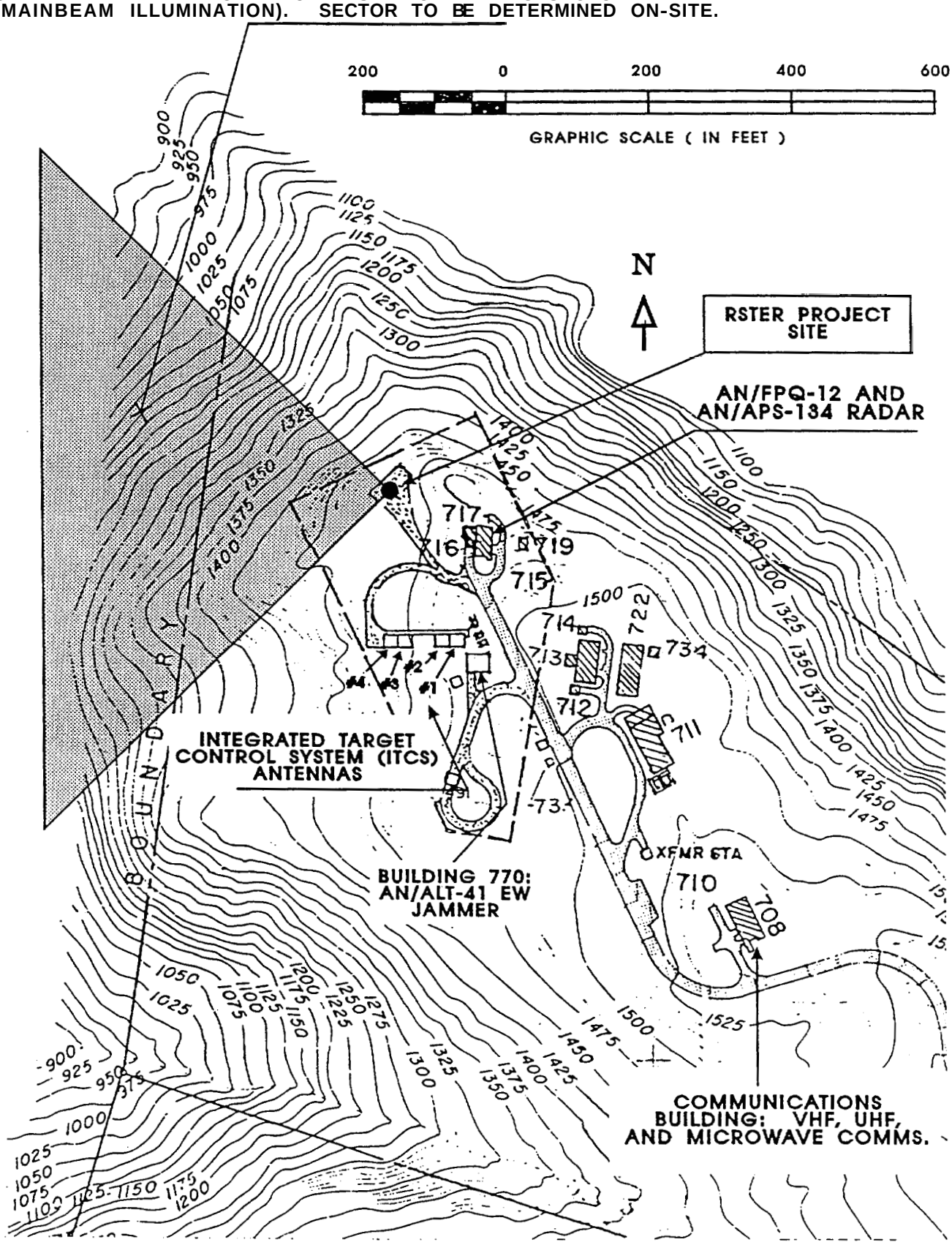


Figure 4. Partial Layout of the Makaha Ridge Facility Showing the RSTER Antenna Location

RSTER AEGIS ADJUNCT ANTENNA

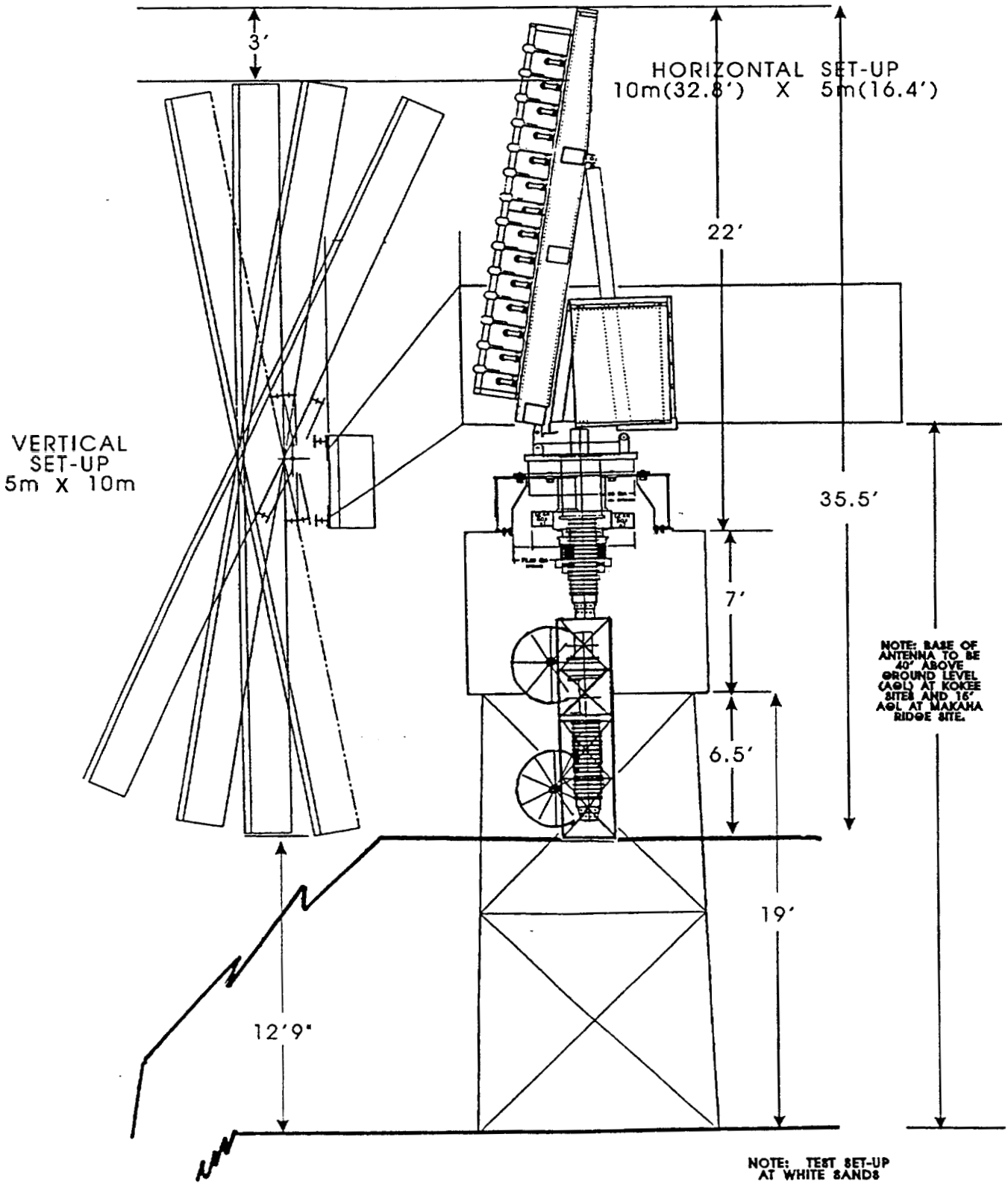


Figure 5. Sketch of the AEGIS Adjunct Antenna

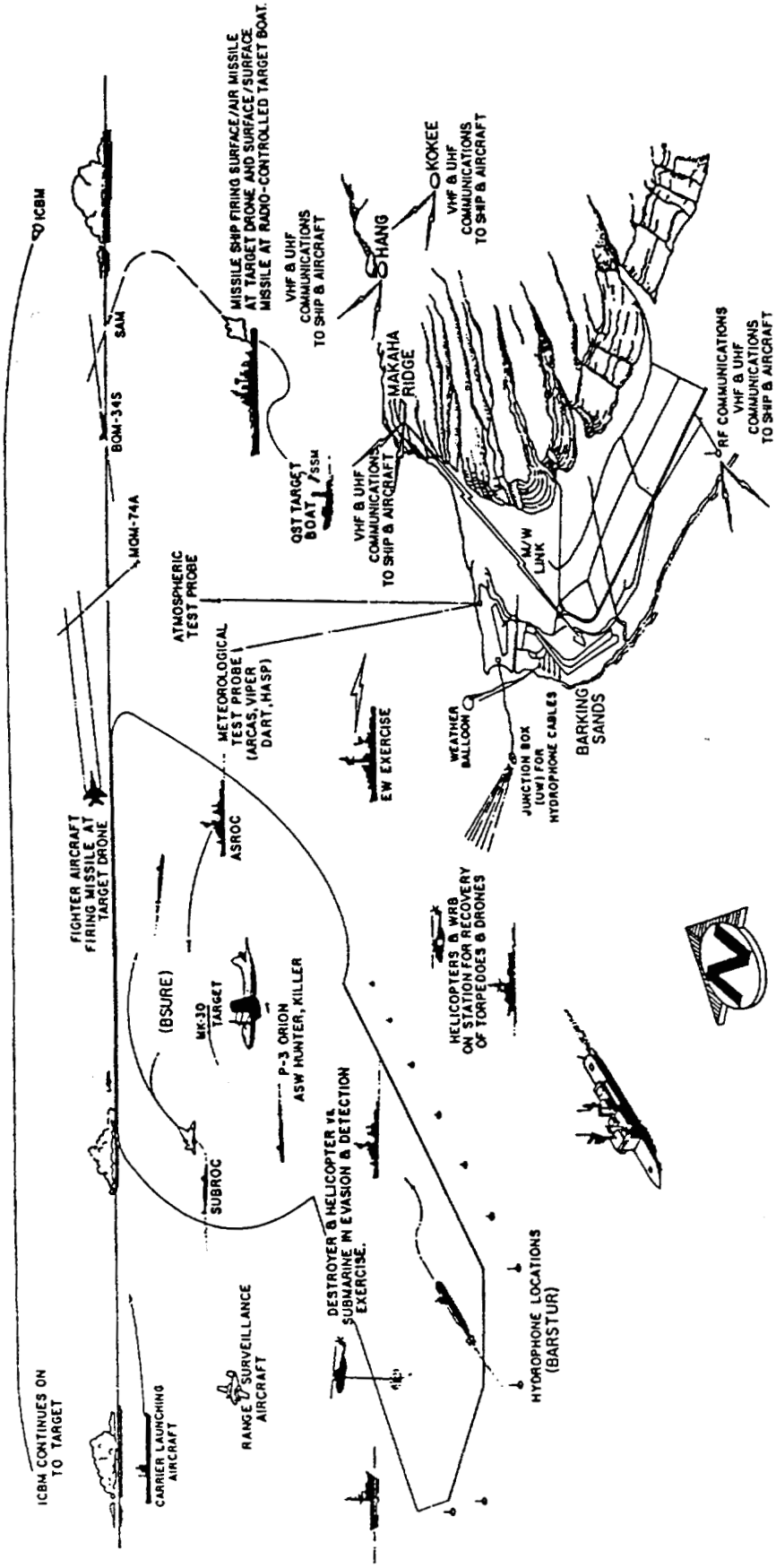


Figure 6. Sketch Showing Typical Pacific Missile Range (PMRF) Operational Functions

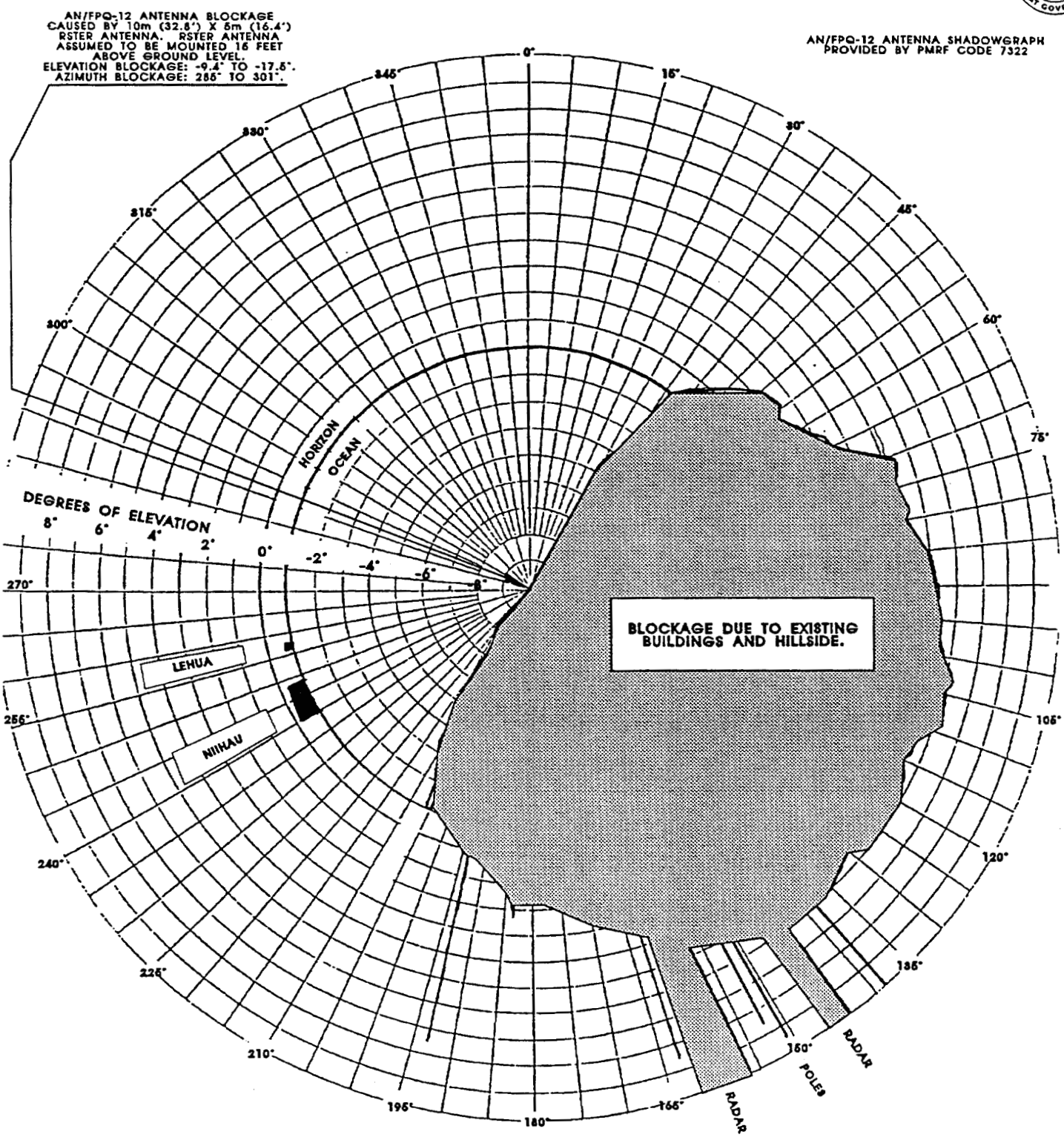


Figure 7. Shadowgraph for the AN/FPQ-12 at Makaha Ridge

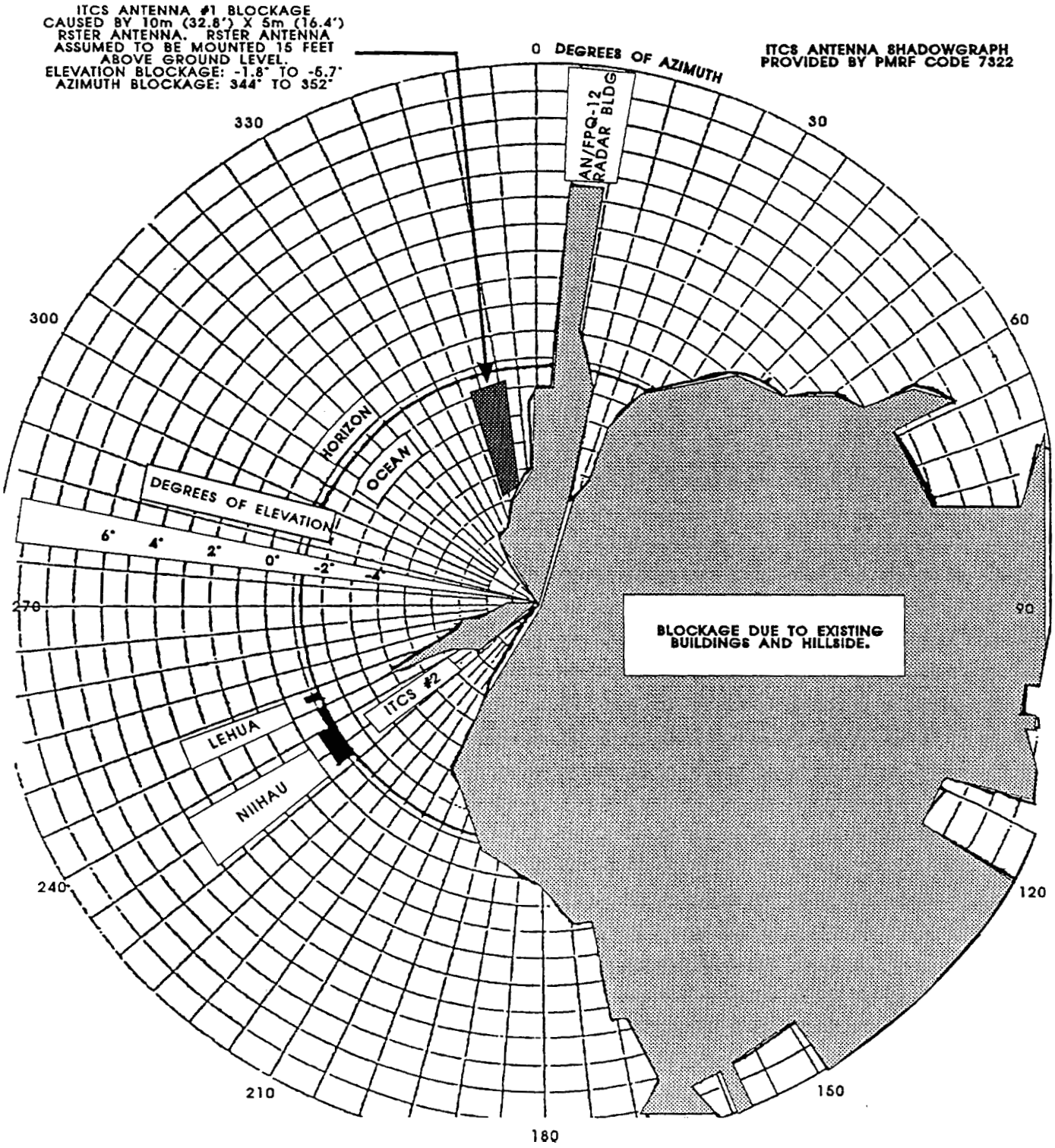


Figure 8. Shadowgraph for the Integrated Target Control System (ITCS) Antenna No. 1 (27C601) at Makaha Ridge

SOURCE: SOURCE DATE(S):	J/F-12 5952 25 MAR 85	ROME LABORATORY 20 MAR AND 4, 12 AND 16 DEC 92
FREQUENCY RANGE		
LOW FREQUENCY (MHz)	420.0	400.0
HIGH FREQUENCY (MHz)	450.0	500.0
MODES	FIXED OR HOPPED	FIXED OR HOPPED
HOP INCREMENT	1 MHZ	1 MHZ
FREQUENCY LOCK OUT?	YES	YES
LOCK OUT CAPABILITY	NO LIMIT	NO LIMIT
PULSE RATE (PPS)	600.0	625.0
PULSE WIDTH (uSEC)	120.0	100.0
PULSE RISE TIME (uSEC)	1.0	NOT LISTED
PULSE FALL TIME (uSEC)	1.0	NOT LISTED
FREQUENCY COMPRESSION	CHIRPPED CW	NOT LISTED
COMPRESSION RATIO	125:1	NOT LISTED
FREQUENCY DEVIATION (MHz)	1 (CALCULATED)	NOT LISTED
TRANSMITTER:		
PEAK POWER (WATTS)	16000.0	64000.0
AVG POWER (WATTS)	1200.0	4000.0
BANDWIDTHS:		
3 dB (MHz)	1.0	NOT LISTED
-20 dB (MHz)	2.2	NOT LISTED
-40 dB (MHz)	2.6	NOT LISTED
-60 dB (MHz)	3.0	NOT LISTED
SPURIOUS EMISSIONS (dB)	-110.0	NOT LISTED
HARMONICS		
2ND (dB)	-90.0	NOT LISTED
3RD (dB)	-120.0	NOT LISTED
OTHERS (dB)	-150.0	NOT LISTED
RECEIVER		
SENSITIVITY (dBm)	-126.0	NOT LISTED
CRITERIA	0 dB SINAD	NOT LISTED
SPURIOUS REJECTION (dB)	100.0	NOT LISTED
IMAGE REJECTION (dB)	100.0	NOT LISTED
FIRST IF FREQUENCY (MHz)	60.0	NOT LISTED
ABOVE OR BELOW TUNED FREQ	ABOVE	NOT LISTED

Table 1. RSTER Transmitter, Receiver, and Antenna Parameters (Sheet 1 of 2)

