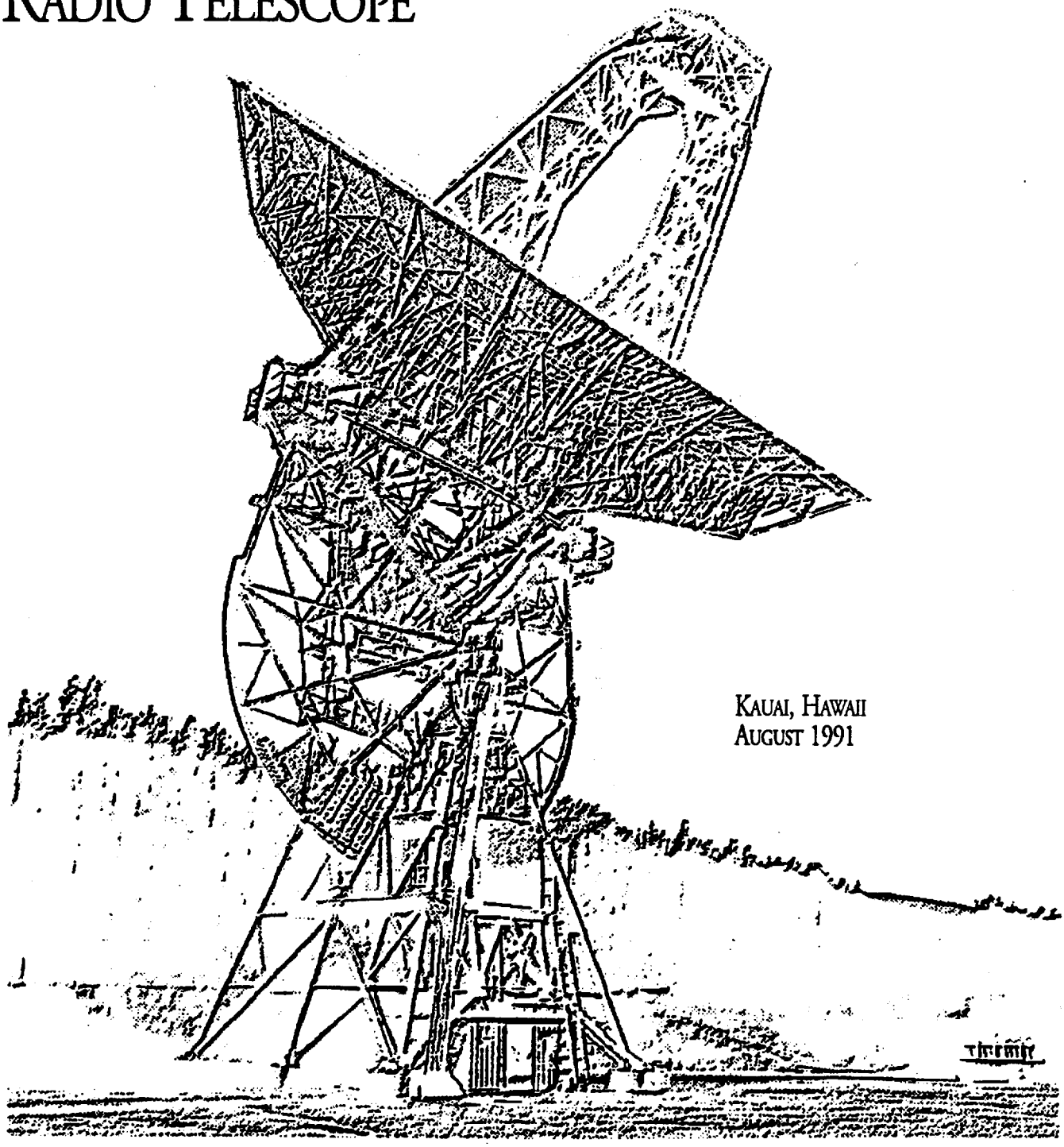
ENVIRONMENTAL ASSESSMENT FOR

THE U.S. NAVAL OBSERVATORY VERY LONG BASELINE INTERFEROMETRY (VLBI) RADIO TELESCOPE



KAUAI, HAWAII
AUGUST 1991

ENVIRONMENTAL ASSESSMENT FOR

THE U.S. NAVAL OBSERVATORY VERY LONG BASELINE INTERFEROMETRY (VLBI) RADIO TELESCOPE

PREPARED FOR:
DEPARTMENT OF THE NAVY
U.S. NAVAL OBSERVATORY

COORDINATING AGENCY:
PACIFIC DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

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AUGUST 1991

KAUAI, HAWAII

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EXECUTIVE SUMMARY

This environmental assessment (EA) is prepared pursuant to the National Environmental Policy Act (NEPA), to address the potential environmental impacts of a proposal to construct a very long baseline interferometry (VLBI) radio telescope at one of four candidate sites, located either at the Pacific Missile Range Facility-Barking Sands (PMRF-BS) or the Kokee Geophysical Observatory (KGO), Kauai, Hawaii ("proposed action") (Figure 1). Three of the candidate sites are located at PMRF-BS. The fourth candidate site is located at KGO, which includes four alternate locations within the complex boundaries (Figure 3).

In general, the proposed action will not generate any significant environmental impact. However, there will be some impact, the most notable of which is common to all four candidate sites; the visibility of the radio telescope from public highways. Although the proposed facility will be visible, impacts will be diminished because the proposed locations are adjacent to existing similar facilities or because visibility will be diminshed due to existing vegetation and topography.

In addition, the range control for PMRF-BS would object to either Site #1 or Site #2, for the VLBI facility, both located at PMRF-BS, because range operations, principally communication capability between radar and launch operations, will be seriously compromised. Further, both Site #1 and Site #3, also located at PMRF-BS, provide habitat for a category 1 candidate endangered species. Finally, Sites #1, #2 and #3 at PMRF-BS evidence levels of radio frequency interference (RFI) that would seriously degrade any VLBI data received.

Based on the analysis contained in this EA, Site #4, located at KGO, is the preferred site, with locations 1 and 2 being the preferred locations at Site #4. Visual impacts associated with either location can be mitigated by landscaping and/or painting the proposed radio telescope to blend in with existing vegetation.

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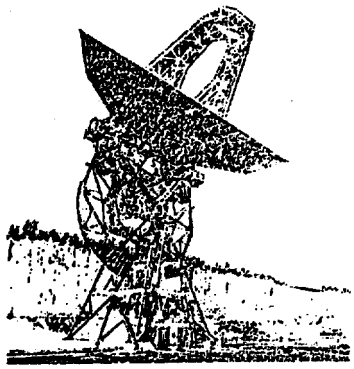
GLOSSARY

AFWTR	Air Force Western Range
AICUZ	Air Installations Compatible Use Zones
BARSTUR	Barking Sands Tactical Underwater Range
BFEC	Bendix Field Engineering Corporation
BSURE	Barking Sands Underwater Range Expansion
CDP	Crustal Dynamics Project
CDUP	Conservation District Use Permit
COMPACMIS-TESTCOM	Commander Pacific Missile Range Test Center
CZM	Coastal Zone Management
DOD	Department of Defense
EA	Environmental Assessment
EMR	Electromagnetic Radiation
ESQD	Explosives Safety Quantity Distance
GHA	Ground Hazard Areas
GPD	Gallons per day
GPS	Global Positioning Satellites
HERF	Hazard of electromagnetic radiation to fuel
HERO	Hazard of electromagnetic radiation to explosives
HERP	Hazard of electromagnetic radiation to personnel
HRS	Hawaii Revised Statutes
HSWA	Hazardous and Solid Waste Amendments
KGO	Kokee Geophysical Observatory
KTF	Kauai Test Facility
KWH	Kilowatt Hours
LLR	Lunar Laser Ranging
NAVMEDCLINIC	Naval Medical Clinic, Pearl Harbor
NAVNET	U.S. Navy VLBI Network
NEACT	PAC Naval Engineering Activity, Pacific
NEPA	National Environmental Policy Act
NEX	Naval Exchange, Pearl Harbor
NVWEXS	Naval Underwater Weapons Engineering Station
OSP	Office of State Planning
PACAF	U.S. Air Force Pacific
PACMISRANFAC HAWAREA	Pacific Missile Range Facility Hawaii Area
PMRF-BS	Pacific Missile Range Facility-Barking Sands
RCRA	Resource Conservation and Recovery Act

GLOSSARY

RFI	**Radio Frequency Interference**
SDZ	**Surface Danger Zone**
SLR	**Satellite Laser Ranging**
T&C	**Telemetry and Command**
TDRSS	**Tracking and Data Relay Satellite System**
UIC	**Underground Injection Control**
UPS	**Uninterruptible Power Source**
USB	**Unified S-Band**
USNAVOBSY	**United States Naval Observatory**
VLBI	**Very Long Baseline Interferometry**



Chapter I
Introduction

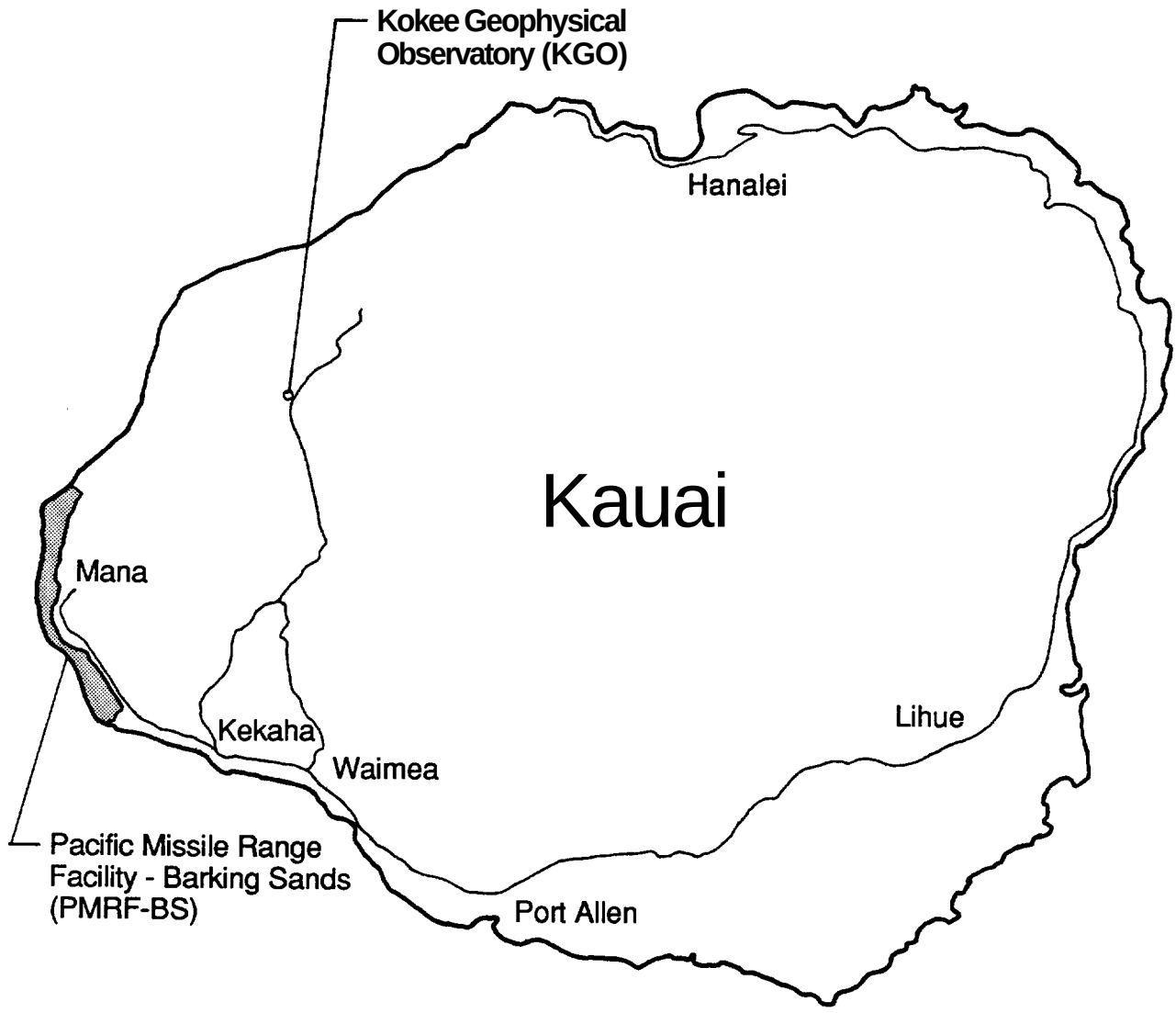
I INTRODUCTION

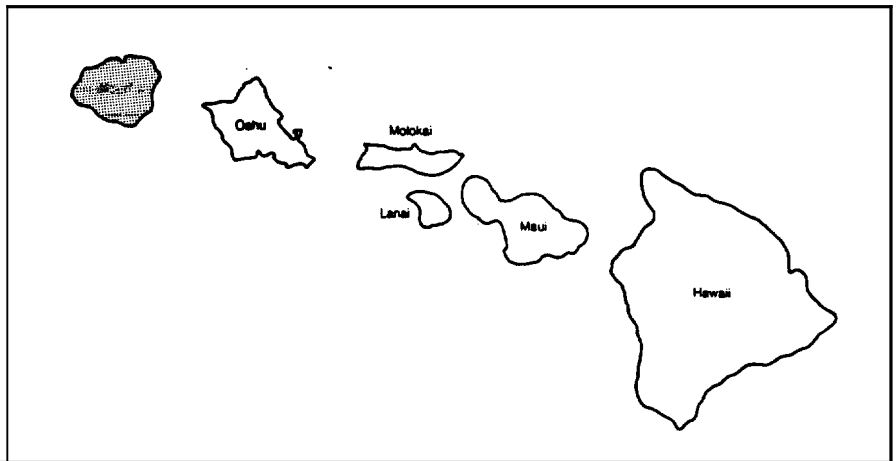
This environmental assessment (EA) is prepared pursuant to the National Environmental Policy Act (NEPA), in support of a proposal to construct a very long baseline interferometry (VLBI) radio telescope at one of four candidate sites, located either at the Pacific Missile Range Facility-Barking Sands (PMRF-BS) or the Kokee Geophysical Observatory (KGO), Kauai, Hawaii ("proposed action") (Figure 1). Three of the candidate sites are located at PMRF-BS: Site #1 is located east of Building 515, the Calibration Lab; Site #2 is located east of an existing paved parking area across from Building 384, the Aircraft Hangar; and Site #3 is located east of North Sidewinder Road, at its intersection with the National Institute of Standards and Technology Radio Station (WWVH) access road (Figure 2). The fourth candidate site is located at KGO, which includes four alternate locations within the complex boundaries (Figure 3).

1.1 Project Description

The U.S. Naval Observatory (USNAVOBSY), which is the sponsor of the VLBI project, requires the operation of fairly large radio telescopes which observe distant natural radio sources known as quasars. Quasars are celestial objects that emit immense quantities of light and/or powerful radio waves that appear to be extremely distant from Earth. Because the radio waves are so far from Earth, the signal reaching Earth is quite weak. The observations of the quasars, which are combined as part of a network of VLBI facilities across the United States, otherwise known as the U.S. Navy VLBI Network (NAVNET), enable USNAVOBSY to establish the most accurate orientation of the Earth that is possible. The accuracy of this system allows the establishment of Earth orientation within one centimeter, which is essential for the navigational purposes of the Department of Defense. Existing facilities that are dedicated to NAVNET are located in Gilmore Creek, Alaska; Green Bank, West Virginia; Maryland Point, Maryland; and Richmond, Florida (Figure 4).

The VLBI radio telescopes are similar in appearance to a large satellite dish, and they are used to receive radio signals only. There are no transmissions of any radio signals. The antenna will consist of a large parabolic reflector, on the order of 60 feet in diameter, sitting on a concrete pedestal. The entire antenna assembly will extend to a maximum height of 80 feet above ground level. It will sit on a circular concrete pad roughly 50 feet in diameter, or the equivalent square, and at least three feet thick (Figure 5).



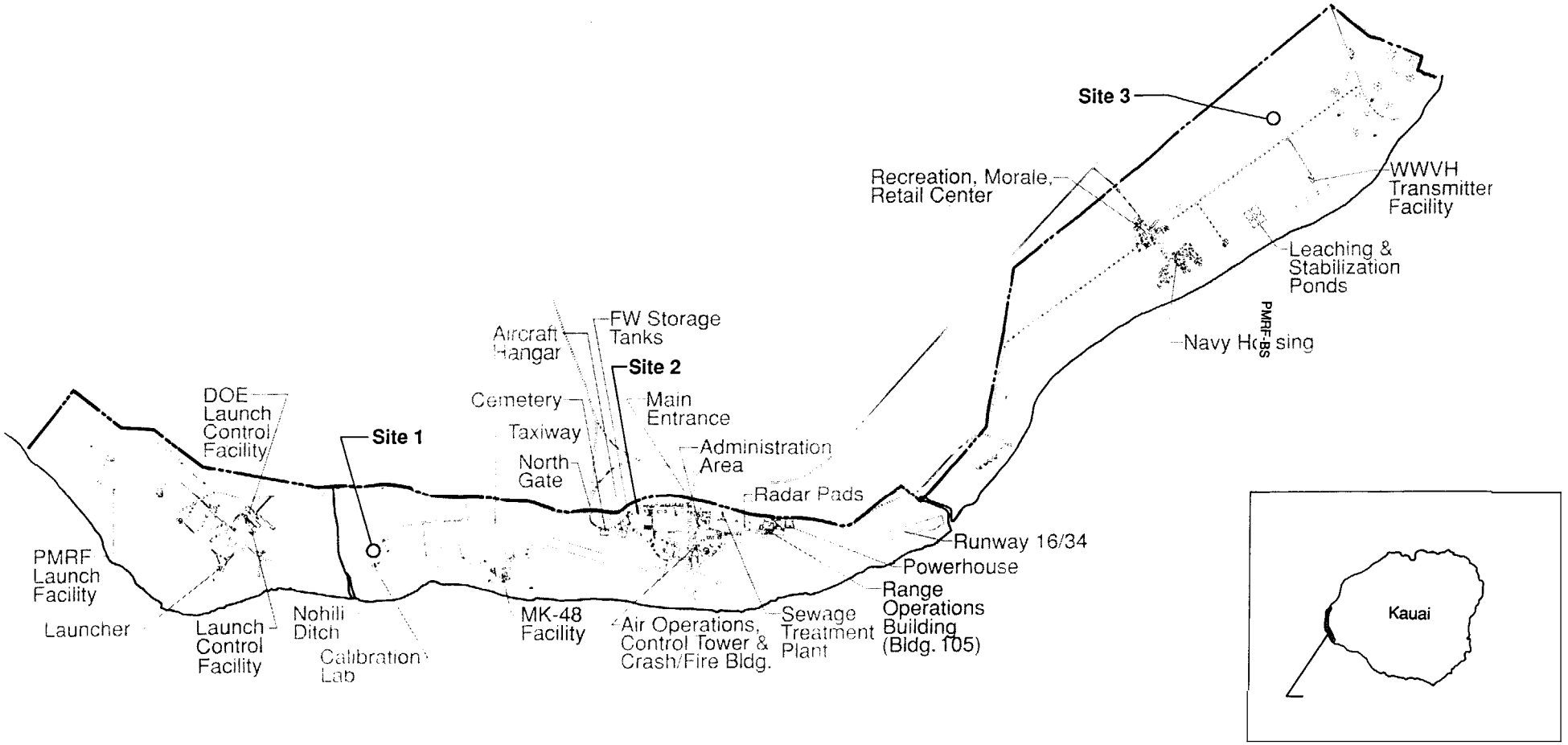


THE **U.S.** NAVAL OBSERVATORY
VERY LONG BASELINE
INTERFEROMETRY (VLBI)
RADIO TELESCOPE

Figure 1

Miles
0 2.5 5 7.5

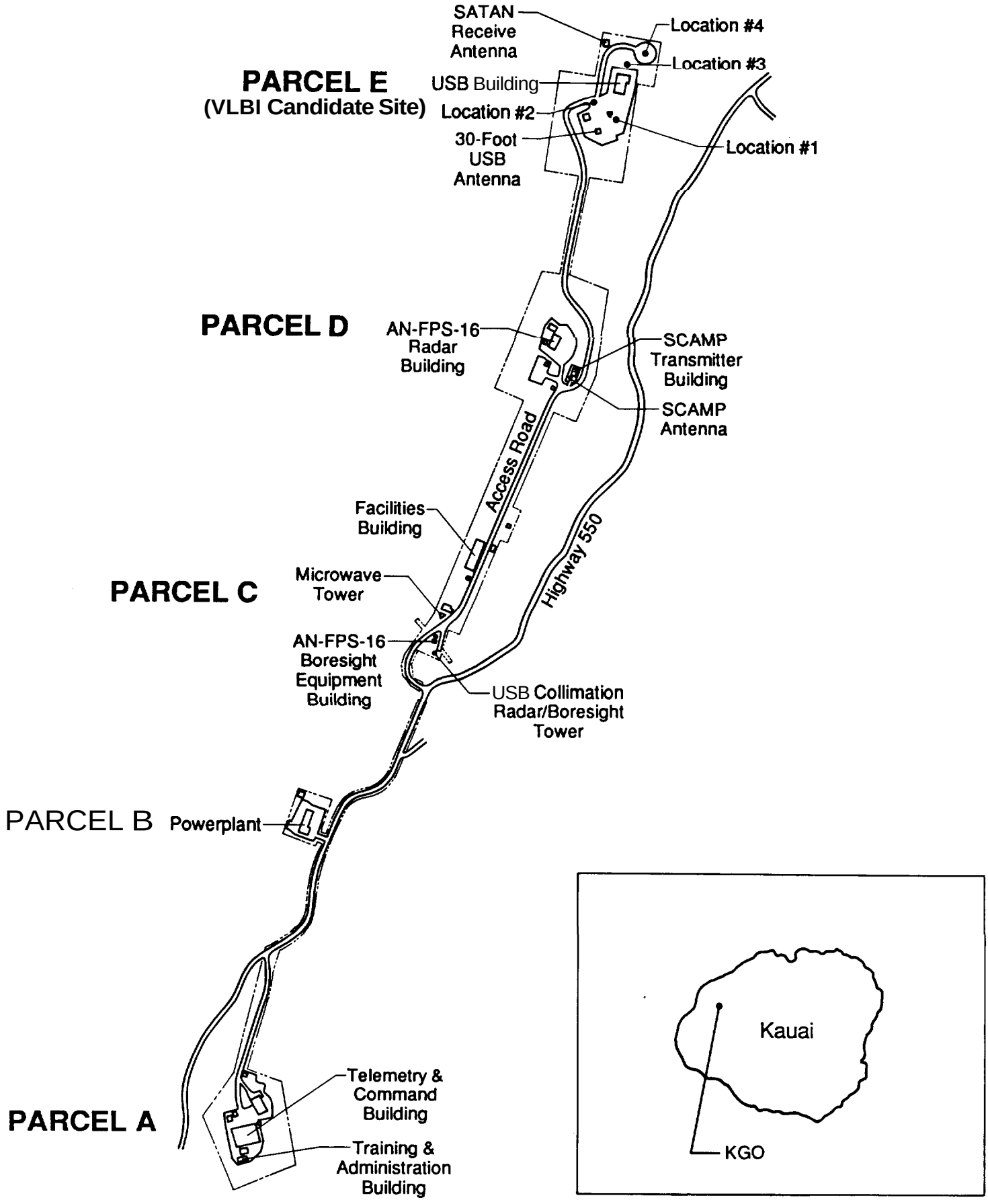
General Location Map



THE U.S. NAVAL OBSERVATORY
VERY LONG BASELINE
INTERFEROMETRY (VLBI)
RADIO TELESCOPE

Figure 2

Candidate Project Sites at PMRF-BS

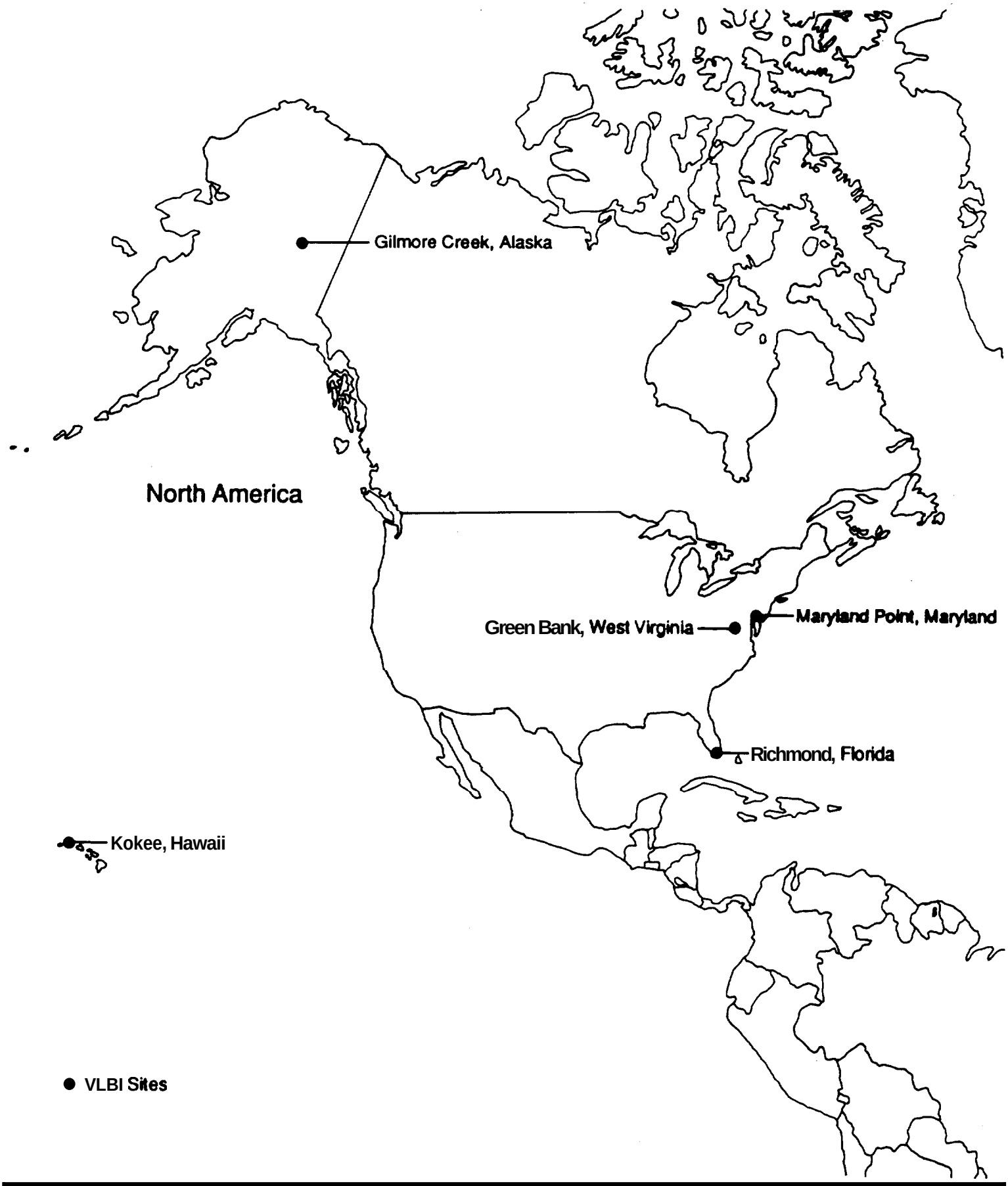


THE U.S. NAVAL OBSERVATORY
VERY LONG BASELINE
INTERFEROMETRY (VLBI)
RADIO TELESCOPE

Feet
0 300 600 900

Figure 3

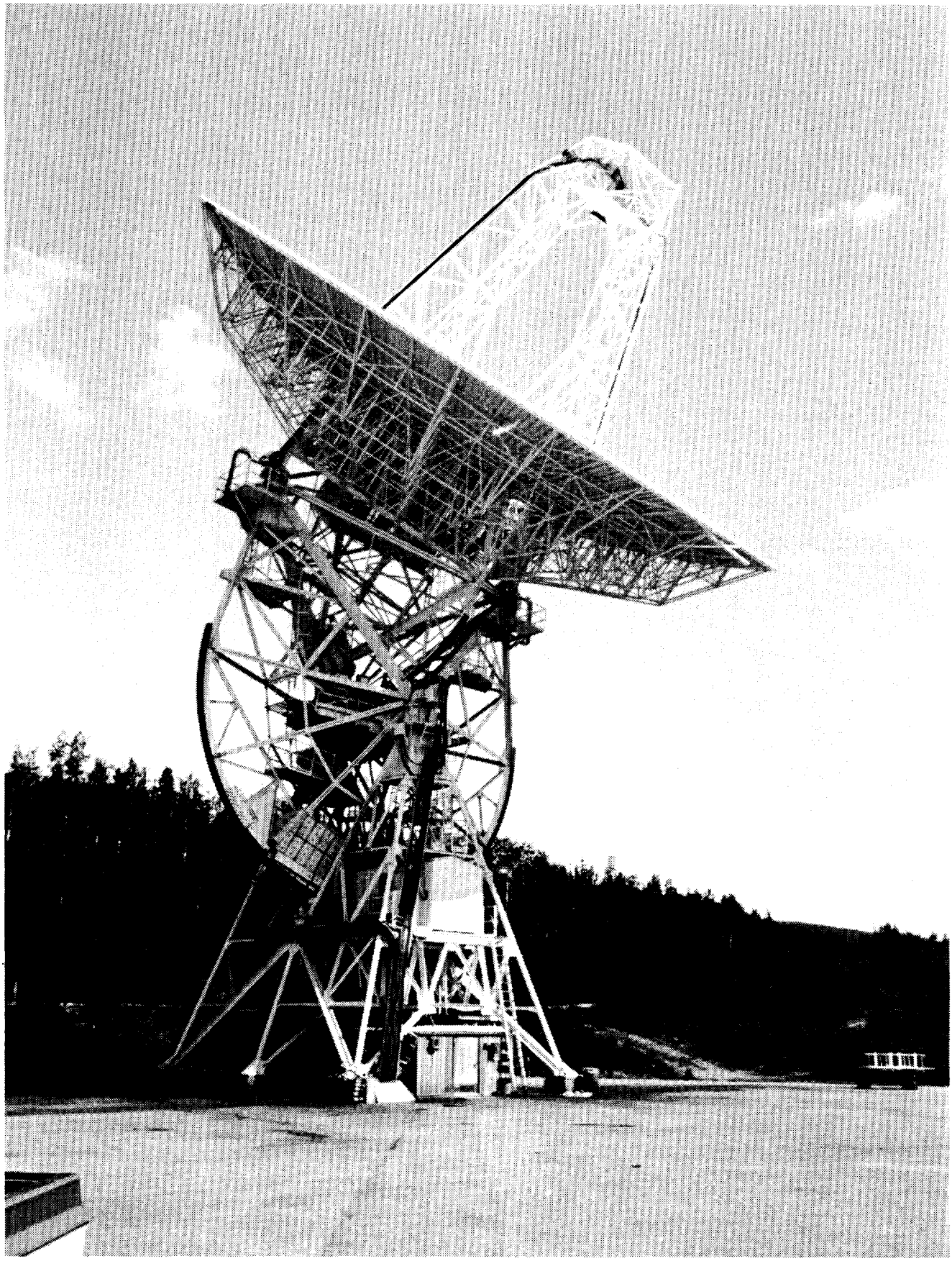
Candidate Project Site at KGO



THE U.S. NAVAL OBSERVATORY
VERY LONG BASELINE
INTERFEROMETRY (VLBI)
RADIO TELESCOPE

Figure 4

U.S. Navy VLBI Network



THE U.S. NAVAL OBSERVATORY
VERY LONG BASELINE
INTERFEROMETRY (VLBI)
RADIO TELESCOPE

Figure 5

Typical VLBI Radio Telescope

The VLBI radio telescope will include a cryogenically cooled receiver at the prime focus. It will record radio noise in 14 channels, each two MegaHertz wide, spread over several hundred megahertz at S band (2.2 to 2.4 GigaHertz) and X band (8.0 to 8.8 GigaHertz). Operation of the radio telescope will involve frequent observations down to elevation angles of five degrees (above the horizon). Approximately 800 square feet of environmentally controlled workspace will be required to support the facility, suitable for digital computers. Backup power generation capability suitable to provide power with no more than a one minute delay will be required as accessory workspace for the facility. At this time Uninterruptible Power Supply (UPS) requirements are not anticipated; however, as with all computer equipment, UPS is recommended in order to prevent failure due to electric power variations. No exterior lighting of the radio telescope is anticipated.

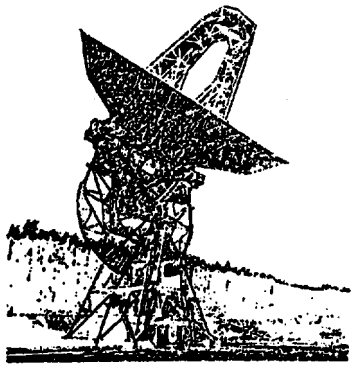
1.2 Alternatives Considered

Three alternatives to the proposed action were considered: a no-action alternative; alternate sites; and alternate technologies. These alternatives were determined to be not feasible for a variety of reasons, such as unacceptable levels of Radio Frequency Interference (RFI), indefinite land tenure and unacceptable levels of technological performance, and were dismissed from active consideration. These alternatives are discussed in more detail under Section 3.

1.3 Summary of Probable Impacts and Mitigation Measures

In general, the proposed action will not generate any significant environmental impact. However, there will be some impact, the most notable of which is common to all four candidate sites; the visibility of the radio telescope from public highways. Although the proposed facility will be visible, its impact will be diminished because the proposed sites are adjacent to existing similar facilities or because visibility will be screened due to existing vegetation and topography.

In addition, the range control for PMRF-BS would object to Site #1 or Site #2, both located at PMRF-BS, because range operations, principally communication capability between radar and launch operations, will be seriously compromised. Sites #1 and #3 are located where there are category 1 candidate endangered plants. Finally, RFI levels at Sites #1, #2 and #3, at PMRF-BS, would seriously degrade the VLBI radio telescope receiving ability.



Chapter II
Purpose and Need For The VLBI Radio Telescope

II PURPOSE AND NEED FOR THE VLBI RADIO TELESCOPE

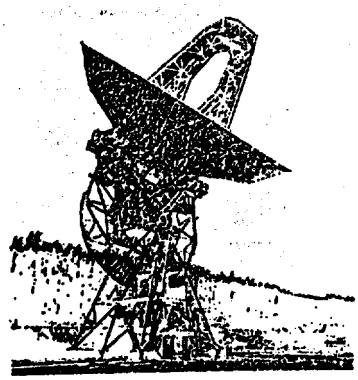
The U.S. Naval Observatory (USNO), as part of its program in Very Long Base line Interferometry (VLBI), intends to locate a radio telescope in the Hawaiian Islands to complete NAVNET. After a total of 16 sites on the islands of Maui, Molokai, Oahu and Kauai were surveyed as possible locations for the new radio telescope, only four sites on two areas were considered to be possible suitable locations: (1) at the National Aeronautics and Space Administration (NASA) Kokee Geophysical Observatory (KGO); and, at the Pacific Missile Range Facility at Barking Sands (PMRF-BS).

The primary function of the Hawaii Telescope will be to gather astronomical information in support of the navigational needs of the Navy, the Department of Defense, other U.S. Government agencies, and the public at large. The radio telescope will also be used for pure research in geodesy and astronomy by the USNO and various other agencies. The program of the USNO in Hawaii is not connected with any planned or future launch activities from the PMRF at Barking Sands or elsewhere, nor will it be used to observe, track or receive telemetry from missiles, whether launched from Barking Sands or from anywhere else and will not be equipped for such a role. Further, the radio telescope is not planned to be used in the development or test of any weapons system, including the weapons systems intended for use in the Strategic Defense Initiative, nor is classified research planned to be conducted from this facility.

The new radio telescope must complement the existing naval Observatory VLBI network. A study of the sensitivity of various proposed USNO VLBI networks first showed that the central Pacific is by far the most advantageous location for a new telescope given the previously existing network (with telescopes in Alaska and the east coast of the continental United States). Of the possible sites in the Pacific, Guam is too far from the east coast of the United States, since there are too few radio sources that can be viewed simultaneously from Guam and from the east coast locations. Locating on Kwajelein Atoll was considered but rejected because of its distance from the East Coast sites, and because of the increased expense of logistical support.

The proposed Hawaii radio telescope will be used by the USNO to provide earth orientation information for use in precise navigation. This information provides an essential role in ensuring the accuracy of celestial navigation and navigation by satellites. Satellite navigation is increasingly used by civilian operators of marine vessels and airplanes, including ships and airplanes travelling to and from the Hawaiian Islands. The USNO will also use the data from the Hawaii radio telescope for pure research into the causes of changes in the Earth's rotation and for pure astronomy, mapping and precisely locating a variety of natural radio resources.

In addition, the Hawaii radio telescope will be used by a number of outside agencies:



CHAPTER III
ALTERNATIVES CONSIDERED

III ALTERNATIVES CONSIDERED

Three alternatives to the proposed action were considered and are discussed below: no-action; alternate locations; and alternate technologies.

3.1 No-Action Alternative

The no-action alternative means that the USNAVOBSY must rely on the existing method of gathering data for NAVNET, namely to utilize the KGO 30-foot Unified S-Band Antenna. 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 VLBI facility.

Detriments of the no-action alternative include the unreliable availability of the KGO Unified S-Band Antenna, thereby limiting the accuracy of NAVNET and reducing the reliability of navigational information. In this case, it is more beneficial to complete NAVNET and construct a VLBI facility in Hawaii, rather than avoiding the cost of constructing a new facility (approximately $2.5 million).

3.2 Alternate Site Alternative

The USNAVOBSY surveyed a total of 16 sites on the islands of Maui, Molokai, Oahu and Kauai as possible locations for the VLBI facility. Of these candidate sites, all but four were eliminated as potential sites for various reasons, as described below:

- Mauna Kea, Hawaii. At or near the summit of Mauna Kea, a large radio telescope at the Mauna Kea "Science City" facility is planned for the Very Long Baseline Array (VLBA), and the possibility of locating the Hawaii VLBI at or near that location was considered. However, an additional radio telescope does not fit into the master plan for the facility and would not be allowed.

- Summit of Haleakala Mountain, Maui. There is no suitable parcel of land for a new radio telescope at the summit of Haleakala. A large new telescope would, in addition, interfere with existing Air Force and NASA operations at the summit and would not be allowed by the site managers. There are also severe RFI problems at the location due to existing transmitters on the summit.

- Kihei Research and Technology Park, Maui. The only suitable parcel for a new radio telescope would require construction of a road, roughly one-half mile in length, and also a control building, with great additional expense. This site is in a rapidly developing area. RFI could not be controlled, and the plan of the developers of this complex would include

the construction of an industrial park near the proposed site which would interfere with telescope operations in the future.

- Old NOAA Ionospheric Station, near Kahului, Maui. This site is on top of old airport underground fuel tanks. These would have to be removed before the construction of a geodetic antenna. It seems likely that the soil beneath the site would not be stable enough for the construction of a large radio telescope without extensive excavations and filling. This site is underneath the glide path for Kahului Airport, and a large structure in that location would be an obstacle to planes landing or taking off from that facility. This site is also in a rapidly developing area and RFI could not be controlled in the future.

- Current NOAA Ionospheric Station. Near Kihei, Maui. This site is in a developed area. with many large buildings nearby, which would cause horizon mask problems and probable RFI problems. The Hawaii radio telescope would not be compatible with the existing use of the site. The County of Maui intends to turn this facility into a park when, and if, the NOAA facility is removed. Therefore, permission to build on the site probably could not be obtained,

- Molokai Airport Naval Reservation. Molokai. This parcel is too close to an active runway for a large antenna, In addition, the existing Marine Corps use (helicopter operations) is incompatible with the planned radid telescope.

- Molokai HF Receiver Site. Western Space and Missile Center, Molokai. This site was given intensive investigation, as a very favorable potential site. The existing facility is leased From the State of Hawaii on land allocated to the Hawaiian Home Lands program. It is operated under a ten-year lease, expiring December 31, 1997. It is likely that the Department of Hawaii Home Lands will require the use of the site for homesteading at that time, which would require the relocation of the radio telescope, at considerable expense and to the severe detriment of the Naval Observatory VLBI program.

- Bellows Air Force Station, Oahu. This facility Is used for high frequency communications by the Strategic Air Command (SAC). This SAC use was judged incompatible with planned U.S. Naval Observatory activity. There Is also a horizon mask problem at this site.

- Kaneohe Marine Corps Air Station. Oahu. There is no room for the radio telescope at this facility, All open space is either used for firing ranges or is slated for development in the master plan of the facility. RFI would also be a problem, given base activities.

- Haiku Omega Station. Oahu. The very powerful radio transmitters located at this site, broadcasting at low radio frequencies, would interfere with the internal workings of the electronics used in the VLBI equipment.

- Naval Communications Station-East Pacific (NAVCOMSEASPAC). Wahiawa. Oahu. There is no room for additional large antenna under the master plan for this facility. There is also a bad horizon mask problem and possible RFI problems from nearby microwave transponders.

- Kaena Point Air Force Tracking: Facility. Oahu. There is no space available given future planned Air Force use of the facility.

3.3 Alternate Technology Alternatives

Three alternate technologies were considered to the VLBI radio telescope. These were Satellite Laser Ranging (SLR), Lunar Laser Ranging (LLR) and Tracking of the Global Positioning Satellites (GPS). In assessing the capability of the various technologies to determine an accurate Earth orientation, it is necessary to understand that three distinct quantities must be measured. These are: variations in the spin angle of the Earth (UT1); location of the rotation pole on the Earth (polar motion); and the location of the rotation pole on the celestial sphere (nutation). Because each of these alternatives was unable to acceptably measure all of these quantities as accurately as the VLBI facility, they were dismissed.

3.3.1 Satellite Laser Ranging (SLR)

Satellite Laser Ranging can determine the polar motion with an accuracy comparable to that obtained from VLBI, but SLR UT1 measurements are subject to serious systematic errors which render them unsuitable as a primary source of UT1 information, and SLR is essentially not able to determine the nutation at all. In addition, accurate SLR measurements of the polar motion require a world-wide network of stations, including stations in the southern hemisphere and in Europe. SLR also requires consistent year-long clear weather for operations.

3.3.2 Lunar Laser Ranging (LLR)

Lunar Laser Ranging can determine the UT1 to an accuracy comparable to that obtained from VLBI, but LLR is not very sensitive to nutation and has not yet been able to demonstrate an ability to usefully determine the polar motion. LLR also requires consistent year-long clear weather for operations.

3 . 3 Tracking of Global Positioning Satellites (GPS)

Tracking of the Global Positioning Satellites could, in theory, determine the polar motion to an accuracy comparable to that obtained from VLBI, and may be able to determine the UT1, but neither of these capabilities has been demonstrated as yet. It is doubtful if GPS will ever be able to meaningfully determine the nutation. In addition, accurate GPS measurements would also require a world-wide network of stations, including the southern hemisphere and Europe.

- NASA will use the radio telescope for studies of relative motions of the continents and of the Hawaiian Islands, that may lead to a means of predicting the occurrence of earthquakes

- The National Geodetic Survey (NGS) will use the proposed radio telescope to support its mapping and research programs. The Hawaii radio telescope will become the primary NGS geodetic reference paint for the Hawaiian Islands, with dl surveying in Hawaii eventually being referred to the position of the Hawaii radio telescope, as determined by VLBI data.

- Precise surveying using the Global Positioning System (GPS) will use the Hawaii telescope as a fiducial reference point, It is likely that differential surveying wing a nearby fiducial reference will become the method of choice for precise surveying, and could have a number of applications on the Hawaiian Wands. One planned application of GPS surveying is to monitor changes in the shape of Mauna Loa mountain as a means of predicting future eruptions of that volcano.

- NGS will also use the Hawaii radio telescope for the primary vertical reference far the Hawaiian Islands and for the entire central Pacific region. All tide gauge measurements in Lis region will be referred to *the* location of Hawaii radio telescope, thus playing an essential role in the studies that NSG and other agencies are conducting in changes in global sea level in connection with global warming and climate change.

- NASA and NGS will use data from the Hawaii radio telescope to study a variety of geophysical effects, including the connection between the Southern Oscillation, El Nino events anc changes in the Length of the Day

- The Hawaii radio telescope will also be available of a limited amount of observing by other users. Agencies in Japan and Italy have already expressed interest in such use. In addition, the proposed radio telescope would be available for use by researchers at the University of Hawaii or other local educational institutions for astronomical or geodetic research on an available basis.

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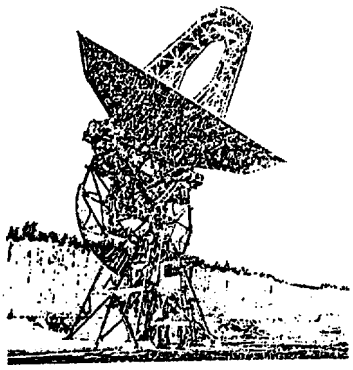


Chapter IV
Description Of
The Existing Environment

IV DESCRIPTION OF THE EXISTING ENVIRONMENT

The following Sections describe the existing environment of the two areas which might host the VLBI facility, PMRF-BS and KGO. This description includes a brief review of the function and operation of the affected areas.

4.1 Pacific Missile Range Facility-Barking Sands (PMRF-BS)

4.1.1 Historical Perspective

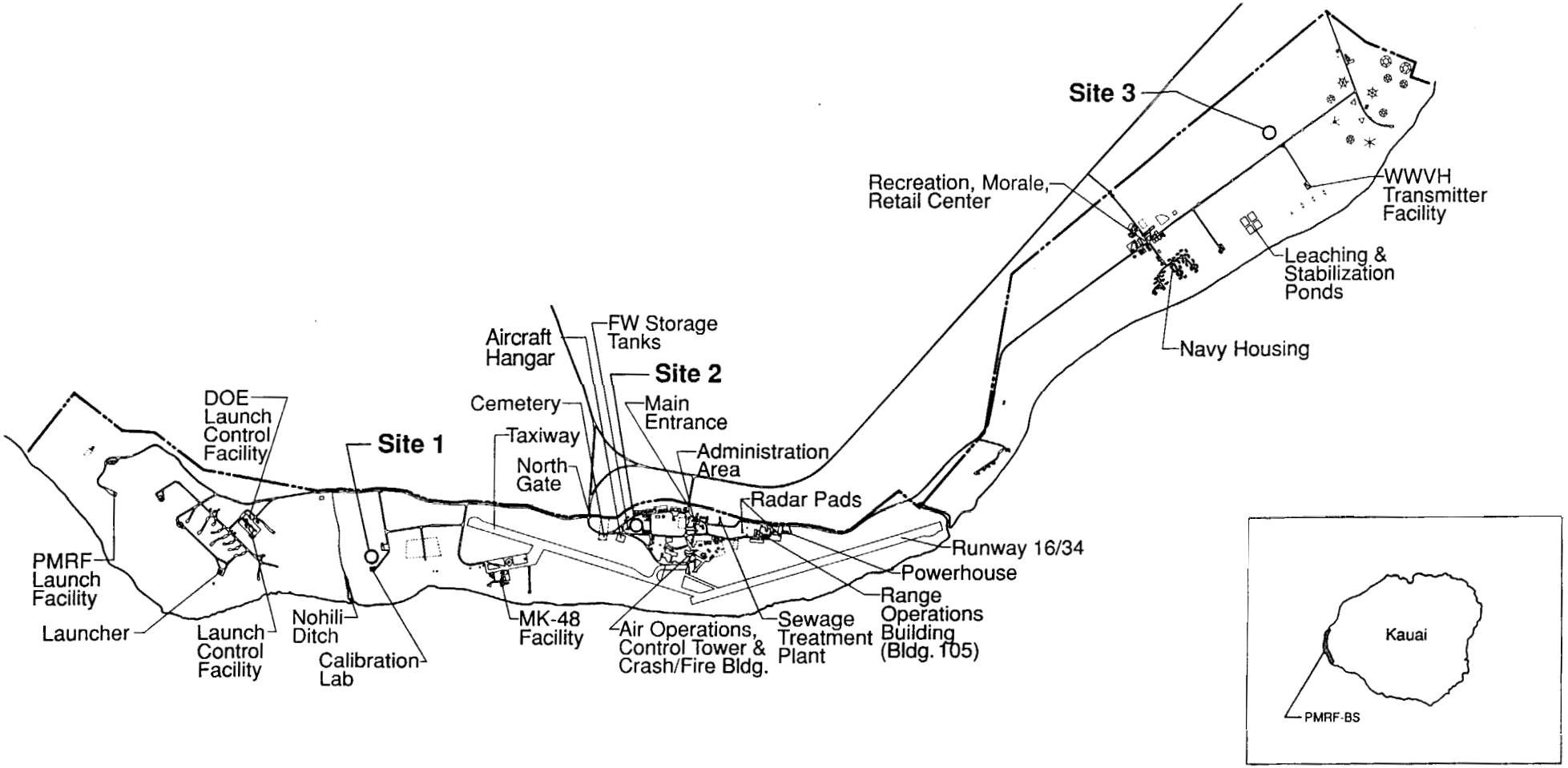
PMRF-BS is a long, narrow site of approximately 2,046 acres, bordered on the west by the Pacific Ocean and on all other sides by agriculture and undeveloped land. Figure 6 shows the boundaries of PMRF-BS and major existing facilities. The land now occupied by PMRF-BS has seen many and varied uses. The first military use of the area occurred in 1940 when the Army acquired 549 acres, including land previously utilized as a grass strip runway. A runway was then paved, and the airfield was named Mana Airport. In 1941 the Army acquired an additional 1,509 acres. Between 1941 and 1964, when the facility, then named Bonham Air Force Base, was officially transferred from the Air Force to the Navy, the field was used by the military and on a limited basis (between 1941 and 1948) by Hawaiian Airlines and by Pan American Clippers departing westward. In 1966 the land was transferred within the Navy Department to the Commander, Pacific Missile Test Center (COMPACMIS-TESTCEN), at Mugu Point, California and renamed Pacific Missile Range Facility (PACMISRANFAC HAWAREA). PACMISRANFAC was established in July 1968, when the activity officially moved to Barking Sands from Marine Corps Air Station, Kaneohe Bay (MCAS Kaneohe Bay), with a small contingent of military personnel. In early 1970, the remainder of the activity moved to Kauai.

