Final

GROUND BASED RADAR (GBR) FAMILY OF RADARS ENVIRONMENTAL ASSESSMENT

May 1993

U.S. ARMY PROGRAM EXECUTIVE OFFICE
GLOBAL PROTECTION AGAINST LIMITED STRIKES

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prepared for:

U.S. ARMY PROGRAM EXECUTIVE OFFICE
GLOBAL PROTECTION AGAINST LIMITED STRIKES
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FINDING OF NO SIGNIFICANT IMPACT

GROUND BASED RADAR (GBR) FAMILY OF STRATEGIC AND THEATER RADARS ENVIRONMENTAL ASSESSMENT (EA)

AGENCY: Department of Defense, United States Army

ACTION: Finding of No Significant Impact

DESCRIPTION OF PROPOSED ACTION: The proposed activities constitute the testing of the GBR project as a part of the defense acquisition process. Phase I of the testing will consist of fabrication and testing of both the Theater Missile Defense (TMD)-GBR and GBR-Test (GBR-T) at various Raytheon Company facilities in Massachusetts. Phase II will consist of installation, integration, and testing of the TMD-GBR at site R-409 on White Sands Missile Range (WSMR), New Mexico. In addition, GBR-T will be installed and tested on Building 1500 at U.S. Army Kwajalein Atoll (USAKA) in the Republic of the Marshall Islands. Phase III will consist of functional technology validation testing against target missiles. The TMD-GBR will be tested at sites R-409 and LC-39 on WSMR and at site IFC-25 located adjacent to WSMR on Fort Bliss. The successful completion of the activities will demonstrate TMD-GBR and GBR-T capabilities to integrate hardware and software, prove discrimination capabilities, and validate the functional technology against target missiles. The above actions have been addressed in the GBR Family of Strategic and Theater Radars EA, May 1993, which is incorporated by reference. In addition, in 1989, an environmental assessment for testing a similar ground based radar at Kwajalein Island, Kwajalein Atoll resulted in a Finding of No Significant Impact.

ALTERNATIVES CONSIDERED: Alternatives considered in the GBR Family of Radars EA in addition to the proposed actions include the following: alternative test ranges; alternative sensors including existing ground based sensors, space-based sensors, ship-borne sensors, airborne sensors, and other ground-based sensing techniques; alternative siting locations (five sites for TMD-GBR and one site for GBR-T); and the No Action Alternatives which would defer the testing activities while continuing with sensor concept exploration activities.

ANTICIPATED ENVIRONMENTAL EFFECTS: The environmental consequences of TMD-GBR and GBR-T activities were determined to be not significant at the Raytheon Company facilities as well as the test sites at WSMR, Fort Bliss and USAKA. Kwajalein Island, Kwajalein Atoll is listed in the National Register of Historic Places. Potentially significant impacts could result from ground disturbing construction activities for facilities, utilities and infrastructure at each test range. These impacts will be mitigated by implementing preconstruction archaeological surveying, testing, and monitoring of selected sites prior to and during construction. The operation of the GBR will result in the generation of electromagnetic radiation (EMR). Potentially significant EMR impacts to public health and safety will be mitigated to a level of no significant impact by implementing operational safety measures, identifying safety zones for TMD-GBR only, utilizing a separate safety computer and EMR monitoring sensors for GBR-T only, and coordinating with range air control. Plant and wildlife species, including endangered and threatened species, will not be significantly affected by the activities due to the previously disturbed nature of the test sites and the low EMR/power density values on the ground near the radars. The power densities on the ground for the GBR-T will not exceed 5 milliwatts per square centimeter averaged over 6 minutes within 2 kilometers of the radar and 1 milliwatt per square centimeter averaged over 6 minutes for distances beyond 2 kilometers. These power densities are within the American National Standards Institute (ANSI) standards for health and human safety. A separate safety computer will be utilized to calculate EMR fields, and ensure that ANSI safety standards are not exceeded. Sensors will also be installed to measure EMR fields, and ensure that safety standards are not exceeded. An EMR safety zone is not required for the GBR-T because ANSI standards will be met on the ground at all locations at USAKA. For the TMD-GBR, a 100 meter safety zone will be established in front of the radar antenna to meet the ANSI health and human safety standard (5 milliwatts per square centimeter averaged over 6 minutes). The GBR will have no significant effects on electroexplosive devices, electronic medical devices, existing radars, and communications equipment since appropriate mitigation measures associated with range operations will be followed. Ground water resources will not be significantly affected by any of the test activities. Potentially significant housing and office space impacts at USAKA, WSMR and Fort Bliss will be mitigated by the dedication of housing units to GBR project personnel and modification of existing structures for housing, office, and operations and maintenance space.

CONCLUSIONS: Based on the environmental impact analyses found in the GBR Family of Radars EA, which are hereby incorporated by reference into this Finding of No Significant Impact (FNSI), it has been determined that implementation of the proposed testing activities will not have significant individual or cumulative impacts on the quality of the natural or the human environment. Because there would be no significant environmental impact resulting from implementation of the proposed activities, an Environmental Impact Statement is not required and will not be prepared.

DEADLINE FOR RECEIPT OF WRITTEN COMMENTS: There is a 15-day waiting period from the date of appearance of this FNSI in the Federal Register for the public to comment prior to implementation of the proposed testing activities.

POINT OF CONTACT: Persons wishing to comment may obtain a copy of the EA or inquire into this FNSI by writing to: Deputy Commander, U.S. Army Space and Strategic Defense Command, ATTN: Mr. Kenneth R. Sims, CSSD-EN-V, P.O. Box 1500, Huntsville, AL 35807-3801. Verbal comments and questions regarding the EA and FNSI may be directed to Mr. Sims at (205) 955-5075.

William S. Chen — 6/18/93

WILLIAM S. CHEN — Date
Major General, U.S. Army
Program Executive Officer
Missile Defense

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THIS ENVIRONMENTAL ASSESSMENT DOCUMENTS THE RESULTS OF AN ANALYSIS OF THE POTENTIAL FOR AND MAGNITUDE OF IMPACTS RESULTING FROM DEMONSTRATION/VALIDATION ACQUISITION PHASE TEST ACTIVITIES FOR THE GROUND BASED RADAR FAMILY OF STRATEGIC AND THEATER RADARS. THE STRATEGIC TEST ACTIVITIES WOULD OCCUR AT U.S. ARMY KWAJALEIN ATOLL, REPUBLIC OF THE MARSHALL ISLANDS. THE THEATER TEST ACTIVITIES WOULD OCCUR AT WHITE SANDS MISSILE RANGE (WSMR), NEW MEXICO, AND AREAS OF FORT BLISS, TEXAS, LOCATED ADJACENT TO WSMR WITHIN NEW MEXICO.

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EXECUTIVE SUMMARY

The Strategic Defense Initiative (SDI) Program, announced by former President Reagan on March 23, 1983, and modified by the Congress in the Missile Defense Act of 1991 and the 1993 Defense Authorization Act, has resulted in an extensive research program designed to determine the feasibility of developing an effective defense against any limited missile strike regardless of the source. The SDI program is being implemented under the Program Executive Office, Global Protection Against Limited Strikes, and is designed to protect the United States, our forces overseas, and our allies and friends abroad. This Ballistic Missile Defense (BMD) program consists of three segments: Global Missile Defense (GMD), National Missile Defense (NMD), and Theater Missile Defense (TMD). As part of its research and development efforts for BMD, the U.S. Army Space and Strategic Defense Command (USASSDC) is implementing a Ground Based Radar (GBR) program.

The requirement for a GBR for both NMD and TMD has led to the development of a family of radars acquisition program. The family of radars includes two different GBR configurations using common components. This approach would provide maximum modularity and commonality in the system components. These two GBRs are identified as TMD-GBR and GBR-Test (GBR-T). TMD-GBR would support TMD requirements. The GBR-T would be designed to support NMD requirements.

The purpose of this Environmental Assessment (EA) is to determine the extent of environmental impacts resulting from implementation of the proposed action and to determine whether these impacts are significant. This EA has been prepared in accordance with Council on Environmental Quality and Department of Defense (DoD) regulations that implement the National Environmental Policy Act. In order to verify that the GBR technology is feasible, effective, and producible for the radar requirements of NMD and TMD systems, the program has entered into the demonstration/validation (DEM/VAL) phase of the DoD acquisition process.

The proposed action for this EA is the implementation of the DEM/VAL program. GBR DEM/VAL includes numerous activities for the design, assembly, and testing of the TMD-GBR and GBR-T systems. The TMD-GBR DEM/VAL effort would involve development of a testbed radar system that would be used to resolve critical TMD radar and interceptor integration technical issues during testing. The GBR-T DEM/VAL activities would develop the GBR-T system to be used to resolve critical NMD radar issues and to be available for integrated testing with ballistic missile interceptor systems.

The TMD-GBR and the GBR-T systems would be designed, assembled, and tested by the Raytheon Company using existing facilities in Massachusetts. After completion of the manufacturing activities at Raytheon Company facilities, the GBR systems would be shipped to their respective proposed test site locations at U.S. Army facilities at White Sands Missile Range (WSMR)/Fort Bliss in New Mexico and U.S. Army Kwajalein Atoll (USAKA) in the Republic of the Marshall Islands.

WSMR/Fort Bliss and USAKA were the National Test Range locations considered reasonable for the proposed action. The use of existing programs and facilities at WSMR/Fort Bliss and USAKA would minimize the cost of the GBR family of radars program as well as minimize the potential for environmental impacts. Both WSMR and USAKA are approved test ranges under the 1972 Anti-Ballistic Missile Treaty.

The selection of USAKA as the location for the GBR-T was based on the fact that USAKA is the primary downrange splashdown zone for ballistic missiles launched in the Western Test Range. Given the current mission of the Western Test Range for missile flight testing, USAKA is the only reasonable location to test the GBR because of the need to locate the radar at the terminus of the target vehicle trajectory as well as the need to rely on existing programs to provide target objects.

Alternatives to the proposed action, including the no action alternatives, were considered for test site locations. Other test site locations considered were rejected as not reasonable for the proposed action due to the potential for increased environmental impacts, and they did not meet mission requirements. Sensor alternatives were previously considered but were not carried forward because they were not appropriate for the GBR mission.

TMD-GBR

The TMD-GBR activities at WSMR/Fort Bliss would last approximately three years. Eight alternative sites at WSMR/Fort Bliss have been identified as suitable for TMD-GBR testing. Of the eight sites, a minimum of three is required. All alternative sites exhibit previously disturbed areas sufficient for location of the TMD-GBR systems. Site-preparation activities would consist of clearing, leveling, compacting, and graveling. Some trenching for placement of utility lines and communications cables would occur in disturbed areas and existing right-of-ways.

Air Quality

Air quality impacts resulting from fugitive dust raised during site preparation activities would be minimal due to the short duration of activities and because the dust primarily is composed of large particles that would settle close to the site. Potential air quality impacts from the emissions of generators and transport vehicles are not anticipated to be significant because daily operation of the TMD-GBR is not anticipated and emissions at WSMR/Fort Bliss would not exceed federal or state ambient air quality standards.

Biological Resources

No impacts to the Aplomado falcon (*Falco femoralis septentrionalis*), a federal endangered species, from the TMD-GBR electromagnetic radiation (EMR) would be anticipated because the falcon's foraging habitat is not in the area of the proposed test sites. Potential impacts to the Texas horned lizard (*Phrynosoma cornutum*), a federal candidate species, also are not anticipated because the lizard is not expected to frequent test site areas that incur human activity.

The effects of EMR on biological resources are not expected to be significant for several reasons: the power density values of potential concern occur only within approximately 1 kilometer (0.6 miles) as measured from the face of the antenna along any given radar main beam; the radar beam would normally be in motion and not concentrated in one spot for a long time; the size of the beam is rather small close to the antenna where EMR values would be the greatest; and removal of the pole at Launch Complex 39 would eliminate possible exposure to birds that may have perched there.

Cultural Resources

No cultural resources sites have been identified or recorded at any of the WSMR/Fort Bliss test locations. However, previously unknown sites may be discovered as a result of the trenching and construction required for the installation of additional power and communication lines and septic facilities. Preconstruction archaeological surveying and testing of selected sites and on-site monitoring during construction are sufficient measures to mitigate any potential impacts to a level of nonsignificance.

Hazardous Materials/Waste

No significant adverse impacts from hazardous materials and waste used and generated by the TMD-GBR program are anticipated due to compliance with appropriate installation guidelines. The asbestos in Building 24068 at WSMR is a potentially significant but mitigable impact because an asbestos abatement program would be implemented, as appropriate, in compliance with federal guidelines.

Infrastructure

No significant adverse impacts to the WSMR/Fort Bliss infrastructure are anticipated because program-related activities would be conducted in existing facilities and mobile trailers. Portable latrines and a septic system would be provided. Power demands would be met by commercial power and portable generators.

Land Use

No changes to the current land uses at WSMR or Fort Bliss are anticipated; therefore, no potential significant impacts are expected.

Noise

No significant noise impacts from the generators are expected because they would be fitted with noise shields. Commercial power would be used where available, thus reducing the need to use portable generators. Due to the short duration of the proposed activities, no other noise impacts are anticipated.

Public Health and Safety

Potentially significant but mitigable impacts to program-related personnel and aircraft resulting from EMR would be brought to a level of nonsignificance based upon an extensive mitigation program that includes numerous safety measures such as operation of the main beam at least 4 degrees above horizontal, computerized safety controls, identified safety zones, and TMD-GBR coordination with range air control.

Socioeconomics

No potentially significant socioeconomic impacts to the region are anticipated due to the limited number of personnel required and the limited duration of stay (approximately three years).

Water Quality

No potentially significant impacts to water quality are anticipated. Runoff should be minimal due to the limited amount of rainfall. Wastes would be disposed of in portable latrines and septic tanks, proper permits would be obtained, water would be trucked to the sites, and accidental discharges of hazardous and nonhazardous waste would be remediated immediately.

GBR-T

The GBR-T activities at USAKA would occur over a period of approximately four years. Construction activities include interior modifications to Building 1500 and installation of utility, communication, and sewer lines to connect Building 1500 to the existing infrastructure systems at USAKA. In addition, two masonry structures would be built to house fire protection equipment and transformers. EMR sensors also would be placed around the island. Most of the construction activities would occur in the fill area of Kwajalein Island. Mitigation measures would be implemented to reduce potentially significant impacts to cultural resources, public health and safety, and socioeconomics to a level of nonsignificance.

Air Quality

GBR-T would use existing power at USAKA. Emissions from the power plants at USAKA, in connection with the GBR-T test activities, would not adversely affect air quality based on current

United States air quality standards. Although the use of the refrigerant hydrochlorofluorocarbon 22 (R-22) to cool Building 1500 would be eliminated by the year 2020 pursuant to the Clean Air Act, the DEM/VAL phase of GBR-T is anticipated to be conducted from 1993 to 1997, which is within the time frame that would permit the use of R-22. Minimal fugitive dust or construction equipment emissions are anticipated. No potential significant impacts to air quality are anticipated.

Biological Resources

No significant adverse impacts to birds from EMR are expected because the probability of birds entering and remaining within the GBR-T main beam is extremely low. No other wildlife would be affected by the GBR-T activities since the main beam would normally be operated at least 2 degrees above horizontal.

Cultural Resources

Previously unknown cultural resources may be discovered as a result of construction activities associated with the installation of additional utility, communication, and sewage lines; the building of two new masonry structures for fire protection and transformers; and the placement of EMR sensors around the island. These potential impacts would be mitigated to a level of nonsignificance by the implementation of an archaeological mitigation program. Mitigation measures would include preconstruction surveying and testing, avoidance of the original area of the island by limiting construction activities to the fill area, and on-site archaeological monitoring during the construction phase. The mitigation program would be coordinated in consultation with the Historic Preservation Officer of the Republic of the Marshall Islands and the U.S. Advisory Council on Historic Preservation.

Hazardous Materials/Waste

No potentially significant impacts from hazardous materials and waste are anticipated from the GBR-T program. Petroleum products would be handled and disposed of properly.

Infrastructure

No potentially significant impacts to USAKA infrastructure are expected as a result of the GBR-T test activities because existing power and waste facilities have adequate capacity to accommodate the program. However, installation of additional utility and sewage lines to connect Building 1500 to the existing systems would be required. No significant impacts to the infrastructure are anticipated.

Land Use

Existing building height limitations associated with the use of the Air Navigation Criterion have no effect on GBR-T because Building 1500 is outside the height limitation envelope. Therefore, no significant adverse effects to land use are anticipated.

Noise

Noise from construction activities associated with the installation of GBR-T at Building 1500 would not create a potentially significant impact because activities would be of short duration and the majority of construction would occur inside Building 1500. Any noise from computers and electrical equipment for the operation of GBR-T would be minimized with appropriate soundproofing material and would be restricted to the area within Building 1500.

Public Health and Safety

Potential significant health and safety impacts from GBR-T EMR would be mitigated to a level of nonsignificance with implementation of a comprehensive mitigation program. This program includes numerous elements such as system design to control radar power densities, normal operation of the main beam at least 2 degrees above horizontal, EMR sensors on the island, coordination and notification with air traffic control, appropriate warnings for people with cardiac pacemakers, and continued studies by the Electromagnetic Compatibility Analysis Center.

Socioeconomics

Potentially significant impacts to existing housing at USAKA would be mitigated to a level of nonsignificance by construction of the currently proposed additional housing at USAKA and reservation of a portion of these units to accommodate GBR-T project personnel and contractors.

Water Quality

No significant adverse water quality impacts from GBR-T are anticipated because project activities would be conducted in compliance with all existing regulations.

CONCLUSION

All potentially significant environmental effects from the GBR DEM/VAL activities would be avoid or mitigated. The only potential cumulative impact that has been identified is the availability of housing at USAKA. The construction of the currently proposed housing units at USAKA would alleviate the shortage, but housing requirements for personnel would continue to be evaluated in the future on a project-by-project basis.

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LIST OF ACRONYMS AND ABBREVIATIONS

ABM	antiballistic missile
ACHP	Advisory Council on Historic Preservation
AEGIS	The Navy's advanced, fast reaction, high fire power, shipboard anti-air warfare area defense system (Greek word for "shield)
AEU	antenna equipment unit
AFB	Air Force Base
ANSI	American National Standard Institute
AR	Army Regulation
AWACS	Airborne Early Warning and Control System
BMD	ballistic missile defense
CEQ	Council on Environmental Quality
CEU	cooling equipment unit
CFR	Code of Federal Regulations
CO	carbon monoxide
DEM/VAL	demonstration/validation – a phase of the acquisition process
dem/val	TMD-GBR system configuration, which has a smaller antenna configuration than the UOE system
DoD	U.S. Department of Defense
EA	Environmental Assessment
ECAC	Electromagnetic Compatibility Analysis Center
EED	electroexplosive device
EEU	electronic equipment unit
EIS	environmental impact statement
EMR	electromagnetic radiation
EPA	U.S. Environmental Protection Agency
FAA	Federal Aviation Administration
FTV	functional technology validation
GBR	ground based radar
GBR-T	ground based radar-test
GMD	global missile defense
GPALS	global protection against limited strikes
HF	high frequency
HMMWV	high-mobility multipurpose wheeled vehicle
HPO	Historic Preservation Officer
ICBM	intercontinental ballistic missile
IFC	in-flight control
IEEE	Institute of Electrical and Electronics Engineers
LC	launch complex
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NMD	national missile defense

NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NTIA	National Telecommunications and Information Administration
O_3	ozone
OCU	operators control unit
OSHA	Occupational Safety and Health Administration
PATRIOT	phased-array tracking to intercept of target
PAVE PAWS	precision acquisition of vehicle entry phased-array warning system
Pb	lead
PCB	polychlorinated biphenyl
PEO	Program Executive Office
PM_{10}	respirable particulate matter
PMRF	Pacific Missile Range Facility
PPU	prime power unit
R-22	hydrochlorofluorocarbon-22, a Class II refrigerant
RCRA	Resource Conservation and Recovery Act
RF	radio frequency
RMI	Republic of the Marshall Islands
ROI	region of influence
RV	reentry vehicle
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SLBM	sea-launched ballistic missile
SO_2	sulfur dioxide
TEMP	Test and Evaluation Master Plan
THAAD	theater high-altitude area defense
TMD	theater missile defense
TOO	target of opportunity
UOE	user operational evaluation
UPH	unaccompanied personnel housing
USAADASCH	U.S. Army Air Defense Artillery School
USACOE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USAKA	U.S. Army Kwajalein Atoll
USANMD	U.S. Army National Missile Defense
USASDC	U.S. Army Strategic Defense Command
USASSDC	U.S. Army Space and Strategic Defense Command
VOC	volatile organic compounds
WSMR	White Sands Missile Range

UNITS OF MEASURE

cm	centimeter
dB	decibel
dBA	A-weighted decibel
°C	degrees Centrigrade
°F	degrees Fahrenheit
ft	foot

ft^2	square foot
FY	fiscal year
in	inch
kg	kilogram
km	kilometer
km^2	square kilometer
kW	kilowatt
L_{dn}	average annual day-night level
m	meter
m^2	square meter
MHz	megahertz
mi	mile
mi^2	square mile
MW	megawatt
mW/cm^2	milliwatt per square centimeter
mW/in^2	milliwatt per square inch
nmi	nautical mile

CHAPTER ONE
DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

chapter one

DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

1.1 INTRODUCTION

This Environmental Assessment (EA) analyzes the potential environmental consequences of activities in the Demonstration/Validation (DEM/VAL) phase of the acquisition process for a proposed family of Ground Based Radars (GBRs). This EA has been prepared pursuant to the National Environmental Policy Act (NEPA); the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 CFR 1500-1508); U.S. Department of Defense (DoD) Directive 6050.1, *Environmental Effects in the United States of Department of Defense Actions* (DoD 1979); and U.S. Army Regulation AR 200-2, *Environmental Effects of Army Actions* (U.S. Department of the Army 1988). These laws and regulations direct that DoD and U.S. Army officials consider environmental consequences when authorizing or approving major federal actions in the United States. This EA also is prepared pursuant to the Compact of Free Association between the United States and the Republic of the Marshall Islands (RMI), which extends the applicability of NEPA to federal actions at the U.S. Army Kwajalein Atoll (USAKA).

Chapter 1 describes the purpose and need for the action, the proposed GBR DEM/VAL program, alternatives, and possible environmental concerns. Chapter 2 describes the affected environment at the locations where DEM/VAL activities would be conducted at White Sands Missile Range (WSMR), New Mexico; Fort Bliss Military Reservation, Texas and New Mexico; and USAKA, RMI. Chapter 2 also describes existing conditions at the Raytheon Company locations where the GBR components would be assembled, integrated, and initially tested. Chapter 3 describes and assesses the potential environmental consequences, cumulative impacts, and mitigation measures of the proposed action at these locations; and Chapter 4 summarizes the conclusions reached as a result of the evaluation.

1.2 BACKGROUND

The Strategic Defense Initiative (SDI), announced by President Reagan on 23 March 1983, initiated an extensive research program to determine the feasibility of developing an effective ballistic missile defense (BMD) system. Subsequently, the Strategic Defense Initiative Organization (SDIO) was established to plan, organize, coordinate, direct, and enhance the research and testing of technologies applicable to strategic defense.

Early in 1991, the U.S. Congress enacted the Missile Defense Act. This act refocused the SDI program from its early emphasis of responding to mass nuclear attack from a single source to protection against limited ballistic missile strikes regardless of their source. The program has been further modified by the 1993 Defense Authorization Act. Pursuant to this legislation, the

SDI program, implemented under the Program Executive Office, Global Protection Against Limited Strikes (PEO GPALS), is being designed to protect the United States and its forces and allies abroad. This BMD program has three segments: (1) Global Missile Defense (GMD), which affords protection for a large portion of the world against a limited ballistic missile attack; (2) National Missile Defense (NMD), which affords protection for the United States against a limited ballistic missile attack; and (3) Theater Missile Defense (TMD), which affords protection for United States forces and allies against a tactical ballistic missile attack in a battlefield setting.

The centrally managed BMD research and development program is under the auspices of the SDIO. As the central manager and overseer of the BMD program, the SDIO defines system requirements, sets standards, manages the overall evolution of the program, ensures the transfer of SDIO technology, and provides funding. The PEO GPALS is the material developer for GBR. Included in this tasking is the responsibility for the planning, coordination, and support of the test and evaluation activities associated with the GBR development program.

The requirement for both an NMD and a TMD-GBR system has led to the development of a "family of radars" acquisition program. The family of radars includes two different GBR configurations using common component parts. This approach would provide maximum modularity and commonality in the system components. These two GBRs are identified as GBR-Test (GBR-T) and TMD-GBR. The GBR-T radar would be designed to support NMD requirements; TMD-GBR would support TMD requirements.

The acquisition process for defense programs is divided into distinct phases separated by major milestone decision points. The milestones and related acquisition phases are:

	Milestone	Phase
0	Concept studies approval	Concept exploration and definition
I	Concept demonstration approval	Demonstration and validation
II	Development approval	Engineering and manufacturing development
III	Production approval	Production and deployment
IV	Major modification approval	Operations and support

Each of the milestone decision points establishes program goals and information required for the next decision point. The activities of the program phase prior to a milestone are designed to provide the information and data required to support either a decision to proceed or a decision not to proceed with the next program phase.

GBR has received concept demonstration approval (Milestone I) and has entered the DEM/VAL phase. The DEM/VAL activities would examine operational suitability and effectiveness by testing to determine the ability of the technology to meet the specified requirements. The DEM/VAL results would provide the necessary information required for future acquisition decisions regarding the GBR family of radars (Figure 1-1).

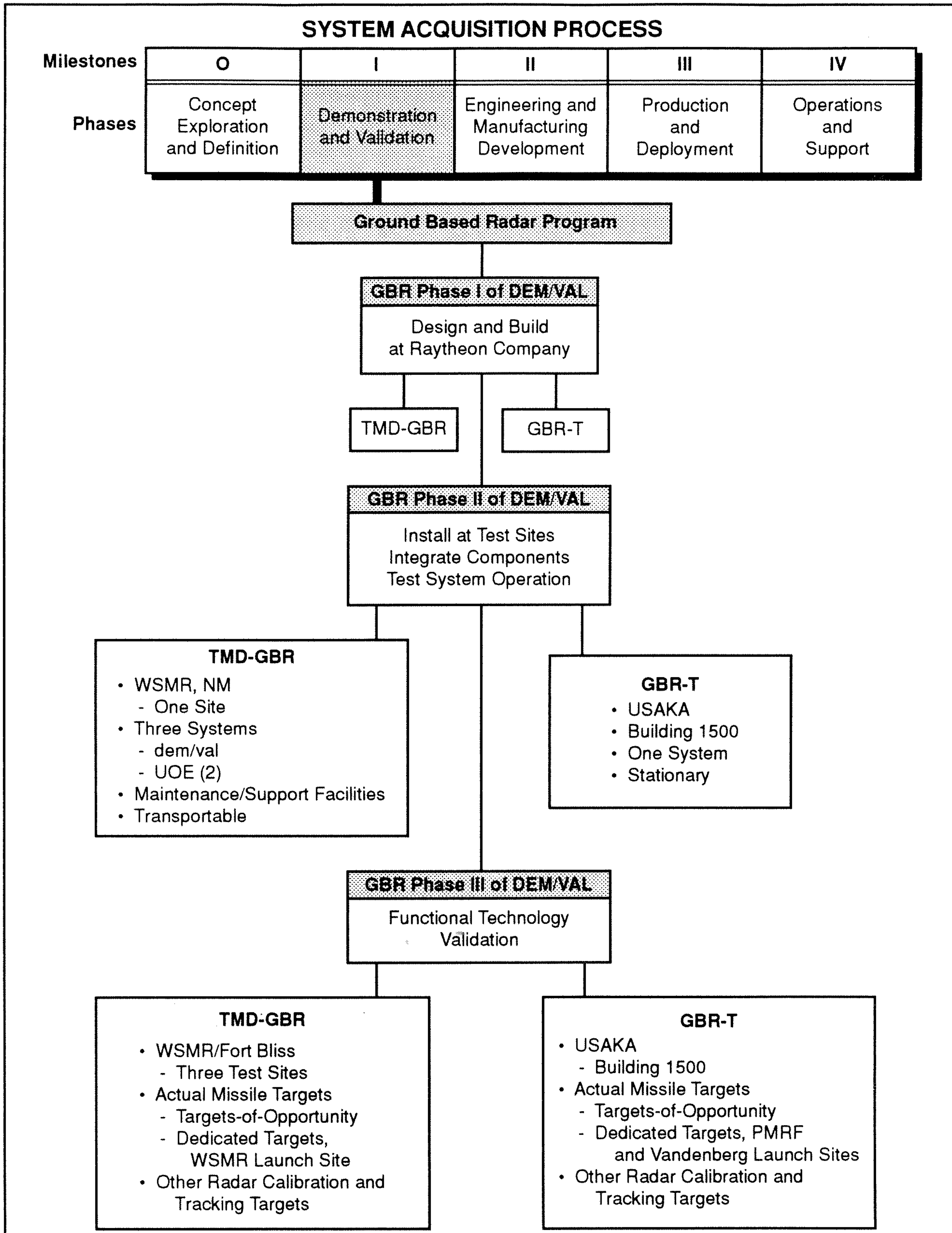


Figure 1-1. GBR program DEM/VAL phases

1.2.1 GBR DEM/VAL Program

As mentioned, the GBR system is progressing with its DEM/VAL program. An essential element of the DEM/VAL program is evaluation and refinement of the technologies that would be implemented in the GBR systems. The technologies of phased-array radar are under consideration.

Phased-array technology, which has been used in radar systems for a number of years, refers to the use of multiple transmitting elements to make up an antenna system. The system is carefully controlled by a computer that generates instructions that control the phase for each array element. The different phases of the array elements cause the transmitted electromagnetic energy to constructively combine to form a main energy beam in one direction. The radar beam is thus "steered," within defined limits, in azimuth and elevation without mechanical action. For some applications, a moveable antenna structure would be used to provide extended azimuth and elevation coverage.

Prior activities have included evaluation of existing large phased-array radar technology and associated improvements or modifications needed to use such a system in a ground-based role to supplement other sensor technologies in detecting and tracking hostile inbound intercontinental and tactical missiles. Radars based on phased-array technology have the capability to provide information to the National Command Authority concerning the characteristics of an attacking ballistic missile force. The Ballistic Missile Early Warning System and PAVE PAWS (precision acquisition of vehicle entry phased-array warning system) are examples of this type of system. Phased-array technology also has served as a deterrent to hostile nations' offensive systems. An example of this type of system is the PATRIOT (phased-array tracking to intercept of target) missile system.

The design and fabrication of both radars (TMD-GBR and GBR-T) are based upon the concept of a family of radars employing phased-array technology and using, to the maximum extent possible, hardware and software common to both systems. This is a cost-effective approach that also allows the acquisition of radar systems that can be modified for specific performance and mission requirements.

The three parameters of a phased-array antenna (pulse length, frequency, and commanded steering angles) would be monitored by computer programs (software) that control the antenna's electromagnetic radiation (EMR) pattern (i.e., the way the antenna transmits the pulsed microwave signal in various directions). This control also would be used to minimize the potential for EMR hazards. (EMR is discussed further in Section 1.2.2 and throughout this EA. Appendix A provides a detailed discussion.) Targets at different locations within the radar's field-of-view would be tracked by controlling the manner in which the radar transmits the microwave signal. Beam direction changes would be virtually instantaneous because the GBR phased-array antenna would be steered electronically. By contrast, parabolic or dish antenna radars use mechanical motion to change the direction of the transmitted beam.

The decision to proceed with the DEM/VAL program for the GBR family of radars does not preclude the possibility of advancing other technologies in the acquisition process; nor is it a decision that indicates that a TMD-GBR or a GBR-T system would be developed and deployed. Further advancement of the GBR systems in the acquisition process would require additional documentation of the environmental impact analysis process in compliance with NEPA.

1.2.2 EMR Environment

The very operation of a radar, including GBR, results in the generation of EMR. High-intensity electromagnetic fields must be evaluated for compliance with applicable standards for human exposure and the possibility of fuel ignition or the inadvertent detonation of explosives and ordnance. Furthermore, interference with aircraft electronic systems, as well as other electronic systems used on the ground, may occur under certain conditions (see Appendix A).

To reduce the potential for adverse effects occurring in individuals exposed to EMR, numerous organizations have set maximum recommended exposure levels for EMR fields. These limits incorporate information from many research studies. The recommended acceptable exposure power densities are set at a factor of 10 (or more) below (i.e., one-tenth) the level that represents a threshold for observed hazardous effects.

The present guidelines used by the U.S. Army are contained in U.S. Army Technical Guide No. 153 (*Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation*) and the USAKA *Kwajalein Missile Range Safety Manual*. Both of these documents are based on an earlier recommendation for human exposure prepared by the American National Standards Institute (ANSI 1982). In 1991, the Institute of Electrical and Electronics Engineers (IEEE) published a major revision of the 1982 ANSI standard (IEEE 1991). This new revision has recently been adopted by ANSI as a suitable replacement of the earlier standard and is central to the adoption of new acceptable EMR exposures within the U.S. Army. The IEEE standard, based on more refined information about how EMR is absorbed by the body, permits slightly higher power densities at X-band frequencies (the operating frequency band for GBR and one of the frequencies within the microwave range of frequencies [see Appendix A]) than the earlier ANSI standard it now replaces. The present U.S. Army guidelines and older ANSI standard permit up to 5 milliwatts per square centimeter (mW/cm^2) averaged over any 6-minute period. The new U.S. Army standard (consistent with the 1991 IEEE standard) would permit levels between 5.3 and 8.0 mW/cm^2 (33.9 and 51.2 milliwatts per square inch [mW/in^2]) within the X-band in uncontrolled environments (i.e., where entry into exposed areas is not controlled) depending on the frequency.

The power density values of 5.3 and 8.0 mW/cm^2 contain a large safety factor to ensure that exposures will not result in adverse health effects. In deriving the exposure standard, a power density of 100 mW/cm^2 was determined from the scientific literature to represent a potentially hazardous level. Therefore, the range of 5.3 to 8.0 mW/cm^2 (33.9 to 51.2 mW/in^2) is at a factor of almost 15 times below the assumed hazard threshold. The standard for exposure to EMR proposed for the GBR DEM/VAL would be even more conservative, thus safer, than the recommended 1992 ANSI standard. The proposed standard for GBR is 5 mW/cm^2 (32.25 mW/in^2) averaged over any 6-minute period. Pursuant to this standard, if individuals were exposed to EMR, their exposure would be a factor of 20 times less than the assumed hazard threshold.

GBR-T and TMD-GBR development and testing activities would comply with applicable federal and state regulations related to EMR exposure of both workers and the general public. In particular, the state of Massachusetts places stringent limits on EMR exposure levels (Commonwealth of Massachusetts 1983, 1986). The Raytheon Company complies with the Massachusetts exposure limits and would use these limits for their GBR DEM/VAL activities.

The GBR systems are designed so that EMR is controlled at all times. Also, GBR-T EMR is monitored continuously. This control greatly limits the amount of time radar energy is present at any given location within its EMR pattern. This is an important factor as exposure limits are time-averaged (see Appendix A).

In addition to the issue of human exposure to EMR from the GBR systems, other EMR-related health and safety concerns include potential ignition during fueling operations, the inadvertent detonation of electroexplosive devices (EEDs) and ordnance (ammunition), potential adverse impacts on wildlife such as birds that may fly through the radar beam, and interference to critical communications equipment and other electronic systems such as weather radars or cardiac pacemakers. The Electromagnetic Compatibility Analysis Center (ECAC) has performed detailed analyses for the GBR-T and TMD-GBR programs. These analyses have evaluated the issue of possible interference caused by GBR-electromagnetic fields on communications and electronics equipment used in the vicinity of the radars (additional discussion of the ECAC analyses is contained in Chapter 3 and Appendix A).

The physical parameters and operating environments of the proposed testing locations, WSMR/Fort Bliss and Kwajalein Island, are significantly different. Furthermore, the performance requirements for TMD-GBR and GBR-T are different, especially in the area of power output; GBR-T has a much higher power output than TMD-GBR. Therefore, the approach to eliminating or mitigating possible EMR effects at Kwajalein Island is a more complex process than would need to be implemented at WSMR/Fort Bliss. Much more control and monitoring of the EMR from GBR-T would be implemented at Kwajalein Island. However, regardless of the location, system operation and EMR power densities would always comply with applicable guidelines and standards for safety. Specific test site EMR discussion for TMD-GBR and GBR-T is provided in Sections 1.4.3.1 and 1.4.4.1.

1.3 PURPOSE AND NEED FOR THE ACTION

The purpose of the GBR DEM/VAL activities is to determine that the GBR technology is feasible, effective, and producible. The need for the action is to collect data to show that the system satisfies the TMD and NMD system sensor requirements. As mentioned previously, the GBR family of radars would consist of two different configurations, the TMD-GBR and the GBR-T.

The TMD-GBR DEM/VAL activities would consist of the design, fabrication, integration, and testing of three radars: a dem/val and two user operational evaluation (UOE) radar systems. The dem/val radar would be a less powerful configuration that would be used to perform testing of sensor and integration issues. **(Note: The term dem/val refers to the TMD-GBR system configuration, which has a smaller antenna configuration than the UOE system. The term DEM/VAL refers to the demonstration/validation phase of the system acquisition process.)** There would be two complete TMD-GBR UOE configurations, which would be used for further testing to resolve critical TMD issues such as surveillance, acquisition, tracking, classification, and interceptor support. The TMD-GBR UOEs would be military cargo-aircraft transportable with the capability to provide sensor support for the Unites States and allied forces in a theater of operation against tactical ballistic missiles in the event of a national contingency such as the recent Middle East Crisis.

The NMD DEM/VAL activities would consist of the design, fabrication, integration, and testing of the GBR-T. The GBR-T would resolve critical NMD radar issues and be available for integrated testing with interceptor missiles. The GBR-T would advance large phased-array radar technology. This technology would satisfy NMD sensor requirements to provide surveillance, acquisition, tracking, discrimination, and interceptor support against submarine-launched or intercontinental ballistic missile threats.

1.4 PROPOSED ACTION

The proposed action is the implementation of DEM/VAL programs for the GBR technology as it relates to missile defense. This implementation process involves planning, designing, fabricating, integrating, and installing the GBR systems at their respective test sites where their performance requirements would be validated by testing against actual targets. The successful completion of DEM/VAL activities would demonstrate that GBR can meet the following general requirements:

- demonstrate successful integration of hardware and software,
- demonstrate discrimination capabilities, and
- validate the functional technology against actual targets.

The GBR DEM/VAL program would be composed of various test program activities to be conducted at several testing sites. These activities are categorized as analyses, simulations, component/assembly testing, and validation testing. The GBR test activities would be conducted in three phases: Phase I – Raytheon Company fabrication and testing at Raytheon facilities in Massachusetts; Phase II – installation, integration, and testing at WSMR and Fort Bliss, New Mexico (for TMD-GBR), and at USAKA (for GBR-T); and Phase III – functional technology validation (FTV) of the GBR systems, to include testing against actual targets. Both GBR systems share some Phase I activities. Phases II and III would be conducted independently for each GBR system. These testing phases are described throughout this chapter (see Figure 1-1).

The Raytheon Company Equipment Division would be responsible for design, fabrication, integration, and test of the GBR systems. They would perform most of the design, fabrication, and component testing activities in their Massachusetts location. Phase II system testing would be conducted at the U.S. Army WSMR, Fort Bliss/McGregor Range, and USAKA Range facilities. A summary of GBR activities, key participants, and participant locations is presented in Table 1-1. The GBR DEM/VAL program and schedule of activities addressed in this EA are shown in Table 1-2.

This EA addresses the GBR DEM/VAL program only. This EA does not address the launch and recovery/impact of missiles being used as targets of opportunity (TOOs) during functional testing (TOOs have been analyzed in previous environmental documentation; see Section 1.4.5.2 of this EA). Any decision to advance beyond the DEM/VAL stage would be analyzed further under NEPA. In addition, the adequacy of this EA will be reevaluated if the GBR program changes.