SOURCE	J/F-12 5952	ROME LABORATORY
ANTENNA	AGEIS ADJUNCT	RSTER
TYPE	PHASEDARRAY	PHASED ARRAY
POLARIZATION	VERTICAL	VERTICAL
MAINBEAM GAIN (dBi)	27.0	28.0
HOR. SIDELOBE (dBi)	-15.0	-15.0
VER. SIDELOBE (dBi)	-15.0	-15.0
BACKLOBE (dBi)	NOT LISTED	NOT LISTED
HOR BEAMWIDTH (DEG)	6.0	6.0
VER. BEAMWIDTH (DEG)	20.0	7.0
MIN ELEVATION ANGLE (DEG)	3.0	-10.0
ROTATION SPEED (RPM)	5.0	5.0
WIDTH (METERS)		10.0
HEIGHT (METERS)		5.0
DEPTH (METERS)		NOT LISTED
ANTENNA		ADS-18S
TYPE		LINEAR ARRAY
POLARIZATION		HORIZONTAL
MAINBEAM GAIN (dBi)		21.0
HOR. SIDELOBE (dBi)		-19.0
VER. SIDELOBE (dBi)		-19.0
BACKLOBE (dBi)		-4.0
HOR BEAMWIDTH (DEG)		7.6
VER. BEAMWIDTH (DEG)		26.0
MIN ELEVATION ANGLE (DEG)		NOT LISTED
ROTATION SPEED (RPM)		5.0
WIDTH (METERS)		6.4
HEIGHT (METERS)		0.6
DEPTH (METERS)		1.8
ANTENNA		PATCH ONE
TYPE		LINEAR ARRAY
MAINBEAM GAIN (dBi)		5.0
HOR. SIDELOBE (dBi)		-10.0
VER. SIDELOBE (dBi)		-10.0
BACKLOBE (dBi)		NOT LISTED
HOR BEAMWIDTH (DEG)		90.0
VER. BEAMWIDTH (DEG)		90.0
MIN ELEVATION ANGLE (DEG)		0.0
ROTATION SPEED (RPM)		0 (FIXED)
WIDTH (METERS)		9.8
HEIGHT (METERS)		0.6
DEPTH (METERS)		0.2

Table 1. RSTER Transmitter, Receiver, and Antenna Parameters (Sheet 2 of 2)

FREQUENCY (MHz)	BAND-WIDTH (KHz)	POWER (WATT)	TRANSMITTER SITE	RECEIVER SITE	SERVICE
398.0000	37.5	50.0	KOKEE AFS	KOKEE	FA, MA
401.2500	23.0	5.0	KOKEE PARK	SPACE	TW
401.2500	23.0	5.0	KOKEE PARK	SPACE	TW
401.7025	1.0	8.0	NAWILIWILI	SPACE	TM
401.7025	1.0	8.0	NAWILIWILI	SPACE	TM
401.7955	1.0	10.0	MT WAIALEALE	SPACE	TM
401.8075	1.0	8.0	PORT ALLEN	SPACE	TM
401.8765	1.0	10.0	MT WAIALEALE	SPACE	TM
406.2500	16.0	25.0	HI	HI	ML
406.5000	360.0	10000.0	WHEELER AFB, OAHU	MISSILES	FAD
406.8250	16.0	25.0	HI	HI	FX, ML
407.0000	500.0	1000.0	BARKING SANDS	SPACE	FLEB
407.4250	16.0	5.0	HI	HI	MO
407.4500	16.0	5.0	HI	HI	ML
407.5000	16.0	5.0	HI	HI	ML
407.8500	36.0	100.0	HI	HI	ML
408.0000	600.0	1000.0	BARKING SANDS	SPACE	FLEB
408.1250	16.0	4.0	HI	HI	FLR
408.5750	16.0	5.0	HI	HI	MO
409.4750	16.0	40.0	BARKING SANDS	KAUAI	FBR, ML, FX
409.5750	16.0	5.0	LIHUE	LIHUE, KA	FX
409.5750	16.0	5.0	LIHUE	LIHUE, KA	FX
409.8250	16.0	90.0	HI	HI	FXR
410.0750	16.0	5.0	LIHUE	LIHUE, KA	FX
410.9750	16.0	10.0	HI	HI	FX
411.1 250	16.0	10.0	HI	HI	FLR
411.2500	16.0	90.0	HI	HI	MLR
412.5000	16.0	100.0	HI	HI	MO
412.7000	16.0	40.0	BARKING SANDS	KAUAI	FX, FB, ML
412.9000	16.0	40.0	HI	HI	ML
413.0250	16.0	4.0	HI	HI	ML
413.9750	16.0	100.0	HI	HI	MO
414.7000	16.0	100.0	HI	HI	ML, MLP
415.0000	16.0	100.0	HI	HI	ML, MLP
415.6000	16.0	100.0	HI	HI	MO
415.7000	36.0	100.0	HI	HI	MO
415.7250	16.0	100.0	HI	HI	ML, MLP

Table 2. Enhanced Frequency Resource Records System (EFRRS) Frequency Assignments in the 399 to 445 MHz Frequency Band for the Island of Kauai or Statewide Usage (Sheet 1 of 2)

FREQUENCY (MHz)	BAND-WIDTH (KHz)	POWER (WATT)	TRANSMITTER SITE	RECEIVER SITE	SERVICE
416.0500	16.0	100.0	HI	HI	MO
416.2000	16.0	100.0	HI	HI	MO
416.3250	16.0	100.0	HI	HI	MO
416.5000	360.0	10000.0	WHEELER AFB, OAHU	MISSILES	FAD
417.0000	600.0	1000.0	BARKING SANDS	KAUAI	FLD
417.0500	16.0	60.0	HI	HI	MO
417.1750	16.0	60.0	HI	HI	MO
417.3250	16.0	100.0	HI	HI	MO
418.0500	16.0	6.0	KEKAHA	KEKAHA	ML
418.0500	16.0	30.0	KOKOLE PT	KOKOLE PT	MLP, ML
418.0500	16.0	30.0	WAIMEA	WAIMEA	ML
418.0500	16.0	6.0	BARKING SANDS	BARKING SANDS	ML
418.5750	16.0	30.0	KOKOLE PT	KOKOLE PT	MLP, ML
418.6750	16.0	100.0	HI	HI	MO
418.7500	16.0	100.0	HI	HI	MO
418.8250	16.0	100.0	HI	HI	MO
418.9250	16.0	60.0	HI	HI	MO
425.0000	300.0	1000.0	BARKING SANDS	BARKING SANDS	FAD
431.0000	300.0	1000.0	BARKING SANDS	BARKING SANDS	FAD
437.0000	300.0	1000.0	BARKING SANDS	BARKING SANDS	FLD
441.0000	300.0	1000.0	BARKING SANDS	BARKING SANDS	FLD
445.0000	300.0	1000.0	BARKING SANDS	BARKING SANDS	FLD

LEGEND:

FA: AERONAUTICAL MOBILE

FAD: AERONAUTICAL WEATHER?

FB: LAND MOBILE, BASE

FBR: LAND BASE RADIOLOCATION?

FLD: TELECOMMAND LAND STATION

FLEB: FLIGHT TELEMETERING LAND

FLR: LAND STATION, RADIOLOCATION

FX: FIXED

FXR: FIXED RADIOLOCATION?

ML: LAND MOBILE STATION

MLP: UNKNOWN

MLR: UNKNOWN

MO: MOBILE

TM: METEROLOGICAL SATELLITE EARTH STATION

TW: EARTH EXPLORATION SATELLITE EARTH STATION

Table 2. Enhanced Frequency Resource Records System (EFRRS) Frequency Assignments in the 399 to 445 MHz Frequency Band for the Island of Kauai or Statewide Usage (Sheet 2 of 2)

FREQ-UENCY	VANDAL		STARS AND ODES		HARPOON		TOMAHAWK		AQM-37	
(MHZ)	CONTROL SIGNAL	LOCK-OUT	CONTROL SIGNAL	LOCK-OUT	CONTROL SIGNAL	LOCK-OUT	CONTROL SIGNAL	LOCK-OUT	CONTROL SIGNAL	LOCK-OUT
420										
421										
422										
423										
424										
425										
426										
427										
428										
429										
430										
431										
432										
433										
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442										
443										
444										
445										
446										
447										
448										
449										

NOTE: RECOMMENDED RSTER OPERATING RANGES ARE 420 TO 449 MHZ AND 470 TO 500 MHZ.
MISSILE AND ROCKET FREQUENCIES FROM 400 TO 420 ARE NOT SHOWN.

NOTE: FOR FURTHER INFORMATION ON MISSILE AND ROCKET FREQUENCIES CONTACT:
PMRF CODE 7333 (MR. M. EICHTEN), SANDIA LABS SITE MANAGER (MR. L. GILLETTE),
OR NAVAIRWARCENWPNDIV CODE P03B08 (MS. I. HOFFER).

Table 3. RSTER Frequency Lock-out Table for Missile and Rocket Launches

Table 4 Calculated RSTER 2ND and 3RD Harmonic Levels

RSTER SECOND HARMONIC EMISSIONS, MAINBEAM ILLUMINATION

VICTIMS: CELLULAR TELEPHONES

RSTER TRANSMIT ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 2ND HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	E-FIELD (dBuV/m)	RECEIVER ANTENNA GAIN (dBi)	RECEIVE SIGNAL LEVEL (dBuV)
AGEIS AD.	64000	-90	18.0	4.0E-03	0.50	52.7	0	30.4
ADS-18S **	64000	-90	11.0	8.1E-04	0.50	45.7	0	23.4

RSTER SECOND HARMONIC EMISSIONS, SIDELOBE AND BACKLOBE ILLUMINATION

VICTIMS: CELLULAR TELEPHONES

RSTER TRANSMIT ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 2ND HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	E-FIELD (dBuV/m)	RECEIVER ANTENNA GAIN (dBi)	RECEIVE SIGNAL LEVEL (dBuV)
AGEIS AD.	64000	-90	-21.3	4.7E-07	0.50	13.4	0	-8.9
ADS-18s **	64000	-90	-32.0	4.0E-08	0.50	2.7	0	-19.6
AGEIS AD.	64000	-90	-21.3	4.7E-07	1.00	7.3	0	-14.9
ADS-18S **	64000	-90	-32.0	4.0E-08	1.00	-3.4	0	-25.6

RSTER THIRD HARMONIC EMISSIONS, SIDELOBE AND BACKLOBE ILLUMINATION

VICTIM: HIANG L-BAND RADAR RECEIVER, SIDELOBE RECEPTION

RSTER TRANSMIT ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 3RD HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	E-FIELD (dBuV/m)	RECEIVE SIGNAL LEVEL (dBuV)	RECEIVE SIGNAL LEVEL (dBm)
AGEIS AD.	64000	-120	-0.5	5.7E-08	0.04	25.5	-5.6	-112.6
ADS-18S **	64000	-120	-9.0	8.1E-09	0.04	17.0	-17.1	-124.1

* RSTER ANTENNA GAIN: SEE APPENDIX A FOR DERIVATION OF ANTENNA GAINS FOR HARMONIC EMISSIONS.

** ADS-18S GAINS REDUCED DUE TO CROSS POLARIZATION LOSS (HORIZONTAL TRANSMIT/VERTICAL RECEIVE). SEE APPENDIX A.

Table 5 Calculated RSTER Spurious Emissions

RSTER TRANSMITTER SPURIOUS EMISSIONS, SIDELOBE AND BACKLOBE ILLUMINATION

VICTIM: UHF RECEIVERS AT HIANG

RSTER TRANSMIT ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER SPURIOUS LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	E-FIELD (dBuV/m)	RECEIVER ANTENNA GAIN (dBi)	RECEIVE SIGNAL LEVEL (dBuV)	RECEIVE SIGNAL LEVEL (dBm)
AGEIS AD.	64000	-110	-4.6	2.2E-07	0.07	26.6	3	7.3	-99.7
ADS-18S **	64000	-110	-8.4	9.3E-08	0.07	22.8	3	3.5	-103.5

RSTER TRANSMITTER SPURIOUS EMISSIONS, SIDELOBE AND BACKLOBE ILLUMINATION

VICTIM: UHF RECEIVERS AT MAKAHA RIDGE

RSTER TRANSMIT ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER SPURIOUS LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	E-FIELD (dBuV/m)	RECEIVER ANTENNA GAIN (dBi)	RECEIVE SIGNAL LEVEL (dBuV)	RECEIVE SIGNAL LEVEL (dBm)
AGEIS AD.	64000	-110	-4.6	2.2E-07	0.10	23.5	3	4.2	-102.8
ADS-18S **	64000	-110	-8.4	9.3E-08	0.10	19.7	3	0.4	-106.6

RSTER TRANSMITTER SPURIOUS EMISSIONS, MAINBEAM ILLUMINATION

VICTIM: MAKAHA RIDGE UHF RECEIVERS IN MAINBEAM OF TRANSMISSIONS FROM KOKEE SITES

RSTER TRANSMIT ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER SPURIOUS LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	E-FIELD (dBuV/m)	RECEIVER ANTENNA GAIN (dBi)	RECEIVE SIGNAL LEVEL (dBuV)	RECEIVE SIGNAL LEVEL (dBm)
AGEIS AD.	64000	-110	18.0	4.0E-05	5.00	12.1	3	-7.2	-114.2
ADS-18s **	64000	-110	-9.0	8.1E-08	5.00	-14.9	3	-34.2	-141.2

* RSTER ANTENNA GAIN: SEE APPENDIX A FOR DERIVATION OF ANTENNA GAINS FOR SPURIOUS EMISSIONS.

** ADS-18S GAINS REDUCED DUE TO CROSS POLARIZATION LOSS (HORIZONTAL TRANSMIT/VERTICAL RECEIVE). SEE APPENDIX A.

Table 6. Calculated AN/ALT-41 Receive Signal Levels (RSL's)

IMPACT OF AN/ALT-41 EW JAMMER (425-445 MHZ) AT MAKAHA RIDGE, MAINBEAM ILLUMINATION

VICTIM: RSTER RECEIVER AT MAKAHA RIDGE, SIDELOBE OR BACKLOBE RECEPTION

RECEIVE ANTENNA	ALT-41 TRANSMIT POWER (WATTS)	ALT-41 ANTENNA GAIN (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	E-FIELD (dBuV/m)	RECEIVER ANTENNA GAIN (dB)	RECEIVE SIGNAL LEVEL (dBuV)	RECEIVE SIGNAL LEVEL (dBm)
AGEIS AD.	100	10	1.0E+03	0.04	128.0	-15	90.7	-16.3
ADS-18s **	100	10	1.0E+03	0.04	128.0	-24	81.7	-25.3

IMPACT OF AN/ALT-41 EW JAMMER (425-445 MHZ) AT MAKAHA RIDGE, SIDELOBE ILLUMINATION

VICTIM: RSTER RECEIVER AT KOKEE SITES, MAINBEAM RECEPTION

RECEIVE ANTENNA	ALT-41 TRANSMIT POWER (WATTS)	ALT-41 ANTENNA GAIN (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	E-FIELD (dBuV/m)	RECEIVER ANTENNA GAIN (dB)	RECEIVE SIGNAL LEVEL (dBuV)	RECEIVE SIGNAL LEVEL (dBm)
AGEIS AD.	100	-10	1.0E+01	5	66.0	28	71.8	-35.2
ADS-18S **	100	-10	1.0E+01	5	66.0	1	44.8	-62.2

IMPACT OF AN/ALT-41 EW JAMMER (425-445 MHZ) AT MAKAHA RIDGE, SIDELOBE ILLUMINATION

VICTIM: RSTER RECEIVER AT KOKEE SITES, SIDELOBE AND BACKLOBE RECEPTION

RECEIVE ANTENNA	ALT-41 TRANSMIT POWER (WATTS)	ALT-41 ANTENNA GAIN (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	E-FIELD (dBuV/m)	RECEIVER ANTENNA GAIN (dB)	RECEIVE SIGNAL LEVEL (dBuV)	RECEIVE SIGNAL LEVEL (dBm)
AGEIS AD.	100	-10	1.0E+01	5	66.0	-15	28.8	-78.2
ADS-18s **	100	-10	1.0E+01	5	66.0	-24	19.8	-87.2

** ADS-18s GAINS REDUCED BY 20 dB DUE TO CROSS POLARIZATION LOSS (VERICAL TRANSMIT/HORIZONTAL RECEIVE).

Table 7 Calculated E-Field Strengths from the AN/FPQ-12 and AN/FPS-93A Radars at Makaha Ridge and the Kokee AFS, Respectively

IMPACT OF MAKAHA RIDGE AN/FPQ-12 RADAR (2927-3030 MHz), MAINBEAM ILLUMINATION

VICTIM: RSTER RECEIVER AT KOKEE SITES, BACKLOBE RECEPTION

RADAR	E-FIELD (V/m)
AN/FPQ-12	77.3

NOTE: E-FIELD LEVEL BASED ON A 1.5 mW/cm^2 READING TAKEN IN THE MAINBEAM OF THE AN/FPQ-12 DURING A PREVIOUS RADIATION HAZARD SURVEY IN 1991. THE MEASUREMENT DISTANCE WAS ALMOST EQUAL TO THE DISTANCE BETWEEN THE AN/FPQ-12 AND THE RSTER SITE.

IMPACT OF KOKEE AFS AN/FPS-93A RADAR (1250-1350), SIDELOBE ILLUMINATION

VICTIM: RSTER RECEIVER AT KOKEE AFS, BACKLOBE RECEPTION

RADAR	AN/FPS-93A TRANSMIT POWER (WATTS)	AN/FPS-93A ANTENNA GAIN (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	E-FIELD (V/m)
AN/FPQ-93	2200000	1	2.8E+06	0.05	105.3

NOTE: SEE APPENDIX A FOR DERIVATION OF AN/FPS-93A ANTENNA GAIN.

APPENDIX A

RADAR ANTENNA GAINS FOR OUT OF BAND FREQUENCIES

The following pages were copied from ECAC-CR-83-117, "Design Electronics Alaorithm (DEEAL) Theory Manual", of April 1984 prepared by T. Lesniakowski and M. Maiuzzo. The radar antenna gains cited are based on two technical notes written in 1974 by S. Guccione (one coauthored by H. Ricker III).

The antenna gain data is provided as a median gain "G" and the standard deviation of the gain. Based on a gaussian distribution of gain values, the probability of an antenna gain being less than one standard deviation above the mean value is 84% and the probability of the gain being less than two standard deviations above the mean value is 92.5%. The gains used in this report are equal to the mean gain plus one standard deviation since the gains two standard deviations above the mean seemed to be unrealistically high.

b. For harmonic interaction perform the following calculations:

1. In the mainbeam region, the gain for any out-of-band frequency gain for any out-of-band frequency is assumed to be 10 dB below the mainbeam gain, in-band, at the fundamental frequency. If the antennas are cross polarized, reduce the mainbeam gain by additional 20 dB. The receiver antenna gain is provided in the REF.

2a. In the sidelobe region, the median gain and standard deviations for the transmitting antenna and beam type are obtained in columns 5 or 6, for a matched or cross-polarized condition, respectively.

2b. In the sidelobe region, the median gain and standard deviation for the receiving antenna and beam type are obtained under column heading f_o from TABLE 5.

c. For adjacent-signal (transmitter) or spurious-response interactions perform the following:

1. In the mainbeam region, both the transmitter and receiver antenna gains are provided in the REF.

2a. In the sidelobe region, the median gain and standard deviations for the transmitting antenna and beam type are obtained under column heading f_o from TABLES 5 or 6, for a matched or cross-polarized condition, respectively.

2b. In the sidelobe region, the median gain and standard deviation for the receiving antenna and beam type are obtained under column heading f_o from TABLE 5.

SABLE 5

HARMONIC MEDIAN GAINS AND STANDARD DEVIATIONS FOR **RADAR** ANTENNAS,
(Matched Polarization)

Antenna Type	Type	Median Gain, $\bar{G}$, in dBi and standard deviation, σ, in dB													
		f_o		$2f_o$		$3f_o$		$4f_o$		$5f_o$		$6f_o$		$7f_o$	
		$\bar{G}$	σ	$\bar{G}$	σ	$\bar{G}$	σ	$\bar{G}$	σ	$\bar{G}$	σ	$\bar{G}$	σ	$\bar{G}$	σ
Arrays	Fan or pencil	-14.1	9.5	-28.4	7.1	-11.0	10.5	-20.2	8.1	-4.6	13.6	-29.7	6.7	-9.1	5.4
Frequency scanning arrays	Fan or pencil	-14.0	14.9	-14.3	3.2	-	-	-	-	-	-	-	-	-	-
Parabolic dish	Pencil	-11.	12.0	-18.9	7.2	-	-	-	-	-	-	-	-	-	-
Parabolic section	Fan	-9.8	8.8	-16.4	6.9	-10.8	8.2	-13.8	8.2	-	-	-	-	-	-
Parabolic section	Cosecant squared	-10.1	7.8	-20.9	6.5	-13.1	11.6	-19.0	19.9	-	-	-	-	-	-

NOTE: For those harmonics where measured data is not available, the median gain is assumed equal to the fundamental gain for a particular antenna type and beam type minus 5 dB accounting **for** nondesign frequency effects of antenna and microwavo components.[15] The standard **deviation** for **these** harmonics will be assumed equal to the standard deviation of the fundamental for a particular antenna type and beam type.

TABLE 6

HARMONIC MEDIAN GAINS AND STANDARD DEVIATIONS FOR RADAR ANTENNAS,
(Cross polarization)

Antenna Type	Type	'Median Gain, G, in dBi and standard deviation, a, in dB													
		f_o		$2f_o$		3f		$4f_o$		5f		$6f_o$		$7f_o$	
		G	σ	G	a	G	σ	G	a	G	a	G	σ	G	σ
Arrays	Fan or pencil	-20.2	11.8	-36.2	4.2	-15.0	6.0	-24.1	6.2	-16.9	7.1	-33.6	5.0	-16.7	6.2
Frequency scanning arrays	Fan or pencil	-20.4	22.1	-25.0	4.0	-	-	-	-	-	-	-	-	-	-
Parabolic dish	Pencil	-12.9	10.9	-	-	-	-	-	-	-	-	-	-	-	-
Parabolic section	Fan	-8.8	5.8	-17.6	8.6	-15.3	8.0	-8.0	6.7	-	-	-	-	-	-
Parabolic section	Cosecant squared	-15.7	9.6	-14.8	19.7	-14.3	12.4	-28.5	7.0	-	-	-	-	-	-

NOTE: For those harmonics where measured data is not available, the median gain is assumed equal to the fundamental gain for a particular antenna type and beam type minus 5 dB accounting for nondesign frequency effects of antenna and microwave components.[15] The standard deviation for those harmonics will be assumed equal to the standard deviation of the fundamental for a particular antenna type and beam type.