4.1.2 Base Loading

As of April 6, 1989, PMRF-BS had 135 permanently stationed military personnel: 114 enlisted and 21 officers. In addition, there were 101 authorized civilian employees and 480 contract civilian personnel working on the base.

4.1.3 Tenant and Supported Commands

Presently, nine other users/commands occupy portions of PMRF-BS. These are: the Department of Energy's (DOE) Kauai Test Facility (KTF); the U.S. Air Force Pacific (PACAF - 326 Air Division (AD)); the Hawaii Air National Guard (HANG - 298th Air Traffic Control Flight); theNational Institute of Standards and Technology; the Naval Underwater Weapons Engineering Station Detachment (NUWES DET); the Naval Medical Clinic, Pearl Harbor (NAVMEDCLINIC Pearl Harbor); the Navy Exchange, Pearl Harbor (NEX); G.E. Americom; the United States



THE U.S. NAVAL OBSERVATORY
VERY LONG BASELINE
INTERFEROMETRY (VLBI)
RADIO TELESCOPE

Figure 6

Major Existing Facilities at PMRF-BS

Department of Agriculture; and, other supported units which need an instrumented range on which multi-participation anti-air, anti-submarine exercises can be conducted, including such allied nations as Australia, Canada, Great Britain and Japan. In addition, the Marine Corps and the Army air units on Oahu use PMRF-BS's aviation facilities for flight training and exercises and the beaches of the station are available for amphibious training.

4.1.4 Base Operations

The dominant restriction of PMRF-BS in terms of area is the explosive safety and airfield clear zones, which blanket approximately 39 percent of the station. Facilities within these two zones include ordnance storage magazines, ordnance and weapons operating and support buildings, runways, taxiways and supporting structures.

Another major land use is outdoor recreation, which covers approximately 400 acres. About 85 percent of the outdoor recreation is located in the southern half of the station adjacent to the family housing. These areas may also serve as training areas several times a year for amphibious exercises.

Operational areas are located throughout the station. To the north are the rocket launch and DOE and underground fuel storage areas. In the central portion of the station is the air operations area. Communications antenna fields are located to the south. Combined, the operational areas total approximately 335 acres.

Supply and maintenance areas are located adjacent to the flight line in the main station and also adjacent to the operations area in the northern portion of the station. Acreages amount to 39 acres and 23 acres, respectively.

The administrative and personnel support areas are located in the main station and the southern portion, respectively. These built up areas lie on generally very flat terrain and provide space for such functions as family housing, administration, bachelor housing, utility facilities, exchange retail, as well as morale, welfare, and recreation facilities.

Off-station land areas used by PMRF-BS include Makaha Ridge, Port Allen and Kamokala Ridge. Makaha Ridge is one of several ridges to the north of Barking Sands. All Navy-controlled land at Makaha ridge is reserved for range operations. Tracking radars, antennas, communications, electronic warfare simulator, target command control and telemetry facilities and a standby power plant make up the Makaha Ridge complex. Other types of land uses are constrained by the terrain, hazard of electromagnetic radiation to personnel (HERP) and security considerations.

Kamokala Ridge is an adjacent ridge east of Barking Sands and is used for ordnance storage.

Two underwater ranges, the Barking Sands Tactical Underwater Range (BARSTUR) and the Barking Sands Underwater Range Expansion (BSURE), are located off-shore. The BARSTUR consists of a five by ten mile rectangular area which provides underwater tracking coverage of slightly more than 50 square miles. The BSURE provides tracking of 500 square miles.

Port Allen is a commercial port situated below a low bluff on flat coastal terrain about 20 miles southeast of Barking Sands. As a berthing location for vessels serving the range areas, it is poorly situated, as transit times to the south BARSTUR are about two hours each way.

Finally PMRF is in the process of negotiating the assumption of the lease for the National Aeronautics and Space Administration (NASA) Tracking Center at Kokee, including KGO. These negotiations have included the Navy, NASA and the State of Hawaii, which owns the land.

4.1.5 Physiography/Topography/Climate

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 Napali formation, Olokele formation, Haupu formation and the Makaweli formation.

As the island aged and volcanic activity became less frequent, many lava flows were eroded by streams and later covered again by new lava flows known as the Palikea formation. Coral reefs developed upon the eroded platforms around the island. The ensuing erosion of coral reefs formed calcareous sand beaches. These sands were then blown inland to form sand dunes which became lithified. The present coral reef was probably formed when the sea was about five feet above its present level. Erosion by wave action and the weather has left it in its present configuration.

PMRF-BS is located on the western side of Kauai in the geologic area known as the Mana Plain. The base is bounded by the Pacific Ocean on the west, sugarcane fields and Kaumualii Highway to the east, sand dunes to the north and Kokole Point to the south. Elevations on the base vary from sea level to +25 feet over most of the base, with some dunes in the north rising to over 100 feet above sea level. There is no terrain on the base with slopes that exceed 20 percent, with the exception of the seaward dune faces and the northern dunes area in general.

The Mana Plain is composed of alluvium washed from the uplands, calcareous and earthy lagoon deposits and calcareous and dune sands. On its inland edge, the lagoonal deposits are earth, overlain by younger alluvium and probably graded into older alluvium. On the seaward side, the deposits are mostly calcareous and probably graded into barrier beach deposits. Clay beds containing gypsum exist in places.

Generally speaking, Kauai has a mild, semi-tropical climate influenced by the ocean and the prevailing northeast tradewinds. At PMRF-BS, long, dry, hot spells are common, especially during the summer months, and the mean annual temperature range is 70 degrees Farenheit to 78 degrees Farenheit. Mean annual rainfall over a 34-year period is 22.9 inches, with three-fourths of this amount falling during the period of October through March.

4.1.6 Soils

The general soils type that underlays PMRF-BS is in the Jaucas-Mokuleia association. This association consists of excessively drained and welldrained soils in dunes and on former beach areas on the island of Kauai. These soils are nearly level to moderately sloping. The natural vegetation is kiawe, klu, feather fingergrass, sandbur, koa haole and bermudagrass. The most dominant soil type, by far, is the Jaucas loamy fine sand (JfB). This soil occurs on old beaches and on windblown sand deposits in the western and southern parts of Kauai. It is characterized by slopes of from 0 to 15 percent. The soil is used for pasture, recreational areas, wildlife habitat, sugarcane and alfalfa. If the soil is irrigated, it has a Capability Subclass rating of IVs. This rating is characterized by very severe soil limitations because of stoniness, shallowness, unfavorable texture or low water-holding capacity. These soils are well drained to excessively drained. If the soil is not irrigated, it has a Capability Subclass rating of IVe, which means the soil is subject to severe erosion if cultivated and not protected. The soils are well drained to moderately well drained.

4.1.7 Flood Hazard

In the past 25 years, several tsunamis have occurred at PMRF-BS. The most severe was in 1946, when the wave run-up reached the 11-foot elevation and inundated an area reaching almost as far as Kaumualii Highway. In 1969, a tsunami wave swept 600 feet inland at Barking Sands and flooded several houses.

4.1.8 Utilities

Electricity. The Kauai Electric Company provides commercial power to PMRF-BS. Power to the main station and the northern complex area is supplied at 12.5 KV from Kauai Electric Company's Mana substation, reduced to 4.16 KV for distribution on-station by a 1,500 KVA transformer which serves the operations building area, and by a bank of three 167 KVA transformers which serve the remainder of the station.

The 4.16 KV feeder from the 1,500 KVA transformer connects to switches in the main power plant, which serves as backup to the Kauai Electric Company system. The power plant contains two 600 and three 300 KW generator units which provide electricity during range operations.

Primary power to the southern area of the base is supplied by a 12.5 KV feed system from Kauai Electric and a 6.9 KV feeder from Kekaha Sugar Company.

Kauai Electric Company has averaged 50 or more power outages a year for the past five years. Due to this unreliability, range operations are provided electricity by the PMRF-BS power plant, with commercial power used as a backup.

Potable Water System. PMRF-BS receives water supplied from two different sources: The Kauai Board of Water Supply and the Kekaha Sugar Company. In 1987, water consumption was about 310,000 gallons per day (gpd). Water is provided to the southern area of Barking Sands by the Kauai Board of Water Supply. This water is obtained form high level water tunnels and stored in the County's Paua Valley Tank, where it is subsequently transmitted to the Navy storage tanks at Kokole Point through approximately three miles of four-inch, asbestos-cement pipeline. An eight-inch main line, pressurized by a hydropneumatic system, distributes the water from two 126,000 gallon Navy storage tanks to station facilities and housing.

The Mana Well, owned and maintained by the Kekaha Sugar Company, is the source of water for the main base and the northern area of PMRF-BS. Water is delivered from the Mana Well, a high level water tunnel located at Kamokala Ridge, to two storage tanks, 100,000 gallons and 420,000 gallons in size, respectively, through approximately two miles of four-, six- and eight-inch pipeline. The water distribution network on station is pressurized through a hydropneumatic system.

Sanitary Sewage System. There are two main sewage treatment facilities serving PMRF-BS: the oxidation pond at the southern area and the treatment plant in the main station. The oxidation pond receives approximately 25,000 gpd of wastewater from the Navy Family Housing units and the community and personnel support facilities. Secondary treatment is accomplished in the oxidation pond. The effluent from the oxidation pond flows into a leaching pond where it is dissipated by percolation and evaporation.

About 28,900 gpd of wastewater is generated on the main station and is treated at the extended aeration package treatment plant, which has a capacity of 30,000 gpd. The effluent of the package plant is discharged into a leaching field where percolation and infiltration occurs. It is anticipated that this treatment plant will reach capacity by 1993.

4.1.9 Circulation

PMRF-BS is reached by the two-lane Kaumualii Highway, a State highway which is a primary circulation route linking PMRF-BS with Kekaha and Lihue. This highway has a paved width of approximately 20 feet and a posted speed limit of 50 miles per hour. Ingress and egress from Kaumualii Highway to the main station is via Imiloa Road, a two-lane roadway approximately 22 feet wide, with a posted speed limit of 20 miles per hour. The left-turn movement from Imiloa Road onto Kaumualii Highway is stop-controlled at the intersection, with right-turn movement from Imiloa Road onto Kaumualii Highway yield-controlled. A dedicated right-turn lane is provided. A second access point to the southern portion of the base serves the family housing and personnel support area. Both gates are open at all times. A third gate, the northern gate, provides secondary access, and is opened only for the transportation of ordnance.

The interior road network of the base generally consists of two-lane roads that are in good physical condition. The major roadways are Sidewinder Road and Nohili Road.

4.1.10 Flora and Fauna

Flora. Many of the plants on PMRF-BS are not indigenous but were introduced by various settlers. The vegetation is characterized by sparse ground cover and semidesert conditions. Eighty-eight species of vascular plants were inventoried during a flora survey of PMRF-BS in 1985.

Of the species observed, 81 percent, or 71 species, were introduced or exotic; eight percent or seven species were endemic (native only to the islands); and nine percent or 10 species were indigenous (native to the islands and elsewhere).

At PMRF-BS, approximately 90 percent of the main station is covered by some type of vegetation. The predominant plant cover is a mix of kiawe (Prosopis pallida) and koa haole (Leucaena leucocepahla) scrub vegetation, covering roughly 400 acres. These are present in equal numbers, although in places one or the other may occur in pure stands. Ground cover is generally a mixture of various herb and grass species. Guinea grass (Panicum maximum), lantana (Lantana camera) and wild basil (Ocimum grassimum) are abundant.

One candidate endangered species that has been found on PMRF-BS is Ophioglossum concinnum. This small, perennial fern is associated with the Dodonaea-Nama scrub where it occurs in low numbers. The Ophioglossum fern successfully establishes and maintains itself where the native scrub community exists. Another candidate endangered species, Sesbania tornentosa, which had been suspected to occur at the facility, was not found during recent botanical surveys of the base.

Fauna. A total of 39 birds, including five endemic species, have been identified at PMRF-BS. Four of the endemic birds are listed by the Department of the Interior as endangered: the Common Moorhen (Hawaiian Gallinule); the American (Hawaiian) Coot; the Black-necked (Hawaiian) Stilt; and the Hawaiian Duck. The fifth endemic species, the Townsend's ("Newell's") Shearwater, is federally listed as threatened. The remaining species include 24 exotics, four migratory and six species that are considered indigenous.

An established nesting site of the indigenous Wedge-tailed Shearwater (not to be confused with Newels Shearwater) is located between the existing Officer's Club and the beach cabins. This habitat represents one of only two principal nesting areas for the species on Kauai.

Two mammals also warrant concern, the federally-listed endangered Hawaiian (Hoary) Bat is likely to inhabit the facility, as well as an occasional Hawaiian Monk Seal. In addition the federally-listed threatened Green Sea Turtle has been found infrequently on the beaches fronting the facility.

4.1.11 Historic, Cultural and Archaeological Sites

The Waimea-Kekaha region is noted for the richness of it. historical and archaeological sites. These are generally grouped into two categories, based on period of origin. In the first group are those sites utilized by native Hawaiians before the arrival of the missionaries. This group includes burial grounds, heiaus and house sites. In 1967, the Bishop Museum designated a major ancient Hawaiian burial ground on Kauai which fell partially within the boundaries of the PMRF-BS.

A review of existing archaeological and historical literature, records and maps in the Bishop Museum, PACNAVFACENGCOM and the State of Hawaii Historic Preservation Office indicates there are numerous recorded and unrecorded archaeological sites within PMRF-BS and the surrounding area. Three sites are adjacent to the northern boundary of PMRF-BS.

Mapped information indicates that there is a large major ancient burial ground in the dune area in the northern portion of PMRF-BS. Existing information indicates human burials or archaeological resources may be uncovered anywhere within PMRF-BS.

Key Navy facilities planning staff at Pearl Harbor and PMRF-BS have indicated that there could be considerable potential for inadvertent disturbance of burials and archaeological materials during construction activities at PMRF-BS.

The second group of archaeological and historical sites includes buildings constructed after the missionaries arrival. The only specific site identified on PMRF-BS is an old Japanese cemetery of potential historical significance, located on the station north of the hangar and near deactivated

Taxiway 1/19. Little is known about the cemetery, except that people were interred there during the period from 1901 through 1930, according to Japanese characters on the headstones. The cemetery is not on the State or National historic registers.

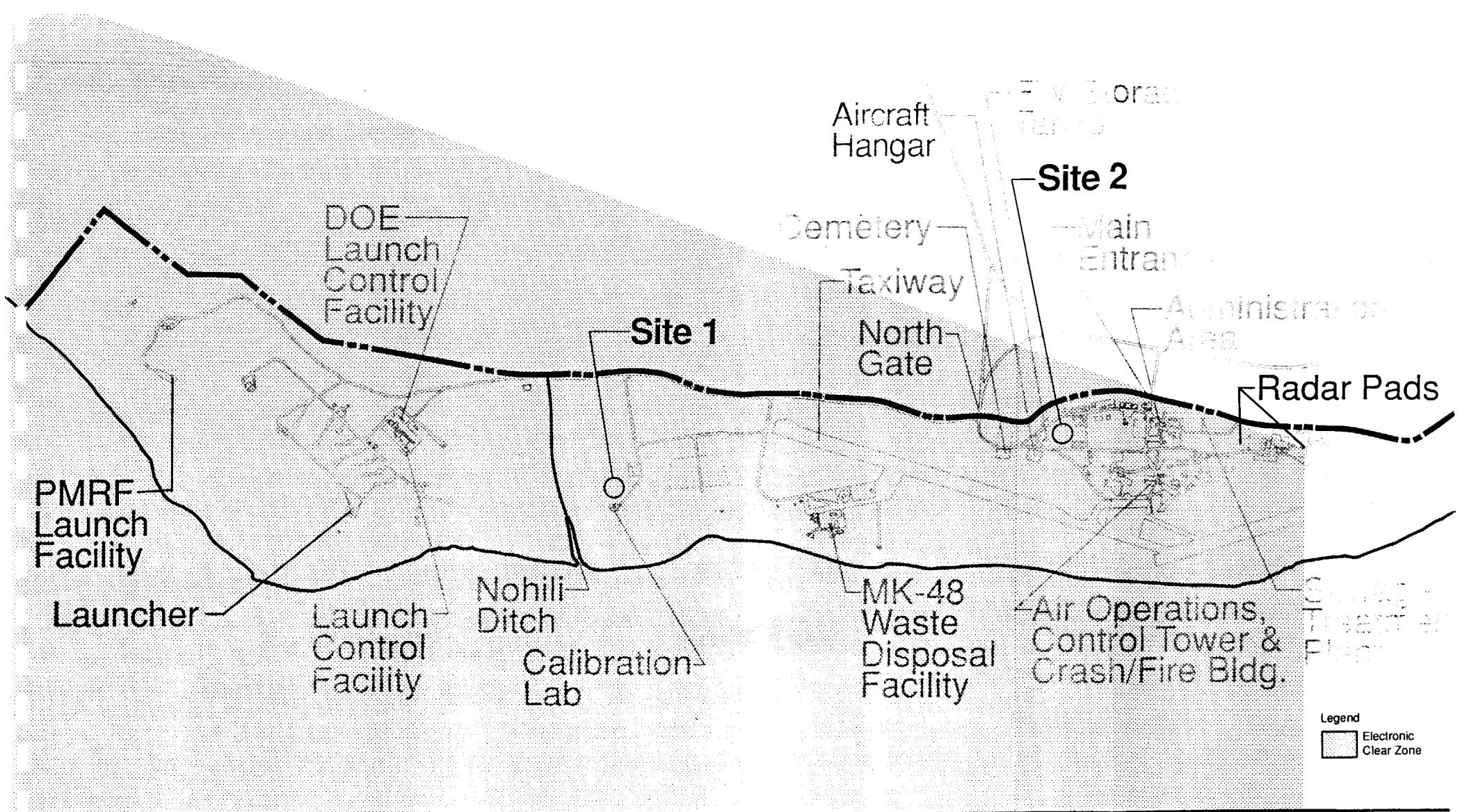
4.1.12 Operational Constraints

Due to the nature of the activities conducted at PMRF-BS, certain limitations, or constraints, are placed on other base operations. This Section briefly discusses eight types of constraints identified at PMRF-BS.

Electronic Clear Zones. 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 it is tracking, 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 the station. 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 (Figure 7).

Radio Frequency Interference (RFI). RFI results from overlapping adjacent uses of the frequency spectrum by different proximate RFI sources. It may also occur from interference or reflection caused by metal sided structures.

Electromagnetic Radiation (EMR). EMR zones designated around transmitter sites and tracking radars are required where high density electromagnetic power may constitute a hazard to personnel (HERP), explosives (HERO), or fuels (HERF), or may interfere with nonmilitary electronic equipment. Of particular interest for this EA is a document referred to as "Guidelines for Siting Structures Near Radars" (OPNAVNOTE 5100, 30 July 1985). According to this document "interference can be severe especially if the radar must track objects close to the existing horizon and the structure juts above that horizon."



THE U.S. NAVAL OBSERVATORY
VERY LONG BASELINE
INTERFEROMETRY (VLBI)
RADIO TELESCOPE

Figure 7

Electronic Clear Zones at PMRF-BS

This document lists five guidelines for construction in the vicinity of radar systems, as follows:

1. The structure should be as low, small and as far from the radar as possible.

2. The structure or any projection planned for the structure such as towers, masts, flag poles, etc., should not enter the space occupied by the radar's main beam when it is positioned at its operational horizon. This space can be typified as a cone with it's apex at the radar antenna and an internal angle equal to the radar's beamwidth.

3. To minimize sidclobe reflections, large flat surfaces such as walls and roofs should be angled to the radar so as to scatter the radiated energy. Sharp indentations in the structure surfaces facing the radar should also be avoided since they can act as corner reflector antennas.

4. Non-conductive or RF energy absorptive materials should be the construction materials of choice, other considerations being equal.

5. The structure should be located in an area which is not often used for tracking.

Explosives Safety Hazard Zone. Explosive safety hazard zones have been established by the Department of Defense (DOD) for various quantities and types of explosives and ordnance. These zones increase in size as the TNT equivalent quantity increases. Minimum distances are prescribed for separating explosives and ordnance from inhabited structures, public roads and other explosives. These distances arc called Explosives Safety Quantity Distance (ESQD) arcs and are proportional to the cube root of the TNT equivalent quantity of explosives stored in the respective magazines.

The possibility of accidental detonation of explosives at ordnance operations and storage areas generally precludes the construction of inhabited buildings, standard structures and recreational facilities within explosive safety hazard zones. The outer portions of explosive safety hazard zones may be used for DOD runways, roads, open recreation for ordnance operations-related military personnel, and uninhabited storage facilities.

There are a number of source.. of **ESQD** arcs at PMRF-BS. These include the interim ordnance handling pad, the DOE's KTF launch complex, the **PMRF** missile launch area, the Ready Services Magazine Buildings 100A and 562, the Small Arms/Pyrotechnic Magazine Building 3992 and the Missile Assembly Building (Building 573).

Ground Hazard Areas (GHA). Ground Hazard Areas are established to protect personnel on the ground from harm due to possible malfunctions and explosive detonations of rockets

in the vicinity of the launch pad. Unauthorized personnel within this hazard area are required to leave by base security personnel during rocket launchings. Presently, a 2,500-foot, 3,000-foot, 6,000-foot and 10,000-foot radius GHA emanates from the rocket launch pads.

Air Installations Compatible Use Zones (AICUZ). The purpose of the AICUZ is three-fold:

- To provide guidelines for preventing incompatible development in high noise exposure areas
- To minimize public exposure to safety hazards associated with aircraft operations
- To protect the operational capabilities of the station from constraint from adjacent non-compatible land uses

An AICUZ study of the PMRF-BS was completed in September 1979 and approved for implementation by the Chief of Naval Operations (CNO) by Letter on 28 November 1979. According to the 1989 Draft Master Plan for PMRF-BS, the noise and accident potential zones identified in the 1979 AICUZ remain generally applicable. AICUZ guidelines recommend that all structures located where noise levels are in the 65 to 75 Ldn contour range should employ a noise level reduction of 25 to 35 dbA if such structures are used for office, administration, industrial or commercial purposes.

Small Arms Range Surface Danger Zone (SDZ). Currently, PMRF-BS maintains an outdoor pistol range with six firing points and a range support building, Building 576, in the northwestern portion of the station. The SDZ extends approximately one mile offshore from the small arms range.

Sites of Potential Contamination. There are three potential hazardous waste sites on PMRF-BS: the Fire Fighting Practice Pit #1, located at the southern end of the existing runway and no longer in use; Fire Fighting Practice Pit #2, located north of the NUWES area and also no longer in use; and the Mark 48 Torpedo Flushing area behind the Mark 48 Torpedo Maintenance Shop.

The fire fighting pits may have had solvents and unspent fuels diluted by diesel oil burned as part of the fire fighting training.

4.1.13 State and County Land Use Policies

Stare 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. Four land use districts are established: urban, rural, agricultural and conservation.

Lands north and south of the main station, and the station itself are classified conservation, which is the most restrictive to development. The State has classified the remainder of the Mana Plain and lower mauka lands agricultural. The nearby towns of Waimea and Kekaha are both classified urban.

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

Kauai County Land Use Policies. The major land use policy document for the County of Kauai, the General Plan, shows the main station area designated public facilities **(PF),** with Open (O) to the north, extending south from the north gate along the base boundary mauka of the runway. The remainder of the Mana Plain is designated agricultural **(A).** However, because the Federal government owns the land and the State of Hawaii has placed PMRF-BS within the State Conservation District, the County has no land use regulation jurisdiction at PMRF-BS.

4.2 Kokee Geophysical Observatory (KGO)

4.2.1 Historical Perspective

KGO is located within the Pacific Missile Range Facility at Kokee. The buildings and structures of this facility, initially 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. Generally, the ownership of the facility has reverted to the major user over these years. Presently, the State of Hawaii, NASA and the Navy are negotiating for the transfer of the lease agreement from NASA to the Navy, although it is probable that some land areas will be returned to the State of Hawaii.

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. Specifically, Kokee Park Tracking Station was part of the sites and assets transferred to the USAF. At that time, the USAF evaluated the Kokee Park role as to its mission and decided that the major user at that time was the NASA manned space flight program. Hence, the USAF transferred the operations and maintenance responsibility to NASA while still retaining property

ownership. 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 ownership of the tracking radar (FPS-16) to the PMRF which currently operates and maintains. As of 1985, NASA implementation of the Tracking and Data Relay Satellite System (TDRSS) permits closure of certain stations of its world-wide spaceflight tracking and data network. Kokee Park Tracking Station is one of those stations. This has resulted in the present circumstances which will transfer the lease to PMRF, with the State of Hawaii reacquiring certain land and buildings that were once part of the Tracking Station.

4.2.2 Site Description

The entire station is made up of five sites located almost in a straight line with the extremities of the site being slightly less than a mile apart (Figure 3). Parcel "A" is the southernmost site and housed the Telemetry and Command (T&C) Building, the Training and Administration Building and the Logistics Building. About 1400 feet to the north, and across Highway 550, is Parcel "B", where a power plant and fuel storage area are located. Parcel "C", 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" is the next site and contains the SCAMP Transmitter Building and SCAMP antenna and the AN/FPS-16 Radar Building. Nine hundred feet further north is Parcel "E", which houses the USB Building and antenna and the SATAN receive antenna in what is known as the Kokee Geophysical Observatory (KGO). KGO is operated by the Bendix Field Engineering Corporation (BFEC), a division of the Services Group of Allied-Signal Aerospace Company, under contract to NASA. Parcel "E" is the proposed site of the VLBI facility. Total land area included in the five sites, including roadways, is approximately 22.32 acres, with Parcel "E" totalling about 5.27 acres.

4.2.3 Facility Loading

Presently KGO employs seven civilian personnel, all under contract to BFEC.

4.2.4 Facility Operations

The primary responsibility of KGO is to perform experiments and retrieve data for three projects; VLBI experiments that are part of NAVNET; other VLBI experiments that are part of another VLBI program, NAVINT; and the Crustal Dynamics Project (CDP), which monitors tectonic movement. These projects are carried out by the 30-foot Unified S-Band antenna, which is located south of the USB Building. The USB Building houses the electronic and computer equipment which is used in association with these experiments in addition to the BFEC personnel. There is also a SATAN Receiver antenna which is located north of the USB Building, which is a VHF receive antenna that supports two satellites by downloading data generated by these satellites.

Finally, BFEC personnel have requested that existing geodetic markers found at KGO not be disturbed. These markers are necessary to establish ground control references for the 30-foot USB antenna. According to BFEC, 10 geodetic markers are dispersed throughout the site. A complete site plan for Parcel E is shown on Figure 8.

4.2.5 Physiography/Topography/Climate

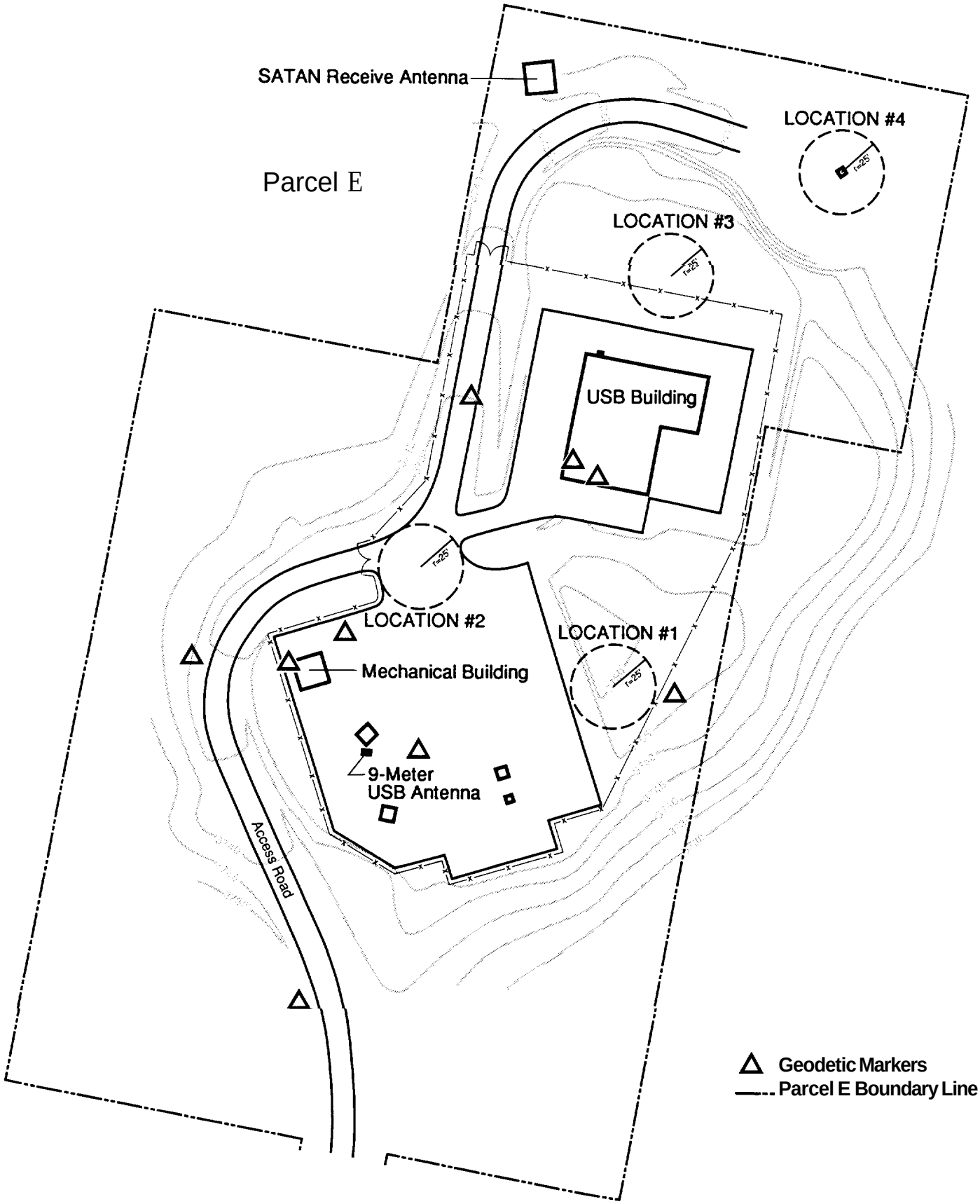
The Waimea Canyon area shares similar geologic development with the Mana Plain (see Section 4.1.5). Waimea Canyon itself is a desiccated remnant of a portion of the single great caldera which essentially formed the entire island. The rocks which formed this caldera are referred to as the Waimea Canyon Series. The elevation at KGO is about 3,750 feet above sea level, at a distance of about 11 linear miles from Kekaha, the nearest town (about 15 and 1/2 miles by automobile).

Although some areas of Parcel "E" exhibit moderate slopes, all the potential locations for the VLBI antenna are nearly level.

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

4.2.6 Soils

Soils which underlay KGO are of the Kokee series, which are characterized as welldrained 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 KGO 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. Anecdotal information received from the personnel at KGO indicate that there is some fill material located south of the USB Building, which has exhibited signs of settlement.



THE U.S. NAVAL OBSERVATORY
VERY LONG BASELINE
INTERFEROMETRY (VLBI)
RADIO TELESCOPE

Feet
0 40 80 120

Figure 8

Existing Facilities at KGO

4.2.7 Utilities

Electricity. Currently the entire tracking station facility is connected to the Kauai Electric Company distribution system. Power is transmitted to the station via a 12.47 KV line, which parallels Highway 550, and is then transformed to 4.16 KV and distributed to the various station facilities via underground wiring. Present peak power capability is about 1,200 kw. In addition, there is a powerplant at Parcel "B" which will function as backup power for the entire station, which is a necessity because of the unreliability of power from Kauai Electric Company. The backup plant consists of five diesel generators with a total capacity of 1,950 KW.

Potable Water System. Water is supplied to the station by the Kokee State Park water system. The source of the water is derived from a stream located approximately 2 miles north of the station. A 3-inch water main, which is fed by the State Park reservoir tank system, is connected to the station's pump house. From there, water is pumped to a 7,500 gallon hydropneumatic tank which supplies all of the station sites. The water line to Parcel "A" is connected to a 5,000 gallon storage tank. A separate hydropneumatic pump system supplies water from the 5,000 gallon tank to Parcel "A".

Water supplied to the station receives no treatment other than chlorination, and based on water quality monitoring studies, is in compliance with State Department of Health Interim Primary Drinking Water Standards for organic and inorganic chemicals. However, violations of the turbidity and microbiological requirements occur frequently. Booster chlorination is applied at the station's pump house to safeguard against poor bacteriological water quality supplied by the State Park system. It should be noted that the mere application of booster chlorination does not guarantee the water to be free from bacteriological contamination. Without an additional filtration treatment, the threat of Giardia cysts and the formation of trihalomethanes (THM's) cannot be dismissed. As a result of these conditions, station personnel bring in their own water for potable use.

Sanitary Sewage System. All station buildings, including the USB Building, rely on individual cesspool systems for sewage disposal. Cesspools servicing Parcel E are located immediately north of and approximately 180 feet south of the USB Building. These systems were installed prior to the adoption of State of Hawaii Public Health regulations for private wastewater treatment works and individual wastewater systems. Presently there have been no problems identified with the cesspools' operations. Therefore, the reliance on cesspools to dispose of sanitary wastewater is adequate since they are exempted from the requirements of Chapter 57 of the State of Hawaii Department of Health regulations.

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

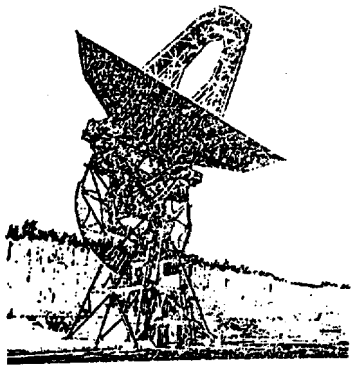
receive solely sanitary wastes where the facility generates less than 1,000 gpd* are excluded from the requirements of Chapter 23. Based on the per capita sewage flow generation criteria established by the State Public Health Service Publication No. 526, the 1,000 gpd translates to approximately 66 persons 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, the permit and submission of data requirements of Chapter 23 are not applicable.

4.2.8 Circulation

KGO is reached by the two-lane Highway 550, a State highway which is a primary circulation route linking Kokee State Park (and KGO) with Kaumualii Highway and Waimea Town, a distance of approximately 15.5 miles. Highway 550 has a posted speed limit of 25 miles per hour, with a paved width that varies between 18 and 20 feet. An alternate access to KGO is via Kekaha Town on a County road that intersects with the State highway at the 6.7 mile marker on Highway 550. Ingress and egress to KGO is via an access road which branches off of Highway 550. Access to the main station is controlled by a security gate immediately off Highway 550. Parcel E is located about 1/2 mile north of the security gate, along a one-lane paved access road.

4.2.9 State and County Land Use Policies

Similar to the PMRF-BS, KGO is located within the State Conservation District. As the State of Hawaii owns the KGO site, compliance with applicable State requirements must be achieved.



CHAPTER V
ENVIRONMENTAL CONSEQUENCES

V ENVIRONMENTAL CONSEQUENCES

This Section contains analyses of the main environmental issues associated with the proposed action.

5.1 Direct Effects and Their Significance

5.1.1 Traffic Impact

Parsons Brinckerhoff Quade & Douglas, Inc. (PBQ&D) completed a traffic assessment of the proposed project in June 1990 and concluded that traffic volumes at PMRF-BS and KGO would only slightly increase as a result of the proposed project. Their complete report is attached as Appendix A. A total of 15 vehicles are projected to enter and exit the radio telescope site on a daily basis. Traffic volumes would increase during the AM peak hour by two vehicles entering and one vehicle exiting the facility. PM volumes would increase by two vehicles entering and one vehicle leaving the facility. Specifically, if the VLBI facility were to be located at PMRF-BS, traffic volumes would increase by 1.2% during the AM and PM peak hours and by 0.9% during a twenty-four hour period. Should the VLBI facility be located at KGO, traffic volumes would increase by 5.2% during the AM peak hour, by 2.1% during the PM peak hour, and by 1.0% during a twenty-four hour period.

The analysis of the Kokee Road traffic patterns is influenced by a pattern of higher midday peak hour traffic volume than the traditional morning and evening peak hours, which is why a greater percentage increase is registered during the AM peak hour (AM peak hour trips were measured at 58, PM trips at 141, and midday trips at 205). This higher midday 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, midday trips. Traffic impacts to Highway 550 would therefore be nominal during the midday peak.

Traffic impacts would be similarly nominal during the construction period, which is expected to last no longer than one year, because of the absence of traditional A.M. and P.M. peak traffic, and the small number of vehicles travelling to and from the work site.

5.1.2 Flora and Fauna

Flora. Char & Associates conducted a botanical survey of PMRF-BS and KGO during June 1990 and concluded that there are no botanical reasons to impose any impediments, restrictions or conditions to the KGO site. However, Char recommends that if either Site #1 or Site #3 at PMRF-BS is selected as the preferred site, then a more intensive survey of these sites should be conducted to determine the extent of the presence of a candidate endangered species,

Ophioglossum concinnum (see Section 4.1.10), which usually occurs only during the rainy season. The complete assessment prepared by Char is attached as Appendix B.

Although no officially listed threatened and endangered species were found on PMRF-BS, a Category 1 candidate endangered species, the pololei fern or adder's tongue fern (Ophioglossum concinnum) is at the facility. A Category 1 listing comprises species for which the U.S. Fish and Wildlife Service currently has substantial information on hand to support the biological appropriateness of proposing the plants as endangered or threatened.

Ophioglossum concinnum was first recorded on the island of Kauai in 1985 during a study of the biological and water resources of PMRF-BS. Ophioglossum habitat on PMRF-BS is primarily Dodonaea-Nama scrub. More recently, it has been found in kiawe/koa haole scrub and open lawn or weedy areas dominated by Bermuda grass and other herbaceous species. The lawn and weedy areas are regularly mowed. Ophioglossum is a small, perennial fern with paddle-shaped fronds, 3-5 inches long, and somewhat tuberous, underground rhizomes. The plants quickly send up new fronds after the first heavy rains of the rainy season (November through December). Fertile fronds bear a simple, spiked structure which contains numerous dust-like spores. The fronds die-back during the dry summer months with only thickened rhizome or root surviving until the next rainy season.

Fauna. Dr. Philip Bruner conducted a faunal survey of PMRF-BS and KGO during June 1990 and concluded that the alteration of any of the small sites at either location would have little or no measurable impact on the overall populations of native or exotic birds. His full report is attached as Appendix C. In summary, no endemic (native) birds were recorded at the three PMRF-BS sites. A total of five endemic species were found in the forest surrounding Parcel E at KGO. These included: Elepaio (Chasiempis sandwichensis); Apapane (Himatione sanguinea); Common Amakihi (Hemiganthis virens); Anianiau (Hemiganthus parvus); and Iiwi (Vestiaria coccinea). The most abundant species was the Apapane.

No migratory birds were observed at either PMRF-BS or KGO, although this was expected because most migratory birds are on their breeding ground during the time of the year the survey was conducted. Although resident indigenous (native) waterbirds and seabirds are known to inhabit both PMRF-BS and KGO, no birds of either variety were recorded during the survey, although Bruner believes that the Black-crowned Night Heron (Nycticorax nycticorax) may occasionally rest in trees at Site #3 at PMRF-BS and the Newell's Shearwater (Puffins newell) may occur in the area of KGO.

Bruner elaborates by pointing out that the PMRF-BS property provides a limited range of habitats which are utilized by the typical array of exotic species of birds one would expect at this elevation and in this type of environment on Kauai. However, some species typically found in this habitat were not recorded. This could have been due to the fact that the survey was too brief or that their

numbers are so low that they went undetected or a combination of these factors. The KGO site likewise contains the expected array of exotic birds.

Native birds found on the KGO property and in the surrounding forest, such as Elepaio, Apapane, Common Amakihi, Anianiau and Iiwi, were those species that are reasonably common at Kokee. No unusual mammal activity was noted at either PMRF-BS or KGO, although anecdotal sightings of Black-tailed deer [Odocoileus henionus) have been reported at KGO.

5.1.3 Aesthetic Impact

The VLBI facility will be a maximum of approximately 80 feet in height when fully extended and will resemble other satellite receiving dishes in appearance and shape. The diameter of the proposed VLBI facility will be about 60 feet, which is larger than any similar facility at either PMRF-BS or KGO. The tallest dish presently at both PMRF-BS and KGO is approximately 30 feet high.

At PMRF-BS, the VLBI radio telescope will protrude above the tree line and rise above all other structures on the base. Although there are some antennae on the base that are taller than the proposed VLBI radio telescope, the radio telescope would be more prominent because of its bulk. This would be true of any of the three candidate sites at PMRF-BS, as the tree line on the base, where trees exist, rarely extends beyond approximately 30 feet. Consequently, the radio telescope will be visible to passing motorists. The degree of impact to each motorist is subjective and difficult to measure. There is no doubt that the receiving dish will be visible. However, taken in the context of the built environment of PMRF-BS, the over-all impact may be minimal, as similar, albeit smaller, satellite dishes are now visible from Kaumualii Highway.

The visual environment at KGO is different than that of PMRF-BS. The approaches to PMRF-BS are on a coastal plain which is relatively flat. Visibility on either side of Kaumualii Highway is fairly unrestricted, especially during periods immediately after cane harvest and during the initial period of cane growth after re-planting. Therefore, the main station and its attendant radar dishes, microwave antennae and other equipment is quite visible as one approaches the base.

KGO, however, is located within the boundaries of the Kokee State Park. The road from Kaumualii Highway to KGO extends about 15 miles 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 parallel the roadway. In addition there are many 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.

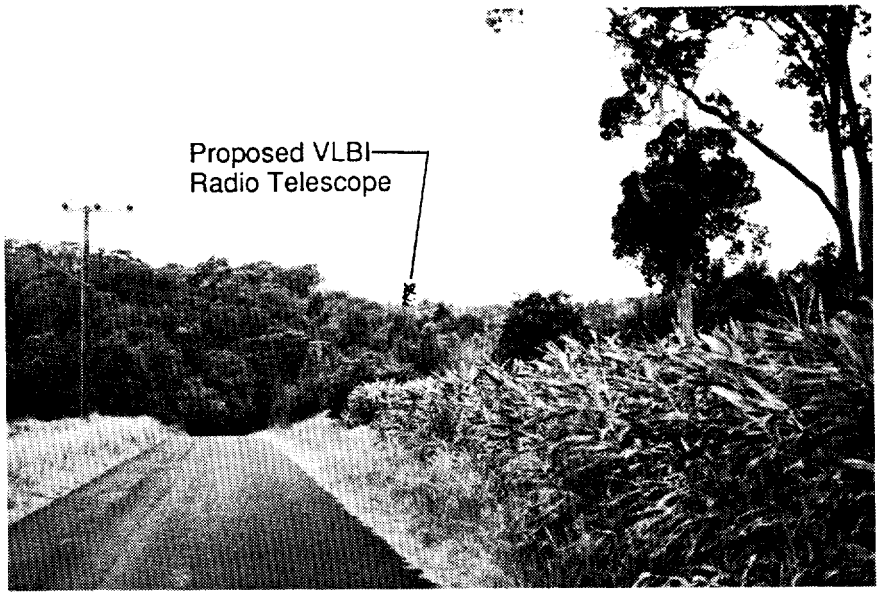
Between the 14 and the 15-mile-marker, two antennae, one an 85-foot collimation tower for the USB receiving dish at KGO and the second, a 190-foot microwave antennae operated for PMRF-BS, are clearly visible as they extend beyond the tree line. No other structures of the KGO site are visible from the highway as one travels uphill, including those at Parcel E. Just before reaching the Kalalau Lookout at the 18-mile marker, the Hawaii Air National Guard maintains a radar facility which is quite prominent from the road as one approaches the lookout. The radar facility is also visible from the parking area for the Kalalau Lookout.

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. A field test simulated the visual impacts of the proposed telescope. A cherry picker was extended to an 80-foot height on Locations #1 and #2 at Site #4. In both locations, the cherry picker is visible from the roadway above the Kokee Lodge. Figure 9 represents a conceptual view of the impacts of proposed radio telescope, based on the results of the field test. The cherry picker was not visible from the Pu'u Hinahina, Kalalau or Pu'u O Kila Lookouts within Kokee State Park. Site #4 is marginally visible from the Waimea Canyon Lookout. The appearance of this site is a long-range view, with structures fading into the contour of the existing ridge line. Any impacts associated with the proposed radio telescope would be negligible. Public viewing would not, therefore, be affected from this vantage point.

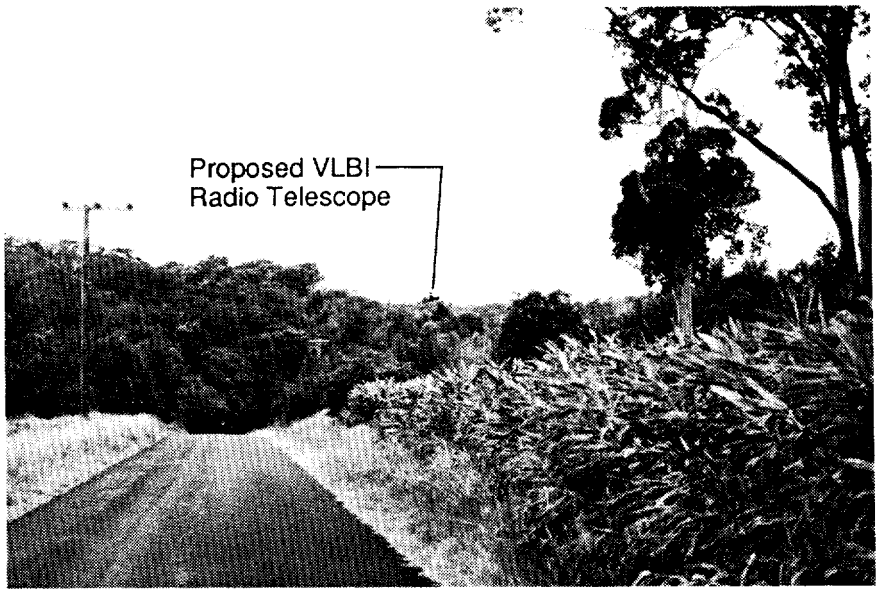
The overall impact of the proposed antenna/radio telescope must be assessed in context with the entire area. For the most part, Parcel E cannot be seen from Highway 550 because of the relationship between topography, vegetation and sight lines. Only brief glimpses of the proposed facility will be possible from selected points on Highway 550, as one drives downhill. Because of the presence of other, more prominent man-made objects in the park, it is not anticipated that the VLBI facility will have a significant visual impact.

5.1.4 Recreation Impact

Both PMRF-BS and KGO are located in areas that offer recreational opportunities. At PMRF-BS, ocean-related recreation is the most important recreational opportunity. Swimming, su ng, fishing and picnicking are possible pursuits on the beach areas fronting PMRF-BS. Currently, the base allows the public access to designated beach recreation areas during periods when base operations would not pose a safety hazard. This access will not be compromised or restricted by the installation of the proposed VLBI facility.



Conceptual view of VLBI Facility at Location #1 from Highway 550, Kokee State Park, above Kokee Lodge.



Conceptual view of VLBI Facility at Location #2 from Highway 550, Kokee State Park, above Kokee Lodge.