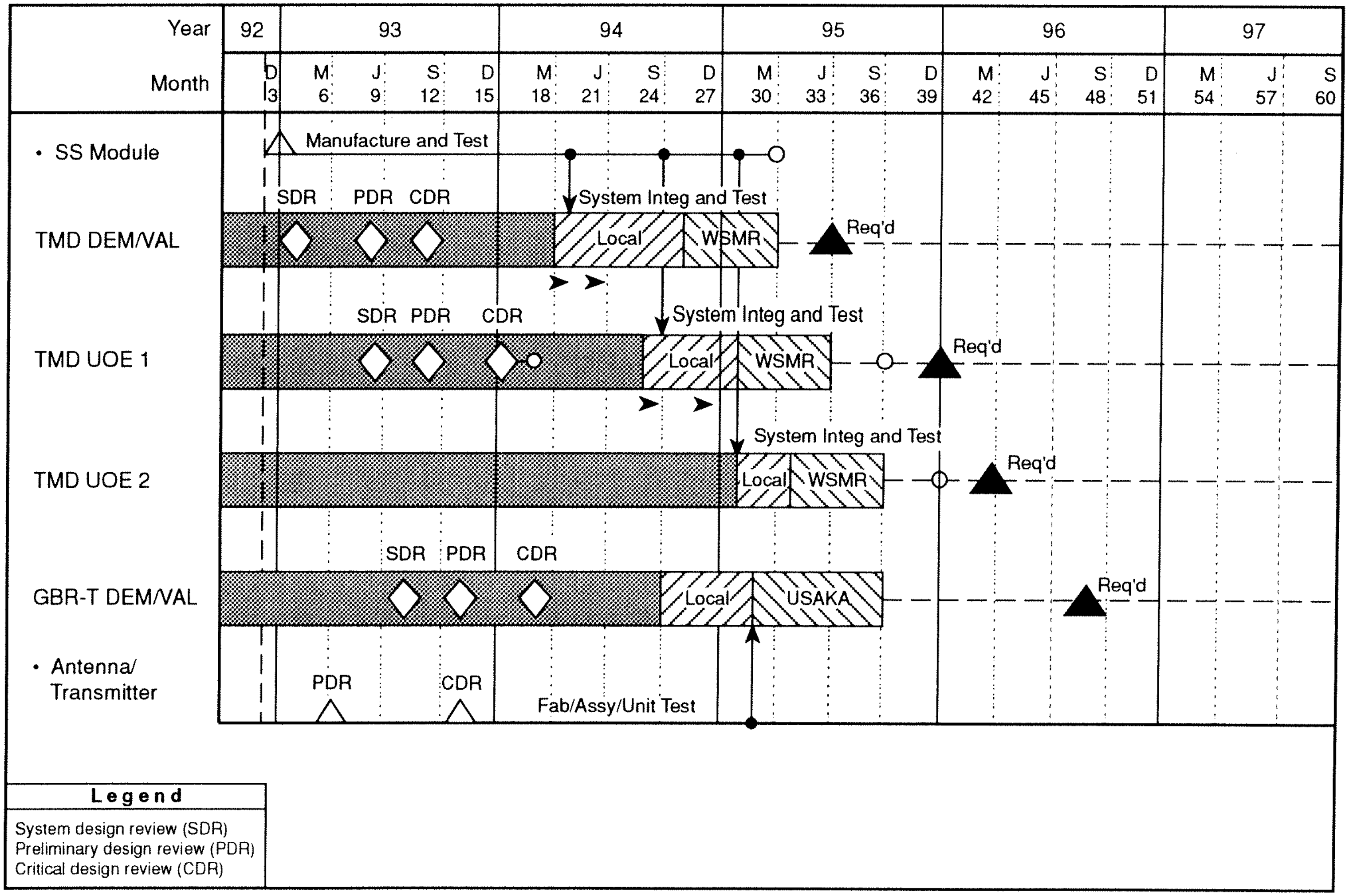
Table 1-1
Summary of GBR key participants, locations, proposed activities, and system type

Participant and Locations	Activities	GBR System
Raytheon Company Equipment Division Marlborough, MA Sudbury, MA Wayland, MA Waltham, MA	System planning, research and development, design; software development and integration, program management; integration and test system	All systems (TMD dem/val and UOEs, GBR-T)
	Fabrication, assembly, and testing of Multi-element Phase Shifter Assemblies	NMD
Raytheon Advance Device Center Andover, MA	Fabrication, assembly, and testing of beam steering module controller	All systems (TMD dem/val and UOEs, GBR-T)
	Fabrication, assembly, and testing of solid-state modules	TMD dem/val and UOEs
Raytheon Missile Systems Division Quincy, MA	Assembly/modules testing of solid-state part	TMD dem/val and UOEs
WSMR/McGregor Range NM	Installation, test, functional technology validation, and interceptor tests	TMD dem/val and UOEs
USAKA Kwajalein, RMI	Installation, test, functional technology validation, and interceptor tests	GBR-T

1.4.1 Phase I of GBR DEM/VAL Program – Raytheon Fabrication, Testing, and TMD-GBR Component Description

The fabrication, component testing, integration, and system string testing of TMD-GBRs (dem/val and two UOE units) would take place in existing Raytheon Company facilities located at several sites in Massachusetts (Figure 1-2). String tests mean the verification of the integrated

Table 1-2
GBR system schedule



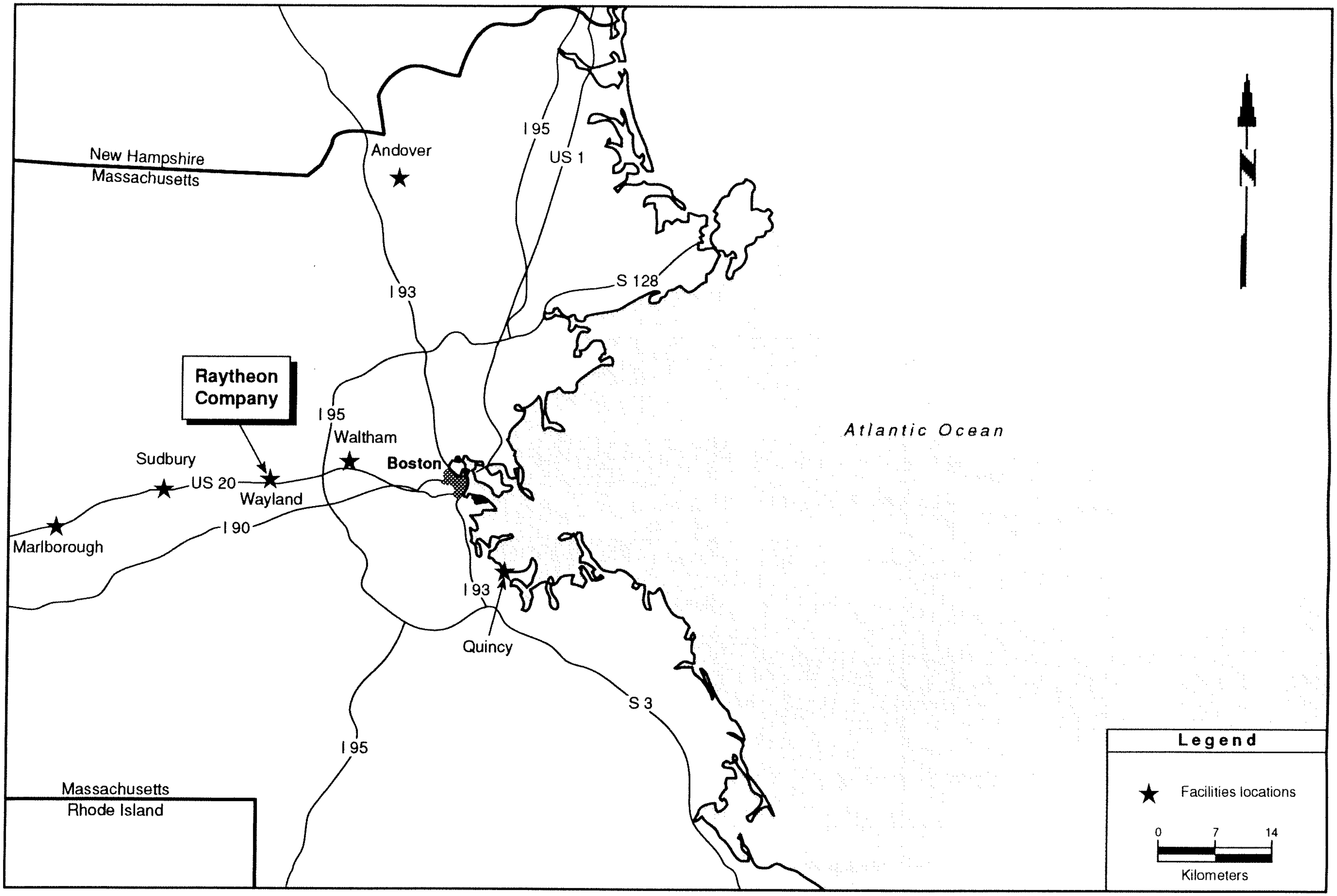


Figure 1-2. Location map of Raytheon Company facilities, Massachusetts

radar hardware/software system, including receiver elements, signal processor, data processor, beam steering generator, displays, radar monitoring, and radar control. Interconnections and interfaces also are verified.

Similar products are routinely fabricated and tested at these Raytheon Company facilities. Fabrication and testing would include the following tasks:

- analysis of test failures to evaluate their occurrence with the goal of eliminating future problems,
- demonstration of real-time waveform generation to evaluate the portions of the GBR systems that produce the microwave energy at the frequency and strength planned,
- testing unique software to verify that computer programs control the radar system as planned,
- analysis of the antenna's ability to survive projected environmental stress by simulating the operating environment of the component equipment or software as it would be employed at the proposed testing locations, and
- evaluation of subsystem maintenance requirements to ensure that the equipment can be cared for by normal maintenance and supply routines.

1.4.1.1 TMD-GBR Component Description

The TMD-GBR would be a truck/trailer and military cargo-aircraft transportable, X-band, single-faced, phased-array radar system. The components of the system would be housed in vehicle- or trailer-mounted shelters, or would be mounted on specially configured flatbed trailers. The TMD-GBR system would be interconnected with power and signal cabling, as required. Cooling for the antenna would be provided by a separate trailer-mounted unit. The shelters would provide environmental protection for the system components and personnel. The TMD-GBR system would comprise five main subsystems or units: antenna equipment unit (AEU), electronic equipment unit (EEU), operators control unit (OCU), cooling equipment unit (CEU), and prime power unit (PPU) (Figure 1-3).

Three radars would be used during the DEM/VAL test activities. The first radar system to be built and tested would be a TMD dem/val configuration. Next, the two UOE configurations would be built and tested. The dem/val and UOE systems are the same except that the dem/val system normally would operate only on commercial power because it would not have mobile generators; the mobile unit containing the antenna equipment is the same as the UOE but the antenna itself is one-half the UOE size; and some other minor mission-oriented features would be omitted from the dem/val system. If necessary, the dem/val system could be upgraded into a UOE system in the future.

1.4.1.2 Antenna Equipment Unit (AEU)

The antenna equipment would employ phased-array technology and provide a rectangular aperture of approximately 9.2 square meters (m^2) (100 square feet [ft^2]) for the UOE system. The TMD-GBR dem/val would have an aperture of approximately 4.6 m^2 (50 ft^2). The antenna would be mechanically adjustable in elevations between 10 to 60 degrees. However, during

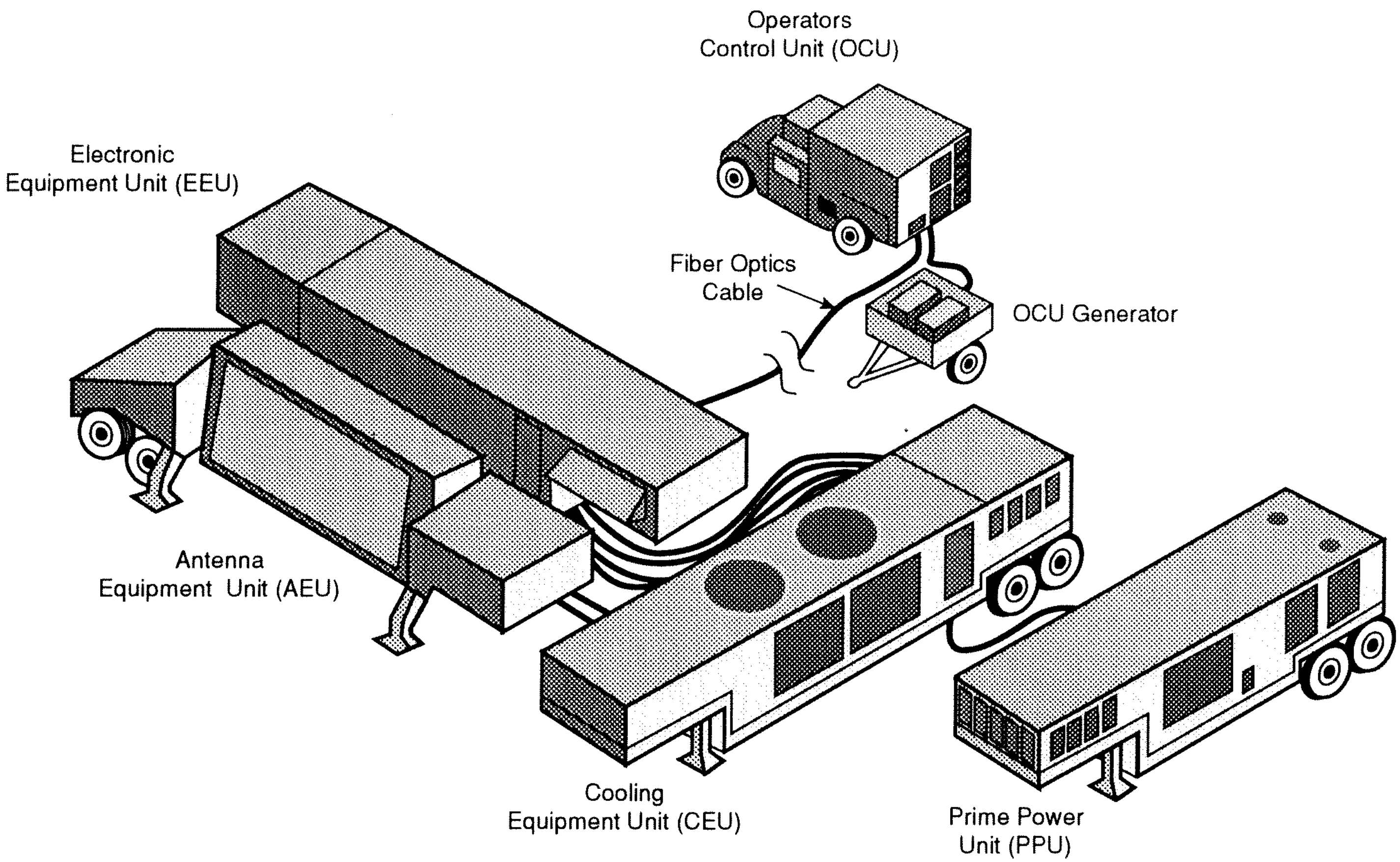


Figure 1-3. TMD-GBR five main subsystems

operation (transmitting) the elevation is fixed. Through electronic control of the antenna, the narrow, pencil-shaped main beam would be instantaneously directed at long-range incoming targets. The antenna design would be based on solid-state transmit/receive module technology. The radar system operates within the X-band of the microwave spectrum, which covers a frequency range of about 8,000 to 12,000 megahertz (MHz). For comparison, VHF (very high frequency) television and FM (frequency modulated) radio stations operate in the frequency range of 54 to 216 MHz.

1.4.1.3 Electronics Equipment Unit (EEU)

The EEU contains the TMD-GBR system data processors, signal processors, high-speed recorders, and the receiver/exciter equipment. Application software within the data processors conducts the GBR mission by scheduling appropriate beam positions and waveforms, and by processing return data (via the signal processor) to form tracks, discriminate threatening objects, provide data to interceptors, and perform target destruction/damage assessment. The EEU interfaces with the AEU to direct radio frequency (RF) energy as required and to process radar return data. There are control functions (software) in the data processors and the beam steering generator to prevent beams at low elevation in order to preclude possible EMR hazards. Because nothing mechanical has to move, electronic beam steering would be virtually instantaneous. The radar would provide an effective horizontal and vertical coverage of about ±50 degrees (polar angle). The EEU also interfaces with the OCU for manual control and direction from external systems.

1.4.1.4 Operators Control Unit (OCU)

The OCU provides the man/machine interface. The OCU is a manned unit with two operator positions. It contains operator workstations that provide radar operation control and maintenance status. Also, it can interface with external systems such as the Theater High-Altitude Area Defense (THAAD) system. The OCU is packaged in a climate-controlled shelter mounted to a high-mobility multipurpose wheeled vehicle (HMMWV) and is readily transportable. The OCU has its own prime power source consisting of two lightweight diesel generators in a trailer.

1.4.1.5 Cooling Equipment Unit (CEU)

Generating and transmitting microwave energy creates a large amount of heat. The largest heat load is from the AEU. A separate trailer-mounted CEU is provided for cooling the AEU and the EEU. The CEU pumps a water and ethylene glycol cooling solution through the AEU and/or the EEU, picking up the heat generated by the various electronic components by conduction, and transfers the heated cooling solution to fan-cooled heat exchangers that use forced ambient air to cool the heated cooling solution. The CEU is a closed-loop system and would have no adverse effect on the environment.

1.4.1.6 Prime Power Unit (PPU)

A trailer-mounted PPU is used to power the TMD UOE system. The PPU is a diesel-powered 4,160-volt, 3-phase, 60-hertz, 1,000-kilowatt (kW) generator. This is a self-contained unit enclosed in a noise-dampening shroud that contains the diesel generator, governor, turbocharger and associated controls, a one-hour day tank, and air-cooled radiators. Its interfaces are fuel connections from a fuel tanker, or fuel cells, and output power and signal cabling to the CEU. At peak demand, which occurs for short durations, it consumes approximately 189 liters (50 gallons) of diesel fuel per hour. Under normal operations, its fuel consumption is less than 95 liters (25 gallons) per hour.

1.4.2 Phase I of GBR DEM/VAL Program – Raytheon Fabrication, Testing, and GBR-T Component Description

The fabrication, component testing, integration, and system string testing of GBR-T would take place in existing contractor facilities of the Raytheon Company (see Table 1-1 and Figure 1-2). These are essentially the same facilities that are being used for TMD-GBR fabrication and testing; however, differences are discussed below. Fabrication and testing would include the same tasks as described for TMD-GBR in Section 1.4.1. Testing of a pilot or sample array would be done on top of the roof at the Raytheon Company Wayland, Massachusetts, facility where the microwave energy propagation can be monitored and controlled. Similar testing has been done in the past at this location.

After GBR-T major critical item component testing, in-plant string test activity would begin. The in-plant test activity would integrate the entire electronic system "string" without the large array plate assemblies, its associated power supplies, or the antenna mount. The string tests would verify the integrated radar hardware/software system, which includes transmitter, receiver, signal processor, data processor, beam steering generator, displays, radar monitoring, and control. Interconnections and interfaces would be verified.

GBR-T Component Description

The GBR-T would be a large, complex, phased-array radar system designed in a single-faced, medium field-of-view antenna configuration. Although the GBR-T components would be similar to those of TMD-GBR in basic design, purpose, and function, the component assembly and integration would differ significantly. This is because the GBR-T has different mission and performance requirements than TMD-GBR. The GBR-T design would provide a higher output power capability. Mobility of the GBR-T system is not a requirement; therefore, the system would be installed in and on an existing facility, Building 1500 on USAKA (Figure 1-4). Modifications to Building 1500 to support this radar system are discussed in Section 1.4.4 of this document. The GBR-T system components are antenna/antenna mount, electronics subsystem, displays and controls, cooling system, and electrical power distribution.

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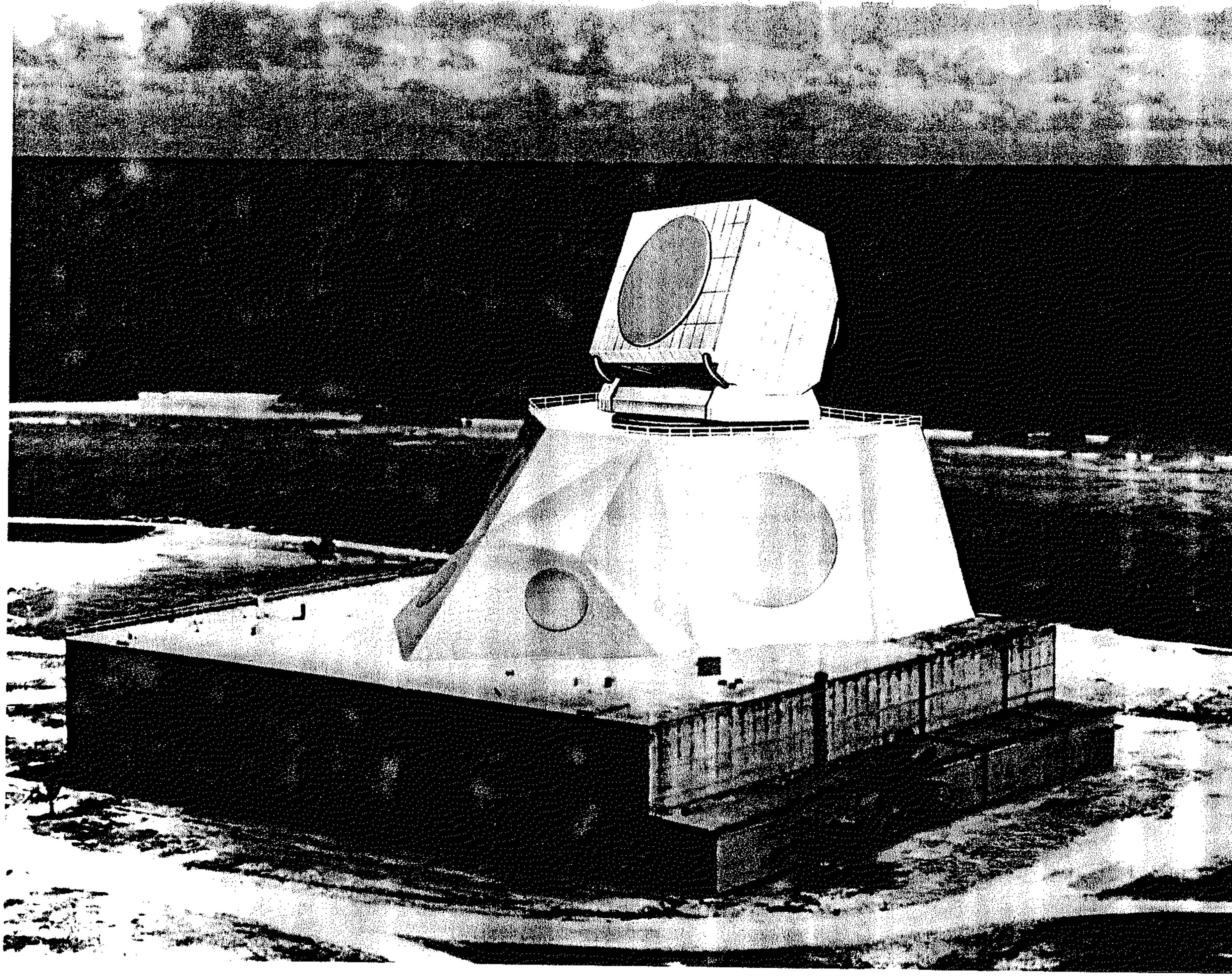

Figure 1-4. GBR-T system (artist's concept)

1.4.2.1 Antenna/Antenna Mount

The antenna has a circular aperture with a diameter of 10 meters (m) (32.5 feet [ft]). The antenna operates in the X-band of the microwave spectrum. A planar radome would cover the antenna face for weather protection. The GBR-T antenna would be placed on an antenna mount, which would be mechanically rotatable in azimuth and elevation. Through electronic control of the antenna EMR pattern, the narrow, pencil-shaped main beam could be directed almost instantaneously at incoming targets within the electronic field of view (74 degrees azimuth, 35 degrees elevation). However, the combination of mechanical control and electronic beam steering would provide GBR-T with an effective horizontal coverage of 360 degrees and a vertical coverage of 90 degrees. Targets at different locations would be detected, identified, and tracked by controlling the manner in which the radar transmits and receives the microwave signal. This electronic (computer) control would provide the capability to precisely direct the antenna EMR pattern. The ability to control the antenna EMR pattern, or beam, prevents or mitigates EMR problems.

1.4.2.2 Electronics Subsystem

The GBR-T electronics subsystem would contain the same components as in the TMD-GBR EEU (such as data processors, signal processors, etc.). One difference is that high-power traveling wave tubes are utilized instead of solid-state technology. Also, these components would be mounted in equipment cabinets suitable for installation in Building 1500.

1.4.2.3 Displays and Controls

The operator workstations that would provide GBR-T radar operation control and maintenance status would be similar in design and function to the OCU for TMD-GBR. However, the workstation consoles could be very different because they would be installed in a room/area of Building 1500 and not in a shelter mounted to an HMMWV. In addition, GBR-T would have a safety console with appropriate displays and controls. Additional discussion on the planned safety system for GBR-T is provided in Section 1.4.4.1 of this EA.

1.4.2.4 Cooling System

Two cooling systems would be provided: a chilled-water system at 42°F and a demineralized water system at 100°F. The demineralized water system would provide cooling liquid for the antenna. Generation of sufficient microwave signal energy creates large amounts of heat in various system components. This heat would be removed by forced cooling with an appropriately designed water-based cooling system. It is not expected that the operating characteristics of this cooling system would be significantly different than the cooling system being designed for TMD-GBR. Cooling for personnel work spaces and additional equipment would be provided by a typical facility cooling system using hydrofluorocarbon-22 (R-22) as the cooling medium. Both cooling systems would be closed systems.

1.4.2.5 Electrical Power Distribution

The GBR-T system would use power provided by existing and planned power plants on Kwajalein Island. This would require the installation of a power distribution system within Building 1500 and connection to feeder lines from transformers. Proposed Power Plant 1B construction activities and operational impacts have been addressed in a previous EA (U.S. Army Strategic Defense Command [USASDC] 1992a), which resulted in a finding of no significant impact.

1.4.3 Phase II of GBR DEM/VAL Program – TMD-GBR Installation, Integration, and Testing at WSMR/Fort Bliss

Final testing would require that the TMD-GBR dem/val configuration and UOE configurations be moved to and installed at selected sites at WSMR/Fort Bliss. After this installation, the components and assemblies that were tested as individual items at the Raytheon Company facilities would be retested and then tested as an integrated radar system at full power in order to confirm system functioning. Site surveys at WSMR and Fort Bliss have identified eight alternative testing locations. Of the eight alternative sites, five are on WSMR and three are on Fort Bliss property; all are within the state of New Mexico. The five WSMR sites are identified as Launch Complex (LC) 39, R-409, C Station, R-409 West, and Rampart site. The three Fort Bliss sites are In-Flight Control (IFC)-25 (located on McGregor Range), Wise site, and R-396 (Figures 1-5 and 1-6).

The GBR project office requires the use of a site for installation and testing of all three systems, positioned side by side or in close proximity to one another (one TMD-GBR dem/val configuration and two UOE configurations) (Figure 1-7). While at the site, no more than one radar system would transmit during a given time period. An estimated 25,304 m^2 (6.25 acres) of relatively flat, accessible area would be required to accommodate all three radar configurations. Site LC 39 is the preferred location for this site. In addition, some specific test scenarios would require UOE configurations to be located at selected alternative sites that have an area of approximately 8,428 m^2 (2 acres). The two preferred sites for location of individual UOEs are R-396 and IFC-25 (Figures 1-8 and 1-9). Also, some testing, such as mobility and deconfiguration/reconfiguration (system tear-down, relocation, and setup), could be facilitated and made more realistic by the use of more than one site. Therefore, it is planned that more than one site would be used during test activities. Existing roads would be used to travel from site to site. Potential TMD-GBR sites are described further in Chapter 2, Section 2.2.

All of the selected alternative test sites have been used extensively and exhibit previously disturbed areas that can accommodate, for the most part, the proposed TMD-GBR systems and support activities. Some site preparation, including clearing, leveling, graveling, and trenching to place electric and telecommunications lines and septic tanks, is expected. An EMR safety zone would be established for the area in front of each radar system. The EMR safety zone would be an area of 53 degrees from each side of center and 100 m (330 ft) in front of the AEU. The exact distance would be determined by actual EMR measurements during installation and testing of the systems to ensure that safety standards are not exceeded. The EMR safety zone would be identified by fencing with warning signs. Appropriate warning lights also would be used at selected locations around the test site(s). As a part of the test activities, radar-jamming

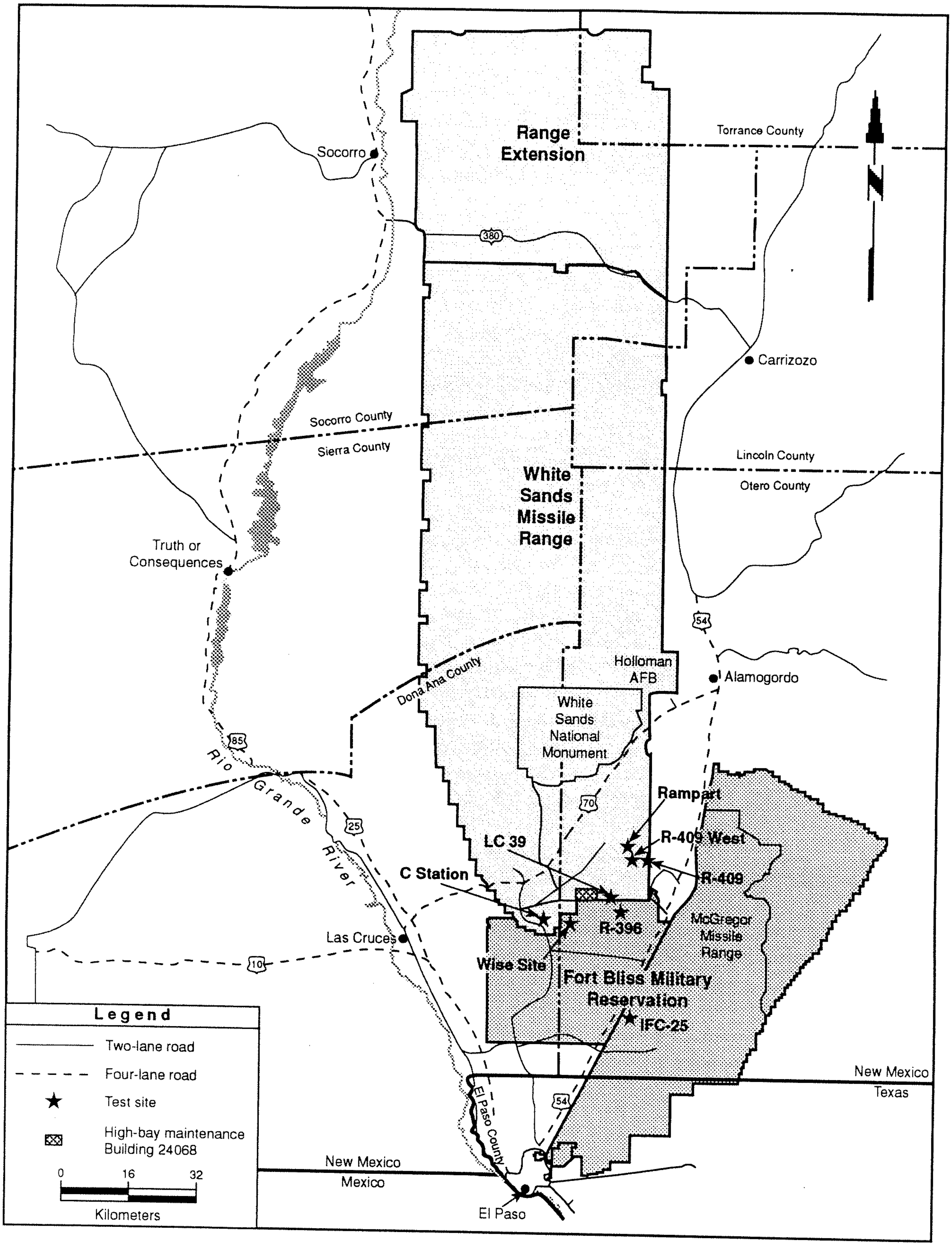

Figure 1-5. Proposed TMD-GBR test sites at WSMR/Fort Bliss

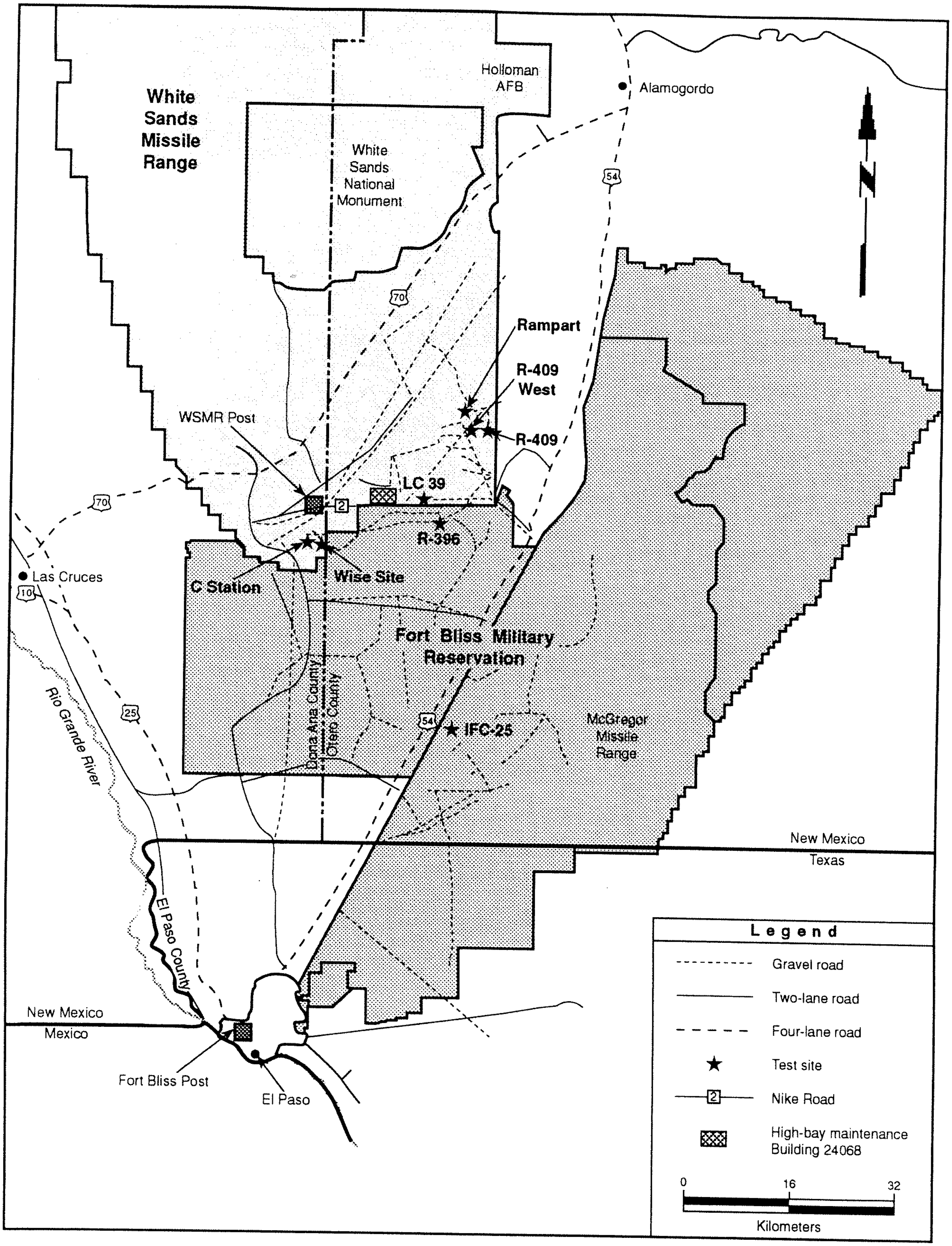

Figure 1-6. Expanded view of proposed TMD-GBR test sites at WSMR/Fort Bliss

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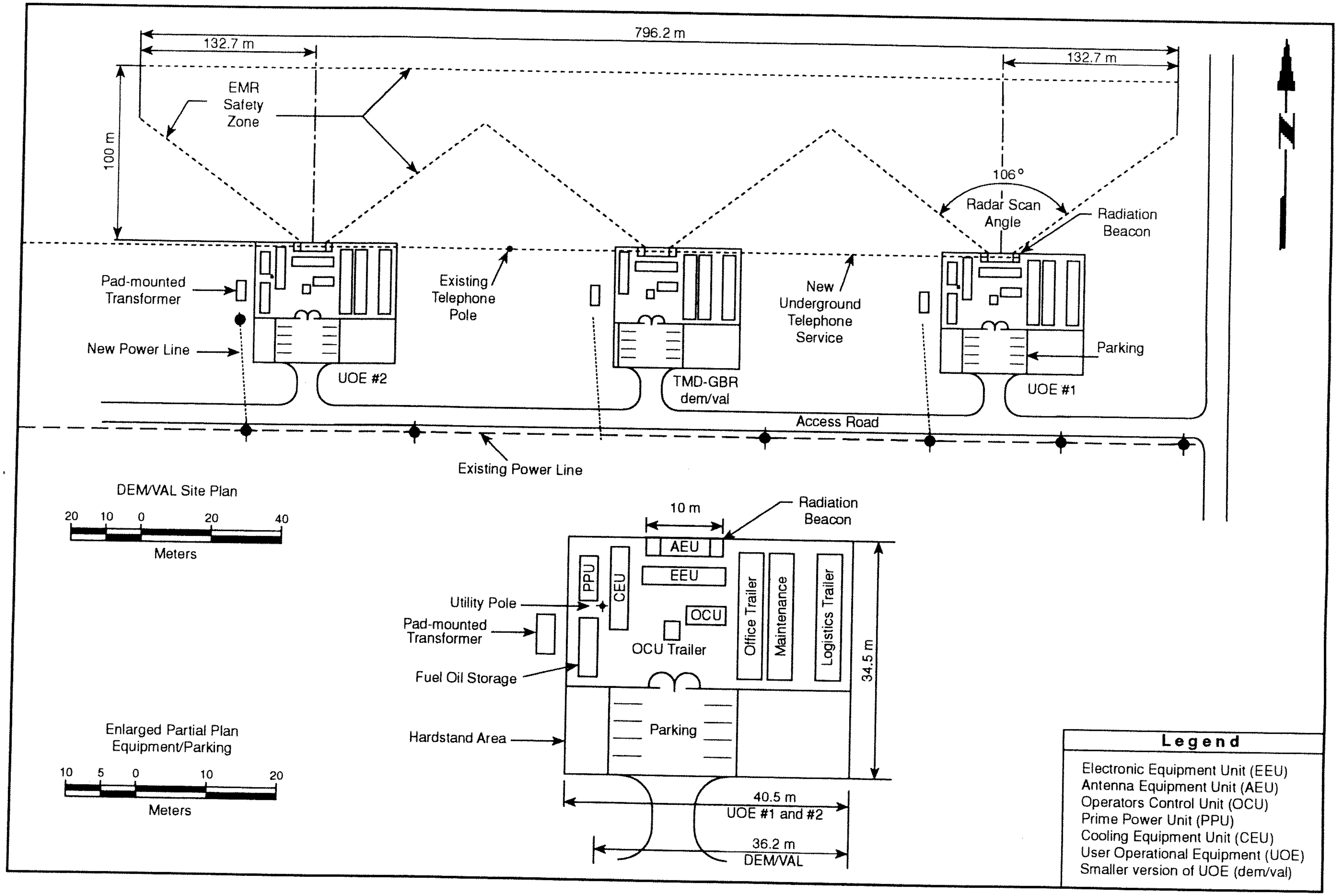

Figure 1-7. Layout of TMD-GBR system at preferred site LC 39

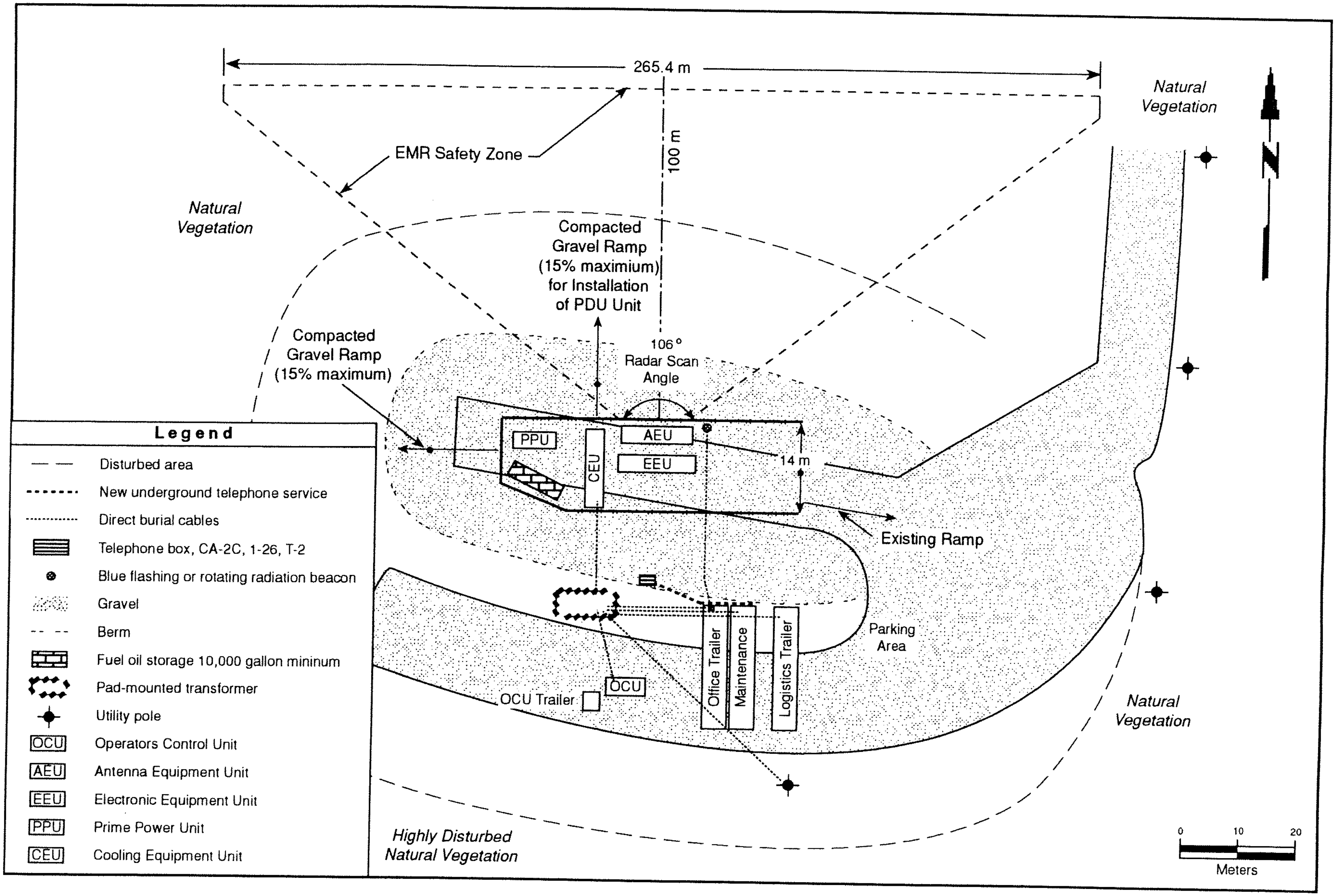

Figure 1-8. User operational equipment located at R-396

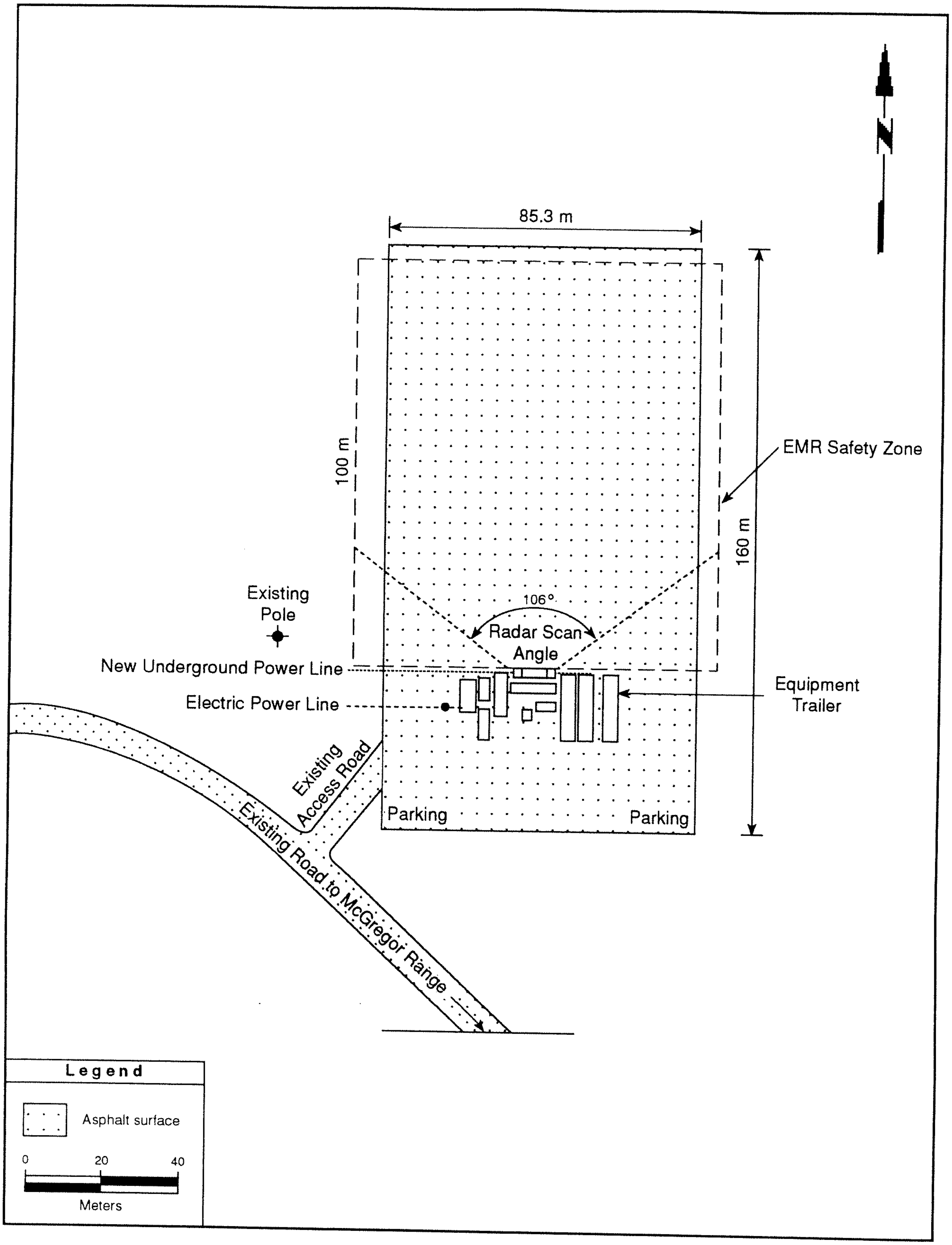

Figure 1-9. User operational equipment located at IFC-25

tmdgbr #3\fig 1-9

equipment would be used. Although the exact locations for the jamming devices have not been identified, they would be placed along the existing roads for right-of-ways in the vicinity of the TMD-GBR test sites.