DEPARTMENT OF THE NAVY
NAVAL COMMAND. CONTROL AND OCEAN SURVEILLANCE CENTER
ISE WEST ACTIVITY
BOX 130
PEARL HARBOR. HAWAII 96860-5170

REFER TO:
2000
Ser 322SK/1110
03 DEC 1993

From: Officer in Charge, Naval Command, Control and Ocean Surveillance Center In-Service Engineering West Activity
To: Commander, Pacific Division, Naval Facilities Engineering Command (Attn: Code 23)

Subj: AMENDMENT TWO TO THE ELECTROMAGNETIC COMPATIBILITY(EMC) STUDY FOR THE ROME LABORATORY UHF RADAR SURVEILLANCE TECHNOLOGY EXPERIMENTAL RADAR (RSTER) TESTING AT PACIFIC MISSILE RANGE FACILITY(PMRF), KAUAI, HAWAII (E3 PROGRAM TASK NO. E92-H029)

Ref: (a) NASA ltr Ser JXG of 3 Aug 1993 (NOTAL)
(b) PACNAVFACENGCOM "Draft Environmental Assessment(EA) - Mountaintop Sensor Integration and Test Program; Kauai, Hawaii" dated April 1993 (NOTAL)
(c) NISE WEST HAWAII ltr Ser 322SK/50 of 21 Jan 1993 (NOTAL)
(d) NISE WEST HAWAII ltr Ser 322SK/490 of 4 Jun 1993 (NOTAL)
(e) PHONCON MIT Lincoln Laboratory(L. Goodman)/NISE WEST HAWAII(S. Kobashigawa) of 17 Sep 1993
(f) PHONCON NASA Wallops Island Frequency Coordinator (R. Smith)/NISE WEST HAWAII(S. Kobashigawa) of 27 Sep 1993
(g) PHONCON White Sands Missile Range DOD Frequency Coordinator (D. Baldwin)/NISE WEST HAWAII(S. Kobashigawa) of 28 Sep 1993
(h) NASA ltr Ser JXG of 3 Dec 1993 (NOTAL)

Encl: (1) EMC STUDY OF THE IMPACT OF THE UHF RSTER TESTING TO NASA OPERATIONS AT THE KOKEE PARK INSTRUMENTATION STATION

1. Reference(a), the National Aeronautics and Space Administration's (NASA's) review of reference(b) pointed out an oversight in the EMC portion of the EA. As noted, the EMC portion based on reference(c) (our EMC study of the RSTER testing at Kauai) failed to address any NASA system at the Kokee Park Instrumentation Station(KPIS). This second amendment to reference(c) specifically covers the impact of the RSTER testing conducted at Parcel "A" in the KPIS and at the Kokee Air Force Station(AFS) to the NASA systems at the Kokee Park Geophysical Observatory(KPGO) at Parcel "E" of KPIS. As noted in reference(a), no EMC problems are anticipated from RSTER testing conducted from the Makaha Ridge sites which are located well below the KPIS and blocked by heavy forested ridges. Reference(d), the first amendment to reference(c) discussed the EMC impact of operating the RSTER at the alternate site at the PMRF Makaha Ridge Facility.

2. The results of this study predict that RSTER fourth harmonic emissions from the Parcel "A" site will exceed the received signal level of the Pan-Pacific Educational and Communications Experiments by Satellite(PEACESAT) downlinks between 1.689 to 1.694 GHz from the National Oceanic and Atmospheric Administration(NOAA) GOES-3 satellite. RSTER fifth harmonic emissions from both sites are predicted to exceed the receiver noise levels of the NASA

Unified S-band (USB) and U.S. Naval Observatory (USNO) Very Long Baseline Interferometry (VLBI) systems that collect signals in the 2.2 to 2.4 GHz band. The fifth harmonic emissions will also exceed the +20 dB RF calibration signal used in the VLBI system. No other harmonic or subharmonic electromagnetic interference (EMI) are predicted. Calculations indicate that the RSTER electromagnetic radiation (EMR) levels in the sector blanked area will not exceed known radiated susceptibility criteria and no EMI due to case penetration is predicted. Although the KPGO site is out of the RSTER operational sector at Kokee AFS, due to the beamwidth of the RSTER antenna the KPGO will be subjected to RSTER mainbeam transmissions. EMI is predicted from these levels since they exceed: test levels shown to cause EMI, minimum DOD MIL-STD-461C (recently superseded) and -D (current) radiated susceptibility criteria, and EMR levels from nearby PMRF UHF transmissions that presently do not cause EMI in the USB and VLBI systems. Enclosure (1) provides the technical report of the study.

3. The fourth and fifth harmonic EMI predictions are based on assumed worst case harmonic emissions from the RSTER transmitter and fourth and fifth harmonic antenna gains of a generic array antenna. Presently, there are no data on the RSTER radiated fourth and fifth harmonic emissions.

As discussed in reference (e), the RSTER has been operating at the NASA Wallops Island Flight Test Center in Virginia and at the White Sands Missile Range, New Mexico, without any reports of EMI aside from co-channel frequency conflicts. As confirmed in references (f) and (g), no EMI was experienced by other S-band satellite communications systems at Wallops Island or the White Sands Missile Range. The distances between the RSTER and the other S-band systems were 7 miles at Wallops Island and 50 miles at White Sands.

4. As advised during reference (e), as an experimental radar, the RSTER's average daily transmission time is only 2 hours with most of the time being spent evaluating test results and designing new tests. Occasionally, the RSTER does transmit eight hours a day for two to three consecutive days. Conversely, there are other periods when no RSTER transmissions are made during an entire week.

5. Based on meetings between the Advance Research Projects Agency (ARPA) and NASA, and the preliminary findings of this study, reference (h) advises that NASA's input to the final EA will be that of "finding of no significant impact" provided that the recommendations listed below are followed.

6. Based on reference (h) and the results of this study, the following conditions should be added to the future real estate agreement with Rome Laboratory with regards to RSTER operations at the Parcel "A" and Kokee AFS sites:

a. Prior to planning the installation of the RSTER radar at either site, an operations planning document should be submitted for approval to the NASA KPGO site manager (Mr. Clyde Cox) in order to preclude possible interference with existing or planned NASA, NOAA, and USNO sensor and communications programs. NASA must be consulted prior to any RSTER operations at either Kokee sites.

SUBJ: AMENDMENT TWO TO THE EMC STUDY FOR THE ROME LABORATORY UHF RSTER TESTING AT PMRF, KAUAI, HAWAII (E3 PROGRAM TASK NO. E92-H029)

b. RSTER system transmissions will be temporarily suspended if it is suspected that their EMR is interfering with present or planned NASA, NOAA or USNO missions. Mitigation of EMI will include:

(1) Cooperative Scheduling: As discussed in reference (e), since the RSTER will be transmitting so infrequently, a cooperative scheduling method will be the preferred way to resolve EMI problems should they occur.

Coordination with NASA and USNO via the NASA KPGO site supervisor will be made prior to RSTER testing requiring eight hour test periods for several consecutive days to ensure that the tests can be run to completion.

(2) Selection of Compatible Frequency Ranges: The RSTER transmission frequency range will be limited to compatible frequency ranges in the proposed UHF operating band.

(a) For fourth harmonic interference, the RSTER transmission frequencies between 422 and 424 MHz will be locked out so that no fourth harmonic emissions will fall within the 1.689 to 1.694 GHz PEACESAT downlink band.

(b) For fifth harmonic interference, the RSTER frequencies will be limited to the 420 to 439 MHz and 481 to 500 MHz bands so that RSTER fifth harmonic emissions will not fall within the 2.2 to 2.4 GHz range of the USB and VLBI systems.

(3) If all other methods of EMI mitigation are unsatisfactory, Rome Laboratory will correct or fund efforts to correct RSTER related EMI problems such as installing harmonic filters in the RSTER transmitter.

c. The RSTER operating sector at the Kokee AFS be reduced to 240° to 315" vice 225° to 315° to prevent mainbeam illumination of the KPGO.

7. For PMRF Code 7031; please route this letter to Codes 7322, 7325, and 7333.

8. Our point of contact is S. Kobashigawa, DSN (315) 471-1976 or COMM (808) 471-1976. Other points of contact are Mr. Lenny Goodman of MIT Lincoln Laboratory, COMM (617) 981-1025 and Mr. Doug Lynch of ROME Laboratory, DSN (312) 587-4441 or COMM (315) 330-4441.

D.K.L. LEE
By direction

Copy to: Next page

SUBJ: AMENDMENT TWO TO THE EMC STUDY FOR THE ROME LABORATORY UHF RSTER TESTING AT PMRF, KAUAI, HAWAII (E3 PROGRAM TASK NO. E92-H029)

Copy to:
NASA (Code JFX)
MIT Lincoln Labs (Group 102-Radar Systems (Mr. Lenny Goodman))
ROME Laboratories (Code OCDS (Mr. D. Lynch))
PACMISRANFAC (Code 7031)
COMNAVFACENGCOM (Code 200)
COMSPAWARSYSCOM (Code 224-3A2)
NAVELEXCEN Charleston (Code 222)
NASA Kokee Park Geophysical Observatory (Mr. Clyde Cox)

TECHNICAL REPORT

ELECTROMAGNETIC COMPATIBILITY (EMC) STUDY OF THE IMPACT OF THE UHF RADAR SURVEILLANCE TECHNOLOGY EXPERIMENTAL RADAR (RSTER) TESTING TO NASA OPERATIONS AT THE KOKEE PARK INSTRUMENTATION STATION, KAUAI, HAWAII

(E3 PROGRAM TASK NO. E92-H029)

DECEMBER 1993

NASA AND USNO DATA PROVIDED BY MR. CLYDE COX, NASA'S KPGO SITE SUPERVISOR

Naval Command, Control and Ocean Surveillance
Center ISE West Activity
Pearl Harbor, Hawaii 96860-5170

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I. INTRODUCTION

A. Background: The National Aeronautical and Space Administration's (NASA's) review of the "Draft Environmental Assessment (EA) - Mountaintop Sensor Integration and Test Program; Kauai, Hawaii dated April 1993" forwarded by NASA letter Serial JXG of 3 Aug 1993, pointed out an oversight in the EMC portion of the EA. As noted, the EMC portion based on NISE WEST HAWAII letter Serial 322SK/50 of 21 Jan 1993 (our EMC study of the RSTER testing at Kauai) failed to address any NASA system at the Kokee Park Instrumentation Station (KPIS).

B. Objective: The objective of this EMC analysis is to assess the impact of the RSTER testing conducted at Parcel "A" at KPIS and at the Kokee Air Force Station (AFS) to the NASA systems. As noted in NASA's review, no EMC problems are anticipated from RSTER testing conducted from the Makaha Ridge sites that are located well below the KPIS and blocked by heavy forested ridges.

II. UHF RSTER PROJECT DESCRIPTION

A. A complete description of the RSTER project has been provided in the original EMC study. Since then, MIT Lincoln Laboratory has released an update to the original JF-12 equipment specification sheet, see Table 1. Figure 1 shows the proposed RSTER testing sites and operating sectors on Kauai.

III. SYSTEMS AT THE NASA KOKEE PARK GEOPHYSICAL OBSERVATORY (KPGO)

A. All NASA and National Oceanic and Atmospheric Administration (NOAA) systems (except for two) and the U.S. Naval Observatory (USNO) Very Long Baseline Interferometry (VLBI) system are located at KPGO which is also known as Parcel "E" at KPIS. The equipment are housed in the Unified S-band (USB) Building and the antennas are located throughout Parcel "E". The two exceptions are the VHF uplink for the Pan-Pacific Educational and Communications Experiments by Satellite (PEACESAT) Project and the DORIS Beacon. Both are located in the adjacent Parcel "D". See Figures 2 and 3 for sketches of the KPIS and KPGO layouts.

B. PEACESAT Project: PEACESAT uses the NOAA GOES-3 geostationary weather satellite to provide low cost communications to the islands of the Pacific. The primary VHF telemetry uplink is at 148.56 MHz and the downlink is at 136.38 MHz. A "small" terminal using 2031.30 to 2031.95 MHz uplinks and 1689.25 to 1689.95 MHz downlinks provide fifteen communications channels separated by 50 kHz. A 1694 MHz downlink serves as the backup telemetry signal.

1. The VHF uplink uses the Spacecraft Antenna on Medium Pedestal (SCAMP) antenna and a transmitter in Building 785 in Parcel "D". The VHF downlink uses the Spacecraft Automatic Tracking Antenna (SATAN) yagi antenna mounted on a tower behind the USB Building.

2. The S-band terminal uses a 3 meter dish mounted at ground level in front of the USB Building. The dish is pointed at 55" elevation and 220° azimuth. The downlink signal level is -121.8 dBm. The noise threshold is -128 dBm for the 15 kHz bandwidth receiver.

C. Interplanetary Monitoring Platform (IMP)-8: The IMP-8 monitors a VHF telemetry downlink signal at 137.98 MHz which originates from a NASA satellite. The IMP-8 also uses the SATAN yagi antenna. Both the PEACESAT and IMP-8 VHF downlinks are occasionally received by either the four or two element yagi antennas in back of the USB Building.

D. DORIS Beacon: The DORIS beacon installation is part of a worldwide network which provides precision orbit determinations for low orbit satellites equipped with the DORIS onboard package. The DORIS beacon consists of 401.25 MHz and 2036.25 MHz signals directed to the zenith (directly overhead) by a righthand-circular polarized, double-dipole antenna, The 401.25 MHz signal is transmitted at 5 watts and the 2036.25 MHz signal is transmitted at 10 watts. There are no receivers associated with the DORIS beacon at KPIS.

E. Global Positioning System (GPS): The GPS is a ground positioning system using transmissions from the NAVSTAR satellites. The downlink frequencies are 1227.60 (L1) and 1575.42 (L2) MHz. There are two GPS receiving systems at KPGO. One system, used to provide timing for the NASA and VLBI systems, receives the L1 signal via the GPS antenna on the roof of the USB Building. The other system, used to provide precision positioning, receives both the L1 and L2 signals via the Rouge antenna located near the 9 meter USB antenna.

F. USB Receiving System: The USB employs a 9 meter parabolic dish to detect signals from space in the 2200-2400 (S-band) and 8200-9000 (X-band) MHz band. The captured RF signals are amplified by a low noise amplifier (LNA) and down converted to intermediate frequency (IF) signals at the antenna. The IF signals are routed back to the USB Building for detection and processing. The S-band system noise level for the USB is -117.8 dBm for a 2 MHz bandwidth.

G. VLBI Receiving System: The VLBI system operated by the USNO employs a 20 meter parabolic dish to detect signals from quasars in the 2200-2400 and 8200-9000 MHz range. Fourteen frequencies, six in the S-band and eight in the X-band, are monitored using detection bandwidths of 2 MHz. The VLBI also employs a LNA and down conversion process to amplify and route captured RF signals from the antenna back to the USB Building.

In the S-band, the VLBI system noise level is -120.8 dBm for a 2 MHz bandwidth. During VLBI operations, a calibration signal 20 dB above the threshold level (-100.8 dBm) is injected at the input to the LNA at every 1 MHz interval in the operating frequency range.

IV. EMC ANALYSIS

A. Co-channel and Adjacent Interference: Our initial report recommended that the RSTER not transmit in the 400 to 420 and 450 to 470 MHz band to prevent co-channel interference to surrounding users. Thus, the potential for co-channel interference to DORIS beacon 401.25 MHz receivers onboard orbiting satellites will be avoided. No other system associated with NASA or USNO fall within the recommended RSTER frequency ranges.

B. Harmonic Interference Analysis

1. Table 2 lists the RSTER harmonics up to the 7th order and subharmonics to the one fourth order. RSTER harmonics fall into the downlink frequency range of two systems. The RSTER fourth harmonics of 422 and 424 MHz fall into the PEACESAT downlink range of 1689 and 1694 MHz. The fifth harmonics of RSTER frequencies between 440 to 480 MHz fall into the USB and VLBI 2200 to 2400 MHz operating range.

2. Fourth Harmonic Electromagnetic Interference (EMI) to PEACESAT:

a. Table 3 shows the calculated RSTER fourth harmonic receive signal levels (RSL's) from the two proposed sites. The RSL's were calculated using the emission levels for harmonics above the third order provided in Table 1, and using the fourth harmonic antenna gain for a generic array antenna provided by the ECAC-CR-83-117 report (see Appendix A of the original EMC report).

The PEACESAT antenna is pointed at 55° elevation and 220" azimuth. The azimuths from KPGO to Parcel "A" and the Kokee AFS sites are 200° and 30°, respectively. PEACESAT receive antenna sidelobe gains provided by Marine-Air Systems, the antenna manufacturer, are shown on Figure 4. Based on Figure 4, the sidelobe gains for the Parcel "A" and Kokee AFS directions will be 1 and -9 dBi, respectively.

b. The worst case (line-of-sight) calculated RSL's are -116.2 dBm for RSTER transmissions from Parcel "A" and -131.3 dBm for RSTER transmissions from Kokee AFS site. The calculations predict EMI will occur when the RSTER is operated at the Parcel "A" site since the RSTER fourth harmonic RSL's exceed the -121.8 dBm downlink level. The calculations predict that RSTER transmissions from the Kokee AFS will not cause EMI since the RSTER fourth harmonic RSL's are below the PEACESAT receive sensitivity of -128 dBm.

c. No fourth harmonic interference problems are predicted for RSTER operating frequencies 420 to 421 and 425 to 500 MHz since their fourth harmonics do not fall within the PEACESAT receive range.

3. Fifth Harmonic EMI to USB and VLBI Receive Systems

a. Tables 4 and 5 show the calculated RSTER fifth harmonic RSL's from the two proposed sites. The RSL's were calculated using the emission

levels for harmonics above the third order provided in Table 1, and using a fifth harmonic antenna gain for a generic array antenna provided by the ECAC-CR-83-117 report.

(1) Since no data was available, the USB and VLBI receive antenna sidelobe gains were estimated from VERTEX 9 and 21 meter geostationary satellite communication antennas.

(a) The sidelobe gains from 1° to 7 are estimated using the Federal Communications Commission(FCC) maximum allowable sidelobe gains followed by VERTEX. The maximum sidelobe gain is given as:

Gsb = 29 - 25*log(SLA) dBi; where Gsb is the sidelobe gain and SLA is the sidelobe angle from boresight.

(b) The sidelobe gains from 7" to 9.2' are given as 8 dBi.

(c) The sidelobe gains from 9.2" to 48° are given as:

Gsb = 32 - 25*log(SLA) dBi.

(d) The sidelobe gains beyond 48° are given as -10 dBi.

b. The worst case (line-of-sight) calculated RSL's range from -84.6 to -106.1 dBm for RSTER transmissions from Parcel "A" and -81.2 to -111.2 dBm for RSTER transmissions from Kokee AFS site. The calculations predict EMI will occur wherever the USB or VLBI antennas are pointed. When the VLBI antenna is pointed within 29.4" (spherically) of the Parcel "A" site and 18.4' (spherically) of the Kokee AFS site, the RSL's from the RSTER will exceed the VLBI calibration level of -100.8 dBm.

(1) Although calculations for boresighting of the USB and VLBI antennas at the RSTER antenna at both sites are shown on Tables 4 and 5, boresighting should not occur since the USB and VLBI antennas do not operate below elevation angles of +5°. The KPGO site is 40 feet above the Parcel "A" site thus increasing the separation angle slightly above 5°. The Kokae AFS is above KPGO and will be 2.3° degrees off boresight when the USB and VLBI antennas are pointed at their minimum 5° elevation angle. RSTER electromagnetic radiation (EMR) from the Kokee AFS site will be attenuated by terrain blockage between the Kokee AFS and KPGO.

(2) The calculated RSTER fifth harmonic power densities of -97.7 and -102.8 dBW/m^2 from the Parcel "A" and Kokee AFS sites, respectively, exceed the VLBI siting criteria of -130 dBW/m^2 for the S-band range of 2100 to 2400 MHz specified by USNO letter Serial S/091 of 2 February 1990. However, the VLBI system at KPGO is limited to 2200 to 2400 MHz.

c. No fifth harmonic interference problems are predicted for RSTER operating frequencies from 420 to 439 MHz and 481 to 500 MHz since their fifth harmonics do not fall within the USB and VLBI S-band receive range.

C. Radiated Susceptibility (RS): One of the major concerns cited in NASA's review of the EMC portion of the EA was the potential of the RSTER signals to penetrate and interfere with the local oscillator (LO) and intermediate frequencies (IF) RF signals that are routed between the USB and VLBI receive antennas and the USB Building.

1. Criteria:

a. Several studies have been conducted on the susceptibility of electronic equipment to high level radar emissions coupling onto chassis wiring and causing interference. The Pan American Special Investigation Report 508 stated that the power density range over which interference was first noted in IF circuits is +20 to +40 dBm/m^2. Another study reported by ECAC report ESD-TR-73-032 found that case penetration may occur in receivers exposed to peak spatial power densities above +40 dBm/m^2.

b. Department of Defence electronic equipment are required to meet RS requirements specified in the MIL-STD-461 series on electromagnetic emission and susceptibility requirements for the control of EMI. Presently, the minimum RS103 requirement for ground electronic equipment in the MIL-STD-461D of 11 January 1993 is 10 V/m (-5.8 dBW/m^2). The minimum RS03 criteria from the previous MIL-STD-461C of 4 August 1986 was 1 V/m (-25.8 dBW/m^2) for Class "B" and electronic equipment located at receiver sites.

2. Table 6 shows the calculated RSTER power density at the KPGO site for transmissions from the Parcel "A" and Kokee AFS sites. All electromagnetic radiation (EMR) levels due to side- and backlobe RSTER illumination are well below the minimum case penetration level of +20 dBm/m^2 or the minimum MIL-STD-461C criteria of -25.8 dBW/m^2. Table 7 shows the calculated EMR levels from existing PMRF transmitters and antennas located at Parcel "C" at KPIS. A comparison of Tables 6 and 7 show that present transmissions from the LUCAS EPSCO command guidance (CG) and command destruct (CD) transmitters exceed the anticipated RSTER EMR levels by at least 13.3 dB. The CG and CD signals fall in the same 400 to 450 MHz range as the lower half of the RSTER band. No EMI has been experienced due to transmissions from PMRF equipment at Parcel "C".

3. Table 8 shows the calculated RSTER EMR levels from mainbeam illumination from the Kokee AFS site. These levels do exceed the Pan American Report 508 level of +20 dBm/m^2 and MIL-STD-461C and -D criteria of -25.8 and -5.8 dBW/m^2, respectively. Although the KPGO site is not in the RSTER operation sector of 225" to 315°, mainbeam illumination of the KPGO site may occur since the RSTER beamwidth is approximately 20" wide as shown on Figure 5. If the start of the RSTER operating sector at the Kokee AFS is changed to 240" vice 225" mainbeam illumination should not occur.

V. CONCLUSIONS AND DISCUSSION

A. Co-channel: If the RSTER frequency hop list is limited to the frequency ranges of 420 to 449 MHz and 470 to 500 MHz no co-channel interference is predicted.

B. Fourth and Fifth Harmonic EMI: The results predict that fourth and fifth harmonic emissions from the RSTER will exceed the downlink RSL of PEACESAT, and the receiver noise levels of the USB and VLBI systems wherever the USB and VLBI antennas are pointed, respectively. The fifth harmonic emissions are also predicted to exceed the +20 dB RF calibration signal used in the VLBI system within 29.4° (spherically) of the Parcel "A" site and 18.4" (spherically) of the Kokee AFS site.