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VERY LONG BASELINE
INTERFEROMETRY (VLBI)
RADIO TELESCOPE

Figure **9**

Visual Impact of
VLBI Facility at KGO

KGO is located within Kokee State Park, a park which offers spectacular views of Waimea Canyon from various lookouts and roadside pullouts, in addition to many of the finest hiking trails within the State, ranging from short, family-oriented day hikes to more strenuous overnight hikes, providing camping, bird watching, fruit picking, and other forms of outdoor enjoyment. Also, Kokee State Park is used by hunters and fishermen (streams in the park are stocked with trout during the summer months). The installation of the VLBI facility at KGO will not hinder access to any of these resources. When completed, it is possible that the receiving dish will be visible from some points along various hiking trails. However, the impact of this visibility will be muted because of the dominance of trees and other vegetation on the views from hiking trails.

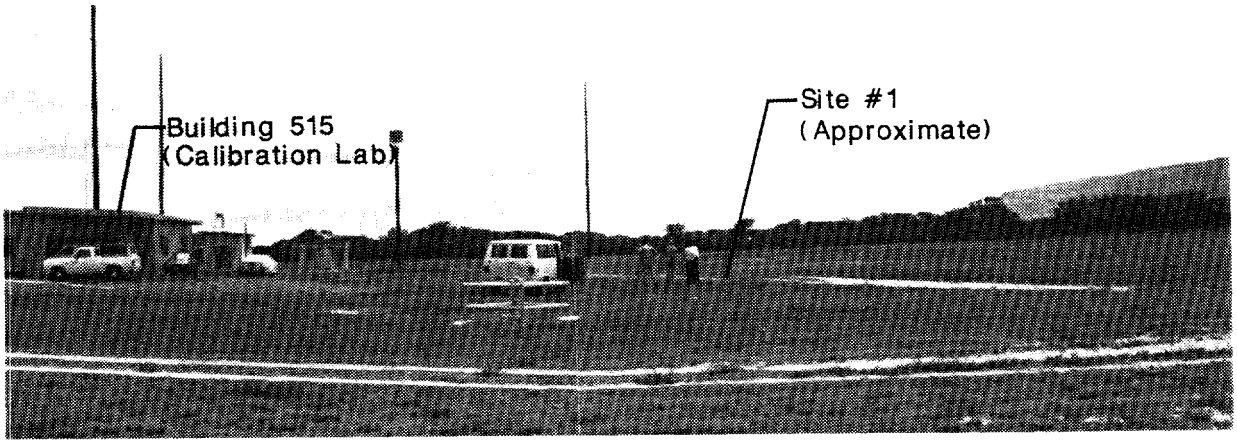
5.1.5 Locational and Physical Site Conditions

PMRF-BS. There are three possible sites for the VLBI facility at PMRF-BS. Site #1 is located east of Building 515, otherwise known as the Calibration Lab, on land that is nearly level and is periodically maintained (Figure 10). The substrate is coralline sand with roughly 40 to 50 percent of the site not vegetated. Where vegetation is present, it consists of weedy grasses and herbs with a few shrubs kept low, from six inches to one-foot tall, by infrequent mowings.

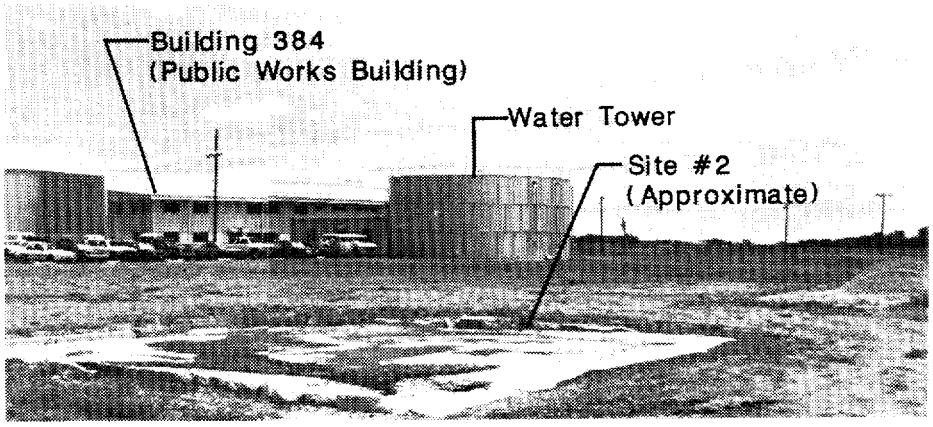
Site #2 is located east of an existing paved parking area across from Building 384, otherwise known as the Public Works Building (Figure 10). This large grassed area appears to be more frequently mowed and maintained than Site #1. Grass cover is dense, with stunted koa-haole shrubs, from four to six inches tall. The substrate is a compacted mixture of soil and sand with broken asphalt and gravel on the surface.

Site #3 is located east of South Sidewinder Road at the intersection with the WWVH access road (Figure 10). Substrate is coralline sand. Vegetation is dense and consists of a closed shrubland, from five to seven feet tall, with scattered trees of kiawe from 25 to 30 feet tall. During the rainy season the site may have surface water as small depressed areas support patches of moss and algae.

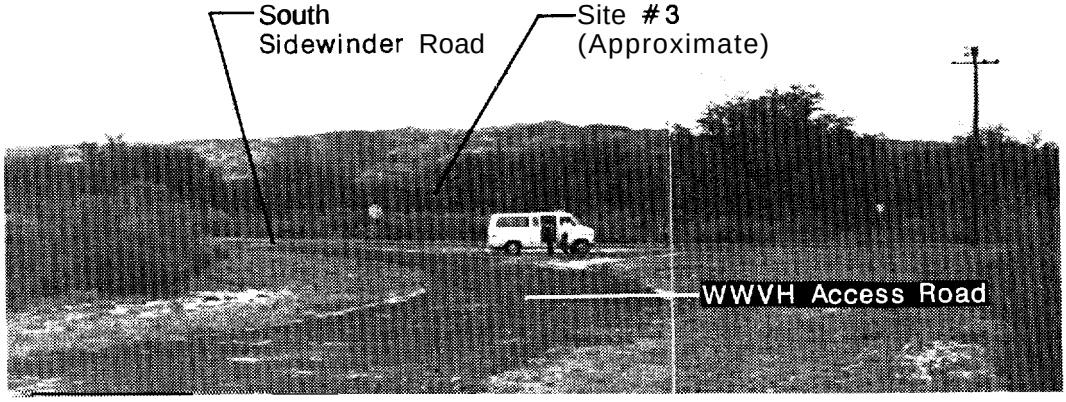
KGO. The fourth candidate site is located at about the 3,750-foot elevation at the Kokee Geophysical Observatory on a parcel of land referred to as Parcel E. This site contains the Unified S-Band telemetry station building (USB) and two antennae, the USB antennae and the Satan Receiver Antenna. Within Parcel E, four possible locations for the radio telescope have been identified. Locations #1 and #3 are on landscaped lawn areas; location #2 is primarily asphalt (part of an existing service road); and location #4 is an open, grassy area already occupied by an existing antenna (Figure 11).



'View looks north at Site #1, with Calibration Lab at left.



View looks north at Site #2. Public Works Building is at left.



View looks east from WWVH Access Road across South Sidewinder Road at Site #3

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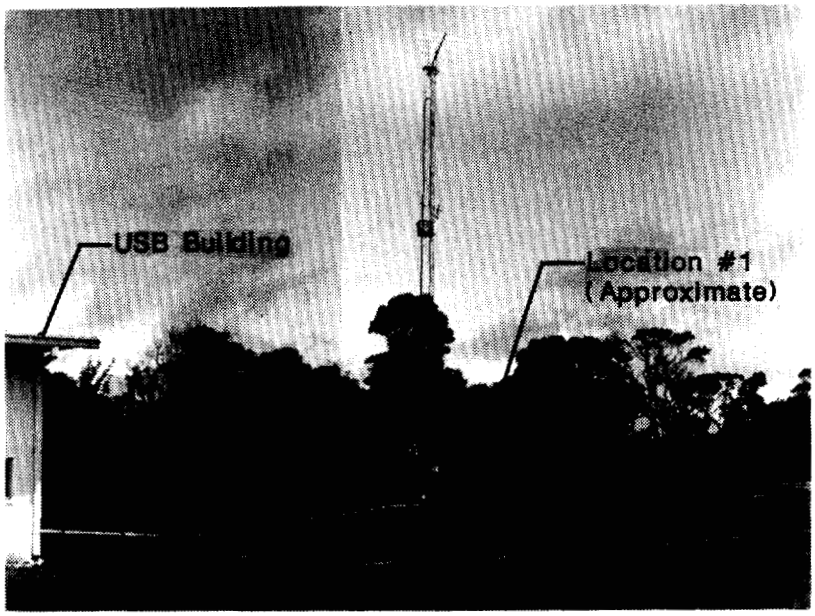
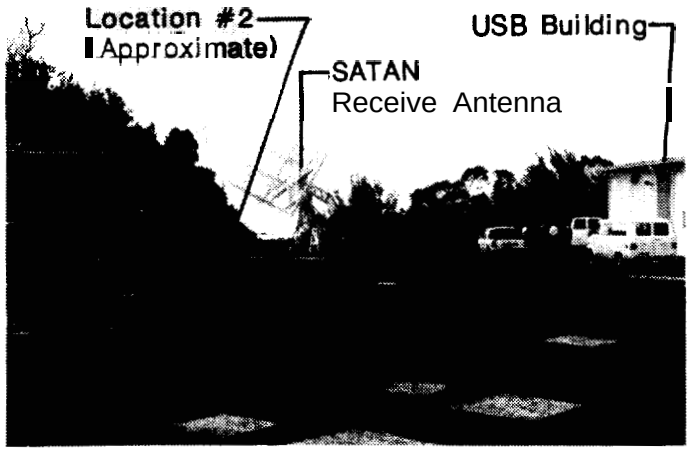
Figure 10

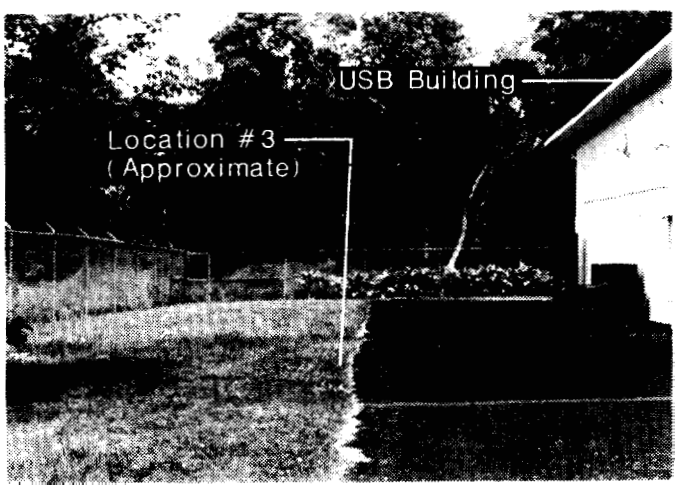
Views of Candidate Project
Sites at PMRF-BS



View of Location **#1** at **Site #4** looking east. USB Building is at left.



View of Location **#2** at Site #4, looking north. SATAN Receive Antenna is in mid-background. Note fenceline in relation to Location #2.



View of Location **#3** at Site **#4,** looking north. USB **Building** is at right.

View of Location **#4** at Site **#4,** looking east. Location **#4** is to north of USB Building in a depression approximately 25 feet below USB Building.

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RADIO TELESCOPE

Figure 11

Views of Candidate Project Locations at KGO

Each location has unique siting characteristics. Location #1 is probably the most visible, while location #2 will require that the access road be realigned and that several trees will have to be removed or relocated. If location #3 is selected, then several small trees will have to be removed or relocated. It is also questionable whether there is sufficient space between the USB Building and the top of the embankment north of the building, to locate the radio telescope. Location #4 is substantially lower than the rest of Site E, with a steep embankment on its south side. In order for the radio telescope to be elevated above the embankment, at least 15 feet of fill will have to be imported.

5.1.6 Electro-Magnetic Radiation (EMR), Radio Frequency Interference (RFI) Interference and Electronic Interference

Electromagnetic Radiation (EMR). The analysis of interference associated with the VLBI facility has two components. One component deals with the impact of surrounding facilities on the VLBI facility. The second component deals with the impact that the VLBI facility will have on the surrounding facilities. Integral to this analysis is the understanding that the VLBI facility only receives signals. There is no transmission of radio signals. Therefore, the proposed facility does not produce any EMR.

Radio Frequency Interference (RFI). In an attempt to evaluate the four candidate sites for the VLBI facility, the USNAVOBSY commissioned the Naval Electronics Engineering Activity, Pacific (NEEACT PAC) to evaluate radio frequency interference (RFI) in the vicinity of the four candidate sites. The survey, which is attached as Appendix D, measured RFI levels at specific frequency bands during each site's normal working hours. All PMRF-BS transmitters were turned on during all tests. Tests were also conducted using the existing USB antenna at KGO. In summary, the three proposed VLBI sites at PMRF-BS do not meet USNAVOBSY VLBI criteria.

Specifically, Site #1 near the Calibration Lab, and Site #2, near the Public Works Building, are adversely affected by a transmitter at Makaha Ridge. Site #3, near the WWVH antennae, are adversely affected by the WWVH transmitters. The locations at the KGO site were generally found to have acceptable levels of RFI.

Electronic Interference. A second level of analysis must include the impact of the VLBI facility on other electronic operations. In Section 4.1.12, operational constraints at PMRF-BS were discussed, including potential problems with electronic clear zones. Of particular interest is the relationship at PMRF-BS between the area devoted to range operations, located in the main station, and two missile launch facilities, located in the north station area. In order for the radar facilities of range operations to track and monitor launch vehicles, both before and after launch, an unobstructed "look-angle" must be maintained between the radar and the launch facility (Figure 6). Objects over 30 feet in height, especially those of metallic fabrication will disrupt the ability

of the radar facilities to communicate with the launch facility, thereby jeopardizing the success of any exercises involving these facilities, whether the VLBI facility is active or not.

5.1.7 Noise Impact

The existing noise quality of PMRF-BS and KGO are dominated by motor vehicular traffic movement along Kaumualii Highway and Highway 550, respectively. Other factors, such as wind moving through the trees, also contribute to the existing noise quality. Impacts to noise quality will be generated by vehicular movements to and from the VLBI facility during construction activities and by employees travelling to and from work (approximately four). Because of the anticipated short period of construction and the small number vehicles that will be added to the traffic flow, 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

The socio-economic impacts of the proposed action are both long and short-term. In the short-term, construction related employment will be provided while the VLBI facility is being built. In the long-term, it is anticipated that four full-time positions will be created to manage and operate the VLBI facility. Because of the relative size of the construction project and the small number of permanent 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, Ph.D., Inc. (PHRI) conducted an archaeological inventory survey of the four candidate sites in July, 1990, which was discussed with Ms. Nancy McMahon, DLNR-HPP/SHPO staff archaeologist for Kauai County. The complete report prepared by PHRI is attached as Appendix E. The basic purpose of an inventory survey is to identify all sites and features of potential archaeological significance present within a specified project area. An inventory survey comprises an initial level of archaeological investigation. It is extensive rather than intensive in scope, and is conducted to determine the presence or absence of archaeological resources. This level of survey indicates both the general nature and variety of archaeological remains present and the general distribution and density of such remains. It permits a general significance assessment of the archaeological resources and facilitates formulation of realistic recommendations and estimates for any subsequent mitigation work as might be necessary and appropriate.

During the survey, a low retaining wall was noted in the vicinity of Location # 2 at Site #4 outside the fenced compound at KGO. The wall is located at the end of the area graded for the fenced compound and appears to be a foundation to retard erosion or stabilize the soil embankment. The

wall appears to be of relatively recent construction. No other surface cultural remains were identified at the remaining sites at PMRF-BS or KGO.

Because the retaining wall appears not to be historic and associated with construction of KGO and the likelihood of subsurface remains being present is low, no further archaeological work is recommended for the four locations within Site #4.

Although no surface cultural remains were identified within the three sites at PMRF-BS, this general area is known to contain human burial remains and may be significant for scientific information content and cultural value (Section 4.1.11). Therefore, a subsurface inventory survey is recommended if one of the three sites is chosen as the preferred alternative. This subsurface inventory survey would include a combination of coring, backhoe trenching and hand excavation. Any human remains that might be discovered or inadvertently disturbed will be treated in accordance with PMRF-BS's tentative burial plan. This would include notifying the Navy's archaeologist, the Office of Hawaiian Affairs, the Kauai Burial Council and the State of Hawaii Historic Preservation Officer, of the discovery of human remains.

The decision as to final disposition of any human remains that may be encountered would be made in consultation with the above-mentioned agencies and individuals.

5.1.10 Hazardous Wastes

Any solid or liquid or contained gaseous material that is no longer suitable for use and may pose substantial hazard to human health or the environment is considered a hazardous waste. Hazardous waste generation, accumulation, transportation, storage and disposal are regulated activities. Federally, they are regulated under the Resource Conservation and Recovery Act (RCRA). Congress enacted RCRA in 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984, which provide specific guidelines for these activities and severe penalties for noncompliance.

It is not expected that the construction and operation of the VLBI radio telescope will generate any hazardous wastes. However, in the event that any hazardous wastes are generated, Unitek Environmental Consultants has prepared a report entitled "Hazardous Waste Management Guidelines for the U.S. Naval Observatory, Kauai, Hawaii", that provides step-by-step procedures on how to dispose of the hazardous waste. Their full report is attached as Appendix F.

5.1.11 Aircraft Navigation

The Federal Aviation Administration has determined that the project is not identified as an obstruction and would not be a hazard to air navigation. In addition, obstruction marking and lighting are not necessary.

5.1.12 Air Quality

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

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 the operators of the radio telescope travelling to and from work. However, because only four additional employees are anticipated as a result of the proposed facility, this impact will be negligible.

5.1.13 Infrastructure/Utilities

As described in Sections 4.1.8 and 4.2.7, infrastructure and utility service to the candidate sites appears adequate, with the possible exception of the water supply system to KGO. However, employees at **KGO** have solved this problem by bringing in their own drinking water. These systems should be **sufficient** for the additional four employees anticipated for the radio telescope, who will increase demand in a negligible manner.

Impacts of construction-related activities on these systems will also be negligible, due to the apparent excess of capacity and the short-term duration of construction (anticipated to last no more than one year).

5.2 Indirect Effects and their Significance

The scope of the proposed action is rather small, adding only four 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, with the possible exception of the extended aeration package treatment plant located at PMRF-BS. This treatment plant already operates at approximately 93 percent of capacity (existing capacity is 30,000 gallons per day). The proposed action will add less than one percent to existing usage.

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 most critical policy of the Department of Defense that must be taken into consideration is the mission of the PMRF-BS:

> The mission of PMRF is to a) provide 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 to activities as assigned by Commander, Pacific Missile Test Center. In addition the facility has assumed the mission of hosting other services and agencies requiring launch facilities in the central Pacific area.

Should the VLBI facility be located at either Site #1 or #2 at PMRF-BS, the ability of the range operations to meet the mission statement of the base will be severely compromised, because the radar function of range operations will be jeopardized.

5.3.2 Coastal Zone Management (CZM)

Under the Coastal Zone Management Act (CZMA), by definition, lands which are subject solely to the discretion of the Federal government, such as federally-owned or leased property, are excluded from a state's coastal zone. However, federal activities which directly affect the coastal zone, are to be conducted in a manner consistent with the state's CZM program, to the maximum extent possible.

The major elements of Chapter 205A, HRS, as amended, the State of Hawaii's statute implementing coastal zone management, are contained in its stated objectives, covering seven areas:

Recreational Resources: Provide coastal recreational opportunities accessible to the public.

Historic Resources: Protect, preserve, and, where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

Scenic and open space resources: Protect, preserve, and where desirable, restore or improve the quality of coastal scenic and open space resources.

Coastal ecosystems: Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

Economic uses: Provide public or private facilities and improvements important to the State's economy in suitable locations.

Coastal hazards: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion and subsidence.

Managing development: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

Policies and guidelines contained in Chapter 205A, as amended, are derived from these objectives. Policies and guidelines relevant to this EA follow from the objective on scenic and open resources, especially as it relates to views from Kaumualii Highway in the vicinity of PMRF-BS. However, as discussed in Section 5.1.3, above, the impact of the proposed action must be taken in context with the existing built environment. Although the VLBI radio telescope will be taller than other similar facilities and will be visible from the coastal highway, it will not alter the appearance of natural landforms or existing public views to or along the shoreline. The proposed action will not substantially interfere with or detract from the line of sight toward the sea, as the ocean is not visible from the coastal highway. If it is determined that the action has any direct spillover effects onto the State's coastal zone, a consistency determination will be submitted to the State for review ninety days before federal agency approval of the action.

5.3.3 State Land Use Designation

As discussed in Sections 4.1 and 4.2, above, both the PMRF-BS and the KGO candidate sites are located within the State Conservation District. However, because PMRF-BS is owned by the Federal government, any activity on the base is excluded from all State and County land use regulations. As the KGO site is owned by the State of Hawaii, compliance with applicable State requirements will be achieved.

5.3.4 Other Local Land Use Policies

The County of Kauai has recognized the military use of PMRF-BS in its land use policies, by designating the base as a public facility on the General Plan Map and as "Military" on the Waimea-Kekaha Region Development Plan. As such, the proposed VLBI facility is consistent with these land use designations.

5.4 The Environmental Effects of Alternatives Including the Proposed Action

Except for the "no-action" alternative, all of the proposed alternatives would have similar impacts to the proposed action. This is particularly true of Satellite Laser Ranging and Lunar Laser

Ranging options of the alternate technology alternative. These two options would require optical telescopes, instead of receiver dish antennae, and would be approximately 50-feet high.

If the alternate site alternative were selected, physical impacts would be generally the same. Specific impacts, especially as they relate to flora, fauna, archaeological and historical resources and electronic clear zones, would depend on the specific siting characteristics of each individual candidate location.

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

It is expected that the VLBI facility would operate about 42 hours per week (it is estimated that NAVNET would operate experiments during one 24-hour period per week and six three-hour periods per week). The USNAVOBSY predicts that peak electric demand would be approximately 102 kw at PMRF-BS and 87 kw at KGO (the lesser impact at KGO would be the result of being able to share existing facilities). Presently, as a comparison, peak demand at KGO for the USB antenna is 30 kw.

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 VLBI facility will require the use of fossil fuels to provide the electricity for the radio telescope/antenna and the control facilities which will support the antenna. In addition, fossil fuels will 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.

Several sites, including Site #3 at PMRF-BS and locations #2 and #3 at Site #4 at KGO would require the destruction or relocation of several trees. At PMRF-BS, these would most likely be koa haole and/or kiawe trees, both exotic species. At KGO, locally abundant native tree species include koa and ohia. In addition, construction at Site #3 at PMRF-BS could very likely remove habitat for a Category 1 candidate endangered species, the pololei fern of adder's tongue fern (Ophioglossum concinnum), as well as possibly destroying individual plants.

5.7 Short-Term Use Versus Long-Term Productivity

The most obvious result of the construction of the VLBI facility will be the installation of a radio telescope/antenna that is primarily dedicated to the mission of NAVNET, that is to provide as

precise a definition of Earth orientation as possible. All sites under consideration in this EA satisfy this requirement. However, two of the Sites, #1 and #2, at PMRF-BS, will disrupt on-going base operations which are critical to the success of the mission of PMRF-BS. While in general terms, the project enhances the performance of NAVNET, in the long-term this benefit must be considered against compromising the mission of PMRF-BS.

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

As discussed in Section 5.1.3, the VLBI facility will have potential aesthetic impact at either of the two stations where it might be located. Both stations, PMRF-BS and KGO, are influenced by the built environment. At PMRF-BS, the built environment consists of clusters of buildings and electronic equipment, including radar and other electronic antenna. At KGO, the ambient visual environment is dominated more by lush foliage and landscape vistas. However, there is also an intrusion of the built environment which has been introduced to Kokee State Park and is described in detail in Section 5.1.3.

In either case, it is not expected that the location of the VLBI facility will significantly harm the existing visual environment. This is because the visual environment already includes similar facilities and because the facility at KGO will be visible for only brief periods of time during transit periods on the roads or hiking trails.

5.9 Means of Mitigating Potentially Adverse Effects

The two most significant impacts associated with the construction of the VLBI facility are the possible loss of habitat area for a Category 1 candidate endangered species at Site #1 and Site #3 at PMRF-BS and the electronic interference of range operations, also at PMRF-BS, if either Site #1 or Site #2 is selected.

In the case of the loss of possible habitat, it will be necessary to resurvey Sites #1 and #3 after the first heavy rainstorm of the winter months to determine the extent of the possible habitat to identify if the facility will actually infringe on existing habitat. Once the habitat area has been more definitively identified, it may be possible to locate the radio telescope/antenna outside of known habitat area or to transplant individual plants to other areas on the station to increase habitat area.

In the case of electronic interference, the only acceptable mitigating measure would be to locate the facility away from areas that would disrupt range operations. This would mean the selection of either Site #3 or Site #4 (at KGO). However, since Site #3 already has other constraints (possible Category 1 candidate endangered species habitat and unacceptable levels of RFI), it

would appear that Site #4 is a more reasonable alternative as a mitigating measure for these impacts.

Also, the proposed radio telescope will be visible from public roads and highways. This would include a 100-yard stretch of Highway 550 above the Kokee Lodge, within Kokee State Park. To mitigate this visual impact, trees will be planted along the north side of Highway 550, within the 100 yard stretch from which the proposed radio telescope would be visible. The planting of trees would totally screen Site #4 from Highway 550. A conceptual presentation of possible landscaping is shown in Figure 12. Another possible method of mitigating any remaining visual impact would be to paint the radio telescope a color that would blend in with the surrounding environment. One shade of green has already been tested and approved by the U.S. Naval Obervatory. This color (Nos. 24373 and 34373; semigloss and lusterlsess, respectively) is shown in Appendix G.

5.10 Cumulative Impacts

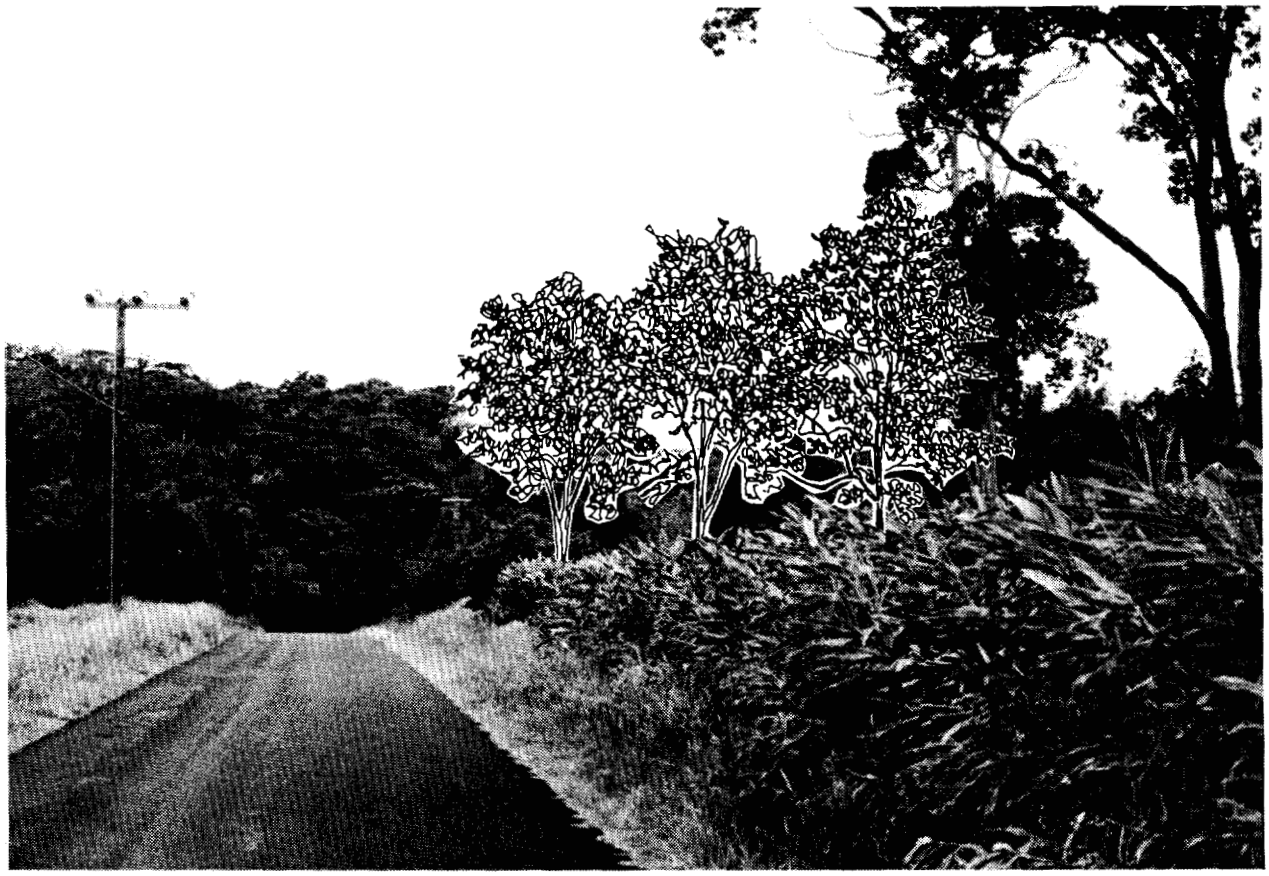
The completion of this project will increase demand on existing infrastructure systems at PMRF-BS and KGO. However, the increases will be minimal and are not expected to tax the capacities of those systems. Only in the case of the extended aeration package treatment plant at PMRF-BS, does there seem to be a near-term problem with capacity (present demand is at approximately 93 percent of plant capacity).

Otherwise, the proposed project will add to the built environment at PMRF-BS and KGO, which, as discussed above, is not expected to create a significant impact.

5.11 Additional Approvals Needed

Federal Consistency Review. As discussed in Section 5.3.2, above, all of the sites located at PMRF-BS are excluded from the State's designated Coastal Zone Management Area. If it is determined that the action has any direct spillover affects onto the State's Coastal Zone, a consistency determination will be submitted to the State for review ninety days before final federal agency approval of the action.

Land Use Approvals. As discussed in Section 5.3.3, above, the PMRF-BS sites are excluded from all State and County land use regulations. As the KGO site is owned by the State, compliance with applicable State requirements will be achieved.

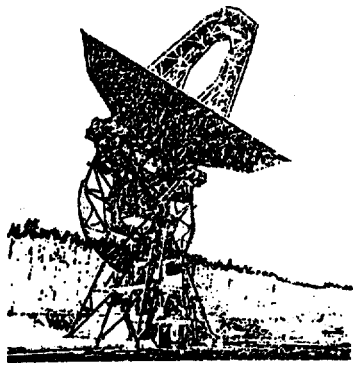


Conceptual view along Highway 550, above Kokee Lodge with new landscaping.
Proposed VLBI Radio Telescope cannot be seen.

THE U.S. NAVAL OBSERVATORY
VERY LONG BASELINE
INTERFEROMETRY (VLBI)
RADIO TELESCOPE

Figure 12

Highway 550
Proposed Landscaping



Chapter VI
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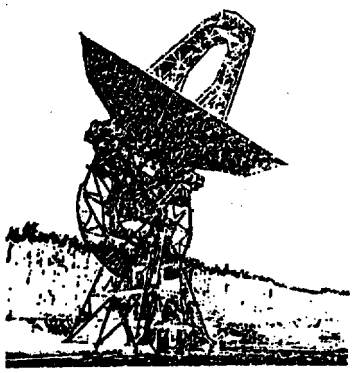

Chapter VII
List Of Preparers

VII LIST OF PREPARERS

The EA was prepared for the U.S State Department by the Pacific Division Naval Facilities Engineering Command (NAVPACDIVFACENGCOM) of the U.S. Navy and Helber Hastert & Kimura, Planners. The following list identifies individuals and organizations who were involved in the preparation of the Draft EA and their respective contributions.

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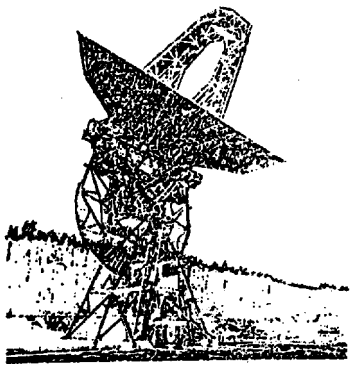

Appendix A
Traffic Assessment
(Parsons Brinckerhoff Quade & Douglass, Inc.)

Parsons Brinckerhoff 100 YEARS

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SUBJECT: U.S. Naval Observatory

The U.S. Naval Observatory, as part of its program in Very Long Baseline Interferometry (VLBI), requires a radio telescope located in the Hawaiian islands. Four alternative sites on the island of Kauai have been selected for development of this observatory. The four sites are the National Aeronautics and Space Administration (NASA) Spacecraft Tracking Data Network site at Kokee Park, Kauai, and three sites within the Pacific Missile Range Facility (PMRF), Kauai.

The following is a summary of our assessment of the traffic related impacts generated by the proposed observatory on the roadways surrounding the alternative sites.

Site 1: NASA Spacecraft Trackina Data Network

The NASA Spacecraft Tracking Data Network site is located within Kokee Park. Access to this site is provided through a twenty-eight (28) foot wide stop controlled roadway that intersects Kokee Road forming the stem of a T-intersection. This access road narrows to fourteen (14) feet as it approaches the guard house.

Kokee Road is a primary circulation route connecting Kokee Park to Waimea and Lihue. It is a narrow two-lane roadway that provides access to Kokee Park, Waimea Canyon Lookout, and Kalalau Lookout. In the vicinity of the NASA Spacecraft Tracking Data Network site, Kokee Road is approximately 19-feet wide with a posted speed limit of 25 miles per hour. Existing traffic volumes on Kokee Road, makai of Kokee Park, were collected from the State Department of Transportation's 1989 Traffic Survey Data. This information is summarized below:

Kokee Road	FAS 550	ADT = 1434
	K = 4.04	AM = 58
	K = 14.30	Mid-day = 205
	K = 9.83	PM = 141

Site 2: Pacific Missile Ranae Facility

Three of the alternative sites are located within the Pacific Missile Range Facility. Access to the PMRF is gained through Imiloa Road. Our analyses for these three alternative sites, therefore, centered on Imiloa Road which provides direct access to the PMRF.

Imiloa Road is a two-lane roadway that provides access into the Pacific Missile Range Facility. It is approximately 22-feet wide with a posted speed limit of 20 miles per hour. Imiloa Road intersects Kaumualii Highway forming the stem of a T-intersection. The left-turn movement from Imiloa Road onto Kaumualii Highway is stop controlled at this intersection. The right-turn movement from Imiloa Road onto Kaumualii Highway is yield controlled at this intersection where a dedicated right-turn lane is provided.

Kaumualii Highway as a primary circulation route linking the Pacific Missile Range Facility with Kekaha and Lihue. In the vicinity of Imiloa Road, Kaumualii Highway is a two-lane roadway, approximately 20-feet wide with a posted speed limit of 50 miles per hour. Existing traffic volumes on Kaumualii Highway, collected from the State Department of Transportation's 1989 Traffic Survey Data , are summarized below:

Kaumualii Highway	FAP 50	ADT = 1733
	K = 14.02	AM = 243
	K = 14.02	Mid-day = 243
	K = 14.02	PM = 243

Trip Generation

The U.S. Naval Observatory is a research facility which will be serviced by approximately four (4) employees on a daily basis. This facility will also require some support services on a daily, weekly, or incident related basis. These support services include ground maintenance, site security, facility maintenance, janitorial service, and fire protection. A total of six (6) employees were, therefore, assumed to service this facility on a daily basis. For trip generation purposes, these employees were also assumed to commute to and from work during the normal weekday commuter periods.

Trip generation rates promulgated by the Institute of Transportation Engineers in the Trip Generation Manual. Fourth Edition, were used to estimate the volume of traffic generated by the proposed project. Research center trip rates were used to estimate traffic volumes. These estimated traffic volumes are summarized below:

U.S. NAVAL OBSERVATORY

	RATE trips/employee	TRIPS
ADT	2.45	15
AM PEAK HOUR	0.474	3
ENTER	94%	2
EXIT	6%	1
PM PEAK HOUR	0.438	3
ENTER	6%	1
EXIT	94%	2

Project Impacts

The 15 total vehicles projected to enter and exit the observatory site on a daily basis will have only nominal traffic impact on either Kaumualii Highway or Kokee Road.

Comparison of the SDOT 1989 traffic volumes and estimated project generated trips revealed that the proposed project would slightly increase traffic volumes on Kaumualii Highway and Kokee Road. Traffic volumes would increase during the AM peak hour by two vehicles entering and one exiting, PM peak hour by one vehicle entering and two exiting, and during a twenty-four hour period by an increase of fifteen vehicles. Should the observatory be located at the PMRF, Kaumualii Highway traffic volumes would increase by 1.2% during the AM peak hour and PM peak hour, and by 0.9% during a twenty-four hour period. Should the Observatory be located at the NASA Spacecraft Tracking Data Network in Kokee Park, Kokee Road traffic volumes would increase by 5.2% during the AM peak hour, by 2.1% during the PM peak hour, and by 1.0% during a twenty-four hour period.

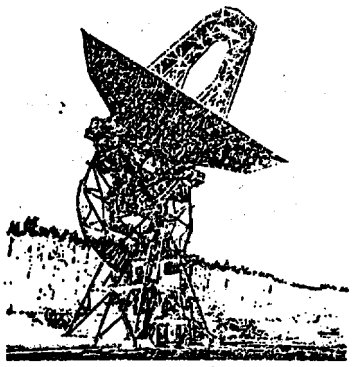
Evaluation of traffic volumes on Kokee Road revealed a higher mid-day peak hour traffic volume than the traditional morning and evening peak hours. This higher mid-day peak is primarily due to tourist oriented traffic visiting the Waimea Canyon Lookout and the Kalalau Lookout. The proposed project, however, is anticipated to generate few if any mid-day trips. Traffic impacts to Kokee Road would therefore be nominal during the mid-day peak hour.

Should you have any questions please contact me at 531-7094 or by fax at 528-2368.

Very truly yours,

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Robert Miyasaki
Traffic Engineer



APPENDIX B
BOTANICAL SURVEY
(CHAR & ASSOCIATES)

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BOTANICAL ASSESSMENT
PROPOSED U.S. NAVY OBSERVATORY RADIO TELESCOPE
PMRF-BS AND KPGO SITES, KAUA'I

INTRODUCTION

The U. S. Navy Observatory proposes to build a radio telescope on approximately 0.75 acres of land either at its Pacific Missile Range Facility at Barking Sands (PMRF–BS) or its Koke'e Park Geophysical Observatory (KPGO) parcel on the island of Kaua'i. Four separate sites are being studied for the radio telescope; three sites are located on PMRF–BS and one at KPGO.

Field studies to assess the botanical resources found on each of the four sites was conducted on 15 June 1990. The primary objectives of the field studies were to describe the vegetation and to search for threatened and endangered plant species protected by federal and state laws.

Prior to the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the area. A walk–through survey method was used. Although the radio telescope will require about 0.75 acres, a larger area of 1 acre was surveyed as final location within each site has not been determined. The plant names used in this report follow Wagner et al. (1990).

DESCRIPTION OF THE VEGETATION

PACIFIC MISSILE RANGE FACILITY - BARKING SANDS (PMRF-BS)

Site 1: This site is located mauka (inland) of Building 515, otherwise known as the Calibration Lab, on land that is periodically maintained. Substrate is coralline sand with roughly 40 to 50% not vegetated. Where vegetation is present, it consists of weedy grasses and herbs with a few shrubs of pluchea or sourbush (Pluchea symphytifolia) and koa-haole (Leucaena leucocephala) kept low, from 6 inches to a foot tall, by infrequent mowings. The dominant grass on this site is buffel grass (Cenchrus ciliaris) and the most frequently observed herbaceous species are hairy spurge (Chamaesyce hirta), graceful spurge (Chamaesyce hypericifolia), Canada fleabane (Conyza canadensis var. pusilla), 'ihi (Portulaca pilosa), and golden crown-beard (Verbesina encelioides). Three native species observed on this site and also commonly throughout PMRF-BS are 'ilima (Sida fallax), nama (Nama sandwicensis), and 'uhaloa (Waltheria indica).

Site 2: This site is located mauka of an existing paved parking area across from Building 384. This large grassed area appears to be more frequently mowed and maintained than Site 1. Grass cover is dense, consisting of a mixture of Bermuda grass (Cynodon dactylon), buffel grass, and smaller patches of lovegrass (Eragrostis tenella). Weedy species are occasional and include Cuba jute (Sida rhombifolia), hairy spurge, red-flowered boerhavia (Boerhavia coccinea), 'ihi, 'uhaloa, and swollen finger grass (Chloris barbata). Again "runned-over" koa-haole shrubs, from 4 to 6 inches tall, are common. Substrate is a compacted mixture of soil and sand with broken asphalt and gravel on the surface.

Site 3: This site is located mauka of North Sidewinder Road at the intersection with the WWVH access road. Substrate is coralline sand. Vegetation is dense and consists of a closed shrubland, from

5 to 7 feet tall, with scattered trees of kiawe (Prosopis pallida), from 25 to 30 feet tall. The native a'ali'i shrub (Dodonaea viscosa) forms a band from 50 to 75 feet wide along the road. Further in from the road, a'ali'i drops out and is replaced by a mixed shrubland of koa-haole, lantana (Lantana camara), and Guinea grass (Panicum maximum). Common associates of the shrubland include Natal redtop (Rhynchelytrum repens), nama, pluchea, 'ihi, 'ilima, 'uhaloa, hairy spurge, golden crown-beard, and lovegrass. During the rainy season the site may have surface water as small depressed areas support patches of moss (probably Weisia ovalis) and the blue-green Nostoc algae. Although not encountered during this survey, one candidate endangered species, the pololei fern or adder's tongue fern (Ophioglossum concinnum), is known from Site 3. The paddle-shaped fronds of this small fern die-back during the dry summer months making detection unlikely. A more detailed discussion is presented in the section on "Threatened and Endangered Plants" of this report.

KOKE'E PARK GEOPHYSICAL OBSERVATORY (KPGO)

The fourth site is located at about the 3,700-foot elevation at the Koke'e Park Geophysical Observatory on a parcel of land referred to as "Site E". This site contains the Unified S-Band telemetry station (USB) building and various antennas. Within "Site E", 4 possible locations for the radio telescope have been identified. Locations #1 and #3 are on landscaped lawn areas; location #2 is primarily asphalt (part of the service road) with a smaller area in lawn; and location #4 is an open, grassy area already occupied by an existing antenna.

#1 and #3: Locations #1 and #3 are mowed lawn areas dominated by kikuyu grass (Pennisetum clandestinum) and white clover (Trifolium repens). Other minor components include carpet grass (Axonopus fissifolius), St. Augustine or buffalo grass (Stenotaphrum secundatum), Italian ryegrass (Lolium multiflorum), velvet grass (Holcus lanatus), hairy cats-ear (Hypochoeris

radicata), and narrow-leaved plantain (Plantago lanceolata). A fairly large sized Japanese pear (Pyrus pyrifolia cultivar) is found on location #1; two small plum trees (Prunus cerasifera x salicinia) are found near location #3.

#2: Most of this location is sited on the existing paved road to the USB Building. Only along the perimeter is there any vegetation, and, this again consists of grassy lawn similar in composition to locations #1 and #3, although Italian ryegrass is somewhat more common.

#4: This location is less well maintained than the other three locations around the USB Building. Kikuyu grass, white clover, and velvet grass are the major components of the grassed area, although narrow-leaved plantain, carpet grass, African dropseed (Sporobolus africanus), and a Melilotus species are locally common. Other weedy species found on this location are Dallis grass (Paspalum dilatatum), dandelion (Taraxacum officinale), hairy cats-ear, daisy fleabane (Erigeron karvinskianus), rice grass (Paspalum scrobiculatum), and bitter herb (Centaurium erythraea). A native mesic forest of koa (Acacia koa) and 'ohi'a (Metrosideros polymorpha) abuts the open grassy area which contains location #4. A few saplings and plants from the forest are found along the margins of the grassy area. These include the following natives: 'ohi'a, koa, pukiawe (Styphelia tameiameiae), naupaka kuahiwi (Scaevola gaudichaudiana), 'uki'uki (Dianella sandwicensis), and two ferns, uluhe (Dicranopteris linearis) and pala'a (Sphenomeris chinensis). Introduced woody elements are firetree (Myrica faya), strawberry guava (Psidium cattleianum), and prickly Florida blackberry (Rubus argutus).

THREATENED AND ENDANGERED PLANTS

No officially listed threatened and endangered plant species are found on the KPGO parcel; nor are any proposed or candidate

threatened and endangered species known from the KPGO site (U.S. Fish and Wildlife Service 1989, 1990).

On PMRF-BS no officially listed threatened and endangered species are found, however, a Category 1 candidate endangered species, the pololei fern or adder's-tongue fern (Opioglossum concinnum) is known from the facility. A Category 1 listing comprises taxa for which the U.S. Fish and Wildlife Service currently has substantial information on hand to support the biological appropriateness of proposing the plants as endangered or threatened.

Ophioglossum concinnum was first recorded from the island of Kaua'i in 1985 during a study of the biological and water resources of PMRF-BS (Botanical Consultants 1985). Opioglossum habitat on PMRF-BS is primarily Dodonaea-Nama scrub (Botanical Consultants 1985; Traverse Group, Inc. 1988). More recently, it has been found in kiawe/koa-haole scrub and open lawn or weedy areas dominated by Bermuda grass and other herbaceous species (U. S. Army 1990). The lawn and weedy areas are regularly mowed. Ophioglossum is a small, perennial fern with paddle-shaped fronds, 3 to 5 inches long, and somewhat tuberous, underground rhizomes. The plants quickly send up new fronds after the first heavy rains of the rainy season (November through December). Fertile fronds bear a simple, spiked structure which contains numerous dust-like spores (Traverse Group, Inc. 1988). The fronds die-back during the dry summer months with only the thickened rhizome or root surviving until the next rainy season.

DISCUSSION AND RECOMMENDATIONS

Vegetation on "Site E" of the Koke'e Park Geophysical Observatory parcel consists of mowed, grassy lawn dominated by introduced grass and weedy herbaceous species. Near the margins of location #4, a few plants from the nearby koa-'ohi'a forest have become established, however, these are common native species found

throughout the Koke'e area and none are officially listed, candidate or proposed threatened and endangered species. There are no botanical reasons to impose any impediments, restrictions or conditions to the KPGO site.

On the Pacific Missile Range Facility at Barking Sands, a candidate endangered species, Ophioglossum concinnum, is known from Site 3. The plant may also occur on Site 1, as it provides suitable habitat. The Opioglossum is not expected on Site 2 as the substrate is compacted soil and sand which appears to have been disturbed or paved over at one time.

If the PMRF-BS sites are selected, then a more intensive survey of Sites 1 and 3 need to be conducted during the rainy season, shortly after the first heavy rainfall. Mitigative measures similar to those initiated for the Exoatmospheric Discrimination Experiment (EDX) project (U. S. Army 1990) should be undertaken. In the EDX project, plants of Ophioglossum were transplanted to another part of PMRF-BS and the roadway servicing the EDX facility was realigned to avoid large concentrations of the Ophioglossum plants.

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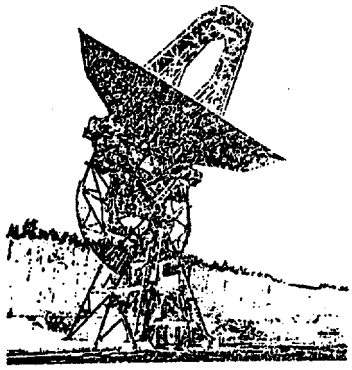

Appendix C
Faunal Survey
(Dr. Philip Bruner)

FIELD SURVEY OF THE AVIFAUNA AND FERAL MAMMALS AT THREE SITES LOCATED ON THE PACIFIC MISSILE RANGE FACILITY AT BARKING SANDS AND AT KOKEE PARK GEOPHYSICAL OBSERVATORY, KAUAI

Prepared for

Helber Hastert & Kimura

by

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18 June 1990

INTRODUCTION

The purpose of this report is to sumnarize the findings of two day (13-14 June 1990) bird and mammal field survey at Pacific Missile Range Facility (PMRF), Barking Sands and at the Kokee Park Geophysical Observatory (KPGO), Kauai (see Fig. 1 and 2 for actual location of property 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 the property or may likely occur given the habitats available.

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". If such occur or may likely be found on the property identify what features of the habitat may be important for these species.