The dem/val system radar would be electrically powered from the WSMR commercial power system. The UOE systems would be powered by mobile generators; also, commercial power, if available, would be used to power the UOEs as an economic measure. Potable water for personnel use would be required at all sites. A sanitary septic holding system would be constructed at LC 39 because it would be in use for approximately three years. Toilets at LC 39 site would flush into a septic holding tank that would be pumped periodically. Its waste would be disposed of using a sanitary contractor currently under contract by WSMR/Fort Bliss. The exact locations for additional power and telecommunication lines are not identified currently. The exact location of the septic holding tank has not been identified. Trenching and construction activities may result in the discovery of previously unknown cultural resources. A mitigation program would be implemented to reduce potential impacts to any cultural resources to a level of nonsignificance. This program would consist of the following:

- avoidance of all known cultural sites;
- a preconstruction archaeological survey of the selected test sites, including testing and data recovery in addition to the surveys already conducted;
- monitoring, testing, and data recovery on-site by an archaeologist during construction, as appropriate; and
- distribution of educational literature to all TMD-GBR-related personnel providing information about the Historical Preservation Act and proper mitigation procedures.

In order to minimize nontest activities and the number of personnel at the radar sites, additional support facilities would be used. Such facilities include additional office space, software maintenance space, logistics space, and a high-bay maintenance area. A number of existing buildings at WSMR appear to be available for these purposes. Buildings 24068, 23625, 23632, and 90133 were visited for an initial review. Building 24068 has a high-bay area suitable for major maintenance and/or repair of the radar subsystems, if needed, during the test period. Building 24068 has not been used in a number of years, but now has been proposed for TMD-GBR use. Some building improvements would be required such as office/maintenance spaces and replacement/rerouting of utilities (Figure 1-10). Building 24068 has been confirmed to contain asbestos materials in its construction. An inspection would be conducted prior to final selection and modification of Building 24068 in order to determine the location, type, and extent of asbestos. Prior to remodeling activities, any asbestos would be encapsulated or removed. Building 23625 has a high-bay area but currently is occupied by Raytheon Company in support of PATRIOT test activities. Building 23625 was rejected because of possible interference with PATRIOT requirements/use. Building 23632 is located in the LC 38 Complex and could be used as office space. No construction would be necessary for use of Building 23632. Building 90133 is a relatively new office building that is not occupied currently. Building 90133 has no high-bay area and would be used for office space if additional personnel involved in test activities could not be accommodated in the on-site office trailer or Building 24068.

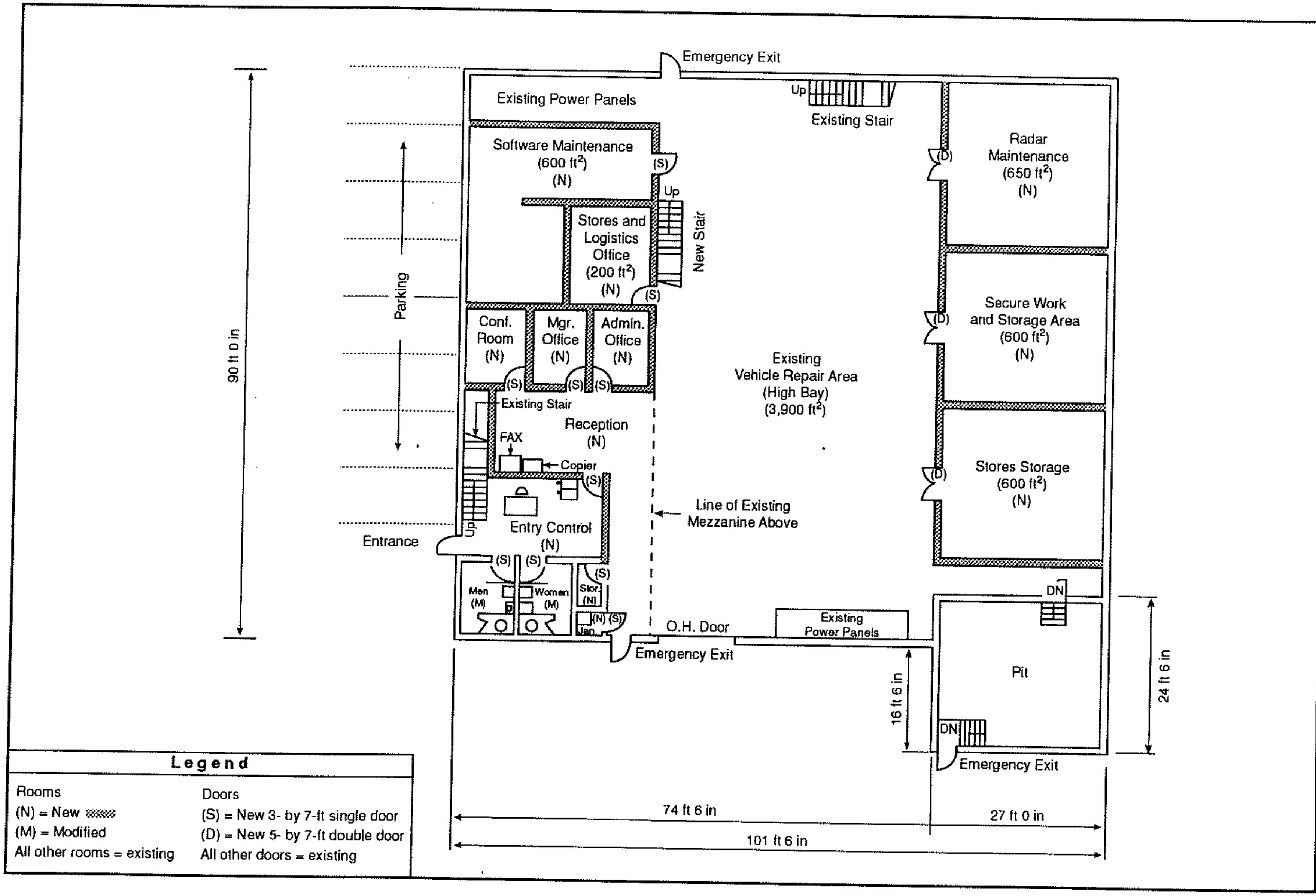

Figure 1-10. WSMR maintenance support Building 24068 - modification floor plan

1.4.3.1 TMD-GBR EMR

EMR is the product of the transmission of microwaves from a radar antenna. In order to understand the potential for exposure to EMR, the pattern of the radar antenna must be described. The antenna pattern generally is composed of a main beam of energy as well as smaller secondary beams called side lobes (Figure 1-11). EMR concerns result from exposure to the main beam as well as to exposure from side lobes outside of the main beam. The TMD-GBR main beam normally would be operated at an angle of at least 4 degrees in elevation above horizontal. Thus, the potential for exposure to EMR from the TMD-GBR would be greatly reduced because the main beam would be focused above the earth's surface and away from humans. In addition, analysis, simulation, and other validation methodologies are planned in order to characterize and evaluate the EMR environment caused by the radar prior to actual testing of TMD-GBR. This would help minimize EMR exposure possibilities and would ensure that all other possible EMR environmental issues can be addressed. Other safety measures would be the designation of an EMR safety zone extending out to approximately 100 m (330 ft) in front of the antenna equipment unit. This zone would be identified by a single-wire safety fence with warning signs posted on the wire every 3 m (10 ft) indicating that the area is unsafe to enter. Warning lights also would be activated during periods when the radar is transmitting.

TMD-GBR system design and operation would limit human exposure to acceptable levels. This also would reduce any impact of the TMD-GBR electromagnetic fields on fuel ignition hazards, and prevent any inadvertent detonation of EEDs or ordnance.

Airspace control and range activity scheduling also are of concern with respect to EMR. Airspace control at WSMR consists of a total of 18 designated restricted-airspace areas. These areas are located in the WSMR/Holloman Air Force Base (AFB)/Fort Bliss areas of southern New Mexico and northwest Texas. Thirteen of these restricted-airspace areas are controlled by WSMR and scheduled for research, development, evaluation, military training, and civilian contract programs. The remaining five restricted-airspace areas are controlled by Fort Bliss. All 18 areas are charted as restricted airspace by the Federal Aviation Administration (FAA), which allows for hazardous activity use. Any civil or military aircraft that have not been authorized and scheduled by the controlling agency are prohibited from entering active airspace. Coordination is maintained between the two controlling agencies with respect to adjacent restricted-airspace areas. The airspace use can be controlled from the surface to unlimited altitude 24 hours a day. A priority schedule system prescribes the use of WSMR airspace. Each authorized activity supported by WSMR is categorized as a range program and is assigned one of four priorities according to the nature of the program. Once a program has received approval for restricted-airspace or surface activities, no other program may use that airspace or range area. A higher-priority program may cause a rescheduling of a lower-priority program's use of the airspace or range.

1.4.4 Phase II of GBR DEM/VAL Program – GBR-T Installation, Integration, and Testing, USAKA, RMI

Discussion of GBR-T DEM/VAL test phase activities is limited because an EA for a similar radar, designated as GBR-X, the predecessor of GBR-T, has been conducted and a finding of no significant impact was made in March 1989 by the USASDC (1989a). The 1989 GBR EA, incorporated herein by reference, documented the results of an assessment of the potential for

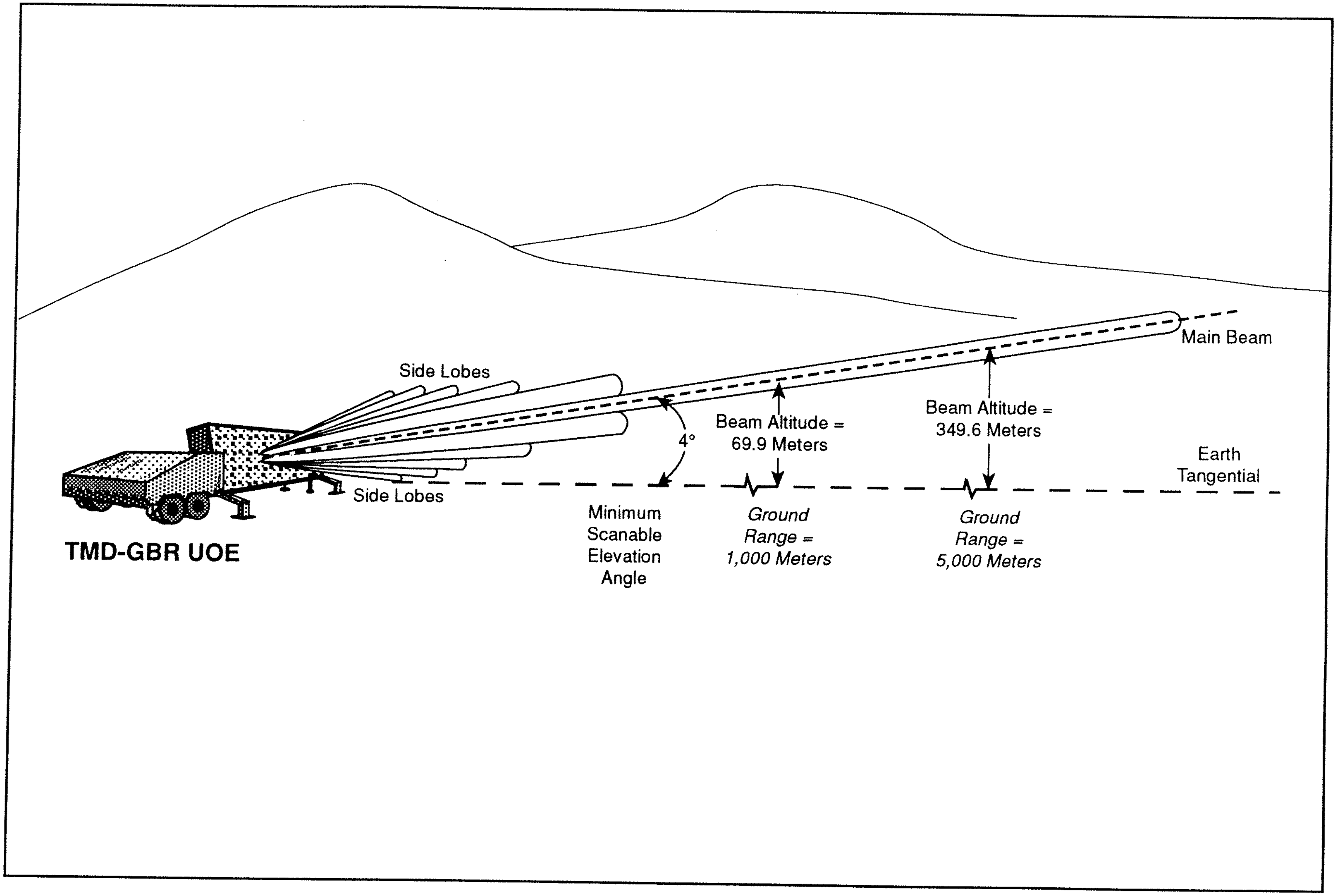

Figure 1-11. TMD-GBR transmitting pattern

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and magnitude of impacts from DEM/VAL activities of a proposed GBR-X. The GBR-X was to be installed and tested at Building 1500 at USAKA, but was never built. A subsequent 1989 USAKA Environmental Impact Statement (EIS) (USASDC 1989b) also addressed the siting and DEM/VAL testing of GBR-X. A Draft Supplemental EIS for USAKA (U.S. Army Space and Strategic Defense Command [USASSDC] 1993) analyzes the cumulative impacts of GBR-T with other test programs at USAKA. The GBR-T is planned for the same location (Building 1500) at the west end of the Kwajalein Island as was the GBR-X; however, GBR-T is a redesigned radar. A discussion of these differences, and analysis thereof, is presented in Chapter 3 of this EA.

Upon completion of in-plant string testing at the Raytheon Company facilities, the GBR-T components would be installed at USAKA, RMI (Figure 1-12). The components to be tested at this location would be transported from the United States by air and sea and would be assembled on top of and inside of Building 1500, which is located at the western end of Kwajalein Island (Figure 1-13). Building 1500 was originally built to hold a large radar. Currently, it is used for temporary storage. Installation of GBR components would require structural improvement of Building 1500, including the construction of an internal support tower and foundation to support the gravity, wind, dynamic, and seismic loads of the radar (Figure 1-14). Within Building 1500, electrical power substations, power distribution equipment, air conditioning and ventilating units, and compressed air and fire protection equipment would be installed on various floors. Computer facilities, office space, a mission control room, and storage rooms would be constructed within the building, and an elevator would be added in a shaft extending through the existing roof to provide access to the radar unit. Additional modifications would be required for utilities, communications, fire protection, security, and air conditioning.

The GBR-T equipment would need to be connected to power and utility lines. This involves adding a 335-m (1,100-ft) potable water line to an existing line, adding a 701-m (2,300-ft) non-potable seawater line to an existing line, and placing 1,707 m (5,600 ft) of underground electrical feeder lines (Figure 1-15). Excavated soil would be placed temporarily along one side of each of the utility line right-of-ways during construction. A 4,000-gallon underground septic holding tank would be installed at the north side of Building 1500. The tank would be double-walled, have a high-level alarm, and be pumped at least every four days. Two new masonry buildings would be constructed, one next to Building 1500 to house fire pumps, and one next to Building 993 and near Power Plant 1B to house transformers. The majority of this construction would take place in areas previously disturbed by fill material. The potential impact to cultural and historic resources by the construction activities in areas that comprise the island's original and pre-World War II ground surface would be mitigated by unexploded ordnance surveys and archaeological surveys, sampling, and data recovery prior to any construction activities. During construction, an archaeologist would monitor construction activities, conduct testing, and perform data recovery, if necessary. The scope of work for this program would be coordinated in consultation with the Historic Preservation Officer of the RMI, and the Advisory Council on Historic Preservation (ACHP). Any comments would be resolved prior to initiation of construction.

As part of an EMR monitoring and safety system, a minimum of 10 EMR sensors would be sited at strategic locations at appropriate distances from the GBR-T. The exact location and number of these sensors would be determined during installation and testing of the radar when actual low-level EMR measurements are taken. The sensors would be mounted a minimum of 3 m (10 ft) high. Maximum use of existing structures, power sources, utility/cable runs, and tmdgbr#3\fig 1-12

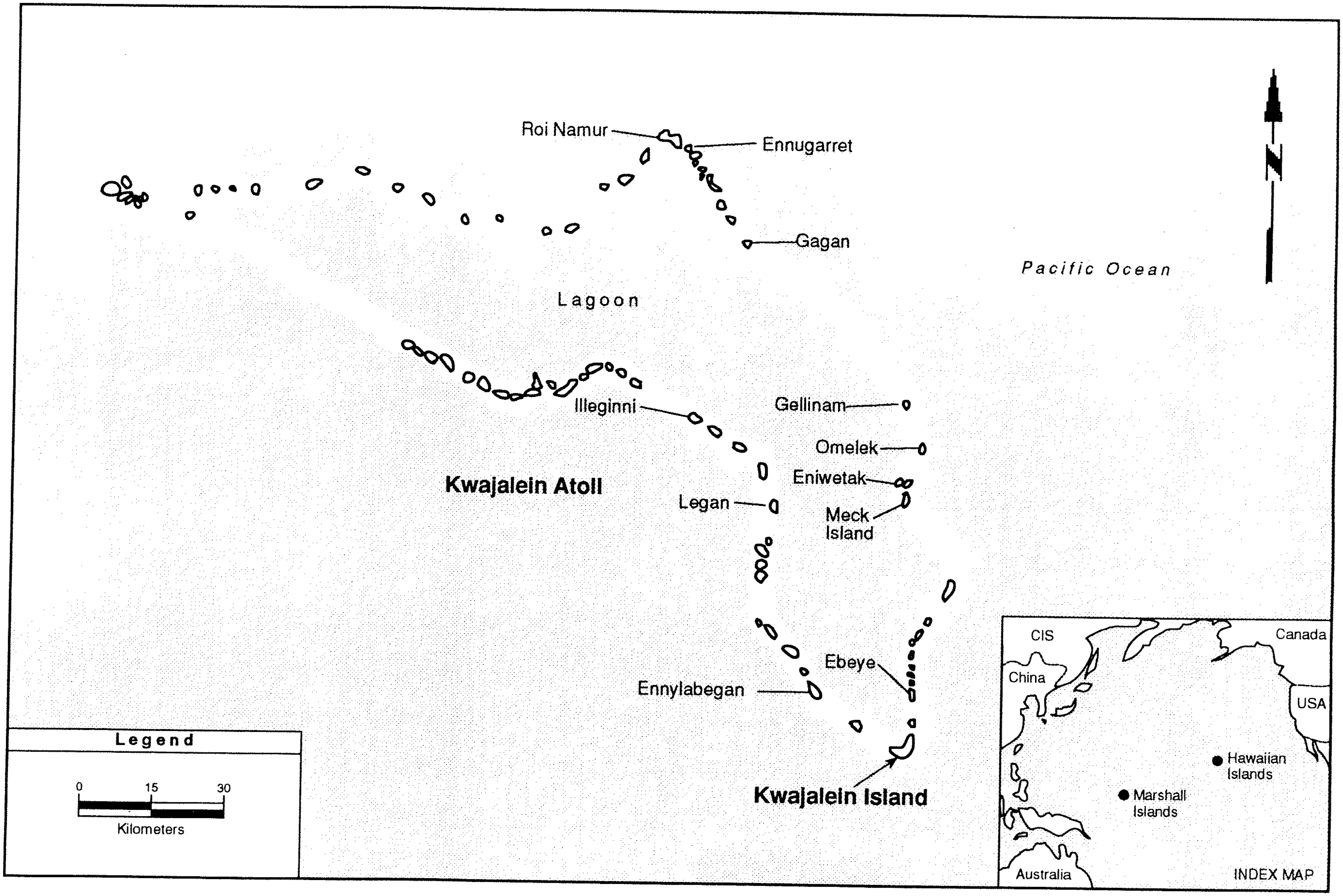

Figure 1-12. Location map of Kwajalein Atoll, Republic of Marshall Islands

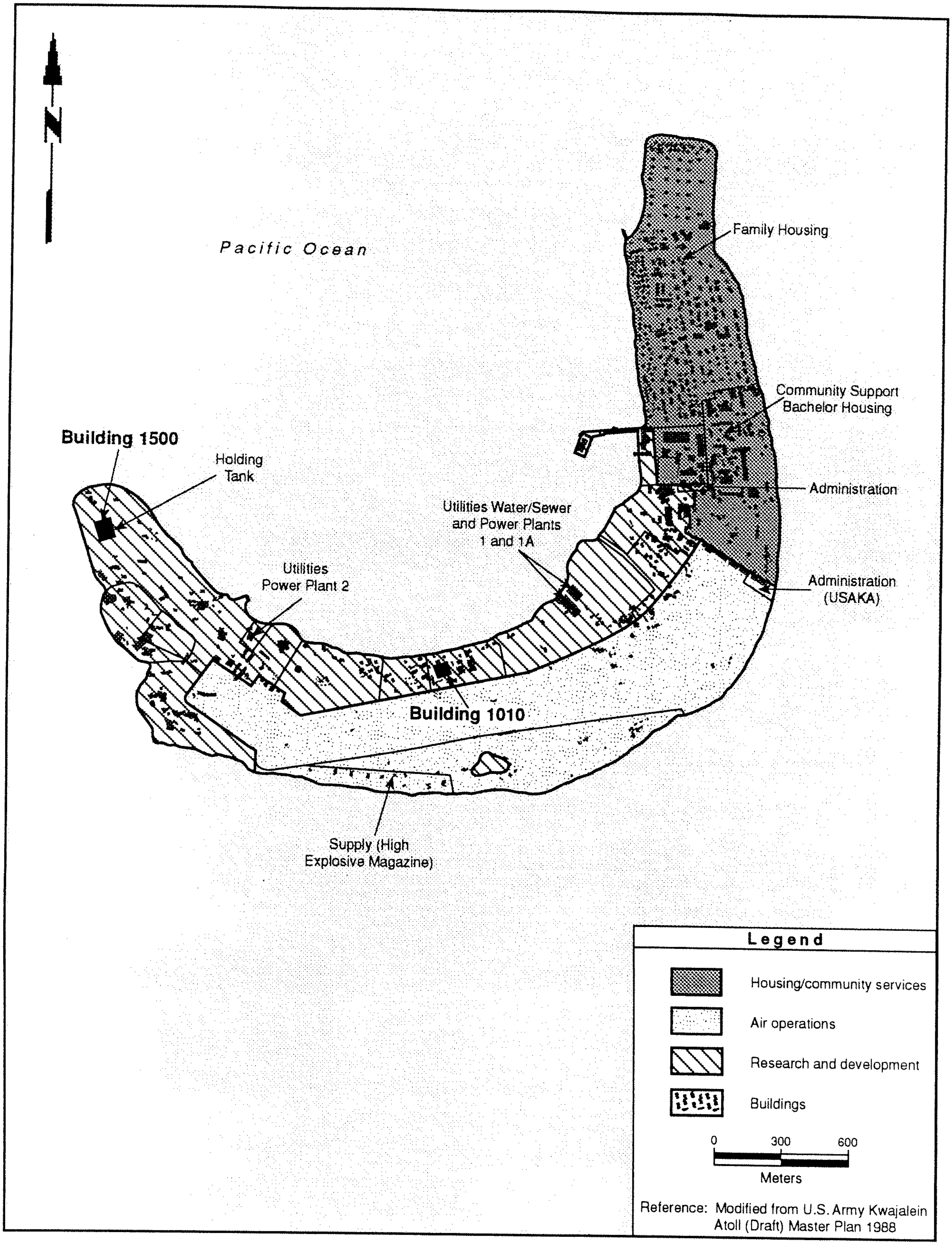

Figure 1-13. Location of Building 1500, Kwajalein Island, USAKA

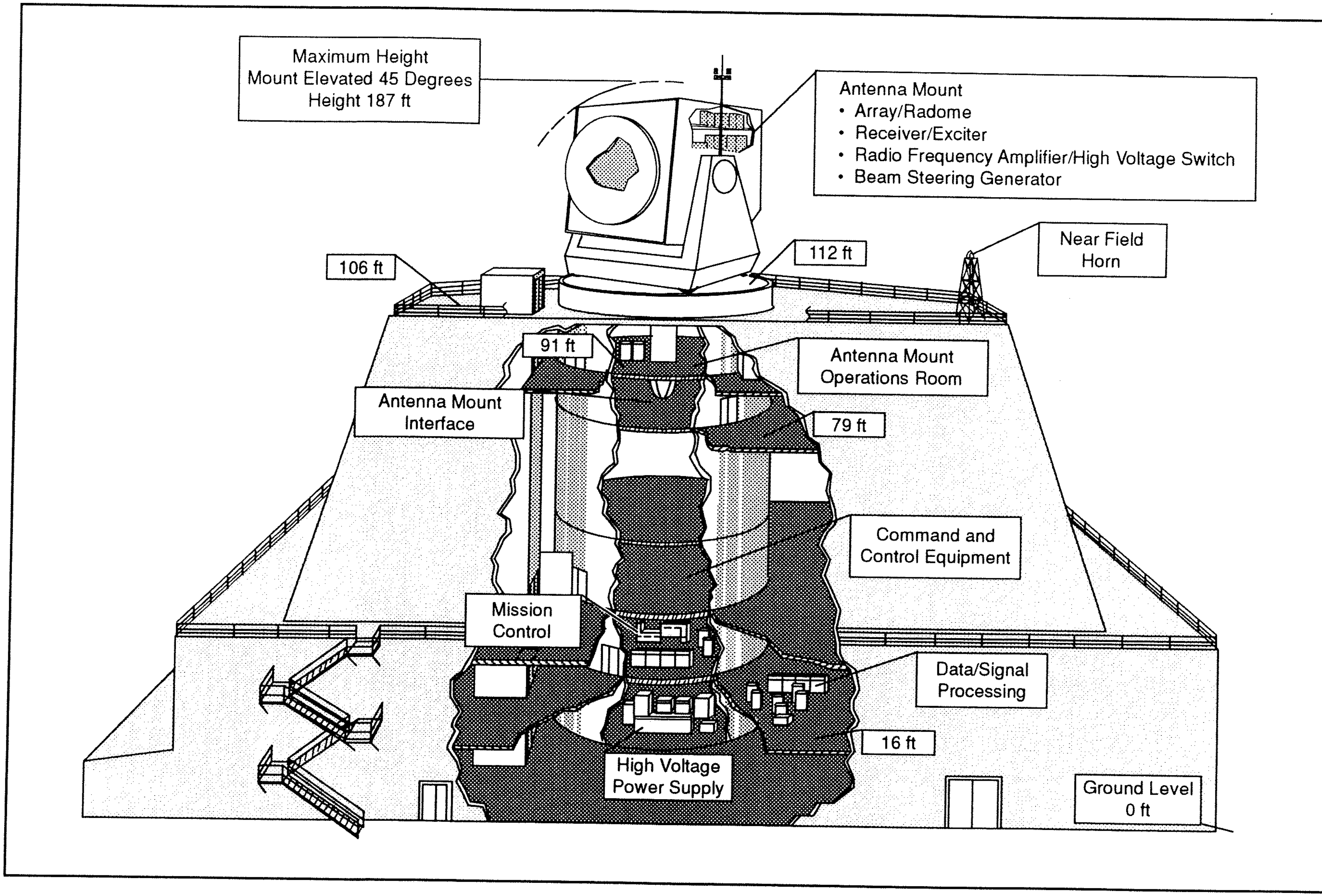

Figure 1-14. GBR-T modifications to Building 1500

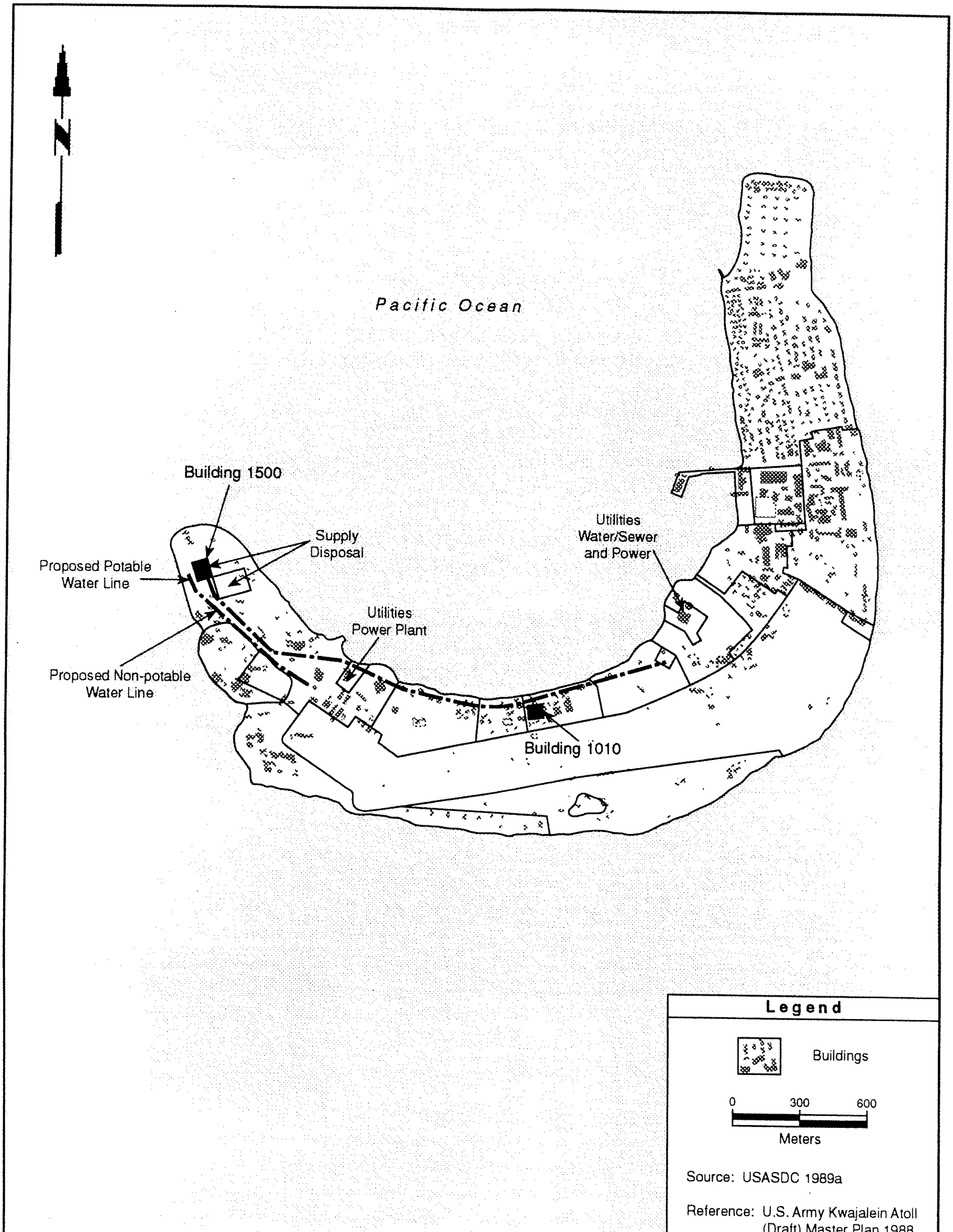

Figure 1-15. New water and power lines to Building 1500, for ground based radar, Kwajalein Island, USAKA

previously disturbed areas would be made. Any trench construction, in places outside fill areas, that might be required for the sensor signal and/or power cables would be surveyed for cultural resources prior to construction and monitored by an archaeologist during construction.

Once installed, GBR-T components and assemblies would be retested, both as individual items and as an integrated radar system. This testing also would include retesting critical elements of support equipment. After integration testing, a series of system tests using known satellites and balloon-launched calibration spheres would demonstrate and quantify performance prior to entering into total system performance (validation) testing. The installation, integration, and testing for GBR-T would last about seven months beginning in March 1995. DEM/VAL testing activities, including tracking of actual missile targets, would begin about the first quarter of fiscal year (FY)96 and continue through the last quarter of FY97.

GBR-dedicated personnel would begin to relocate to Kwajalein Island in late 1993. Peak staffing requirements would occur in the second quarter of FY95. Anticipated peak staffing would include 51 full-time personnel (14 accompanied and 37 unaccompanied) and 9 transient workers. This would create a peak demand for 60 housing units: 14 family housing units and 46 unaccompanied personnel housing (UPH) units. Demand would then taper off to about one-half the peak-year requirements by FY97 (PEO GPALS 1993).

The construction of additional housing units to support potential future ground and flight testing programs and other activities that may be located at Kwajalein Island is being studied in the Draft EIS for USAKA (USASSDC 1993). Current plans call for the construction of 188 units at Building 501 (demolishing 24 existing units for a net increase of 164 units), another 100 units at Building 602, and 90 family housing units off of Ocean Road (USASSDC 1993). Currently, the GBR program Office is funding the addition of approximately 9 Bachelor Officer Quarters above the dry goods store on Kwajalein Island. Additionally, the GBR-T program, in coordination with USAKA, would provide housing for the anticipated number of accompanied and unaccompanied personnel as reflected in the April 1993 Draft Kwajalein Missile Range GBR-T Siting Study (PEO GPALS 1993).

1.4.4.1 GBR-T EMR

The antenna design for GBR-T creates a different antenna pattern that, in addition to a main beam and side lobes, includes grating lobes. Grating lobes are secondary beams whose energy is generally above side lobe energy but below main beam energy. Grating lobes of primary concern (i.e., those directed at the ground) occur at angles in the range of 31 to 46 degrees with respect to the main beam (Figure 1-16). Although grating lobes occur, their effects can be controlled to a safe level. The far-field power density in the grating lobes varies with positions and operational variables but never exceeds a strength of 1.5 percent (-18 decibels [dB]) of the main beam at the same distance in the far field. The main beam would normally be operated at an angle of at least 2 degrees in elevation above horizontal. Therefore, the EMR hazard of the main beam would only occur well above earth and water surfaces. It is possible that the GBR-T, under certain range operations such as missile transponder acquisition for range safety and splashdown observation, would operate the main beam below the normal minimum of positive 2 degrees. GBR-T activities during these range operations are restricted to a greatly reduced duty cycle to ensure that EMR safety standards are not exceeded.