1. The fourth and fifth harmonic EMI predictions are based on assumed worst case harmonic emissions from the RSTER transmitter and worst case fourth and fifth harmonic antenna gains of a generic array antenna. Presently, there is no data on the RSTER radiated fourth and fifth harmonic emissions.

2. Based on previous testing at the NASA Wallops Island Flight Test Center in Virginia, and White Sands Missile Range in New Mexico, the potential for EMI occurring may be substantially less than predicted in this report. The NASA frequency coordinator (Mr. Roger Smith) at the NASA Wallops Island Flight Test Center and the DOD frequency coordinator (Mr. Donald Baldwin) at the White Sands Missile Range, advised that they did not receive any reports of EMI to 2 GHz satellite communication systems. The NASA and RSTER sites at Wallops Island were separated by 7 miles of flat land with no terrain obstruction between sites. Sector blanking was employed at Wallops Island. The NASA and RSTER sites at White Sands Missile Range are 50 miles apart.

3. The PEACESAT S-band antenna is located at ground level and tucked into a heavily forested area to minimize sidelobe pick-up. An additional 12 dB attenuation from the trees, which is very conceivable, will reduce the predicted RSTER fourth harmonic RSL from Parcel "A" to a level below the -128 dBm receiver sensitivity.

C. Radiated Susceptibility:

1. The calculations show that the side and backlobe RSTER transmissions will be below EMR levels known to cause interference due to case penetration. The levels will also be below any MIL-STD-461C and -D RS criteria. Finally, the calculated RSTER EMR levels will be below existing UHF EMR levels from the PMRF site at Parcel "C" which to this date have not caused interference to the USB or VLBI receive systems.

2. The calculations also show that due to the beamwidth of the RSTER antenna, the KPGO site falls within the mainbeam transmissions from the Kokee AFS site. The RSTER EMR is predicted to exceed the minimum Pan American Report 508 and MIL-STD-461C and -D RS criteria, as well as the existing EMR levels from the PMRF site at Parcel "C". Decreasing the RSTER operational sector at the Kokee AFS to 240" to 315° azimuth should prevent any mainbeam illumination of the KPGO site.

D. RSTER Operational Hours: MIT Lincoln Lab. (Mr. Lenny Goodman) advised that since the RSTER is an experimental radar, most of the time is spent evaluating test results and designing new tests. The average daily

transmission time is approximately 2 hours. On rare occasions, the RSTER will be transmitting eight hours a day for two to three consecutive days. Conversely, there are other periods when no transmissions are made during an entire week.

VI. RECOMMENDATIONS:

A. Based on meetings between the Advance Research Projects Agency (ARPA) and NASA, and the preliminary findings of this study, NASA letter Serial JXG of 3 December 1993 advises that NASA's input to the final EA will be that of "finding of no significant impact" provided that the recommendations listed below are followed.

B. Based on NASA's 3 December letter, and the results of this study, the following conditions should be added to the future real estate agreement with Rome Laboratory with regards to RSTER operations at the Parcel "A" and Kokee AFS sites:

1. Prior to planning the installation of the RSTER radar at either site, an operations planning document should be submitted for approval to the NASA KPGO site manager (Mr. Clyde Cox) in order to preclude possible interference with existing or planned NASA, NOAA, and USNO sensor and communications programs. NASA must be consulted prior to any RSTER operations at either Kokee sites.

2. RSTER system transmissions will be temporarily suspended if it is suspected that their EMR is interfering with present or planned NASA, NOAA or USNO missions. Mitigation of EMI will include:

a. Cooperative Scheduling: As advised by MIT Lincoln Lab. (Mr. Lenny Goodman), since the RSTER will be transmitting so infrequently, a cooperative scheduling method will be the preferred way to resolve EMI problems should they occur.

Coordination with NASA and USNO via the NASA KPGO site supervisor will be made prior to RSTER testing requiring eight hour test periods for several consecutive days to ensure that the tests can be run to completion.

b. Selection of Compatible Frequency Ranges: The RSTER transmission frequency range will be limited to compatible frequency ranges in the proposed UHF operating band.

(1) For fourth harmonic interference, the RSTER transmission frequencies between 422 and 424 MHz will be locked out so that no fourth harmonic emissions will fall within the 1.689 to 1.694 GHz PEACESAT downlink band.

(2) For fifth harmonic interference, the RSTER frequencies will be limited to the 420 to 439 MHz and 481 to 500 MHz bands so that RSTER fifth harmonic emissions will not fall within the 2.2 to 2.4 GHz range of the USB and VLBI systems.

c. If all other methods of EMI mitigation are unsatisfactory, Rome Laboratory will correct or fund efforts to correct RSTER related EMI problems such as installing harmonic filters in the RSTER transmitter.

3. The RSTER operating sector at the Kokee AFS be reduced to 240" to 315° vice 225" to 315° to prevent mainbeam illumination of the KPGO.

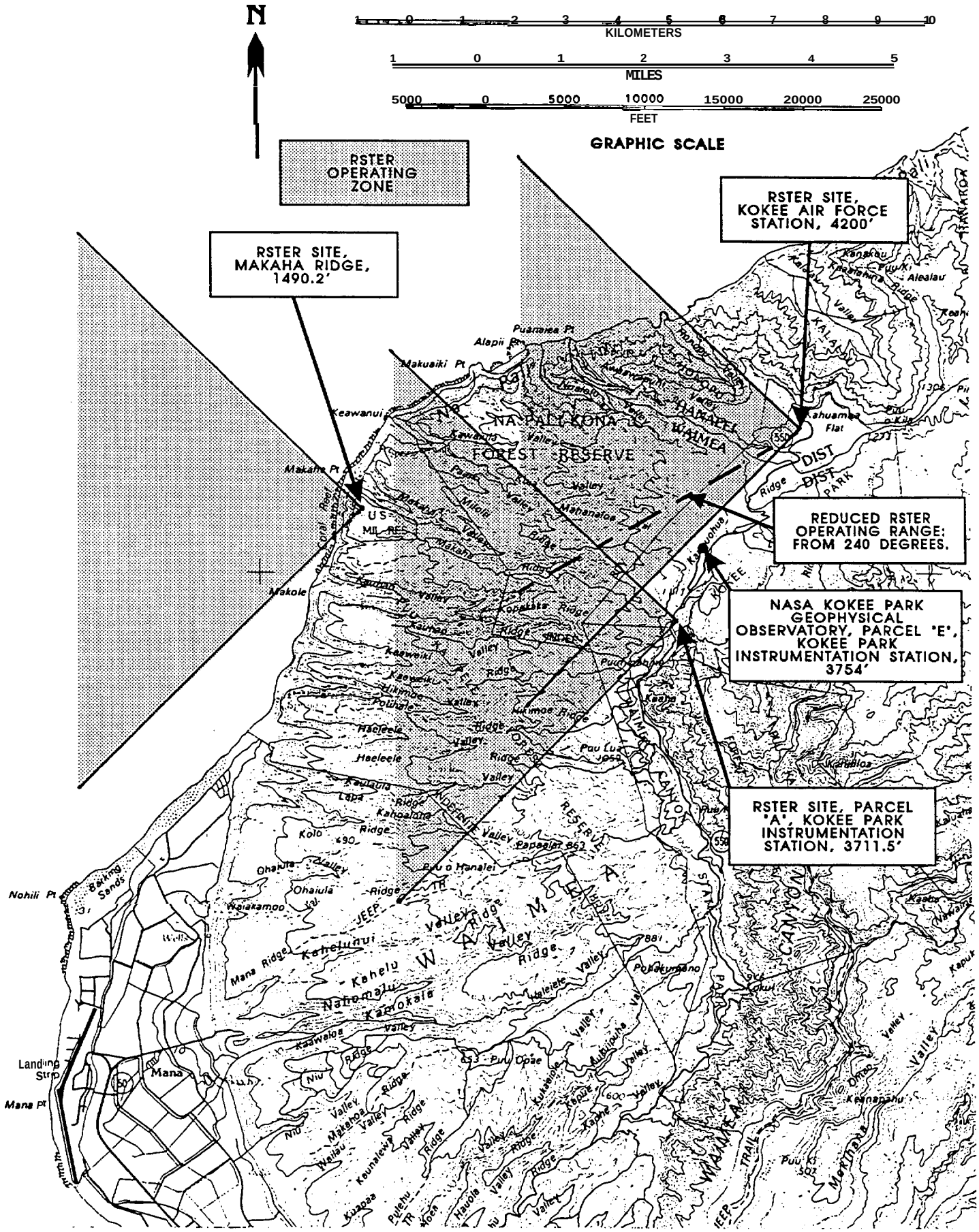


Figure 1. Map of Western Kauai Showing the Proposed RSTER Sites

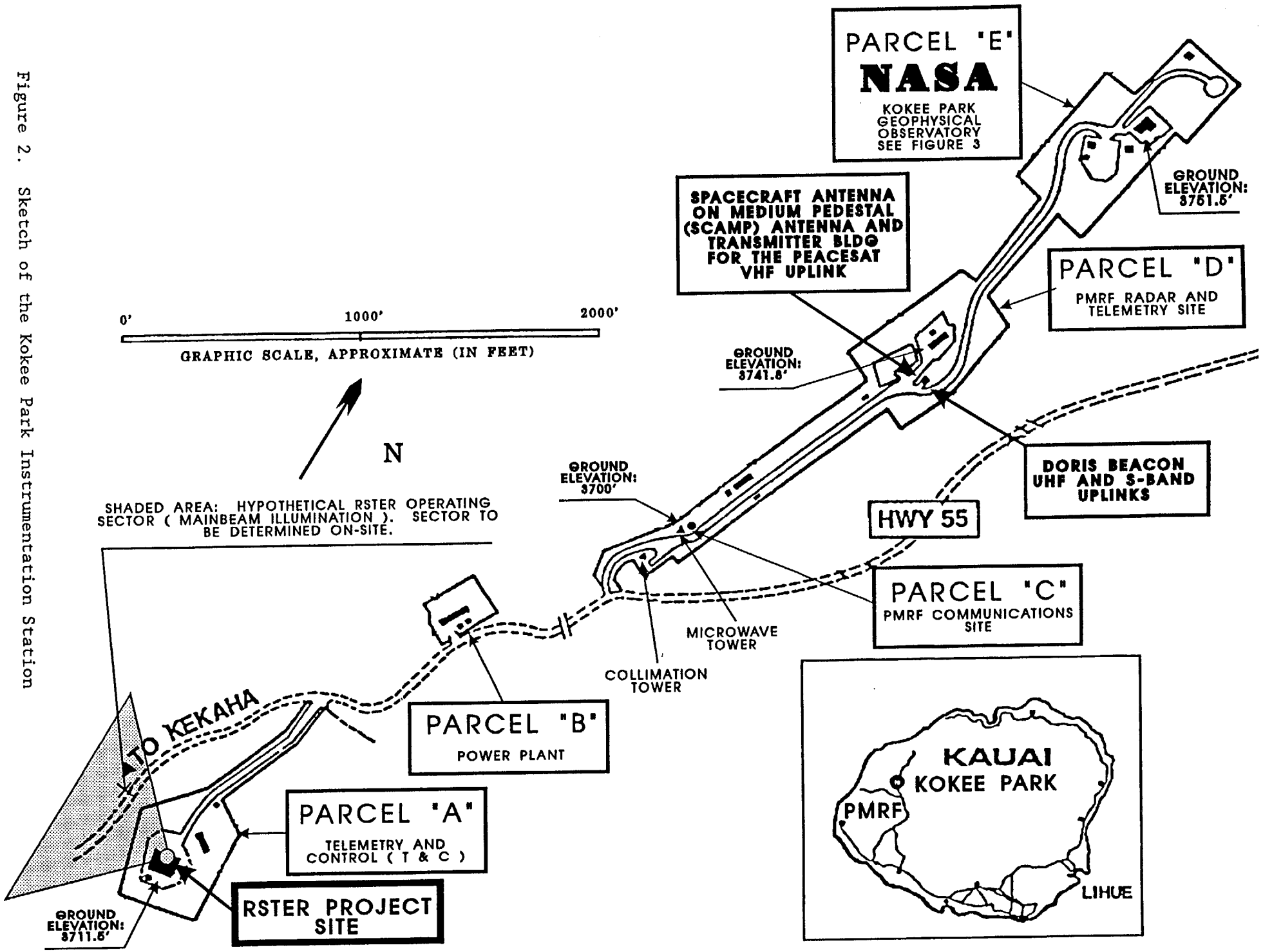


Figure 2. Sketch of the Kokee Park Instrumentation Station

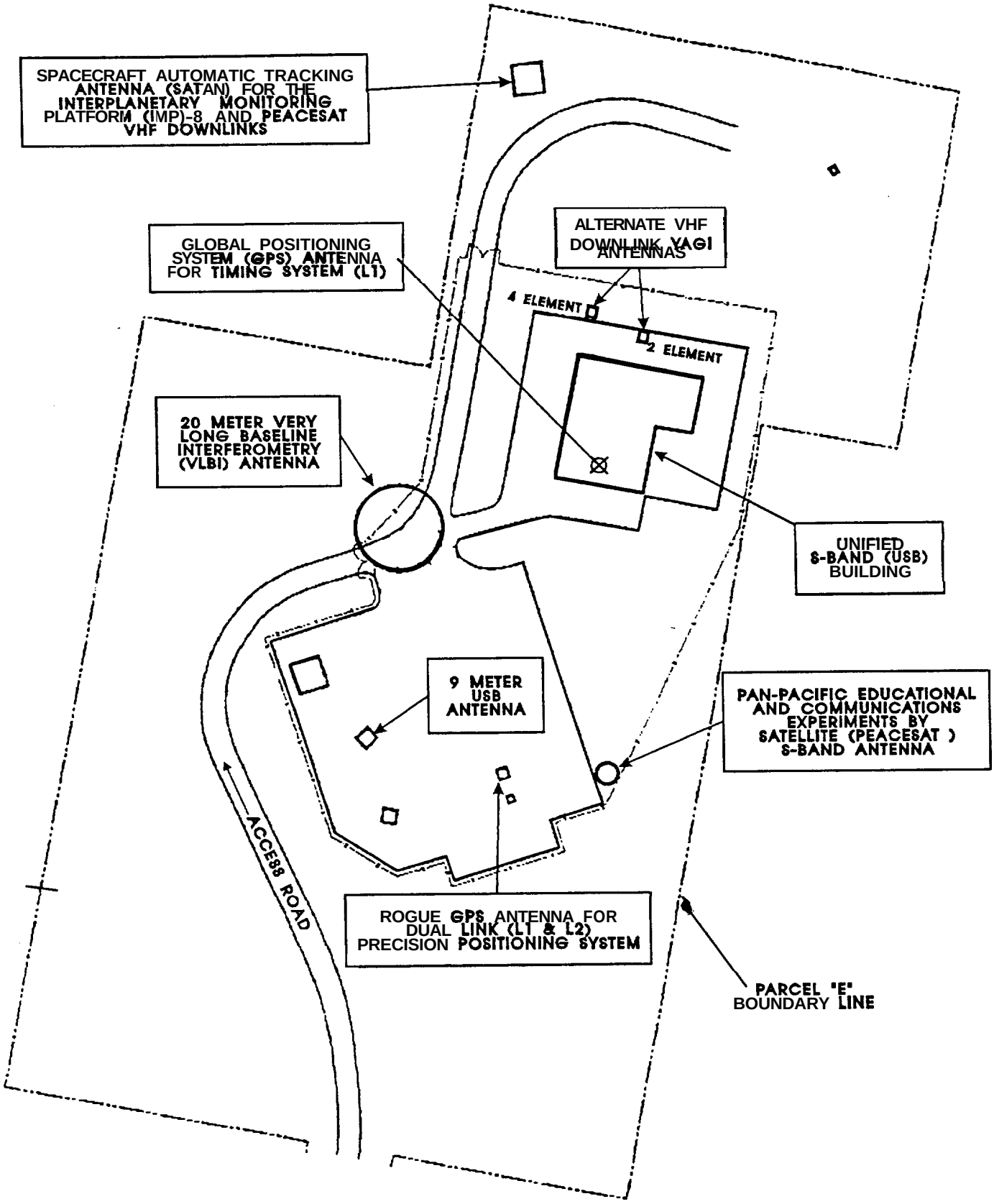


Figure 3. NASA Kokee Park Geophysical Observatory, Parcel "E", Kokee Park Instrumentation Station

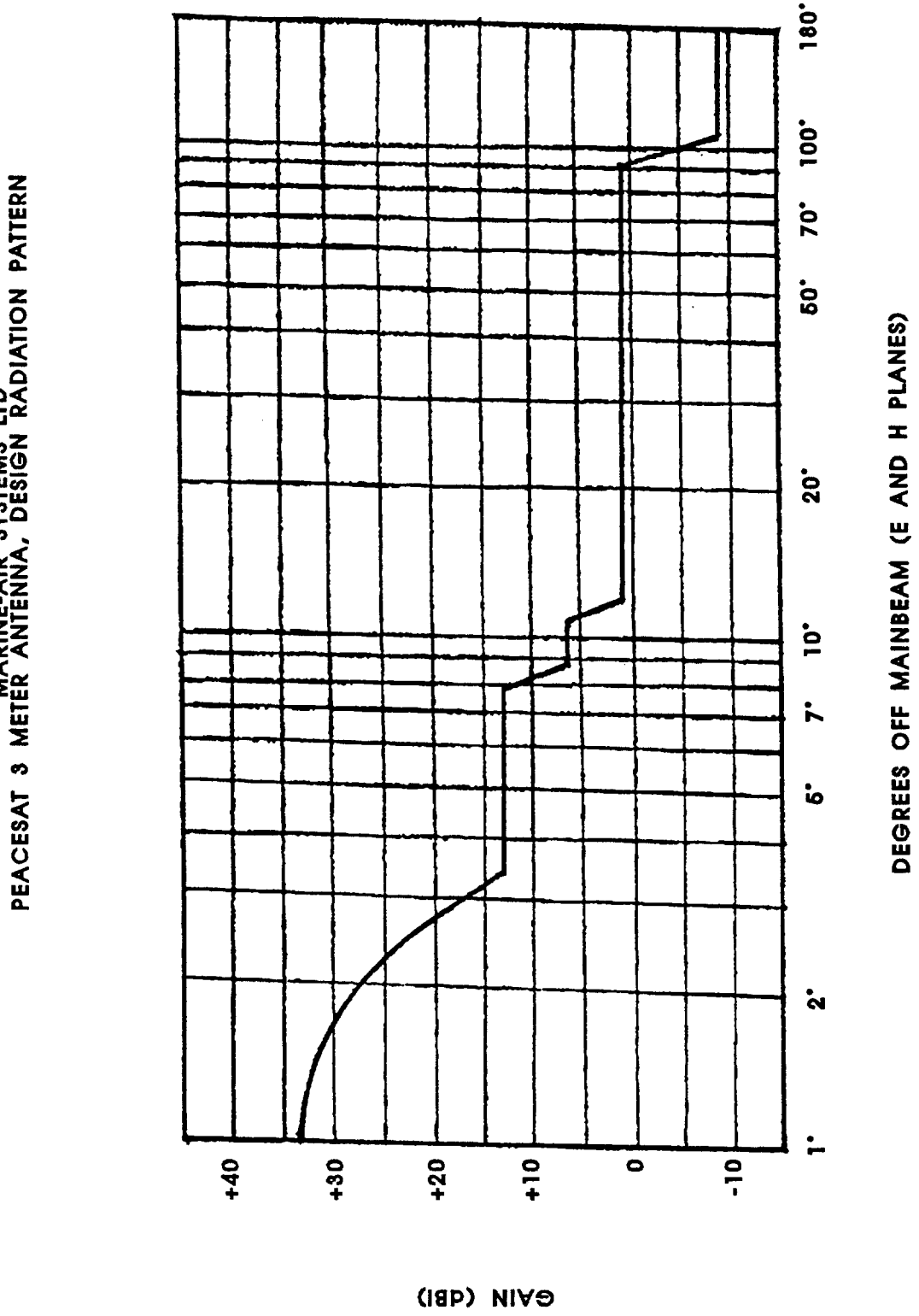
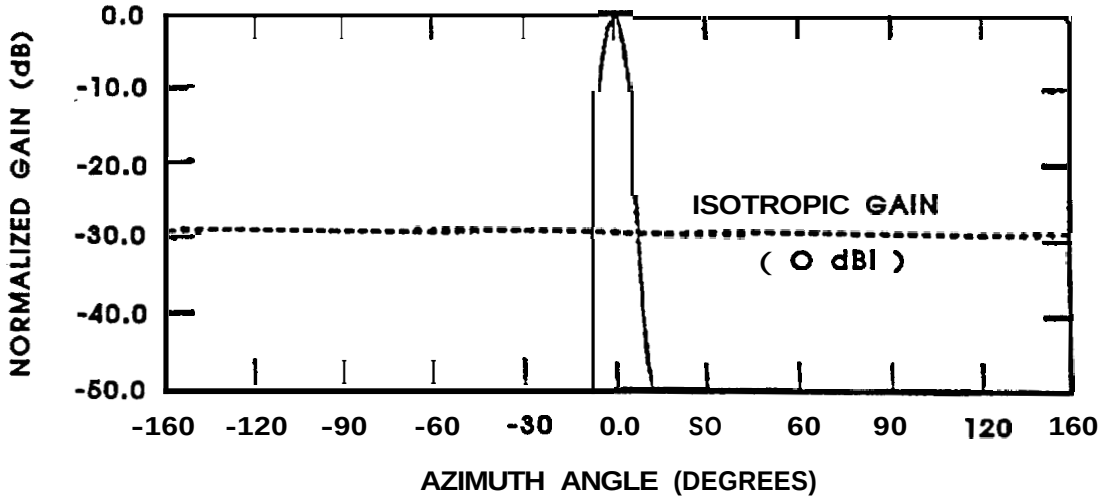


Figure 4. Graph of the PEACESAT 3 Meter Antenna Sidelobes



AZIMUTH PATTERN FOR 14-ROW ARRAY AVERAGED OVER 410 TO 460 MHz

Figure copied from the article An Ultralow-Sidelobe Adaptive Array Antenna, Carlson et al, Lincoln Laboratory Journal, Volume 3, Number 3, 1990.