4- Determine if the property contains any special or unique habitats that if lost or altered by development might result in a significant Impact on the fauna in this region of the island.

GENERAL SITE DESCRIPTION

The PMRF sites one and two (fig.1) are located on grass fields surrounded by either buildings or brushy second growth habitat dominated by Kiawe (Prosopis pallida) arid Koa Haole (Leucaena leucocephala). Site three at PMRF is totally covered in exotic forest. The KPGO property (Fig.2) is located at 3500 feet elevation and contains a mixture of native and exotic forest as well as cleared areas covered in grass.

Weather during the field survey was variable with some cloudy periods and passing showers. Winds were from the NE at 15-30 mph.

STUDY METHODS

Field observations were made with the aid of 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 in and around the PMRF and KPGO sites eight minute count stations were established where all birds seen or heard were tallied. 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. 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; TGI 1988; Bruner 1988, 1990a, 1990b, 1990c. Hawaii Audubon Society 1989). 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 herein follow those given in the most recent American Ornithologist's Union Check-list (A.O.U 1983), Hawaii's Birds (Hawaii Audubon Society 1989). A field guide to the birds of Hawaii and the Tropical Pacific (Pratt et al. 1987), Mammals species of the World (Honacki et al. 1982) and Hawaiian Coastal Plants (Merlin 1980).

RESULTS AND DISCUSSION

Resident Endemic (Native) ~~Land and Water Birds~~:

No endemic birds were recorded at the three PMRF sites. Given the nature of the habitat available at these sites the only likely endemic species that might occur there would be the Pueo or Short-eared Owl (*Asio flammeus sandwichensis*). This owl is active during the day and forages over open fields as well as forest. The KPGO property occurs in native forest and at a high enough elevation to support native endemic forest birds. A total of five endemic species were found in the forest surrounding

the KGPO grounds. Table One lists these species and gives relative abundance estimates. The most abundant species was the Apapane (Himatione sanguinea).

Migratory Indigenous (Native) Birds:

No migratory birds were recorded at the PMFR or KPGO sites. This was not unexpected at this time of year since most migratory birds are on their breeding grounds in the arctic. The species most likely to use the sites at PMFR would be the Pacific Golden Plover (Pluvialis fulva). Plover prefer open areas such as mud flats, fields and lawns. Johnson et al. (1981), Bruner (1983) and Johnson et al. (1989) have shown plover are extremely site-faithful (returning each year to the same spot and maintaining this behavior throughout their life time). 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. (Johnson et al. 1989). Other migratory species which may utilize the PMRF sites one and two would be the Ruddy Turnstone (Arenaria interpres) and the Sanderling (Calidris alba).

Wandering Tattler (Heteroscelus incanus) can be found along the rocky intertidal, on mud flats and in mountains streams. Their occurrence on the proposed sites is unlikely. However, tattler would utilize the shoreline habitat makai of site one at PMRF.

Resident Indigenous (Native) 'Waterbird:

The Black-crowned Night Heron (Nycticorax nycticorax) is the only species in this category. This bird occurs at PMRF and may occasionally rest in the trees at the PMRF site three. No Night Heron were recorded on the survey.

Resident Indigenous (Native) Seabirds:

The Wedge-tailed Shearwater (Puffinus pacificus) is known to nest at PMRF and the Laysan Albatross (Diomedea immutabilis) also are found at the facility. No seabirds were recorded during the survey. Newell's Shearwater (Puffinus newelli) nests in mountainous areas covered by fern. This species was not recorded at KGPO but may occur in the area.

Exotic (Introduced) Birds:

Table One lists all exotic birds recorded at both PMRF and KGPO. Given the data from surveys in similar habitat elsewhere on Kauai (Bruner 1988, 1990a, 1990b, 1990c) and information provided in Pratt et al. (1987), TGI (1988), Hawaii Audubon Society (1989) the following exotic bird species might also reasonably be expected to occur on or near these properties: Chestnut Mannikin (Lonchura malacca), Japanese Bush-warbler (Cettia diphone), Eurasian Skylark (Alauda arvensis) and Barn Owl (Tyto alba). Java Sparrow (Padda oryzivora) has also recently become established in the Princeville area (Hawaii Audubon Society 1989) and will likely spread to other lowland and urban habitats on the island.

Feral Mammals:

No evidence of rats or mice were found but these ubiquitous mammals undoubtedly occur at both PMRF and KGPO. No trapping was conducted in order to access the relative abundance of mammals at this site. Three feral cats were seen on the survey of the PMRF properies. Black-tailed Deer (Odocoileus henionus) are listed by TGI (1988) as "rarely found at PMRF." The station manager at KGPO (pers, comm.) reports seeing deer on the compound grounds at Kokee.

Records of the endemic and endangered Hawaiian Hoary Bat (Lasiurus cinerus semotus) are sketchy but the species is fairly common on Kauai (Tomich 1986). No bats were observed on the two day survey. This species roosts solitarily. Much remains to be known about the natural history of the hoary bat and its ecological requirements here in Hawaii.

The Hawaiian Monk Seal (Monachus schauinslandi) occasionally occurs on Kauai beaches (TGI 1988, Bruner 1990c). This endangered species primary range is in the NW Hawaiian Islands.

CONCLUSION

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 due to food resources and reproductive success. Species which are migratory will quite obviously be a part of the faunal picture only at certain times during the year. Exotic species sometimes prosper for a time only to later disappear or become a less significant part of the ecosystem (Williams 1987). Thus only long term studies can provide a comprehensive view of the bird and mammal populations in a particular area. However, when brief field studies are coupled with data gathered from other similar habitats the value of the conclusions drawn are significantly increased.

The following are some general conclusions related to birds and mammals on this property.

1- The PMRF property provides a limited range of habitats which are utilized by the typical array of exotic species of birds one would expect at this elevation and in this type of environment on Kauai. However, some species typically found in this habitat were not recorded. This could have been due to the fact that the survey was too brief or that their numbers are so low that they went undetected or a combination of these and other factors.

2- The KGPO site likewise contains the expected array of exotic birds.

3- Native birds found on the KGPO property and in the surrounding

forest were those species that are reasonably common at Kokee.

4- The alteration of any of the small sites at either KGPO or PMRF should have little or no measurable impact on the overall populations of native or exotic birds.

5- In order to obtain more definitive data on mammals, a trapping program would be required. No unusual mammal activity was noted at either PMRF or KGPO.

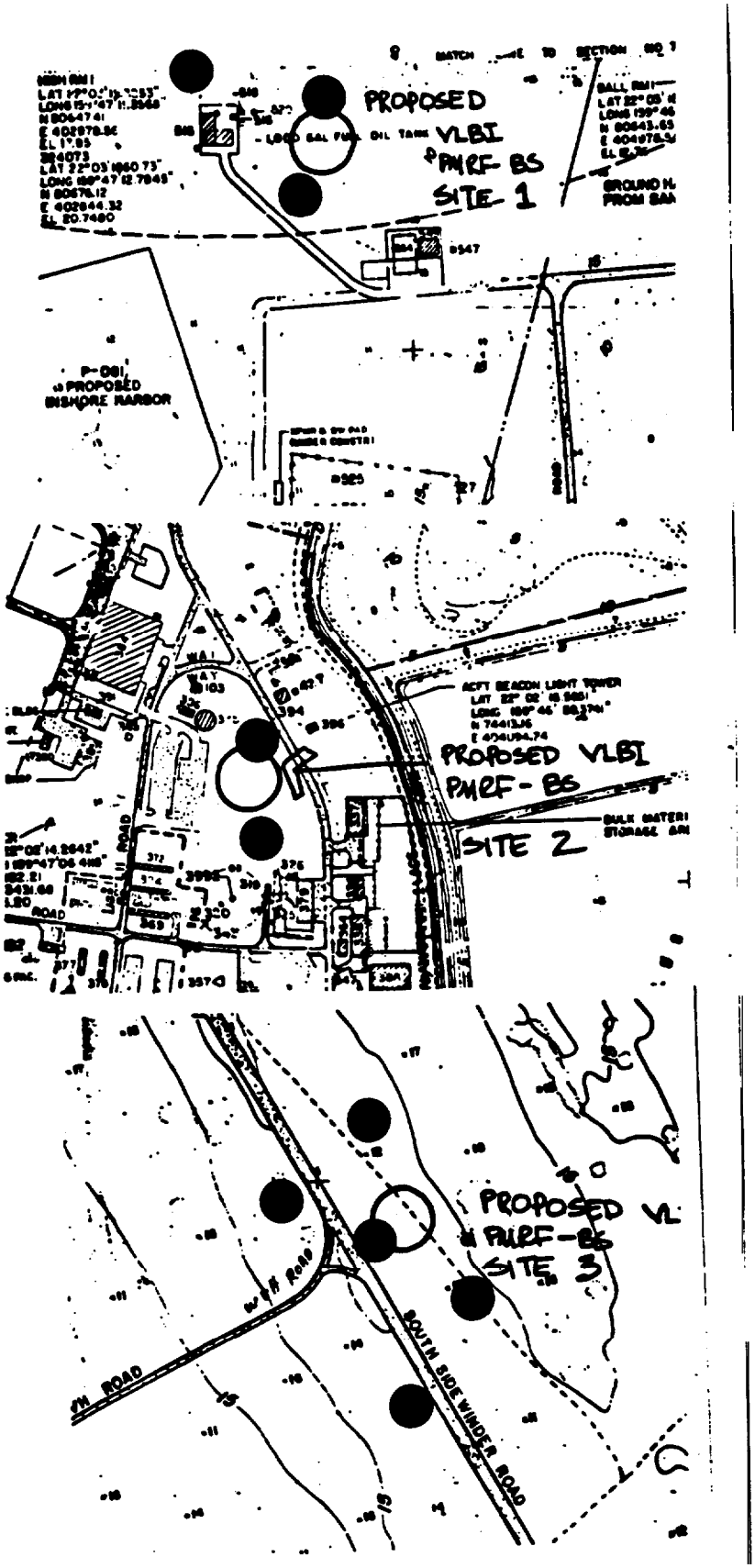

Fig. 1. PMRF sites with location of census stations shown as solid circles.

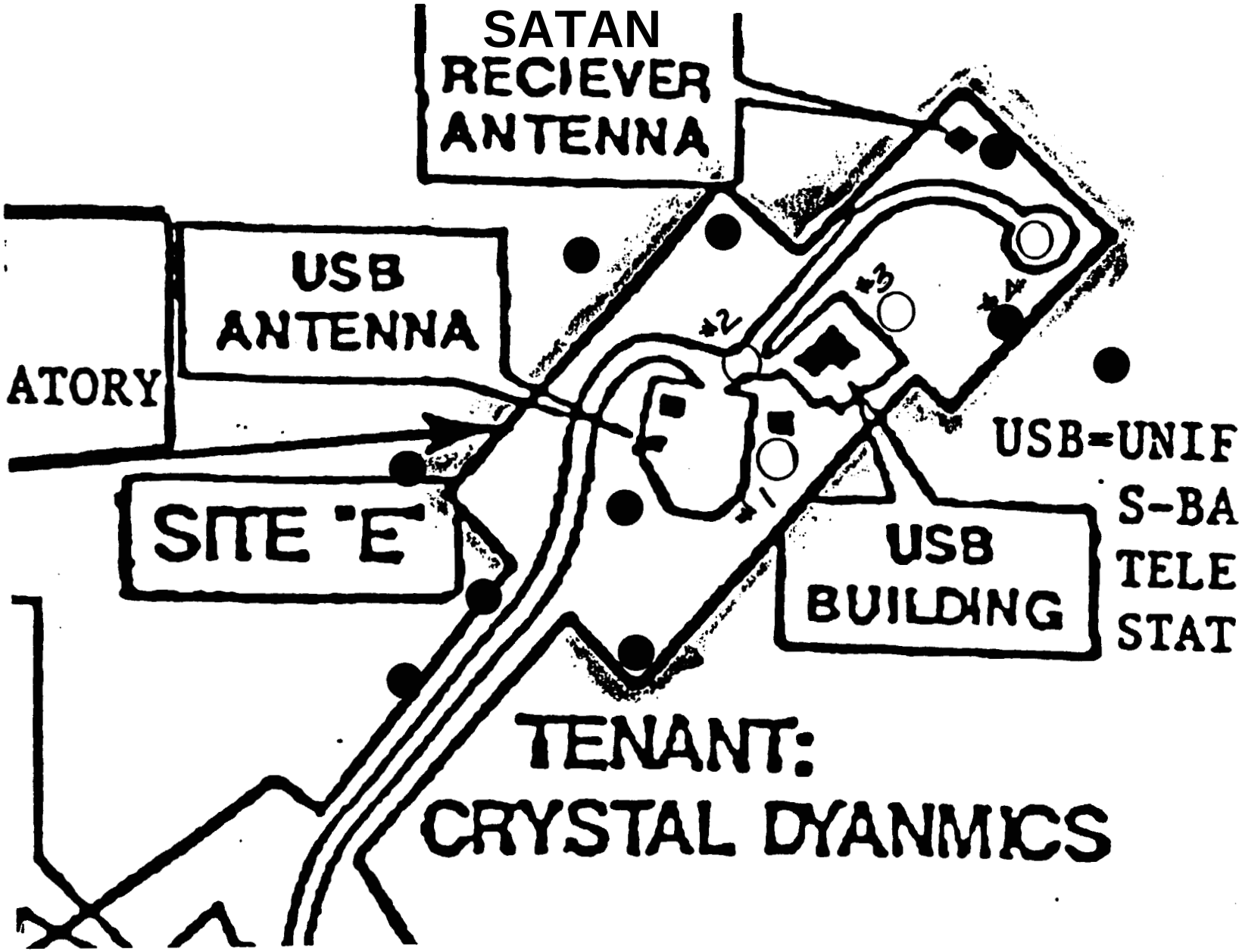

Fig. 2. KPGO site with location of census stations indicated by solid circles.

Birds recorded at PMRF and KGPO, Kauai

COMMON NAME	SCIENTIFIC NAME	LOCALITY AND RELATIVE ABUNDANCE*	
Endemic Species		KGPO	PMRF
Elepaio	Chasiempis sandwichensis	C= 5	---
Apapane	Himatione sanguinea	A=13	---
Common Amakihi	Hemignathus virens	C= 6	---
Anianiau	Hemignathus parvus	R= 1	---
Iiwi	Vestiaria coccinea	U= 4	---
Exotic Species			
Feral Chicken	Gallus gallus	C= 8	C= 6
Ring-necked Pheasant	Phasianus colchicus	---	R= 2
Cattle Egret	Bubulcus ibis	---	R= 3
Spotted Dove	Streptopelia chinensis	R= 1	U= 4
Zebra Dove	Geopelia striata	R= 3	A=12
Common Myna	Acridotheres tristis	R= 4	C= 9
Western Meadowlark	Sturnella neglecta	---	R= 2
Northern Cardinal	Cardinalis cardinalis	C= 6	C= 5
Red-crested Cardinal	Paroaria coronata	---	C= 7
Northern Mockingbird	Mimus polyglottos	---	U= 4
White-rumped Shama	Copsychus malabaricus	R= 1	R= 2
Hwamei	Garrulax canorus	U= 3	U= 4
Japanese White-eye	Zosterops japonicus	A=11	C= 6
Nutmeg Mannikin	Lonchura punctulata	---	A=14
House Finch	Carpoddcus mexicanus	U= 4	C= 9
House Sparrow	Passer domesticus	---	C= 6

* (see page 12 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 that on 8 min. counts. Number which follows is the total number seen or heard over the duration of the survey).

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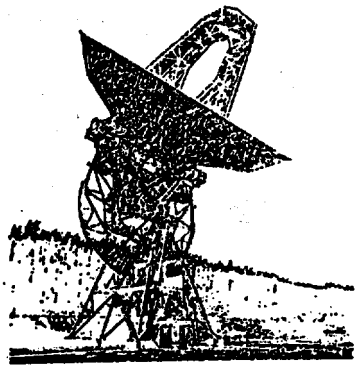

Appendix D
Radio Frequency Interference (RFI) Survey (Naval Electronics Engineering Activity, Pacific)

RADIO FREQUENCY INTERFERENCE SURVEY AT KOKEE PARK GEOPHYSICAL OBSERVATORY, AND PACIFIC MISSILE RANGE FACILITY, HAWAII AREA AT BARKING SANDS, KAUAI, HAWAII

(E3 Program Task No. E90091-H016)

FEBRUARY 1990

SURVEY TEAM MEMBERS: MILES TERAYAMA

STEVE KOBASHIGAWA

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PEARL HARBOR, HAWAII 96860-5170

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I. INTRODUCTION

A. Objective: The purpose of this survey was to measure RFI (Radio Frequency Interference) levels for specific frequency bands at the KPGO (Kokee Park Geophysical Observatory) and PMRF HAWAREA-BS (Pacific Missile Range Facility Hawaii Area at Barking Sands), Kauai, Hawaii. The data collected and presented in this report will be reviewed by NAVOBSY (U.S. Naval Observatory) to determine if the RFI levels are compatible with operation of a radio telescope.

B. Background: NAVOBSY, as part of its program in VLBI (Very Long Baseline Interferometry), plans to build a radio telescope in the Hawaiian Islands starting in fiscal year 1990. The KPGO and three sites at PMRF HAWAREA-BS are being investigated as possible sites. NEEACT PAC was tasked by NAVOBSY letter Serial S/091 of 2 February 90 to measure RFI at specific frequency bands on-site and to report the detected power levels found at those bands. Figure 1 shows the locations of the proposed sites on Kauai.

II. SITE DESCRIPTION

A. The KPGO site is located on Parcel "E" of the Kokee Instrumentation Station (formerly known as the NASA Tracking Station) on the Kaunuohua Ridge on the west side of the Island of Kauai, Hawaii. The station is approximately 3750 feet above sea level and the surrounding area is wet, consisting mostly of mountain ridges. The station occupies 19 acres with Parcel "E" being 5.27 acres. Parcel "E" is presently occupied by the NASA USB (Unified S-Band) Telemetry Station. Figure 2 shows the layout of the Kokee Instrumentation Station and the location of the KPGO site.

B. PMRF HAWAREA-BS is located on the western shores of the Island of Kauai, Hawaii. The surrounding area is dry, consisting mostly of level sandy areas. The site occupies approximately 2,000 acres and is approximately 20 feet above sea level. Figures 3 through 5 show the general site locations and Figures 6 through 8 show detailed site layouts.

III. FREQUENCIES OF INTEREST

A. As cited in NAVOBSY letter Serial S/091 of 2 February 1990, the radio telescope will observe distant natural radio sources (Quasars) and record radio noise in fourteen channels, each 2 MHz wide, spread over several hundred megahertz in the S and X bands. RFI at the X band should be less than -115 dBW/m^2 (dBWatts per meter squared) from 8.0 to 8.8 GHz and less than -130 dBW/m^2 from 2.1 to 2.4 GHz in the S band. Broadband RFI at or above these levels could render the site unsuitable.

1. Limitations of NEEACT PAC's Test Equipment: During the previous VLBI RFI survey at the USAF HF Receiving Station at Molokai, Hawaii, NEEACT PAC letter Serial 322SK/759 of 18 May 1989 advised NAVOBSY that at the 2.1 to 2.4 GHz and 8.0 to 8.8 GHz frequency range, our antennas and equipment limited the minimum detectable RFI to levels above those specified by NAVOBSY. This was also the case during this survey.

B. The NAVOBSY tasking letter also cited two additional frequency bands of interest, the 10 kHz to 2 MHz and 4.9 to 5.1 MHz bands. The 10 kHz to 2 MHz band is the channel bandwidth and is the baseband used by the recording system. NAVOBSY is especially concerned with 100 kHz RFI. The 4.9 to 5.1 MHz band is used by frequency and control equipment associated with the VLBI recording system. The recording systems are less sensitive to RFI, therefore, only noise that exceeds -75 dBW/m^2 warrants attention.

C. Specific VLBI Frequencies: During the telephone conversation between NAVOBSY (M. Eubanks) and NEEACT PAC (M. Terayama) on 14 August, 1989, specific frequencies of interest were provided. The future VLBI system will include these frequencies but will not be limited to them. See Table 1 for a list of the frequencies.

IV. SURVEY PROCEDURE

A. The measurement sites where as follows:

1. KPGO: Measurements were taken on the rooftop on the south side of the USB Building as shown on Figure 2.

2. PMRF HAWAREA-BS Site No. 1: Measurements were taken in an open area near the Test Equipment Calibration Laboratory, 70 feet due north of the Diver Support Facility as shown on Figure 6.

3. PMRF HAWAREA-BS Site No. 2: Measurements were taken in an open area near the aircraft maintenance hanger just north of the SATCOM area, 200 feet due north of Building 3992 as shown on Figure 7.

4. PMRF HAWAREA-BS Site No. 3: Measurements were taken with the ODC-100 whip antenna in an open area next to S. Sidewinder Road and opposite of the roadway to the WWVH Facility as shown on Figure 8. Due to RF noise from the portable AC power generator, measurements taken with the horn antennas were made adjacent to the WWVH facility where AC power could be drawn from the building as shown on Figure 8.

B. RFI measurements were taken in the following frequency ranges (Table 2 lists equipment used for the tests):

1. 10 kHz to 100 kHz (omni-directional whip antenna with pre-amplifier).

2. 100 kHz to 2 MHz (omni-directional whip antenna with pre-amplifier).

3. 4.9 MHz to 5.1 MHz (omni-directional whip antenna with pre-amplifier).

4. 2.1 GHz to 2.4 GHz (directional horn, vertically and horizontally polarized).

5. 8.0 GHz to 8.8 GHz (directional horn with reflector, vertically and horizontally polarized).

6. For both the 2.1 to 2.4 and 8.0 to 8.8 GHz tests, the antennas were rotated 360 degrees horizontally to ensure maximum detection in all directions for both polarizations.

C. All tests were run during the site's normal working hours with measurements taken between 9:00 a.m. and 3:00 p.m.

D. The PMRF HAWAREA letter Serial 7003/1332 of 21 December 1989 requested that the impact of PMRF transmitters collocated at the Kokee Instrumentation Station on the VLBI be considered. With the assistance of the PMRF Frequency Manager (Mr. Jim Bulloch), all PMRF transmitters operating in the VLBI frequency ranges at Kokee, Makaha Ridge, Kukui Tower, and Barking Sands, were turned on during our tests.

1. Several PMRF EW (Electronic Warfare) transmitters at Makaha Ridge that operate in the VLBI frequency bands have tracking antennas. These antennas were aimed directly at the test sites when possible. Otherwise, the antennas were swept through their entire directional range so that the worst case sidelobe illumination would be detected.

2. Tests were also conducted using the existing NASA USB radio telescope at the KPGO site. Part of the radio telescope's present mission is to conduct experimental VLBI measurements in the same 2 and 8 GHz bands. While monitoring the radio telescope's output, its antenna was pointed as close as possible to the energized PMRF transmitters at Kokee, Makaha Ridge, Kukui Tower, and Barking Sands. The USB radio telescope's antenna could not be pointed lower than 0 degrees, however, the VLBI antenna's lowest working elevation angle will be +5 degrees.

V. RESULTS

A. The data has been collected in the form of spectrum analyzer plots showing the accumulated peaks of received RFI power. The received RFI power were converted to power densities using the formulas shown in Appendix A. The plots are included as figures in this report and are scaled to show the corresponding power densities for comparison with the MARL (Maximum Allowable RFI Levels) specified by NAVOBSY.

B. Also shown are plots of the MDPD's (Minimum Detectable Power Density) for the test equipment at the required frequencies.

1. The MDPD's in the 2.1 to 2.4 GHz range were -90 dBW/m^2 for KPGO, and PMRF HAWARFA-BS sites No.1 and 3; and -87 dBW/m^2 for PMRF HAWAREA-BS Site No. 2. Both were above the MARL of -130 dBW/m^2. The MDPD at PMRF HAWAREA-BS Site No. 2 is higher because a 3 dB RF attenuator was used to protect the front end of our spectrum analyzer from the transmissions from the AN/FPS-81 weather radar adjacent to the site.

2. The MDPD's in the 8.0 to 8.8 GHz range were -86 dBW/m^2 for KPGO, and PMRF HAWAREA-BS sites No.1 and 3; and -83 dBW/m^2 for PMRF HAWAREA-BS Site No. 2. These were above the MARL of -115 dBW/m^2. The MDPD at PMRF HAWAREA-BS Site No. 2 is higher because a 3 dB RF attenuator was used to protect the front end of our spectrum analyzer from the transmissions from the AN/FPS-81.

3. Figures 9 through 13 show the MDPDs' for all test frequency bands.

C. KPGO:

1. RFI detected in the 10 to 100 kHz band peaked at -66 dBW/m^2, above the MARL of -75 dBW/m^2. RFI detected in the 100 kHz to 2 MHz band peaked at -76 dBW/m^2, below the MARL of -75 dBW/m^2. See Figures 14 and 15.

2. Peak RFI detected in the 4.9 to 5.1 MHz range was measured at -101 dBW/m^2, below the MARL of -75 dBW/m^2. See Figure 16.

3. No RFI above the MDPD's were detected in the 2.1 to 2.4 GHz or 8.0 to 8.8 GHz band. See Figures 17 and 18, respectively.

4. Test results with the NASA USB radio telescope: No RFI signals were detected from the PMRF transmitters.

D. PMRF HAWAREA-BS Site NO. 1 (Near the Test Equipment Calibration Laboratory, 70 feet due north of the Diver's Support Facility):

1. RFI detected in the 10 to 100 kHz band peaked at -67 dBW/m^2, above the MARL, of -75dBW/m^2. RFI detected in the 100 kHz to 2 MHz band peaked at -66 dBW/m^2, above the -75 dBW/m^2 MARL. See Figures 19 and 20.

2. Peak RFI detected in the 4.9 to 5.1 MHz range was measured at -90 dBW/m^2 below the -75 dBW/m^2 MARL. See Figure 21.

3. Peak RFI detected in the 2.1 to 2.4 GHz band was measured at -54 dBW/m^2, above the -130 dBW/m^2 MARL. RFI were detected at 2.212, 2.2405, and 2.246 GHz. 2.212 GHz is assigned to a tenant at PMRF HAWAREA-BS but no frequency assignments could be found for the other two frequencies. The 2.2405 GHz frequency is very close to the VLBI frequency of 2.238 GHz listed on Table 1. Additional data for these signals are provided in Appendix B. See Figures 22 and 23.

4. The peak RFI detected in the 8.0 to 8.8 GHz band was measured at -48 dBW/m^2, above the -115 dBW/m^2 MARL. The detected signals ranged from 8.676 through 8.720 GHz and were generated by the ENSYN, DLQ-3, and DPT-1 transmitters at Makaha Ridge. All RFI were above the VLBI frequencies listed on Table 1. Additional data for these signals are provided in Appendix B. See Figures 24 and 25.

E. PMRF HAWAREA-BS Site NO. 2 (Near the aircraft maintenance hanger, 200 feet due north of Building 3992):

1. RFI detected in the 10 to 100 kHz band peaked at -67 dBW/m^2, above the MARL of -75dBW/m^2. RFI detected in the 100 kHz to 2 MHz band peaked at -63 dBW/m^2, above the -75 dBW/m^2 MARL. See Figures 26 and 27.

2. Peak RFI detected in the 4.9 to 5.1 MHz range was measured at -87 dBW/m^2, below the -75 dBW/m^2 MARL. See Figure 28.

3. Peak RFI detected in the 2.1 to 2.4 GHz band was measured at -74 dBW/m^2, above the -130 dBW/m^2 MARL. RFI were detected at 2.121 and 2.1716 GHz but below the VLBI frequencies listed on Table 1. Both signals are from the Hawaiian Telephone microwave links between PMRF HAWAREA-BS and Puu Ka Pele Tower. Additional data for these signals are provided in Appendix C. See Figure 29. The spectrum plot for the horizontally polarized scan was omitted since no RFI were detected above the MDPD.

4. The peak RFI detected in the 8.0 to 8.8 GHz band was measured at -24 dBW/m^2 above the -115 dBW/m^2 MARL. The RFI were detected at 8.040, 8.120, 8.200, 8.260, 8.290, 8.380, and 8.676 through 8.720 GHz. Overlapping of VLBI frequencies 8.211 and 8.251 are predicted due to the 25 MHz bandwidth of the 8.200 and 8.260 signals. The 8.676 through 8.720 GHz RFI were generated by the ENSYN, DLQ-3, and DPT-1 transmitters at Makaha Ridge. The remaining frequencies can be traced to the various microwave links within PMRF HAWAREA-BS, between PMRF HAWAREA-BS and Makaha Ridge, and between PMRF HAWAREA-BS and Kukui Tower. Additional data for these signals are provided in Appendix C. See Figures 30 and 31.

F. PMRF HAWAREA-BS Site NO. 3 (Near WWVH Facility):

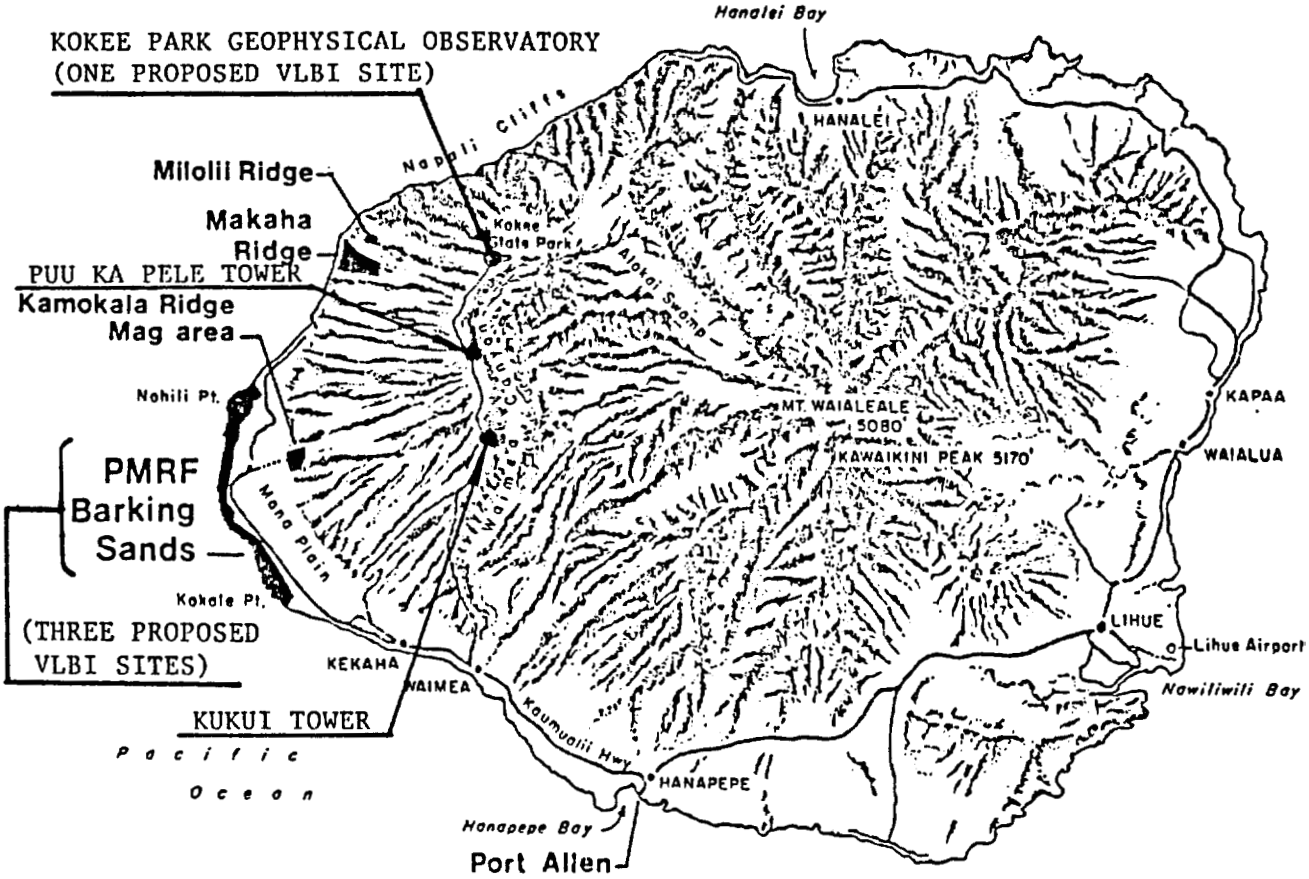
1. RFI detected in the 10 to 100 kHz band peaked at -75 dBW/m^2, equal to the MARL of -75 dBW/m^2. RFI detected in the 100 kHz to 2 MHz band peaked at -61 dBW/m^2, above the MARL of -75 dBW/m^2. See Figures 32 and 33.

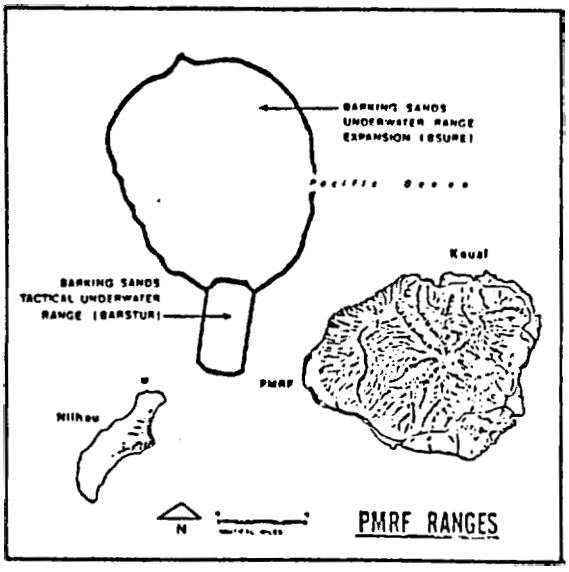
2. Peak RFI detected in the 4.9 to 5.1 MHz range was measured at -45 dBW/m^2, above the MARL of -75 dBW/m^2. See Figure 34.

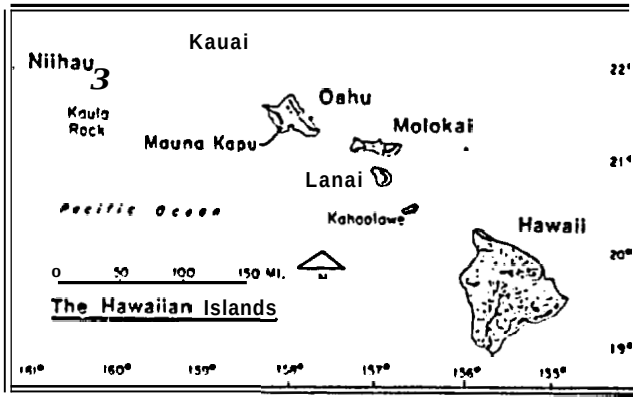
3. No RFI above the MDPD's were detected in the 2.1 to 2.4 GHz or 8.0 to 8.8 GHz band. The spectrum plots for these test were omitted since no RFI were detected above the MDPD's.

VI. EVALUATION OF RESULTS

The results presented in this report will be reviewed by NAVOBSY in evaluating the suitability of the KPGO and PMRF HAWAREA-BS sites as a possible VLBI sites. Although measurements taken were limited by the sensitivity of the test equipment, the data collected provides a preliminary view of RFI present at the site.







LOCATION MAP

ISLAND OF KAUAI

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Figure 1

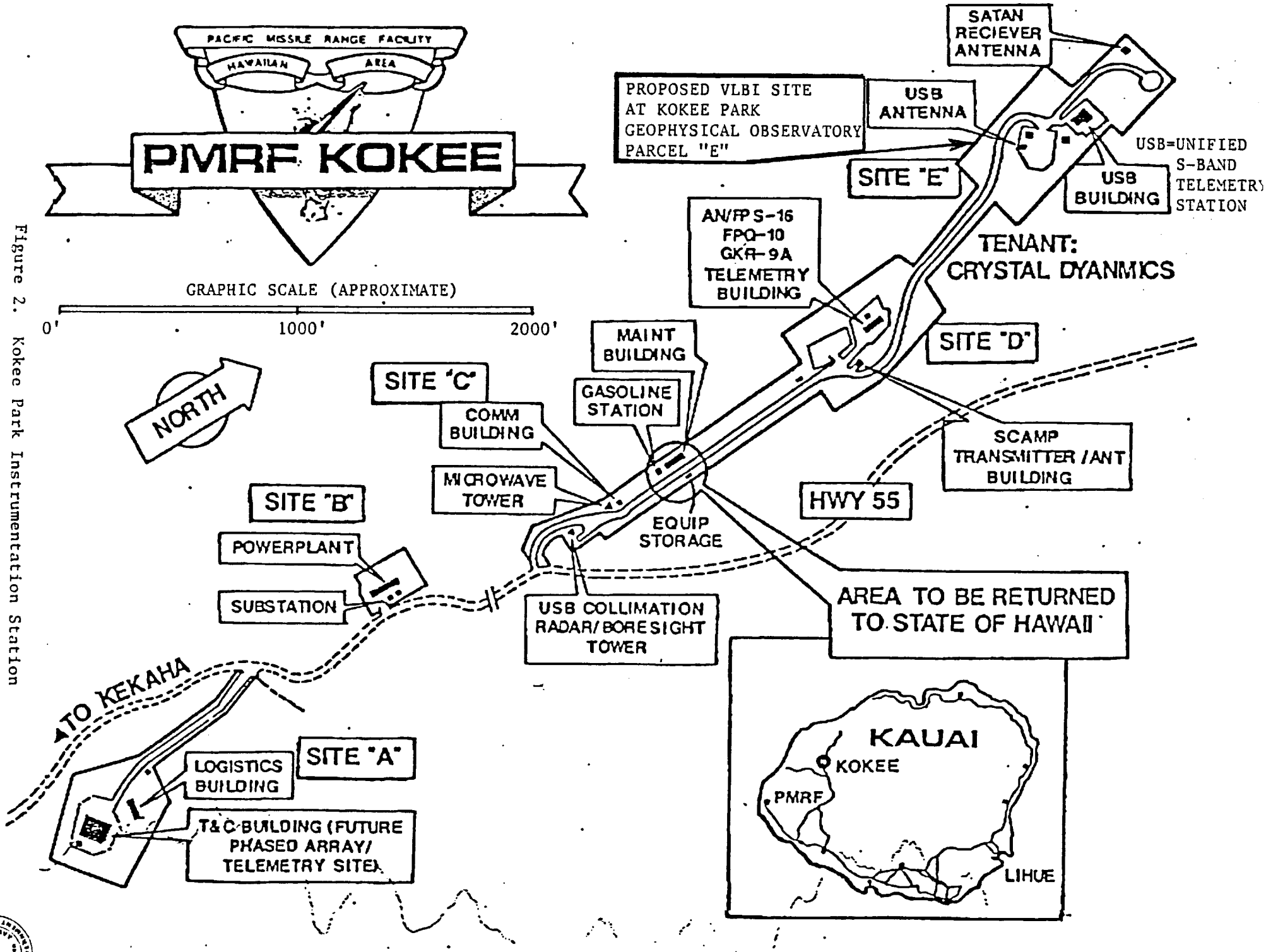


Figure 2. Kokee Park Instrumentation Station

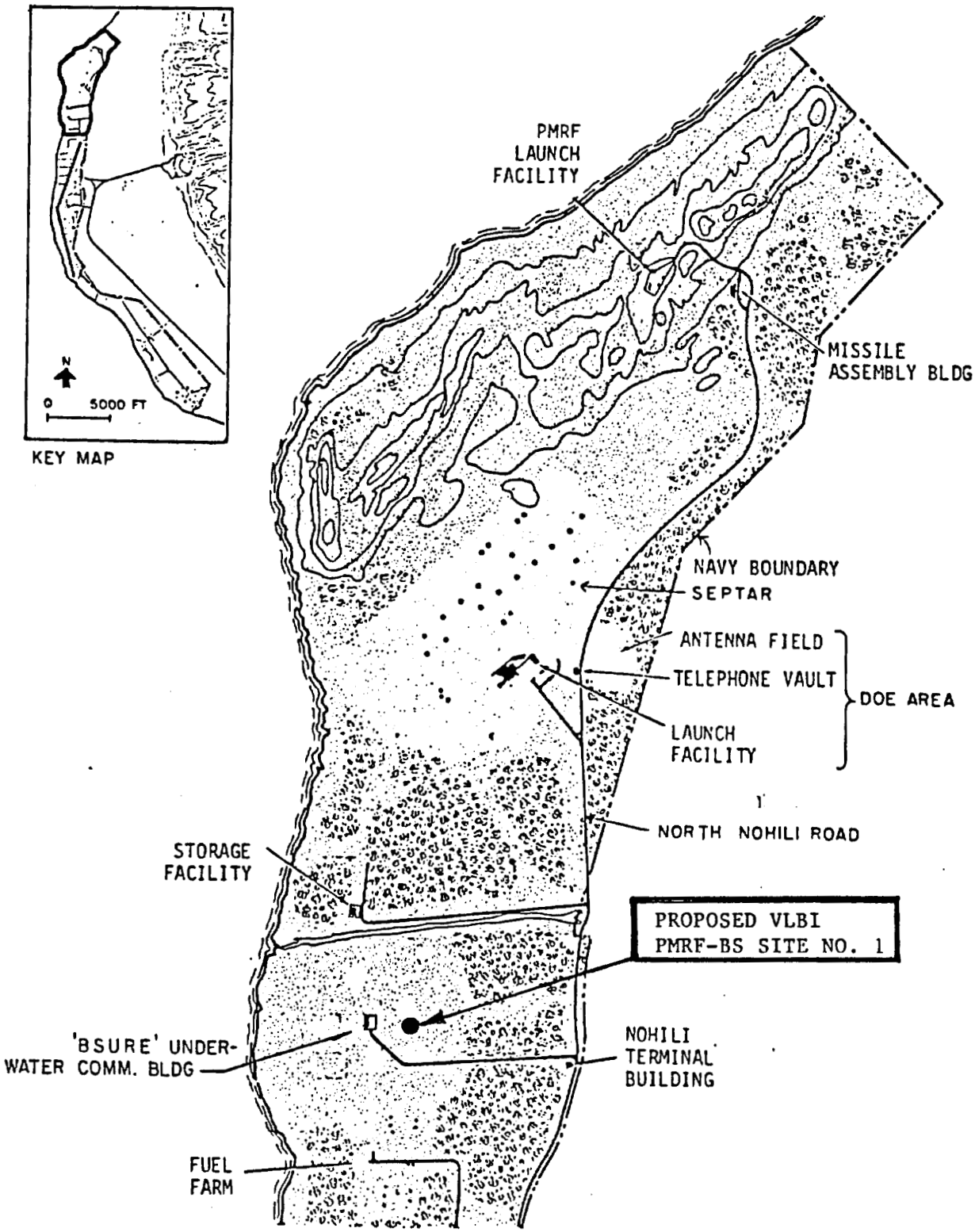


Figure 3. Map of the Northern Portion of PACMISRANFAC HAWAREA at Barking Sands Showing the Location of Site No. 1

EXISTING FACILITIES
NORTHERN DUNES AREA

N
0 600 1200 1800 FT

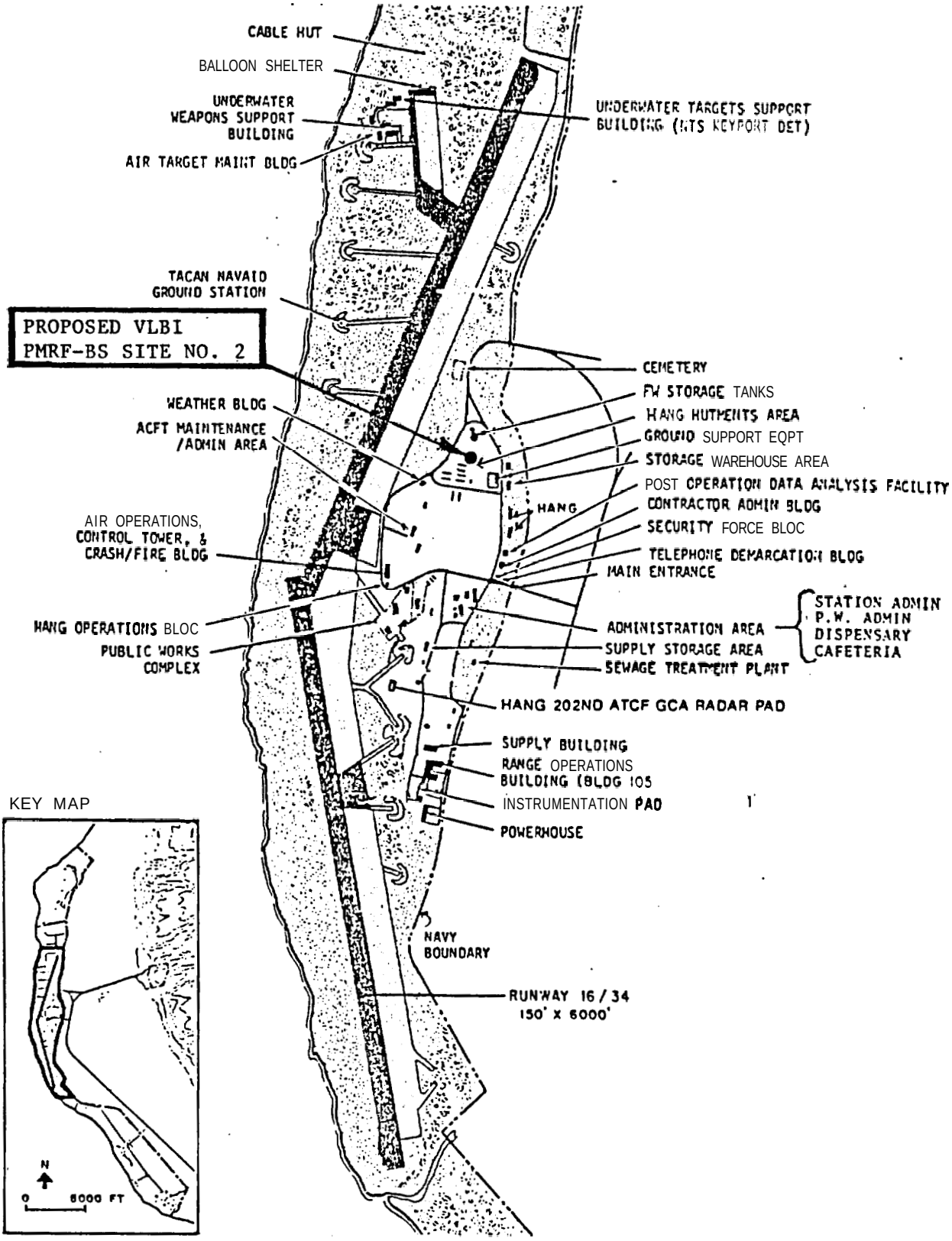


Figure 4. Map of the Central Portion of PACMISRANFAC HAWAREA at Barking Sands Showing the Location of Site No. 2

EXISTING FACILITIES

MAIN STATION

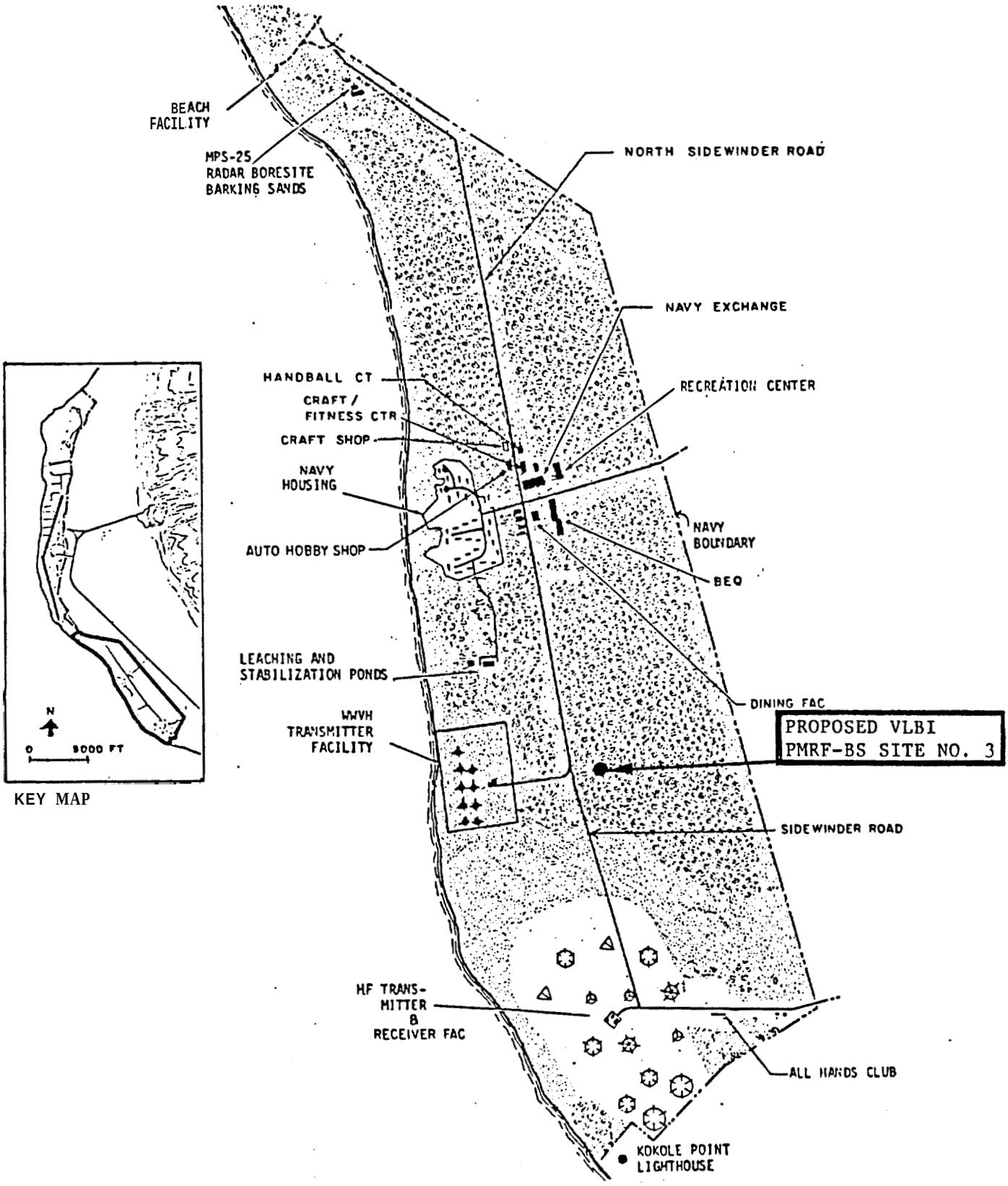


Figure 5. Map of the Southern Portin of PACMISRANPAC HAWAREA at Barking Sands Showing the Location of Site No. 3