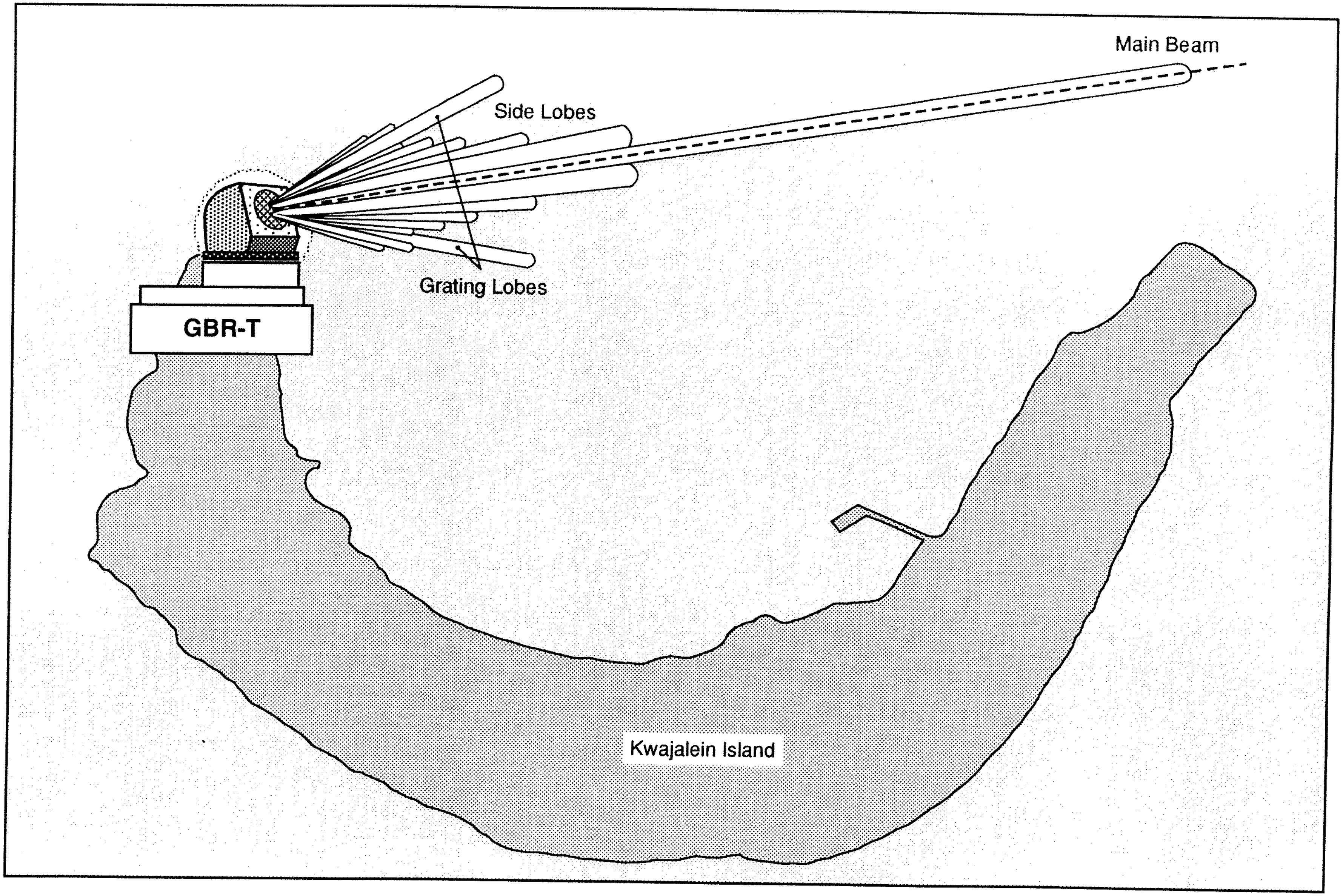

Figure 1-16. GBR-T beam

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Safe operation of the GBR-T is a major criterion associated with the design of the system. Inherent to the GBR-T design is the requirement that EMR power densities produced in areas accessible by persons be in compliance with appropriate standards for human exposure. Three specific criteria have been defined to assure that operation of the GBR-T would not result in excessive EMR exposure of individuals in its vicinity. The GBR-T would incorporate provisions to prevent microwave power densities from exceeding the following:

- 5 mW/cm^2 (32 mW/in^2) averaged over any 6-minute period on the ground or on any existing structure within 2 kilometers (km) of the radar,
- 1 mW/cm^2 (6.5 mW/in^2) averaged over any 6-minute period on the ground or on any existing structure at distances greater than 2 km from the radar, and
- 50 mW/cm^2 (320 mW/in^2) averaged over any 1-second period on the ground or on any existing structure.

In each of these three criteria, the exposure levels are more stringently controlled than those permitted in the latest recommendations for human exposure issued by the IEEE (1991) and ANSI (1992) for exposures in uncontrolled environments (see Appendix A for additional discussion). To ensure that EMR exposure levels are in accordance with the above criteria, the following positive actions would be taken in GBR-T design and testing.

- Effects from the main beam would be controlled by establishing a minimum beam elevation limit of 2 degrees above horizontal for normal operations. If the radar beam is required to go below an elevation of 2 degrees to gather data on the splashdown of impacting objects or to assist in range operations, the radar duty cycle would be reduced to the extent necessary so that resulting power densities would not exceed the above criteria (the maximum duty cycle of the GBR-T is 25 percent).
- Effects from the antenna grating lobes and side lobes would be controlled by establishing computer operating rules in the main data processor to ensure that EMR power densities are in accordance with the above-specified criteria. Before each mission, simulations would be used to verify the adequacy of the computer operating rules.
- Effects from the antenna grating lobes and side lobes also would be controlled by a separate computer used to calculate real-time EMR power densities for several geographical cells surrounding the GBR-T. This safety computer would inhibit the GBR-T from transmitting if a predetermined threshold was exceeded. The safety computer would be supplemented with 10 EMR sensors placed throughout Kwajalein Island. These sensors would provide measured data on EMR power densities to the safety computer that would inhibit the GBR-T from transmitting if the measured data exceeds a predetermined threshold. This overall monitoring system is illustrated in Figure 1-17. In addition, EMR sensors (recording only) could be located on Ebeye or other islands, as appropriate.
- To ensure personnel safety and eliminate the need for a controlled-access zone outside the GBR-T facility, independent evaluations by Raytheon Company and USAKA safety personnel would verify the ability of the GBR-T to control power densities on land and sea. Testing would be supported by the placement of measuring equipment in the vicinity of the GBR-T. To ensure that personnel exposure limits are not exceeded, testing would proceed in a step-by-step manner, initially using low duty cycles to perform limited radar operations. Only when measurements successfully verify the predicted operational conditions would increases in power levels for testing be allowed.

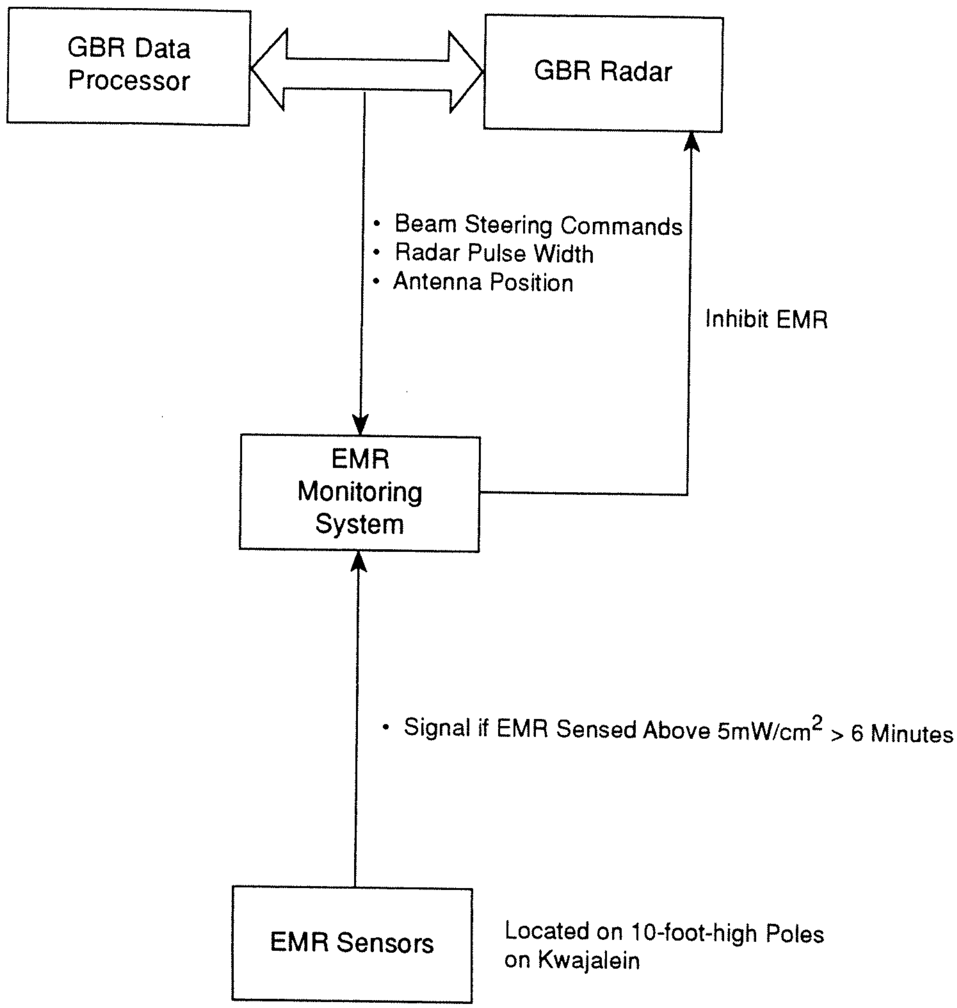

Figure 1-17. GBR-T EMR monitoring system

The monitoring system receives radar commands directly from the data line between the data processor and the radar. It computes the EMR grating and side lobe strength at ground level every second for the geographical cells and will inhibit EMR transmission if the specified limits are approached. The program will be calibrated by using actual measurements as the GBR-T system becomes operational at USAKA. In addition, the pole-mounted EMR sensors, which continuously monitor the radar emissions, signal the monitoring system to inhibit EMR transmission if the power-density threshold is approached. This system is in addition to the main data processor, which would have EMR power-density levels set within predetermined safety standards for various beam-steering elevations. These safety measures ensure personnel safety at USAKA and in the off-shore vicinity.

The GBR-T is near Bucholz Army Airfield on Kwajalein Island, and EMR from the radar that might impact personnel and aircraft activities at the airport will be controlled. In addition to the potential hazard to personnel identified above, large electromagnetic fields can detonate EEDs or induce malfunctions in avionics equipment on aircraft. Actions similar to those described above for mitigating personnel exposure will limit EMR power density at the airport, except that power density criteria for human exposure and for EED safety will be applied. The limit for EEDs is currently an instantaneous power density of 10 mW/cm^2 (Air Force Regulation 127-100 3 August 1990, *Explosive Safety Standards*).

If aircraft in flight are illuminated at close range by the radar, malfunctions induced in avionics equipment or EED detonations are possible. Prior permission from the commander of USAKA is required to land at Bucholz and the airspace out to 180 nautical miles (nmi) is controlled by the tower or the FAA Air Route Traffic Control Center at Oakland, California, so aircraft without the knowledge and permission of an air traffic control authority are not expected to fly within close range of GBR-T. Local flights are managed by the tower and USAKA flight operations. Because all GBR-T operations that involve transmitting EMR energy would be considered Kwajalein Missile Range operations, GBR-T EMR will be coordinated with other activities, including range safety and flight safety, through the range scheduling organization. The range schedule is therefore the probable vehicle for coordinating GBR-T EMR with flight operations to avoid illuminating aircraft at close range. In addition, communication procedures will be established with the tower and the range safety organization to inhibit EMR immediately should an unplanned penetration of a hazard zone occur. Additional safety measures, to be developed in cooperation with FAA and USAKA flight safety personnel, would be designation of any aviation hazard areas, publication of Notices To Airmen, and briefings to local aviators about any safety procedures that may be needed regarding GBR-T.

ECAC studies were conducted to examine the potential for interference with or damage to marine and aeronautical weather radar systems from high-intensity, pulsed-radar fields arising from the GBR-T operation, and to identify the means to eliminate any unacceptable risk of such impacts. Means to control interference or damage to marine and aeronautical weather radar systems may include coordinating GBR-T test activities with aircraft and marine activity, control tower operations, and other USAKA operations; and issuing an appropriate Notice to Airmen to specify procedures for coordination between the aircraft control tower and approaching aircraft.

GBR-T system design and operation would limit human exposure to acceptable levels. This would reduce any impact of the GBR-T electromagnetic fields on fuel ignition hazards, prevent any inadvertent detonation of EEDs or ordnance, and reduce interference with critical medical electronic devices such as cardiac pacemakers.

Potential hazards from fuel ignition or inadvertent detonation of explosives and ordnance would be evaluated by calculating the potential EMR levels of the locations involved (e.g., hot pads, meteorological rocket launchers, fueling points) and comparing the EMR levels with all applicable safety criteria. Before initiating activities involving the use of explosive devices and/or fueling operations during GBR-T activities, measurements would be taken at the selected sites using the USAKA mobile EMR surveillance system or portable hand-carried instrumentation, as appropriate. If measurements indicate a potential hazard, operational constraints would be imposed to eliminate the potential hazards by coordinating USAKA and GBR-T operations.

Although EMR levels associated with the GBR-T would be less than the personnel exposure limits established in U.S. Army standards, there is a possibility that such EMR could affect the operation of some models of cardiac pacemakers. Because of the potential for significant adverse effects in the form of interference with cardiac pacemakers worn by some individuals living on and traveling to Kwajalein Island, an administrative procedure would be implemented to inform all travelers of the presence of EMR fields near the GBR-T before traveling to USAKA. Separately, residents of USAKA who wear pacemakers would be identified and informed of the EMR fields near the GBR-T prior to initiation of operation.

1.4.5 Phase III of GBR DEM/VAL Program

Phase III of GBR DEM/VAL program is the actual testing or FTV of the GBR systems. The testing would be conducted against actual targets, both TOOs, and the dedicated targets discussed below.

1.4.5.1 TMD-GBR FTV

In general, two types of tests would be conducted at the WSMR/Fort Bliss test sites – technical performance assessments and operational suitability assessments. During a specific test activity, the data collected may be used to satisfy data requirements for both test types.

As indicated by the test events discussed above, most testing involving actual targets would be accomplished with TOOs. These are missiles that are launched from WSMR/Fort Bliss for other programs. However, in order to ensure collection of some specifically required data, two dedicated targets are planned. These targets would be near-vertical launches (like KITE 3 launches) from the WSMR SULF site. This is an existing WSMR launch site from which small missiles are launched routinely. The ground impact area also is on WSMR and is used routinely. Impact to WSMR is expected to be no different from previous similar launches (USASDC 1989c). These launches are addressed in the following environmental documentation: Extended Range Intercept Technology (ERINT) EA (USASDC 1991a); High Endoatmospheric Defense Interceptor EA (USASDC 1989c). Findings of no significance were issued for each EA.

The majority of the testing would be conducted to collect technical performance data on the various components, subsystems, and the overall system. These data are used to validate data obtained during in-plant testing and to verify that the system performance is in compliance with the specified system requirements. Other tests, such as teardown, move, and setup, would be performed to provide data to support an early operational assessment of the ability of the TMD-GBR UOE system to support potential contingency operations.

The major TMD-GBR test events would include the following.

- **Subsystem testing/system integration (regression) testing** – Individual hardware/ software configuration items would be tested and integrated into a functional radar system. A series of regression tests would be accomplished using simulators/test drivers to reaffirm baseline system performance.
- **Safety/EMR/antenna pattern testing** – Upon conclusion of a series of system safety checks, low-level EMR tests would be accomplished to reverify system safety and to measure initial transmitter performance. These tests would be followed by full-power EMR tests and initial tracking and antenna pattern testing using radar calibration spheres.
- **Subsystem/system calibration and alignment testing** – Individual hardware configuration items would be calibrated and aligned (e.g., timing, gains). Then a series of system tests using radar calibration spheres, and possibly satellites, would be performed.
- **Search/acquisition/tracking/discrimination testing** – This testing would be composed of a series of tests, both simulated and real, conducted at varying traffic levels to establish system-level performance. These tests would be performed with a TOO, to the maximum extent possible, that is consistent with test requirements. Two dedicated targets also would be used.
- **Operations in electromagnetic countermeasures environment** – A series of operations (e.g., search, acquisition, tracking, and discrimination activities) would be conducted in both simulated and real electronic warfare environments.
- **Other technical tests, as required** – The Test and Evaluation Master Plan (TEMP) for TMD-GBR will provide further descriptions for all tests planned for this DEM/VAL activity. The TEMP is a classified document and would not be released to the public.
- **Other tests and data** from the technical testing would be used to provide a basis for an operational assessment. The assessment would address the capability of the system to satisfy minimum operational objectives.

1.4.5.2 GBR-T FTV

This phase of the GBR-T program would take advantage of TOOs that will be launched from Vandenberg AFB for other programs. Additionally, two GBR-T dedicated missions are planned, one launched from Vandenberg AFB and one from the Pacific Missile Range Facility (PMRF). The target missile launched from Vandenberg AFB would use a Minuteman I delivery system, which has been launched routinely from the AFB. The dedicated launch from Vandenberg AFB was addressed in the 1989 GBR EA (USASDC 1989a). The target set would consist of reentry vehicles (RVs), replicas, and other objects. This test would be planned for the first quarter of

FY96. Environmental documentation for the TOOs is addressed in the EA for Minuteman and Thor Missile Launches at Vandenberg AFB, April 1976 (U. S. Air Force [USAF] 1976); the Peacekeeper in Rail Garrison and Small ICBM Flight Test Program, November 1987; and Final (1979a) and Supplemental (1979b) EIS, MX, Missile Flight Testing. Findings of no significance were issued for these programs.

The target launched from PMRF would be the Strategic Target System delivery system. The target set would consist of RVs, replicas, and other objects. This test is planned for the second quarter of FY96. This phase of testing will validate system performance using actual targets to evaluate discrimination schema performance and to demonstrate the performance capability of other GBR-T functions. Discussion of target launches from PMRF is contained in the Strategic Target System EA and EIS (USASDC 1990, 1992b).

1.5 ALTERNATIVES OTHER THAN THE PROPOSED ACTION

Alternatives to the proposed action were considered for test site locations and sensor types. Other test site locations considered were rejected as not reasonable for the proposed action. Several sensor alternatives were considered but were not carried forward for the reasons described below.

1.5.1 Test Locations

Since the late 1950s, USAKA has served as a primary site for testing intercontinental ballistic missiles (ICBMs), sea-launched ballistic missiles (SLBMs), and antiballistic missiles (ABMs), and to support a variety of other DoD programs. USAKA and WSMR are the two national test ranges designated in the 1972 Anti-Ballistic Missile Treaty with the former Soviet Union for conducting field testing of ABM radars, launches, and missiles. However, WSMR has significant size and safety limitations. Consequently, full-scale intercept and system integration testing has been conducted at USAKA, and future testing is expected to take place there as well. The use of existing programs and facilities at USAKA also would help to minimize the cost of the GBR-T system as well as minimize the potential for environmental impacts.

WSMR/Fort Bliss were considered as reasonable test locations based upon several factors. One factor is that demonstration of the ability of the TMD-GBR to acquire, track, and classify tactical missile objects during the midcourse and terminal phases of the trajectory would be achieved using realistic targets with a flight time and viewing geometries that represent real-world conditions. The selection of WSMR/Fort Bliss provides these real-world conditions. Additionally, at WSMR/Fort Bliss, TMD-GBR can take advantage of the existing tactical missile test programs (such as PATRIOT) and other ongoing programs providing TOOs. At the completion of DEM/VAL testing, the two TMD-GBR UOE systems are planned to be transferred to the THAAD Missile System Development program for use in support of its DEM/VAL test activities, which are currently planned for WSMR in the 1995 to 1996 time frame.

The selection of USAKA as the location for the GBR-T was based on the fact that USAKA is the primary downrange splashdown zone for ballistic missiles launched in the Western Test Range. Given the necessary use of the Western Test Range for testing realism, USAKA is the only reasonable location for the GBR because of the need to locate the radar at the terminus of the target trajectory and because of the need to rely on existing programs to provide target objects. Within USAKA, siting of the radar on Kwajalein Island was done because such siting provides the best viewing geometries for the vast majority of possible targets with minimal impact on radar design (e.g., tracking rates, field of view) and also minimizes the possible impacts of new construction. Use of other USAKA locations would result in less advantageous viewing geometries, land use impacts, major new construction requirements (i.e., a new power plant and technical facilities), and major transportation requirements (daily inter-island transport).

On Kwajalein Island, two sites were determined feasible. Both sites were on Building 1500, an existing structure at the western end of the island. Location on the top of Building 1500 was selected over the alternative location at the first roof level, 13 m (42 ft) above ground level, because the former allows less restrictive operation and has the potential for greater utility as a range radar asset after completion of GBR testing.

1.5.2 Previously Considered Sensor Alternatives But Not Carried Forward for the GBR Mission

In defining the GBR sensor requirements for the several applications of various GPALS defensive systems and the DEM/VAL requirement for test, a number of alternatives were postulated, analyzed, and rejected for the reasons presented below.

- **Use of existing theater sensors** – The PATRIOT radar, already being employed in theater roles, was the most likely sensor to be analyzed as an alternate acquisition and fire control radar of the upper tier of the Theater Defense. PATRIOT is the lower-tier component of the Theater Defense, and expansion of its radar capability in terms of increased range, additional interceptor support capabilities, and improved traffic capability to meet high-altitude TMD requirements was considered but rejected on technical, programmatic, and cost objections. The additional range and resource requirements could not be achieved without major redesign. The cost of the redesign of the radar to meet increased requirements would be as significant as the cost of a new sensor.

- **Use of other existing sensors** – The THAAD Project Office conducted a survey of other existing radar designs to assess whether or not their designs were sufficiently close in capability to support the TMD functional requirements with a performance acceptable to be adapted to this application. The search, track, target characterization, and missile support functions required are not supported together in any other sensors. Many of the sensors represent obsolete technology, designs that are not compatible with military standards, or special-purpose designs that do not lend themselves to inclusion of additional capabilities. No cost-effective candidates were identified.

- **Space-based sensors** – The SDIO has studied extensively the ability of a space-based radar to perform acquisition and track functions against a variety of threats from a geosynchronous or a near-earth orbit. For SDI missions, space-based sensor alternatives are still in research. In the case of tactical ballistic missiles, intermediate range ballistic missile threats may be detected and tracked; but the short-range ballistic missiles, which have short burn times, short flight times, and low apogees, make space-based sensors unreliable for all cases.

- **Ship-borne sensors** – SDIO has sponsored a U.S. Navy-led analysis of the use of AEGIS radar and suitably modified standard missiles as an alternate TMD Sensor and Interceptor System. The ship-borne system showed promise in transportability and flexible application, but is beset by the inability to defend the required areas expected to be targeted in the TMD theaters.

- **Airborne sensors** – Two different airborne approaches have been considered that use the Airborne Early Warning and Control System (AWACS): the use of AWACS to cue PATRIOT, and the use of AWACS and a short-range ballistic missile modified to be an interceptor. Neither approach meets the mission requirements.

- **Alternative ground-basing techniques** – Several alternative ground-based siting techniques were identified and evaluated for possible use in the TMD role. Fixed radar siting was assessed and rejected for a variety of reasons: the long lead time and cost of developing a permanent facility, the vulnerability of the siting to defense suppression attack, and the limitation of immobility in an application that requires responsive and flexible deployment. Rail mobile siting was assessed and rejected as too costly.

- **Use of early warning radars** – The SDIO has analyzed the capability of existing or upgraded early warning radars to perform NMD sensor missions. Although the early warning radars can provide limited capability, they are unable to provide adequate information and coverage needed for target object selections and missile interceptor support.

1.6 NO ACTION ALTERNATIVE

The no action alternative is not to proceed with DEM/VAL but to continue with sensor concept exploration activities. With respect to GBR-T, one specific sensor alternative would be the GBR-X concept. Failure to progress to the DEM/VAL phase could adversely impact the TMD and NMD sensor development, resulting in an expanded, restructured program and cost increases. If testing is not performed, then no GBR system could be evaluated. Therefore, without the appropriate testing evaluations, the no action alternative could impact the ability of the nation to have an effective defense against theater and strategic ballistic missiles.

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CHAPTER TWO
AFFECTED ENVIRONMENT

chapter two

AFFECTED ENVIRONMENT

This chapter describes the environmental setting of each proposed GBR test site in terms of physical and operational characteristics, permit status, and previous environmental documentation. The description of the affected environment of the test sites provides a context for understanding the potential impacts. Those components of the affected environment that are of higher concern relative to potential impacts are described below in greater detail. Specific physical characteristics include test site size, support facilities, and environmental and public health and safety conditions. Operational characteristics include the socioeconomic variables of staffing, payroll, and housing; the characteristics of the surrounding communities; and the infrastructure characteristics of electricity, solid waste, sewage treatment, transportation, and water supply. Referenced permits are those that relate to air quality, water quality, and hazardous waste.

Previous environmental documentation (e.g., EISs, EAs, biological assessments, cultural resource studies, and base master plans) was reviewed. Data gaps (i.e., questions that could not be answered from the literature) were then identified. To verify and update available information, site visits were made to the WSMR and Fort Bliss Military Reservation locations; meetings and discussions were held with installation personnel; and federal, state, and local regulatory agencies were contacted. Information from the 1993 Draft Supplemental EIS for USAKA (USASSDC 1993) was relied upon for the proposed GBR-T at Kwajalein Island. Site visits to Kwajalein Island were made in connection with the preparation of the 1993 Draft Supplemental EIS (USASSDC 1993).

Eight alternate sites were selected as being potentially feasible and reasonable test locations for the TMD-GBR system. Five sites are located on WSMR, and three are on Fort Bliss. The five WSMR sites are LC 39, R-409, C Station, R-409 West, and Rampart. The three sites located on Fort Bliss are IFC-25 site on McGregor Range, the Wise site, and R-396. These sites are adjacent to the southeast boundary of WSMR (Figures 1-5 and 1-6), and within the state of New Mexico.

All identified sites would be considered and evaluated as possible testing locations. However, three sites have been identified as preferred locations. The preferred sites are LC 39, R-396, and IFC-25. LC 39 is large enough to accommodate all three (dem/val and two UOE configurations) TMD-GBR systems. R-396 and IFC-25 would be used for testing of single UOE systems, individually or simultaneously.

The GBR-T system is proposed to be tested at USAKA. The proposed test site is located at an existing facility, Building 1500, situated at the west end of the island (Figure 1-13).

2.1 ENVIRONMENTAL COMPONENTS

Ten broad environmental components were considered to provide a context for understanding the potential effects of the proposed action and to provide a basis for assessing the significance of potential impacts. The data presented are commensurate with the importance of the potential impacts, and are intended to focus attention on the key issues. Several of these environmental components are regulated by federal and/or state environmental statutes, many of which set specific guidelines, regulations, and standards (Appendix B). These federal- and/or state-mandated standards provide a benchmark that assists in determining the significance of environmental impacts under the NEPA evaluation process and the Compact of Free Association of the RMI. The status of compliance of each project area/installation with respect to environmental requirements was included in the information collected on the affected environment. The 10 areas of environmental consideration are 1) air quality, 2) biological resources, 3) cultural resources, 4) hazardous materials and waste, 5) infrastructure, 6) land use, 7) noise, 8) public health and safety, 9) socioeconomics, and 10) water quality. The 10 areas of environmental consideration are discussed below briefly.

2.1.1 Air Quality

Air quality at each installation was reviewed. Particular attention was paid to background ambient air quality compared with the National Ambient Air Quality Standards (NAAQS) and whether the installation was located in an attainment or nonattainment area as defined by those standards. Existing air emissions sources at each installation were evaluated.

2.1.2 Biological Resources

Existing information on plant and animal species and habitat types in the vicinity of each site was reviewed with emphasis on the presence of any protected species and federal- or state-listed threatened or endangered species. Field surveys were conducted at the proposed test sites on WSMR and Fort Bliss. The 1993 Draft Supplemental EIS for USAKA (USASSDC 1993) was reviewed to determine if any biological resources were of concern at USAKA.

2.1.3 Cultural Resources

Existing cultural and historic resources at each installation were reviewed with emphasis on known sites listed in the National Register of Historic Places and Native American sacred sites to determine if there were any significant cultural resources at, or in proximity to, the facilities that could be affected by test activities. Archaeological field inspections of the proposed test sites were conducted at WSMR and Fort Bliss. The 1993 Draft Supplemental EIS for USAKA (USASSDC 1993) and the 1989 GBR EA (USASDC 1989a) were reviewed for information regarding cultural resources at USAKA.

2.1.4 Hazardous Materials/Waste

Existing hazardous waste management practices and the record of compliance were reviewed to determine the capability of each installation (WSMR/Fort Bliss and USAKA) to handle any additional wastes and to determine any potential problems with hazardous waste use, handling, treatment, or disposal. For this EA, a review of information concerning environmental regulatory compliance of the Raytheon Company facilities at Waltham, Quincy, and Andover, Massachusetts, was conducted. The Wayland facility was addressed in the 1989 GBR EA (USASDC 1989a).

2.1.5 Infrastructure

Electricity, solid waste, sewage treatment, water supply, housing, and transportation are examples of infrastructure requirements that could ultimately limit the activities associated with the proposed action. Capacity and current demand were examined for each installation.

2.1.6 Land Use

Base master plans, environmental management plans, and other documentation for each installation were reviewed. The existence of any known conflicts between WSMR and Fort Bliss and any planned expansions that could be affected by TMD-GBR test activities were investigated. Potential height limitations and facilities surrounding Building 1500 on USAKA were reviewed.

2.1.7 Noise

Existing environmental documentation was reviewed to determine if noise level was an issue at any of the installations.

2.1.8 Public Health and Safety

Existing environmental documents were reviewed to determine if public health and safety concerns, including EMR, were issues at any of the installations. ECAC is conducting a special analysis at both WSMR and USAKA to assess possible electromagnetic interference between the GBR systems and communications-electronics equipment in the vicinity of the GBR test sites.

2.1.9 Socioeconomics

Key socioeconomic indicators (population, housing, and employment) for the supporting region of each installation were examined to evaluate the potential consequences of increased population and employment.

2.1.10 Water Quality

Water quality concerns at each location were identified. Records of compliance with permits were examined for each installation.

2.2 TEST SITE DESCRIPTIONS

The following sections present a brief description of the Raytheon Company facilities, as well as each military installation, and the proposed test sites where the GBR family of radars DEM/VAL activities are planned. Because the proposed test sites located on WSMR and Fort Bliss are relatively close to one another, they are discussed together in one subsection. Each individual proposed test site is described below. Detailed information is presented only where it is relevant to understanding the potential impacts. The areas of environmental consideration are presented following the discussion of the proposed test sites.

2.3 RAYTHEON COMPANY FACILITIES

Design, fabrication, assembly, and initial testing of the GBR components for both TMD-GBR and GBR-T would be conducted at the Raytheon Company facilities located at Andover, Marlborough, Sudbury, Wayland, Waltham, and Quincy, Massachusetts. Site visits were made to the Marlborough, Andover, and Waltham, Massachusetts, facilities from 27 through 29 January 1993. The Marlborough facility is an office building. The Andover, Wayland, Quincy, and Waltham sites are manufacturing and test facilities. The Sudbury site would support computer software design activities. Similar activities at these existing facilities are conducted in compliance with all state and federal environmental regulations.

2.4 TMD-GBR TEST SITE DESCRIPTIONS, EXISTING ENVIRONMENTAL CONDITIONS – WSMR, NEW MEXICO/FORT BLISS MILITARY RESERVATION, WITHIN NEW MEXICO

WSMR is located in the Tularosa Basin of south-central New Mexico. The headquarters is approximately 72 km (45 miles [mi]) north of El Paso, Texas, and approximately 43 km (27 mi) east of Las Cruces, New Mexico. The main range encompasses about 8,163 square kilometers (km^2) (3,152 square miles [mi^2]). However, WSMR has access to leased co-use areas, increasing the total area available for use to more than 16,968 km^2 (6,552 mi^2). The installation, including the co-use areas, contains portions of six counties: Doña Ana, Otero, Sierra, Lincoln, Socorro, and Torrance. Fort Bliss borders WSMR to the south (Figure 1-5).

WSMR is a national range that supports missile development and test programs for the Army, Navy, Air Force, National Aeronautics and Space Administration (NASA), and foreign governments. The installation is equipped with a network of highly accurate optical and electronic data-gathering instruments that are essential for valid testing. WSMR has more than 1,000 precisely surveyed instrumentation sites and approximately 700 of the most advanced types of optical and electronics instrument systems, including long-range cameras, tracking telescopes, ballistic cameras, radars, and telemetry equipment.

The estimated 1990 population of the six-county area containing and surrounding WSMR was approximately 804,000 (U.S. Bureau of Census 1991). WSMR has a base population of approximately 980 people and a work force of approximately 7,550 military, civilian, and contractor personnel (USASDC 1991a).

The Fort Bliss Military Reservation supports the U.S. Army Air Defense Artillery School (USAADASCH) and its defense missions, hosts the Strategic Army Forces, operates Biggs Army Airfield, supports missile development, and conducts desert training. The primary mission of McGregor Missile Range on Fort Bliss is to serve as a training site for United States military forces in the use of modern weapon systems, including a limited number of missile launches. Fort Bliss is located in the far west corner of Texas and the south-central part of New Mexico (Figure 1-5). The installation is an elongated area encompassing slightly more than 4,000 km^2 (400,000 hectares) of land. The majority of the area (90 percent) is in New Mexico. The remainder, approximately 10 percent, is in Texas. The installation boundaries are within three counties: eastern Doña Ana and western Otero Counties of New Mexico, and El Paso County, Texas. The 1990 census estimated population of the three-county area containing Fort Bliss was 767,103 (U.S. Bureau of Census 1992). The Fort Bliss 1993 base population is approximately 24,000 (USAADASCH and Fort Bliss 1984; Cuciniello 1993).

The McGregor Range boundaries are completely within the state of New Mexico in Otero County, northeast from Fort Bliss Post Headquarters. Various activities are conducted on McGregor Range, including missile and artillery testing and desert maneuvers (USAADASCH and Fort Bliss 1984).

2.4.1 LC 39, WSMR

The 15-acre LC 39 site at WSMR contains a previously disturbed area large enough to provide the 25,304 m^2 (6.25 acres) needed for the primary DEM/VAL installation and testing of all three TMD-GBR systems in a side-by-side configuration or in close proximity to each other (Figure 1-7). This site has been designated as the preferred location for this installation and testing. An existing direct-access paved road leads to the site, which has existing power poles/lines and telephone junction boxes (Figure 2-1). The surrounding area is moderately disturbed land dominated by mesquite dunes and bunch grass (Figure 2-2).

tmdgbr#2\fig 2-1

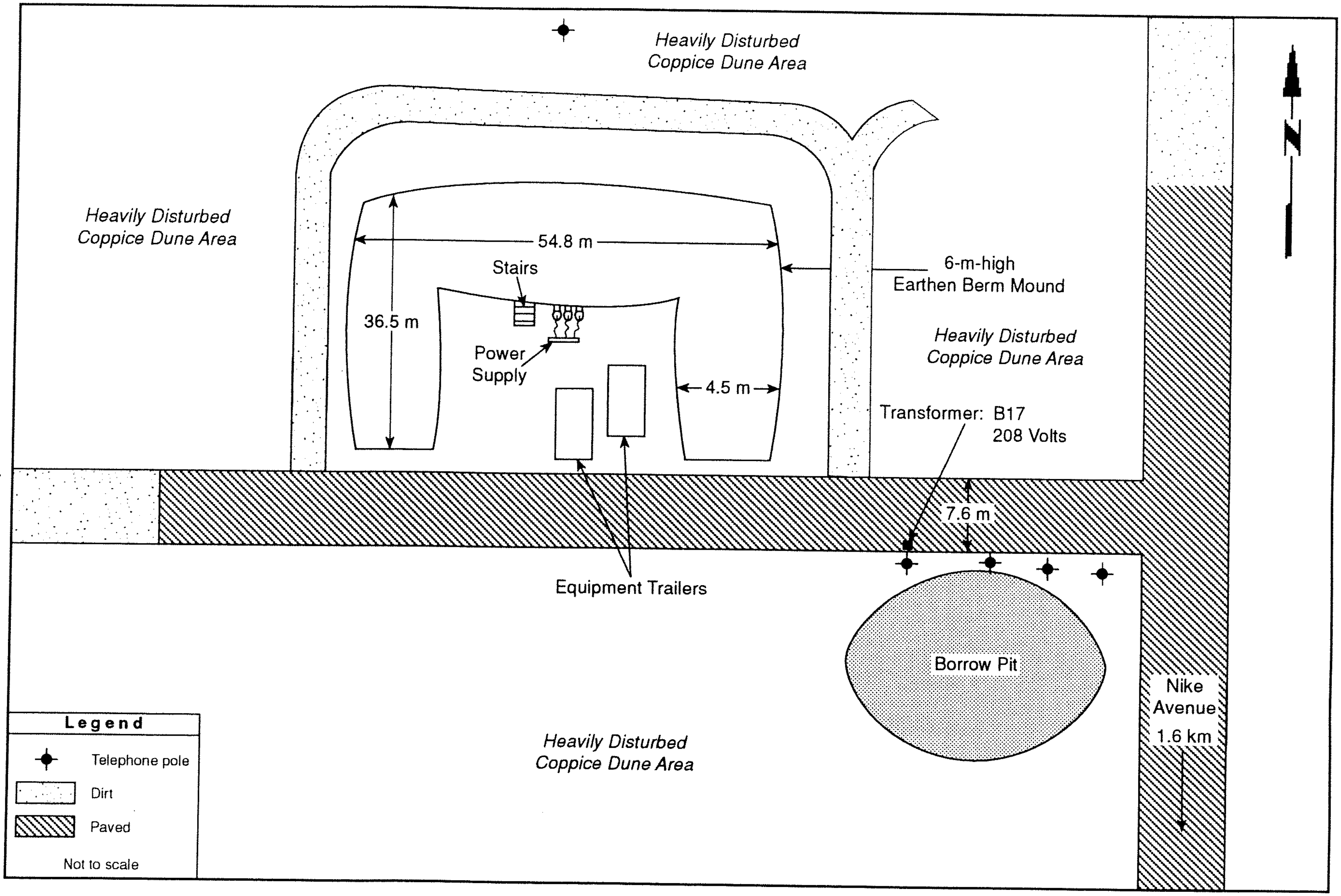

Figure 2-1. LC 39 site sketch

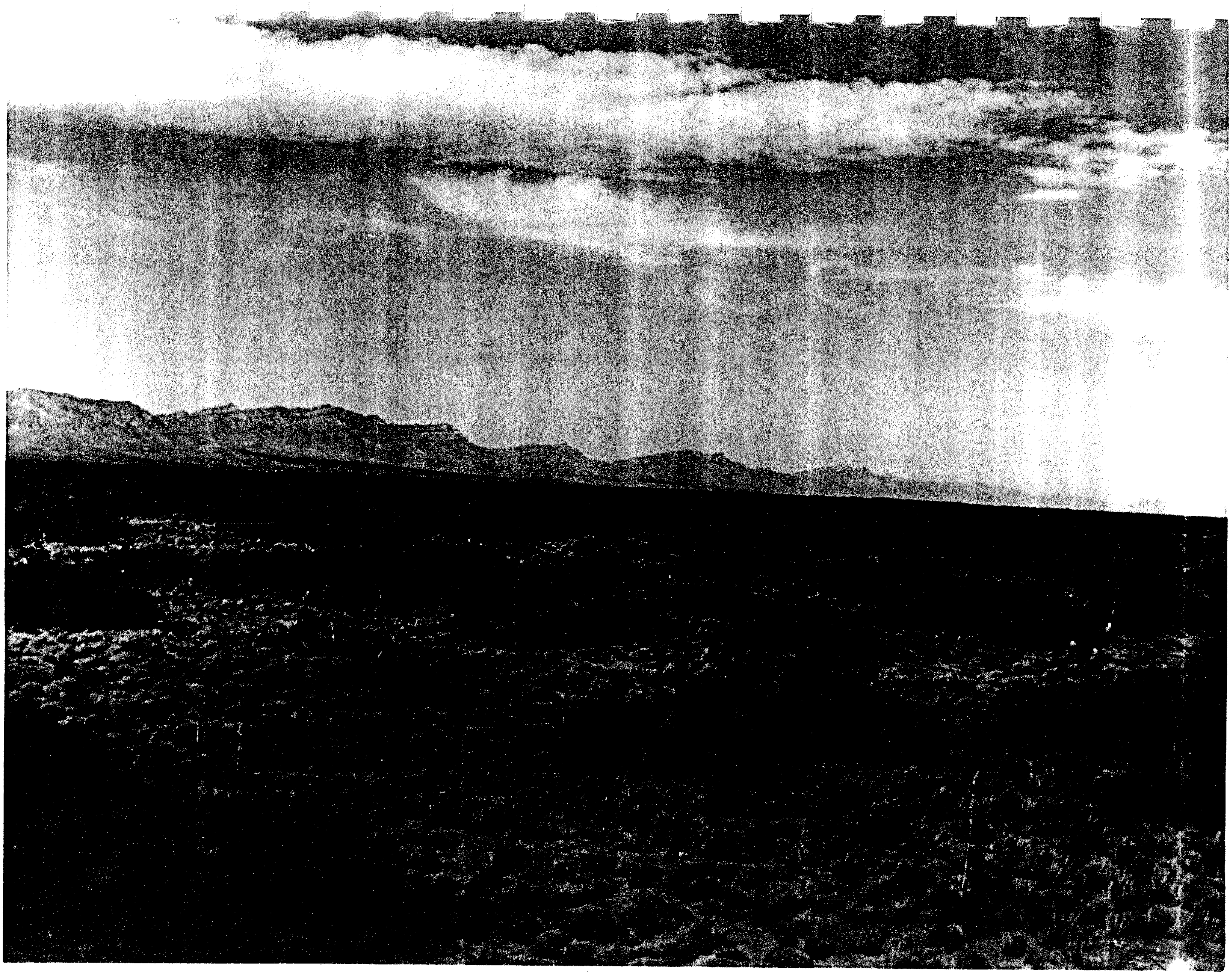

Figure 2-2. LC 39

2.4.2 R-409 Site, WSMR

The R-409 site at WSMR consists of approximately 9 acres of previously disturbed creosote bush habitat area large enough to use as an alternative to LC 39 for the DEM/VAL installation and testing (Figures 2-3 and 2-4). The site is located close to a paved road. The site has been used previously as a radar system location.