Figure 5. Sketch of the RSTER Antenna Beamwidth

TRANSMITTER EQUIPMENT CHARACTERISTICS

1. NOMENCLATURE, MANUFACTURER'S MODEL NO.
RADAR SURVEILLANCE TECHNOLOGY EXPERIMENTAL RADAR (RSTER)

2. MANUFACTURER'S NAME
MIT LINCOLN LABORATORY

3. TRANSMITTER INSTALLATION
FIXED GROUND (TEST SITE)

4. TRANSMITTER TYPE
CHIRPED CW PULSE RADAR

5. TUNING RANGE
400 TO 500 MHz

6. METHOD OF TUNING
FREQUENCY SYNTHESIZER

7. RF CHANNELING CAPABILITY
FROM 400 MHz IN 1 MHz INCREMENTS

8. EMISSION DESIGNATOR(S)
2M80Q1N (UNHOPPED)

9. FREQUENCY TOLERANCE
0.2 PPM PER YEAR AGING RATE

10. FILTER EMPLOYED (X one)
[X] a. YES [ ] b. NO

11. SPREAD SPECTRUM (X one)
[X] a. YES [ ] b. NO

12. EMISSION BANDWIDTH (X and complete as applicable)
CALCULATED [X] MEASURED

13. MAXIMUM BIT RATE
N/A

a. -3 dB 500 KHz
b. -20 dB 1.8 MHz
c. -40 dB 2.3
d. -60 dB 2.6 MHz
e. OC-BW 2.2 MHz

14. MODULATION TECHNIQUES AND CODING
FREQUENCY HOPPING, LINEAR FREQUENCY MODULATION PULSES

15. MAXIMUM MODULATION FREQUENCY.
N/A

16. PRE-EMPHASIS (X one)
[ ] a. YES [X] b. NO

17. DEVIATION RATIO
N/A

18. PULSE CHARACTERISTICS
a. RATE 300 pps min, 1500 pps max
b. WIDTH 5 us min, 200 us max
c. RISE TIME 0.2 us
d. FALL RME 0.2 us
e. COMP RATIO 1 min,100 max

19. POWER
a. MEAN 8.75 KW
b. PEP 140 KW

20. OUTPUT DEVICE
PARALLEL ARRAY OF CLASS C TRANSISTORS, COHERENTLY COMBINED

21. HARMONIC LEVEL
a. 2nd
-80 dBc
b. 3rd
-80 dBc
c. OTHER
-80 dBc

22. SPURIOUS LEVEL
-80 dBc

23. FCC TYPE ACCEPTANCE NO.

24. REMARKS

ITEM 8: FREQUENCY HOPPING CHARACTERISTICS:
NUMBER OF CHANNELS: 100
HOP RATE: PULSE-TO-PULSE (PRF BATE)
HOP FREQUENCY RANGE: 400 TO 500 MHz

ITEM 19: DOES NOT INCLUDE ALMOST 3 dB OF CABLE LOSS BETWEEN TRANSMITTER AND ANTENNA RADIATING ELEMENTS

Table 1. RSTER JF-12 Equipment Specifications

SUBHARMONIC (MHz)		RSTER FREQ	HARMONIC (MHz)					
1/4	1/2	(MHZ)	2	3	4	5	6	7
105.00	210.00	420	840	1260	1680	2100	2520	2940
105.25	210.50	421	842	1263	1684	2105	2526	2947
105.50	211.00	422	844	1266	1688	2110	2532	2954
105.75	211.50	423	846	1269	1692	2115	2538	2961
106.00	212.00	424	848	1272	1696	2120	2544	2968
106.25	212.50	425	850	1275	1700	2125	2550	2975
106.50	213.00	426	852	1278	1704	2130	2556	2982
106.75	213.50	427	854	1281	1708	2135	2562	2989
107.00	214.00	428	856	1284	1712	2140	2568	2996
107.25	214.50	429	858	1287	1716	2145	2574	3003
107.50	215.00	430	860	1290	1720	2150	2580	3010
107.75	215.50	431	862	1293	1724	2155	2586	3017
108.00	216.00	432	864	1296	1728	2160	2592	3024
108.25	216.50	433	866	1299	1732	2165	2598	3031
108.50	217.00	434	868	1302	1736	2170	2604	3038
108.75	217.50	435	870	1305	1740	2175	2610	3045
109.00	218.00	436	872	1308	1744	2180	2616	3052
109.25	218.50	437	874	1311	1748	2185	2622	3059
109.50	219.00	438	876	1314	1752	2190	2628	3066
109.75	219.50	439	878	1317	1756	2195	2634	3073
110.00	220.00	440	880	1320	1760	2200	2640	3080
110.25	220.50	441	882	1323	1764	2205	2646	3087
110.50	221.00	442	884	1326	1768	2210	2652	3094
110.75	221.50	443	886	1329	1772	2215	2658	3101
111.00	222.00	444	888	1332	1776	2220	2664	3108
111.25	222.50	445	890	1335	1780	2225	2670	3115
111.50	223.00	446	892	1338	1784	2230	2676	3122
111.75	223.50	447	894	1341	1788	2235	2682	3129
112.00	224.00	448	896	1344	1792	2240	2688	3136
112.25	224.50	449	898	1347	1796	2245	2694	3143

PEACESAT DOWNLINK BAND

USB AND VLBI OPERATING FREQUENCY BAND

EXISTING NASA AND VLBI SYSTEM FREQUENCIES

DORIS BEACON: TRANSMIT - 401.25 AND 2036.25 MHz

PEACESAT: TRANSMIT - 148.56 AND 2031.25-2031.95 MHz

PEACESAT: RECEIVE - 136.38 AND 1689.25-1694 MHz

IMP-8: RECEIVE - 137.98 MHz

GPS: RECEIVE - 1227.6 AND 1575.42 MHz

USB: RECEIVE - 2200 TO 2400 AND 8200 TO 9000 MHz

VLBI: RECEIVE - 2200 TO 2400 AND 8200 TO 9000 MHz

Table 2. Subharmonics and Harmonics of the RSTER Transmissions, Sheet 1 of 2

SUBHARMONIC (MHz)		RSTER FREQ	HARMONIC (MHz)					
1/4	1/2	(MHZ)	2	3	4	5	6	7
117.50	235.00	470	940	1410	1880	2350	2820	3290
117.75	235.50	471	942	1413	1884	2355	2826	3297
118.00	236.00	472	944	1416	1888	2360	2832	3304
118.25	236.50	473	946	1419	1892	2365	2838	3311
118.50	237.00	474	948	1422	1896	2370	2844	3318
118.75	237.50	475	950	1425	1900	2375	2850	3325
119.00	238.00	476	952	1428	1904	2380	2856	3332
119.25	238.50	477	954	1431	1908	2385	2862	3339
119.50	239.00	478	956	1434	1912	2390	2868	3346
119.75	239.50	479	958	1437	1916	2395	2874	3353
120.00	240.00	480	960	1440	1920	2400	2880	3360
120.25	240.50	481	962	1443	1924	2405	2886	3367
120.50	241.00	482	964	1446	1928	2410	2892	3374
120.75	241.50	483	966	1449	1932	2415	2898	3381
121.00	242.00	484	968	1452	1936	2420	2904	3388
121.25	242.50	485	970	1455	1940	2425	2910	3395
121.50	243.00	486	972	1458	1944	2430	2916	3402
121.75	243.50	487	974	1461	1948	2435	2922	3409
122.00	244.00	488	976	1464	1952	2440	2928	3416
122.25	244.50	489	978	1467	1956	2445	2934	3423
122.50	245.00	490	980	1470	1960	2450	2940	3430
122.75	245.50	491	982	1473	1964	2455	2946	3437
123.00	246.00	492	984	1476	1968	2460	2952	3444
123.25	246.50	493	986	1479	1972	2465	2958	3451
123.50	247.00	494	988	1482	1976	2470	2964	3458
123.75	247.50	495	990	1485	1980	2475	2970	3465
124.00	248.00	496	992	1488	1984	2480	2976	3472
124.25	248.50	497	994	1491	1988	2485	2982	3479
124.50	249.00	498	996	1494	1992	2490	2988	3486
124.75	249.50	499	998	1497	1996	2495	2994	3493
125.00	250.00	500	1000	1500	2000	2500	3000	3500

USB AND VLBI OPERATING FREQUENCY BAND

EXISTING NASA AND VLBI SYSTEM FREQUENCIES

DORIS BEACON: TRANSMIT - 401.25 AND 2036.25 MHz

PEACESAT: TRANSMIT - 148.56 AND 2031.25-2031.95 MHz

PEACESAT: RECEIVE - 136.38 AND 1689.25-1694 MHz

IMP-8: RECEIVE - 137.98 MHz

GPS: RECEIVE - 1227.6 AND 1575.42 MHz

USB: RECEIVE - 2200 TO 2400 AND 8200 TO 9000 MHz

VLBI: RECEIVE - 2200 TO 2400 AND 8200 TO 9000 MHz

Table 2. **Continued, Sheet** 2 **of** 2

Table 3. CALCULATED RSTER FOURTH HARMONIC EMISSIONS FROM PARCEL "A"
AND KOKEE AIR FORCE STATION
SIDELOBE AND BACKLOBE ILLUMINATION
VICTIM: PEACESAT S-BAND 3 METER DISH POINTED AT 220 DEG AZIMUTH AND 55 DEG ELEVATION.

RSTER TRANSMITTER SITE	RSTER TRANSMIT POWER (WATTS)	RSTER 5TH HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	POWER DENSITY @ PEACESAT (dBW/m^2)	PEACESAT SIDELOBE GAIN** (dBi)	RSTER EMI LEVEL (dBm)
PARCEL " A	70000	-80	-12.1	4.3E-05	1.00	-118.8	1	-116.2
KOKEE AFS	70000	-80	-12.1	4.3E-05	1.80	-123.9	-9	-131.3

* GENERIC FOURTH HARMONIC GAIN FOR ARRAY ANTENNA FROM ECAC-CR-83-117 REPORT

** SIDELOBE GAINS FROM MARINE-AIR SYSTEMS (DISH MANUFACTURER).

NOTE: RSTER JF-12 PEAK OUTPUT POWER OF 140 kWATT REDUCED TO 70 kWATT AT ANTENNA DUE TO CABLE LOSS.
EXCEEDS -121.8 dBm DOWNLINK RECEIVE SIGNAL LEVEL AND -128 dBm SYSTEM NOISE LEVEL.

Table 4. CALCULATED RSTER FIFTH HARMONIC EMISSIONS FROM PARCEL "A"
SIDELOBE AND BACKLOBE ILLUMINATION

VICTIM: USB AND VLBI RECEPTION, USB AND VLBI ANTENNAS BORESIGHTED AT RSTER

RECEIVE ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 5TH HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	POWER DENSITY @ RCVANTS (dBW/m^2)	RECEIVE ANTENNA GAIN (dBi)	RSTER EMI LEVEL (dBm)
USB 9m DISH	70000	-80	9.0	5.6E-03	1.00	-97.7	44	-52.1
VLBI 20m DISH	70000	-80	9.0	5.6E-03	1.00	-97.7	52	-44.1

VICTIM: USB AND VLBI RECEPTION, ANTENNAS 5 DEGREES OFF BORESIGHT

RECEIVE ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 5TH HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	POWER DENSITY @ RCVANTS (dBW/m^2)	SIDELOBE GAIN** @ 5 DEG (dBi)	RSTER EMI LEVEL (dBm)
USB AND VLBI	70000	-80	9.0	5.6E-03	1.00	-97.7	11.5	-84.6

VICTIM: USB AND VLBI RECEPTION, ANTENNAS 29.4 DEGREES OFF BORESIGHT

RECEIVE ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 5TH HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	POWER DENSITY @ RCVANTS (dBW/m^2)	SIDELOBE GAIN** @ 29.4 DEG (dBi)	RSTER EMI LEVEL (dBm)
USB AND VLBI	70000	-80	9.0	5.6E-03	1.00	-97.7	-4.7	-100.8

VICTIM: USB AND VLBI RECEPTION, ANTENNAS BEYOND 48 DEGREES OFF BORESIGHT

RECEIVE ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 5TH HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	POWER DENSITY @ RCV ANTS (dBW/m^2)	SIDELOBE GAIN** >48 DEGS (dBi)	RSTER EMI LEVEL (dBm)
USB AND VLBI	70000	-80	9.0	5.6E-03	1.00	-97.7	-10	-106.1

* GENERIC FIFTH HARMONIC GAIN FOR ARRAY ANTENNA FROM ECAC-CR-83-117 REPORT

** SIDELOBE GAINS ESTIMATED FROM VERTEX SATELLITE COMMUNICATIONS ANTENNAS

NOTE: RSTER JF-12 PEAK OUTPUT POWER OF 140kWATT REDUCED TO 70 kWATT AT ANTENNA DUE TO CABLE LOSS.

EXCEEDS +20 dB VLBI CALIBRATION LEVEL (-100.8 dBm) AND USB AND VLBI SYSTEM NOISE LEVELS.

EXCEEDS USB (-117.8 dBm) AND VLBI (-120.8 dBm) SYSTEM NOISE LEVELS.

Table 5. CALCULATED RSTER FIFTH HARMONIC EMISSIONS FROM KOKEE AIR FORCE STATION SIDELOBE AND BACKLOBE ILLUMINATION

VICTIM: USB AND VLBI RECEPTION. USB AND VLBI ANTENNAS BORESIGHTED AT RSTER

RECEIVE ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 5TH HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	POWER DENSITY @ RCVANTS (dBW/m ^ 2)	RECEIVE ANTENNA GAIN (dBi)	RSTER EMI LEVEL (dBm)
USB 9m DISH	70000	-80	9.0	5.6E-03	1.80	-102.8	44	-57.2
VLBI 20m DISH	70000	-80	9.0	5.6E-03	1.80	-102.8	52	-49.2

VICTIM: USB AND VLBI RECEPTION, ANTENNAS 2.3 DEGREES OFF BORESIGHT

RECEIVE ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 5TH HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	POWER DENSITY @ RCV ANTS (dBW/m ^ 2)	SIDELOBE GAIN** @ 2.3 DEG (dBi)	RSTER EMI LEVEL (dBm)
USB AND VLBI	70000	-80	9.0	5.6E-03	1.80	-102.8	20	-81.2

VICTIM: USB AND VLBI RECEPTION, ANTENNAS 18.4 DEGREES OFF BORESIGHT

RECEIVE ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 5TH HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	POWER DENSITY@ RCV ANTS (dBW/m ^ 2)	SIDELOBE GAIN** @ 18.4 DEG (dBi)	RSTER EMI LEVEL (dBm)
USB AND VLBI	70000	-80	9.0	5.6E-03	1.80	-102.8	0.4	-100.8

VICTIM: USB AND VLBI RECEPTION, ANTENNAS BEYOND 48 DEGREES OFF BORESIGHT

RECEIVE ANTENNA	RSTER TRANSMIT POWER (WATTS)	RSTER 5TH HARMONIC LEVEL (dB)	RSTER ANTENNA GAIN * (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	POWER DENSITY@ RCV ANTS (dBW/m ^ 2)	SIDELOBE GAIN** >48 DEGS (dBi)	RSTER EMI LEVEL (dBm)
USB AND VLBI	70000	-80	9.0	5.6E-03	1.80	-102.8	-10	-111.2

* GENERIC FIFTH HARMONIC GAIN FOR ARRAY ANTENNA FROM ECAC-CR-83-117 REPORT

** SIDELOBE GAINS ESTIMATED FROM VERTEX SATELLITE COMMUNICATIONS ANTENNAS

NOTE: RSTER JF-12 PEAK OUTPUT POWER OF 140kWATT REDUCED TO 70 kWATT AT ANTENNA DUE TO CABLE LOSS.

EXCEEDS +20 dB VLBI CALIBRATION LEVEL (-100.8 dBm) AND USB AND VLBI SYSTEM NOISE LEVELS.

EXCEEDS USB (-117.8 dBm) AND VLBI (-120.8 dBm) SYSTEM NOISE LEVELS.

Table 6. CALCULATED RSTER POWER DENSITY IN SECTOR BLANKED REGION
PARCEL "A" EMISSIONS

TRANSMIT ANTENNA	TRANSMIT POWER (WATTS)	SIDELOBE ANTENNA GAIN (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	RSTER POWER DENSITY (dBW/m^2)	RSTER POWER DENSITY (dBm/m^2)	RSTER E-FIELD STRENGTH (V/m)
RSTER (PEAK POWER)	70000	-21.0	556.0	1.00	-47.7	-17.7	0.080
RSTER (AVERAGE POWER)	4375	-21.0	34.8	1.00	-59.7	-29.7	0.020

KOKEE AFS EMISSIONS

TRANSMIT ANTENNA	TRANSMIT POWER (WATTS)	SIDELOBE ANTENNA GAIN (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	RSTER POWER DENSITY (dBW/m^2)	RSTER POWER DENSITY (dBm/m^2)	RSTER E-FIELD STRENGTH (V/m)
RSTER (PEAK POWER)	70000	-21.0	556.0	1.80	-52.8	-22.8	0.045
RSTER (AVERAGE POWER)	4375	-21.0	34.8	1.80	-64.8	-34.8	0.011

Table 7. CALCULATED EMISSIONS FROM THE PMRF KOKEE COMMS SITE AT PARCEL "C"

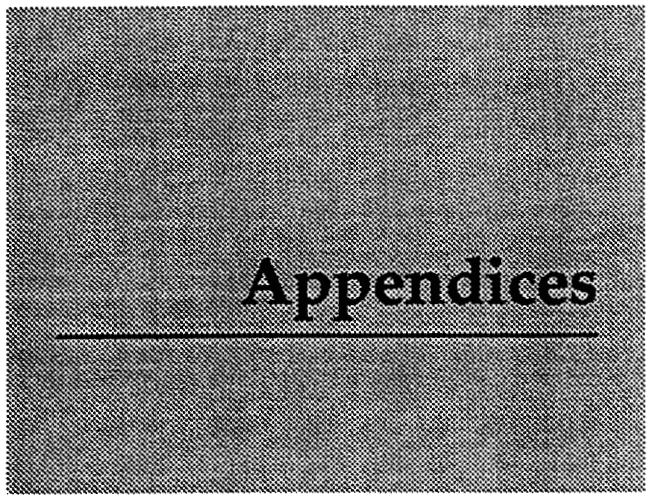
TRANSMITTER	TRANSMIT FREQ (MHz)	TRANSMIT POWER (WATTS)	MAINBEAM ANTENNA GAIN (dBi)	DISTANCE (MILES)	RSTER POWER DENSITY (dBW/m^2)	RSTER POWER DENSITY (dBm/m^2)	RSTER E-FIELD STRENGTH (V/m)
AN/GRC-211	116-150	25.0	1.0	0.46	-53.4	-23.4	0.041
AN/GRT-22 & AM-6155	225-399	50.0	1.0	0.46	-50.4	-20.4	0.059
LUCAS EPSCO CG & CD	400-450	1000.0	4.0	0.46	-34.4	-4.4	0.371

Table *8.* CALCULATED RSTER POWER DENSITY IN MAINBEAM REGION
RSTER TRANSMISSIONS FROM KOKEE AFS

TRANSMIT ANTENNA	TRANSMIT POWER (WATTS)	MAINBEAM ANTENNA GAIN (dBi)	EFFECTIVE RADIATED POWER (WATTS)	DISTANCE (MILES)	RSTER POWER DENSITY (dBW/m^2)	RSTER POWER DENSITY (dBm/m^2)	RSTER E-FIELD STRENGTH (V/m)
RSTER (PEAK POWER)	70000	28.0	44167014.1	1.80	-3.8	26.2	12.557
RSTER (AVERAGE POWER)	4375	28.0	2760438.4	1.80	-15.8	14.2	3.139

LEVELS EXCEED RADIATED SUSCEPTIBILITY LEVELS

NOTE: RSTER JF-12 OUTPUT POWERS OF 140k (PEAK) AND 8750 (AVERAGE) ARE REDUCED BY HALF DUE TO 3 dB CABLE LOSS BETWEEN TRANSMITTER AND ANTENNA.



G. National Aeronautics and Space Administration Comment Letter

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001

Reply to Attn of: JXG

DEC - 3 1993

Mr. J. M. Kilian
Director, Real Estate Division
Department of the Navy
Naval Facilities Engineering Command
Pearl Harbor, Hawaii 95560-7300

Dear Mr. Kilian:

This document supersedes my previous letter of August 3, 1993, regarding operation of the Radar Surveillance Technology Experimental Radar (RSTER) at three potential sites on the Island of Kauai, Hawaii. The letter noted NASA's concern with operation of the radar at the two RSTER sites in Kokee Park. These concerns, very real at the time due to limited contact between execution agents of the Advanced Research Projects Agency (ARPA) and NASA have been mitigated by program coordination and the second amendment to the electromagnetic compatibility study for the ARPA UHF RSTER.

Installation and operation of the RSTER at the Kokee Park Parcel A and Kokee Park Air Force Station sites are acceptable to NASA provided that mitigation of an3 interference to the Kokee Park Geophysical Observatory is provided should a problem arise. Such mitigation should include:

1. Cooperative scheduling.

2. Sector blanking.

3. Use of harmonic filters in the RSTER transmitter (if measurements demonstrate the need).

4. Selection of a compatible frequency range in the proposed UHF operating band.

5. Prior coordination of RSTER operations end test schedules.

Prior *to* planning installation of the RSTER radar at either site, an operations planning document should be submitted for approval to the Kokee NASA Site Manages to preclude possible interference

with existing or planned NASA, NOAA and USNO sensor and communications programs. Please consult our office prior to any RSTER operations at either of the Kokee Park sites.

If required, these provisions and a requirement for interference mitigation should be incorporated into the final Environmental Assessment document that is to be forwarded to the Department of the Navy for a "finding of no significant impact-"

Please contact Mr. Robert Hammond, Chief, Facilities Operations and Maintenance Office at (202) 358-1095 for further assistance concerning this important matter.

Sincerely,

Billie J. McGarvey
Director, Facilities Engineering Division

Appendices

H. CZMA Letter of Concurrence (Office of State Planning)

OFFICE OF STATE PLANNING
Office of the Governor
MAILING ADDRESS: P.O. BOX 3540, HONOLULU, HAWAII 96811-3540
STREET ADDRESS: 250 SOUTH HOTEL STREET, 4TH FLOOR
TELEPHONE: (808)587-2846, 587-2800

JOHN WAIHEE, Governor
FAX: Director's Office 587-2848
Planning Division 587-2824

Ref. No. C-196

August 18, 1993

Mr. Melvin Kaku
Code 23
Pacific Division, Naval Facilities
Engineering Command
Pearl Harbor, Hawaii 96860-7300

Dear Mr. Kaku:

Subject: Hawaii Coastal Zone Management (CZM) Program
Federal Consistency for the Mountaintop Sensor
Integration Test Program (MSITP) at Waimea, Kauai

Your proposal to construct and operate a radar array facility at four sites at three locations: two sites at the Pacific Missile Range Facility - Makaha Ridge; the Pacific Missile Range Facility - Kokee; and the Kokee Air Force Station, has been reviewed for consistency with Hawaii's CZM Program. We concur with your CZM assessment and finding that the activity is consistent to the maximum extent practicable based on the following conditions:

1. Security lighting shall be designed to be deflected downwards to prevent native birds becoming disoriented and injuring themselves. Also, security lighting shall be avoided during the months of October and November when Newell's Shearwaters migrate.