EXISTING FACILITIES

SOUTHERN AREA

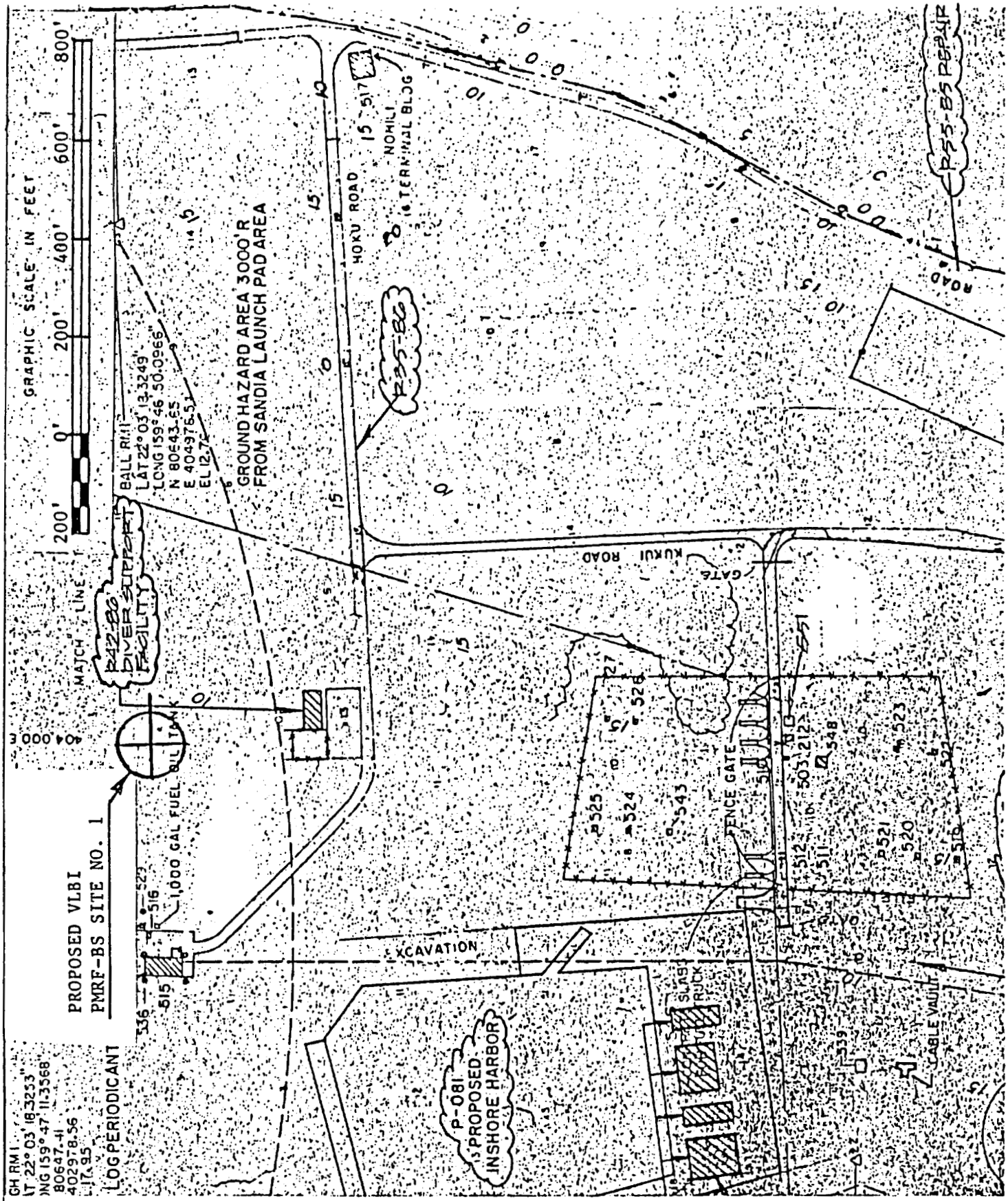


Figure 6. Detailed Site Layout of PACMISRANFAC HAWAREA at Barking Sands Site No. 1

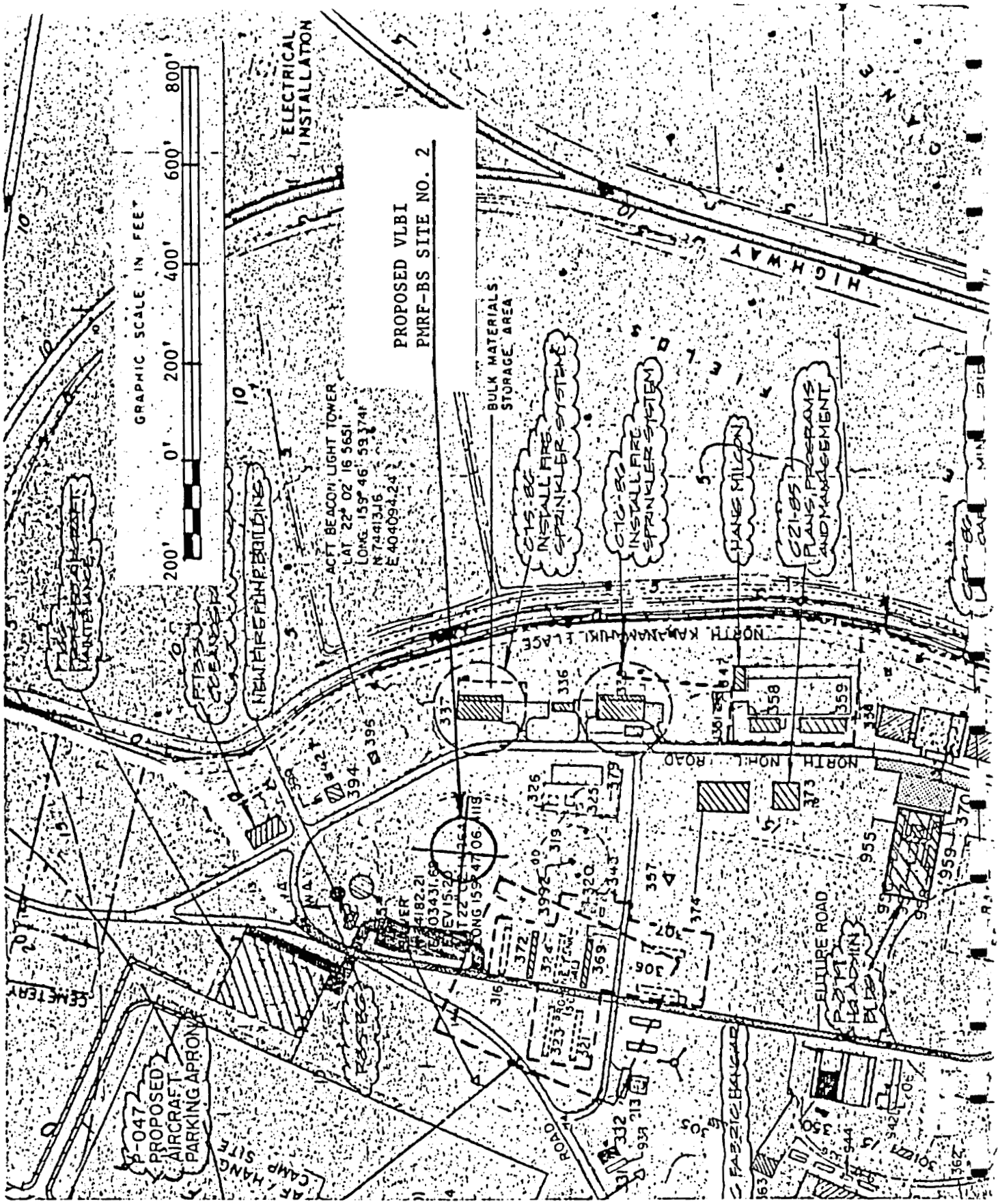


Figure 7. Detailed Site Layout of PACMISRANFAC HAWAREA at Barking Sands Site No. 2

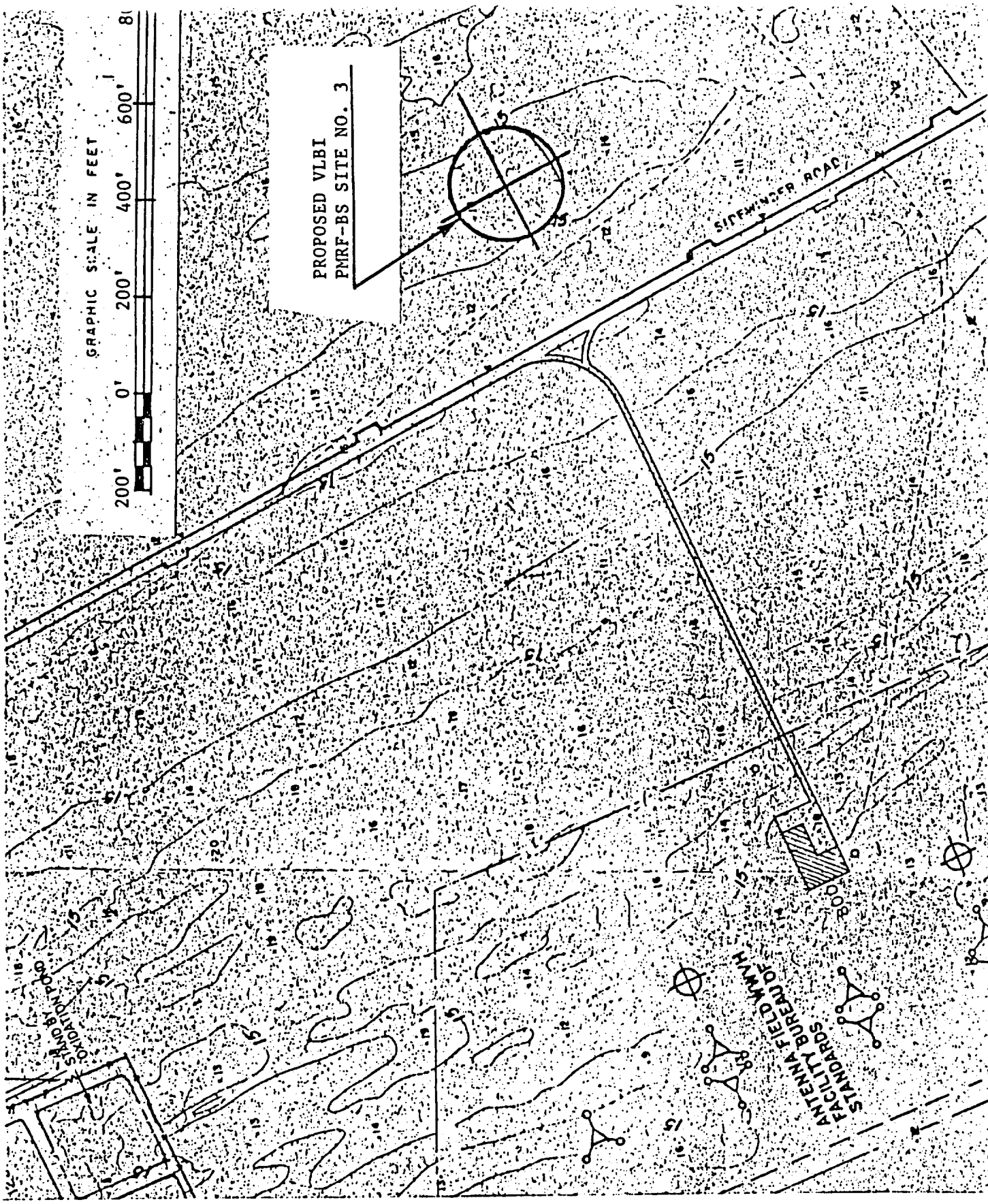


Figure 8. Detailed Site Layout of PACMISRANFAC HAWAREA at Barking Sands Site No. 3

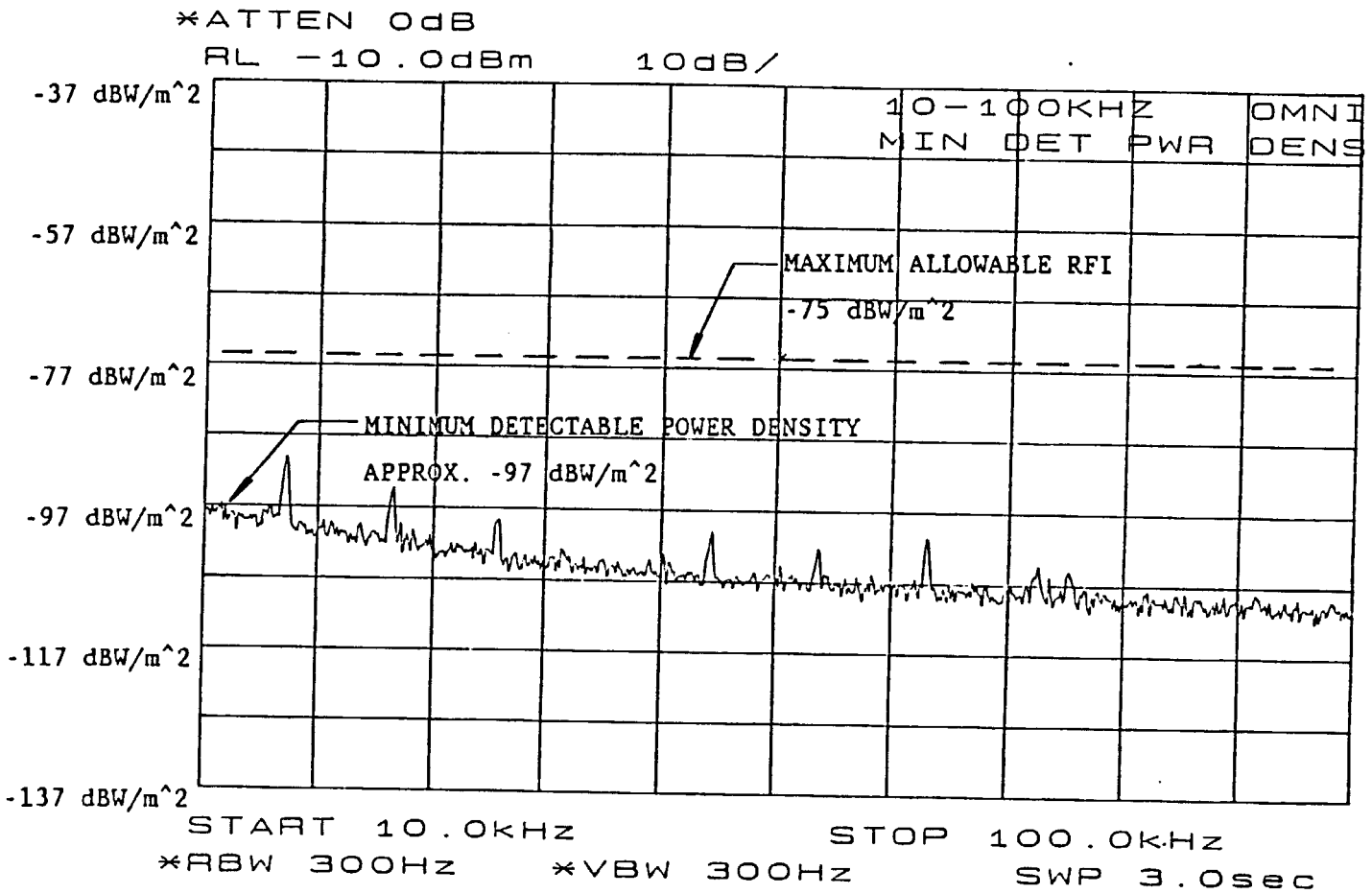


Figure 9. Minimum Detectable Power Density, 10 to 100 KHz

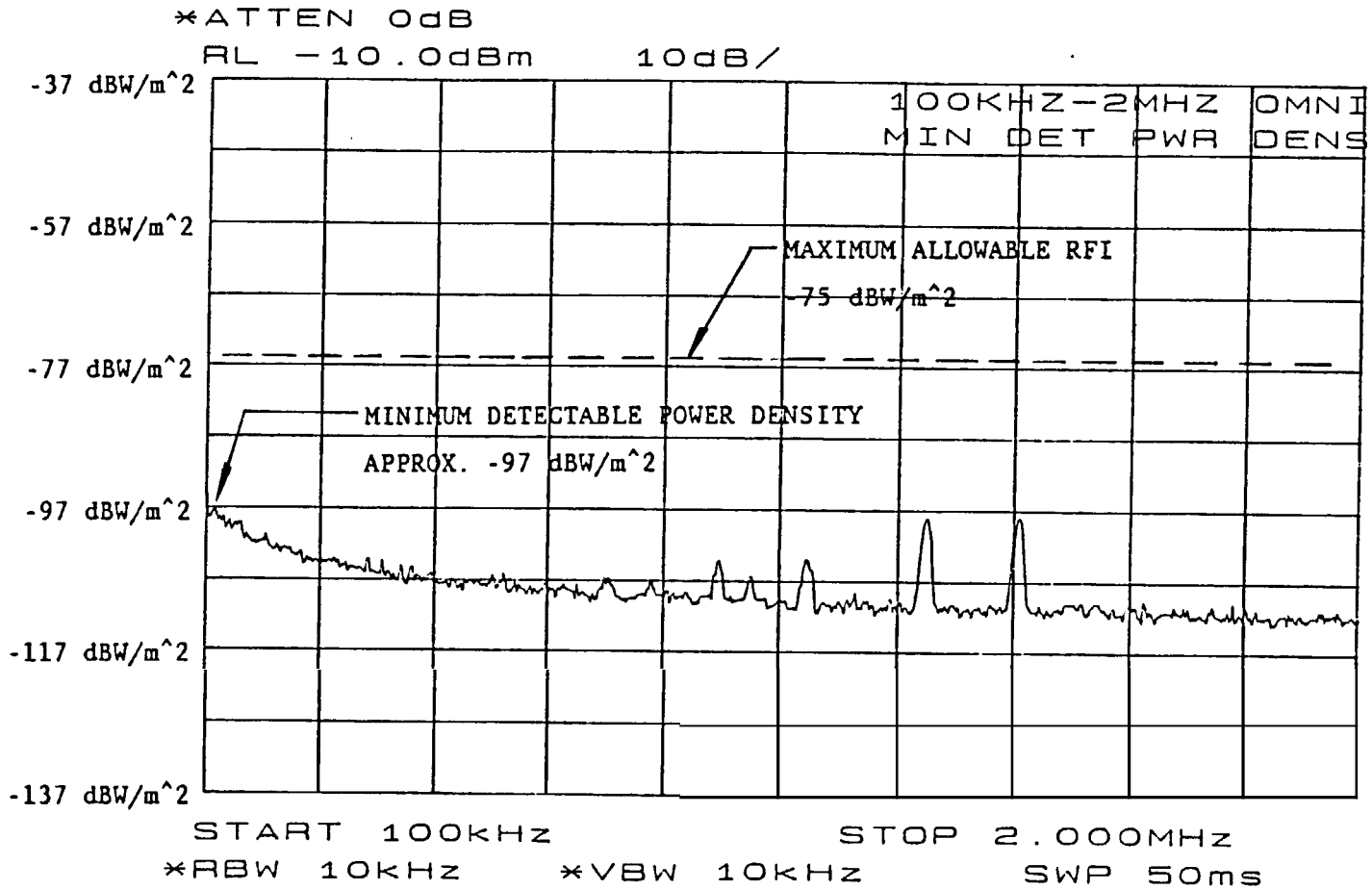


Figure 10. Minimum Detectable Power Density, 100 KHz to 2 MHz

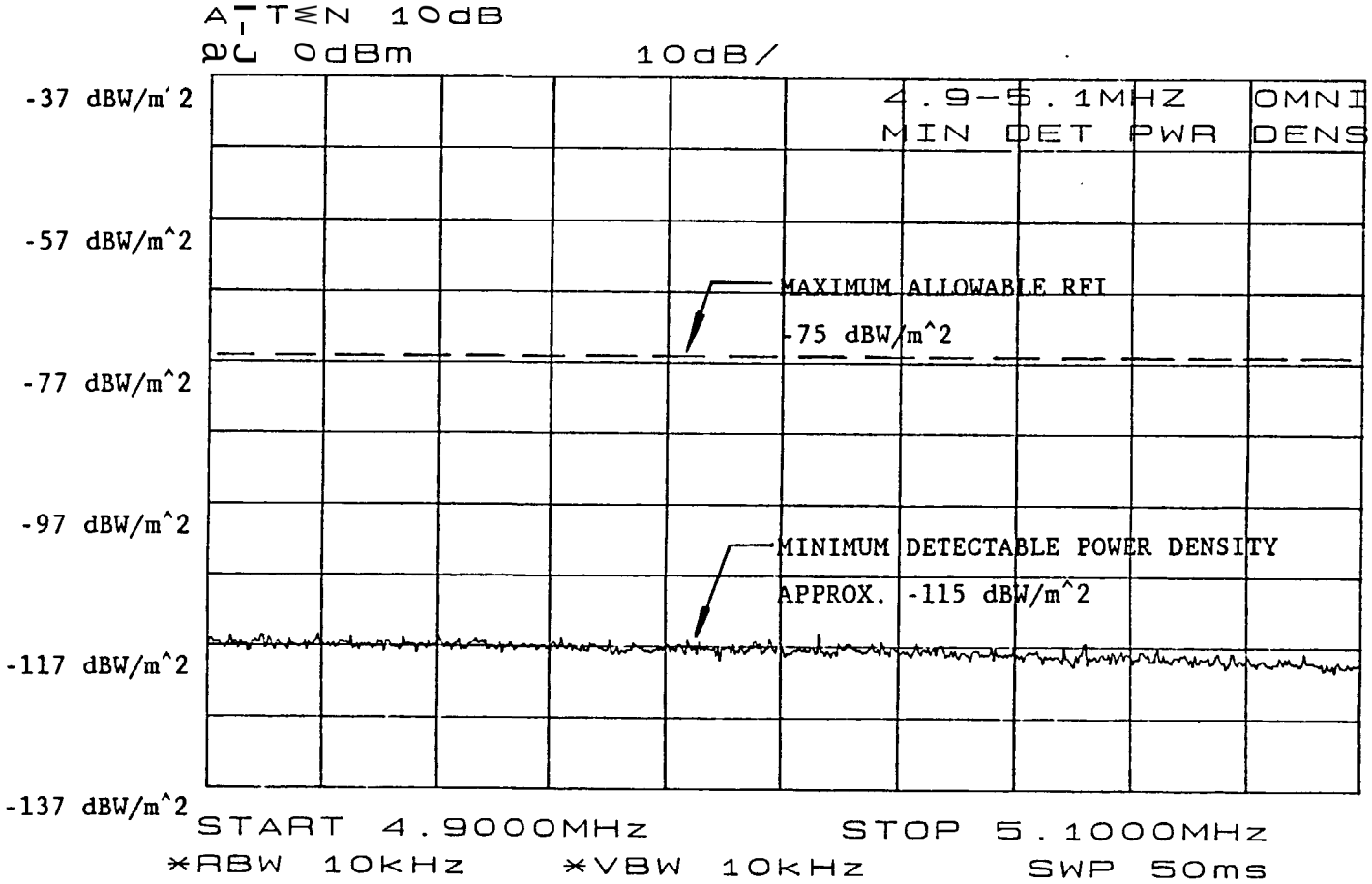


Figure 11. Minimum Detectable Power Density, 4.9 to 5.1 MHz

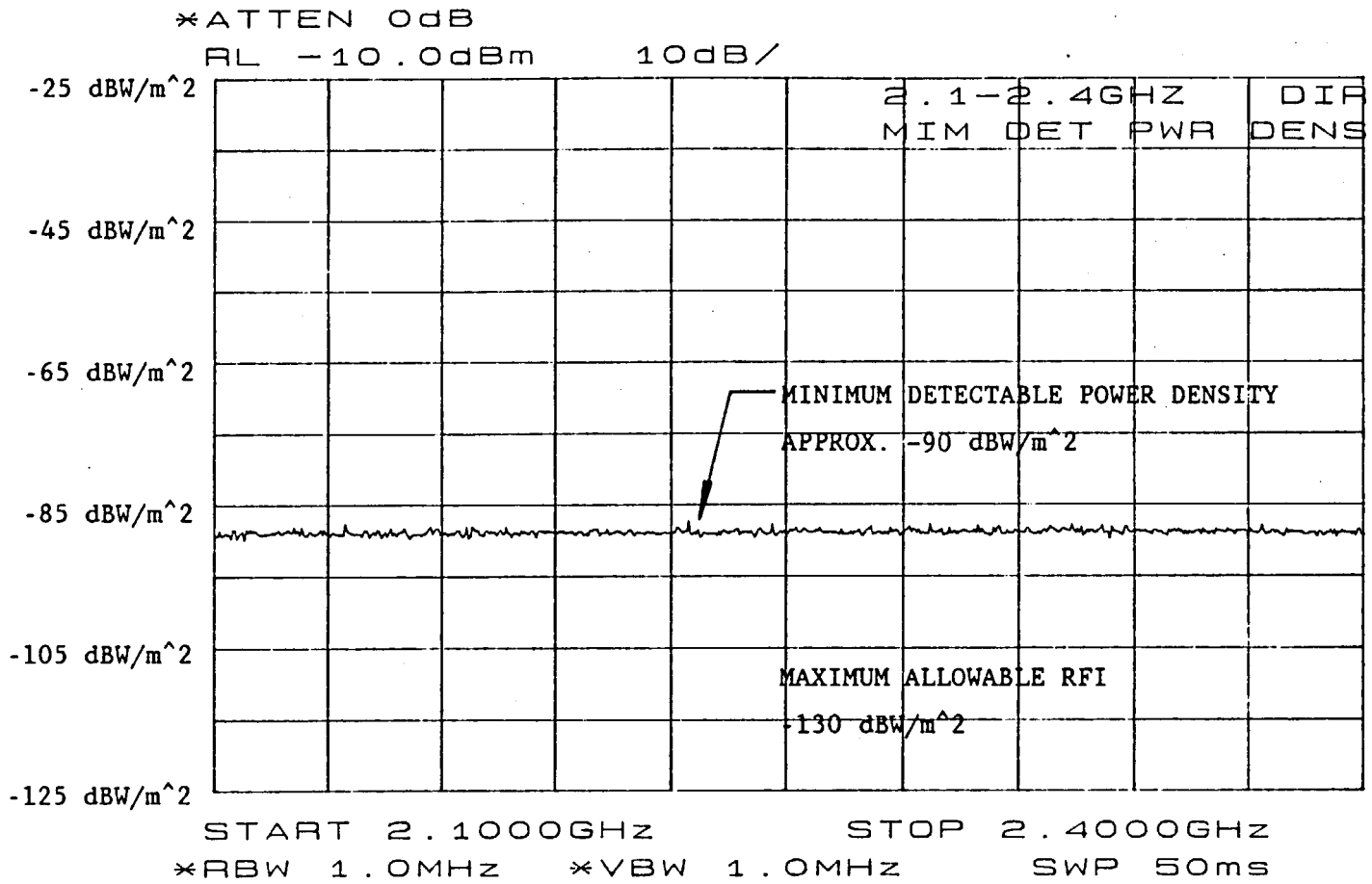


Figure 12. Minimum Detectable Power Density, 2.1 to 2.4 GHz

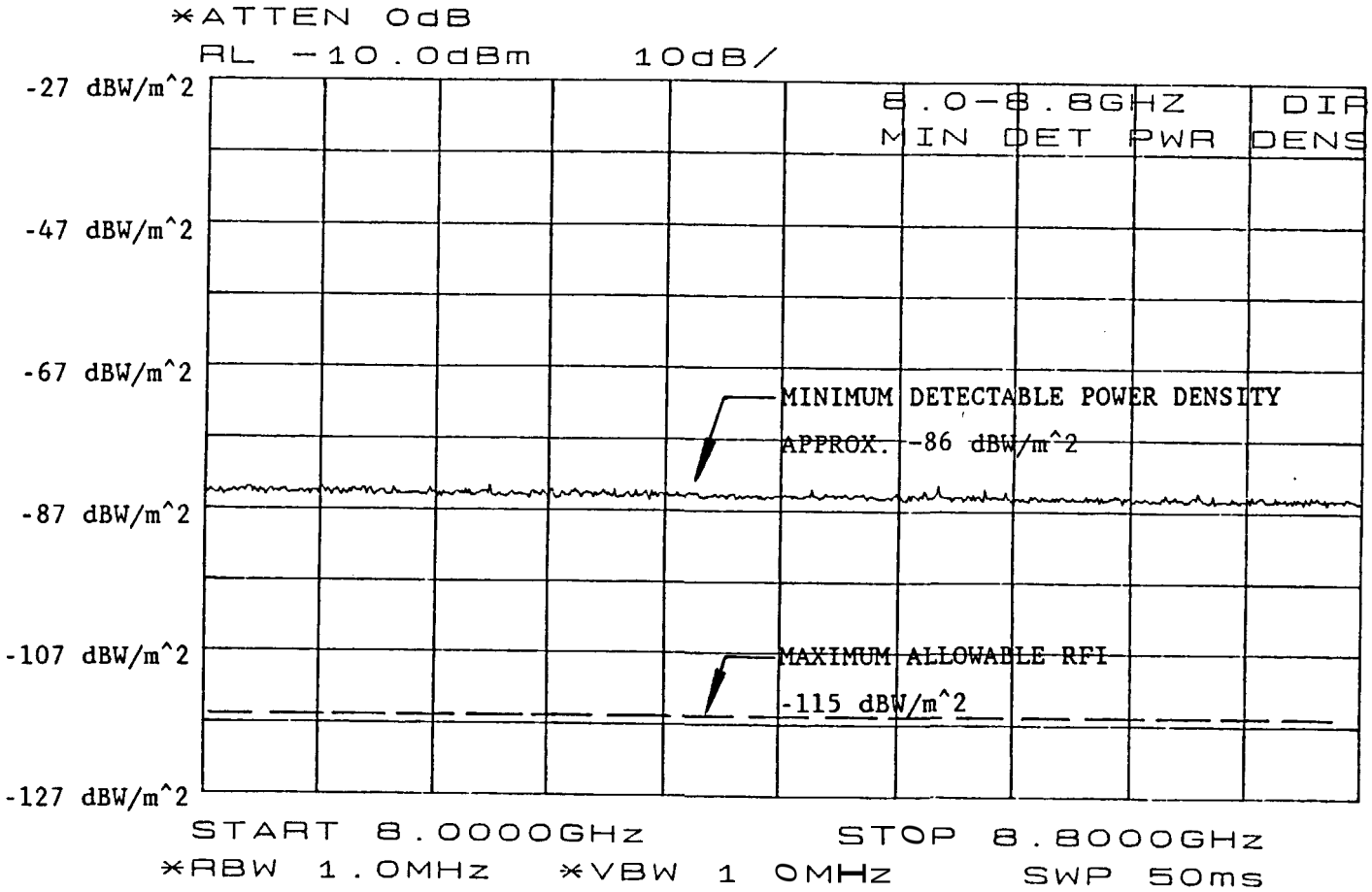


Figure 13. Minimum Detectable Power Density, 8.0 to 8.8 GHz

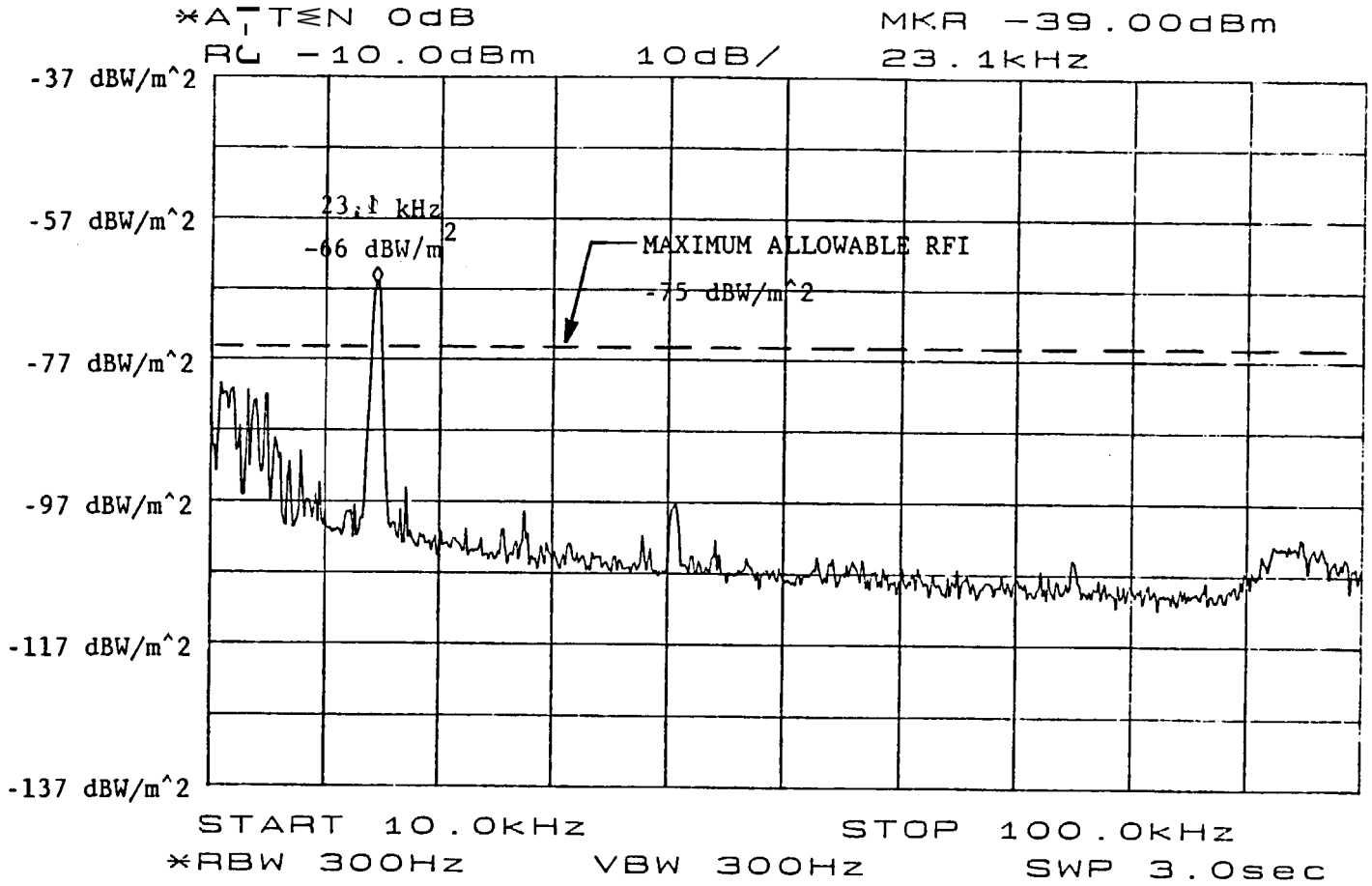


Figure 14. Spectrum Plot, 10 to 100 kHz, Omni-directional
Kokee Park Geophysical Observatory, Kauai

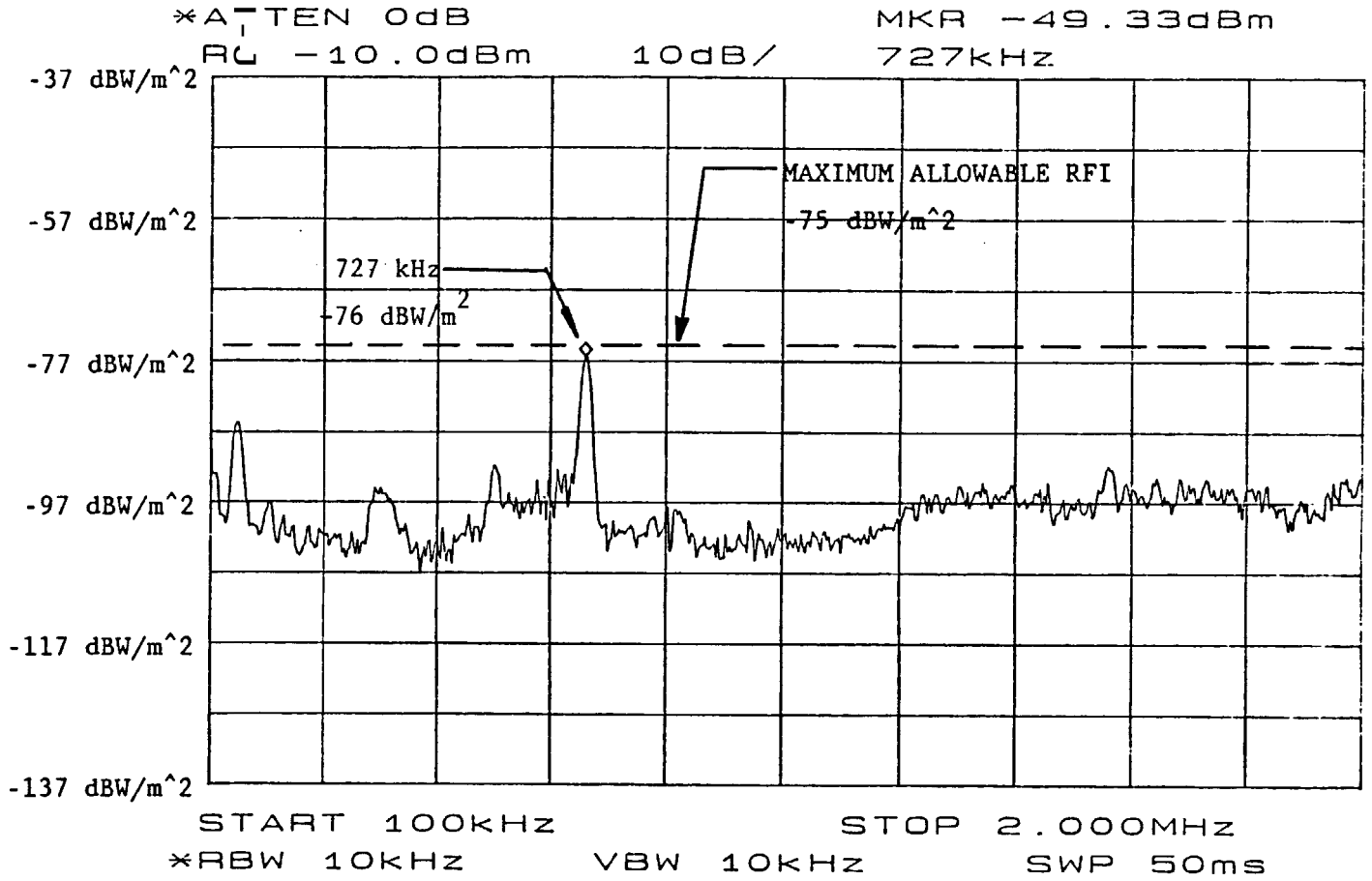


Figure 15. Spectrum Plot, 100 kHz to 2 MHz, Omni-directional
Kokee Park Geophysical Observatory, Kauai

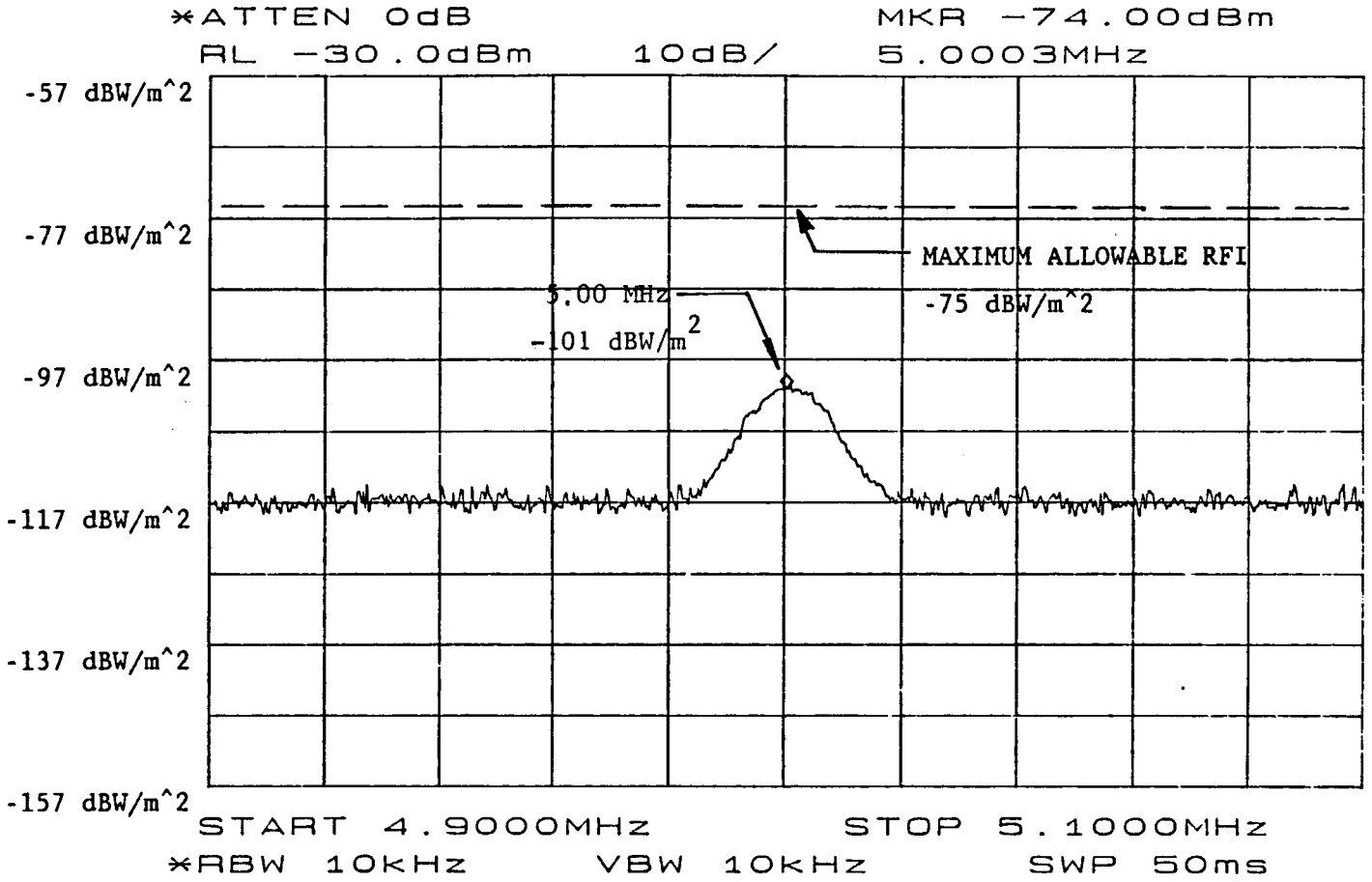


Figure 16. Spectrum Plot, 4.9 to 5.1 MHz, Omni-directional
Kokee Park Geophysical Observatory, Kauai

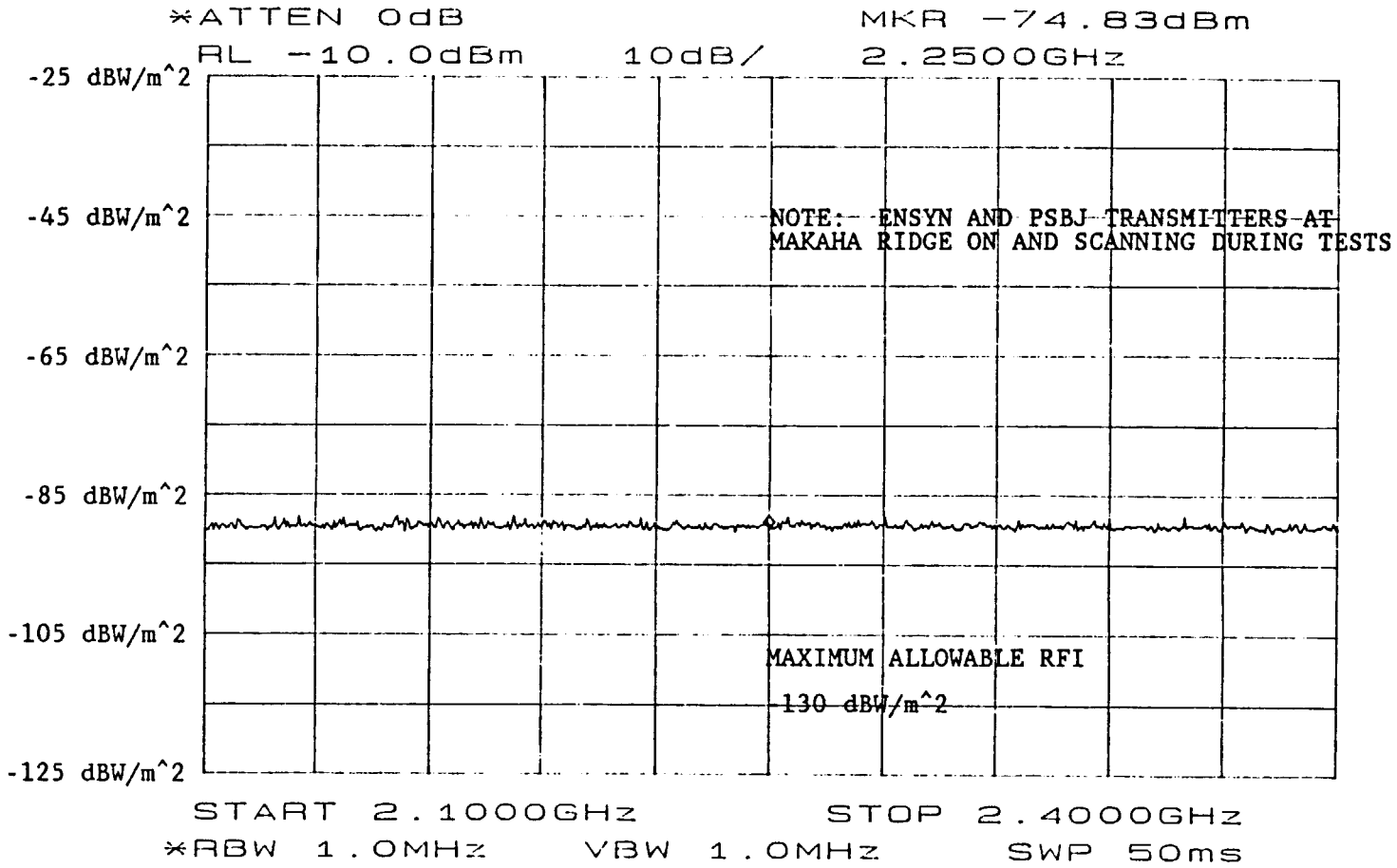


Figure 17. Spectrum Plot, 2.1 to 2.4 GHz, Vertically and Horizontally Polarized, Antenna Rotated 360 Degrees for Full Horizontal Scan. Kokee Park Geophysical Observatory, Kauai