2.4.3 C Station, WSMR

The C Station site at WSMR is a 3-acre active facility with a number of buildings, graded roads, pads, and operating radar sites (Figures 2-5 and 2-6). It is currently understood that the existing radar system would not be moved from this site prior to the time that TMD-GBR would need to occupy the C Station site. However, if the current radar system is removed from C Station, the area could accommodate one TMD-GBR UOE system.

2.4.4 R-409 West, WSMR

The R-409 West site consists of 3 acres of previously disturbed (creosote bush) and is located about 402 m (1,318 ft) west of R-409. This site has a previously disturbed area large enough to locate one TMD-GBR UOE system. It is located at the junction of two unimproved roads and it has a level, elevated area similar to the other radar sites (Figures 2-7 and 2-8). It is currently occupied with abandoned instrumentation vans and other equipment that would be expected to be removed before the TMD-GBR UOE could be tested at this location.

2.4.5 Rampart Site, WSMR

The Rampart site is a very large radar facility that has been inactive for several years. This status is not expected to change. The site consists of an existing building that is currently occupied, large asphalt-covered and previously disturbed areas, and a large radar dish antenna that occasionally is used for receiving purposes only. Approximately 2 acres of the Rampart site could be used as a testing location for one TMD-GBR UOE (Figures 2-9 and 2-10).

2.4.6 Wise Site, Fort Bliss

The 3-acre Wise site is located approximately 0.8 km (0.5 mi) northeast of C Station on Fort Bliss property. This area was investigated as a possible alternative test site for the location of one of the TMD-GBR UOE systems. The Wise site is an existing, unoccupied radar site that has been used often by other radar programs. The site has a graded access road and pad (Figures 2-11 and 2-12).

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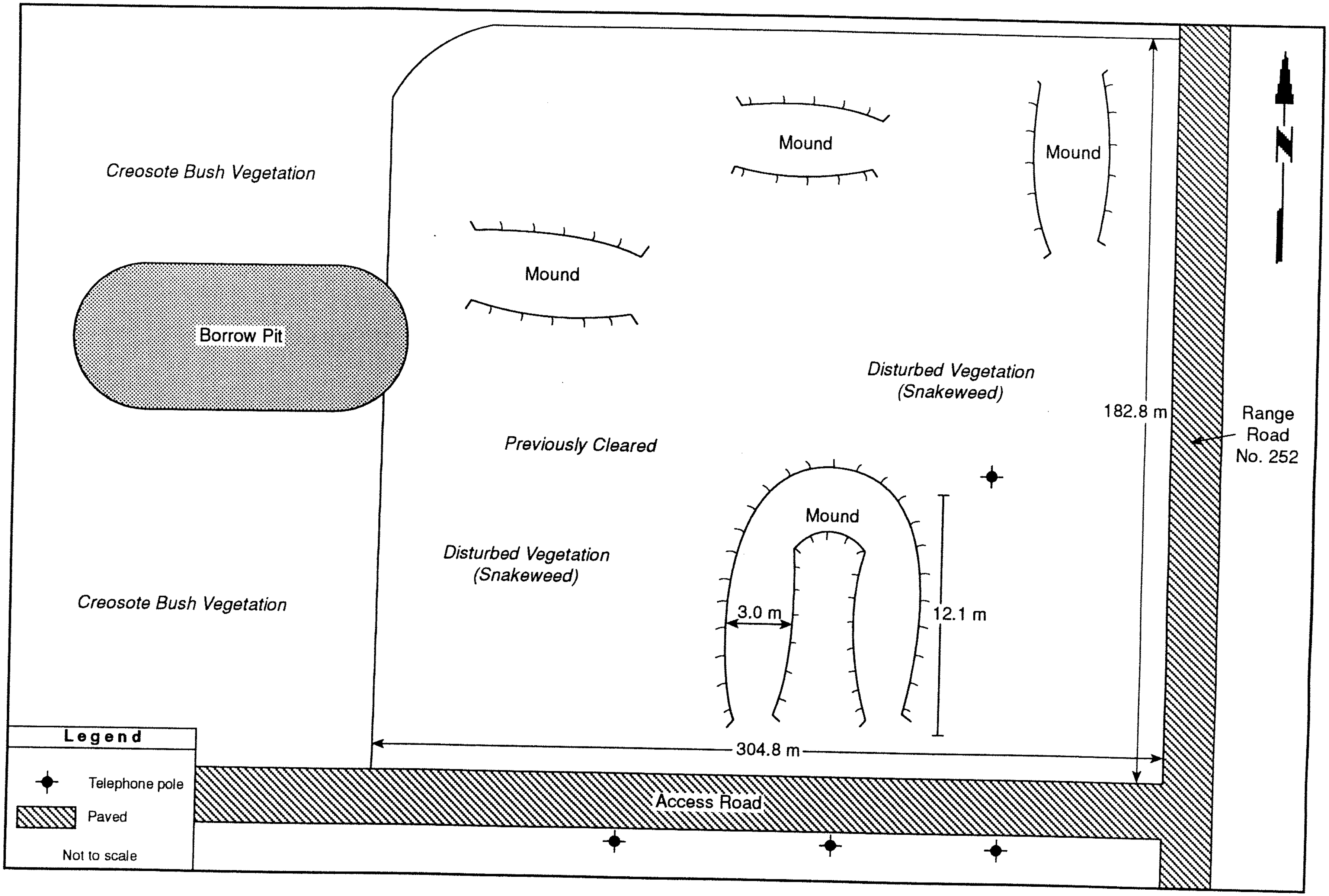

Figure 2-3. R-409 site sketch

Figure 2-4. R-409

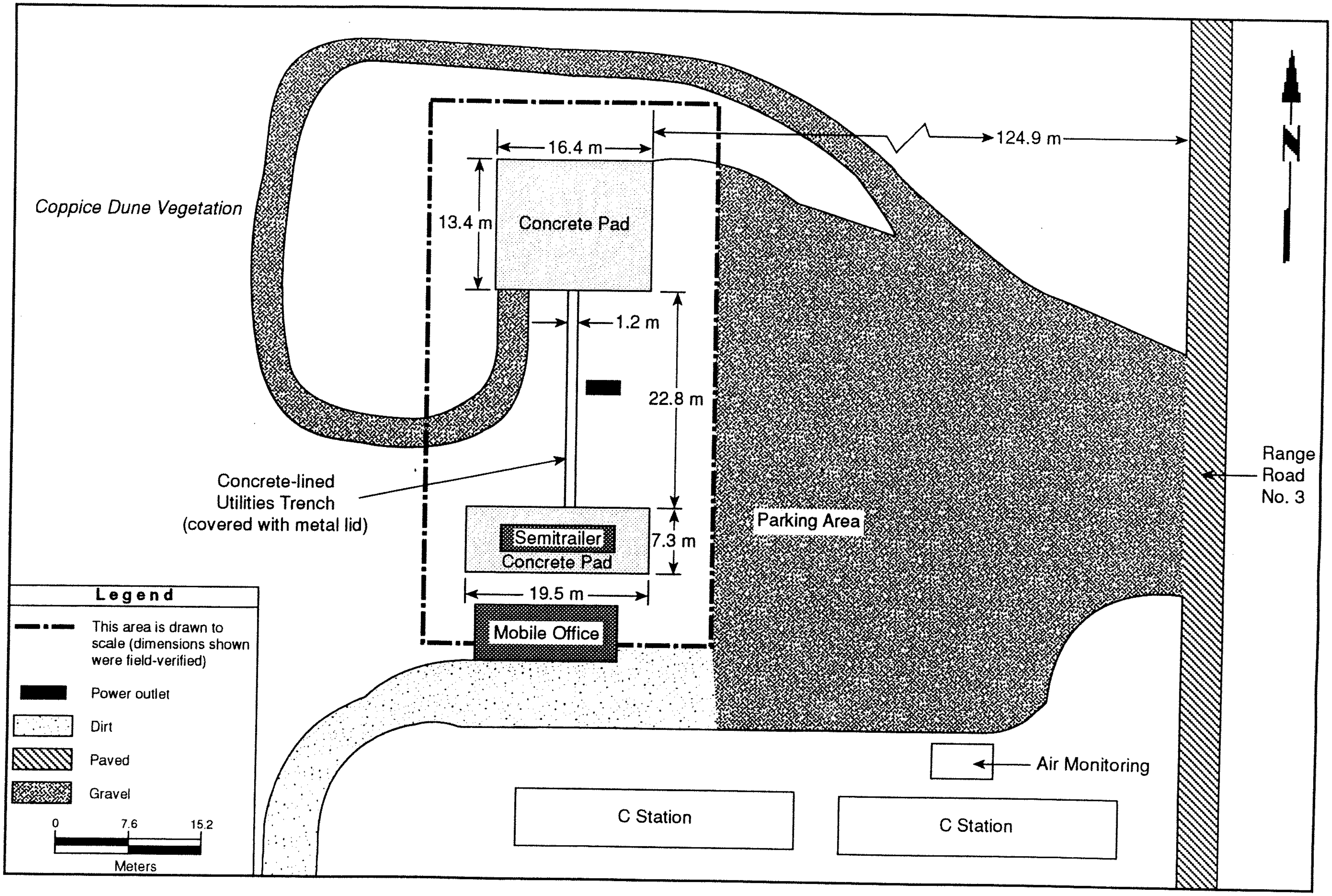

Figure 2-5. C Station site sketch

Figure 2-6. C Station

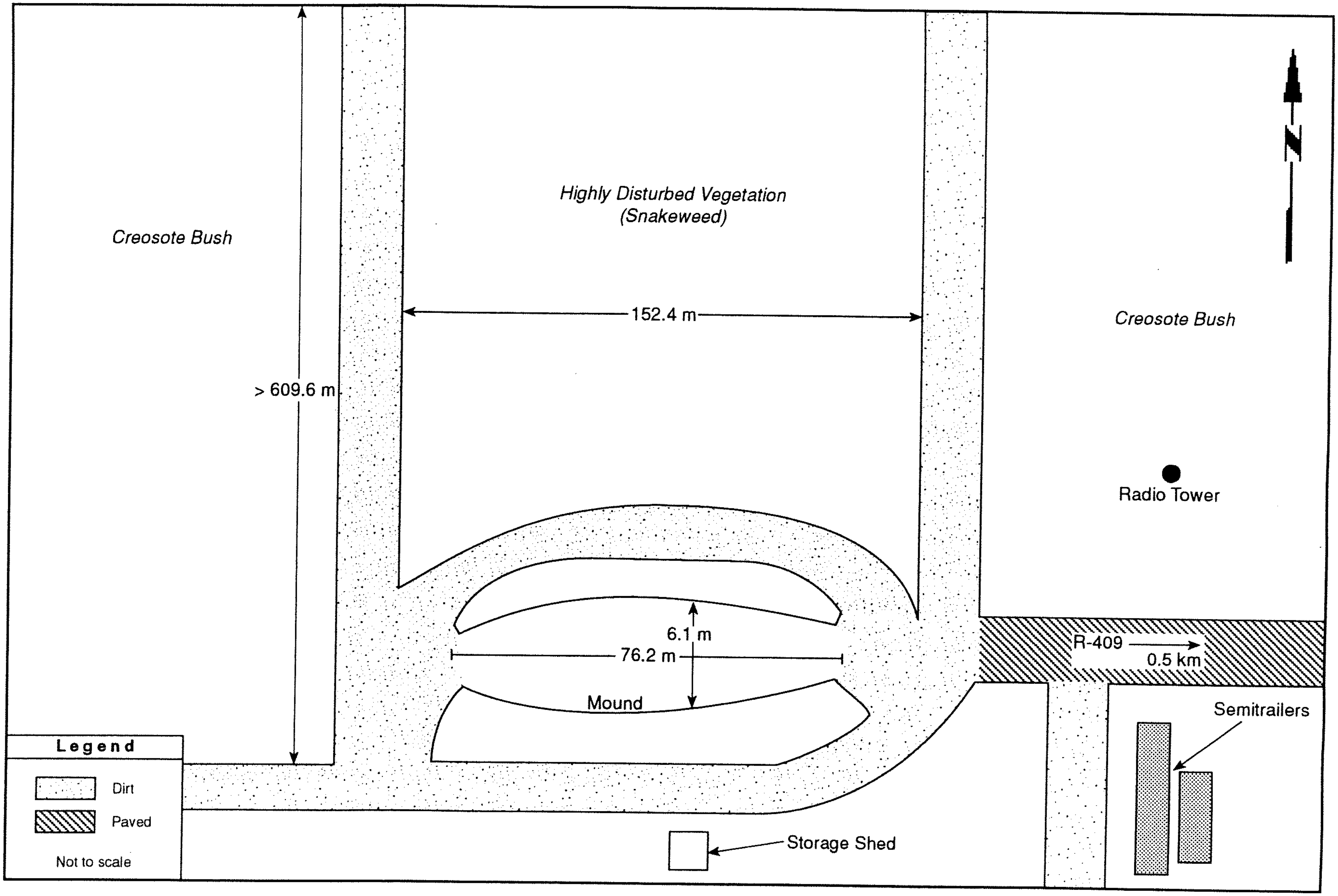

Figure 2-7. R-409 West site sketch

Figure 2-8. R-409 West

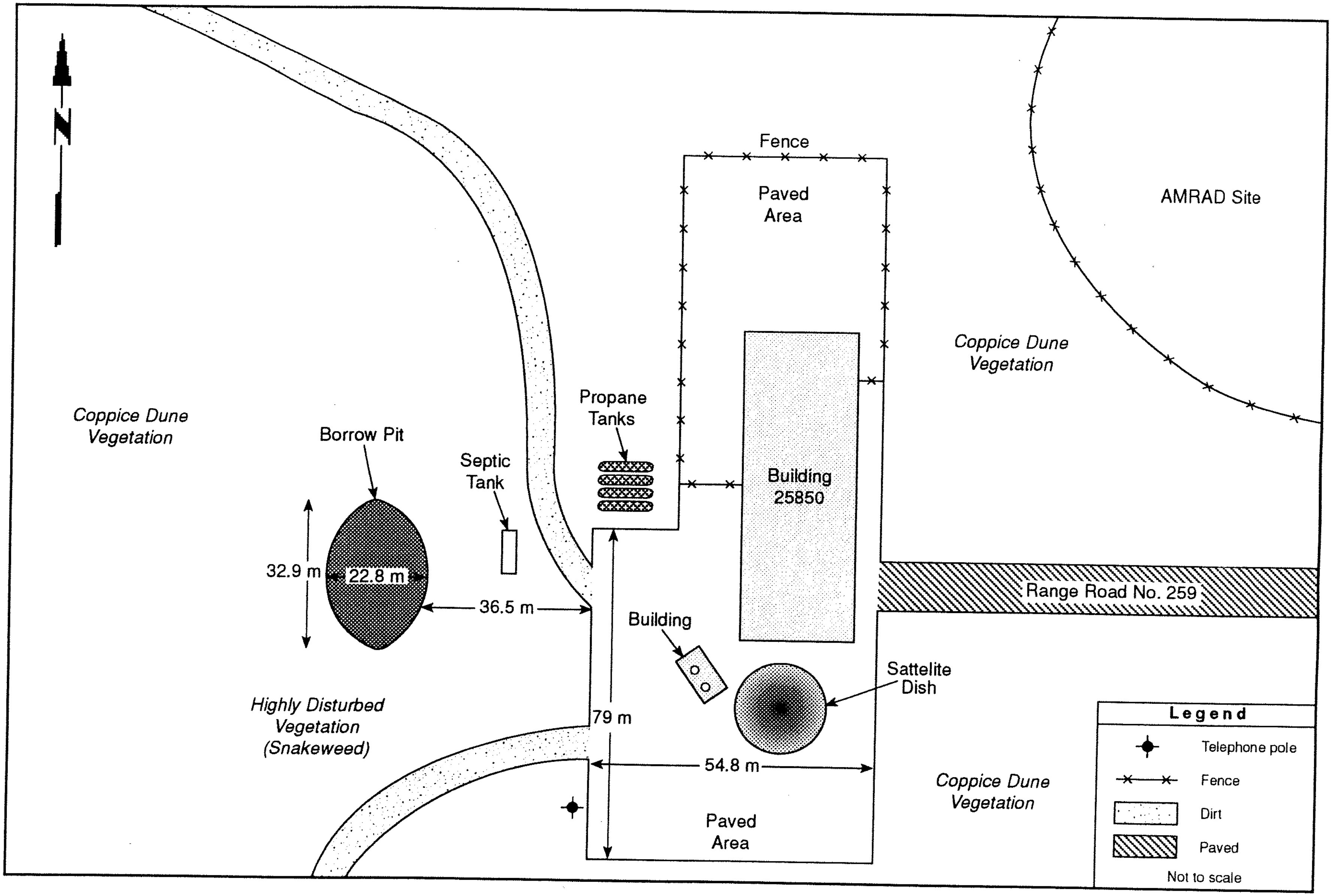

Figure 2-9. Rampart site sketch

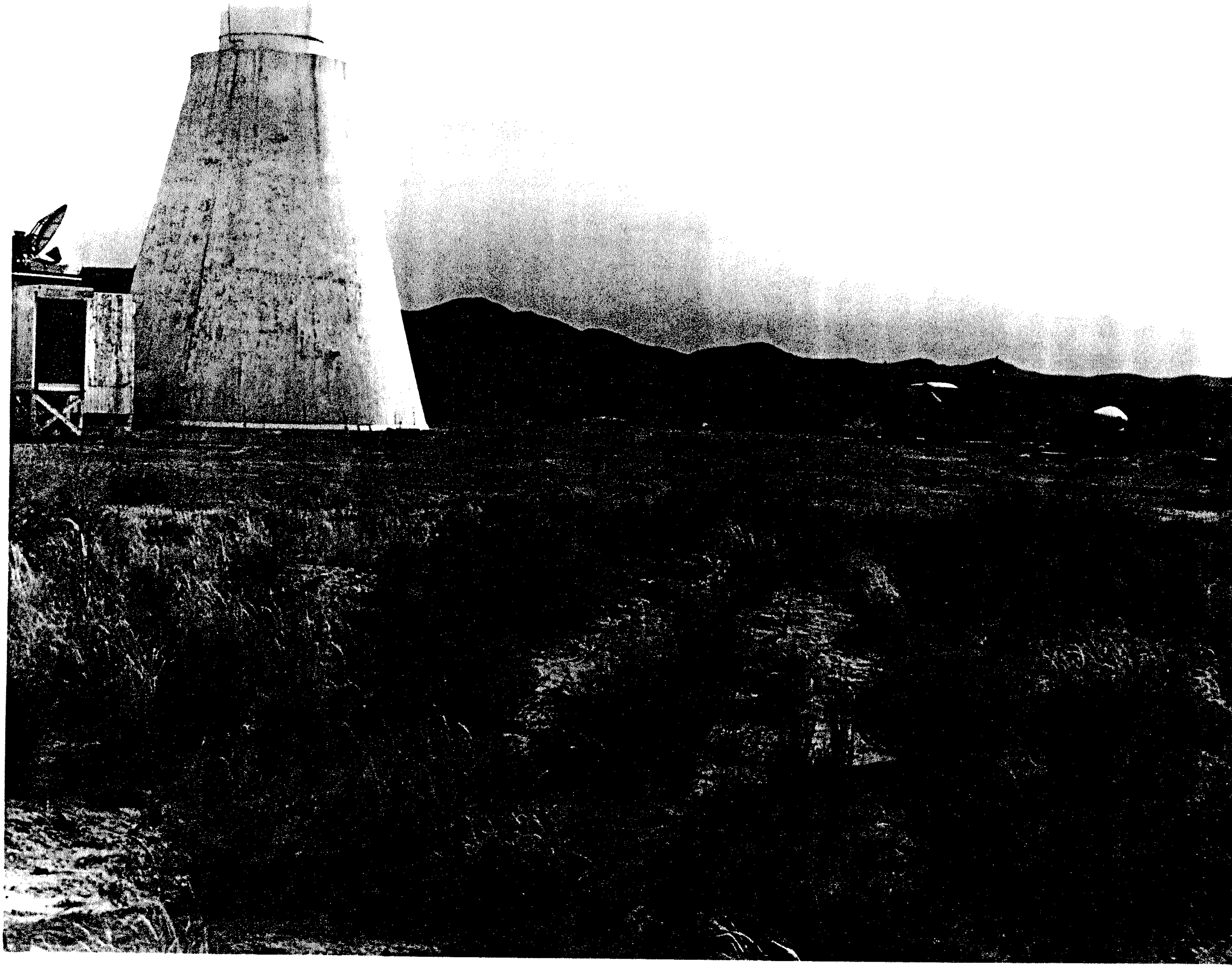

Figure 2-10. Rampart site

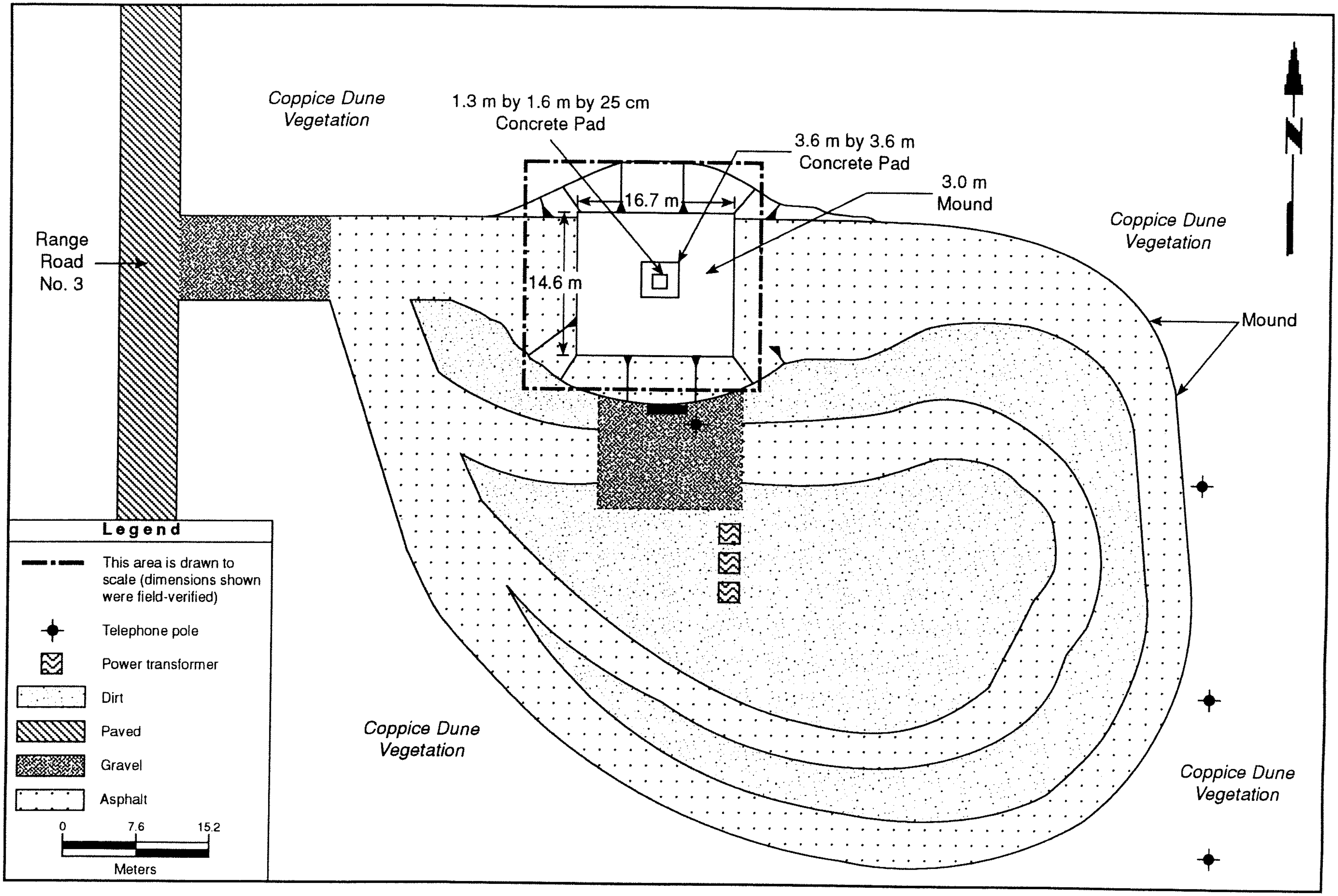

Figure 2-11. Wise site sketch

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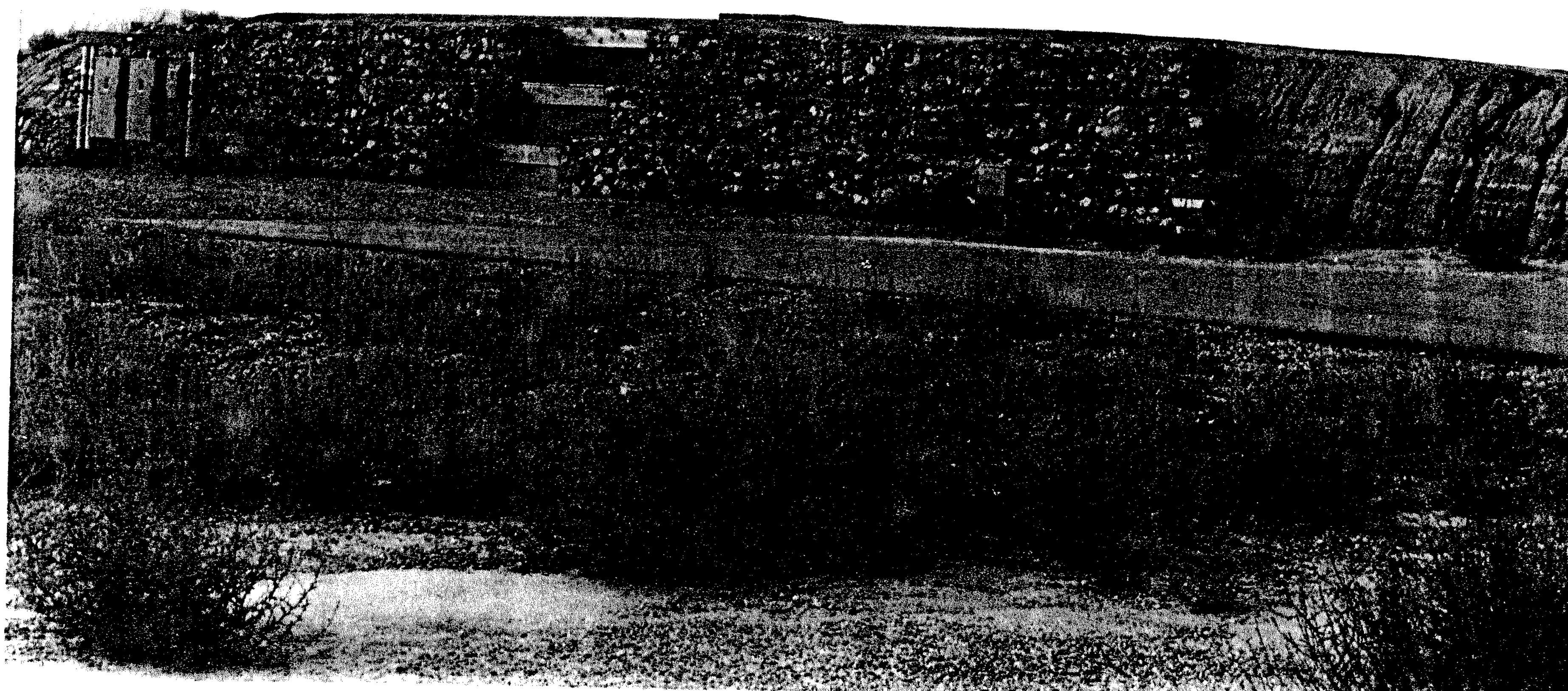

Figure 2-12. Wise site

2.4.7 Radar Station R-396, Fort Bliss

The Radar Station R-396 site consists of 3 acres of previously disturbed coppice dune habitat located on Fort Bliss property in the WSMR Annex, south of Nike Road. Physically, this area resembles active radar sites similar to those on WSMR. This site has an existing dirt access road, a level graded area of approximately 8,500 m^2 (2.1 acres), and an elevated area of approximately 400 m^2 (0.1 acre). This cleared area would accommodate one TMD-GBR UOE. There is evidence of electrical power having been available (a breaker and distribution box), but the overall status of utilities is unknown (Figures 2-13 and 2-14). LC 39 is located north across Nike Road. Also located on the north side of Nike Road are launch complexes that could provide a source of targets of opportunity for radar tests and evaluations.

2.4.8 IFC-25, McGregor Range, Fort Bliss

The IFC-25 site consists of 4 acres located on the McGregor Range area of Fort Bliss adjacent to the southeast boundary of WSMR within the state of New Mexico. The site is situated off IFC Road. It is a large, level, asphalt-paved area of approximately 13,600 m^2 (3.3 acres) and would accommodate the TMD-GBR dem/val and several UOEs. The site was used previously for Nike-Hercules test programs (Figures 2-15 and 2-16).

2.5 EXISTING ENVIRONMENTAL CONDITIONS – WSMR/FORT BLISS

The existing environmental conditions for the proposed test sites located at WSMR and Fort Bliss are described in the following subsections. The environmental components for climate and air quality, biological resources, cultural resources, land use, hazardous materials/waste, infrastructure, noise, public health and safety, socioeconomics, and water resources are briefly discussed.

2.5.1 Climate and Air Quality

The climate of the Tularosa Basin is typical of arid regions at low latitudes. Sunshine is abundant throughout the year. Rainfall is sufficient for desert vegetation growth. The average annual precipitation is about 25.4 centimeters (cm) (10 inches [in]), but this varies with elevation. Several months without rain are not unusual. The spring months, April and May, are the driest time of the year. Half of the annual precipitation falls from afternoon and evening thunderstorm activity in July, August, and September. Snowfall is typically light. The average annual snowfall totals about 20.3 cm (8 in) (Eschrich 1990).

During the winter, daytime temperatures reach 13°C to 16°C (55°F to 60°F); nighttime temperatures often drop below freezing. In the summer, temperatures typically rise above 32°C (90°F), and frequently above 37°C (100°F), during the day. At night, temperatures fall into the 16°C (60°F) range (Eschrich 1990).

The prevailing wind direction throughout the year, with one significant exception, is from the west. That exception to wind direction occurs in July and August when winds with a strong

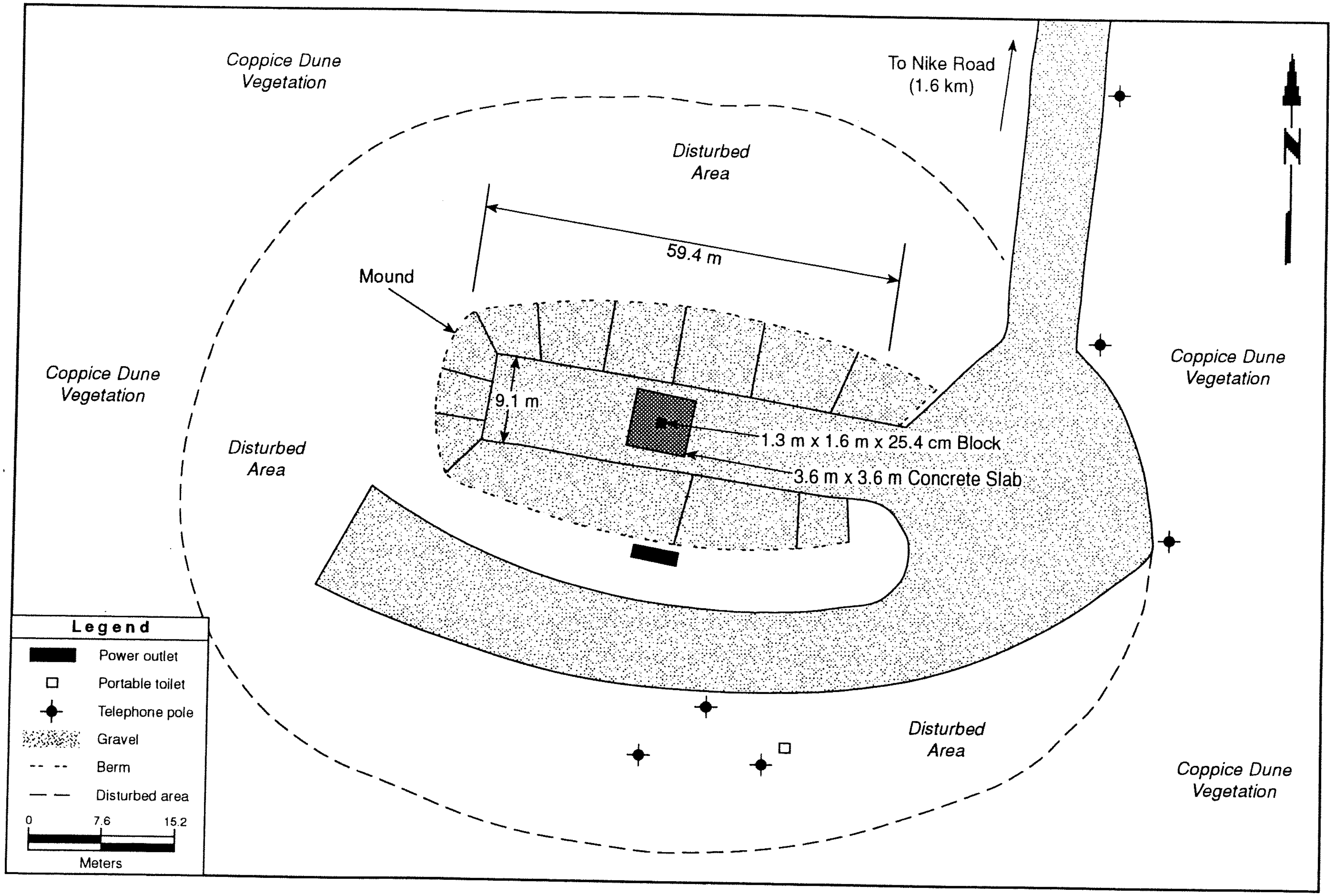

Figure 2-13. Radar (R-396) site sketch

Figure 2-14. Radar (R-396) site

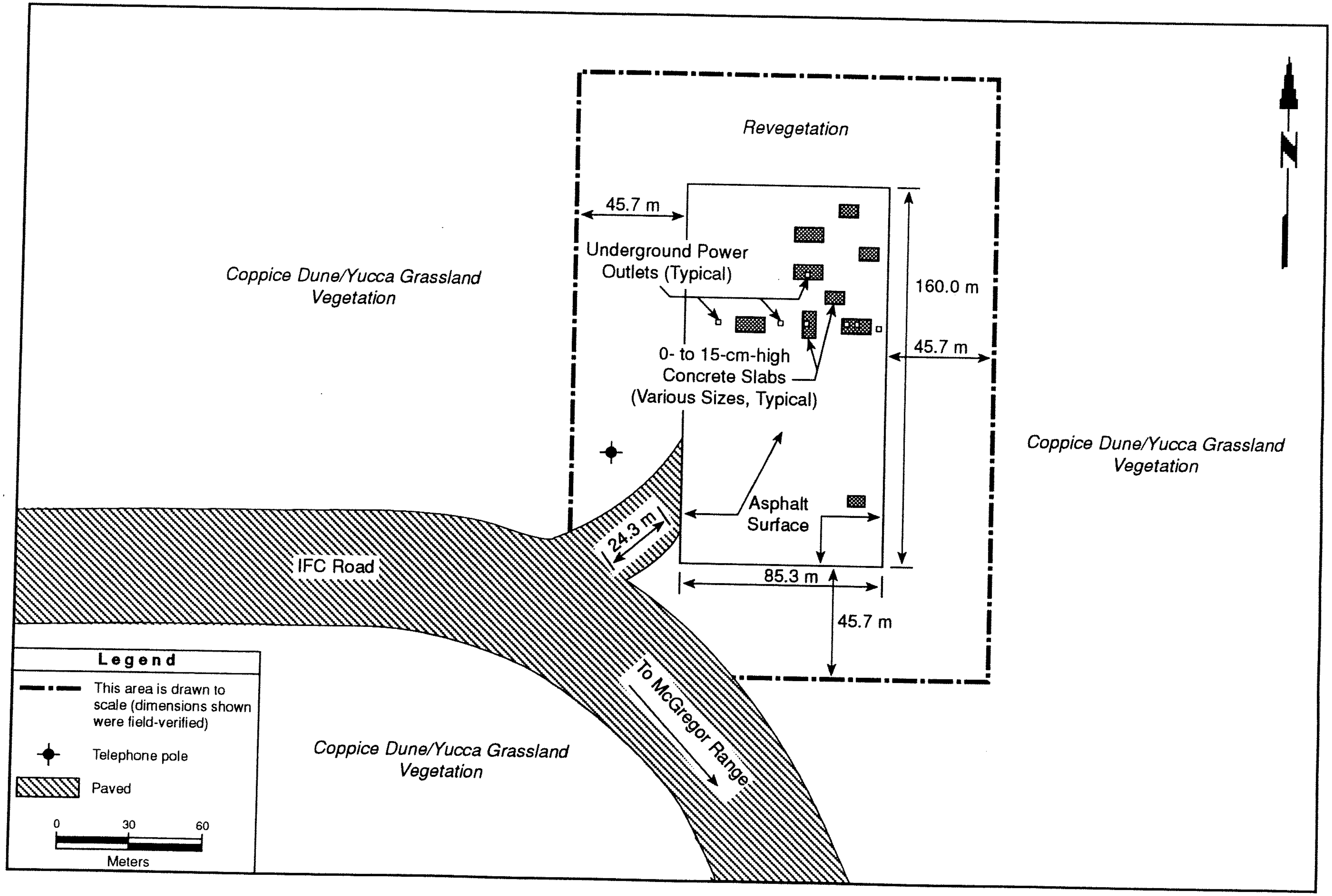

Figure 2-15. IFC-25 McGregor Range site sketch

tmdgbr#2/fig 2-15

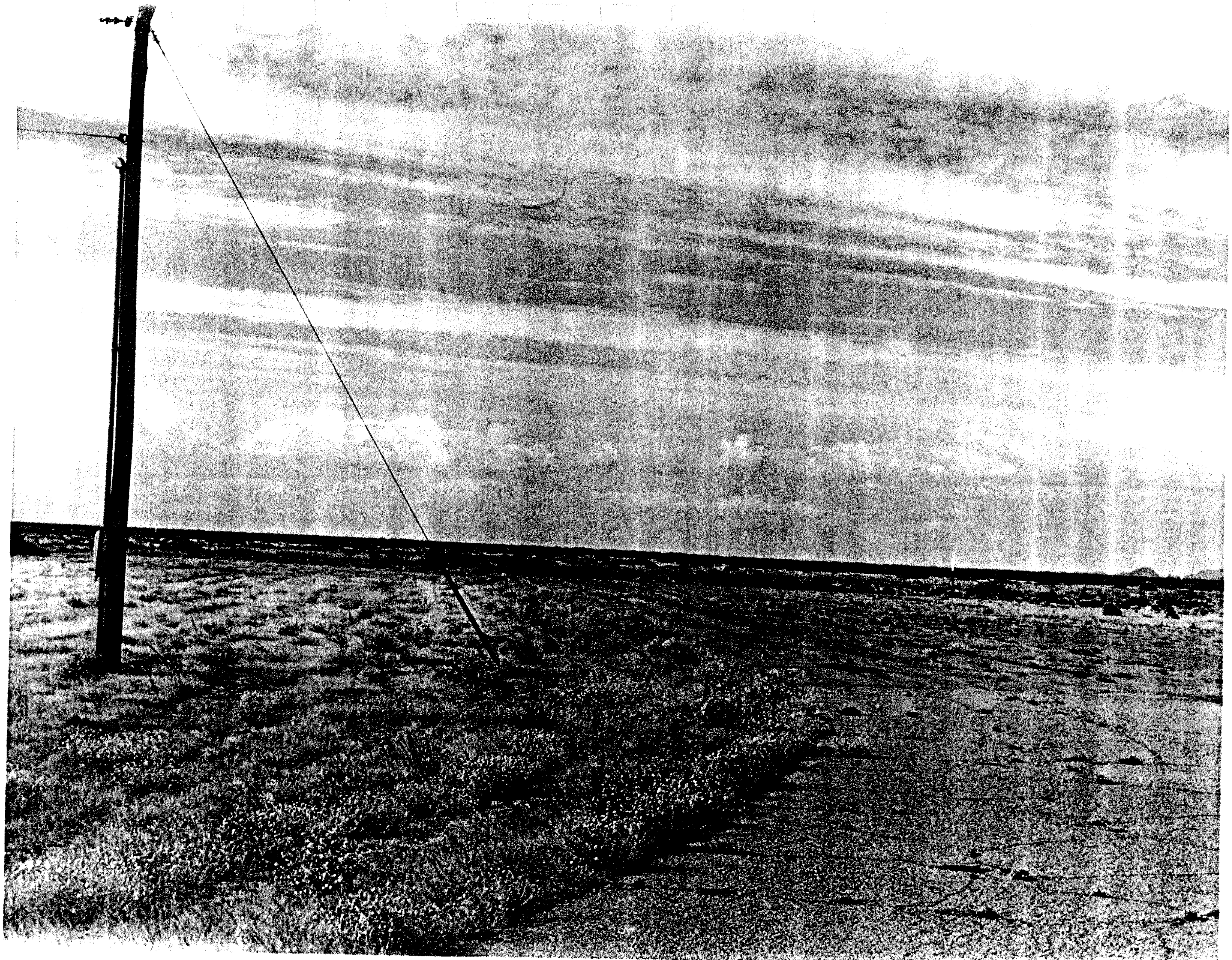

Figure 2-16. IFC-25

southerly component stimulate thunderstorm activity. Spring is notable for dust storms, caused by the combined effects of strong west winds, little moisture, dry soil, and sparse vegetation (Eschrich 1990). The Franklin, Organ, and San Andres mountain ranges on the western side of the valley add noticeably to the gustiness of winds during periods of high winds. This topographical influence causes variable wind directions during periods of light winds (Eschrich 1990).