2. At the Kokee Air Force Station site, no construction activities shall occur on the undisturbed portion which is dominated by native habitat characteristic of a diverse mesic forest. As stated in the CZM consistency certification, the undisturbed portion of the site should remain intact to preserve habitat for native plants and land birds.

3. The MSITP Facility will be rotated among each of the three locations over a three year period after the first site is operational. The sites will not be used simultaneously and will be returned to their existing conditions upon conclusion of the program.

CZM consistency approval is not an endorsement of the project nor does it convey approval with any other regulations administered by any State or County agency.

Thank you for your cooperation in complying with Hawaii's CZM Program. If you have any questions, please call our CZM office at 587-2878.

Sincerely,

Harold S. Masumoto
Director

cc: ✓Mr. Scott Ezer, Helber Hastert & Fee
Department of Land & Natural Resources, OCEA
Planning Department, County of Kauai

Helber Hastert
Planners

19 July 1993

Mr. Harold Masumoto
Director
Office of State Planning
State of Hawaii
P.O. Box 3540
Honolulu, Hawaii 96811-3540

Attention: Coastal Zone Management Program

Dear Mr. Masumoto:

Coastal Zone Consistency Determination
Mountaintop Sensor Integration Test Program

The Navy is planning to construct and use a radar Array facility called the Mountaintop Sensor Integration and Test Program facility (MSITP) in Waimea, District of Waimea, on the island of Kauai (TMK: 4-1-2-01:6; 4-1-4-01:13; and 4-5-9-01:16)). The project is being evaluated for construction at four alternative sites (see attached project documentation). Two of the sites are within the Pacific Missile Range's Makaha Ridge Facility. These are referred to as site 1 and site 2. Site 3 is at the Hawaii Air National Guard (HIANG) Kokee Air Force Station (AFS), and site 4 is at Parcel "A" (formerly known as the National Aeronautics and Space Administration (NASA) Telemetry and Control (T&C) site), Pacific Missile Range Kokee Park Instrumentation Station (KPIS).

The proposed construction includes a primary variable 48-foot to 85-foot tower (height contingent on site location) and a smaller secondary 25-foot adjacent tower which 'will house the radar arrays, antennas, and ancillary support test equipment. Additionally, there will be two eight-foot by 45-foot mobile support vans which houses the electronic signal processing systems arid computer equipment. Electrical power will be from a commercial source with backup power being provided by on-site power plant generators at Makaha Ridge, Kokee NASA Tracking Station or the Kokee Air Force Station as required.

The enclosed documents and Coastal Zone Consistency Determination are provided for your review in accordance with 15 CFR Part 390 on behalf of the Department of the Navy, Pacific Division Naval Facilities Engineering Command. We have evaluated the impacts of this action proposed within federal enclaves on State of Hawaii property, and have determined that the dispersion of radar beams from proposed radar testing facilities constitutes a "spillover" effect. Your concurrence with our determination that the proposed action is consistent to the maximum extent practicable, with the objectives and policies of the State of Hawaii Coastal Zone Management (CZM) Program is requested.

As discussed in the enclosed documentation, no adverse effects are anticipated to native birds as the result of radar beams because the power density of the radar will be below the threshold to cause harm to birdlife, and the radar will only be illuminated in an 80° arc in a westerly direction. Security lighting shall be designed to be deflected downwards to mitigate the potential for disoriented birds and will be avoided entirely

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Honolulu, Hawaii 96813
Telephone 808 545-2055
Facsimile 808 545 2050

during the months of October and November when young Newell's Shearwaters leave their nests.

Also, we do not anticipate any adverse visual effects associated with the construction of the proposed project. Two of the proposed sites (at Makaha Ridge) will be visible from the ocean. However, they will be located within an existing military installation that hosts other radar facilities, currently visible from the ocean. Therefore, the overall impact of the proposed project will be minimal. The other two proposed sites are located in Kokee State Park. One of the sites, the former NASA Tracking Station, is briefly visible from Highway 550 within the park. However, the current view of the site already includes mechanical equipment, so the visual impacts will be minimal. It should also be noted that the proposed project is temporary in nature, lasting no more than three years.

We appreciate your expeditious review of this CZM consistency determination. Should you have any questions, please free to call me or Tom Fee of Helber Hastert & Fee, telephone 545-2055.

Sincerely,

HELBER HASTERT & FEE, Planners

Scott Ezer
Senior Associate

Enclosures

CC: Mr. Melvin N. Kaku, Director
PACDIV Environmental Planning Division

1.0 INTRODUCTION/SUMMARY

This environmental assessment (EA) is prepared pursuant to the National Environmental Policy Act (NEPA). The EA supports a proposed ground-based test and demonstration of airborne surveillance and communication technology and algorithms associated with long-range detection and tracking of advanced airborne targets by an airborne platform. The project is referred to as the Mountaintop Sensor Integration and Test Program (MSITP). The primary physical components of the program include two 45-foot long trailers, and an antenna/pedestal structure (hereinafter referred to as the "MSITP facility").

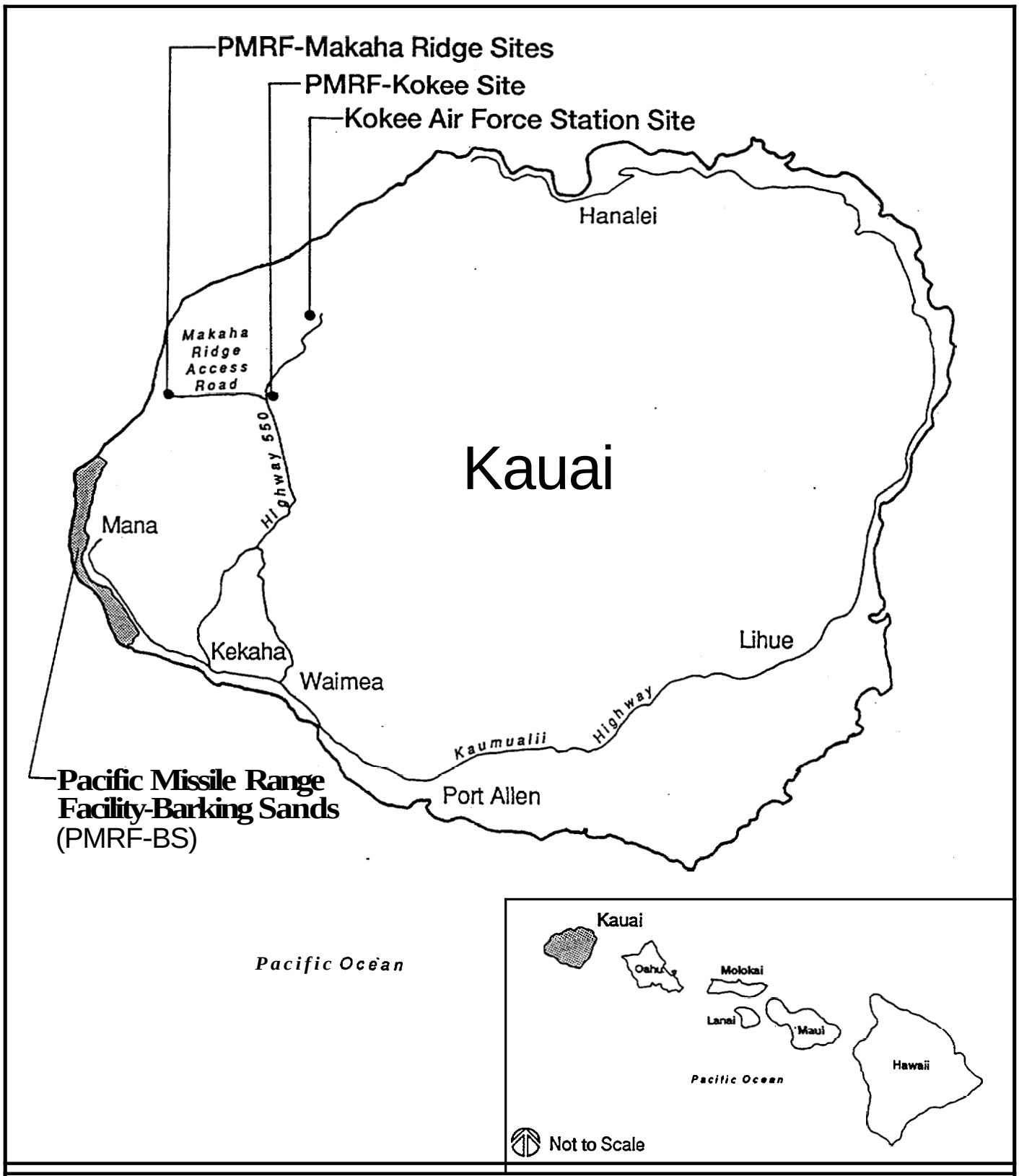
Four sites have been selected as possible locations for this test: two sites at the Pacific Missile Range Facility-Makaha Ridge ("PMRF-Makaha Ridge"); the Pacific Missile Range Facility-Kokee ("PMRF-Kokee"); and, the Kokee Air Force Station ("KAFS"). All sites are located on the island of Kauai, Hawaii (Figure 1). The MSITP Facility will be rotated among each of the three main sites over a three-year period. The sites will not be used simultaneously.

1.1 Project Description

The Advanced Research Projects Agency (ARPA) in Washington, D.C., sponsor of the MSITP project, requires a land-based capability to test different types of radars and communications equipment without the expense of flying. The United States Air Force, Rome Laboratory (Griffiss Air Force Base, New York) is managing the MSITP project for ARPA. The U.S. Navy is providing logistical and engineering support for the MSITP project.

Various radar models can be brought to the test facility for analysis without the requirement for flying. The MSITP project is designed to provide a signal environment consisting of targets, clutter, and noise levels representative of an operational airborne surveillance and tracking radar. The parameters which determined the final selection of the three sites on Kauai include:

- altitude;
- depression angle;
- near-in ground clutter;
- controlled air space;
- targets of opportunity;
- site preparation; and,
- environmental considerations.



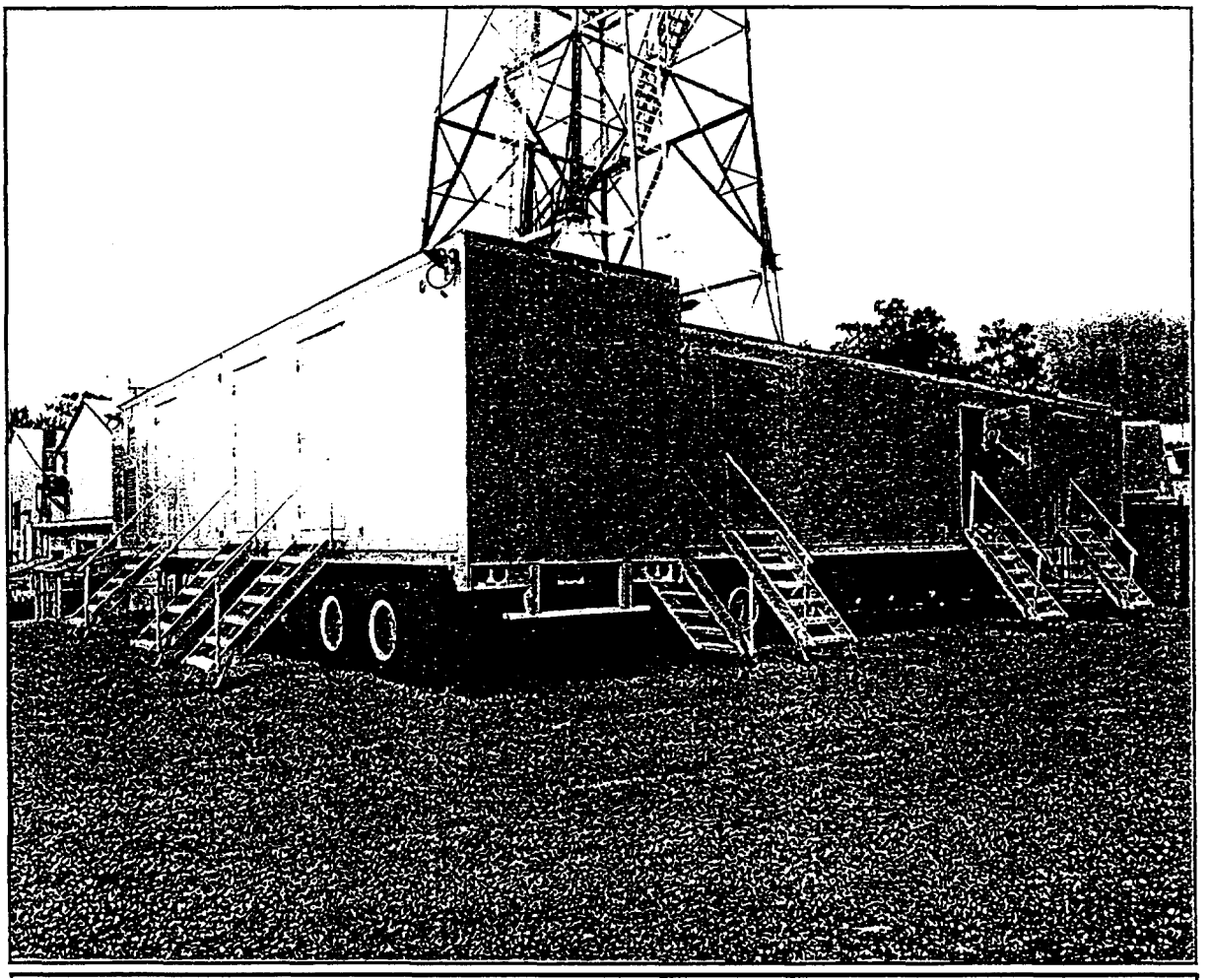
General Location Map

Figure: 1

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

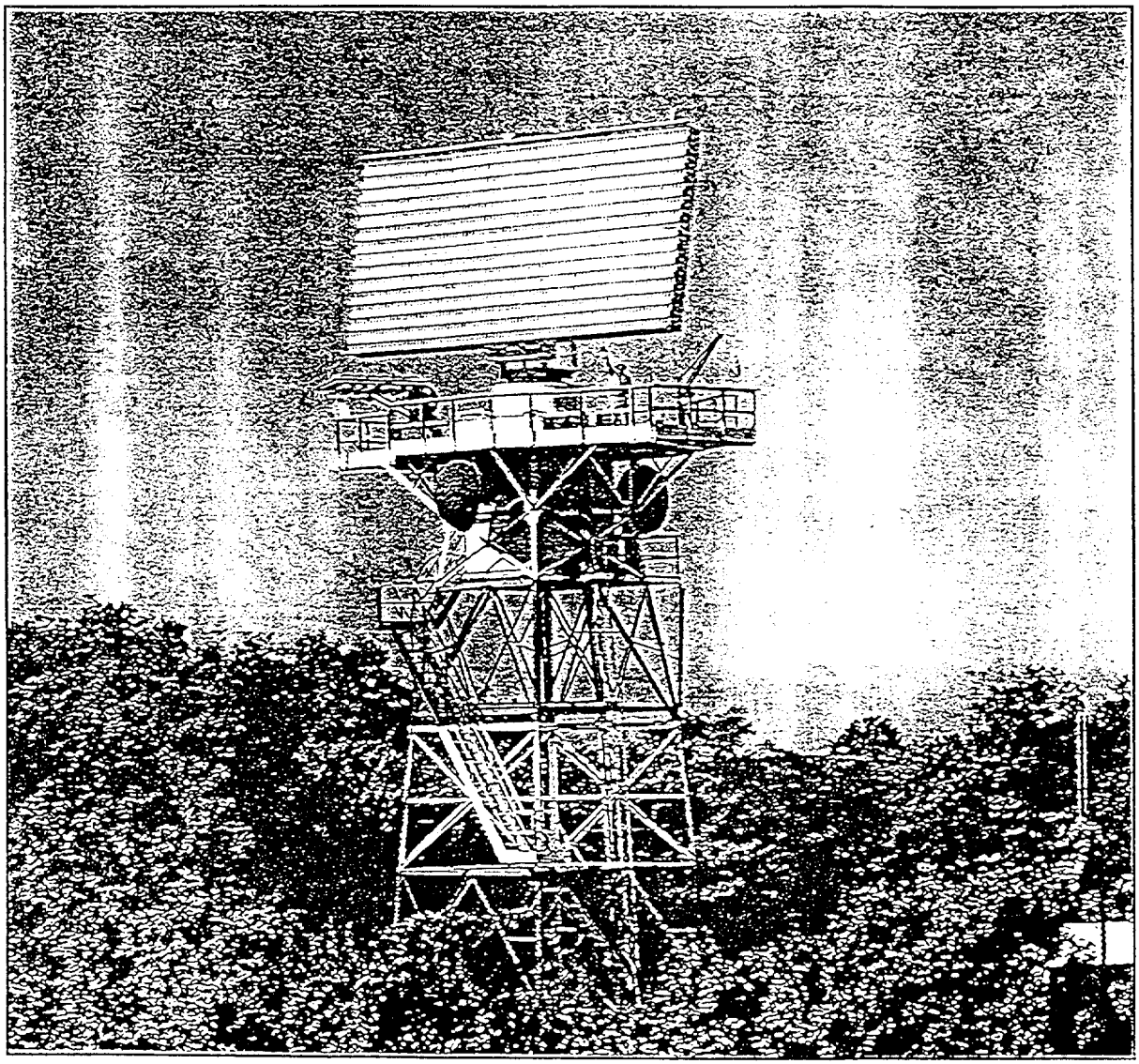
0 2.5 5

The primary radar equipment to be tested is designated the Radar Surveillance Technology Experimental Radar **(RSTER).** The RSTER is a long-range surveillance radar designed by MIT/Lincoln Labs (Lexington, Massachusetts), to provide surface ship detection and tracking capability against anti-shipping cruise missiles. The RSTER is "transportable" and self-contained. It consists of two 45-foot long trailers and an antenna/pedestal unit. One trailer houses the transmitter and the receiver signal processing equipment. The second trailer houses the display and operations center. Each trailer weighs 45,000 pounds, and can be transported by tractor. **A** typical two-trailer configuration is shown in Figure 2.



Typical Trailer Configuration Figure: *2*

The antenna will be mounted on a steel tower or pedestal to be erected as part of the site preparation. (The PMRF-Kokee site already has an existing 30-foot tower which is undergoing structural analysis to determine its feasibility for the mounting of the MSITP antenna. If determined structurally adequate, a new tower will not be needed.) The overall height of the pedestal/antenna unit will vary with each of the four sites: approximately 85 feet above ground elevation at PMRF-Makaha Ridge; approximately 56 feet above ground elevation at KAFS; and approximately 52 feet above ground elevation at PMRF-Kokee. A typical antenna/pedestal unit with a RSTER attached is shown in Figure **3.**



Typical Pedestal/Antenna Unit — Figure: 3

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

The antenna and pedestal are separate units, each weighing about 5,000 and 7,000 pounds, respectively. Prime power for operation of the system is 300 kilowatts (kW). The 16-foot (5 meter) by 32-foot (10 meter) antenna structure rotates at 5 revolutions per minute (rpm). Fixed 5.8° azimuth pencil beams are scanned in elevation using low power phase shifters. The 14 solid state amplifiers develop 600 watts each for a total of 8 kW average and 128 kW peak power at the transmitter output (input to the antenna is 4 kW average and 64 kW peak). The best antenna performance is provided across the 420 to 450 megaherz (MHz) band, although nearly the same performance is provided from 400 to 500 MHz.

In addition to the primary steel tower, an auxiliary tower (approximately 25 feet high), will be located on site to support assembly and checkout of the RSTER-90 antenna prior to lift and mounting on the primary RSTER steel tower.

The linear (patch 1) antenna to be used in conjunction with the RSTER system is an auxiliary array to be used at the same time as the RSTER antenna. Its purpose is to transmit successive pulses out of individual patch elements in the array. This movement of the phase center of the array has the effect of making the radar act as if it is moving with respect to the ground like an airborne radar. The array is about two feet high and 32 feet long and a few inches thick. The patches have a beam width of about 120 degrees. The positioning of this array is not as critical as the main RSTER array.

The ADS-18s antenna to be used in conjunction with the RSTER system is a new experimental upgrade antenna for the E2 radar system. For some tests, this antenna will take the place of the RSTER antenna and will be used with the RSTER transmitter. It will be in an enclosure which rotates but the antenna also has azimuth scanning capability to about +60 degrees. The array itself is a horizontal linear array with 18 elements. The array is about two feet high, 21 feet wide and six feet wide.

None of the sites would be operational simultaneously. When testing is completed at one site, the radar equipment and trailers will be moved to the next test site. It is anticipated that testing would be completed within three years after the first site is operational, at which time all sites will be returned to their existing condition. The MSITP project will employ about five personnel for three years on a full-time basis.

1.2 Alternatives Considered

Three alternatives to the proposed action were considered: a no-action alternative; alternate sites; and alternate technology. These alternatives were determined to be not feasible for a variety of reasons, such as: absence of targets of opportunity; range control,

flight safety; and, proximity to the ocean. Therefore these alternatives were dismissed from further consideration. These alternatives are discussed in more detail in Chapter 3.

1.3 Summary of Probable Impacts and Mitigation Measures

This section summarizes the probable impacts anticipated as the result of the construction of the MSITP project, and measures that can be used to mitigate these impacts, where appropriate.

Flora. A botanical assessment survey of the four proposed sites revealed no listed, candidate, or proposed threatened and endangered species, nor are any of the plants considered rare and vulnerable. Although the KAFS site does not host any listed, candidate or proposed threatened and endangered species, the undisturbed portion of the site is dominated by native habitat characteristic of a diverse mesic forest. This portion of the site should remain intact to preserve habitat for native plants and land birds. There is sufficient area on the disturbed portion of the site to accommodate the MSITP antenna/pedestal (the trailers would be located on a separate portion of the KAFS, on an area already disturbed).

Fauna. An avifaunal and feral mammal survey of the four sites revealed no listed, candidate or proposed threatened and endangered species. The Hawaiian Hoary bat, an endangered mammal has been placed at the KAFS site by anecdotal information. Construction of the MSITP project would not have a significant impact on the Hawaiian Hoary Bat.

Impacts from security lighting associated with the MSITP project at all sites could cause native birds to become disoriented and injure themselves. Security lighting shall be designed to be deflected downward to mitigate the potential for disorientation. Security lighting should be avoided during the months of October and November, when young Newell's Shearwaters leave their mountain burrows and head out to sea.