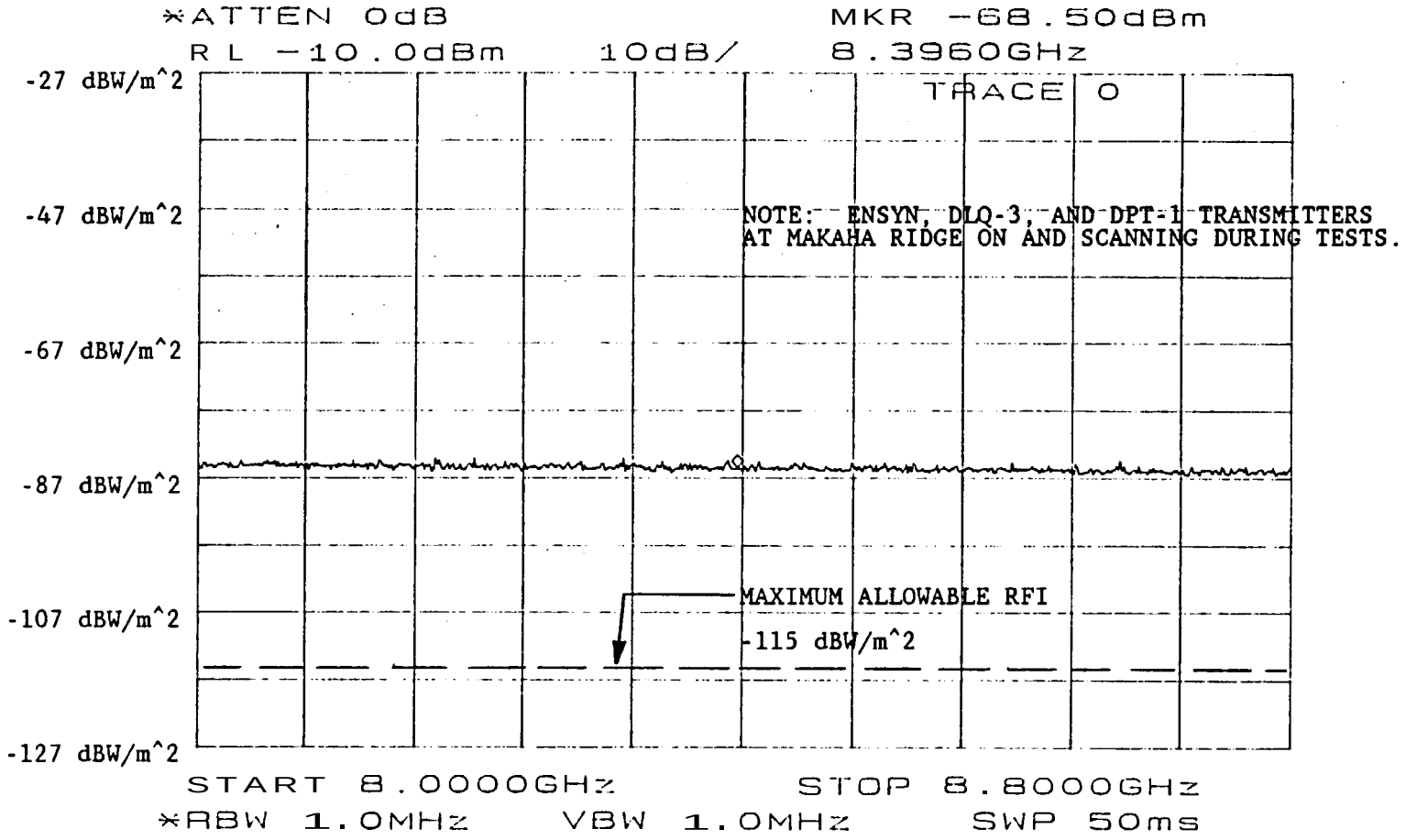


Figure 18. Spectrum Plot, 8.0 to 8.8 GHz, Vertically and Horizontally Polarized, Antenna Rotated 360 Degrees for Full Horizontal Scan. Kokee Park Geophysical Observatory, Kauai

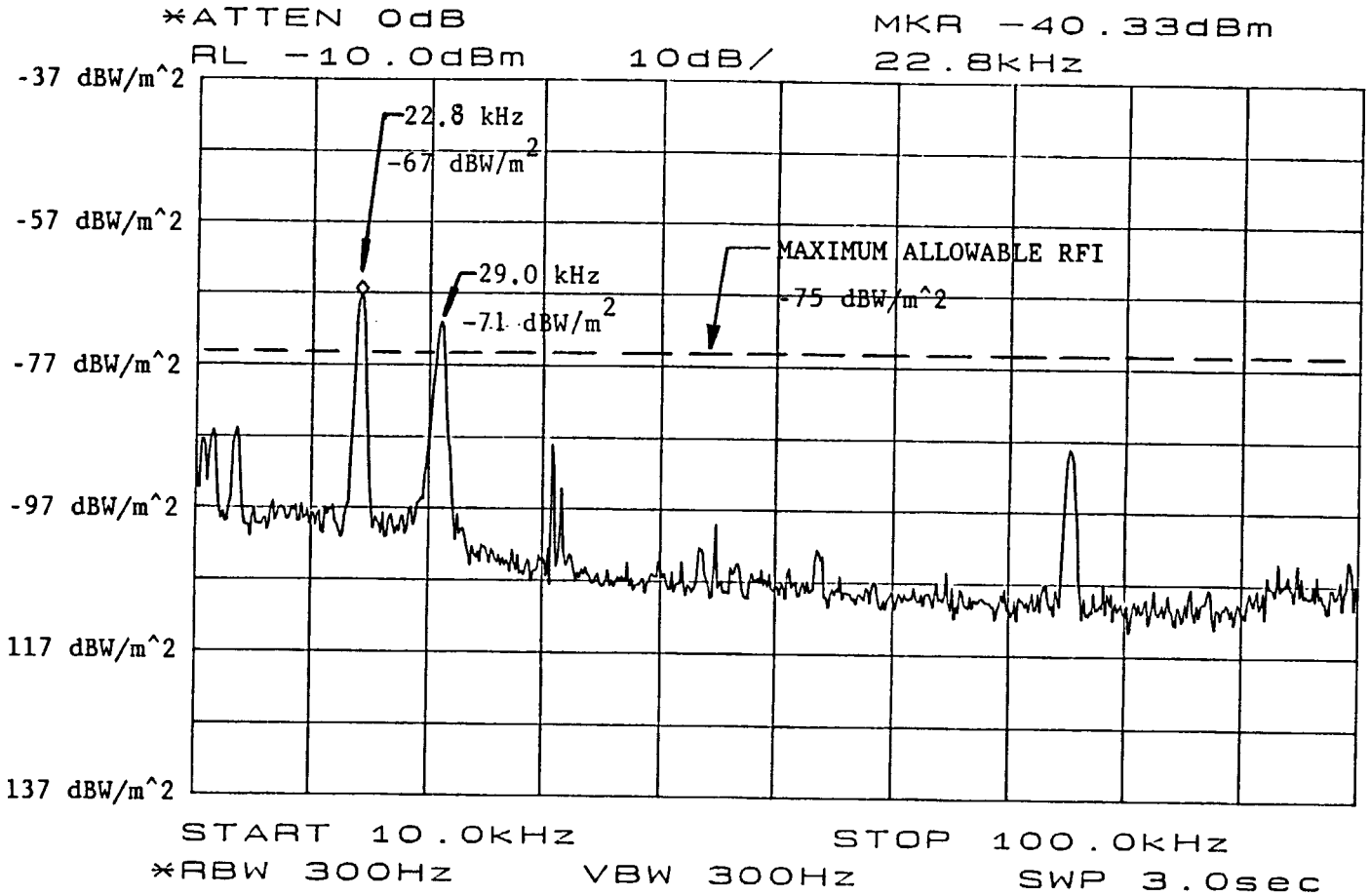


Figure 19. Spectrum Plot, 10 to 100 kHz, Omni-directional
Site No. 1, 70 Feet Due North of the Diver Support Facility,
PACMISRANFAC HAWAREA at Barking Sands, Kauai

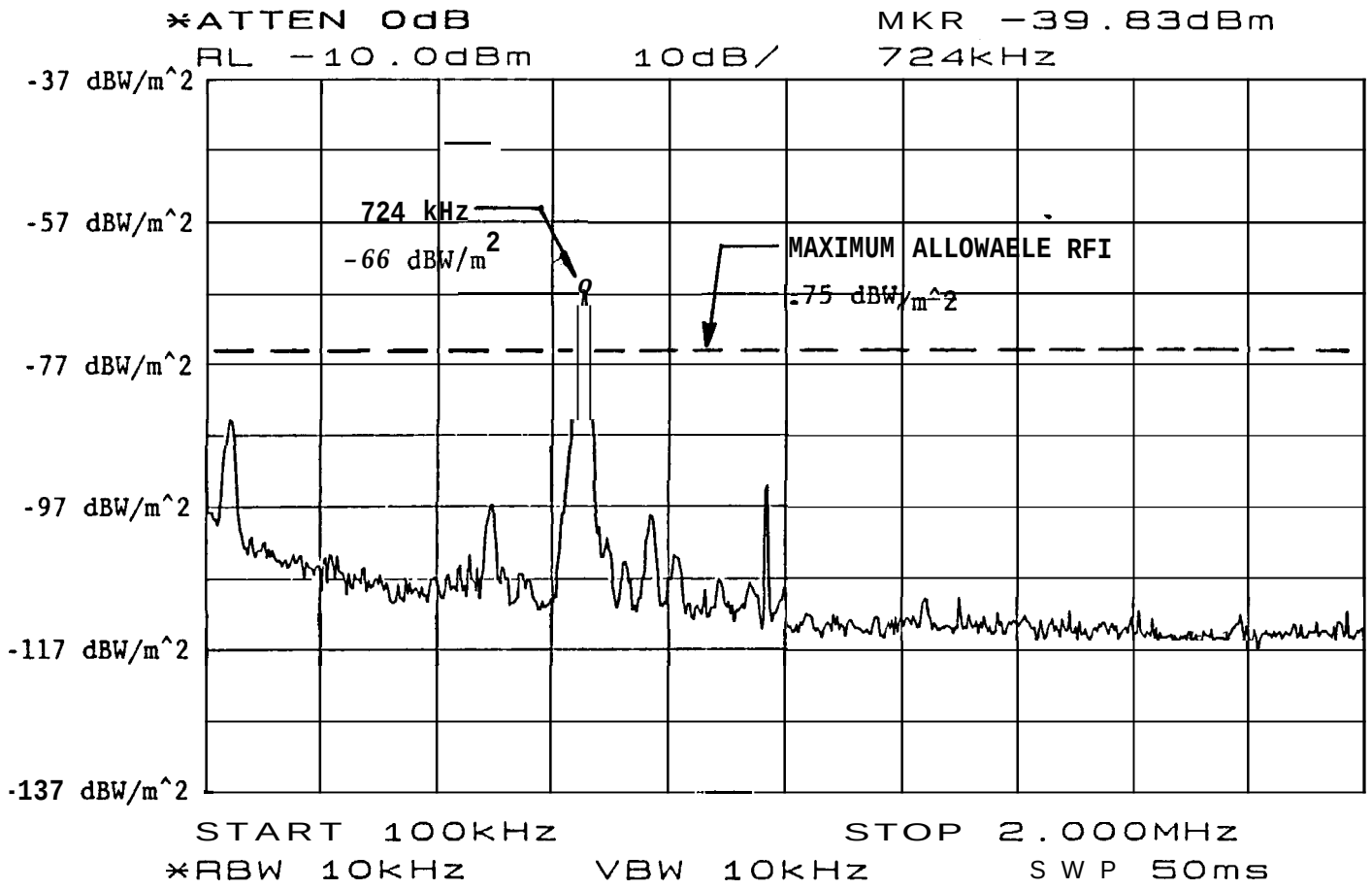


Figure 20. Spectrum Plot, 100 kHz to 2 MHz, Omni-directional Site No. 1, 70 Feet Due North of the Diver Support Facility, PACMISRANFAC HAWAREA at Barking Sands, Kauai

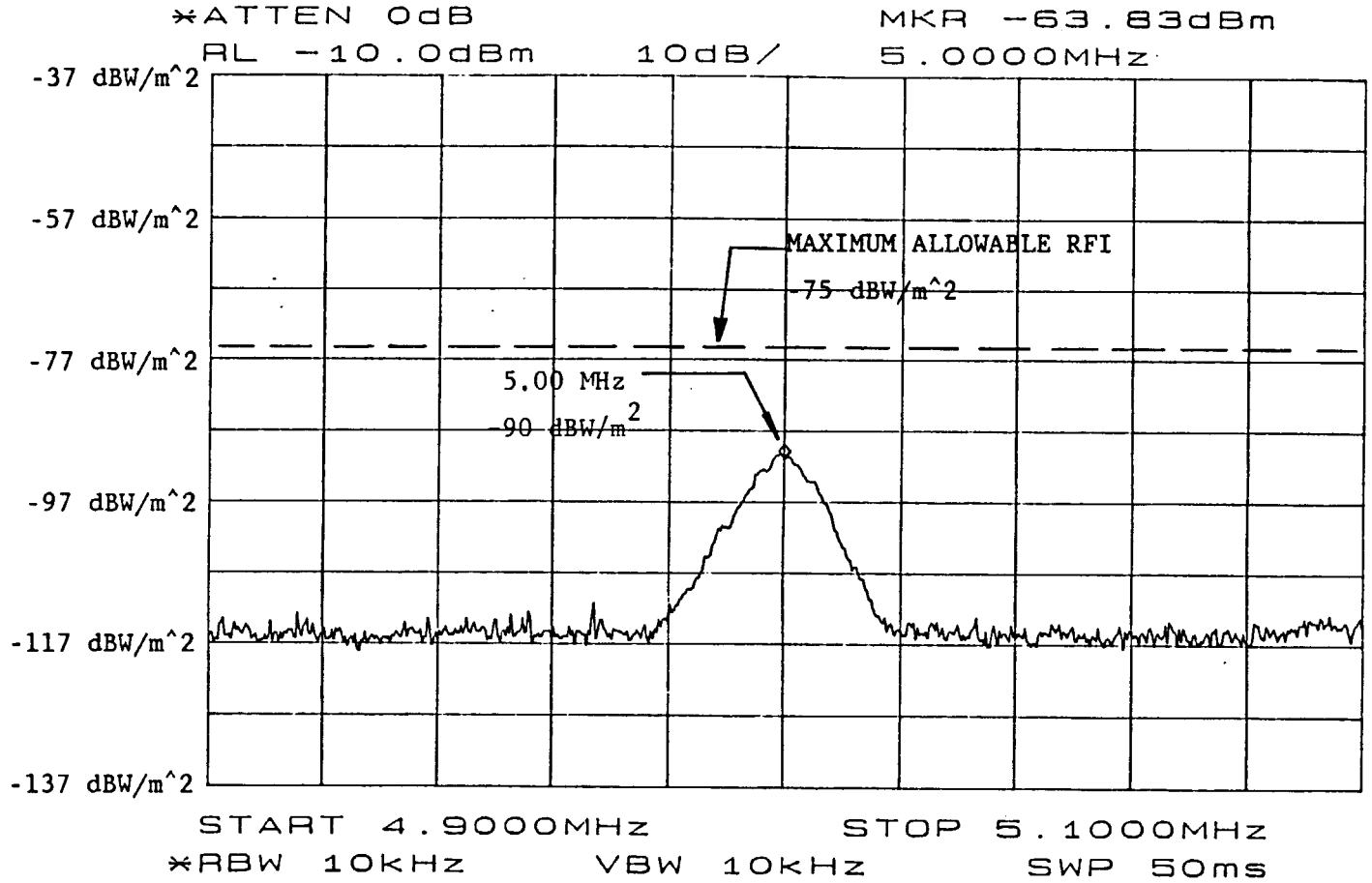


Figure 21. Spectrum Plot, 4.9 to 5.1 MHz, Omni-directional
Site No. 1, 70 Feet Due North of the Diver Support Facility
PACMISRANFAC HAWAREA at Barking Sands, Kauai

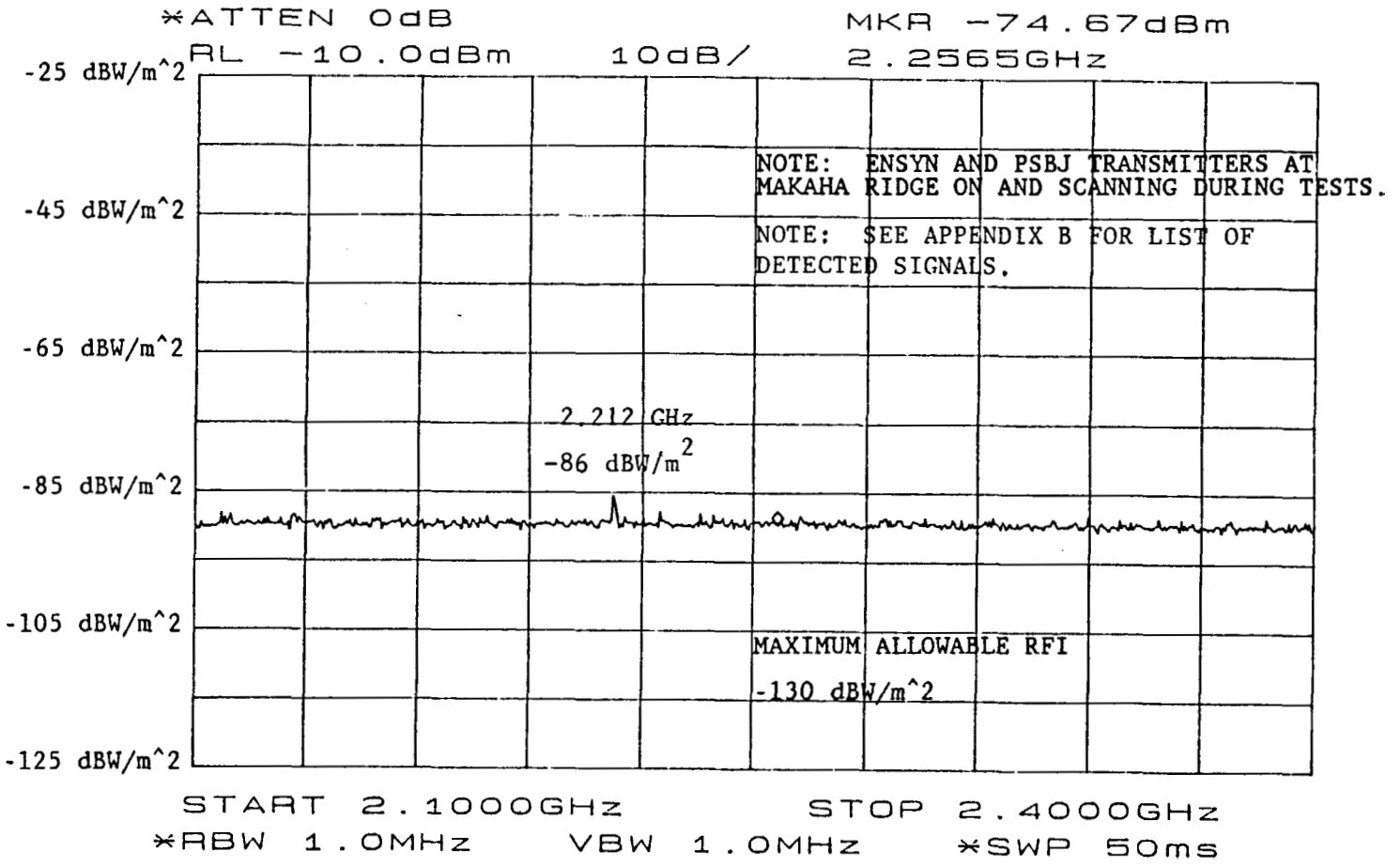


Figure 22. Spectrum Plot, 2.1 to 2.4 GHz, Vertically Polarized, Antenna Rotated 360 Degrees for Full Horizontal Scan. Site No. 1, 70 Feet Due North of the Diver Support Facility,

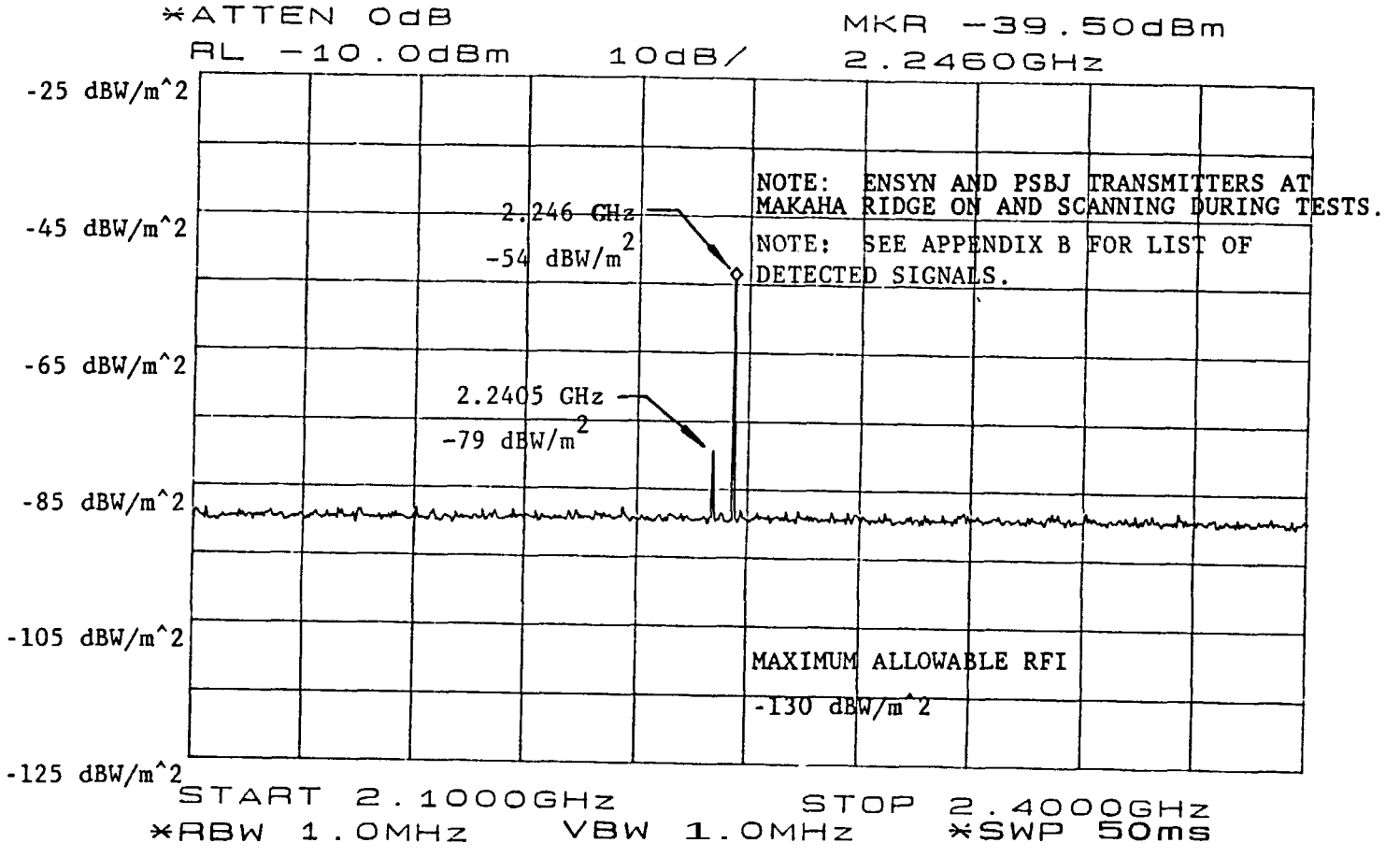


Figure 23. Spectrum Plot, 2.1 to 2.4 GHz, Horizontally Polarized, Antenna Rotated 360 Degrees for Full Horizontal Scan. Site No. 1, 70 Feet Due North of the Diver Support Facility,

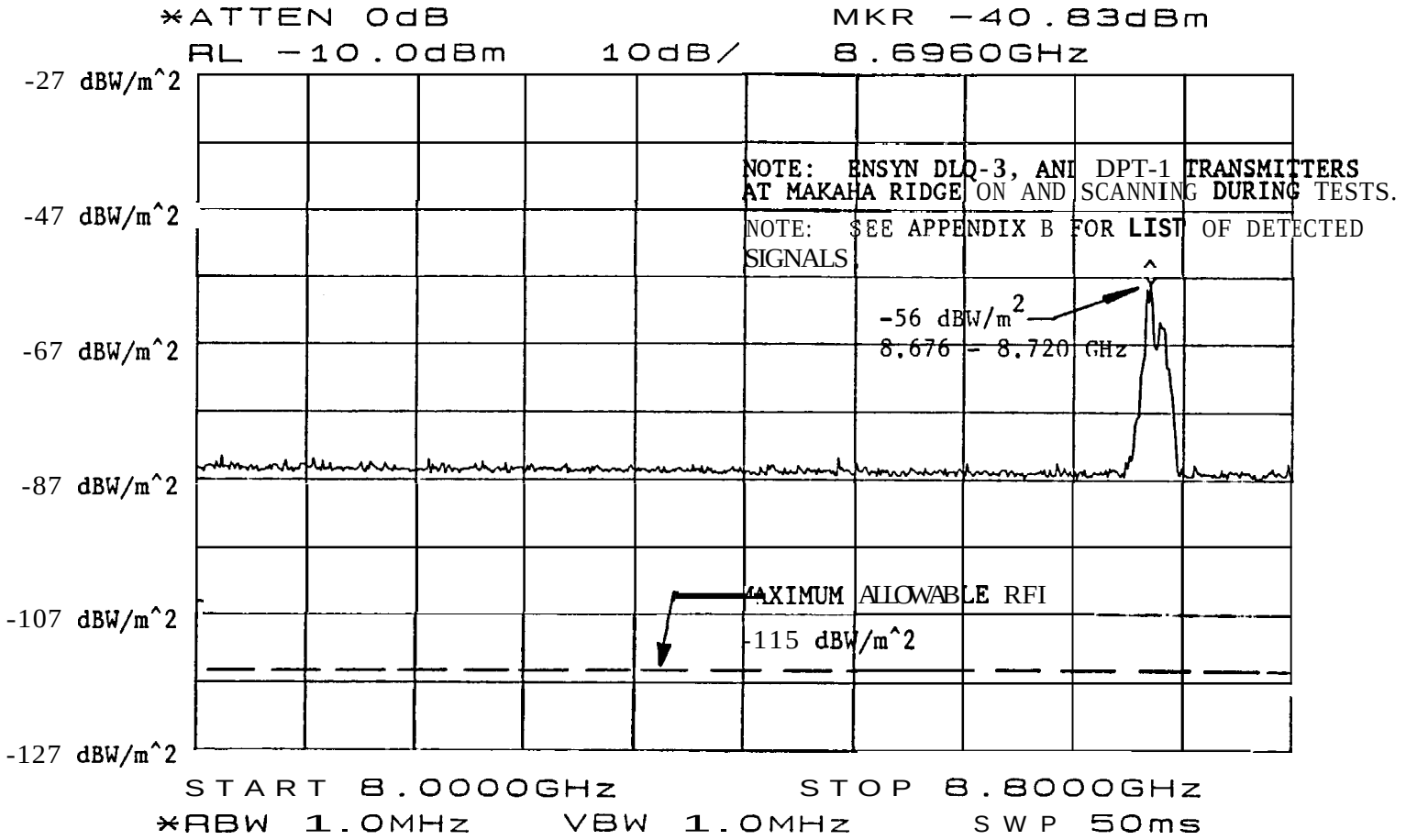


Figure 24. Spectrum Plot, 8.0 to 8.8 GHz, Vertically Polarized, Antenna Rotated 360 Degrees for Full Horizontal Scan. Site No. 1, 70 Feet Due North of the Diver Support Facility, PACMISRANFAC HAWAREA at Barking Sands, Kauai

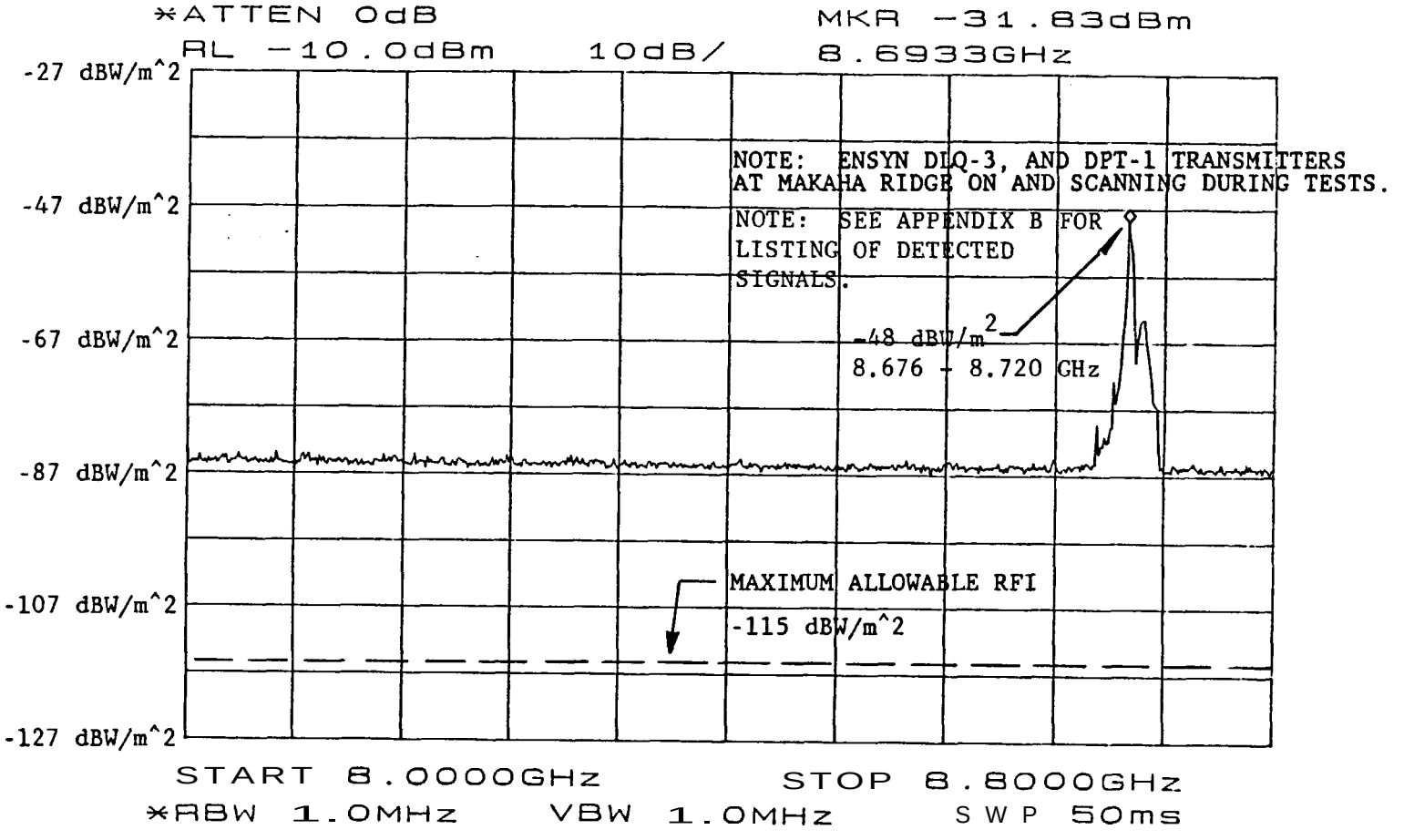


Figure 25. Spectrum Plot, 8.0 to 8.8 GHz, Horizontally Polarized, Antenna Rotated 360 Degrees for Full Horizontal Scan. Site No. 1, 70 Feet Due North of the Diver Support Facility, PACMISRANFAC HAWAREA at Barking Sands, Kauai

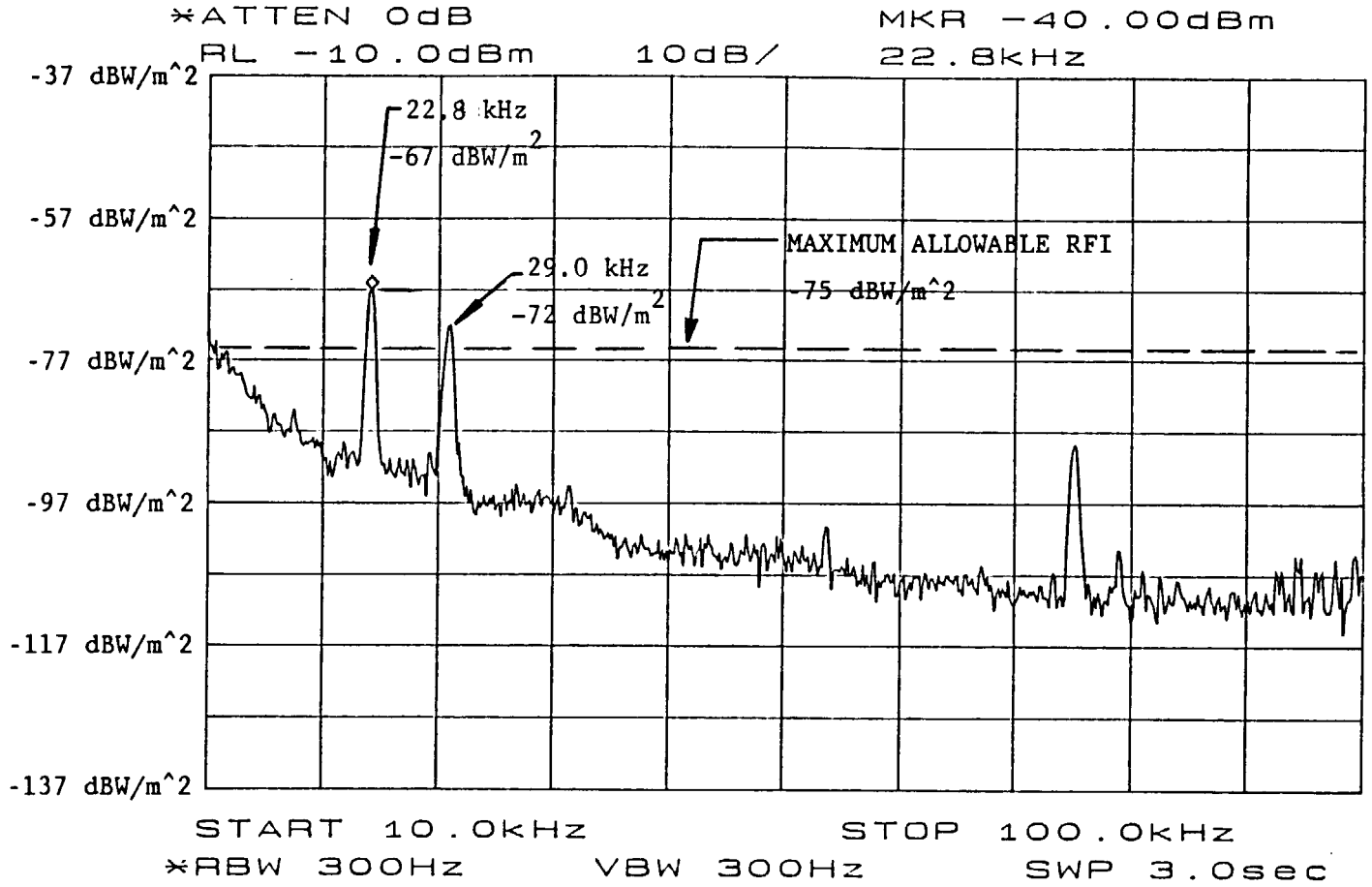


Figure 26 Spectrum Plot, 10 to 100 kHz, Omni-directional
Site No. 2, 200 Feet Due North of Bldg 3992,
PACMISRANFAC HAWAREA at Barking Sands, Kauai

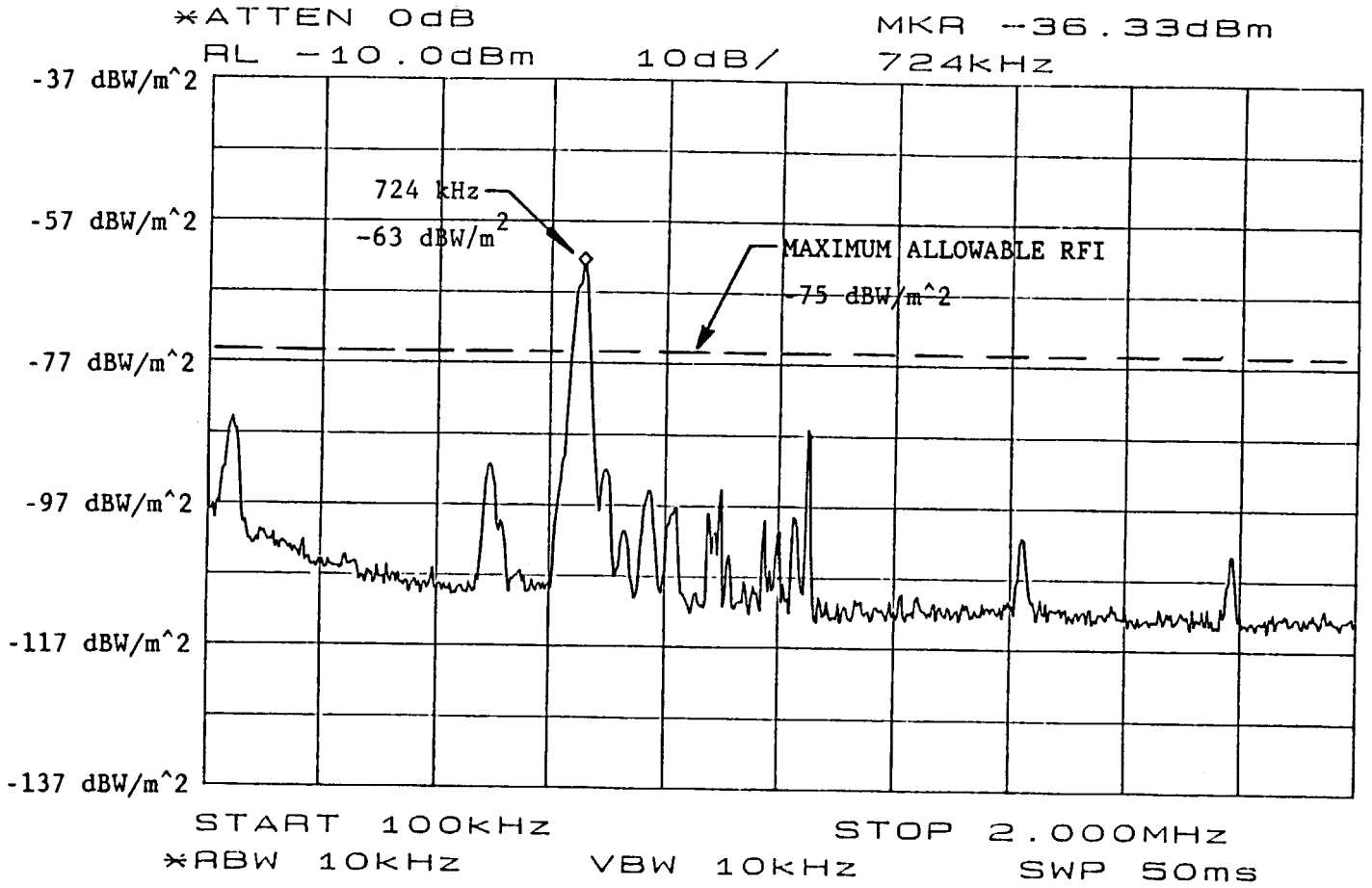


Figure 27 Spectrum Plot, 100 kHz to 2 MHz, Omni-directional Site No. 2, 200 Feet Due North of Bldg 3992, PACMISRANFAC HAWAREA at Barking Sands, Kauai

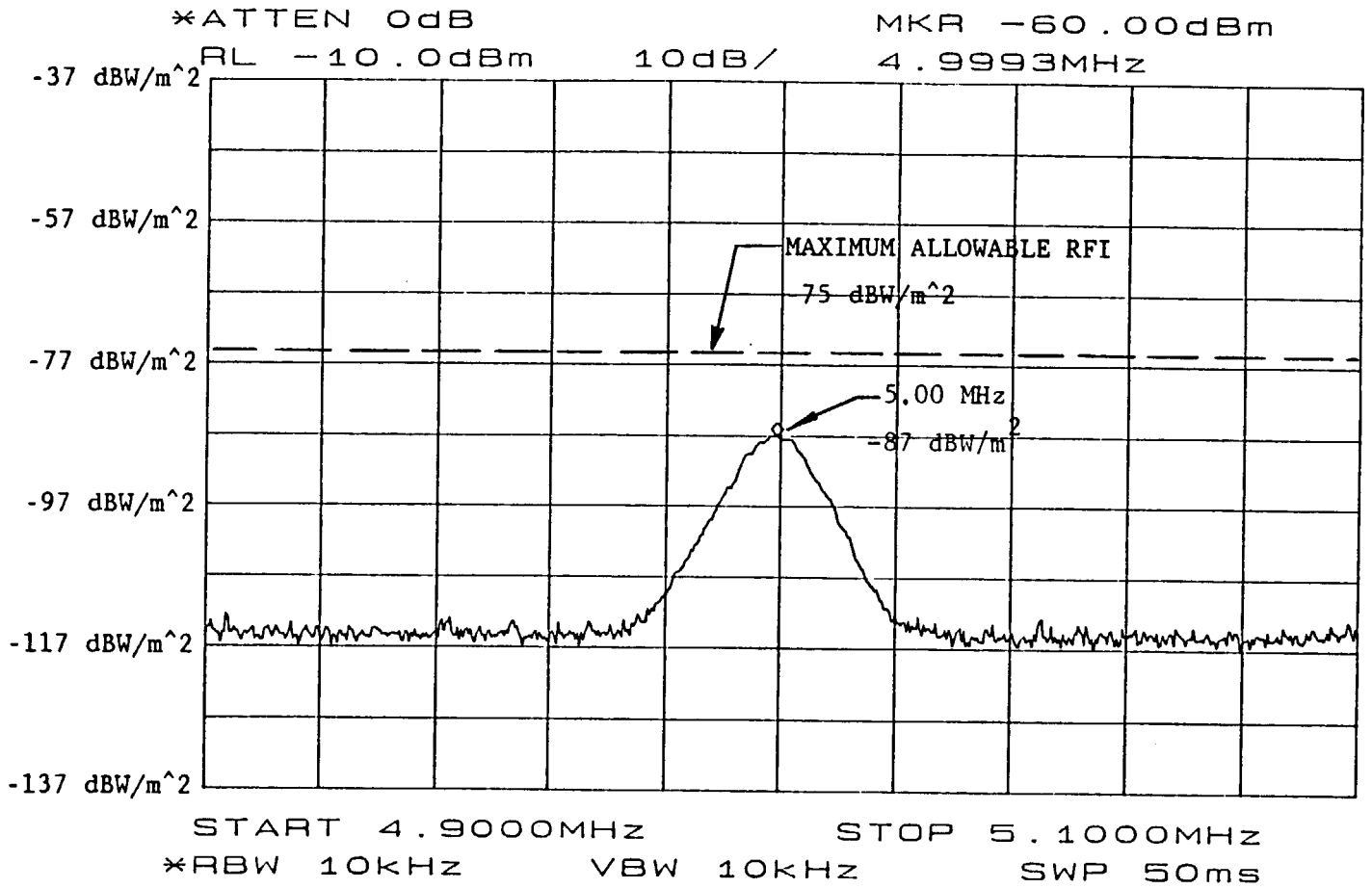


Figure 28. Spectrum Plot, 4.9 to 5.1 MHz, Omni-directional Site No. 2, 200 Feet Due North of Bldg 3992, PACMISRANFAC HAWAREA at Barking Sands, Kauai

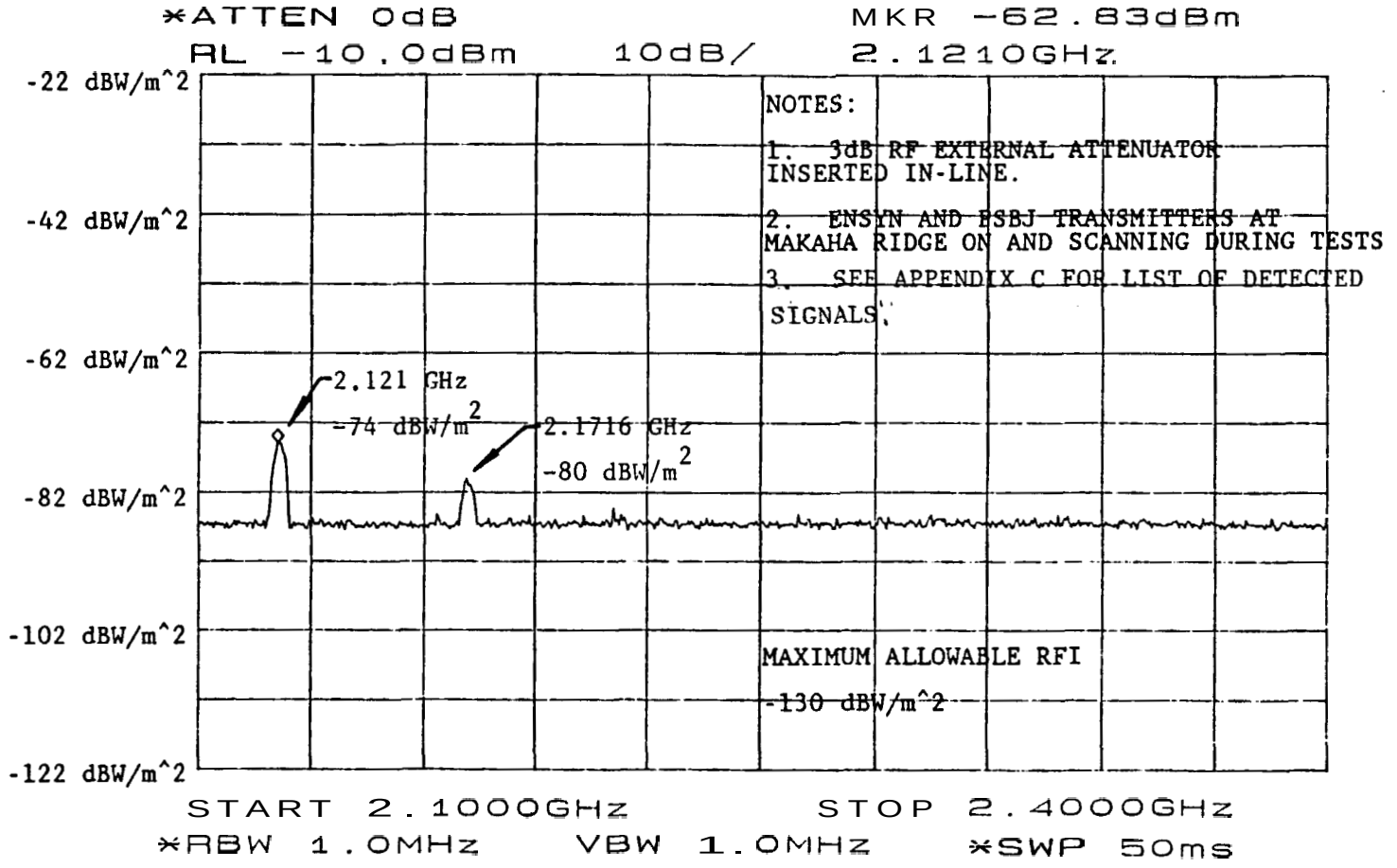


Figure 29. Spectrum Plot, 2.1 to 2.4 GHz, Vertically Polarized, Antenna Rotated 360 Degrees for Full Horizontal Scan. Site No. 2, 200 Feet Due North of Bldg 3992, PACMISRANFAC HAWAREA at Barkings Sand, Kauai