The air quality of an area is evaluated by compliance with the U.S. Environmental Protection Agency (EPA) NAAQS. The EPA has established NAAQS for six criteria pollutants: carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), respirable particulate matter (PM_{10}), and lead (Pb) (Table 2-1). For each criteria pollutant, an area bears the classification "attainment" if the area meets the NAAQS for that pollutant, "nonattainment" if it does not. The proposed action is located in extreme eastern Doña Ana County and western Otero County where the air quality is classified as attainment for all federal criteria pollutants.

In addition to the federal standards, the state of New Mexico has set forth ambient air quality standards that are as strict or more strict than the NAAQS (Table 2-1). The New Mexico standards are designed to protect against air pollution that injures animals and vegetation, corrodes building materials and works of art, reduces visibility, and generally diminishes the quality of life in addition to protecting human health (State of New Mexico Environment Department 1991; State of New Mexico Health and Environment Department n.d.). In addition to having its own standards for the six criteria pollutants, the state also has standards for photochemical oxidants and total suspended particulate matter. Within the Tularosa Basin, the state of New Mexico does not operate ambient air pollution monitors. In the WSMR-northern Fort Bliss area, the ambient background concentrations of criteria pollutants are not monitored but considered to be low due to the lack of major transportation or industrial sources.

The state of New Mexico operated a sampler for total suspended particulate matter in Alamogordo (on the east central side of the Tularosa Basin) until 1988. That site routinely recorded exceedances of the outdated 24-hour NAAQS for total suspended particulate matter, but the site was in compliance with the annual NAAQS for total suspended particulate matter. This situation can probably be attributed to the dust storms characteristic of the windy spring months in the Tularosa Basin. Since 1988, the state has not operated a particulate matter sampler in the area of the Tularosa Basin (State of New Mexico Environment Department 1991).

A complete emissions inventory of the air pollution sources at WSMR has not been conducted. Stationary sources are few. Primary pollution sources are mobile sources such as automobile and truck traffic, missile launches, aircraft, and fugitive particulate matter sources such as dust from unpaved roadways and land disturbance. Current sources of air pollution at the five alternative sites on WSMR would be from building space heaters, highway vehicles, and dust from unpaved roadways and parking lots. The low density of air pollution sources at WSMR mitigates the impact of these emissions on the air quality of the Tularosa Basin.

As of November 1992, a partial emissions inventory of air pollution sources at Fort Bliss had been compiled. Although the inventory information does not calculate total emissions from all sources on the entire facility, it does provide some fuel or process information for boilers, incinerators, paint-spray booths, and aboveground organic-liquids storage tanks. The inventory addresses particulate matter emissions from four source categories: emissions from natural gas consumption, which are determined insignificant; emissions from JP-4 fuel consumption by tanks

Table 2-1
Ambient air quality standards[a]

Pollutant	Averaging Time	National Standard (NAAQS)	New Mexico Standard
Carbon monoxide (CO)	1-hour 8-hour	35 ppm 9 ppm	13.1 ppm 8.7 ppm
Ozone (O_3)	1-hour	0.12 ppm	none
Photochemical oxidants	1-hour	none	0.06 ppm
Nitrogen dioxide (NO_2)	24-hour annual	none 0.05 ppm	0.10 ppm 0.05 ppm
Sulfur dioxide (SO_2)	3-hour 24-hour annual	0.50 ppm 0.14 ppm 0.03 ppm	none 0.10 ppm 0.02 ppm
Respirable particulate matter (PM_{10})	24-hour annual	150 $\mu g/m^3$ 50 $\mu g/m^3$	none none
Total suspended particulate matter (TSP)	24-hour annual	none none	150 $\mu g/m^3$ 50 $\mu g/m^3$
Lead (Pb)	quarterly	1.50 $\mu g/m^3$	none

Sources: State of New Mexico Environment Department 1991; State of New Mexico Health and Environment Department n.d.

[a] Standards are expressed in parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$) as indicated.

Notes: Standards are presented for pollutant data reported in the *State of New Mexico Air Quality Bureau Annual Report* summaries.

National standards, other than ozone and those based on annual or quarterly averages, are not to be exceeded more than once a year. Standards based on annual or quarterly averages are not to be exceeded. The ozone standard is not to be exceeded on more than an average of one day a year over a three-year period.

All NAAQS are primary standards except the 3-hour sulfur dioxide standard, which is a secondary standard. New Mexico standards are not to be exceeded.

and other sources, which are not yet calculated; emissions from unpaved roadways, which are not yet calculated; and emissions from paved roadways, which are calculated at 330 tonnes (sic) per calendar year 1990. Most of the information in the inventory applies to air pollution sources at the south end of the facility in the El Paso metropolitan area (Von Finger 1992). At the three alternative sites on Fort Bliss, current sources of air pollution would be similar to those at the five alternative sites on WSMR. Again, the low density and infrequent utilization of these sources minimizes the effect of any associated emissions on the air quality of the area.

2.5.2 Biological Resources

Biological studies, consisting of literature review, field reconnaissance, and map documentation, were conducted for WSMR and Fort Bliss. An initial field reconnaissance of the project area was conducted on 19 September 1991. Additional field reconnaissance was conducted 18 November 1992. On 24 and 29 January and 23 November 1992, threatened and endangered species surveys were conducted in areas potentially affected by the proposed project. The entire area of each proposed test site was surveyed. A follow-up survey was conducted on 11 September 1992 at the R-396 site. On 8 March 1993, additional follow-up surveys were conducted at preferred TMD-GBR sites: LC 39, R-396, R-409, and C Station. No threatened or endangered plant or animal species were observed at these four sites.

Plant species observed at the WSMR and Fort Bliss test sites included shrubs, grasses, and forbs (Table 2-2). Typical species included broom snakeweed (*Gutierrezia sarothrae*), honey mesquite (*Prosopis glandulosa*), mesa dropseed (*Sporobolus flexuosus*), Russian thistle (*Salsola kali*), and golden crownbeard (*Verbesina enceliodes*). No threatened or endangered plant species were observed during the field surveys, and none are expected to occur in potential GBR sites.

Wildlife species observed at the WSMR and Fort Bliss test sites included reptiles, mammals, and birds (Table 2-3). The only reptiles observed were the side-blotched lizard (*Uta stansburiana*) and the little striped whiptail (*Cnemidophorus inornatus*). The black-tailed jackrabbit (*Lepus californicus*) and desert cottontail (*Sylvilagus audubonii*) were the only mammals observed during the survey. However, several species such as the coyote (*Canis latrans*) and the oryx (*Oryx gazella*) were identified by the presence of scat and tracks in the area of the potential sites; the badger (*Taxidea taxus*) was detected by the observation of burrows. Bird species observed included the cactus wren (*Campylorhynchus brunneicapillus*), red-tailed hawk (*Buteo jamaicensis*), and black-throated sparrow (*Amphispiza bilineata*). Additional bird species are known to occur in the area (Table 2-3).

No threatened or endangered wildlife species were observed during the field surveys. However, some areas at WSMR and Fort Bliss satisfy at least one of the habitat requirements for the federally listed endangered Aplomado falcon (*Falco femoralis septentrionalis*). The northern Aplomado falcon has been observed on portions of WSMR. The sightings are currently unconfirmed and occurred considerably north of the project area. The habitat present on the proposed sites consists of mesquite coppice dunes or creosote-dominated semidesert scrub. The Aplomado falcon is a bird of desert grasslands with widely spaced mesquite or soaptree yucca (Hector 1990). The habitats within and adjacent to the site do not represent suitable Aplomado falcon habitat as described for the United States in the Northern Aplomado Falcon Recovery Plan

Table 2-2
Plant species observed at TMD-GBR alternative test sites

Alternative Test Sites	C	Wise	R-396	IFC-25	LC 39	R-409	R-409 West	Rampart
Shrubs								
Artemisia filifolia (sand sagebrush)				X	X			X
Atriplex canescens (fourwing saltbush)	X	X	X	X				X
Ephedra torreyana (Mormon tea)		X		X				
Gutierrezia sarothrae (broom snakeweed)	X	X	X	X	X	X	X	X
Larrea tridentata (creosote)	X							
Opuntia violacea (purple prickly pear)				X		X		
Prosopis glandulosa (honey mesquite)	X	X	X	X	X			X
Yucca elata (soaptree yucca)		X	X	X	X			X
Grasses								
Aristida longiseta (red three-awn)	X		X					
Aristida divaricata (poverty three-awn)	X	X	X					
Aristida adscencionis (six-weeks three-awn)			X					
Aristida barbata (Harvard three-awn)								X
Bothriochloa saccharoides (silver beardgrass)			X			X		
Bothriochloa scoparia (little bluestem)	X							
Bouteloua barbata (six-weeks grama)	X		X					
Eragrostis cilianensis (stinkgrass)	X		X					X
Eragrostis lehmanniana (Lehman lovegrass)	X							

(table continues)

Table 2-2 (continued).

Alternative Test Sites	C	Wise	R-396	IFC-25	LC 39	R-409	R-409 West	Rampart
Grasses (continued)								
Erioneuron pulchellum (fluffgrass)	X	X	X	X				
Muhlenbergia porteri (bush muhly)	X							X
Setaria leucopila (plains bristlegrass)				X				
Sporobolus contractus (spike dropseed)	X			X		X	X	
Sporobolus flexuosus (mesa dropseed)	X	X	X	X	X		X	X
Cenchrus incertus (goathead)								X
Forbs								
Boerhavia sp. (spiderling)	X							
Croton dioicus (croton)			X					
Cucurbita foetidissima (stinking gourd)	X							
Dimorphocarpa wislizenii (spectacle pod)					X		X	
Eriognum annuum (annual buckwheat)				X				
Helianthus petiolaris (prairie sunflower)				X				
Heterotheca cf. *psammoplinla* (telegraph plant)		X		X				
Ipomopsis longiflora (throated trumpet)	X	X						
Lepidium sp. (pepperweed)	X			X		X		
Machaeranthera tanacetifolia (Tahoka daisy)	X							
Mentzelia cf. *pumila* (blazing star)	X			X				
Penstemon ambiguus (bush penstemon)				X				

(table continues)

Table 2-2 (continued).

Alternative Test Sites	C	Wise	R-396	IFC-25	LC 39	R-409	R-409 West	Rampart
Forbs (continued)								
Salsola kali (Russian thistle)	X	X	X				X	
Spaeralcea cf. *angustifolia* (mallow)	X		X	X				
Tidestromia lanuginosa (amaranth)	X							
Verbesina encelioides (golden crownbeard)	X	X	X		X			
Parthenium incanum (mariola)					X			

(Hector 1990). The Texas horned lizard (*Phrynosoma cornutum*), a federal Category 2 candidate species, is known to occur throughout WSMR and has been found on the WSMR south range area (WSMR 1990, 1992a).

Baird's sparrow is a federal Category 2 species and a group 2 state endangered species that has been observed as a fall migrant in grassland habitats of southern New Mexico (New Mexico Department of Fish and Game 1985). Baird's sparrows feed on seeds and insects, and grass and forb seeds are presumed to be the major food during the fall. Potential habitat for this species occurs only at one of the eight alternative sites (IFC-25).

2.5.3 Cultural Resources

An archaeological field reconnaissance was conducted at the proposed WSMR and Fort Bliss TMD-GBR test sites. The initial review occurred on 19 June 1991 with additional field review on 15 January and 23 November 1992. The purpose of the reconnaissance was to determine the presence or absence of cultural resources within the proposed TMD-GBR test sites. As part of the reconnaissance, cultural records were checked with the WSMR staff archaeologist and the New Mexico State Historic Preservation Office, Automated Records Management System. No cultural resource sites are recorded at any of the proposed test sites. However, cultural resources have been recorded near some of the proposed test areas. A lithic scatter has been recorded east of the Rampart site. Several cultural resource sites have been recorded approximately 304 m (1,000 ft) to the south of C Station. In addition to this, an area that is in the National Register of Historic Places, National Historic Landmark, and New Mexico State

Table 2-3
Wildlife species observed at TMD-GBR alternative test sites

Alternative Test Sites	C	Wise	R-396	IFC-25	LC 39	R-409	R-409 West	Rampart
Reptiles								
Uta stansburiana (side-blotched lizard)	X	X	X	X				
Cnemidophorus inornatus (little striped whiptail)	X	X	X	X				
Sceloporus undiolatus (eastern fence lizard)								X
Birds								
Amphispiza bilineata (black-throated sparrow)		X		X	X			
Amphispiza belli (sage sparrow)	X							
Bubo virginianus (great horned owl)			X					
Campylorhynchus brunneicapillus (cactus wren)	X	X	X	X				
Carpodacus mexicanus (house finch)		X						
Spizella passerina (chipping sparrow)		X						
Sturnella neglecta (western meadowlark)			X	X				
Tyrannus verticalis (western kingbird)	X		X	X				
Callipepla squamata (scaled quail)								X
Buteo jamaicensis (red-tailed hawk)					X			
Mammals								
Canis latrans[a] (coyote)	X	X		X				
Lepus californicus (black-tailed jackrabbit)	X	X	X	X				
Sylvilagus audubonii (desert cottontail)				X	X			X

(table continues)

Table 2-3 (continued).

Alternative Test Sites	C	Wise	R-396	IFC-25	LC 39	R-409	R-409 West	Rampart
Mammals (continued)								
Odocoileus herminous[a] (mule deer)				X				
Oryx gazella[a] (oryx)			X		X			X
Taxidea taxus[b] (American badger)		X	X	X	X			

[a] Scat observed
[b] Burrows observed

Register of Cultural Properties is located approximately 4.8 km (3 mi) northeast of C Station. This area is known as LC 33 (WSMR V-2 Launch Site) and is well outside the area where the proposed activities would occur at C Station.

Intensive area surveys have been conducted immediately south of the WSMR boundary on Fort Bliss (New Mexico State Historic Preservation Division, Santa Fe, Archaeological Records Management System) as well as in areas of the far southeast corner of WSMR (Anscheutz et al. 1990; Seaman et al. 1988). The surveys found a variety of cultures and temporal periods ranging from the Paleoindian (9000 to 6000 B.C.) through the historic ranching period (A.D. 1870 to 1942), which was ended by the military in 1942 (Table 2-4).

The studies at C Station, Wise, and R-396 were accomplished by conducting pedestrian transects within and around the perimeter of each site at a distance not greater than approximately 33 m (108 ft). The McGregor IFC-25 site was handled differently due to the size of the pad area. The perimeter of the pad was reviewed for the presence of cultural resources. A reconnaissance of Rampart and R-409, R-409 West, and LC 39 was conducted by criss-crossing the proposed site areas with random transects. All the proposed site locations were found to have been subjected to extensive ground disturbance from military operations. In all cases, the reconnaissance results were negative; no visible cultural resource sites were identified.

2.5.4 Land Use

All potential testing sites at WSMR and Fort Bliss have been disturbed by grading. Access to all sites is by improved or unimproved (gravel) roads. LC 39 had been occupied and utility/ communication equipment is still present. R-409 was used previously as a radar system location.

Table 2-4
Cultural-temporal sequence in the Tularosa Basin

Period	Date
Paleoindian	9000 to 6000 B.C.
Archaic	6000 B.C. to approximately A.D. 400
Formative	
Mesilla phase	approximately A.D. 400 to 1100
Doña Ana phase	A.D. 1100 to 1200
El Paso phase	A.D. 1200 to 1400+
Protohistoric - Apache - Mexican	A.D. 1540 to 1870
Euro-American	A.D. 1870 to 1942
U.S. Military	A.D. 1942 to Present

R-409 West currently has equipment on-site. Rampart is a large radar facility that has been inactive for several years. C Station consists of an active facility with a number of building and operating sites. Radar testing is usually conducted at this site. The Wise site is a seldom-used camera or radar site. The site consists of looping asphalt roads that lead to a raised mound capped by a concrete pad. Site R-396 also is a seldom-used camera or radar site. The site consists of a horseshoe-shaped embankment on which a concrete slab is located. IFC-25 site is a deteriorating asphalt pad measuring 85 by 160 m (280 by 525 ft). Site access is by means of IFC Road.

2.5.5 Hazardous Materials/Waste

There is no single authority for the management of hazardous materials/waste at WSMR and Fort Bliss; however, similar activities/procedures are followed by each installation. For example, the group primarily responsible for compiling hazardous materials information at WSMR is the Safety Division of the Environmental and Safety Directorate. This agency identifies and tracks hazardous materials at WSMR. The central receiving, storage, and dispensing facility for hazardous materials is the responsibility of the Director of Logistics. Additional duties and accountability reside with the Safety Officer and the WSMR Fire Department. The Main Post Fire Department does maintain Emergency Contingency Plans and is responsible for inspecting hazardous material storage facilities (WSMR 1991a). Hazardous material would be disposed of in accordance with the Resource Conservation and Recovery Act (RCRA).

Safe storage and handling of hazardous materials at WSMR are the responsibility of each user. These users include government agencies and private contractors. Currently, there are no existing base procedures for the transportation of hazardous materials/waste throughout the installation; however, each user is expected to comply with Department of Transportation hazardous materials regulations. A Spill Prevention, Control, and Countermeasure plan and an Installation Spill Contingency Plan have been implemented at WSMR (U.S. Army Corps of Engineers [USACOE] 1985).

WSMR currently has a Part B RCRA permit for storage of hazardous waste. No compliance issues exist in reference to this permit. AR 200-1, *Environment Protection and Enhancement*, provides guidelines for the handling and management of hazardous waste and ensures compliance with all federal, state, and local laws regulating generation, handling, treatment, storage, and disposal of hazardous wastes. Each range user is responsible for disposal of hazardous waste from its own activities.

The Environmental and Safety Directorate manages the WSMR Hazardous Waste Tracking System developed by the U.S. Army Test and Evaluation Command. The system tracks hazardous wastes from the generator, to WSMR satellite accumulation points and 90-day storage sites, continuing through the WSMR Hazardous Waste Storage Facility where the wastes are shipped off the base, treated, or destroyed. The system currently has 17 satellite accumulation points and three 90-day accumulation points (WSMR 1991a).

2.5.6 Infrastructure

The proposed test sites on WSMR and Fort Bliss are accessed by existing roads, the majority of which are paved. The primary power source for TMD-GBR would be commercial power if available. If commercial power is not available, the system Prime Power Unit would be used by the UOEs. If additional power is required, coordination will be conducted through Range Command at WSMR and Fort Bliss. Water and sewer utilities currently do not exist on most sites. Telecommunication would use existing lines. If additional lines are required, such requirements are coordinated through Range Command at WSMR and Fort Bliss. Four existing buildings are being considered for use. Buildings 24068 and 23625 are high-bay maintenance buildings. Building 24068 is unoccupied (Figure 2-17). Currently, Building 23625 is occupied. Building 23632 is currently used as a dining facility, but has office space available. Building 90133 is a relatively new office building that is unoccupied.

2.5.7 Noise

Noise sources above the natural background at WSMR are associated with military operations at WSMR and Holloman AFB. The primary mission of WSMR is to serve as a DoD facility for the test and evaluation of military hardware. A large component of this hardware is associated with aircraft flights and missile launch systems. Ground systems and commercial systems also are tested and evaluated at WSMR.

Noise sources above the natural background at the Fort Bliss McGregor Range are associated mainly with military training operations. These operations include a limited number of missile launches from McGregor supporting the WSMR mission.

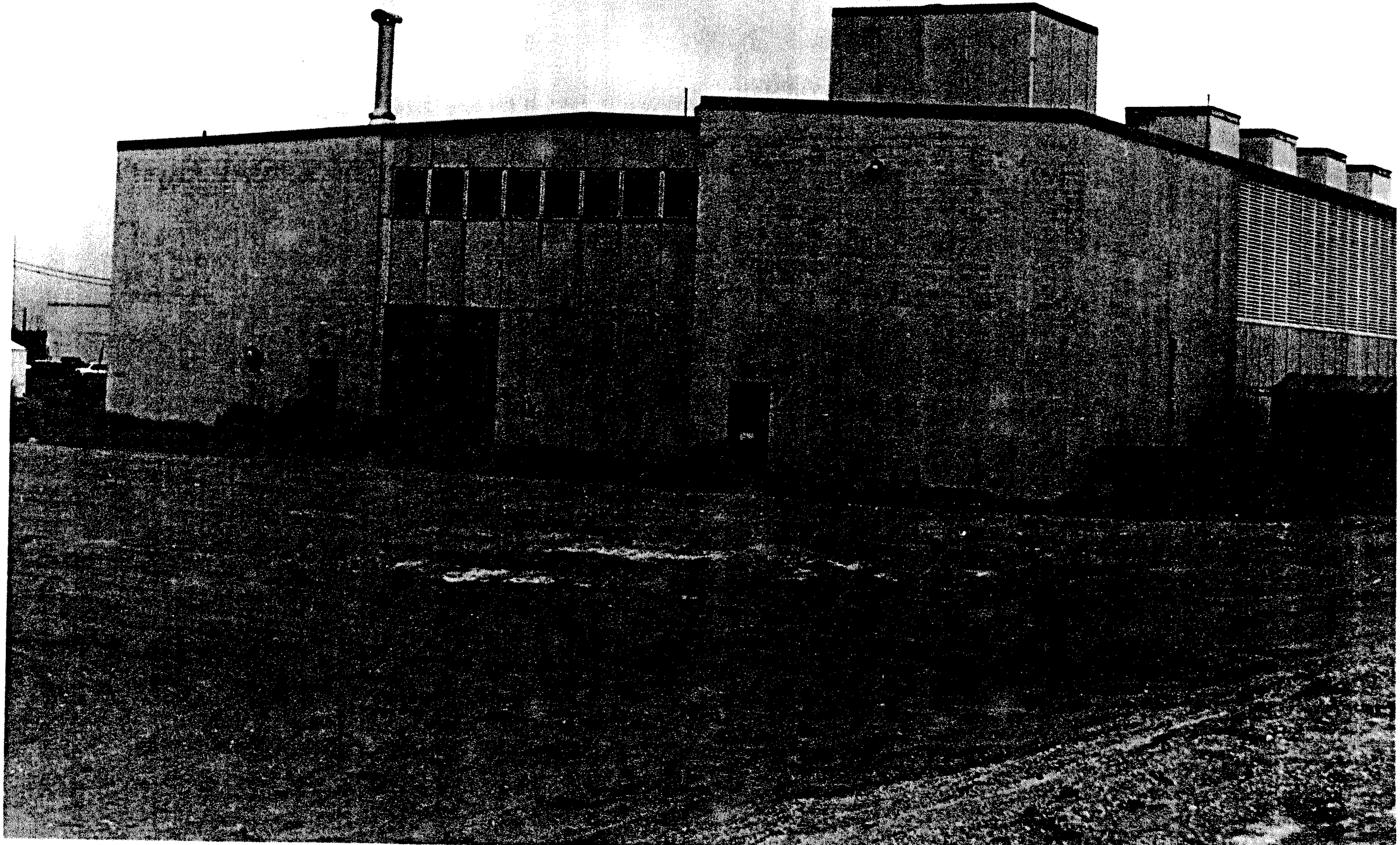

Figure 2-17. WSMR Building 24068

Ambient noise levels at the WSMR Main Post area, the WSMR-Fort Bliss property boundary, and the San Andres National Wildlife Refuge (located approximately 19.3 km [12 mi] north of the WSMR Main Post area) have been estimated to be 55 to 65 A-weighted decibels (dBA), 45 to 55 dBA, and 45 dBA respectively. The WSMR/Fort Bliss area can be characterized primarily as undeveloped, wide-open areas with few center-of-population concentrations (Main Post).

The U.S. Air Force uses the airspace over the extreme southern range areas of WSMR for flights transiting the area en route to McGregor Range tactical training areas, for military exercises, and for very limited supersonic aircraft operations supporting range testing. Generally, subsonic flight activities are at a high enough altitude and a low enough frequency to generate sound levels anticipated to be no greater than 70 dBA, which is the sound level of freeway traffic. A special test of the frequency, magnitude, and duration of sonic booms (supersonic aircraft operations) was conducted in the WSMR airspace from July 1988 through January 1989. From this study, it was determined that supersonic aircraft operations could generate sound-pressure levels greater than 115 dBA. However, the average sonic boom noise level was expected to be in the range of 55 to 60 dBA.

The U.S. Army primarily uses the airspace over the southern range areas of WSMR for helicopter flight operations such as search and rescue, drone recovery, test debris recovery, range evacuation missions, and general helicopter flights transiting the area. The U.S. Army range support helicopter is the UH-1H, which has an anticipated sound level no greater than in the low 80-dBA range.

The U.S. Army weapon systems training activities on Fort Bliss (McGregor Range) consists of HAWK missile launches, Stinger missile shots, rocket firings from airborne helicopter platforms, Vulcan gun firing, U.S. Air Force tactical aircraft air-to-ground gunnery range operations (dropping of various munitions), and long-range PATRIOT missile shots (into WSMR) supporting operational testing.

Representative noise levels could be a HAWK missile launch generating peak sound pressure levels of 149.8 dBA, a QF-100 full-scale aircraft target drone producing single-event noise levels of 95.7 dBA, vehicular traffic typically rated at 70 dBA, and low-altitude military jet traffic (B-52 or F-4 aircraft) producing estimated noise levels of 65 to 70 dBA at ground level directly below the aircraft.

2.5.8 Public Health and Safety

As part of a study of potential RF interference that could result from operation of the TMD-GBR at WSMR, ECAC identified a number of existing EMR sources. These sources include numerous radars, a point-to-point microwave communications system, and satellite earth stations. These systems are summarized below.

Summary of Identified EMR Sources Operating at WSMR

Emitter Functional Type	System Nomenclature
Airborne weather radar	AN/APN-158
Precision approach radar	AN/FPN-62
Fire control	AN/AWG-9
Beacon	VEGA 320
Glide path	AN/FPN-62
CW illuminator	HAWK AN/MPQ-57
Mortar locating	AN/TPQ-36
Surveillance	DIVAD
Track	MIDI
Navigation (terrain avoidance)	AN/APQ-170
Point-to-point microwave	Collins MW-508D
Fire control	HAWK
Earth station	Generic (NASA)

Each of these systems produces EMR. The point-to-point communications microwave network is very low powered and the other radar systems are high powered. Hence, the WSMR environment is characterized by the presence of EMR sources scattered throughout the range, some of which may have the potential for creating high RF fields in their vicinity. While public access to the immediate vicinity of these systems is controlled, WSMR personnel occupy areas that may be subject to elevated EMR levels. Because of this possibility, EMR hazard surveys have been accomplished to define controlled-access areas, thereby reducing the likelihood of personnel being exposed to hazardous microwave power densities. Currently, a range-wide EIS is being prepared for WSMR (Final EIS due in September 1994). This EIS would identify sources of microwave and RF EMR along with any RF hazard restrictions.

2.5.9 Socioeconomic Resources

The general WSMR area is lightly populated and contains the communities of Alamogordo and Las Cruces, New Mexico. The 1990 combined estimated population for these communities was 89,721. The 1990 estimated population of Otero County, which comprises the majority of the TMD-GBR region of influence (ROI), was 51,928. Alamogordo, New Mexico (Otero County), located approximately 96 km (60 mi) from the TMD-GBR mission control location (WSMR Main Post), had a 1990 population of 27,596 (U.S. Bureau of Census 1991). The nearest community to the TMD-GBR mission control location (WSMR Main Post) is Las Cruces, New Mexico (Doña Ana County), approximately 64 km (40 mi) away with a 1990 population of 62,126 (U.S. Bureau of Census 1991). Historic (1980) and current (1990) census populations for New Mexico and Texas (Otero, Doña Ana, and El Paso Counties, and selected cities) are presented in Table 2-5.

The overall population density of the areas adjacent to WSMR is relatively low. Otero County has an average population density of approximately 7.7 people per mi^2 (New Mexico Bureau of Business and Economic Research 1989). The permanent resident density within 10 to 20 mi of

Table 2-5
Selected 1980 and 1990 populations for Texas and New Mexico and WSMR/Fort Bliss region of influence (ROI)

Jurisdiction	1980	1990	Percent Change
Texas	14,229,191	16,593,063	14.2
El Paso County	479,899	579,665	17.2
El Paso	454,159	509,158	10.8
New Mexico	1,302,894	1,515,069	14.0
Otero County	44,665	51,928	13.9
Alamogordo	24,024	27,596	12.9
Doña Ana County	96,340	135,510	28.9
Las Cruces	45,086	62,126	27.4

the TMD-GBR target areas is estimated to be 2 people per mi^2 (Dzeilak 1991). Transient visitor populations increase this amount, particularly during military testing and other operations in the area.

WSMR personnel totaled 9,033 in FY91 (WSMR 1991b). The principal employers as of 1991 for Las Cruces, New Mexico (which is the nearest center of population and commerce to the TMD-GBR area), include New Mexico State University (7,252), Las Cruces Public Schools (2,443), WSMR (4,890 living in Las Cruces), NASA (1,872 at White Sands Test Facility), and the Bureau of Land Management.

All emergency services (emergency medical treatment and medical evacuation, fire and rescue, and civil and military police) for the TMD-GBR ROI are operated or supervised by the U.S. Army at WSMR. Emergency services personnel (fire and rescue, paramedics, military police, and civilian security staff) are based at WSMR Main Post. All proposed TMD-GBR test locations are accessible to emergency personnel from the Main Post via all-weather roads and helicopter evacuation. Additional emergency services are available in Las Cruces and Alamogordo, New Mexico.

2.5.10 Water Quality

Average annual precipitation for the area of the Tularosa Basin where the eight alternative TMD-GBR test sites are located generally ranges from 20 to 25 cm (8 to 10 in). Nearly one-half of the annual precipitation in the region occurs in a "normal" year during the months of July, August, and September, when infrequent but often intensive summer thunderstorms occur (Weir 1965; Basabilvazo et al. 1991). Most stream flows are generated from the relatively high-elevation mountainous areas along the flanks of the Tularosa Basin (WSMR 1992b). Specific to the TMD-GBR sites, several small mountain springs flow to the west and north of the WSMR Main Post area. However, no perennial streams are known to occur through this area (Herrick 1955). No substantive stream flows occur in the nearby areas surrounding any of the alternative TMD-GBR test sites located at WSMR; however, short-term storm-generated runoff caused by intensive summer thunderstorms may occur at any or all of these sites.

The area of the WSMR Main Post is on the western part of the Tularosa Basin (Herrick 1955). The principal source of ground water is the precipitation that falls on the mountainous area contributing to that resource. Water table contours indicate that groundwater moves generally eastward out of the re-entrant into the lower part of the basin to the east, then moves generally southeast. In the areas of the TMD-GBR alternative sites, groundwater, in general, is relatively highly saline several hundred feet below the ground surface (Herrick 1955).

A total of 11 production wells serve the WSMR Main Post area (WSMR 1992b). These wells are capable of supplying water to an effective population in excess of 14,100 inhabitants (Higginbotham & Associates 1986a). The water supply distribution system of the Main Post and Lower Range areas are described by Parkhill, Smith & Cooper, Inc. (1972). A regionwide water requirements study (USACOE 1991) indicated that projected water use over a 40-year planning period (between 24 and 58 percent increase to the year 2030) could be met, using groundwater from the Hueco Underground Water Basin.

The wastewater treatment facility servicing the WSMR Main Post is located approximately 2.4 km (1.5 mi) southeast of this area (Higginbotham & Associates 1986b). This facility comprises a trickling-filter plant, constructed in 1958, capable of achieving secondary wastewater treatment. The plant facility currently operates without a National Pollutant Discharge Elimination System permit. Neither the water supply (production) wells nor the wastewater treatment facility servicing the Main Post area are in the proximity of the eight alternative sites under consideration for the TMD-GBR program.

For the northern and central parts of the Fort Bliss Military Reservation addressed in this EA, the general conditions of low annual precipitation, infrequent surface-water runoff occurrences, and generally saline groundwater resources at depth would apply to the alternative TMD-GBR test sites on this military reservation. The Hueco Bolson aquifer is extensively used for water supplies in this part of the WSMR/Fort Bliss region. Groundwater withdrawals from the Hueco Bolson have increased appreciably during the past 50 to 80 years (Orr and White 1985) due to demands for military, industrial, agricultural, and municipal (primarily the city of El Paso) purposes. Recent feasibility studies for additional water supplies have been conducted on groundwater resources of the Soledad Canyon re-entrant and adjacent areas (Wilson and Myers 1981; USACOE 1988).

2.6 USAKA

Kwajalein Atoll is a northern atoll within the Ralik Chain in the western part of the RMI, in the west-central Pacific Ocean southwest of Hawaii (Figure 1-12). Kwajalein Atoll consists of a large interior lagoon (2,850 km^2 [1,100 mi^2]) surrounded by approximately 100 component islands/islets.

The Kwajalein Atoll environment is the product of millions of years of natural development, followed by a brief but critical period of human influence. The atoll was out of the mainstream during German colonization of the Marshall Islands from 1885 to 1914. The Japanese took over administration of the Marshall Islands in 1914 and continued in this role until 1944 when the Americans invaded the area as a part of World War II actions. The atoll has been used continuously since then for military purposes by the U.S. government. The United States administrated the Marshall Islands as a trust territory from 1944 until 1986 when the islands became a sovereign nation, the RMI (USASDC 1989a).

Kwajalein Island is 1 of 11 islands leased by the U.S. Army and is the headquarters for USAKA. It is the location of the largest work force in the atoll (USASDC 1989a). The primary mission of USAKA is to support missile flight testing for DoD research and development efforts. Technical facilities on USAKA include multiple-launch facilities and numerous supporting elements such as tracking radar, optical instrumentation, satellite communications, and telemetry stations (USASDC 1989b).

The proposed location for the DEM/VAL phase of GBR-T at USAKA is at Building 1500 located at the western end of Kwajalein Island on an area of fill (Figure 1-13).

2.7 GBR-T TEST SITE DESCRIPTION, EXISTING ENVIRONMENTAL CONDITIONS – USAKA

The existing environmental conditions for the proposed test site at USAKA are described in the following subsections. These sections briefly discuss air quality, biological resources, cultural resources, land use, hazardous materials/waste, infrastructure, noise, public health and safety, socioeconomics, and water quality.

2.7.1 Air Quality

Air quality at the Kwajalein Atoll is affected by ongoing activities that include electric power generation, fuel storage tanks, solid waste incinerators, transportation, and missile launches. The information presented here is taken from the 1993 Draft Supplemental EIS for USAKA (USASSDC 1993). Kwajalein Island has 11 air pollution point sources with various emissions (Table 2-6). Most of the air pollution sources at USAKA are combustion sources that produce particulate matter, nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), and volatile organic compounds (VOCs) emissions. The three power plants on the island and the others located throughout the atoll use diesel fuel. Currently these power plants are the largest combustion air pollution point sources in the atoll. Power Plants 1 and 1A are considered to be a major source of emissions. Solid waste incineration is the second largest air pollution point source. The fuel tank farm also is considered to be a major source of VOC emissions. Current United States air quality regulations apply to USAKA activities.

Table 2-6
Summary of annual air pollutant emissions on Kwajalein Island
(tons per year)

Sources	CO	NO_x	SO_2	TSP[a]	PM_{10}[b]	Pb[c]	VOCs[d]
Power Plant 1	240	741	307	84	84	0.01	0.1
Power Plant 1A	116	1,390	97	34	17	0.001	41
Power Plant 2	63	154	47	6	6	—	0.05
Solid waste incinerator	42	0.1	8	10	20	0.03	1
Commercial boilers	< 0.1	0.3	2	0.03	0.02	—	0.005
Fuel tank farm	—	—	—	—	—	—	743
Aircraft operations	148	34	5	45	15	—	127
Motor vehicles	59	14	—	62	21	—	10
Marine vessels	2	10	64	7	2	—	1
Maintenance/photo lab	—	—	—	—	—	—	35
Bakery	—	—	—	—	—	—	1

Source: Calculated from emission factors from the U.S. Environmental Protection Agency (EPA) *Compilation of Air Pollutant Emission Factors*, (EPA 1985) and source testing of June 1989; USAKA DSEIS (USASSDC 1993).

[a] Total suspended particles
[b] Particle matter less than 10 microns
[c] Lead
[d] Volatile organic compounds

2.7.2 Biological Resources

The natural environment of Kwajalein Island was heavily disturbed by Japanese occupation, fighting, and bombing during World War II. Currently, the area is dominated by man-made structures used for USAKA headquarters (USASDC 1989a).

Biological surveys of several USAKA islands, including Kwajalein, were conducted in March 1988 and February 1992 (USASDC 1989a; USASSDC 1993). The surveys included inventories of terrestrial plants and animals, and marine biological resources. Plant resources on Kwajalein Island were limited to nonnative grasses and forbs (USASDC 1989a; USASSDC 1993).

Wildlife species observed on Kwajalein Island included birds, lizards, and rodents, and domestic dogs and cats (USASSDC 1993). A total of 51 species of birds have been recorded at Kwajalein Atoll (USASSDC 1993). Typical bird species on Kwajalein Island include resident seabirds, such as noddies (*Anous* sp.), terns (*Sterna* sp.), and migratory shorebirds, such as the lesser golden plover (*Pluvialis dominica*) and ruddy turnstone (*Arenaria interpres*) (USASDC 1989a). Several seabird roosting areas are located in the northeast, southwest, and northwest portions of Kwajalein Island (USASSDC 1993).

Marine biological resources are found throughout the reefs of, and in the open ocean areas around, Kwajalein Atoll. Major near-shore habitat types for Kwajalein Island include ocean reefs, lagoon reefs, lagoon floor, harbor, quarries, and seagrass beds (USASSDC 1993). Characteristic components of the near-shore marine biota for Kwajalein Island include corals, algae, invertebrates, and fish (Table 2-7). Fourteen reef and pelagic fish species are caught frequently in the waters of Kwajalein Atoll (Table 2-8).

The federal-listed threatened green sea turtle (*Chelonia mydas*) and the federal-listed endangered hawksbill sea turtle (*Eretmochelys imbricata*) are commonly sighted in the waters of Kwajalein Atoll, including Kwajalein Island (USASSDC 1993). Individuals of both species have established semipermanent residence at the "turtle ponds" on Kwajalein Island (USASSDC 1993). Sea turtles are not known to nest at Kwajalein Island, although they may do so at other USAKA islands (USASSDC 1993). Sea turtles are a traditional food source for the Marshallese. The RMI has afforded the green or hawksbill sea turtle endangered or threatened status (USASSDC 1993).

Marine mammals such as dolphins, porpoises, and whales (cetaceans), and seals and sea lions (pinnipeds) may occur in the waters of Kwajalein Atoll. All species of marine mammals are protected by the U.S. Marine Mammal Protection Act of 1972, as amended. Some species of marine mammals are federal-listed as threatened or endangered and are, therefore, also protected by the U.S. Endangered Species Act of 1973, as amended.

There are five species of giant clams found throughout the Marshall Islands, the largest species being *Tridacna gigas*. The only reproductively viable population of *T. gigas* has been found off Gellinam Island. *T. gigas* is not currently listed as an endangered or threatened species; however, its status is being evaluated for classification by the RMI and the National Marine Fisheries Services. A rare species of seagrass (*Halophila minor*) is found in the lagoon of Kwajalein Island (USASSDC 1993).