In addition, native vegetation at the KAFS site should be preserved to protect habitat for native land birds. There is sufficient area on the disturbed portion of the site to accommodate the MSITP antenna/pedestal (the trailers would be located on a separate portion of the KAFS, on an area already disturbed). No negative impacts are anticipated to native birds as the result of radar beams because the power density of the RSTER will be below the threshold to cause harm to birdlife and the radar will only be illuminated in an 80° arc in a westerly direction.

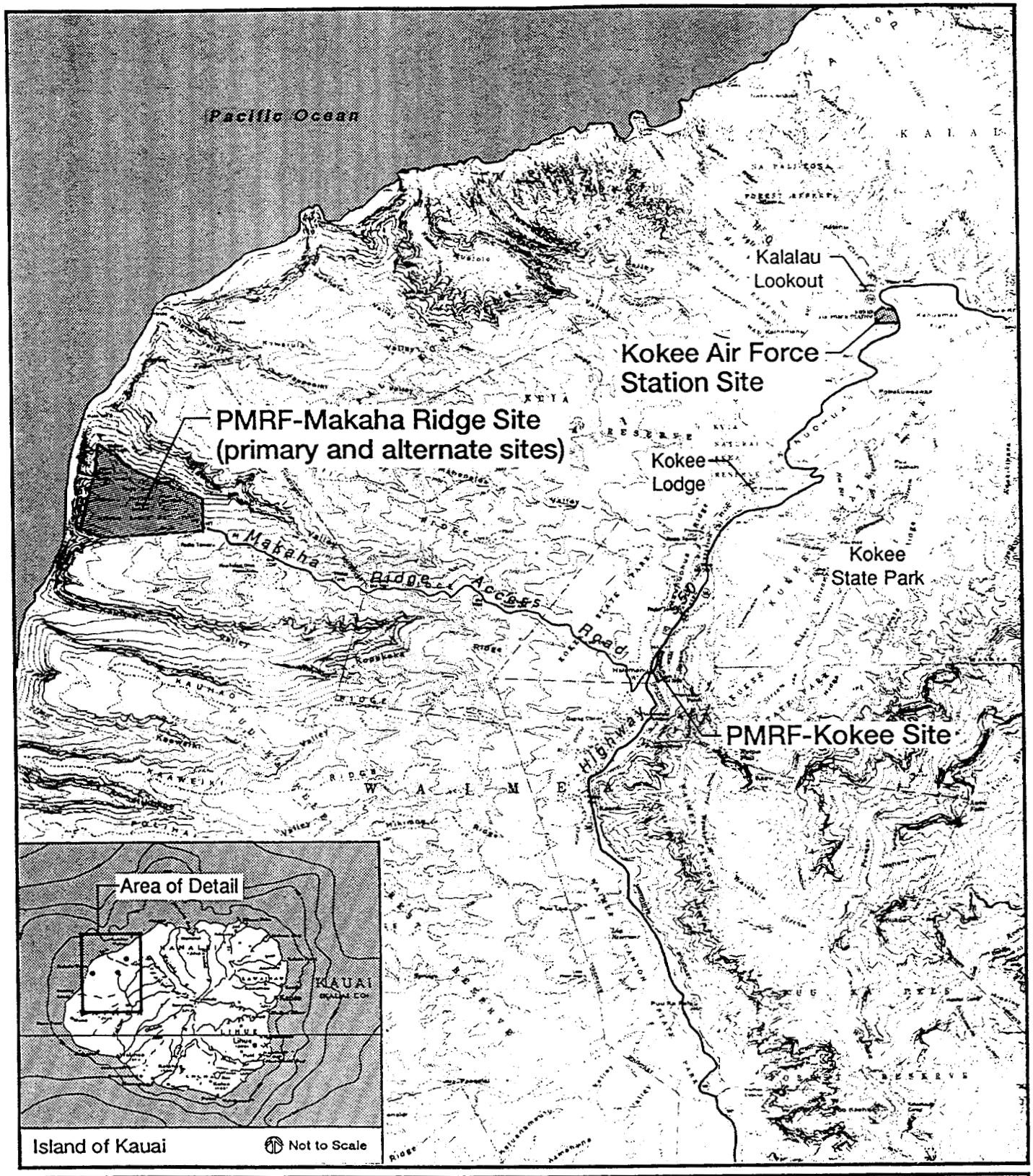
Electromagnetic Radiation (EMR). Hazards of electromagnetic radiation to personnel (HERP) and birds at all sites will be minimal due to the rotation of the RSTER during

most operations and sector blanking. Hazards of electromagnetic radiation to fuel (HERF) is minimal at all sites because there are no hazardous fuel locations within the calculated HERF distance of the RSTER. The potential for electromagnetic interference (EMI) occurring to existing facilities at KAFS and PMRF-Makaha Ridge is minimal since high powered radars are already operating at these sites and the RSTER will use sector blanking. EMI at the KAFS site will be minimized further because the height of the antennae would prevent mainbeam illumination of surrounding structures. During the preparation of this EA it was determined that locating the MSITP project at the primary site at PMRF-Makaha Ridge would interfere with PMRF-BS range operations, specifically the Integrated Target Control System (ITCS) Facility. The MSITP project will be moved to an alternate site approximately 100 yards east of the preferred site.

Visual Resources. The existing 30-foot antenna pedestal at the PMRF-Kokee site is visible for a distance of about 100 yards between the 14- and 15-mile marker along Highway 550 travelling in a downhill direction. The RSTER antenna would add about 23 feet of mechanical equipment to the existing pedestal. However given the existing visual environment (the currently visible 30-foot antenna pedestal and prominent utility poles and lines along Highway 550), the impacts of the MSITP facility would be minimal. Additionally, there will be no known long-term visual aesthetic impacts due to the temporary (three years) nature of the MSITP project.

Archaeological, Cultural and Historic Resources

The Makaha Ridge site 2 and the Kokee Air Force Station site 3 underwent full archaeological inventory survey which consisted of 100% surface survey and limited shovel subsurface testing. No archaeological sites or cultural materials were identified during the survey. The Makaha Ridge site 1 was not surveyed because the area was previously heavily developed and is completely paved with asphalt. The Kokee NASA station Parcel A site also was not surveyed because the area was previously heavily developed and has an existing concrete slab with an existing 300-foot tower on grade at the proposed site. There will be no ground disturbing activity at this site. In accordance with 36 CFR 800, the proposed construction and use of the MSITP radar facility will have "no effect" on any historic sites or cultural resources.

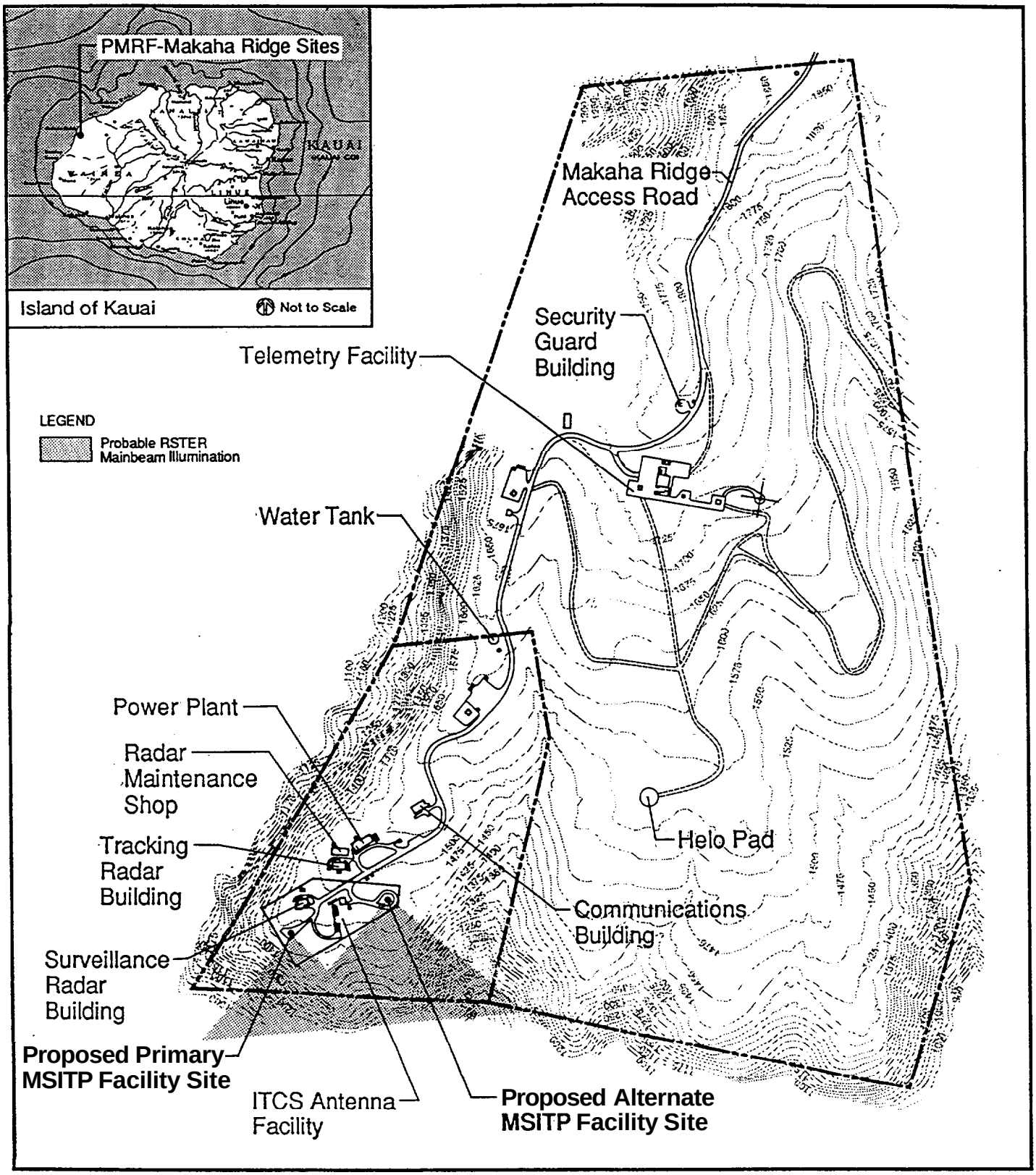


Regional Location Map

Figure: 4

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

0' 2500' 5000'



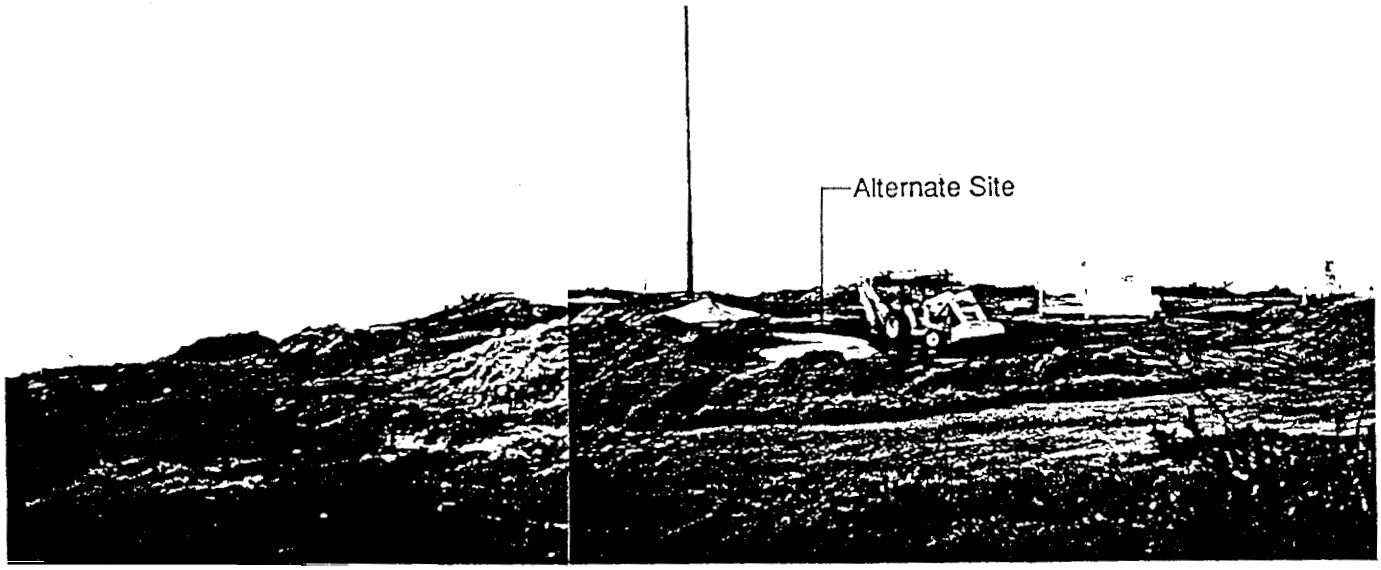
Area Map
PMRF-Makaha Ridge

Figure: 5

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

0' 300' 600'

View of primary site at PMRF-Makaha Ridge looking west.

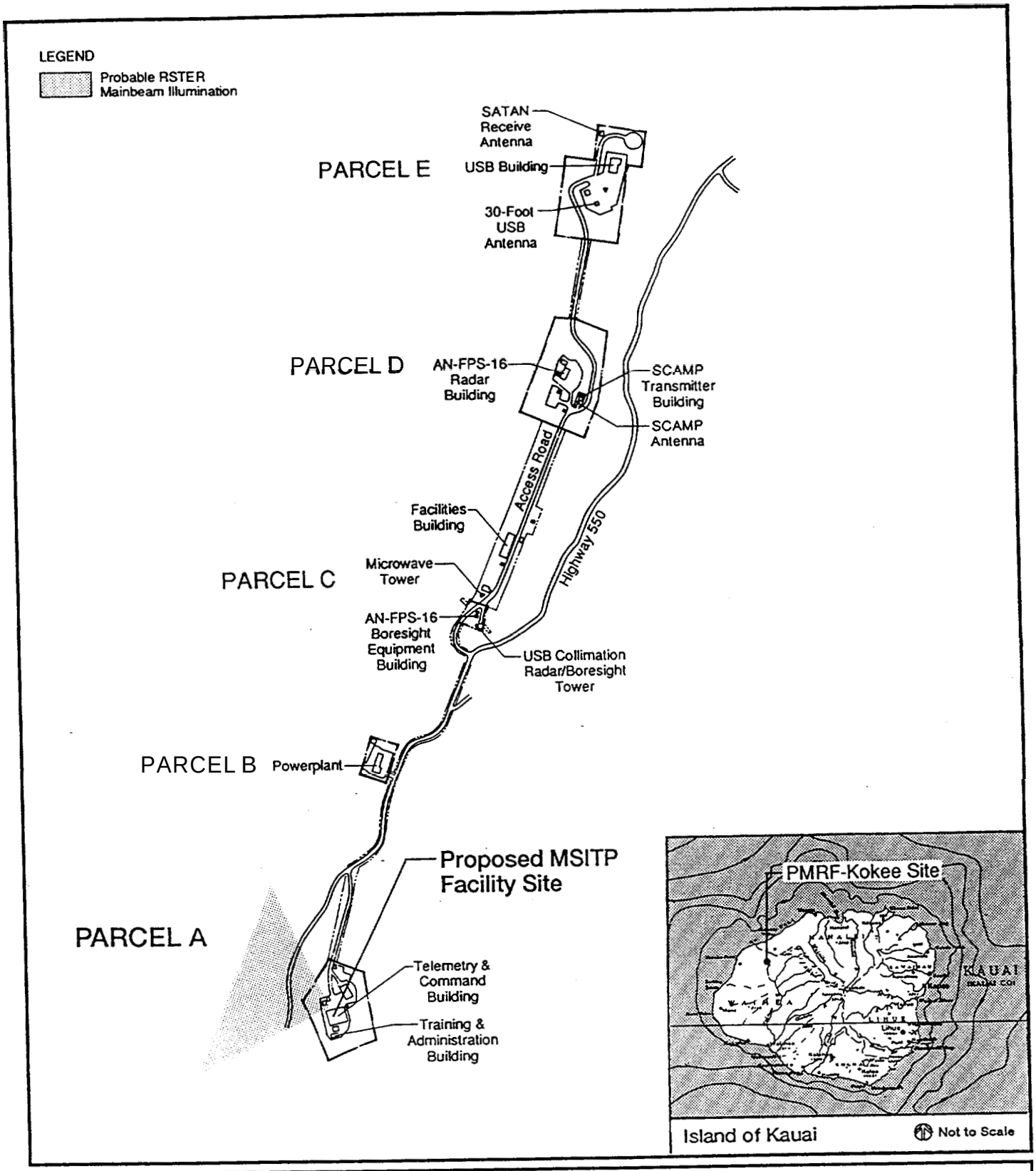


View of alternate site at Makaha Ridge looking south from access road

Proposed MSITP Facility Sites at PMRF-Makaha Ridge

Figure: 6

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

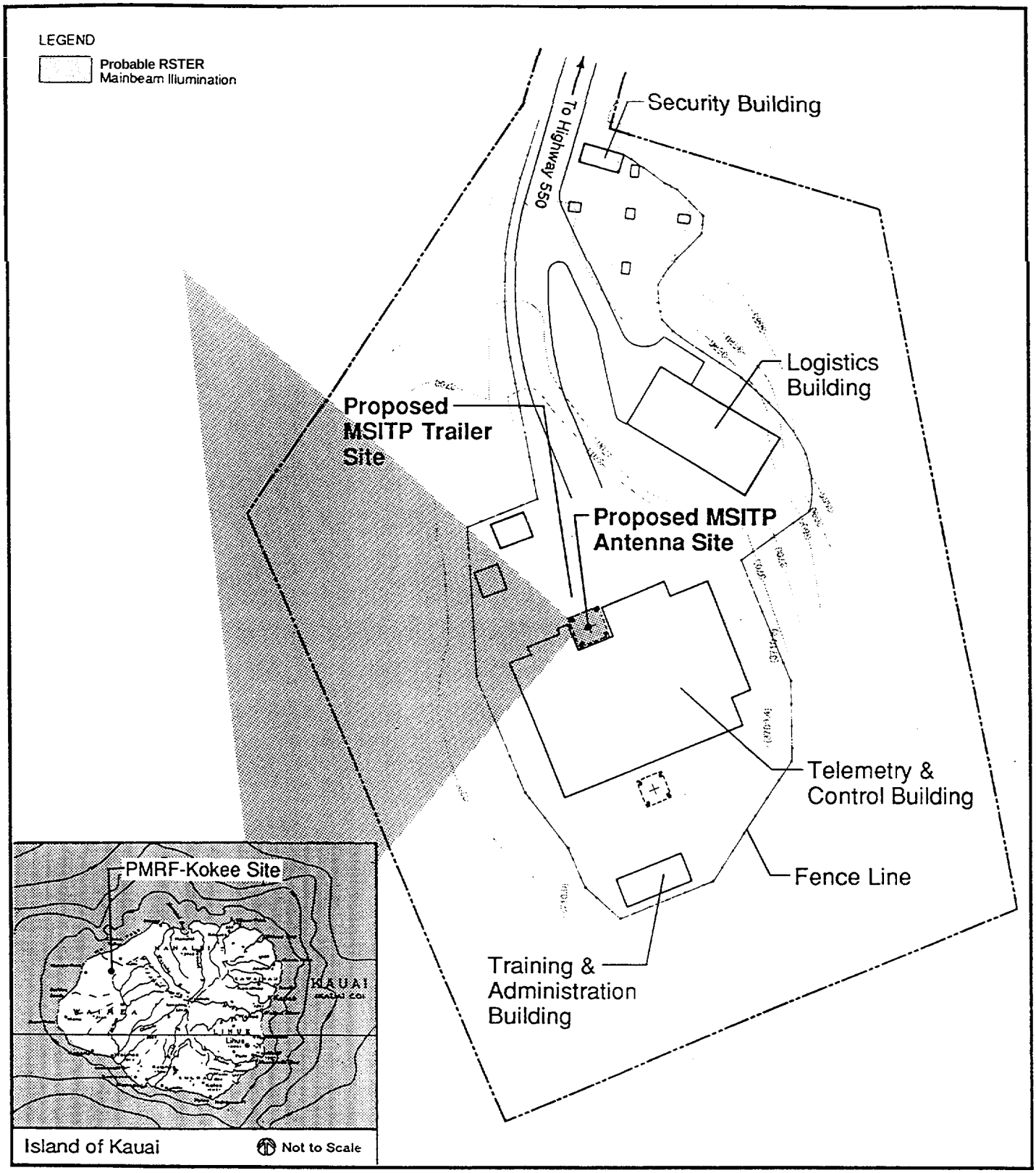


PMRF-Kokee Site Plan

Figure: 7

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

0' 4000' 8000'

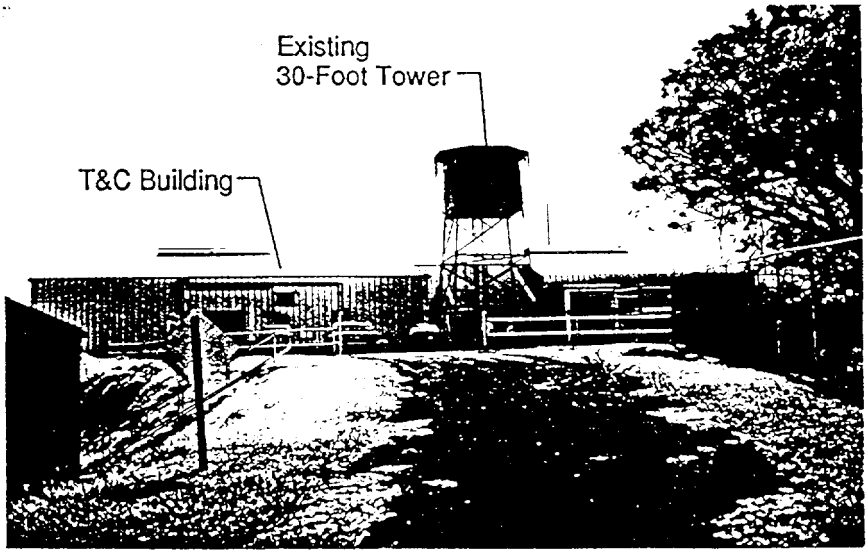


PMRF-Kokee
Parcel "A"

Figure: 8

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

0' 40' 80'