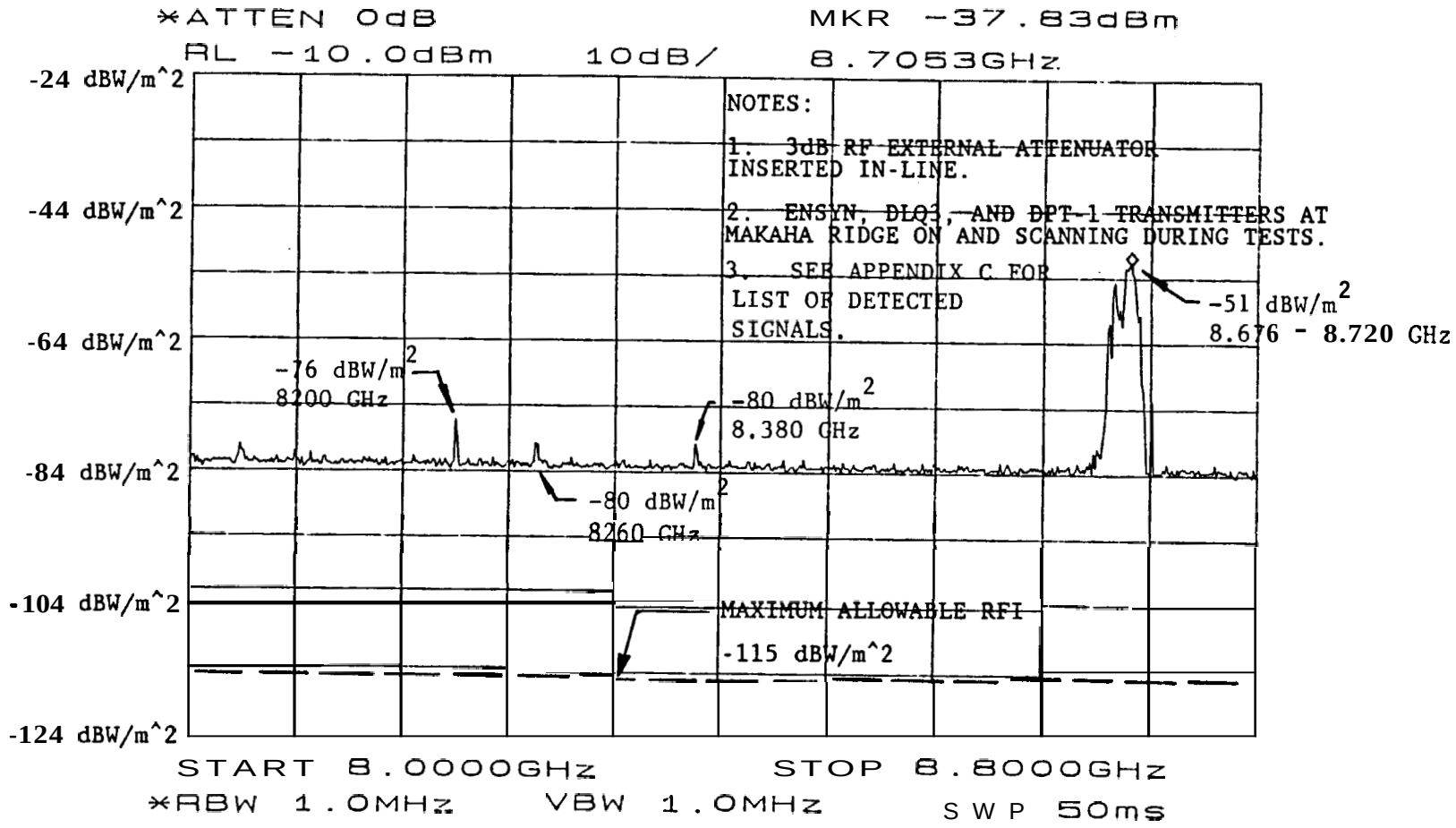


Figure 30. Spectrum Plot, 8.0 to 8.8 GHz, Vertically Polarized, Antenna Rotated 360 Degrees for Full Horizontal Scan. Site No. 2, 200 Feet Due North of Bldg 3992, PACMISRANFAC HAWAREA at Barkings Sand, Kauai

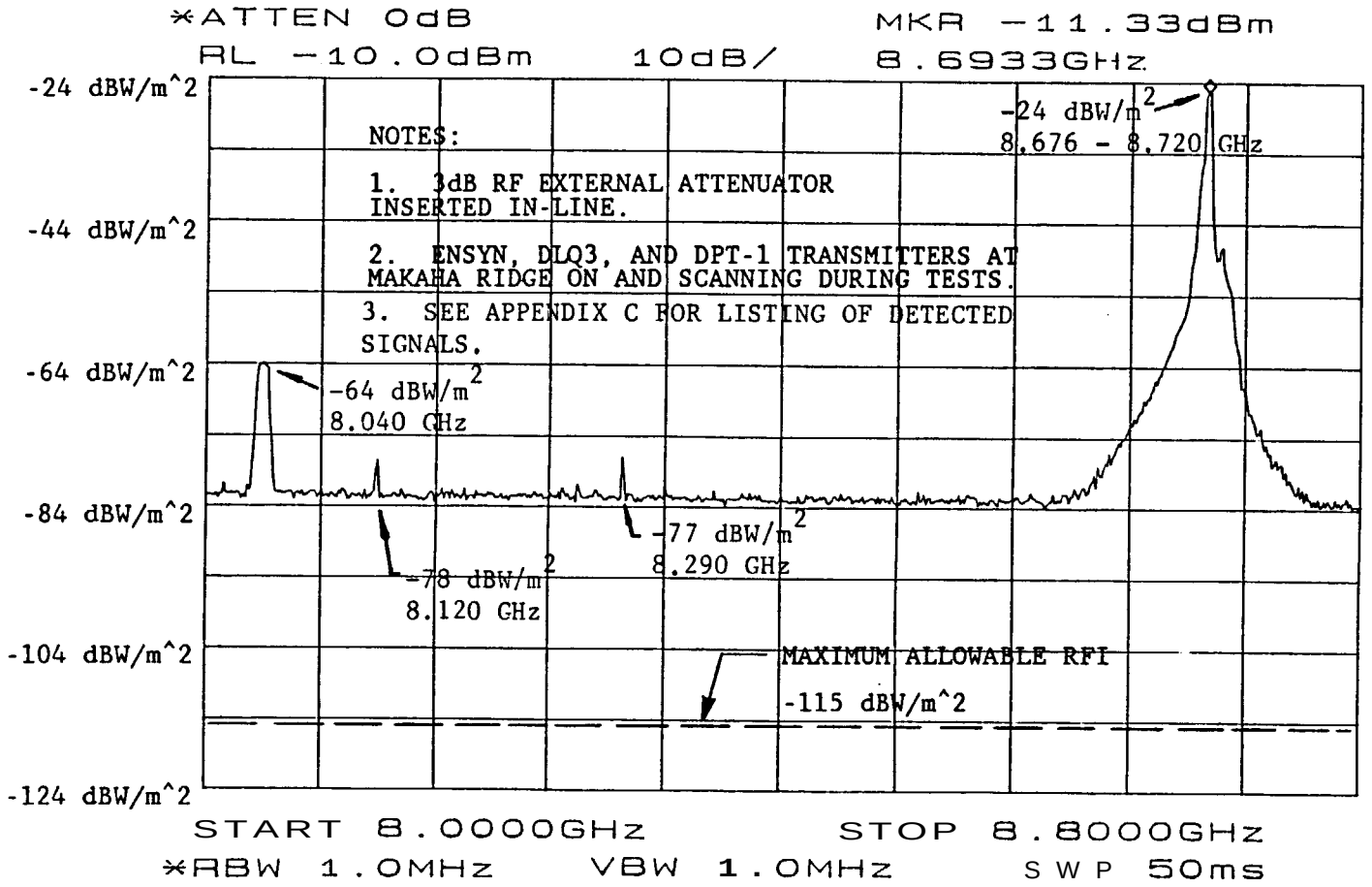


Figure 31. Spectrum Plot, 8.0 to 8.8 GHz, Horizontally Polarized, Antenna Rotated 360 Degrees for Full Horizontal Scan. Site No. 2, 200 Feet Due North of Bldg 3992, PACMISRANFAC HAWAREA at Barkings Sand, Kauai

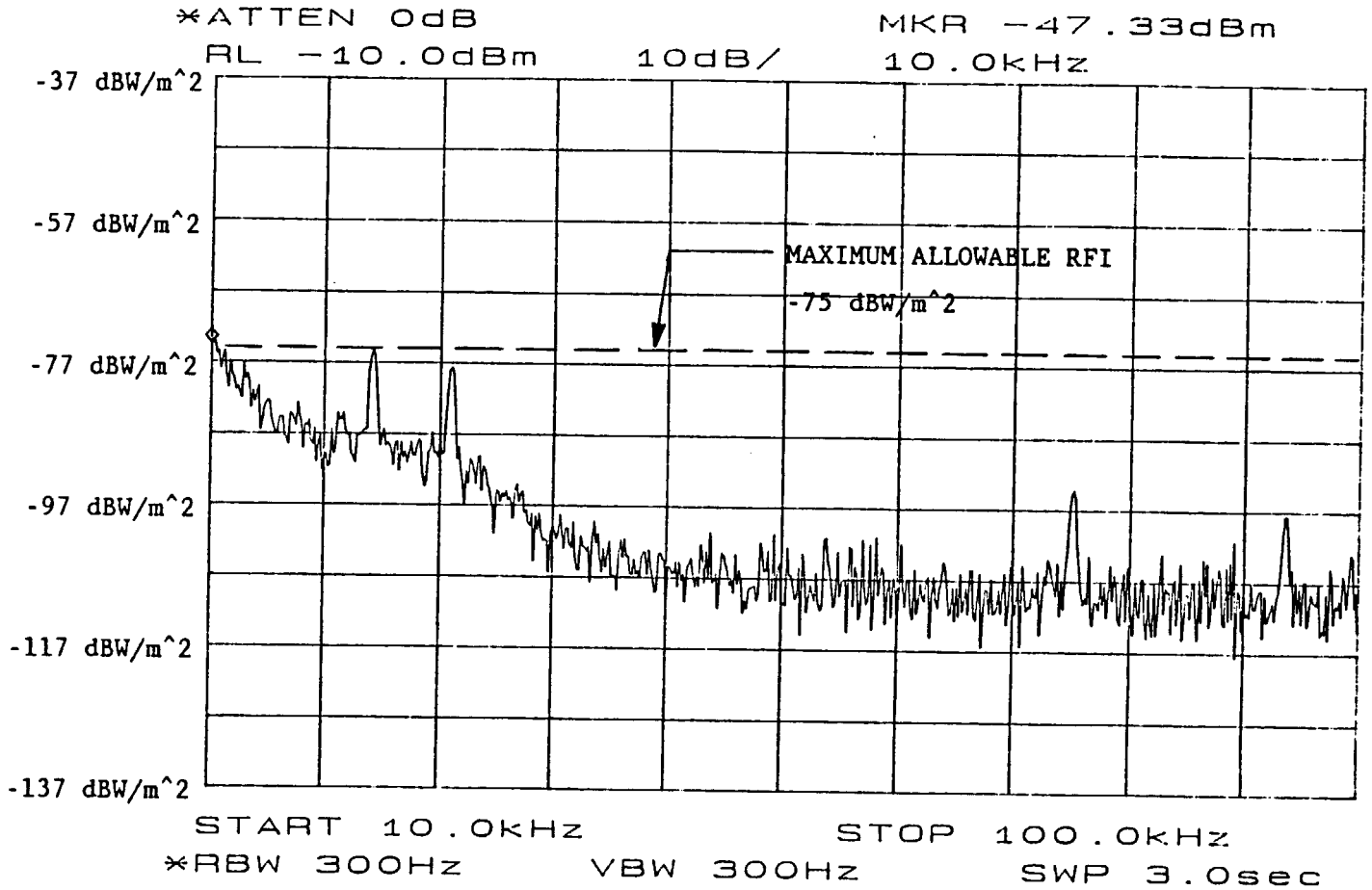


Figure 32. Spectrum Plot, 10 to 100 kHz, Omni-directional Site No. 3, Along Sidewinder Road Directly Across the Access Road for WWVH, PACMISRANFAC HAWAREA at Barking Sands, Kauai

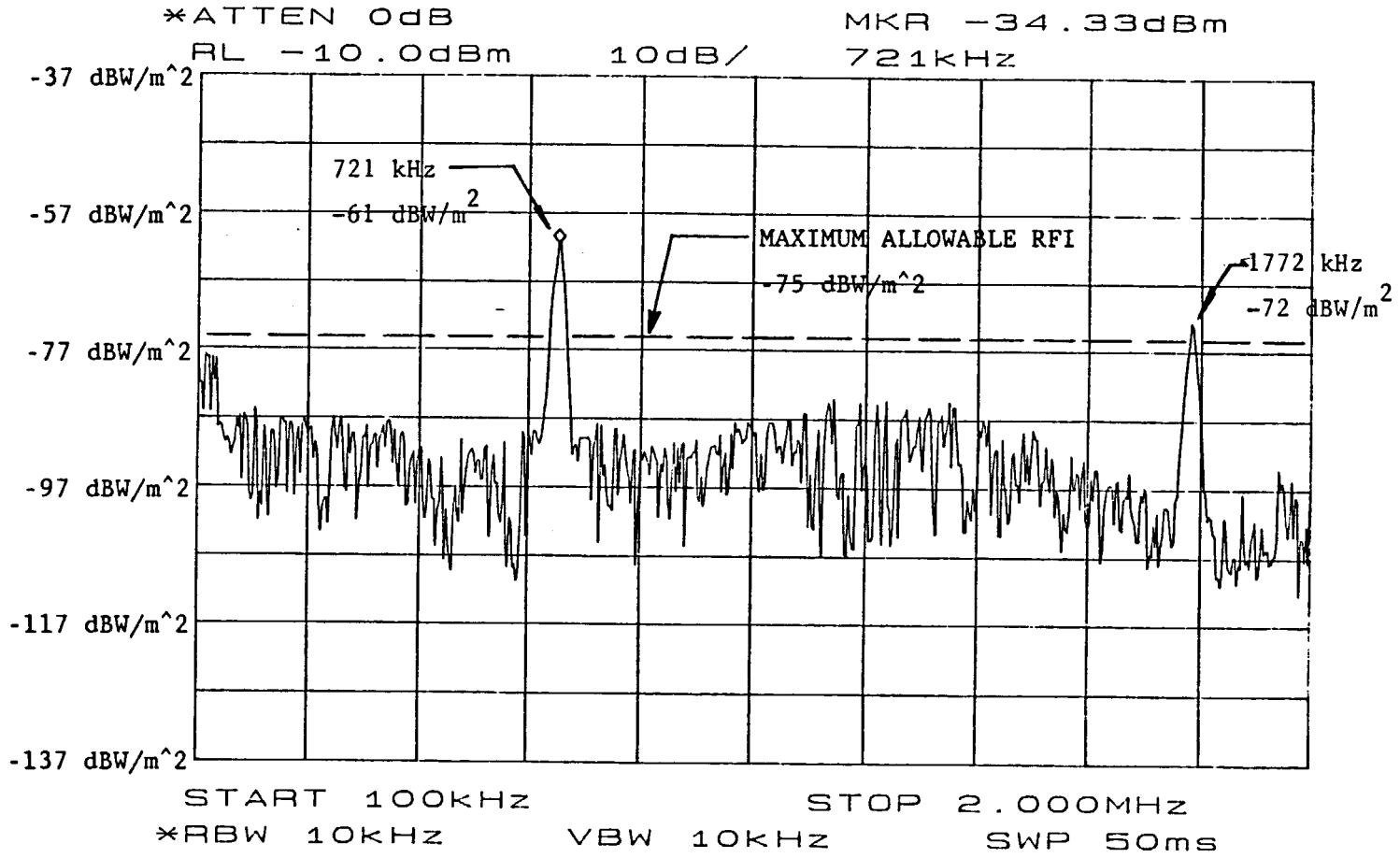


Figure 33. Spectrum Plot, 100 kHz to 2 MHz, Omni-directional Site No. 3, Along Sidewinder Road Directly Across the Access Road for WWVH, PACMISRANFAC HAWAREA at Barking Sands, Kauai

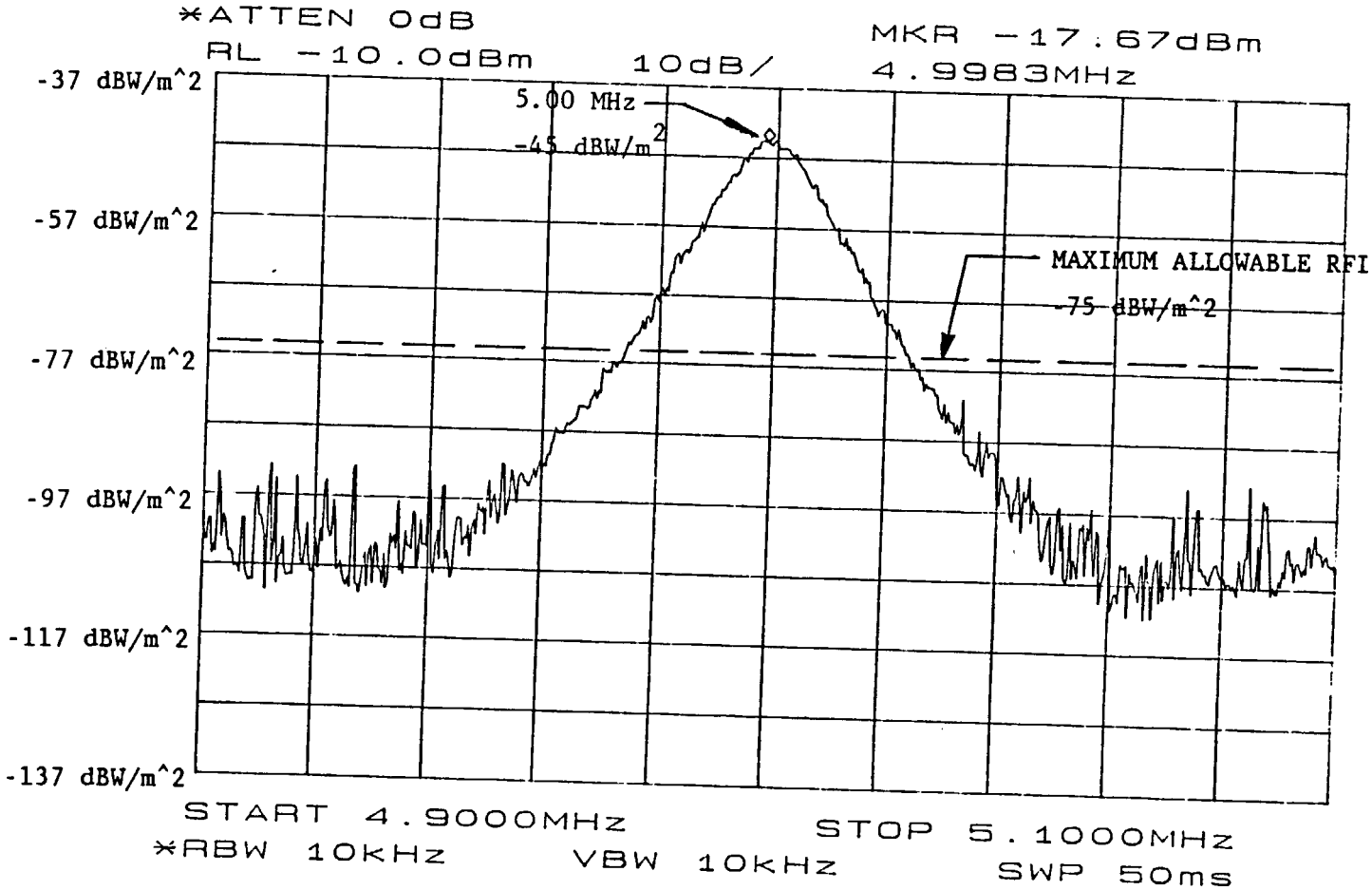


Figure 34 Spectrum Plot, 4.9 to 5.1 MHz, Omni-directional Site No. 3, Along Sidewinder Road Directly Across the Access Road for WWVH, PACMISRANFAC HAWAREA at Barking Sands, Kauai

TABLE 1

SPECIFIC VLBI FREQUENCIES

S-BAND (GHZ): (+/- 2 MHz)

2.218
2.223
2.238
2.268
2.293
2.303

X-BAND (GHz): (+/- 2 MHz)

8.211
8.221
8.251
8.311
8.421
8.501
8.551
8.571

NOTE: FREQUENCIES PROVIDED DURING PHONCON BETWEEN U.S. NAVAL OBSERVATORY (M. EUBANKS)/NEEACT PAC (M. TERAYAMA) OF 14 JULY 1989

TABLE 2

LIST OF TEST EQUIPMENT

1. Spectrum Analyzer, Hewlett Packard model number HP-8562A

2. Integral Personal Computer, Hewlett Packard model number 207

3. Antennas and cables (values used for calculations are indicated):

TEST RANGE	ANTENNA	ANT. FACTOR	CABLE TYPE	CABLE LOSS
10 KHz to 100 KHz	ODC-100 (whip w/ preamp)	12 dB	RG-58	0.2 dB (use 0 dB)
100 KHz to 2 MHz	ODC-100 (whip w/ preamp)	12 dB	RG-58	0.2 dB (use 0 dB)
4.9 to 5.1 MHz	ODC-100 (whip w/ preamp)	12 dB	RG-58	0.2 dB (use 0 dB)
*2.1 to 2.4 GHz	Polarad CA-S (directional horn)	2.1 GHz: 21.4 dB 2.4 GHz: 21.8 dB (use 22 dB)	RG-214	2 dB
*8.0 to 8.8 GHz	Stoddart 91891-2 (directional horn w/ 91892-1 reflector)	8.0 GHz: 19 dB 8.8 GHz: 20 dB (use 20 dB)	RG-214	2 dB

* Note: At Pacific Missile Range Facility at Barking Sands, VLBI Test Site No. 2, a NARDA 3 dB RF external attenuator was inserted in-line with the RF input of the spectrum analyzer to avoid possible damage from transmissions from a near-by AN/FPS-81 weather radar.

APPENDIX A

POWER DENSITY FORMULA

To find power density:

$$P = E^2/R$$

$$10 \log P = 20 \log E - 10 \log R$$

$$P(dBW/m^2) = E(dBV/m) - 26 \text{ dB ohms}$$

where: P = power density in dBW/m^2 (dBWatt per meter squared)
E = electric field intensity in dBV/m (dBVolt per meter)
R = resistance of air = 377 ohms

To account for antenna factor, cable loss, and external RF attenuators:

$$E = [(S + 107 \text{ dB}) + K + C + A] - 120 \text{ dB}$$

where: S = spectrum analyzer reading in dBm
107 dB = conversion from dBm to dBuV for 50 ohm system
K = antenna factor in dB
C = cable loss in dB
A = external RF attenuator loss in dB
-120 dB = conversion from dBuV to dBV

Therefore:

$$P = S + 107 + K + C + A - 120 - 26 \text{ (dBW/m}^2\text{)}$$

APPENDIX B

DETECTED SIGNALS AT VLBI SITE NO. 1, PACIFIC MISSILE RANGE FACILITY AT BARKING SANDS, KAUAI

The following signals were detected in the 2.1 to 2.4 GHz and 8.0 to 8.8 GHz bands above the maximum allowable RFI levels for the VLBI radio telescope at Site No. 1, near the Test Equipment Calibration Laboratory, 70 feet due north of the Diver's Support Facility at PACMISRANFAC. The maximum allowable RFI levels were -130 dBW/m^2 (dBWatt per meter squared) in the 2.1 to 2.4 GHz band and -115 dBW/m^2 in the 8.0 to 8.8 GHz band. The test results are limited by the test equipment minimum detectable power densities of -90 dBW/m^2 in the 2.1 to 2.4 GHz band and -86 dBW/m^2 in the 8.0 to 8.8 GHz band that are above the maximum allowable RFI level.

1. Transmitting frequency: 2.212 GHz
   Measured power density at site: -86 dBW/m^2
   Probable source: Missile check-out
   Transmitter power: 5 Watts
   Bandwidth: .375 MHz
   Polarization: Vertical
   Location of transmit antenna: 220337N1594638W (Building 573, PACMISRANFAC at Barking Sands)
   Location of receive antenna: 220337N1594638W (Building 573, PACMISRANFAC at Barking Sands)
   Path length: 0 statute miles

2. Transmitting Frequency: 2.2405 GHz
   Measured power density at site: -79 dBW/m^2
   Probable source: Unknown

3. Transmitting Frequency: 2.246 GHz
   Measured power density at site: -54.5 dBW/m^2
   Probable source: Unknown

4. Transmitting frequency: 8.676 through 8.720 GHz
   Measured power density at site: -48 dBW/m^2
   Probable source: Combination of three EW transmitters at Makaha Ridge
   a. AN/DPT-1
      (1) Transmitter power: 70 kWatts (Peak pulsed power)
      (2) Bandwidth: 12 MHz
      (3) Polarization: Horizontal
   b. ENSYN
      (1) Transmitter power: 1 kWatt (Peak pulsed power)
      (2) Bandwidth: 12 MHz
      (3) Polarization: Horizontal

c. AN/DLQ-3

(1) Transmitter power: 100 Watts

(2) Bandwidth: 6 MHz

(3) Polarization: Horizontal

Location of transmit antenna: 220811N1594348W (PACMISRANFAC at Makaha Ridge)

Location of receive antenna: Offshore of Western Kauai (Air and Surface Moving Targets)

Path length: Variable

APPENDIX C

DETECTED SIGNALS AT VLBI SITE NO. 2, PACIFIC MISSILE RANGE FACILITY AT BARKING SANDS, KAUAI

The following signals were detected in the 2.1 to 2.4 GHz and 8.0 to 8.8 GHz bands above the maximum allowable RFI levels for the VLBI radio telescope at Site No. 2, near the aircraft maintenance hanger, 200 feet due north of Building 3992, PACMISRANFAC. The maximum allowable RFI levels were -130 dBW/m^2 (dBWatt per meter squared) in the 2.1 to 2.4 GHz band and -115 dBW/m^2 in the 8.0 to 8.8 GHz band. The test results are limited by the test equipment minimum detectable power densities of -87 dBW/m^2 in the 2.1 to 2.4 GHz band and -83 dBW/m^2 in the 8.0 to 8.8 GHz band that are above the maximum allowable RFI level.

1. Transmitting frequency: 2.121 GHz
   Measured power density at site: -74 dBW/m^2
   Probable source: HAWTEL Microwave
   Transmitter power: 2.5 Watts
   Bandwidth: 3 MHz
   Polarization: Vertical
   Location of transmit antenna: 220501N15940009W (Puu Ka Pele Tower)
   Location of receive antenna: 220203N1594659W (Near the Main Gate, PACMISRANFAC at Barking Sands)
   Path length: 8 statute miles

2. Transmitting Frequency: 2.1716 GHz
   Measured power density at site: -80 dBW/m^2
   Probable source: HAWTEL Microwave
   Transmitter power: 2.5 Watts
   Bandwidth: 3 MHz
   Polarization: Vertical
   Location of transmit antenna: 220203N1594659W (Near the Main Gate, PACMISRANFAC at Barking Sands)
   Location of receive antenna: 220501N15940009W (Puu Ka Pele Tower)
   Path length: 8 statute miles

3. Transmitting Frequency: 8.040 GHz
   Measured power density at site: -64 dBW/m^2
   Probable source: PMRF Microwave
   Transmitter power: 1 Watts
   Bandwidth: 25 MHz
   Polarization: Horizontal
   Location of transmit antenna: 220811N1594346W (Building 710, PACMISRANFAC at Makaha Ridge)
   Location of receive antenna: 220143N1594706W (Building 105, PACMISRANFAC at Barking Sands)
   Path length: 8.3 statute miles

4. Transmitting Frequency: 8.120 GHz
Measured power density at site: -78 dBW/m^2
Probable source: PMRF Microwave
Transmitter power: 1 Watts
Bandwidth: 25 MHz
Polarization: Horizontal
Location of transmit antenna: 220337N1594638W (Building 573, PACMISRANFAC at Barking Sands)
Location of receive antenna: 220143N1594706W (Building 105, PACMISRANFAC at Barking Sands)
Path length: 3 statute miles

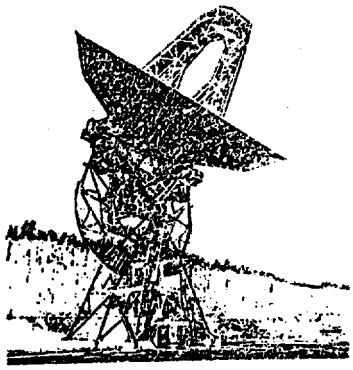
5. Transmitting Frequency: 8.200 GHz
Measured power density at site: -76 dBW/m^2
Probable source: PMRF Microwave
Transmitter power: 1 Watts
Bandwidth: 25 MHz
Polarization: Vertical
Location of transmit antenna: 220143N1594706W (Building 105, PACMISRANFAC at Barking Sands)
Location of receive antenna: 220322N1593952W (Kukui Tower)
Path length: 7.5 statute miles

6. Transmitting Frequency: 8.260 GHz
Measured power density at site: -80 dBW/m^2
Probable source: PMRF Microwave
Transmitter power: 1 Watts
Bandwidth: 25 MHz
Polarization: Vertical
Location of transmit antenna: 220322N1593952W (Kukui Tower)
Location of receive antenna: 220143N1594706W (Building 105, PACMISRANFAC at Barking Sands)
Path length: 7.5 statute miles

7. Transmitting Frequency: 8.290 GHz
Measured power density at site: -77 dBW/m^2
Probable source: PMRF Microwave
Transmitter power: 1 Watts
Bandwidth: 25 MHz
Polarization: Horizontal
Location of transmit antenna: 220337N1594638W (Building 573, PACMISRANFAC at Barking Sands)
Location of receive antenna: 220143N1594706W (Building 105, PACMISRANFAC at Barking Sands)
Path length: 3 statute miles

8. Transmitting Frequency: 8.380 GHz
Measured power density at site: -80 dBW/m^2
Probable source: PMRF Microwave
Transmitter power: 1 Watts
Bandwidth: 25 MHz
Polarization: Horizontal
Location of transmit antenna: 220322N1593952W (Kukui Tower)
Location of receive antenna: 220143N1594706W (Building 105, PACMISRANFAC at Barking Sands)
Path length: 7.5 statute miles

9. Transmitting frequency: 8.676 through 8.720 GHz
Measured power density at site: -24 dBW/m^2
Probable source: Combination of three EW transmitters at Makaha Ridge
a. AN/DPT-1
(1) Transmitter power: 70 kWatts (Peak pulsed power)
(2) Bandwidth: 12 MHz
(3) Polarization: Horizontal
b. ENSYN
(1) Transmitter power: 1 kWatt (Peak pulsed power)
(2) Bandwidth: 12 MHz
(3) Polarization: Horizontal
c. AN/DLQ-3
(1) Transmitter power: 100 Watts
(2) Bandwidth: 6 MHz
(3) Polarization: Horizontal
Location of transmit antenna: 220811N1594348W (PACMISRANFAC at Makaha Ridge)
Location of receive antenna: Offshore of Western Kauai (Air and Surface Moving Targets)
Path length: Variable



APPENDIX E
ARCHAEOLOGICAL SURVEY
(PAUL H. ROSENDAHL, INC.)

Report 876-071690

Archaeological Inventory Survey
USN Radio Telescope Project Area

Land of Waimea
Waimea District, Island of Kauai

PHRI

Paul H. Rosendahl, Ph.D., Inc.

Archaeological • Historical • Cultural Resource Management Studies & Services

305 Mohouli Street • Hilo, Hawaii 96720 • (808) 969-1763 • FAX (808) 961-6998

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Report 876-071690

Archaeological Inventory Survey USN Radio Telescope Project Area

Land of Waimea
Waimea District, Island of Kauai

by

Alan T. Walker, B.A.
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July 1990

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SUMMARY

At the request of Mr. Scott Ezer of Heiber, Hastert & Kimura - 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 USN Radio Telescope project area. The project area is located in the Land of Waimea. District of Waimea. Island of Kauai. It consists of three separate one-acre sites within the Pacific Missile Range Facility-Barking Sands (PMRF-BS) and four areas within the Kokee Park Geophysical Observatory (KPGO). The overall objective of the survey was to provide information appropriate to and sufficient for compliance with applicable federal historic preservation statutes.

During the survey, a low retaining wall was noted in the vicinity of Site 2 outside the fenced compound at KPGO. The wall is located at the end of the area graded for the fenced compound of KPGO and appears to be a foundation to retard erosion or to stabilize the soil embankment. The retaining wall appears to be of relatively recent construction and was not designated as an archaeological site. No other surface cultural remains were identified at the other six sites at PMRF-BS or KPGO.

The retaining wall identified during the current project is assessed as significant solely for scientific infonnation content. No further archaeological work is recommended for the four sites within the KPGO portion of the project area, because (a) the retaining wall appears to be historic and associated with construction of KPGO, and **(b)** it is unlikely that subsurface remains are present.

Although no surface cultural remains were identified at the three sites within PMRF-BS, this general area is known to contain human burial remains and possibly subsurface cultural deposits, which may be significant for scientific information content and/or cultural value. Therefore, a subsurface inventory survey for each of the three sites at PMRF-BS is recommended. This subsurface inventory survey could include acombination of coring, backhoe trenching, and handexcavation.

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INTRODUCTION

BACKGROUND

At the request of Mr. Scott Ezer of Hclbert, Hastert & Kimura - Planners for his client, the United States Navy (USN), Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted an archaeological inventory survey of the USN Radio Telescope project area. The project area is located in the Land of Waimea, District of Waimea, Island of Kauai. The survey field work was conducted on July 2, 1990 by Supervisory Archaeologist Alan T. Walker, B.A., assisted by Field Archaeologist Jenny L. O'Claray. The work was conducted under the overall direction of Principal Investigator Dr. Paul H. Rosendahl. Approximately two man-days of labor were required to complete the field work. The overall objective of the survey was to provide information appropriate to and sufficient for compliance with applicable Federal historic preservation statutes.

This report is the final report for the prcscnt project: it includes (a) background information on thc environment and cultural-historical setting of the projcct area, (b) a summary of previous archaeological investigations relevant to the project area, (c) a description of field methods, and (d) a discussion of findings.

SCOPE OF WORK

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

The basic objectives of thc prcscnt survey were fourfold: (a) to identify (find and locatc) all sitcs and site-complexes present within the project arca, (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 further data collection and/or other mitigation work that might be necessary or appropriate.

Based on a review of readily available background literature, on extensive familiarity with the current requirements of pertinent State and County review authorities, and on discussions with Mr. Ezor, the following specific tasks were determined to constitute an adequate and appropriate scope of work for the inventory survey:

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

2. Conduct a 100% coverage, variable intensity (30-90 ft intervals) ground survey to identify and record all sites in the project area. At the instruction of Mr. Ezor, the survey would not include any subsurface testing within the project area; and

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

The inventory survey was carried out in accordance with the standards for inventory-level survey recommended by Hawaii State Department of Land and Natural Resources-Historic Preservation Program/State Historic Preservation Office (DLNR-HPP/SHPO).

PROJECT AREA DESCRIPTION

The USN Radio Telescope project area consists of three separate one-acre sites located within the Pacific Missile Range Facility-Barking Sands (PMRF-BS) and four areas within the Kokee Park Geophysical Observatory (KPGO) (Figure 1). Three abandoned concrete building foundations are present within Site 2 at PMRF-BS. The KPGO parcel is located on a parcel referred to as "Site E" and includes several buildings. It is composed of a fenced compound and

includes the forest areas immediately adjacent to the compound. There is asphalt paving at Site 2, within the fenced compound of KPGO.

The three one-acre project area sites in PMRF-BS are located at an elevation 10-15 ft above mean sea level (AMSL), and the terrain is level. The soil consists of Jaucas loamy fine sand (0-8% slopes) representing the Jaucas series "...of excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean...[t]hey developed in wind- and water-deposited sand from coral and seashells" (Foote et al. 1972:48). Jaucas loamy fine sand (0-8% slopes) "...occurs on old beaches and on windblown sand deposits in the western and southern parts of Kauai" (Foote et al. 1972:49). Because the terrain within PMRF-BS consists of sand dune deposits, they are likely to contain human burial remains. Such remains have, in fact, been documented in several areas of the facility (R. Inouye, Environmental Engineer at PMRF-BS, pers. comm.).

The KPGO project area is located at c. 3,755 ft AMSL, and the terrain in the four survey locations ranges from level to undulating. The soil 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 PMRF-BS project areas ranges from 15-20 inches per year, and the mean annual temperature is approximately 70-80 degrees F. Rainfall in the vicinity of the KPGO project areas ranges between 50-75 inches per year, and the mean annual temperature there is approximately 60-70 degrees F (Armstrong 1983:62,64).

Vegetation in two of the three one-acre project sites in PMRF-BS (Sites 1 and 2), and the area inside the fenced compound of the KPGO project area, consists of level lawn. Vegetation in the third one-acre project site at PMRF-BS (Site 3) is moderately dense and consists primarily of lantana (*Lantana camara* L.) and 'a'ali'i (*Dodonaea eriocarpa*) with scattered specimens of kiawe (*Prosopis pallida* [Humb. and Bonpl. ex Willd.] HBK), 'ilima (Sida *fallax* Walp.), naupaka-kahakai (Scaevola sericea Vahl), indian pluchea (*Pluchea* indica [L.] Less.), and grasses. Vegetation outside the fenced compound at KPGO consists of a moderately dense forest of 'ohia (Metrosideros collina [Forst.] Gray) and koa (Acacia *koa* Gray) with an understory of various shrubs and grasses.

PREVIOUS ARCHAEOLOGICAL WORK

Archaeological work conducted within the general vicinity of the present project area includes, but is not limited to, surveys by Bennett (1931) and Kikuchi (1979), and subsurface testing within PMRF-BS by Welch (1990 and IN ASI 1990 [Draft. Cited by permission of Randy Gallien, U.S. Army, Strategic Defense Command Environmental Coordinator]). Bennett's survey identified several sites well inland of PMRF-BS, but none within the present project area.

In 1979, Kikuchi conducted a reconnaissance survey of an area near Nohili Ditch (Kikuchi 1979). In examining the naturally eroded bank of Nohili Ditch, Kikuchi noted the presence of level C, a thin, gray layer of sand-ash containing two horizontal features (a possible post-hole and a possible pit or firepit). With the exception of a single fish vertebra, Kikuchi found no charcoal, midden remains, or artifacts. He suggested that the deposit had resulted from human influence, but he could not determine its age (1979:5).

In February of 1990, Welch conducted an archaeological survey and subsurface testing of a proposed parking area at the Department of Energy Kauai Test Facility (KTF), located at PMRF-BS (Welch 1990). The basic objectives of the survey were: (a) to determine the presence or absence of cultural resources, (b) to evaluate the significance of any identified resources and their eligibility for inclusion in the National Register of Historic Places, and (c) to assess any potential adverse effects on identified cultural resources.

During a surface survey of the project area, no cultural remains or sites were identified. Subsurface testing was done using a manual auger which utilized both 3 1/2- and 7-inch buckets. Within the project area, a total of 14 auger bores placed c. 15.0 m (50 ft) apart were excavated to a maximum depth of 1.5 m. Excavated material was screened through both 1/4-inch and 1/8-inch mesh.

Although the testing identified a possible subsurface cultural deposit in a portion of the project area, it also indicated that it was unlikely that concentrated human burials were present. Based on the findings of the subsurface testing, Welch recommended more extensive testing in the vicinity of the cultural deposit he identified (1990:6).

During January, February and April, Welch conducted an archaeological survey and testing in two phases at the proposed missile launch facility at PMRF-BS. The following

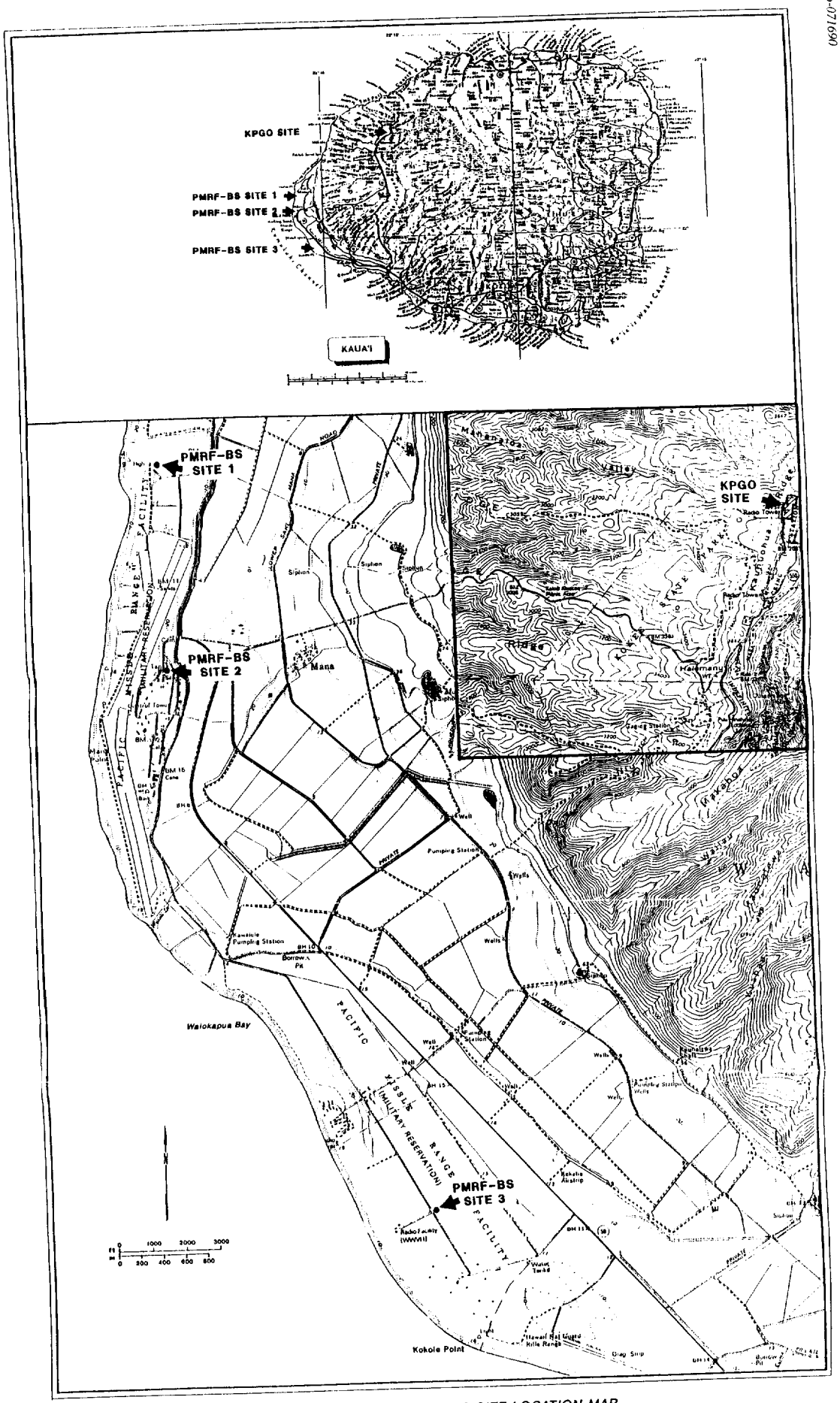

Figure 1. PROJECT AREA AND SITE LOCATION MAP

description of the survey and testing is summarized from a draft report by Advanced Sciences Inc. (ASI 1990: Appendix A, pp. 1-33).

The purpose of the survey and testing was: (a) to identify cultural resources in the project area (b) to evaluate the significance of the findings in terms of the criteria for eligibility for inclusion in the National Register of Historic Places, and (c) to assess any potential adverse effects on any significant archaeological remains.

The planned scope of work included a 100% surface survey of proposed construction areas and subsurface testing to a depth of 1.5 m, using a manual auger with both a 3 1/2- and 7-inch buckets. A total of 187 holes were bored. During the first phase all recovered material was screened through 114-inch mesh. In Phase II, most of the recovered material was screened a second time through 118-inch mesh.

All cultural remains recovered during the survey were modem, except a subsurface possible cultural deposit. It was determined that this deposit was probably disturbed. The subsurface testing found nothing to indicate the presence of major archaeological sites or concentrations of human burials in the area, although isolated human burials may be uncovered during subsequent work. With the exception of archaeological monitoring, no further mitigation work was recommended. The secondary cultural deposit was also determined to not be eligible for nomination to the National Register of Historic Places.

The ASI Archaeological Survey and Testing Report (1990), which contains Welch's two studies, also includes, on pages 20-25, additional information on previous archaeological work in nearby areas. Though these studies are not in the immediate vicinity of the project area, they are summarized below for the background information they provide.

The report mentions an undated United States Navy Pacific Naval Facilities Planning Department map of the area, which indicates a "major ancient burial ground" in the northern area of PMRF-BS It is north of the project area, 400 meters south of the mouth of the Nohili Ditch, at the southern boundary of Polihale State Park.

Evidence of continuous occupation of the area north of Nohili Ditch has been found in more recent studies (Gonzalez IN ASI 1990, Doolittle and McMahan IN Ibid.). Midden deposits and imu revealed in the eroding edges of the dunes, as well as the discovery of human remains indicate an extensive archaeological site with subsurface deposits. Recent studies with ground-penetrating radar also indicate the likelihood of subsurface cultural deposits.

The report also cites a "brief archaeological field reconnaissance" conducted in July 1989 within the KTF, north of the project area, which recovered only a single cowry shell and a small piece of burned mammal bone (U.S. Army, Strategic Defense Command letter to Hawaii SHPO, Dec. 8, 1989). The report also cited two surveys near the south boundary of PMRF-BS (Bordner 1977, McMahon 1988a,b) which yielded no cultural findings but indicated the possibility of burials in the area.

Additional work in the vicinity of the project area mentioned in ASI (1990) includes: Thrum (1907), Ching (1974), Kennedy/Jenks (1982), Sinoto (1978), Yent (1982), and Cleeland (1975).

FIELD METHODS AND PROCEDURES

Field personnel conducted a 100% surface survey at each of the seven project area locations (three at PMRF-BS and four at KPGO). This was performed by means of several pedestrian transects, with team members zig-zagging to inspect the entire area. Crew members maintained transect intervals of 10.0-15.0 m, and used Xerox maps (c. 1"=200 ft scale) of the seven project area locations to facilitate the survey. Ground visibility was excellent at Sites 1 and 2 at PMRF-BS, and inside the fenced compound of the KPGO project area, because the areas are covered with lawn and very low vegetation. Ground visibility was only fair at Site 3 at PMRF-BS, and in the area outside the fenced compound of the KPGO project area, due to moderately dense vegetation. At least one 35 mm black-and-white photograph was taken of each project area location (PHRI Roll No. 1486).

FINDINGS

During the survey, a low retaining wall was noted near Site 2 outside the fenced compound at KPGO. The wall is located at the end of the area graded for the fenced compound of KPGO and appears to be a foundation to retard erosion or to stabilize the soil embankment. The retaining wall appears to be of relatively recent construction and was not designated as an archaeological site. No other surface cultural remains were identified at the remaining six sites at PMRF-BS KPGO.

CONCLUSION

DISCUSSION

Although no surface prehistoric cultural remains were identified within the PMRF-BS portion of the project area, this does not rule out the presence of subsurface cultural remains. PMRF-BS is located along the coast, a zone associated with prehistoric habitation and exploitation of marine resources (Rosendahl 1973, Cordy 1985). The area is composed of extensive sand dune deposits (Foote et al. 1972). Coastal sand dune deposits on Oahu, at Bellows (Pearson et al. 1971, Kirch 1985), Malaekahana (Yent and Estioko-Griffin 1980), Mokapu Peninsula (Snow 1974, Davis et al. 1976), and Kahuku (Walker et al. 1988a,b), have been documented to contain significant prehistoric cultural remains. In addition, previous archaeological studies in the vicinity of PMRF-BS have documented similar remains (Kikuchi 1979, Welch IN ASI 1990). R. Inouye, Environmental Engineer at PMRF-BS, has also indicated that such remains exist (pers. comm.).

It is unlikely that there are prehistoric subsurface cultural deposits at the KPGO sites. Although the KPGO portion of the project area is located in the inland forest zone, which was exploited by early Hawaiians for various raw materials (floral and faunal products, including bird feathers), it was an area that was rarely inhabited (Rosendahl 1973, Cordy 1985). Also, there has recently been grubbing in the area, associated with the construction of the KPGO facilities (buildings and asphalt pavement).

GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

Significance categories used in the site evaluation process are based on the National Register criteria for evaluation. as outlined in the Code of Federal Regulations (36 CFR Part 60). DLNR-HPP/SHPO uses these criteria for evaluating cultural resources. Sites determined to be potentially significant for information content fall under Criterion D, which defines significant resources as ones which "...have yielded, or may be likely to yield, information important in prehistory or history." Sites potentially significant as representative examples of site types are evaluated under Criterion C, which defines significant resources as those which "...embody the distinctive characteristics of a type, period, or method of construction... or that represent a significant and distinguishable entity whose components may lack individual distinction."

Sites with potential cultural significance are evaluated under guidelines prepared by the Advisory Council on Historic Preservation (ACHP) entitled "Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review" (ACHP Draft Report, August 1985). The guidelines define cultural value as "...the contribution made by an historic property to an ongoing society or cultural system. A traditional cultural value is a cultural value that has historical depth." The guidelines further specify that "[a] property need not have been in consistent use since antiquity by a cultural system in order to have traditional cultural value."

Based on the above federal criteria, the retaining wall identified during the current project is assessed as significant solely for scientific information content. No further archaeological work is recommended for the four sites within the KPGO portion of the project area, because (a) the retaining wall appears to be historic and associated with construction of KPGO, and (b) it is unlikely that there are subsurface remains at the sites.