2.7.3 Cultural Resources

The earliest archaeological resources on Kwajalein Island date from circa 350 B.C. Although little archaeological or cultural exploration has been done on the island, the possibility exists for both prehistoric period resources (350 B.C. to A.D. 1500) and historic period resources (circa A.D. 1500 to present). The potential for cultural resource impacts exists on those portions of the islands that make up its pre-World War II surface. Since 1944, the size of the island has been enlarged by dredging and filling at its west and north ends and along its lagoon side (Figure 2-18). A layer of dredged fill approximately 1 m (3.2 ft) deep covers most of the island surface (USASSDC 1993).

Despite extensive ground disturbances that have occurred at Kwajalein Island, previous archaeological investigations on the island suggest a high probability for discontinuous, intact prehistoric and/or historic era sedimentary/cultural deposits and remains throughout those portions of the island corresponding to its pre-World War II surface. The main study areas that

Table 2-7
Characteristic components of the near-shore marine biota of Kwajalein Island

Reef Components	Description
Ocean Reef	
Coral	Low coverage of branching and encrusting forms
Algae	Abundant blue-greens, green, browns; corallinae present
Invertebrates	Numerous sea urchins, sea cucumbers, topahelle, snails, and crabs
Fish	Numerous eels, schools of mullet, gobies, and wrasse
Lagoon Reef	
Coral	Lush coral; branching forms dominate; large knolls
Algae	Abundant greens, browns, reds
Invertebrates	Abundant sponges, crabs, snails, hydroids, sea cucumbers
Fish	Rich, diverse; parrot, rabbit, sturgeon, rudder fishes; sharks

Source: USASDC 1989a

have been examined for archaeological resources are located on the present taxiway and aircraft maintenance hangar sites, and along a saltwater-lined trench that parallels Ocean Road on Kwajalein Island (USASDC 1989a).

Prehistoric resources include permanent indigenous living sites, subsistence sites, and temporary occupation-exploitation sites. Historic resources could include sites and artifacts from various Spanish explorers of the 16th century, and from the German and Japanese occupation periods of 1870 to 1914 and 1914 to 1944, respectively. Some of the archaeological and historical findings on Kwajalein Island are shown in Figure 2-18 and are described in Table 2-9. The numbers identifying the archaeological and historic sites in Table 2-9 are consistent with the numbered sites on Figure 2-18. The Kwajalein Island Battlefield is listed in the National Register of Historic Places for its military significance in 1944 and is also listed as a National Historic Landmark (USASDC 1989b).

2.7.4 Land Use

DoD organizations, including the U.S. Army, carry out sensitive missile research, development, and testing on USAKA. The majority of existing structures on Kwajalein Island are less than three stories (11 m [36 ft]) in height, and there are no current plans, with the exception of Building 1500, to construct or modify existing structures to heights greater than five stories (18 m [60 ft]). Existing land use on Kwajalein Island falls into three principal categories:

Table 2-8
Common, scientific, and local names of the most frequently caught reef and pelagic fish species by Kwajalein Atoll fishermen

Common Name	Scientific Name	Local Name
Reef Species		
Unicorn fish	*Naso* spp.	Mone
Squirrel fish	*Myripristis* sp.	Mon and Jera
Goat fish	*Mulloides*	Jome
Mullet	*Valamugil* sp.	Iool
Grouper	*Valiola* sp.	Momo
Rainbow runners	*Elagatis bipinnulata*	Ikaidik
Gray job fish	*Aprion virescens*	Laum
Flying fish	*Cypselurus poecilopterus*	Jojo
Flagtail fish	*Kuhlia mugil*	—
Pompano	*Carangoides* sp.	—
Pelagic Species		
Skipjack tuna	*Katauwonus pelamis*	Lojabwil
Dolphinfish	*Coryphacha hippurus*	Koko
Wahoo	*Acanthocybium solandri*	Al
Blue marlin	*Makaira nigricans*	Lojkaan

Source: USASDC 1989a

housing/community services on the eastern end of the island, air operations in the center of the island, and research and development (range operations) in the center and at the western end of the island (USASDC 1989b).

Building 1500 is located in the research and development area. Most of the buildings in this area are less than 11 m (36 ft) high. Building 1500 is the tallest structure at 32 m (106 ft) high.

2.7.5 Hazardous Materials/Waste

Operations at Kwajalein Island require the use and storage of both hazardous materials and hazardous wastes. Hazardous materials used and stored at Kwajalein Island include fuels, lubricants, paints, cleaning solvents, and explosive ordnance.

Hazardous wastes at Kwajalein Island consist of both hazardous and toxic waste such as solvents, solvent-oil mixtures, polychlorinated biphenyls (PCBs), acids/bases, and unexploded

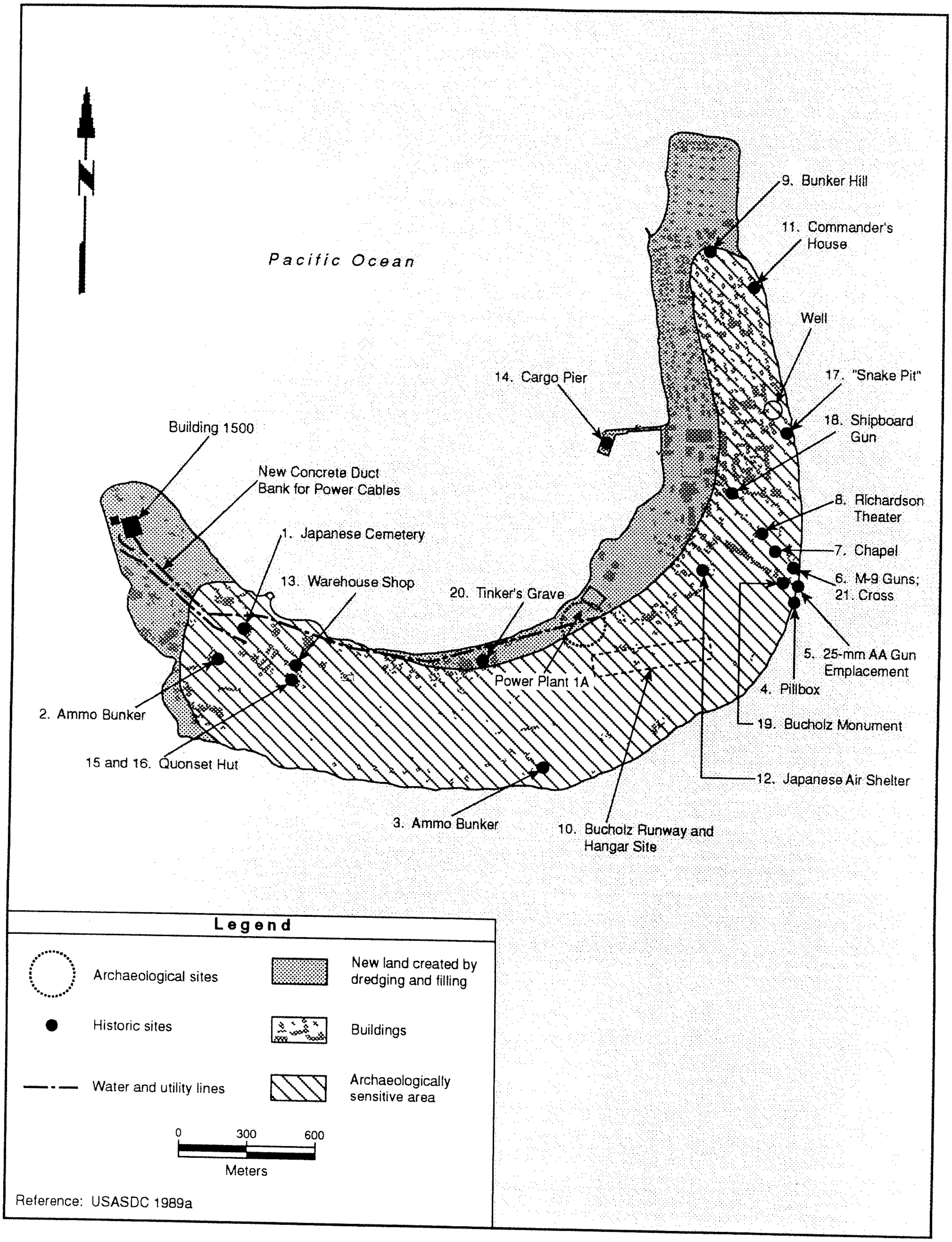

Figure 2-18. Cultural resource sites and new power and utility lines, Kwajalein Island, USAKA

Table 2-9
Kwajalein archaeological and historic resources

Archaeological Resources

1. From a cultural layer, two charcoal samples that date back to A.D. 40 to 355 and to 140 B.C. to A.D. 255, respectively.
2. Charcoal flecks.
3. Fauna remains (possibly those of a turtle).
4. Possible remnants of a taro swamp.
5. A shell weaving implement.

Historic Resources

1. A Japanese memorial built in 1969—a reminder of Kwajalein's Japanese defense.
2. 7th Infantry Division landing monument/ammo storage bunker—this is one of the few Japanese fortifications that still stands on Kwajalein. It is a monument to the 7th Infantry Division landing.
3. Ammo storage bunker — this is a uniquely structured ammo bunker (a vaulted construction having a window in the ammo room that is case-matted).
4. Beach defense fire control post pillbox—this is the only example of a fire control post on Kwajalein. The structure possibly could have been moved to this locale at an earlier time.
5. 25-millimeter, AA-gun emplacement.
6. Two 3-inch M-9 field guns not used in the invasion but as memorials (Rock Island Arsenal, 1943).
7. Island Memorial Chapel—this structure was built during 1944 and 1945. The chapel, along with the commander's house and a shed associated with the Richardson Theater are the only three structures that have survived since that period under American presence. The chapel has been dedicated to the men who gave their lives in the fight for Kwajalein.
8. Richardson Outdoor Theater—of the structure, the stage and screen/restroom elements date from 1945.
9. "Bunker Hill," 12.7-centimeter, AA dual-purpose type 89 gun position.
10. Bucholz Army Airfield Runway—current runway marks the approximate position and location of the previous Japanese runway, taxiway, and apron.
11. Commander's house, Building 241.
12. "Japanese Air Shelter" at fuel tank farm.
13. "Warehouse Shop" butler-type building (S-1309)
14. Cargo pier—built by the Japanese in 1944.
15. Quonset hut (S-1336).
16. Quonset hut (S-1337).
17. Ocean View Club, "Snake Pit"—built in 1945, this cultural landmark on Kwajalein has been recommended for inclusion in the National Register of Historic Places.
18. Shipboard gun, static display.
19. Bucholz Monument— this monument has been erected for PFC Bucholz, who died during battle on Kwajalein on February 4, 1944.
20. Tinker's Grave and Monument.
21. World War II Memorial Cross.

Source: USASDC 1989b

ordnance. Implementation of the 1989 Environmental Mitigation Plan has changed the way in which these wastes are handled at Kwajalein Island. For example, waste solvents and oils are no longer disposed of or burned in unlined bermed pits. Used lubricating oil is either burned as supplemental stock after blending with virgin fuel oil, or it is transported off the island for reclamation under a used-oil disposal contract with a recycling firm (USASSDC 1993). Removal of the oil/solvent mixture and cleanup of the pits are currently being conducted but are not yet complete. Unexploded ordnance is frequently discovered on the island during construction. It is stored safely, when identified, before being transported to Illeginni Island for destruction (USASSDC 1993).

A portion of Building 1500 was previously used for storage of transformers containing PCBs and oil contaminated with PCBs. Remediation of the contaminated concrete and soil within the building was completed in October 1991 (USASDC 1991b). PCB-contaminated materials or other hazardous wastes are no longer stored in Building 1500.

Studies have been initiated to assess waste management practices and potable water quality. In response to the recommendations of the Environmental Mitigation Plan, USAKA has implemented a waste inventory program.

2.7.6 Infrastructure

Infrastructure demands for the GBR-T include electrical power, telecommunications, fresh and sea water, and sewage. Currently, power generation on Kwajalein Island is supplied by three power plants: Power Plants 1, 1A, and 2. Power Plant 1A, which is relatively new, became operational in 1991. Power Plant 1 has a 13,500-kW capacity and Power Plant 1A has a 12,000-kW capacity (USASSDC 1993). Power Plant 2 has a 4,290-kW capacity. The planned Power Plant 1B would have a 17,600-kW capacity.

Telecommunication support exists from the Kwajalein Island communications exchange (USASSDC 1993). However, additional telecommunication lines would be required for GBR-T. Water and sewer lines extend out to Building 1500; however, additional lines would need to be added to accommodate the GBR-T at Building 1500.

2.7.7 Noise

The primary noise sources on Kwajalein Island are aircraft, power plants, marine sandblasting and service, air conditioning units, and small diesel engine generators. The average annual day-night level (L_{dn}) contour lines of 65 dBA at the airport show that no noise-sensitive receptors are affected (USASDC 1989a). At the time the 1989 USAKA Draft EIS was prepared, there were two power plants: Power Plant 1 has nine 1,500-kW units, and Power Plant 2 has six 715-kW units. On-site monitoring of Power Plant 1 and estimated noise levels for Power Plant 2 define a 65 dBA L_{dn} contour that does not encompass any sensitive receivers.

The source-to-receptor distances for a 65-dBA L_{dn} contour for 9- to 45-metric ton (10- to 50-ton) and 45.9- to 180-metric ton (51- to 200-ton) air conditioning units are 29 and 52 m (95 and 170 ft), respectively. All other noise sources emit less than 65-dBA L_{dn} at sensitive-receiver locations.

The only major change in potential noise sources since the 1989 USAKA Draft EIS was prepared has been the addition of Power Plant 1A. Concerns about the possible noise levels from Power Plant 1A and the planned Power Plant 1B facilities were evaluated in the USAKA Draft Supplemental EIS 1993 and found to be negligible (USASSDC 1993).

2.7.8 Public Health and Safety

Public health and safety areas of concern on Kwajalein Island have been identified for the explosive storage and launch facilities, the EMR environment, and aircraft restrictive zones. There are six explosive storage areas currently in use on Kwajalein Island; storage bunkers are located along the ocean shoreline, south of the runway. The meteorological rocket launch facilities are located at the western end of the island. The explosive storage and launch facilities and the aircraft restriction zones have specified explosive safety quantity-distance restrictive radii or clear-zone spaces (Figure 2-19) (USASDC 1989b).

EMR Environment

RF sources on USAKA are radar installations, microwave communications stations, and other communication equipment that emit EMR such as high-frequency (HF) short-wave communication antennas. Protection standards and a listing of RF hazards are contained in USAKA Regulation 385-3 (issued 9 January 1989) (USASDC 1989a). The restrictions (e.g., tower height, exclusionary zones) placed on the EMR sources in accordance with that regulation are such that the emitters create no hazard. Currently, there are 17 identified sources of microwave and EMR on Kwajalein Island that are regulated by RF Hazard restrictions. These sources have been identified in the 1989 GBR EA. The HF communications and microwave communications are described below.

High-Frequency Communications. There are 11 HF communications antennas that have a lower elevation height restriction of 11 m (36 ft) above the ground surface. There is a fenced electrical hazard area at the ground surface around each antenna also. All of the HF antennas are on the northwest tip of the island near Building 1500 (USASDC 1989a).

Microwave Communications and Other Systems. There are three sources of microwave emissions: the Command Control Transmitter, consisting of two antennas with a hazard area radius of 112 m (367 ft) and a lower height limit restriction of 4.3 m (14 ft); the AN/FSC-78 Satellite Communications Transmitter, with a EMR safety zone restricted to the interior of the radome; and the Global Positioning System, which also has an EMR safety zone restricted to the interior of the radome (USASDC 1989a).

Kwajalein Island Radars. There are three radar systems currently operating on Kwajalein Island with hazard restrictions: FPQ-19 radar has a structural height restriction of 4.3 m (14 ft) on top of the mound at the transmitter and a lower-level restriction of 30 m (98 ft) within a radius of 600 m (1,968 ft); WRS-74S weather radar (on the golf course) has a height restriction of 4.3 m (14 ft) within a radius of 51 m (167 ft) of the transmitter; and MPS-36 radar has a height restriction of 4.3 m (14 ft) within a radius of 110 m (360 ft). The composite background EMR power density from the above emitters are presented in Table 2-10 for six selected measurement locations. The data were obtained from an EMR hazard survey conducted at USAKA and are representative

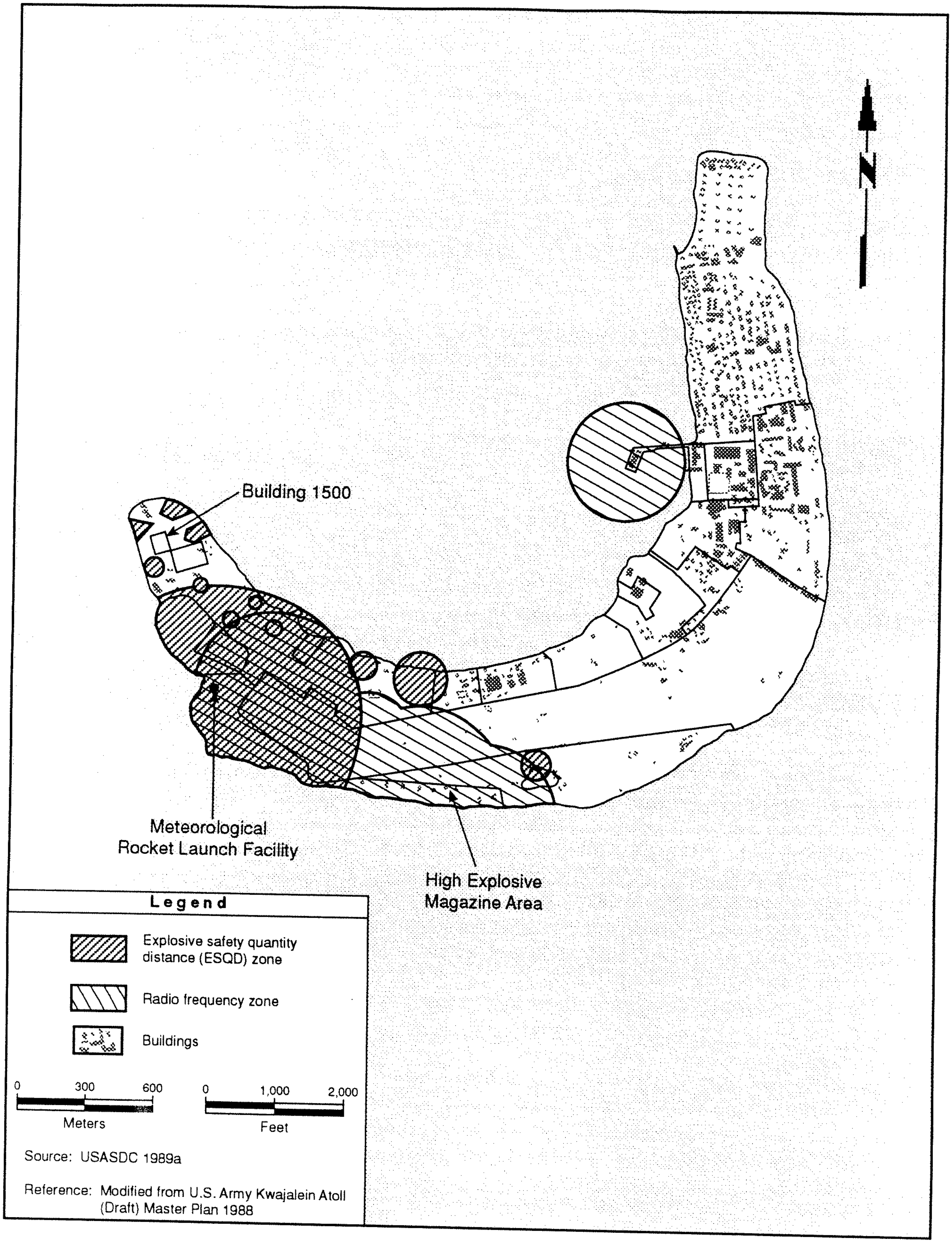

Figure 2-19. Existing radio frequency sources and explosive safety zones, Kwajalein Island, USAKA

Table 2-10
Background RF power density measurements – Kwajalein Island

Measurement Location	RF Power Density[a]	Fractional Contribution to Permissible Exposure Level
1	0.178	0.036
2	0.050	0.010
3	0.050	0.010
4	0.050	0.010
5	0.146	0.029
6	0.065	0.013

Source: USASDC 1989a

[a] Expressed in milliwatts per square centimeter

of worst-case background EMR power density levels produced when all existing EMR emitters are simultaneously operating and directional emitters (radars) are pointed in the direction of the measurement location. The measurement locations are indicated in the GBR EA 1989. The result of the RF hazard survey, as indicated in Table 2-10, shows that the worst-case composite background RF power density of 0.178 mW/cm^2 (1.15 mW/in^2) is less than 4 percent of the permissible exposure level used by the U.S. Army.

The existing EMR emitters on Kwajalein Island pose no personnel hazard at ground level due to the existence of the identified hazard restrictions and the incorporation of elevation and azimuth beam stops within the operating software. These stops ensure that exposure to EMR levels remains well below the permissible exposure levels identified in the U.S. Army Environmental Hygiene Agency document, *Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation.* Verification of these stops/limits is part of the ongoing EMR protection program in existence on USAKA (USASDC 1989a).

2.7.9 Socioeconomics

The Kwajalein Atoll population is dispersed primarily at the northern and southern ends of the atoll. The 1991 estimated Marshallese population of the atoll was approximately 10,960 (USASSDC 1993). Of these, 10,000 live on Ebeye and the remainder on the islands of Ebadon, Ennubirr, Biggerman, Ennylabegan, Ennubuj, and Gugeegue (USASSDC 1993). The 1992 estimated nonindigenous population at USAKA, which consists primarily of military, federal civilian, and contractor personnel and their dependents, was approximately 3,000

(USASSDC 1993). Employment in the atoll is tied primarily to operations at USAKA. In 1992, USAKA employed 1,690 nonindigenous personnel (USASSDC 1993). Housing requirements for these personnel are of key concern.

Housing for operations personnel employed at USAKA is located primarily on Kwajalein Island and, to a lesser extent, Roi-Namur. Facilities include family housing units, UPH units, and transient housing units. Historically, construction worker housing has been provided by the contractor in temporary facilities, although they can utilize the family housing and UPH units if space is available.

Family housing units are located on the northeastern side of Kwajalein Island. The family housing inventory consists of 425 single- and multifamily units and 249 trailer units, for a total of 674 units (USASSDC 1993). Of these, 136 units were constructed in 1989.

UPH units are located on both Kwajalein and Roi-Namur islands. These units are used to house base operations personnel without family, and temporary construction workers when available. There are 384 rooms with capacity for 674 people on Kwajalein Island (USASSDC 1993). On Roi-Namur, UPH consists of 231 single rooms and 10 two-bedroom trailers that can accommodate 20 persons (USASSDC 1993).

Transient personnel facilities are located on Kwajalein Island and consist of the Kwajalein Lodge, two dormitories, and one floor of Building 704B. The lodge can accommodate 52 visitors and the dormitories and Building 704B can take up to 373 transient personnel (USASSDC 1993). In addition, there are 11 "VIP" and 3 "vacation" trailer units available.

Objectives have been established by USAKA to meet housing standards as set forth in AR 210-50, AR 210-11, and the USACOE design standards for new construction. A vast majority of the housing units do not meet the above-referenced standards and are thus designated as "substandard" housing units. Only the 136 recently constructed family housing units meet AR 210-11 (USASSDC 1993). Currently, the overall availability of housing at USAKA, including the substandard units, is a problem. There is an insufficient supply of housing for USAKA personnel, both in accompanied and unaccompanied units.

2.7.10 Water Quality

Abundant rainfall collected into rainwater catchments is the primary source of fresh water on the atoll. This water is supplemented by pumped groundwater occurring in a freshwater lens on top of the more dense saltwater, as is typical of coral atolls. Because of the island dependency on rainfall and the limitations on available fresh groundwater, water conservation is a necessary and routine part of life on USAKA.

Groundwater typically occurs within about ±0.3 m (±1 ft) of sea level, varying with tidal fluctuations. Therefore, surface spills of hazardous substances are a concern in maintaining the groundwater quality for potable use. Currently, wells pumped for potable water supply are located primarily in the vicinity of the water treatment plant area in the central portion of the island. The groundwater underlying Building 1500 and areas to be used in support of GBR are not designated for use as a potable water source. There are no potable water wells in this area.

Marine water quality around the island is generally satisfactory except in certain localized areas (U.S. Department of Energy 1992).

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CHAPTER THREE
ENVIRONMENTAL CONSEQUENCES AND MITIGATIONS

chapter three

ENVIRONMENTAL CONSEQUENCES AND MITIGATIONS

This chapter examines the potential environmental consequences and mitigations for the proposed GBR DEM/VAL program activities. Section 3.1 of this EA describes the methodological approach of assessing the potential environmental consequences by comparing proposed program activities with potentially affected environmental components. Section 3.2 provides a discussion of the potential environmental consequences for the proposed TMD-GBR and GBR-T test activities and mitigation measures to be implemented to reduce potential impacts to a level of insignificance. The amount of detail presented in this section is proportional to the potential for impacts. Sections 3.3 through 3.10 provide discussions of the following issues with regard to proposed testing activities: FTV cumulative impacts, environmental consequences of the no action alternative; any conflicts with federal, regional, state, local, or Indian tribal land use plans, policies, and controls; energy requirements and conservation potential; natural or depletable resource requirements; unavoidable adverse environmental effects; the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity; irreversible or irretrievable commitment of resources; and conditions normally requiring an EIS.

3.1 METHODOLOGICAL APPROACH

This section assesses the significance of potential environmental impacts of the proposed GBR family of radars program activities. Any environmental documentation that addresses the types of activities proposed for each installation is incorporated by reference.

To assess the potential for and significance of environmental impacts from the proposed GBR activities, the approach listed in Figure 3-1 was utilized. First, a list of activities necessary to accomplish the proposed action was developed (Chapter 1). Second, the environmental setting at each affected installation was described, with emphasis on any special environmental sensitivities (Chapter 2). Next, the program activities were compared with potentially affected environmental components to determine if the activities presented a potential for significant environmental consequences.

Federal, state, and local environmental laws and regulations were reviewed to assist in determining the significance of environmental impacts (if any) in fulfillment of the NEPA and the Compact of Free Association of the RMI. Appendix B provides a description of the federal laws and regulations for each relevant environmental component. Proposed activities were evaluated to determine their potential to cause significant environmental consequences using an

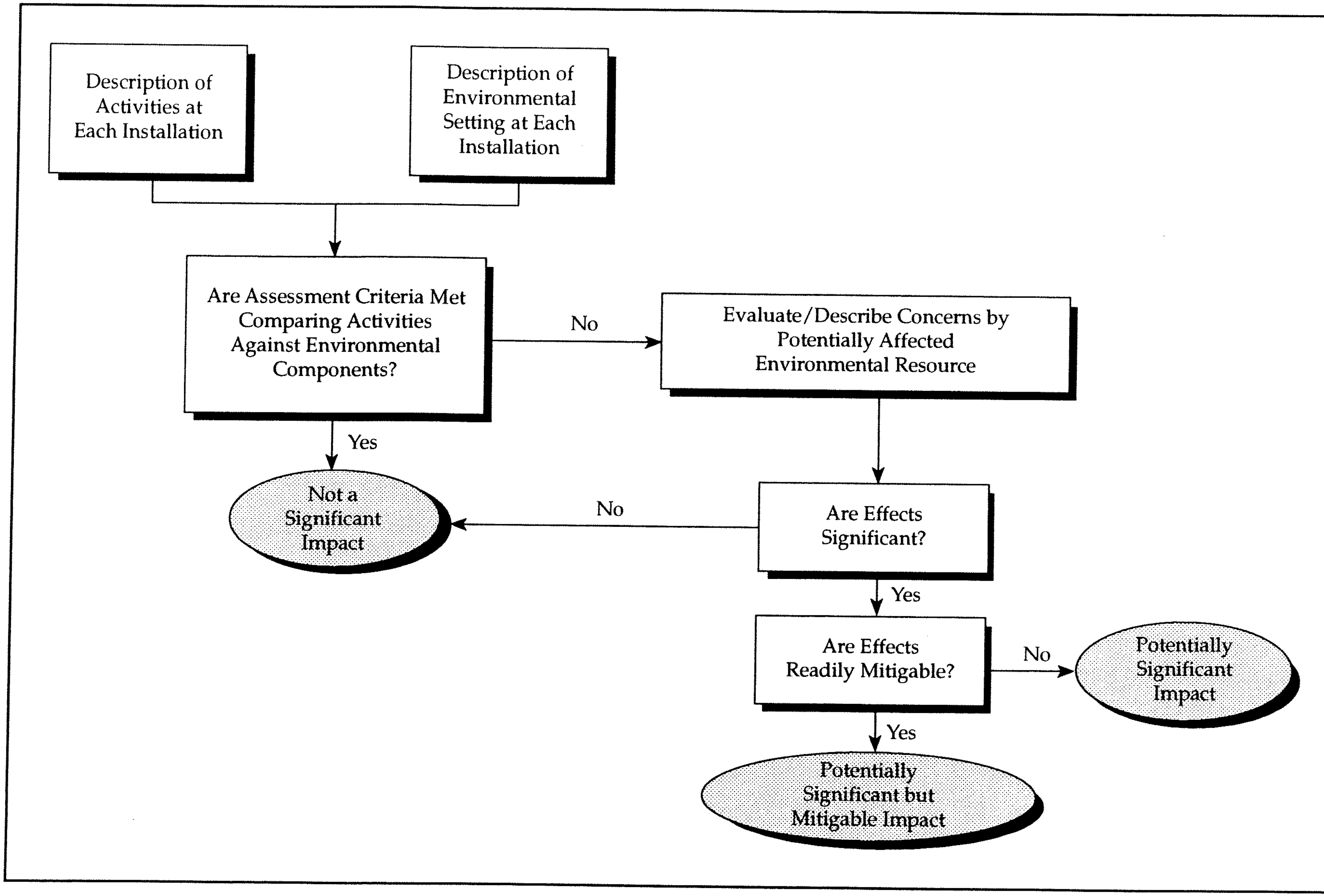

Figure 3-1. Approach for assessing impact significance

approach based on the interpretation of "significantly" as outlined in the CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508). In order to provide a brief and concise explanation of the significance evaluation, the wording from the CEQ regulations has been modified slightly for inclusion in this assessment.

Evaluations of significance used in this EA include an assessment of the intensity and extent of potential impacts. Intensity is based on relative changes:

- to the unique characteristics of the area (visual quality, prime agricultural land, paleontological resources, archaeological sites, wetlands, ecologically critical areas, etc.);
- likely to be controversial (examples of impacts considered to be controversial include those impacts for which there is a likelihood of a substantial dispute, those impacts about which segments of the public indicate substantial concern, or those impacts that have been found to be controversial on other projects);
- in cumulative impact;
- likely to adversely affect threatened, endangered, or otherwise unique species;
- in public health and safety;
- which may establish a precedent for future actions or represent a decision in principle about a future consideration;
- in compliance with federal, state, and local environmental laws or regulations;
- in resources considered to be important or valuable from the perspective of scientific opinion and management agency concerns; and
- involving uncertain, unique, or unknown risks.

Extent is related to:

- the area/quantity of a resource affected relative to the area/quantity of a resource available,
- the potential for change in reproductive success and maintenance of a plant or animal population at preproject levels, and
- the period of time during which recovery will occur.

The determination of significance for a particular impact may be based on one or more of the intensity (severity) or extent criteria and the context in which the impact occurs. The significance of an action also is evaluated in the context of society as a whole (e.g., human, national), affected interests, the affected region, and locality.

In addition, for this EA the proposed activities at a site were determined to have no potential for significant environmental effects if:

- the installation and its associated infrastructure were determined to be adequate for the proposed activities (i.e., the test can be conducted without new construction, excluding minor modifications);

- the current installation staffing is adequate to conduct the test(s), excluding minor staff-level adjustments; and
- the resources of the surrounding community are adequate to accommodate the proposed testing.

If a proposed program activity was determined to present a potential for impact (i.e., if one or more of the above criteria were not met or uncertainty exists), the potential for the proposed activities to cause significant impacts was evaluated in greater depth. The further evaluation was made by considering the relative changes in intensity, extent, and context in which the impact would occur.

As a result of that evaluation, impacts were categorized as not significant, potentially significant but mitigable, or potentially significant. Environmental impacts were determined to be **not significant** if, in the judgment of the agency preparing this document or as concluded in existing environmental documentation of similar actions, no potential for significant environmental impacts exists. Impacts were deemed **potentially significant but mitigable** if concerns exist but it was determined that all potential consequences could be readily mitigated through standard procedures or by measures recommended in this and previous environmental documentation. Mitigation measures considered for impacts from the testing activities proposed in this EA include: avoiding the impact altogether by not taking action or parts of an action; minimizing impacts by limiting the degree or magnitude of the action and its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or compensating for the impact by replacing or providing suitable resources or environments. If the predicted impacts could not be readily mitigated, the activity was determined to present **potentially significant** environmental impacts.

Proposed GBR activities also were reviewed against existing environmental documentation on current and planned actions and information on anticipated future projects at each of the sites to determine the potential for cumulative impacts. Cumulative effects were evaluated using the same criteria as the direct and indirect effects and are discussed in Section 3.3.

The project, its components, and potential impacts were evaluated to determine if they met the criteria given in AR-200-2, *Environmental Effects of Army Actions* (U.S. Department of the Army 1988), for actions that normally require an EIS. The evaluation indicated that the project did not meet these criteria.

3.2 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

This section contains analyses of the potential environmental effects of the proposed action at Raytheon Company and at the proposed test sites at WSMR, Fort Bliss Military Reservation, and USAKA. The results of the analyses are then discussed for each environmental component. Mitigation measures are presented for potentially significant but mitigable impacts.

3.2.1 Raytheon Company Facilities

The GBR manufacturing activities are defined as design, analysis, simulations, fabrication, and component/assembly tests. These activities would be conducted at Raytheon Company facilities at Wayland, Waltham, Sudbury, Marlborough, Quincy, and Andover, Massachusetts. Analysis and simulation would analyze test failures, demonstrate real-time waveform generation, test unique software, analyze the antenna's ability to survive environmental stress, and evaluate subsystem maintainability. The Raytheon Company facilities are routinely used for the types of activities planned for the GBR family of radars program. All GBR activities would be conducted in existing facilities. Because no ground disturbance would be involved, there would be no direct impacts on biological resources, cultural resources, or land use, and no indirect impacts have been identified. Additional personnel requirements would be minimal (approximately 10 percent increase at the Andover facility) for these activities. In addition, the availability of the GBR program would keep current employment from decreasing at the other facilities. Therefore, no significant infrastructure or socioeconomic impacts would occur. No air quality or noise impacts have been identified and no public health and safety or water quality issues are expected. There are no hazardous materials/waste noncompliance issues or significant deficiencies pertaining to the operation of the Raytheon Company facilities.

Raytheon Company complies with regulations issued by both the Massachusetts Department of Labor and Industries and the Massachusetts Department of Public Health relative to EMR generation. Testing inside the building includes component matching and assembly, physical alignment, and electrical continuity testing, which does not involve EMR generation. The antenna testing on the rooftop of the Raytheon Company facility in Wayland, Massachusetts, would involve the generation of EMR. This testing would be conducted within the Massachusetts exposure limits, and would occur in a controlled environment that includes automatic door interlocks to prevent unauthorized entry to the roof during test activities. Massachusetts laws regulate EMR testing, and a permit is required to ensure public safety. Antenna component tests would be conducted within the applicable guidelines established by the commonwealth of Massachusetts and the Federal Communications Commission. To gain civilian and military frequency approval for testing on the rooftop at Wayland, Raytheon Company will complete DD Form 1494 and will forward it to the USASSDC, which would submit it to the Military Communications Electronics Board for test authorization (frequency allocation). The permits required in Massachusetts for component testing would be requested using established procedures. GBR family of radars component testing would be conducted within the approved testing range for similar tests routinely conducted at Raytheon Company (USASDC 1989a).

Based upon the fact that the assessment criteria requirements would be met, the environmental consequences of testing the GBR family of radars would be considered not significant. Raytheon Company DEM/VAL activities were reviewed against current and planned actions and anticipated future projects, and no cumulative impacts were identified as a result of such testing (USASDC 1989a).

3.2.2 TMD-GBR, WSMR and Fort Bliss

Eight alternative locations have been evaluated for the TMD-GBR DEM/VAL activities: LC 39, R-409, C Station, R-409 West, and Rampart located on WSMR; and IFC-25, located on Fort Bliss McGregor Range, R-396, and the Wise site, located on Fort Bliss, as discussed in Section 1.4.3. The three preferred alternative sites are LC 39, R-396, and IFC-25.

Activities associated with final testing of the TMD-GBR include moving the component parts of the system to the selected sites, installation of TMD-GBR dem/val and two UOE systems in close proximity to one another at preferred site LC 39. **(Note: The term dem/val refers to the TMD-GBR system configuration, which has a smaller antenna configuration than the UOE system. The term DEM/VAL refers to the demonstration/validation phase of the system acquisition process).** Later, the individual TMD-GBR UOEs would be relocated to preferred sites R-396 and IFC-25 or one of the alternative sites. These activities are anticipated to be conducted for approximately three years and use existing and available site support capabilities, including existing personnel plus 21 to 25 additional TMD-GBR-dedicated personnel. Commercial power would be provided to LC 39 for use by the dem/val system and other site support facilities. The individual UOE sites would use mobile generators for system power or, if available, commercial power. Transportable/relocatable water supplies and a septic system would be provided at the sites selected. All potential sites have been previously disturbed by grading associated with military activities (Chapter 2). Site preparation would consist of clearing, compacting, and grading in the previously disturbed areas. The use of the test sites would be similar to the level and intensity that commonly occur at these locations.

Other proposed activities associated with the TMD-GBR DEM/VAL would be the interior modification and use of Buildings 24068 and 23632, near the proposed test sites, for maintenance of the component systems; use of Building 90133, for additional office space; the use of radar jamming equipment; and performance testing against actual targets. The TMD-GBR activities and the potential impacts of such activities to air quality, biological resources, cultural resources, hazardous materials/waste, infrastructure, land use, noise, public health and safety, socioeconomics, and water quality are discussed below.

3.2.2.1 Air Quality

Potential air quality consequences may occur from the test activities and thus warrant discussion. Land-disturbance activities, such as earth moving, grading, and contouring, have the potential to generate fugitive dust that may impact local air quality. The amounts of fugitive dust would depend on several factors, including the extent of area regraded for test activities as well as the soil silt content and moisture. Fugitive dust amounts would vary daily with changes in the level of activity, the specific operations, and the weather conditions. The impact of fugitive dust emissions is limited because the emissions are mostly large particles that settle a short distance from the source (Seinfeld 1986). The state of New Mexico does not have any permitting or notification requirements for land disturbances outside the Albuquerque-Bernalillo County area (Gudoor 1992).

Because radar system power would be provided by both commercial and mobile generators, the most important pollutants would be nitrogen oxides, carbon monoxide, hydrocarbons, particulate matter, and sulfur oxides, in descending order of concern. Proper maintenance and minimization of idling times would reduce emissions from the equipment. Some visible emissions during cold-starts and possible odorous emissions can be expected. Two diesel-powered generators, each rated at 1 megawatt (MW), are proposed for the two individual TMD-GBR UOEs. Table 3-1 provides an estimate of the quantities of emissions for the two generators for each hour of operation.

TMD-GBR transport vehicles would be another source of air pollutant emissions associated with the project. These are generally highway vehicles (trucks and automobiles) that convey personnel and equipment to and from the site. The carbon monoxide, hydrocarbon, and nitrogen oxides emissions from this as yet undefined fleet of diesel- and gasoline-powered vehicles would not be different from those of other highway mobile sources.

The amounts of emissions generated by these three source categories over the approximate three-year test period would not be significant because emissions output from the operation of the radars and support equipment would be very small. Generally the air quality of the region is excellent. Existing air pollution sources in the area are few and individually small. Air quality resource impacts would not be significant.

3.2.2.2 Biological Resources

Each of the eight WSMR/Fort Bliss alternative sites is characterized by a combination of paved or dirt access roads, graded areas, buildings, pads, and equipment. Biological surveys of the proposed sites indicated that no sensitive plant or animal species were present. Therefore, no significant direct or indirect impacts are expected from the TMD-GBR activities.

The Aplomado falcon (*Falco femoralis septentrionalis*), a federal endangered species, has been sighted (unconfirmed) north of the proposed test site areas at WSMR. The Aplomado falcon's

Table 3-1
Emissions estimates for two diesel generators (1-megawatt each)*

Emissions	Pounds Per Hour
Nitrogen oxides	66.2
Carbon monoxide	17.2
Sulfur dioxide	7.4
Particulate matter	6.6
Volatile organic compounds	1.9

Source: EPA 1985

*Assumes fuel consumption rate of 25 gallons per hour per generator.

hunting habitat consists of large areas of grassland. There are no areas of grassland at or near the proposed test sites. Although no suitable habitat is available, an analysis of potential impacts from EMR was conducted.