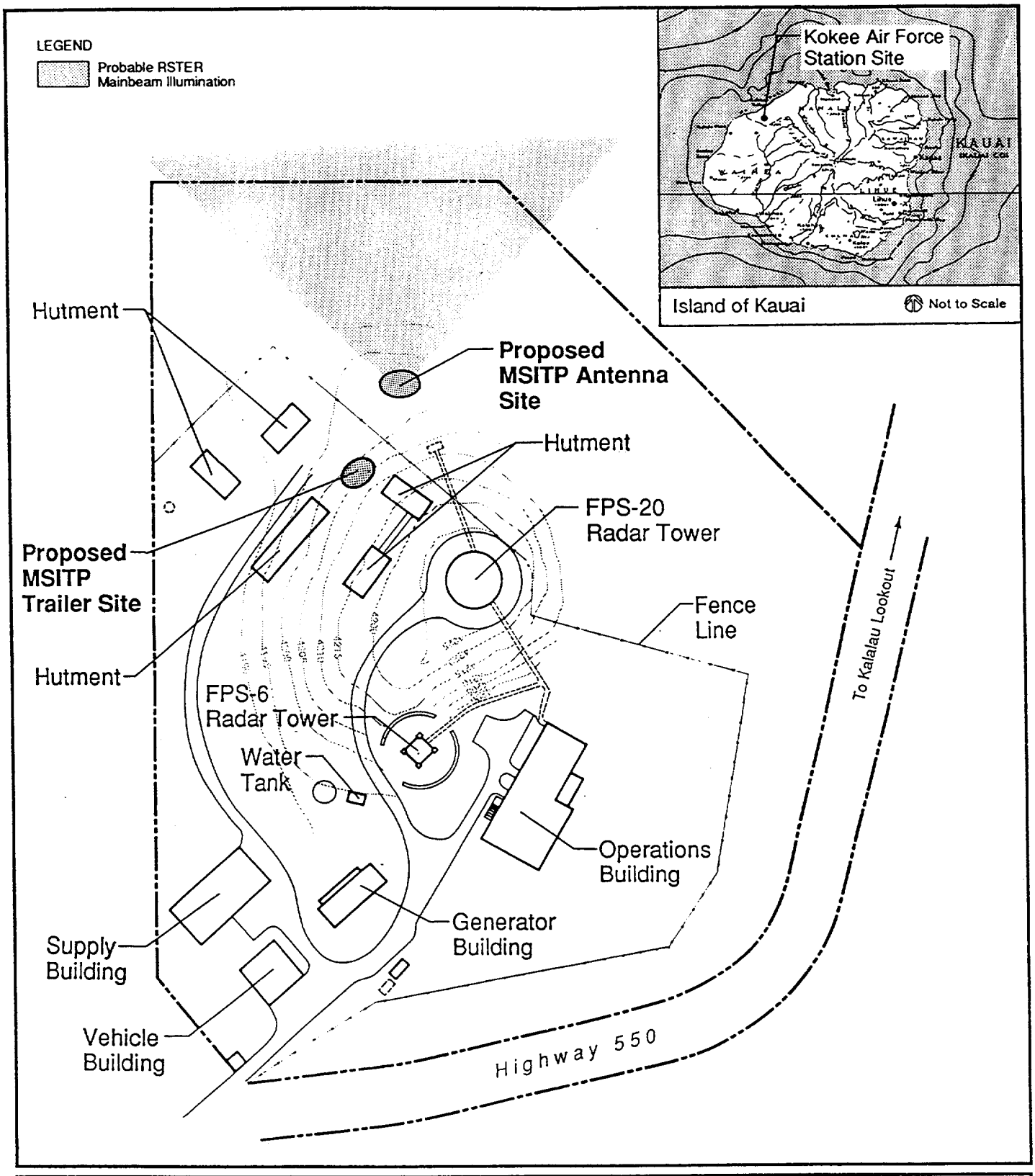


View of proposed MSITP site at PMRF-Kokee, looking south from access driveway.

Proposed MSITP Facility Site at PMRF-Kokee

Figure: 9

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

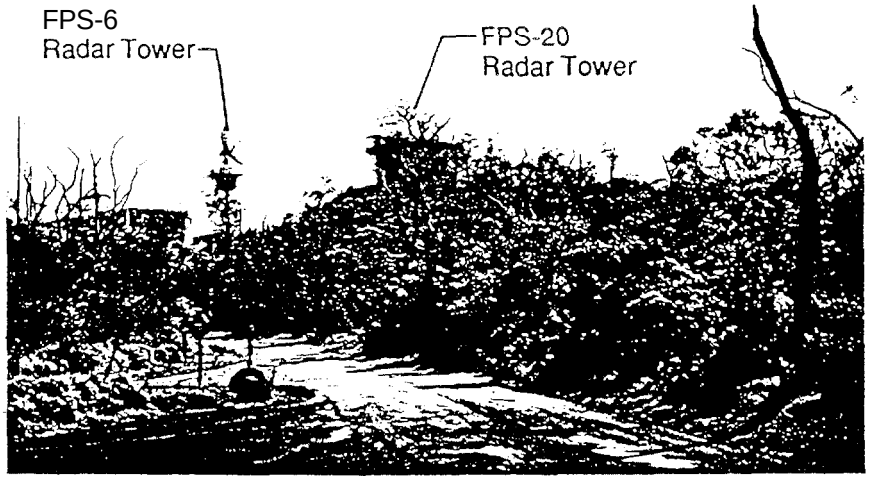


Area Map
Kokee Air Force Station

Figure: 10

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

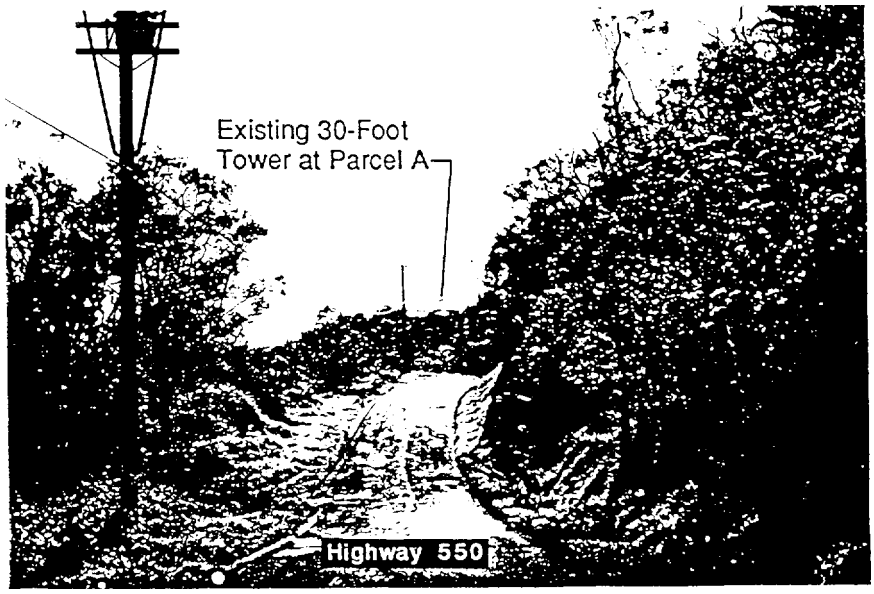
0' 60' 120'



View of KAFS, looking west, from Kalalau Lookout parking lot.

Existing Visual Environment; Kalalau Lookout Parking Lot Figure: 12

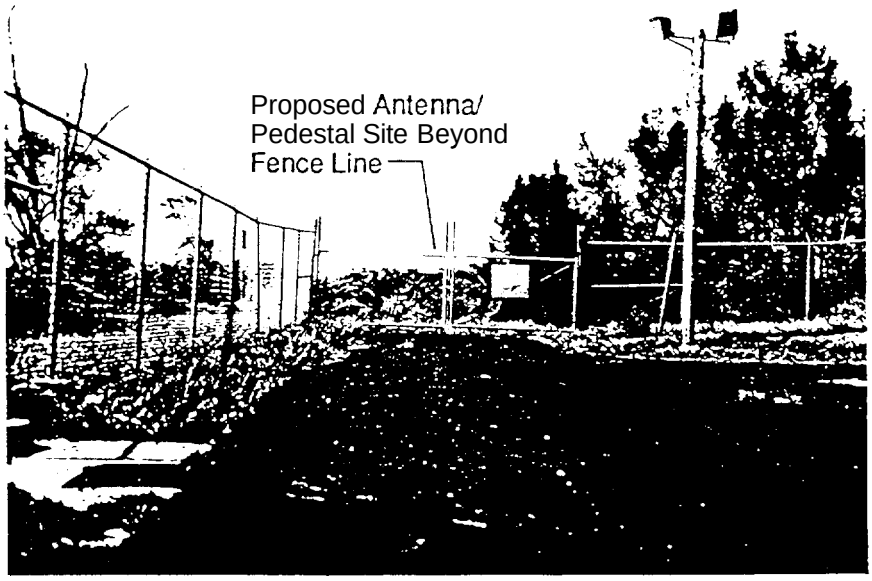
MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii



Downhill view along Highway 550, between 14- and 15- mile marker.
Exisiting 30-foot tower at PMRF-Kokee Parcel A is visible in the distance.

Existing Visual Environment Along Highway 550 Figure:13

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii



View of Kokee Air Force Station site, looking west beyond fence line.

Proposed MSITP Facility Site at Kokee Air Force Station Figure: 11

MOUNTAINTOP SENSOR INTEGRATION & TEST PROGRAM
Kauai, Hawaii

HAWAII CZM PROGRAM
ASSESSMENT FORMAT

RECREATIONAL RESOURCES

Objective: Provide coastal recreational activities accessible to the public.

Policies:

(1) Improve coordination and funding of coastal recreation planning and management.

(2) Provide adequate, accessible, and diverse recreational opportunities in the coastal management area by:

(a) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;

(b) Requiring replacement of coastal resources having significant recreational value, including, but not limited to surfing sites and sandy beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;

(c) Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;

(d) Encouraging expanded public recreational use of County, State, and Federally owned or controlled shoreline lands having recreational value;

(e) Adopting water quality standards and regulating point and non-point sources of pollution to protect and where feasible, restore the recreational value of coastal waters;

(9 Developing new shoreline recreational opportunities, where appropriate, such as artificial reefs for surfing and fishing;

(g) Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the State Land Use Commission, Board of Land and Natural Resources, county planning commissions; and crediting such dedication against the requirements of section 46-6.

Check either "Yes" or "No" for each of the following questions.

		Yes	No
(1)	Will the proposed Action involve or be near a dedicated public right-of-way?		X
(2)	Does the project site abut the shoreline?		X
(3)	Is the project near a State of County park?	X	
(4)	Is the project site near a perennial stream?		X
(5)	Will the proposed action occur in or affect a surf site?		X
(6)	Will the proposed project occur in or affect a popular fishing area?		X
(7)	Will the proposed action occur in or affect a recreational boating area?		X
(8)	Is the project site near a sandy beach?		X
(9)	Are there swimming or other recreational uses in the area?	X	

DISCUSSION:

Two areas are located within the boundaries of the Pacific Missile Range Facility, Makaha Ridge. The other two sites are situated within Kokee State Park, which is managed by the Department of Land and Natural Resources, Division of State Parks. The State Park includes Waimea Canyon, one of the primary tourist destinations on Kauai. The project will not affect park recreational resources in the vicinity.

HISTORIC RESOURCES

Objective: Protect, preserve, and where desireable, restore those natural and man–made historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

Policies:

(1) **Identify** and analyze significant archaeological resources;
(2) Maximize information retention through preservation of remains and artifacts or salvage operations;
(3) Support state goals for protection, restoration, interpretation, and display of historic resources.

Check either Yes' or 'No' for each of the following questions.

		Yes	No
(1)	Is the project within a **historic/cultural** district?		X
(2)	Is the project site listed or nominated to the Hawaii or National Register of Historic **Places?**		X
(3)	Does the project site include undeveloped **land** which has not been surveyed by an archaeologist?		X
(4)	Has a site survey revealed any information on historic or archaeological resources?		X
(5)	**Is** the project site within or near a Hawaiian fishpond or historic settlement area?		X

DISCUSSION:

An archaeological inventory survey was conducted at one of the Makaha Ridge sites and at the Kokee Air Force Station site in December 1992 by Paul H. Rosendahl, Ph. D., Inc. (The other two sites were not surveyed because they already had been heavily developed and have existing concrete pads over them). No historic or archaeological remains were discovered at either of the sites during the inventory survey. However, during the course of future development, if potentially significant cultural remains are encountered in the in the project area consultation will be initiated immediately.

SCENIC AND OPEN SPACE RESOURCES

Objective: Protect, preserve, and where desirable, **resotre** or improve the quality of coastal scenic and open space resources.

Policies:

(1) **Identify** valued scenic resources in the coastal zone management area;

(2) Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of the natural **landforms** and existing public views to and along the shoreline;

(3) Preserve, maintain and, where desirable, improve and restore shoreline open space and scenic resources;

(4) Encourage those developments which are not coastal dependent to locate in inland areas.

Check either 'Yes" or 'No" for each of the following questions.

		Yes	No
(1)	Does the project site abut a scenic **landmark?**		X
(2)	Does the proposed action involve the construction of a multi–story structure or structures?	X	
(3)	Is the project adjacent to undeveloped parcels?	X	
(4)	Does the proposed action involve construction of structures visible between the nearest coastal roadway and the shoreline?		X
(5)	Will the proposed action involve construction in or on waters seaward of the shoreline?		X

DISCUSSION:

The MSITP project will construct an **antenna/pedestal** and includes two 45–foot long site–support equipment trailers. The **antenna/pedestal** will be a maximum of 85 feet in height. The PMRF–Kokee and KAFS sites are located within the boundaries of Kokee State Park, and the facility will have limited **visibility** from points along Highway 550. However, given the existing visual environment in those areas of the highway (an existing **30**–foot **antenna/pedestal** and prominent utility poles and lines), the MSITP facility is expected to have. minimal impact. In addition, there will be no known long–term impacts to scenic and open space resources, since the MSITP project is temporary (three years).

ECONOMIC USES

Objective: Provide public or private facilities and improvements important to the state's economy in suitable locations.

Policies:

(1) Concentrate in appropriate areas the location of coastal dependent development necessary to the State's economy.

(2) Ensure that coastal dependent development such as harbors and ports, visitor industry facilities, and energy generating facilities are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and

(3) Direct the location and expansion of coastal dependent development to areas presently designated and used for such development and permit reasonable long–term growth at such areas, and permit coastal dependent devleopment outside of presently designated areas when:

(a) Utilization of presently designated facilities is not feasible;
(b) Adverse environmental effects are minimized; and
(c) Important to the State's economy.

Check either "Yes' or 'No' for each of the following questions.

		Yes	No
(1)	Does the project involve a harbor or port?		X
(2)	Is the project site within a designated tourist destination area?		X
(3)	Does the project site include lands used/designated for agriculture?		X
(4)	Does the proposed activity relate to commercial fishing or seafood production?		X
(5)	Does the proposed activity relate to energy production?		X
(6)	Does the proposed activity relate to seabed mining?		X

DISCUSSION:

The MSITP project will provide a land–based capability to test different types of radars without the expense of flying. Testing of new radar systems is essential to the state of military readiness of existing and future operations world–wide.

COASTAL ECOSYSTEMS

Objective: Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

Policies:

(1) Improve the **technical** basis for natural resource management;

(2) Preserve valuable coastal ecosystems of significant biological or economic importance;

(3) Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing needs; and

(4) Promote water quantity and q u a l i planning and management practices which reflect the tolerance of fresh water and marine ecosystems and prohibit land and water uses which violate State water **quality** standards.

Check either "Yes' or **"No"** for each of the following questions.

		Yes	No
(1)	Does the proposed action involve dredge or **fill** activities?		X
(2)	Is the project site within the Shoreline Setback Area?		X
(3)	Will the proposed action require some form of effluent discharge into a body of water?		X
(4)	Will the proposed project require earthwork beyond clearing and grubbing?		X
(5)	Will the proposed action include the construction of special waste treatment facilities, such as injection wells, discharge pipes, or cesspools?		X
(6)	Is an intermittent or perennial stream located on or near the project site?		X
(7)	Does the project site provide habitat for endangered species of plants, birds, or mammals?		X
(8)	Is any such habitat located nearby?	X	
(9)	Is there a wetland on the project site?		X
(10)	Is the project situated on or abutting a Natural Area Reserve?		X
(11)	Is the project site on or abutting a Marine Life Conservation Distriit?		X
(12)	Is the project situated on a abutting an estuary?		X

DISCUSSION:

An avifaunal and feral mammal survey and a botanical survey of the four sites conducted in December 1992 revealed no listed candidate or proposed threatened and endangered species. The Hawaiian Hoary bat, an endangered mammal, has been placed at the KAFS site by anecdotal information. Construction of the MSITP project will not haw a significant impact on the Hawaiian Hoary bat. Security lighting associated with the project will be designed to deflect downward, to minimize adverse impacts to the Newell's Shearwater, a threatened native seabird which may fly over the Makaha Ridge sites. It should also be noted that the operation of the radar will not adversely affect birds in the area because the radar will be rotating, thus limiting exposure to radar beams, and the radar will only be operational within a limited arc.

Although no threatened or endangered species are present, the undisturbed portion of the KAFS site is dominated by native habitat characteristic of a diverse mesic forest. This portion of the site will remain intact to preserve habitat for native plants and land birds.

COASTAL HAZARDS

Objective: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, and subsidence.

Policies:

(1) Develop and communicate adequate information on storm wave, tsunami, erosion, and subsidence hazar

(2) Control development in areas subject to storm wave, tsunami, erosion, and subsidence hazard;

(3) Ensure that developments comply with the requirements of the Federal Flood Insurance Program; and

(4) Prevent coastal flooding from inland projects.

Check either "Yes" or "No" for each of the following questions.

		Yes	No
(1)	Is the project abutting a sandy beach?		X
(2)	Is the project within a potential tsunami inundation area as depicted on the National Flood Insurance Program flood hazard map?		X
(3)	Is the project within a potential flood inundation area according to a flood hazard map?		X
(4)	Is the project within a potential subsidence hazard area according to a subsidence hazard map?		X
(5)	Has the project site or nearby shoreline areas experienced shoreline erosion?		X

DISCUSSION:

None of the four proposed sites is subject to any flood hazards.

MANAGING DEVELOPMENT

Objective: Improve the development and review process, communication, and public participation in the management of coastal resources and hazards.

Policies:

(1) Effectively utilize and implement existing law to the maximum extent possible in managing present and future coastal zone development;

(2) Facilitate timely processing of applications for permits and resolve conflicting permit requirements; and

(3) Communicate the short– and long–term impacts of proposed significant coastal developments early in their life cycle in terms understandable to the general public to facilitate public participation in the planning and review process.

Check either 'Yes' or 'No' for each of the following questions.

		Yes	No
(1)	Will the proposed activity require more than two (2) permits or approval?		X
(2)	Does the proposed activity conform with the State and County land use designations for the site?	X	
(3)	Has or will the public be notified of the proposed activity?	X	
(4)	Has a draft or final environmental impact statement or an environmental assessment been prepared?	X	

DISCUSSION:

Two of the proposed project sites (PMRF–Kokee and KAFS) are situated within Kokee State Park, owned and managed by the State of Hawaii. These sites, as well as the PMRF Makaha Ridge site, are leased by the State to the federal government.

The major land use policy document for the County of Kauai, the General Plan, shows no designation for PMRF–Makaha Ridge, PMRF–Kokee or KAFS. Likewise, there are no County zoning designations for these three State–owned areas. The County of Kauai has no jurisdiction over the four proposed sites becuase they are situated in the State Conservation District

An environmental assessment for the project was prepared by Helber Hastert & Fee, Planners.

FEDERAL CONSISTENCY
SUPPLEMENTAL INFORMATION FORM

Date: _____

Project/Activity Tile or Description: Mountaintop Sensor Integration and Test Program, **Kauai,** Hawaii

Location: Island -- **Kauai** District -- Waimea

Tax Map Key No. **4-1-2-01:6; 4-1-4-01:13; 4-5-9-01:16**

Other applicable **area(s),** if appropriate:

Estimated **Start** Date: Estimate Duration: three years

APPLICANT

Name and Title: **Melvin** Kaku, Code 23

Agency/Organization: **Pacific** Division, Naval Facilities Engineering Command

Address: **Pearl** Harbor, Hawaii 96860-7300

Telephone No. during Business Hours: (808) 471-9338

AGENT

Name and Tile: Scott Ezer, Project Manager

Agency/Organization: Helber Hastert & Fee, Planners

Address: 733 Bishop Street, **Suite 2590,** Honolulu, Hawaii 96813

Telephone No. during Business Hours: (808) 545-2055

CATEGORY OF **APPLICATION** (check only one)

[X] I. Federal **Activity** [ ] III. OCS **Plan** Permit
[ ] II. Permit of License [ ] IV. Grants & Assistance

TYPE OF STATEMENT (check only **one**)

[X] Consistency

[ ] General Consistency (Category I only)

[ ] Negative Determination (Category I only)

[ ] Non–Consistency (Category I only)

APPROVING FEDERAL AGENCY (Categories II, III, and IV only)

Agency:

Contact Person:

Telephone Number during Business Hours:

FEDERAL AUTHORITY FOR ACTIVITY

National Coastal Zone Management Act of 1972, 15 CFR Part 930

OTHER STATE AND COUNTY APPROVALS REQUIRED

Agency	Type of Approval	Date of Application	Status

Appendices

I. Section 106 Letter of Concurrence (Department of Land and Natural Resources, State Historic Preservation Division)

JOHN WAIHEE
GOVERNOR OF HAWAII

KEITH AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCE

DEPUTIES

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STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

REF:HP-AMK

SEP 23 1993

RECEIVED
SEP 24 1993
HELBER HASTERT & FEE PLANNERS

LOG NO: 9494
DOC NO: 9309NM30

Mr. Alan Walker
PHRI
305 Mohouli Street
Hilo, Hawaii 96720

Dear Mr. Walker:

SUBJECT: National Historic Preservation Act Compliance –
Mountaintop Sensor Integration and Test Program Facility (MSITP)
TMK: **1-2-01: 6; 1-4-01: 13;** and **5-9-01: 16**
Waimea, Waimea, Kauai

Thank you for your letter of the revised report entitled Archaeological Inventory Survey Mountaintop Sensor Integration and Test Program Project Area, Land of Wairnea, Waimea, District, Island of Kauai (Dowden and Rosendahl, PHRI, 1993). This report is now acceptable since it has adequately presented the results of the inventory survey. No historic sites were identified. We concur that the undertaking will have "no effect" on historic sites and with the recommendation no further archaeological work will be necessary and construction activities may begin.

If you have any questions, please call Nancy McMahon at 587-0006.

Very truly yours,

KEITH AHUE, Chairperson and
State Historic Preservation Officer

NM:amk

c: Melvin Kaku, U.S. Navy
Steve Ezer, Helbert, Hastert & Kimura