Although no surface cultural remains were idcntificd within the three sites at PMRF-BS, this general area is known to contain human burial remains and possibly subsurface cultural deposits which may be significant for scientific information content and/or cultural value. Therefore, a subsurface inventory survey for each of the three sites at PMRF-BS is recommended. This survey could include a combination of coring, backhoe trenching, and hand excavation.

In June 1990, the above tentative evaluations and recommendations were discussed with Ms. Nancy McMahon, DLNR-HPP/SHPO staff archaeologist for Kauai County. Upon submission of this final report, Ms. McMahon will review the conclusions and recommendations regarding further archaeological work at the USN Radio Telescope project area.

The evaluations and recommendations presented here are based on an inventory survey of the project area. There is always the possibility, however remote, that potentially significant, unidentified surface and/or subsurface cultural remains will be encountered in the course of future archaeological investigations or subsequent development activities. In such situations, archaeological consultation should be sought immediately.

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APPENDIX A

LIMITED HISTORICAL DOCUMENTARY RESEARCH

by Helen Wong Smith, B.A.

The four project areas lie in the ahupua'a of Waimea. KPGO Site is near Koke'e Ridge, and the three PMRF-BS sites are near Mana. This report focuses on citations relevant to these two areas.

Place Names of Hawaii gives the following translations for the two names: Koke'e - "to bend or to wind," and Mana - "arid." The entry for Mana continues, "where an older sister of Pele, Na-maka-o-Kaha'i (the eyes of Kaha'i) introduced the kauana'oa, dodder" (Pukui et al. 1974).

Legendary accounts refer to Mana as a place of wandering spirits and as a land of mirages. Kamakau writes:

> The places said to be for wandering spirits were:...Mana for Kauai;...In these friendless souls ('uhane makamaka 'ole) wandered.
>
> They were where spirits were divided (mahele ana) to go into the realm of wandering spirits, the ao kuewa or ao 'auwana; or to the ancestral spirit realm, to ao 'aumakua; or to the realm of endless night, the po pau'ole (Kamakau 1964:49).

Pukui includes sayings regarding Mana in 'Olelo No'eau (1983). including those which refer to the mirages of Mana, below:

> Ahu kupanaha ka la i Mana.
> Peculiar is the action of the sun in Mana.
>
> Said of a delusion. Mana, Kaua'i, is a place where mirages were once seen [#18].
>
> Kukulu kauhale a Limaloa
> Limaloa builds his house.
>
> Limaloa was the god of mirages who at certain times of the year would build a village in the moonlight at Mana, Kaua'i. The village would vanish as quickly as it had appeared [#1909].
>
> Ka wai li'ula o Mana
> Mirage of Mana
>
> Mirages were seen at Mana on the nights of Ku and Kane [#1657].
>
> 'Ikea mai la o Mana, ua hale i ka wai li'ula.
> Mana notices the waters of the mirage.
>
> The attempt to fool is very obvious [#1203].
>
> Ke'anapa nei ka waili'ula o Mana
> The water in the mirage of Mana sparkles.
>
> Said of one who is overdressed [#1680].
>
> Kukulu kala'ihi ka la i Mana.
> The sun sets up mirages at Mana.
>
> Said of a boastful person who exaggerates [#1908].

It is interesting to note the following chant, which was recited at the marriage of Mataio Kekaunao'a and Elizabeth Kina'u, on Sept. 19, 1827:

I ke kane o Mana	The man of Mana.
I ka hao a Limaloa,	Is taken by Limaloa,
I ka li'ula.	By a mirage.
Pau ka li'ula,	The mirage ends,
Maka ka 'ainako,	The cane trash, still fresh,
Pu oia na hale.	Is heaped outside the house.
I Kaunalewa	At Kaunalewa
Hao mai koi,	A gale tears,
A Lolornauna,	The Lolomauna,
Kupu i ke kalio	The familiar gusty breeze
Kalamakopi'i.	Of Kalamakopii.

["Agale tears" refers to Kaahumanu's anger at this marriage, as she desired to have Kauikeaouli and Kinau wed each other.] (Ii 1959:150).

Other sayings regarding Mana found in 'Olelo No'eau are:

> Ke one kapu o Kahamalu'ihi
> The sacred sand of Kahamalu'ihi.
>
> A city of refuge for those of Waimea, Mana, and the Kona side of Kaua'i [#1775].
>
> Mana kaha kua welawela.
> Mana where the back feels the heat (of the sun).

Refers to Mana, Kaua'i [#2136].

'ale'ale Mana i ke kaha o Kaunalewa
ana ripples over the land of Kaunaiewa.

Said of the movements of a dance. A play on 'ale'ale (to ripple like water), referring to the gestures of the hands, and lewa (to sway), referring to the movement of the hips [#1018].

Waikahi o Mana.
The single water of Mana.

When schools of 'opelu and kawakawa appeared at Mana, Kaua'i, news soon reached other places like Makaweli, Waimea, Kekaha, and Poki'i. The uplanders hurried to the canoe landing at Keanapuka with loads of poi and other upland products to exchange for fish. After the trading was finished, the fishermen placed their unmixed poi in a large container and poured in enough water to mix a whole batch at once. It didn't matter if the mass was somewhat lumpy, for the delicious taste of fresh fish and the hunger of the men made the poi vanish. This single pouring of water for the mixing of poi led to the expression, "Waikahi o Mana" [#2910].

'Umeke piha wai o Mana.
A calabash full of water is Mana.

Refers to Mana, Kaua'i, which is flooded during the rainy season [#2874].

Mana, i ka pu'e kalo ho'one'ne'e a ka wai.
Mana, where the mounded taro moves in the water.

Refers to Mana, Kaua'i. In ancient days there were five patches at Kolo, Mana, in which deep water mound-planting was done for taro. As the plants grew, the rootlets were allowed to spread undisturbed, because they helped to hold the soil together. When the rainy season came, the whole area flooded as far as Kalamaihiki, and it took weeks for the water to subside. The fanners built rafts of sticks and rushes, then dived into the water. They worked the bases of the taro mounds free and lifted them carefully, so as not to disturb the soil, to the rafts where they were secured. The weight of the mounds submerged the rafts but permitted the taro stalks to grow above water, just as they did before the flood. The rafts were tied together to form a large, floating field of taro [#2135].

Handy and Handy mention the floating taro fields in Native Planters in Old Hawaii. They write that at one time there were extensive marshlands at Wai'eli and Mana, but that these were drained by the Kekaha Sugar Company. Residents recalled that wet taro was grown in the swampy ground at the northern end of the Mana marsh. According to Handy and Handy: "...there is a tradition that formerly taro was grown on 'rafts' which were floated on the marshes themselves" (Handy and Handy 1972:411).

Handy and Handy also mention the Hawaiian people who inhabited the inland valleys of Waimea district and had infrequent contact with the sea. This unusual group was referred to as kua'aina (backlanders). "For these backlanders...the trails leading from the ridge between Koai'e and the Po'omau into the forested area of Halemanu and Koke'e joined to form 'the way' (ke ala) along the Alaka'i Swamp and down to the sea" (ibid:398).

Above the junction of the Koke'e road and the road leading to Halemanu is a jutting promontory which, according to Handy and Handy, has been:

> ...artifically 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 Mt. 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 on to Kalalau or the Alaka'i Swamp. Oldtimers know the spot as Hale (House), which would indicate a halfway house for travelers (ibid:399).

Handy and Handy stress that the forest encompassing Halemanu and Koke'e once extended down the ridges and valleys, covering a greater area than it does now. It was later denuded by cattle, goats, wild hogs, and by ranchers, who cut down the trees for fence posts (ibid:400). They also describe the variety of forest vegetation, some of which was endemic to Kaua'i (e.g. hahalua a lobelia variety). The forest also contained: kauila, maile, popolo, mokihana and pukiawe, and 'uki (a ground cover with notable violet-colored berries used for tapa dying), as well as sandalwood (ibid:401).

Handy and Handy maintain that when the forest extended to the coastline, the small gulches probably held tiny year-round streams, and that on the coastal plain the lakes and springs were larger and less swampy (ibid:412). In 1935 they noted the names of 22 "dry streams" and their valleys, ranging from Mana to Miloli`i. They regarded this as proof that "at some former time they represented dwelling or planting sites in a now arid land. Names would not have been given to (or remembered of) mere worthless pieces of topography" (ibid:412).

Their theory is supported by early historical accounts. Captain James Cook was the first Westerner to record his impressions of the area around Waimea Delta:

> [The] moist ground, produces taro, of a much greater size than we had ever seen (in southern Polynesia); and the higher ground furnishes sweet potatoes, that often weigh ten and sometimes twelve and fourteen pounds, very few being under two or three.
>
> What we saw of their agriculture, furnishes sufficient proofs that they are not novices in that art. The vale ground has already been mentioned as one continuous plantation of taro, and a few other things, which have all the appearance of being well attended to. The potato fields, and spots of sugar cane, or plantains, on higher ground, are planted with the same regularity; and always with some determinate figure; generally as a square or oblong; but neither these, nor the others, are enclosed in any kind of fence (ibid:406).

There are two nearby heiau which should be mentioned for their archaeological significance, though they are not in the immediate vicinity of the present project. Thrum lists them as:

> Elekuna - Near Barking sands of Mana. This is termed a heiau by the natives of the district, and is without doubt a place of marked distinction as it was visited on various occasions by royalty; nothing of a structural character was found; simply a mound of out-cropping sandstone at the base of which were placed the offerings of devotees.
>
> Kahelu - Kahelu, Mana. A heiau of platform character at base of the hill, about 6 feet high in front. Not of large size (Thrum 1907:39).

MAHELE

In 1848, during the reign of Kamehameha III, the traditional Hawaiian land ownership system was replaced with a more Western style system. This radical restructuring was called The Great Mahele. The Great Mahele (division) separated and defined the undivided land interests of the King and the high-ranking chiefs, and the konohiki, who were originally those in charge of tracts of land on behalf of the king or a chief (Chinen 1958:vii and Chinen 1961:13). More than 240 of the highest-ranking chiefs and konohiki in the kingdom joined Kamehameha III in this division. The first mahele was signed on Jan. 27, 1848 by Kamehameha III and Princess Victoria Kamamalu, and by her guardians Mataio Kekuanaoa and Ione Ii. The last mahele was signed by the King and E. Enoka on March 7, 1848 (Chinen 1958:16).

The Mahele, itself, did not convey title to any land. The chiefs and konohiki were required to present their claims to The Land Commission to receive awards for lands quitclaimed to them by Kamehameha III. The chiefs and konohiki were required to pay commutations to the government in order to receive Royal Patents on their awards. Until an award for these lands was issued, title remained with the government. The lands awarded to the chiefs and konohiki became known as Konohiki Lands. Because there were few surveyors in Hawaii at the time of the Mahele, the lands were identified by name only, with the understanding that the ancient boundaries would prevail until the land could be surveyed. This expedited the work of the Land Commission and speeded the transfers (Chinen 1% 1:13).

During this process all land was placed in one of three categories: Crown Lands (for the occupant of the throne), Government Lands, and Konohiki Lands. These were all "subject to the rights of native tenants" (Laws of Hawaii, 1848:22). Questions concerning the nature and extent of these rights began to arise as the King, the government, and konohiki began selling off parcels of land. On December 21, 1849 the Privy Council attempted to clarify the situation by adopting four resolutions intended to protect the rights of native tenants referred to in the 1848 law (Chinen 1958:29).

These resolutions authorized the Land Commission to award fee simple title to all native tenants who occupied and improved any portion of Crown, Government, or Konohiki lands. These awards were to be free of commutation except for house lots located in the districts of Honolulu, Lahaina, and Hilo (ibid.).

Before receiving their awards from the Land Commission, the native tenants were required to prove that they cultivated the land for a living. They were not permitted to acquire wastelands or lands which they cultivated "with the seeming intention of enlarging their lots." Once confirmed, a survey was required before the Land Commission was authorized to issue any award. These lands became known as "Kuleana Lands" (Chinen 1958:30). Until its dissolution on March 31,1855, the Land Commission issued thousands of awards to the native tenants for their kuleana. Even so, less than 30,000 acres of land were awarded to the native tenants as Kuleana Lands.

The —of— Waimea was classified as Crown Land during the Mahele (Board of Commissioners 1929:28), with the usual provision that tenants could submit claims for cultivated parcels. Perhaps because of the large size of Waimea ahupua'a, and possibly because it had a large population, 152 claims for parcels were submitted there. The largest claim awarded in the Land of Waimea, 1,546.74 acres, was made to the American Board of Commissioners for Foreign Missions (Board of Commissioners 1929:526).

ADDITIONAL HISTORICAL INFORMATION

The Archaeological Survey and Testing Report for the United States Army, Strategic Defense Command's Proposed EDX Project at PMRF-BS (ASI 1990) contains additional relevant historical information on pages 36 through 45, which is summarized below.

In 1804 the Russian explorer, Urey Lisianski recorded the first description of the Mana plain by a Westerner. He wrote that the land, "on the western side, rises gradually from the water; and from its numberless habitations, which appear better built than those of the island of Owyhee, presents everywhere a most beautiful landscape." Nearly 40 years later another Westerner recorded his impression of the Mana area. The man was Lieutenant Charles Wilkes, Commander of the 1840 United States Exploring Expedition to the Hawaiian Islands. His impression was less favorable than that of Lisianski, and contrasts sharply with the description of marshlands and floating taro fields reported by Handy and Handy. Wilkes wrote that though the soil in the Mana area was excellent, there was little water, and the land looked arid. barren, and "...fit for little except the pasturage of goats."

An unsigned letter, written in 1854, indicates that PMRF-BS might have been part of the land known as Po Kapu, which means the "realm of darkness or death which is forbidden." This forbidding name did not discourage the Westerners who obtained leases there. In the mid-1850's, after the first leaseholder, Archibald Archer, failed in an attempt to raise tobacco near Pokii, Kekaha, and Mana, Vaidemar Knudsen obtained the lease of crown lands in western Kauai. He was appointed konohiki over these lands by Kameharneha IV, and established a ranch at Waiawa, southeast of PMRF-BS. He experimented there with various tropical and sub-tropical crops. Knudsen noted in a letter that the ahupua`a of Waimea was river-bottom and mostly "kuleanas," with grazing land confined to the hillsides. In 1878, he and a partner began the first commercial sugar venture in western Kauai, at Pokii, and in 1884 Knudsen's nephew, Hans P. Faye, drilled the first artesian well in the Mana area, near Waiawa. Readily available water made possible the development of a large-scale sugar industry, and in 1898 the Kekaha Sugar Co., Ltd. was incorporated.

From the mid-1860's until 1922, rice was cultivated in the former marshlands of Mana. A Chinese immigrant, Leong Pah On, led the way in developing the rice business there. He eventually opened his own mill, but in 1922 Kekaha Sugar Company acquired the Territorial Government lease on lands in the Mana area, and the rice lands were converted to sugar.

A school building was constructed in the community of Mana in 1889, and a 1910 map shows thirty structures there. In the early 1920's the Territorial Government established game preserves and public parks in the vicinity of PMRF-BS, and in 1928, land south of PMRF-BS was set aside for an airstrip. That year, aviator Kingsford-Smith used the area as his departure point, on what was at the time the longest over-water flight in aviation history, a 34 hour and 24 minute flight from Barking Sands to Suva, Fiji.

In 1940 The Mana Airport Military Reservation was created by the Temtorial Government in the general area now occupied by PMRF-BS facilities. The reservation was greatly expanded in June 1941, and during World War II the Army operated a large Air Corps base there. After the war, Inter-Island Airways (the predecessor of Hawaiian Airlines) and westbound Pan American clipper airplanes, used the runway at Barking Sands.

The facility was officially designated Bonham Auxiliary Airfield in 1954, and it was operated by the Air Force. Two years later the Navy joined the Air Force at Bonham under a joint-use agreement. The Atomic Energy Commission (now the Department of Energy) began construction of the Kauai Test Facility, at the north end of Barking Sands, about a year before the Air Forced ceased operations there, in

November 1962. In 1964 The Navy acquired 1,885 acres in the area. The State of Hawaii withdrew 132.5 acres from the northern part Navy installation in 1978, and the land was later designated Polihale Slate Park.

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APPENDIX B

PHOTOGRAPHS

Figure B-1. PMRF-BS SITE 1. VIEW TO NNE. (Neg. 1486-2)

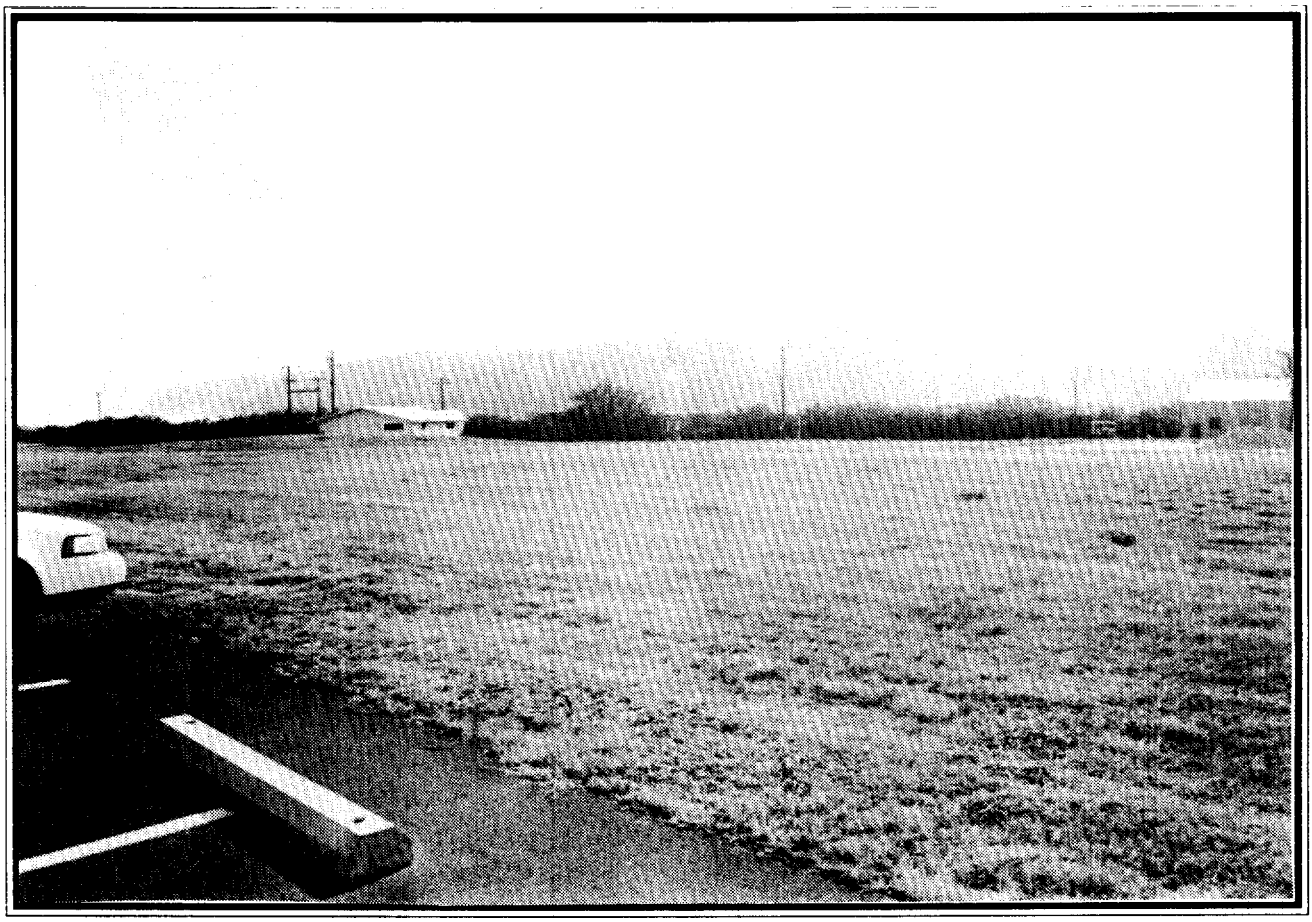


Figure B-2. PMRF-BS SITE 2. VIEW TO NNE.
(Neg. 1486-1)

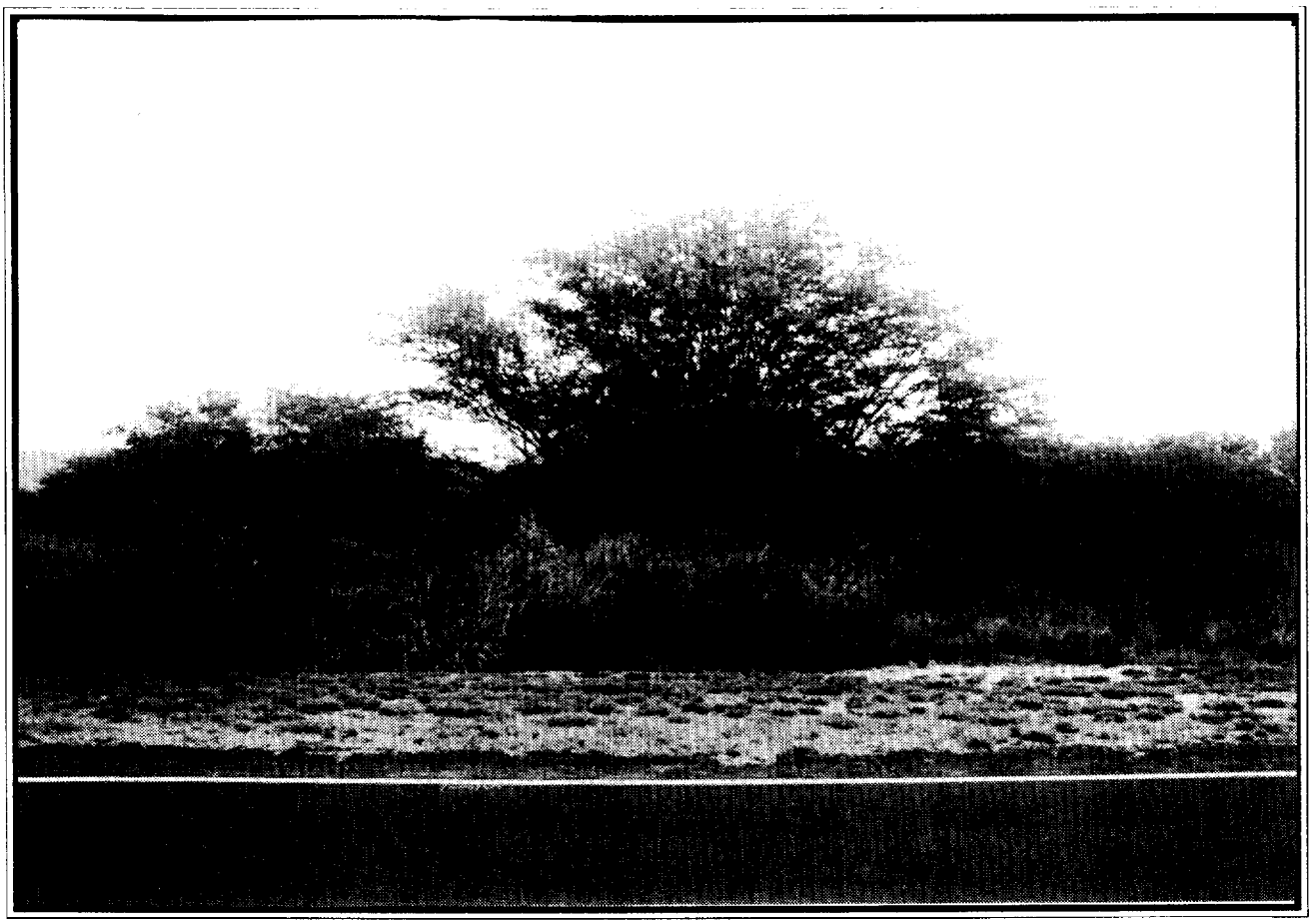


Figure B-3. PMRF-BS SITE 3. VIEW TO N.
(Neg. 1486-4)

Figure B-4. KPGO SITE 1. VIEW TO NNE.
(Neg. 1486-10)

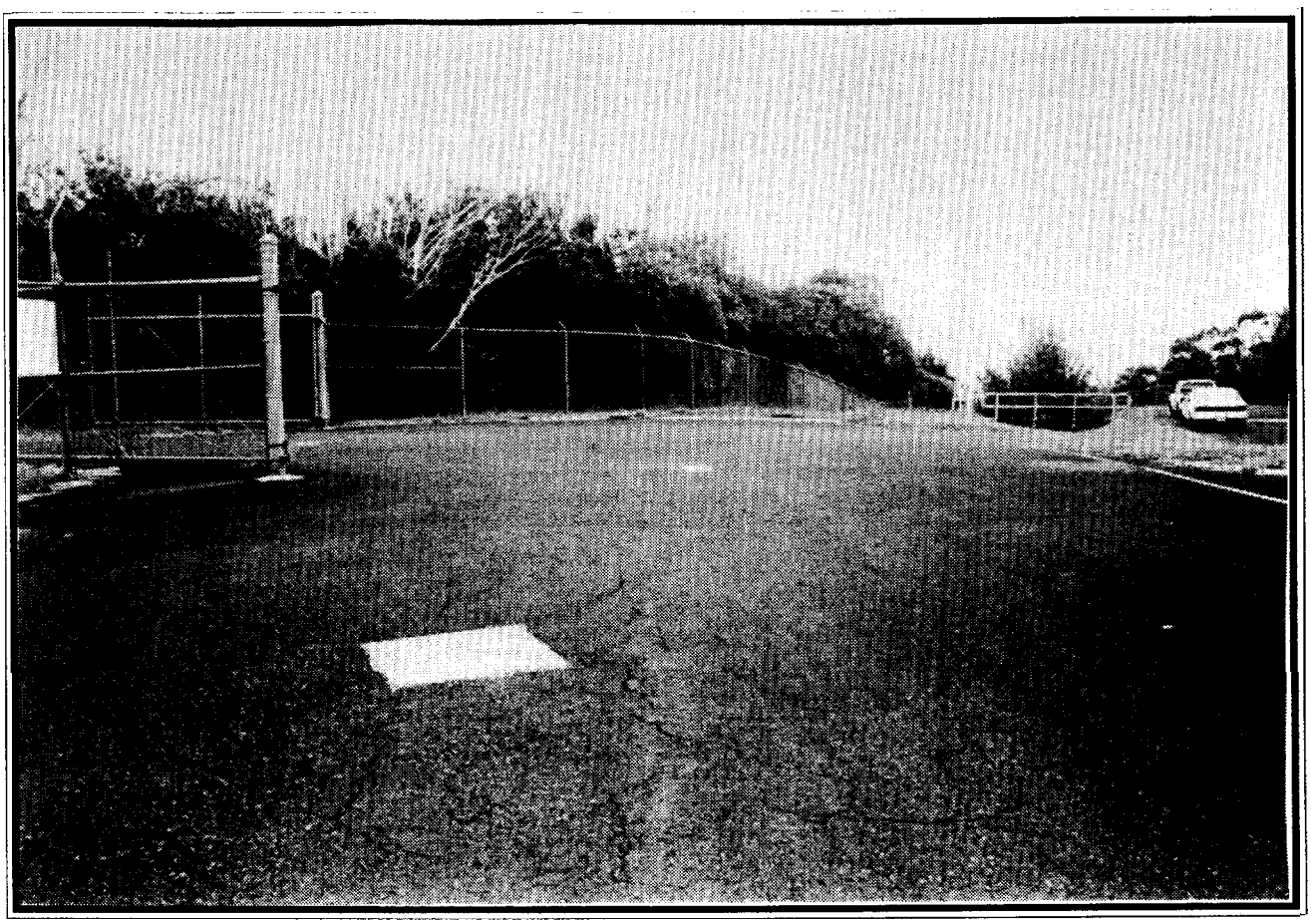
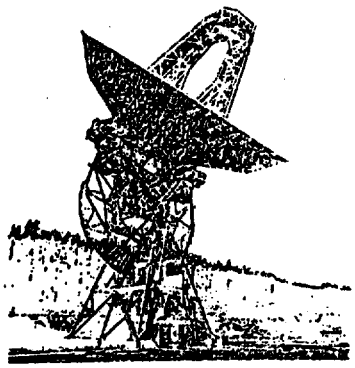


Figure B-5. KPGO SITE 2. VIEW TO NNW. (Neg. 1486-7)

Figure B-6. KPGO SITE 3. VIEW TO ESE.
(Neg. 1486-14)

Figure B-7. KPGO SITE 4. VIEW TO ESE. (Neg. 1486-12)



Appendix F
Hazardous Waste Assessment
(Unitek Environmental Consultants, Inc.)

HAZARDOUS WASTE MANAGEMENT GUIDELINES
FOR THE U.S. NAVAL OBSERVATORY
KAUAI, HAWAII

JULY 12, 1990

prepared for

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PROJECT 9034

TABLE OF CONTENTS

1.0 INTRODUCTION

Interpreting regulations for hazardous wastes is very specific to the hazardous waste being generated. The following guidelines are only highlights of the Environmental Protection Agency (EPA) and the U.S. Department of Tranportation (DOT) regulations and are meant only as a general overview not as a working hazardous waste management plan. For specific information Title 40 of the Code of Federal Regulations (CFR) §§ 260-268 and Title 49 CFR §§ 171-180 should be reviewed.

2.0 DEFINITION OF A HAZARDOUS WASTE

Any solid or liquid or contained gaseous material that is no longer suitable for use and may pose substantial hazard to human health or the environment is considered a hazardous waste.

Hazardous waste generation, accumulation, transportation, storage, and disposal are highly regulated activities. Federally they are regulated under the Resource Conservation and Recovery Act (RCRA). Congress enacted RCRA in 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984, which provide specific guidelines for these activities and severe penalties for noncompliance.

In general, hazardous wastes regulated by the Environmental Protection Agency are:

A Wastes specifically listed in Subpart D of 40 CFR Part 261. There are four lists of hazardous wastes with a total of over 400 wastes. These lists are hazardous wastes from non-specific sources, hazardous wastes from specific sources, acute hazardous wastes and toxic wastes. These wastes are listed because they either meet one of the EPA characteristics described below or they are determined toxic to health.

B. Wastes exhibiting a hazardous waste characteristic as found in Subpart C of 40 CFR Part 261. The four EPA characteristics are as follows:

Ignitable: In general has a flash point of less than 140 F.
Example: waste paints, solvents and certain degreasers.

Corrosive: In general is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5. Example: rust removers, waste acid or alkaline, waste battery acid.

Reactive: Unstable or undergoes violent or rapid reaction with air or water. Example: cyanide plating wastes, waste bleaches and other strong oxidizers.

Toxicity: Extract of a waste that is found to contain concentrations of the following chemicals above specific threshold values:

EP Toxicity - Current list in effect:

Arsenic
Barium
Cadmium
Chromium
Lead
Mercury
Selenium
2,4,5-TP, Silvex
Silver
Endrin
Lindane
Methoxychlor
Toxaphene
2.4-Dichlorophenoxyacetic acid

TCLP (Toxicity Characteristic Leaching Procedure) to be instituted for some generators by September 1990. Includes EP Toxicity constituents plus the following:

Benzene
Carbon tetrachloride
Chlordane
Chlorobenzene
Chloroform
O-cresol
M-cresoi
P-cresol
1,4-dichlorobenzene
1,2-dichloroethylene
1,1-**dichloroethylene**
2,4-dinitrotoluene
Heptachlor
Hexachlorobenzene
Hexachloro-1,3-butadiene
Hexachloroethane
Methyl ethyl ketone
Nitrobenzene
Pentachlorophenol
Pyridine
Tetrachloroethylene
Trichloroethylene
2,4,5-trichlorophenol
2,4,6-trichlorophenol
Vinyl chloride

C. Mixture Rule: (40 CFR § 261.3) A solid waste is a hazardous waste if it is a mixture of a solid waste and one or more hazardous wastes listed in Subpart D or if the mixture exhibits a characteristic listed in Subpart C.

It is the responsibility of the generator to determine if the wastes are hazardous. Some contacts that can assist the generator are as follows:

Government Agencies:

EPA Regional Office: **1-(415)-744-1730**

RCRA/Superfund Hotline: 1-800-424-9346

EPA Small Business Ombudsman **Hotline: 1-800-368-5888**

State of Hawaii, Department of Health **(808) 543-8226**

Private Contractors:

Unitek Environmental Services, Inc. **(808) 834-1444**

3.0 GENERATOR TYPE

There are three types of generator categories that the **EPA** designates, based on how much hazardous waste they accumulate monthly. These generator classifications are listed below:

A Conditionally Exempt Small Quantity Generator:

Generates no more than **100 kilogram/month** of hazardous waste or no more than 1 kg. of acutely hazardous waste per month **(40** CFR **§261.5).**

Highlights of EPA regulations for the conditionally exempt small quantity generator are:

- Identify all hazardous wastes generated

- Send the generated wastes to a hazardous waste disposal facility approved by state or federal agencies.

- Never accumulate greater than 1,000 kg. of hazardous waste on your property (if more than 1,000 kg. is accumulated, the generator is considered a small quantity generator).

- Record keeping (not required but recommended).

B. Small Quantity Generator:

Generates more than 100 kg. and less than 1,000 kg. of hazardous wastes and no more than 1 kg. of acutely hazardous waste in any month. (40 CFR §§262.42 and 262.44)

Highlights of EPA regulations for the small quantity generator are:

- Store no more than 6,000 kg. of hazardous waste on site no more than 180 days.

- Store no more than 1 kg. of acutely hazardous waste in any calendar month.

- Notify EPA of hazardous waste activities **(i.e.,** obtain an EPA identification number).

- Keep records or copies of test results, waste analysis, exception reporting, manifests and biennial reports for a minimum of three years.

C Large Quantity Generator:

Generates 1,000 kg. or more of hazardous waste or more than 1 kg. of acutely hazardous waste in any month (40 CFR Part 262).

Highlights of EPA regulations for the large quantity generator are:

- Compliance with all applicable hazardous waste management rules.
- Store hazardous wastes for no longer than 90 days.
- Notify EPA of hazardous waste activities **(i.e.,** obtain an EPA identification number).
- Keep records: or copies of test results, waste analysis, exception reporting, manifests and biennial reports for a minimum of three years.

4.0 PREPAREDNESS/PREVENTION AND CONTINGENCY PLANS

A Preparedness/Prevention (Accident prevention and preparedness).

Generators must take steps to prevent any releases of the stored or generated hazardous waste to the environment. Some of these steps are listed below (40 CFR § 265.30-37):

- Emergency equipment installed at the facility such as an alarm, fire extinguishers, telephone, automatic sprinklers or hoses. This equipment must be readily available to employees trained in its use.
- Notify in writing to local agencies (fire, police, hospital and state or local emergency response teams) of types of wastes at the facility and ask for their **cooperation** in the event of an emergency. Also familiarize these agencies with your facility.
- Provide enough space for emergency response teams and their equipment to gain access into your facility during an emergency.

B. Contingency Plans Highlights **(40** CFR **§ 265.50-56):**

- Emergency coordinator must be appointed and available **24** hours a day.
- The name and telephone number of the emergency coordinator, phone numbers of emergency agencies and location of emergency equipment must be posted near a telephone in the facility.
- Employees must be familiarized with hazardous waste handling and emergency procedures.
- In the event of a fire, call the fire department or use a fire extinguisher if feasible.
- In the event of a spill, attempt to contain the flow of hazardous waste and call the National Response Center (NRC) **(1-800-424-8802).** As soon as possible, clean up the hazardous waste and any materials that are contaminated by the spill.
- In the event of a fire, explosion or other release notify the NRC immediately.
- Have an evacuation plan in case evacuation becomes necessary.

5.0 CHOOSING A HAZARDOUS WASTE HAULER

The hazardous waste generator is responsible for its hazardous waste from "cradle to grave", or from the moment the waste is generated until its ultimate disposal. Even though the hazardous waste hauler and the ultimate treatment or disposal site is handling your hazardous wastes beyond your control, you are still responsible for proper management of the hazardous waste. Choose them **carefully!**

Choose a hauler and hazardous waste management facility with a EPA identification number. Check with the state hazardous waste management agency to determine if the company has an EPA identification number and if it has a good reputation.

Check that the company has the necessary permits and Insurance.

6.0 MARKING, LABELING AND PACKAGING

Before transportation of hazardous waste a generator must mark, label and package the waste in accordance with applicable DOT regulations for hazardous materials.

A Marking highlights:

In general, any person who offers for transportation a hazardous material in packaging with a capacity of 110 gallons or less must mark the package with the proper shipping name and identification number that is listed for the specific hazardous material in 49 CFR §§172.101 or 172.102 and with the following words and information displayed in accordance with the requirements of 49 CFR 172.304:

HAZARDOUS WASTE
Federal Law Prohibits Improper Disposal
If found, contact the nearest police or public safety
authority, or the U.S. Environmental Protection Agency

Generator's Name and Address_____
Manifest Document Number_____
(An example of this mark is included in the Appendix of this report.)

1. The proper shipping name is not required to include the word "waste" if the package has the EPA marking as in 49 CFR 172.304.
2. Each non-bulk package of hazardous material must be marked with the

technical name of the hazardous material in parentheses and written next to the proper shipping name (49 CFR 172.301 (c).

3. Marking must be durable and affixed to a label, tag or sign on the surface of the package. The mark must be unobscured by labels or attachments and away from any other marking that could impede its effectiveness. The mark must be displayed on a background of contrasting color (49 CFR §172.304).

4. Each package containing a hazardous material to be transported must be marked with the name and address of the consignee or consigner (49 CFR 172.306).

5. Abbreviations are not allowed in the proper shipping name except for "ORM" and other exceptions listed in this section (49 CFR 9172.308).

B. Labeling Highlights:

In general, any person who offers a package, overpack, or freight container containing a hazardous material for transportation shall label it with labels listed for the material in 49 CFR §172.101 (column 4).

1. A package containing a material that is defined as more than one hazard class must be labeled for each class of material. For example, a poison B liquid that is also flammable must be labeled as a poison and flammable liquid (49 CFR $172.402).

2. Each label required by this subpart must be printed on or fixed to the surface of the package near the marked proper shipping name (49 CFR § 172.407).

3. Each label fixed or printed on a package must be weather resistant and durable. In addition, the label must be a diamond or square on point shape and at least four inches on each side with a black solid line border one quarter inch from the edge (49 CFR §§ 172.411, 172.416, 172.444).

C. Packaging Highlights (CFR 49 Part 173)

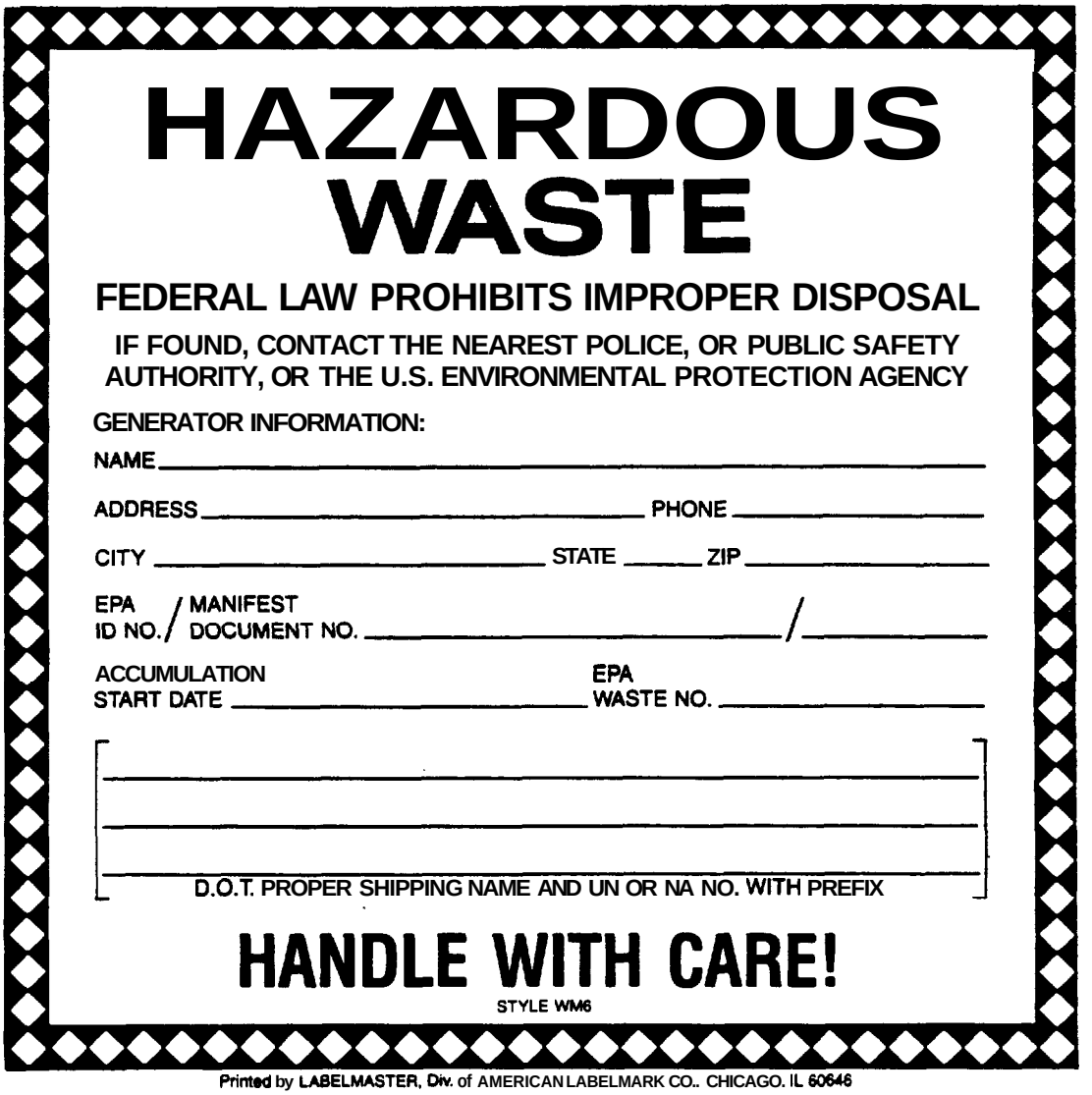
Standard requirements for all packages (CFR 49 § 173.24):

- Each package used for shipping hazardous materials will be constructed and designed so that there is no release of hazardous materials to the environment and there will be no mixture of gases or vapors which could cause the package to explode.

- Each DOT specified container must be marked in an unobstructed area with letter and numerals identifying the container (example DOT -1A or DOT 17E). Refer to the Hazardous Material Table 49 CFR § 172.101 column 5.

- Letters should be easily read and at least one half inch high.

APPENDIX



EPA marking required by 40 CFR 262.32

WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL

IF FOUND, CONTACT THE NEAREST POLICE, OR PUBLIC SAFETY AUTHORITY, OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY

GENERATOR INFORMATION:

NAME _____

ADDRESS _____ PHONE _____

CITY _____ STATE Z I P _____

EPA ID NO. / MANIFEST DOCUMENT NO. _____ / _____

ACCUMULATION START DATE _____ EPA WASTE NO. _____

_____

_____

_____

D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX

HANDLE WITH CARE!

STYLE WM6

Printed by LABELMASTER. Div. of AMERICAN LABELMARK CO.. CHICAGO. IL 60646

EPA marking required by 40 CFR 262.32

Environmental Hotlines

Solid Waste and Hazardous Waste (RCRA) and Superfund .....(800) 424-9346

Chemical Emergency Preparedness Program, including Community Right-to-Know, Sections 311-313 of Title III (provides information on reporting of hazardous substances for community planning purposes) .....(800) 535-0202

Toxic Substances Control Act (TSCA) & Asbestos Technical Information & Referral .....(202) 554-1404

Safe Drinking Water (provides information on public water supply program, policy, technical and regulatory items) .....(800) 426-4791

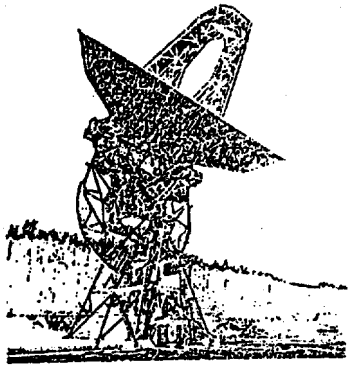
National Pesticide Telecommunications Network (provides information about pesticides—spill handling, disposal clean-up and health effects) .....(800) 858-7378

National Response Center (operated by the U.S. Coast Guard for reporting oil spills and hazardous substance releases) .....(800) 424-8802

National Appropriate Technology Assistance Service (operated by the Department of Energy for inquiries on energy related matters) .....(800) 428-2525

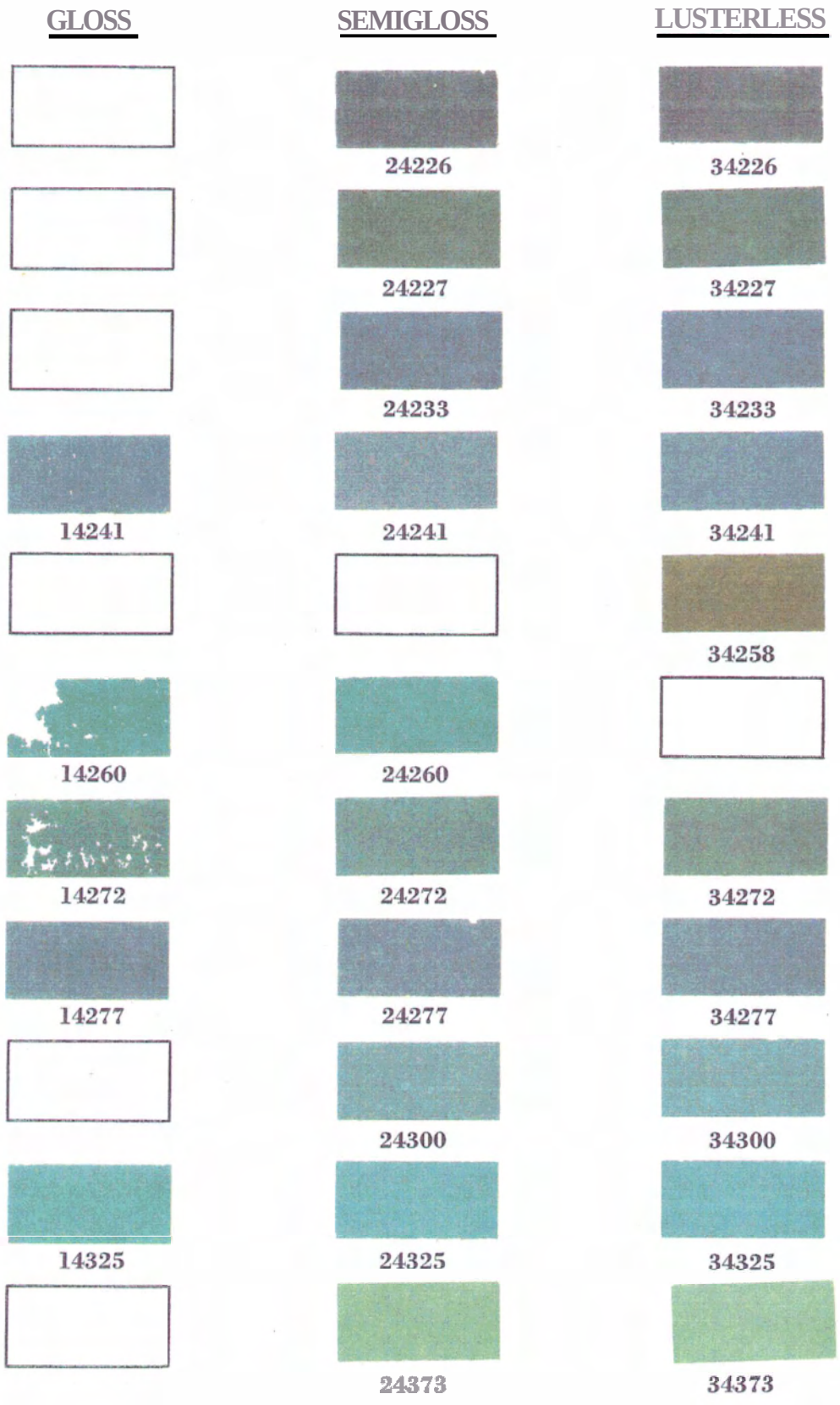
Transportation of Hazardous Materials (operated by the Department of Transportation and the Federal Emergency Management Administration) for questions about the transportation of hazardous materials .....(800) 752-6367

Municipal and Hazardous Waste Management (operated by the Government Refuse, Collection and Disposal Association) .....(800) 456-4723



Appendix G
Federal Paint Samples

Appendix G
Federal Paint Samples



Source: Federal Standard No. 595a colors, January 2, 1968.