The same analysis considers potential impacts from EMR to ground-dwelling wildlife, including the Texas horned lizard, *Phrynosoma cornutum*, a federal Category 2 species. This species occurs in shrublands and grasslands on sandy and sandy/gravelly soils. The Texas horned lizard is active on the surface during April through September. Harvester ants of the genus *Pogonomyrmex* are the primary food source for the Texas horned lizard. Although this species is known to occur throughout WSMR, it was not observed at any of the proposed TMD-GBR test sites during biological surveys conducted in September 1992.

The Baird's sparrow, a federal Category 2 species, may occur in grassland habitats associated with WSMR/Fort Bliss during the fall and winter. The only test site that has potential habitat for the Baird's sparrow is IFC-25. However, the IFC-25 test site is approximately a 3-acre asphalt pad surrounded by a 30-m (100-ft) cleared area. Therefore, no potential Baird's sparrow habitat would be affected by the proposed test activities at IFC-25.

The relatively high microwave power density that would exist in the main beam of the TMD-GBR provides a potential for impact to birds that might fly through the beam. To determine potential impacts, an analysis, based on a conservative approach of limiting the microwave energy absorption rate on the Aplomado falcon, was conducted. The average absorption rate of the falcon was based on the falcon remaining continuously within the beam of the TMD-GBR. The absorption rate was then compared to the bird's resting metabolic rate. The analysis indicated power densities would have to exceed 42 mW/cm^2 (269 mW/in^2) to affect the falcon. Such power densities can only exist within approximately 1 km (0.6 mi) (as measured from the face of the antenna) for any given radar beam. For other birds, with a weight range of up to 3.5 kilograms (7.7 pounds), a range of power densities extending from 38 to 61 mW/cm^2 (243 to 390 mW/in^2) was determined to be potentially important.

Several factors significantly reduce the likelihood that such exposures to birds and other wildlife would occur.

- The radar main beam normally would be located at least 4 degrees above horizontal.
- The radar beam normally would be in motion, tracking targets, thereby making it extremely unlikely that a bird would stay within the most intense area of the beam for any considerable period of time.
- The size of the beam is rather small; therefore, the probability of the falcon or other bird species remaining within this limited region of space, even if the beam were motionless, is low.
- EMR power densities would not exceed 5 mW/cm^2 (32.25 mW/in^2) on the ground anywhere within the 100-m (330-ft) safety zone.

The analysis that was conducted was based on the assumption that the energy absorption rate of a bird's body was equal to the bird's resting metabolic rate and that this may pose a potential for an adverse effect. It is likely that such an assumption is overly conservative. Birds in general typically expend energy at up to 20 times their resting metabolic rates during flight. The

Aplomado falcon's metabolic rate when in flight normally ranges between 7 and 10 times its resting rate. The analysis assumes that a thermal loading of only 10 percent of the in-flight metabolic rate may pose a hazard. Therefore, the likelihood of harmful exposure is not great.

Another analysis was conducted that concentrated on the EMR area in front of the TMD-GBR antenna. This analysis indicated that this area represents, at any given instant, less than 0.025 percent of the potentially affected volume in the environment (see Appendix A). These considerations, including the facts that the Aplomado falcon has been observed only twice within the past two years at WSMR and its hunting habitat is absent, indicate that no significant impact would occur to the Aplomado falcon.

Analyses of the potential for steady-state power densities sufficient to pose potential hazards is minimal, when considering general bird behavior and the absence of suitable habitat. Inspection of the proposed test sites concluded that no objects or vegetation are high enough to be of concern if birds did perch on them. However, in the case of site LC 39, a single pole is located directly north of the edge of the site. Since power densities in this region, at elevated points, have the potential to reach hazardous levels, consideration must be given to the possibility that a bird perched on top of this pole could be adversely affected. Removal of this pole from in front of the radar would minimize the likelihood of bird exposure near the radar.

Energy absorption by ground-oriented wildlife species such as the Texas horned lizard, small mammals, and birds, would not be significant because the ground-level power densities from the TMD-GBR would not exceed 5 mW/cm^2 within the 100-meter safety zone. Outside the 100-meter safety zone, ground-level power densities would typically be below 1 mW/cm^2. When the potential for energy absorption is combined with a general lack of suitable wildlife habitat within the safety zone, the overall impacts of EMR on wildlife species would not be significant.

3.2.2.3 Cultural Resources

The ground surfaces of each of the TMD-GBR preferred and alternative sites have been previously disturbed by extensive scraping and grading. No cultural resources sites have been identified or recorded at any of the test locations. The preferred test locations, LC 39, R-396, and IFC-25, and the alternative locations provide an area sufficient to accommodate the proposed test activities. Radar jamming equipment would be located in existing right-of-ways.

The potential for significant inadvertent impacts to cultural resources could result from trenching for the installation of additional power and telecommunication lines and septic holding tanks because the location of these facilities is not known at the time of the preparation of this EA.

Mitigation Measures

The mitigation program to reduce potential impacts to cultural resources to a level of nonsignificance at the selected TMD-GBR test sites would include: avoidance of newly discovered cultural sites; a preconstruction archeological survey, including testing and data recovery of the selected sites; monitoring, consisting of testing and data recovery on-site by an archaeologist during construction; and distribution of educational literature to all TMD-GBR-related personnel providing information about the National Historic Preservation Act and the importance of archaeological and historical resources.

3.2.2.4 Hazardous Materials/Waste

Materials of concern utilized during testing of the TMD-GBR may include limited quantities of petroleum products and coolant fluids. Portable generators and transport vehicles would use standard U.S. Army petroleum products, which include gasoline, diesel fuel, and engine oil. Operation of antenna units and radar components may require limited quantities of petroleum-based lubricating oil. The truck-mounted mobile cooling equipment unit would use a mixture of ethylene glycol and water.

On-site storage of most materials is not anticipated. However, extra diesel fuel storage for the power generators would exist in aboveground tanks with spill containment provisions. Because the TMD-GBR system is mobile, maintenance and repair of the generators and operational equipment would be performed primarily at WSMR in Building 24068. Test site maintenance activities may include replacement of generator engine oil, generator refueling, and minor equipment repair. Because waste materials accumulated during operation and maintenance of the TMD-GBR would be handled and stored in accordance with existing hazardous waste management guidelines at WSMR and Fort Bliss, no significant impacts are anticipated.

Asbestos

Building 24068 is being considered as the maintenance facility for TMD-GBR. It has been confirmed that the building was constructed with and contains asbestos materials. Asbestos is a known cancer-causing substance. Exposure to asbestos can cause cancer of the lungs, stomach, colon, and rectum. Asbestos also causes asbestosis, a scarring of the lungs that restricts breathing and can cause death (Speights and Runyan 1989).

Asbestos Mitigation Measures

Mitigation measures, or an asbestos abatement program, for the asbestos in Building 24068 would be conducted pursuant to RCRA, Occupational Safety and Health Administration (OSHA), and WSMR procedures. Since the asbestos would be abated properly, no further risk to health would be present. Therefore, no significant impacts from asbestos are anticipated.

3.2.2.5 Infrastructure

The TMD-GBR dem/val and UOEs are trailer-mounted, mobile systems. The majority of the maintenance and repair would be conducted at an existing facility, Building 24068. Modifications to Buildings 24068 and 23632 would be limited to the interior. Additional office space would be provided in an existing facility, Building 90133. No modifications to Building 90133 are anticipated. Power demands would be accommodated by existing commercial power and portable generators. Since program-related activities would be conducted in existing facilities and mobile trailers, no direct or indirect impacts are expected as a result of TMD-GBR test activities.

3.2.2.6 Land Use

The TMD-GBR program would not alter the designated use of the proposed test sites or support facilities. Therefore, no adverse impacts to land use are expected.

3.2.2.7 Noise

No significant noise impacts are anticipated from the TMD-GBR test activities. Noise from system installation and setup would be of short duration. Low noise level generators (80 dB or less in accordance with OSHA) are required to be used at WSMR.

The testing activities would create some noise from trucks moving radar and support equipment onto the sites as well as from the radar system and from generators needed to power the equipment. However, the testing operations would not be continuous and would last only for very short periods. Therefore, no adverse noise impacts are anticipated.

3.2.2.8 Public Health and Safety

EMR

EMR would pose potential health and safety impacts. Although the TMD-GBR would be designed to preclude or restrict the generation of grating lobes and the main beam would operate at an elevation high enough to avoid potential human contact, other health and safety EMR concerns do exist. EMR associated with the jamming equipment would not have an adverse effect on common electronic equipment because of the low-power output and isolated location of the jamming devices. However, the following mitigation measures have been included in the proposed action to reduce the potential impact to a level of nonsignificance.

EMR Mitigation Measures

The safety of the TMD-GBR operation would be verified low-level testing before it is fully used. The TMD-GBR is being designed to ensure that operational personnel are not exposed to EMR power densities exceeding the ANSI standard of 5 mW/cm^2 (32.25 mW/in^2) averaged over any 6-minute period, or 50 mW/cm^2 averaged over any 1-second period, or 1 mW/cm^2 averaged over any 6 minutes at distances greater than 1 km from the TMD-GBR. TMD-GBR system design and operation would limit exposure to the public to within acceptable levels. The design and operation also would reduce any impact of the TMD-GBR electromagnetic fields on fuel ignition hazards, prevent any inadvertent detonation of EEDs or ordnance, and reduce interference with critical medical electronic devices such as cardiac pacemakers. Mitigation measures for EMR also include a safety zone. A warning beacon located on top of the radar would illuminate when the radar is in the operational mode. The TMD-GBR could result in interference with military and aircraft communications-electronics systems at WSMR (ECAC 1993a). However, during actual tests of the TMD-GBR, range operations scheduling procedures, including the enforcement of air space restrictions, would eliminate adverse effects to aircraft and military communications-electronics equipment. In addition, the TMD-GBR would have no adverse effects to television and radio reception or other public communication systems because these systems operate in a different frequency and at sufficient distance (> 1 km) from the TMD-GBR test sites. EEDs, including ordnance storage areas, are not located within several km of any proposed radar test site. Therefore, there is no potential for the TMD-GBR to affect EEDs or ordnance. Furthermore, range operation scheduling would ensure that no ordnance would be utilized/transported near the TMD-GBR radar during testing activities.

The TMD-GBR main beam normally would be operated at an angle of at least 4 degrees above horizontal. Thus, the potential for exposure to EMR from the TMD-GBR would be greatly reduced because the main beam would be focused above the earth's surface and away from humans. In addition, analysis, simulation, and other nontransmitting validation methodologies are planned in order to characterize and evaluate the EMR environment caused by the radar. This would help minimize EMR exposure possibilities and would ensure that all other possible EMR environmental issues can be addressed. Other safety measures would be the designation of an EMR safety zone extending out to 100 m (330 ft) in front of the antenna equipment unit. This zone would be identified by a single-wire keep-out fence with warning signs posted on the wire every 3 m (10 ft) indicating that the area is unsafe to enter. Warning lights also would be activated during periods when the radar is transmitting. These measures would ensure that the TMD-GBR would have no adverse effects on the public, including individuals with pacemakers.

Airspace control also is a concern with respect to EMR. Airspace control at WSMR consists of a total of 18 designated restricted-airspace areas. These areas are located in the WSMR/ Holloman AFB/Fort Bliss areas of southern New Mexico and northwest Texas. Thirteen of these restricted-airspace areas are controlled by WSMR and scheduled for research, development, and evaluation; military training; and civilian contract programs. The remaining five restricted-airspace areas are controlled by Fort Bliss. All 18 areas are charted as restricted airspace by the FAA, which allows for hazardous activity use. Any civil or military aircraft that have not been authorized and scheduled by the controlling agency are prohibited from entering the airspace. Coordination is maintained between the two controlling agencies with respect to adjacent restricted-airspace areas. The airspace use can be controlled from the surface to unlimited altitude 24 hours a day. A priority schedule system prescribes the use of WSMR airspace. Each authorized activity supported by WSMR is categorized as a range program and is assigned one of four priorities according to the nature of the program. Once a program has received approval for restricted airspace or surface activities, no other program may use that airspace or range area. A higher-priority program may cause a rescheduling of a lower-priority program's use of the airspace or range.

3.2.2.9 Socioeconomics

Approximately 21 to 25 personnel would be required for the TMD-GBR DEM/VAL. The duration of the entire DEM/VAL program would be approximately three years. Mission-specific personnel will have little interaction with the communities surrounding WSMR or Fort Bliss.

The two municipalities having the potential to be impacted by the TMD-GBR DEM/VAL from a socioeconomic standpoint are Las Cruces (Doña Ana County) and Alamogordo (Otero County), New Mexico. Temporary mission-related personnel would be located at WSMR and Las Cruces, New Mexico. The small number of personnel temporarily staying in the ROI would not result in significant socioeconomic impacts.

3.2.2.10 Water Quality

No surface waters of any consequence are known to occur at any TMD-GBR alternative site, and groundwater resources are estimated to occur several hundred feet below the ground surface at these sites. Groundwater underlying these alternative TMD-GBR test sites is, for the most part, relatively saline, and thus of inferior quality for most beneficial uses.

Human wastes would be disposed of in portable latrines and a septic holding system. Any environmental permits required by the state of New Mexico would be obtained prior to construction of latrines and septic holding tanks. Wastes from portable latrines and septic holding tanks would be disposed of by approved and licensed contractors. Wastes in the septic tanks would be pumped periodically. Other domestic wastewaters would be disposed of in soakage pits using approved procedures. Therefore, no significant adverse impacts on water quality or available water resources of these sites are judged to occur, as a result of proposed or planned activities at these sites. All applicable federal and state regulations would be adhered to regarding generation and/or release of waste streams potentially affecting nearby water resources or underlying groundwater resources.

It is anticipated that water supplies for selected TMD-GBR test sites would be transported in by truck. Possibly, moveable water-supply bladders will be placed at required locations; these bladders will be filled with water from existing WSMR supply sources. Calculated maximum daily usage at a selected TMD-GBR test site is estimated to be 265 liters (70 gallons) per person. Relative to the present groundwater withdrawal rates of groundwater from the Hueco Bolson, this additional use should not increase this depletion rate in a significant manner. Therefore, no significant impacts to water quality are anticipated.

3.2.3 GBR-T USAKA

The proposed GBR-T DEM/VAL would be conducted on USAKA, RMI. Analysis and validation testing evaluates subsystem maintainability and antenna survivability, verifies software and discrimination performance, and demonstrates target acquisition and tracking. Use of the USAKA facilities is consistent with the current mission and operation of those facilities. The site for this final test phase of the GBR-T would be Building 1500, located at the western end of Kwajalein Island. Building 1500 is an existing facility that was originally built to hold a large radar (see Section 1.4.4). The activities would involve unloading, transporting, assembling, and installing the GBR-T system components inside and on the roof of Building 1500.

Modifications to Building 1500 include the conversion of the inside of the building to office and equipment spaces (Figure 1-14). The structural modifications required for Building 1500, as well as provisions within the building for utilities, communications, fire protection, security, air conditioning, and air flow systems, were addressed in a Record of Environmental Consideration prepared for GBR-X by Col. J. Allred in 1988. This document determined that the action qualified for a Categorical Exclusion and that no significant impact to the environment would result (USASDC 1989a). Other construction activities include the installation of additional power and utility lines and two new masonry buildings to house fire pumps and transformers. The majority of project construction activity would occur in the fill area. Further discussion and analysis of the GBR-T activities and the various environmental components are presented below.

3.2.3.1 Air Quality

Any fugitive dust or emissions from equipment during construction would be minimal and quickly dispersed by the trade winds. Therefore, no significant air quality impacts are expected due to project-related activities.

A refrigerant, hydrochlorofluorocarbon-22 (R-22), would be used to cool Building 1500. R-22, an ozone-depleting chemical, is a Class II substance. Class II substances can be used as a refrigerant until 2020 (Clean Air Act 1990). As the Army proceeds with final system design for the GBR DEM/VAL program and supporting facilities, alternatives to the use of R-22 would be considered where feasible. This coolant would be used in the initial phases of the program. An alternative coolant would be identified to replace the R-22 by the year 2020. The air conditioning system is a closed system. There is no planned or intended release of R-22 into the atmosphere; therefore, there would be no significant environmental effect.

3.2.3.2 Biological Resources

Biological surveys of Kwajalein Island indicated that no sensitive plant or animal species were present on the island. However, a seabird roosting area is located approximately 76 m (250 ft) west of Building 1500 (USASSDC 1993). Noise resulting from the construction activities at Building 1500 may cause flushing behavior and other startle effects at the seabird roosting area. However, impacts from noise would be of short duration and would cease after the completion of structural improvement activities. No significant impacts to biological resources from project-related construction are expected.

The potential for impacts to wildlife, particularly birds, from EMR is remote (Section 3.2.3.8). Due to the extremely low probability of birds entering and remaining within the GBR-T transmitted beam and the maximum power densities that would be permitted on the ground and in the sea, no significant impact is foreseen for wildlife in the vicinity of the GBR-T.

3.2.3.3 Cultural Resources

Potential impacts to cultural resources may result from the construction associated with the installation of additional utility lines, the 335-m (1,100-ft) potable waterline, the 701-m (2,300-ft) non-potable seawater line, the 1,707 m (5,600 ft) of underground electrical feeder lines needed by GBR-T DEM/VAL (Figure 2-18), and the two new masonry structures for transformers and fire protection equipment. The majority of this construction would be conducted in the fill area.

The excavation of trenches for these utilities, beyond the fill area, may result in exposing skeletal and/or cultural material remains associated with the indigenous presence or the World War II battle for Kwajalein Island.

Sensors to measure EMR exposure levels would be sited in the vicinity of the GBR-T. Previously disturbed areas and existing structures would be used, where possible, for placement of sensor equipment and utilities. Placement of the EMR sensors may require excavation of utility trenches. If construction of trenches for these utilities becomes necessary, the disturbance of a new area may have the potential for cultural resource impacts; however, the area would be mitigated as described below. Overall, potential impacts for GBR-T DEM/VAL activities are considered to be mitigable and not significant.

Mitigation Measures

Potentially significant impacts from construction activity would be mitigated to a level of nonsignificance by implementation of a preestablished archaeological sampling and data recovery program that would be conducted prior to any construction activities. Unexploded ordnance surveys and archaeological monitoring (which is an aspect of mitigation) also would be conducted during ground-disturbing construction activities. Any cultural resources discovered as a result of the monitoring program would be treated in accordance with the preestablished data recovery plan. Special attention would be paid during construction of the utility lines to avoid known historic resources. The scope of work for this program is to be coordinated in consultation with the HPO of the RMI and the ACHP. Any comments from the HPO would be resolved into the program prior to construction. Implementation of the mitigation program by coordination with the HPO of the RMI and ACHP would result in a Determination of No Adverse Effects to the Kwajalein Battlefield National Historic Landmark or to other cultural resources.

3.2.3.4 Hazardous Materials/Waste

Hazardous materials of concern required for GBR-T may include limited quantities of petroleum products and air conditioning coolant. The radar components and antenna units may require some periodic applications of petroleum-based lubricating oils, which have relatively low hazard properties.

Up to 208 liters (55 gallons) of waste generated at the site such as empty petroleum product containers and oily rags would be stored in closed, labeled containers in a satellite facility within the operational unit until it is full. The wastes would subsequently be transported to the nearby hazardous waste storage building (Building 1521). Therefore, no significant impacts associated with hazardous materials or waste are anticipated.

3.2.3.5 Infrastructure

Electrical power required for GBR-T operations at USAKA, estimated to be 8.3 MW, would be supplied by Kwajalein Island power generation facilities. Dedicated electrical power generation would not be provided for GBR-T. A new power plant (1B) is scheduled to be completed in FY95. The power plant will be located adjacent to Power Plant 1A.

Power Plant 1B will serve as a future source of electrical power for Kwajalein Island. Currently, electricity is generated by Power Plants 1, 1A, and 2. Power Plant 1B is planned as an upgrade of the power plant system. Due to the age and condition of Power Plant 1 facilities and equipment, it may be removed at the completion of the construction of Power Plant 1B.

Power Plants 1 and 2 can produce up to a maximum of 17,790 kW of power. With the addition of Power Plant 1A, power capabilities have increased to a maximum theoretical capacity of 29,790 kW. Completion of Power Plant 1B will add 17,600 kW of power. When Power Plant 1 is decommissioned, total net power-producing capability will be 33,890 kW (USASSDC 1993).

Installation of 2,316 m (7,600 ft) of new electrical feeder lines would connect GBR-T equipment at Building 1500 to the power grid. This power generation upgrade should satisfy anticipated new users, including GBR-T, and should increase capacity and reliability for current users. Current sewage capacity is adequate to accommodate the personnel associated with GBR-T. Therefore, no significant impacts would affect the infrastructure on Kwajalein Island due to the GBR-T DEM/VAL activities.

3.2.3.6 Land Use

The land use impacts of assembling the GBR-T unit on top of and within Building 1500 and adding new utility connections are not considered to be significant. Building 1500 is an existing structure. Modifications and additions to Building 1500 already have been addressed in an Environmental Assessment (USASDC 1989a), which concluded that no significant impacts to the environment would result.

Existing building height limitations associated with the use of the Air Navigation Criterion have no effect on GBR-T because Building 1500 is outside the height limitation envelope (Army Technical Bulletin TB5-803-4).

The main beam EMR from the GBR-T would effectively impose an occupied-building-height restriction on much of the western portion of Kwajalein Island of about 60 m (200 ft). The maximum height of GBR-T on Building 1500 would be 57 m (187 ft) with the center of the antenna (which represents the center of the main beam) 47 m (154 ft) above the ground. The GBR-T design would establish a minimum beam elevation limit of at least 2 degrees above horizontal. Currently, most existing buildings are below 11 m (36 ft) in height and no occupied building of more than seven stories (24 m [80 ft]) has been or is likely to be proposed. This building height limitation does not represent a significant impact on future land use (USASDC 1989a).

Therefore, overall potential impacts on land use for GBR-T DEM/VAL activities are not considered to be significant. Potential impacts from EMR are discussed in Section 3.2.3.8.

3.2.3.7 Noise

Noise-generating sources of the GBR-T system include installation at Building 1500, some system components (when operating) generation of power to operate the system, and testing using actual targets.

The majority of the system installation would occur within the closed portions of Building 1500, with a limited amount of construction to install the antenna on the roof and digging of trenches to install utility and communication lines. Construction personnel would wear noise attenuation devices when necessary. Construction activities are expected to be completed within one year. Based upon the short duration of the construction period, occurring mostly inside the building, and the adoption of necessary noise safety measures, no significant noise impacts are expected to occur from installation.

Noise generated from system operation would occur from computers, transformers, and air conditioning contained inside Building 1500. Proper insulation would minimize the noise. Noise from power plant operation to provide electricity to Kwajalein Island, including GBR-T, has been analyzed in previous environmental documentation (USASDC 1989a; USASSDC 1993). Therefore, no significant noise impacts are anticipated in connection with GBR-T operation.

3.2.3.8 Public Health and Safety

Personnel exposure to the main beam of the GBR-T represents a potential EMR hazard that can be easily avoided by controlling the direction and elevation of the main beam. Exposure to grating or side lobes also can be a hazard to personnel. Grating and side lobes are predictable given a fixed set of operational conditions for a given location. The presence of grating lobes necessitates a requirement for more control over possible personnel exposure. An analysis of the maximum grating lobe power densities at ground/sea level near the GBR-T demonstrates that it would be possible for ground/sea level power densities to reach or exceed 5 mW/cm^2 (32.25 mW/in^2) if no safety procedures were incorporated. As a result, computer-operated controls and procedures are incorporated into the GBR-T design to assure that personnel are not exposed to EMR power densities exceeding 5 mW/cm^2 (32.25 mW/in^2) averaged over any 6-minute period, 50 mW/cm^2 (320 mW/in^2) averaged over any 1-second period, and 1 mW/cm^2 (6.4 mW/in^2) averaged over any 6-minute period at distances beyond 2 km (1.2 mi) from the GBR-T. These power densities are more stringent than the permissible exposure levels outlined in the U.S. Army Environmental Hygiene Agency's Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation appended to the 1989 GBR EA as Appendix A (USASDC 1989a). Consequently, grating and side lobes from the GBR-T antenna have been determined to represent a mitigable and nonsignificant impact on public health and safety based on the implementation of the mitigation measures (design features) outlined below and incorporated as part of the proposed action in Chapter 1.

Normal GBR-T operation would keep the main beam at least 2 degrees above horizontal. If, during operation of the GBR-T, the radar beam is required to go below an elevation of 2 degrees to gather data on objects tracked to splashdown or to assist in range operations, the radar would operate at reduced duty cycles (contrasted with a maximum duty cycle of 25 percent) and the resulting power densities will not exceed permissible levels. The controls implemented in the computer operating rules are such that permissible exposure limits would not be exceeded at heights less than 6 m (20 ft) above water or land surfaces or below the height of any existing structures. Operation of the GBR-T at less than 2 degrees normally would occur in a sector bounded by an azimuth of 288 degrees on the west and 17 degrees on the east. The restriction of operations to this sector and the reduction of the duty cycle at elevations of less than 2 degrees would be controlled by the system operating software. Consequently, exposure of the sea and land at antenna elevations of less than 2 degrees within this sector has been determined to represent a mitigable and nonsignificant impact on public health and safety, based on the implementation of the mitigation measures (design features) outlined below and incorporated as part of the proposed action in Chapter 1.

Validation testing would proceed in a step-by-step manner, initially using low duty cycles to perform limited radar operations. Testing will be supported by sensors placed in the vicinity of the GBR. Only when measurements successfully verify the predicted operational conditions would increases in power levels for testing be allowed (USASDC 1989a).

EMR Mitigation Measures

To ensure personnel safety and eliminate the need for a controlled-access zone, independent evaluations by Raytheon Company and USAKA safety personnel would verify the ability of the GBR-T design to control power densities on land and sea. Testing would be supported by sensors placed in the vicinity of the GBR-T.

The safety of the GBR-T operation would be verified before it is fully used. The GBR-T is being designed to ensure that personnel are not exposed to EMR power densities exceeding 5 mW/cm^2 (32.25 mW/in^2) averaged over any 6-minute period, or 50 mW/cm^2 (320 mW/in^2) averaged over any 1-second period, or 1 mW/cm^2 (6.4 mW/in^2) averaged over any 6 minutes at distances greater than 2 km (1.2 mi) from the GBR-T. In addition, the design would include the following positive actions.

- Effects from the main beam would be controlled by establishing a minimum beam elevation limit of 2 degrees above horizontal for normal operations. If the radar beam is required to go below an elevation of 2 degrees to gather data on the splashdown of impacting objects or to assist in range operations, the radar duty cycle would be reduced to the extent necessary so that resulting power densities would not exceed the above criteria (the maximum duty cycle of the GBR-T is 25 percent).
- Effects from the antenna grating lobes and side lobes would be controlled by establishing computer operating rules in the main data processor to ensure that EMR power densities are in accordance with the above-specified criteria. Before each mission, simulations would be used to verify the adequacy of the computer operating rules.
- Effects from the antenna grating lobes and side lobes also would be controlled by a separate computer used to calculate real-time EMR power densities for several geographical cells surrounding the GBR-T. This safety computer would inhibit the GBR-T from transmitting if a predetermined threshold was exceeded. The safety computer would be supplemented with 10 EMR sensors placed throughout Kwajalein Island. These sensors would provide measured data on EMR power densities to the safety computer that would inhibit the GBR-T from transmitting if the measured data exceeds a predetermined threshold. This overall monitoring system is illustrated in Figure 1-17. In addition, EMR sensors (recording only) could be located on Ebeye or other islands, as appropriate.

- To ensure personnel safety and eliminate the need for a controlled-access zone outside the GBR-T facility, independent evaluations by Raytheon Company and USAKA safety personnel would verify the ability of the GBR-T to control power densities on land and sea. Testing would be supported by the placement of measuring equipment in the vicinity of the GBR-T. To ensure that personnel exposure limits are not exceeded, testing would proceed in a step-by-step manner, initially using low duty cycles to perform limited radar operations. Only when measurements successfully verify the predicted operational conditions would increases in power levels for testing be allowed.

Inherent to the overall EMR hazard control plan will be a measurement verification phase in which, after the GBR-T is installed on Kwajalein Island, power-density measurements would verify that ground/sea level time-averaged power densities do not exceed 5 mW/cm^2 (32.25 mW/in^2) averaged over a 6-minute time period, 50 mW/cm^2 (320 mW/in^2) averaged over any 1-second period, and 1 mW/cm^2 (6.4 mW/in^2) averaged over any 6-minute period 2 km (1.2 mi) or greater from the GBR-T.

EMR generated by the GBR-T potentially could interfere with existing emitters and communications systems at USAKA: avionics, communications, and navigation aids on USAKA and transient aircraft as well as communication and navigation aids on lagoon shipping. In addition, EMR potentially could interfere with air traffic navigation aids (Tactical Air Navigation and Nondirectional Beacon) at USAKA Bucholz Army Airfield. An electromagnetic compatibility analysis by the ECAC, Annapolis, Maryland, was performed in February 1993 to determine what interferences could exist from a proposed GBR-T (ECAC 1993b). This study determined that, for many of the different waveforms that the GBR-T could use, there would be a potential for interference with several communications-electronics systems in use at USAKA including splashdown detection radars, marine navigation radars, aircraft weather radars, and other nonradar systems. ECAC determined that the potential for high-power effects to out-of-band systems at the Kwajalein Missile Range needs to be evaluated by considering the likelihood of the various coupling situations, and the probable distance separations between the GBR-T and the environmental systems. The projection of potential interference with the in-band radars indicates the need for coordination of GBR-T and USAKA operations as well as with commercial air traffic in the region. To minimize the impact of airborne weather radar interference, aircraft activity within 640-km (345-nmi) range of the control tower at Kwajalein Island would be coordinated with GBR-T test activities, USAKA operations, and control tower personnel. In addition, an appropriate Notice to Airmen would be published in order to alert them to GBR operations.

The ECAC study would continue to be updated to reflect the latest in design changes for the GBR-T and will recommend any necessary corrective actions (e.g., routine range scheduling and/or minor adjustments to operations). In addition, ECAC would study the potential for high-intensity radar pulses to damage aircraft weather radars. This issue would be studied to assess the need for modifying any restricted airspaces near USAKA to ensure that no significant impact would exist relative to this phenomenon. The continued ECAC studies would provide measures that would control any predicted EMR interference with existing emitters and communications at USAKA. Therefore, these potential interference impacts would be mitigated.

The National Telecommunications and Information Administration (NTIA) would evaluate the corrective actions before allocating a frequency assignment through the DoD. Only when these corrective actions are coordinated with USAKA and procedures are in place to incorporate them can the frequency assignment allocation be granted by NTIA. EMR concerns and mitigation measures applicable to both the GBR-T and TMD-GBR are discussed further in Chapter 1 and in Appendix A.

In addition to a concern over human exposure to potentially hazardous electromagnetic fields caused by the GBR-T, consideration has been given to several other possible side effects, including potential ignition during fueling operations, the inadvertent detonation of EEDs or ordnance, and interference with critical medical electronic devices such as cardiac pacemakers.

Fuel ignition potentially can become a problem when EMR currents, which can be induced in metallic objects by intense EMR fields, lead to possible arcing and sparks. This phenomenon is a rare event and has been observed under contrived test conditions during refueling operations. Ignition may occur if the proper mixture of fuel vapor and air exists at the point where the spark occurs, but this is considered unlikely. EED detonation (e.g., inadvertent firing of meteorological rockets during arming operations) also is related to the electromagnetic field-induced currents that flow in the electrical leads connected to the explosive device. DoD standards (88, 110) provide guidelines for maximum permissible electromagnetic field intensities to avoid these hazards. These standards would continue to be rigorously maintained to avoid any potential problems. GBR-T operational restrictions may be required during meteorological rocket-arming operations.

Although EMR levels associated with the GBR-T would be less than the personnel exposure limits established in Army standards, there is a possibility that such EMR could affect the operations of some models of cardiac pacemakers. Most modern pacemakers are subjected to testing to evaluate their potential response to electromagnetic fields, but almost all of this testing is done at two specific frequencies, 450 MHz and 2,450 MHz, not at the proposed operational frequency of the GBR-T. Data from available literature indicates that since the early 1970s, pacemaker manufacturers have made significant improvements in pacemaker susceptibility to EMR (Denny and Jenkins 1993). While present testing is not routinely done at frequencies as high as the GBR-T frequency, there are data that suggest that pacemaker susceptibility would not be any worse at higher microwave frequencies than at 450 MHz (Mitchell and Hurt 1976). Therefore, test data available at 450 MHz, for pulsed conditions, may be useful to estimate the threshold for susceptibility at 10 gigahertz.

Virtually all present-day designs of pacemakers appear to be able to sustain an ambient EMR level of about 13 mW/cm^2 (84 mW/in^2) for pulsed fields at 450 MHz. Pacemaker testing has indicated that the general characteristic of susceptibility of solid-state electronic devices becomes less at higher frequencies. This testing has suggested the possibility that pacemakers might have interference thresholds as much as 26 dB higher (a factor of 400 times in power density) at 10,000 MHz compared to 450 MHz (Denny 1993). However, testing of pacemakers to confirm the 26-dB-higher interference threshold has not been conducted. If the testing data indications were correct, the threshold at 10,000 MHz might be as much as 5,200 mW/cm^2 (33,550 mW/in^2). Based upon these existing test data, the susceptibility threshold for interference from the GBR-T EMR may be concluded to lie in the range of 13 to 5,200 mW/cm^2. Since the upper end of this range is significantly greater than the momentary power densities projected near the GBR-T at ground level, the likelihood of interference with pacemakers at the GBR-T site could be low. However, the lower end of this power density range is considerably less than the EMR levels that are expected to be occasionally present on the ground in the vicinity of the GBR-T. Herein lies the uncertainty with regard to potential impacts. As such, the lack of interference test data on pacemakers in the unique field characteristics produced by the GBR-T do not allow definitive assessments of the likelihood of adverse impact on pacemakers from the GBR-T operation. Therefore, it is concluded that adverse impact on pacemakers is possible and this possibility could be significant for some individuals.

Appropriate administrative measures are deemed suitable for mitigating potential impact to pacemaker wearers through the mechanism, for example, of an advisory notice contained in travel orders for personnel traveling to Kwajalein Island. The notice would be used to inform individuals who may wear cardiac pacemakers of the presence of high-intensity EMR fields near the GBR-T. Separately, a review of the present population would be made to ascertain those individuals presently resident at USAKA who use pacemakers and to inform them of the presence of high-intensity EMR fields upon initial operation of the GBR-T.

The GBR-T is near the Bucholz Army Airfield on Kwajalein Island, and EMR from the radar that might impact personnel and aircraft activities at the airport would be controlled. In addition to the potential hazard to personnel identified above, high-strength electromagnetic fields can detonate EEDs or induce malfunctions in avionics equipment on aircraft. Actions similar to those described above for mitigating personnel exposure would limit EMR power density at the airport, except that power-density criteria for human exposure and for EED safety would be applied. The limit for EEDs is currently an instantaneous power density of 10 mW/cm^2 (64 mW/in^2).

If aircraft in flight are illuminated at close range by the radar, malfunctions induced in avionics equipment or EED detonations are possible. Prior permission from the commander of USAKA is required to land at Bucholz and the airspace out to 333 km (180 nmi) is controlled by the tower or the FAA Air Route Traffic Control Center at Oakland, California, so aircraft without the knowledge and permission of an air traffic control authority are not permitted to fly within the controlled-airspace zone. Local flights are managed by the tower and USAKA flight operations. Because all GBR-T operations that involve EMR energy would be considered Kwajalein Missile Range operations, GBR-T EMR will be coordinated with other activities, including range safety and flight safety, through the range scheduling organization. The range schedule is therefore the probable vehicle for coordinating GBR-T EMR with flight operations to avoid illuminating aircraft at close range. In addition, communication procedures would be established with the tower and the range safety organization to inhibit EMR immediately, should an unplanned penetration of a hazard zone occur. Additional safety measures to be developed in cooperation with FAA and USAKA flight safety personnel would be designation of any aviation hazard areas needed, publication of Notices to Airmen, and briefings to local aviators about any safety procedures that may be needed regarding GBR-T.

One additional potential effect is the cumulative impacts of EMR exposure in the overlap areas of multiple EMR emitters (e.g., high-frequency communications systems and radars). The GBR-T unit is located in the vicinity of the majority of the RF emitters located on Kwajalein Island. The data contained in Table 2-10 are representative of the composite background of RF power densities produced when all existing RF emitters are operating at the same time and the emitters (radars) are pointed toward the measurement location. These data were obtained from an RF survey conducted at USAKA and are representative of the highest background RF power density levels. Measurement locations are indicated in the 1989 GBR EA (USASDC 1989a).

Of the measured sites shown in Table 2-10, the highest composite background RF power density measurement of 0.178 mW/cm^2 (1.1 mW/in^2) was obtained at location 1 and was less than 4 percent of the permissible exposure criterion of 5 mW/cm^2 (32.25 mW/in^2). Hence, even under a condition of maximum possible power density from the GBR-T, the composite power density at any given point, due to all transmitters operating simultaneously, would not exceed the applicable new IEEE exposure limit for humans.

Based on the foregoing discussion, potential impacts on public health and safety from GBR-T DEM/VAL activities are considered to be mitigable and nonsignificant.

3.2.3.9 Socioeconomics

Currently, the availability of housing on USAKA is limited. In addition, much of the existing stock of housing (both family and UPH units) does not meet the housing standards established by USAKA. Additional project activities slated for USAKA, which bring in additional personnel, would exacerbate the existing shortfall of adequate housing.

The GBR-T project would bring in additional operations personnel to USAKA over a four-year period starting at the end of FY93. Project personnel would come from the GBR Project Office as well as subcontractors. Peak staffing requirements would occur in the second quarter of FY95 and would include 51 full-time personnel (14 accompanied and 37 unaccompanied) and 9 transient workers (Table 3-2). This would translate into a peak demand for 14 family housing units, 37 UPH units, and 9 spaces in the transient personnel housing facilities. Demand would then taper off to about one-half the peak-year requirements by FY97. As discussed in the Draft Supplemental EIS for USAKA (USASSDC 1993), additional housing construction is being studied to support potential future ground and flight testing programs and other activities that may be located at Kwajalein Island. Current plans call for the construction of 188 UPH units at the site of Building 501 (demolishing 24 existing units for a net increase of 164 units), another 100 UPH units south of Building 602, and 90 family housing units off of Ocean Road (USASSDC 1993). The GBR-T program, in coordination with USAKA, would provide housing for the anticipated number of accompanied and UPH as reflected in the April 1993 Draft Kwajalein Missile Range GBR-T Siting Study (PEO GPALS 1993).

3.2.3.10 Water Quality

Any spills of lubricating materials, solvents, or other hazardous materials would be cleaned and disposed of following routine operation requirements in accordance with regulations. Since the project-related activities are in the fill area and not in areas of aquifer recharges, no significant impacts to water quality would occur (USASSDC 1993).

Table 3-2
Anticipated GBR housing requirements at USAKA

GBR Personnel	FY93 4*	FY94 1	FY94 2	FY94 3	FY94 4	FY95 1	FY95 2	FY95 3	FY95 4	FY96 1	FY96 2	FY96 3	FY96 4	FY97 1	FY97 2	FY97 3	FY97 4
Accompanied																	
Government	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Contractor	–	2	2	2	7	12	12	12	12	9	9	9	9	9	9	9	9
Subtotal	**1**	**3**	**3**	**4**	**9**	**14**	**14**	**14**	**14**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**
Unaccompanied																	
Government																	
Contractor					9	9	37	37	22	22	22	10	10	10	10	10	10
Subtotal					**9**	**9**	**37**	**37**	**22**	**22**	**22**	**10**	**10**	**10**	**10**	**10**	**10**
Transient																	
Government			1	3	3	3	3	3	3	4	4	4	4	4	4	4	4
Contractor	1	1	2	3	5	5	6	6	6	8	7	7	7	5	5	5	5
Subtotal	**1**	**1**	**3**	**6**	**8**	**8**	**9**	**9**	**9**	**12**	**11**	**11**	**11**	**9**	**9**	**9**	**9**
TOTAL	**2**	**4**	**6**	**10**	**26**	**31**	**60**	**60**	**45**	**45**	**44**	**32**	**32**	**30**	**30**	**30**	**30**

Source: PEO GPALS 1993

* Fiscal year by quarter

3.3 TMD-GBR AND GBR-T FTV

FTV of the GBR family of radars would include testing with actual targets. Potential environmental consequences of the targets has been considered in previous environmental documentation (USASDC 1989a, 1990, 1992b; USAF 1976).

3.4 CUMULATIVE IMPACTS

In accordance with CEQ regulations (40 CFR 1508.7), cumulative impacts also must be addressed. A cumulative impact is "... the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions..."

Range Command at WSMR has been notified of the TMD-GBR program. The TMD-GBR activities have been reviewed in conjunction with current and planned actions, and information regarding anticipated future projects, and no cumulative impacts were identified.

With respect to GBR-T activities at USAKA, the DEM/VAL testing was reviewed against existing environmental and planning documentation (USASDC 1989a; USASSDC 1993) on both current projects and anticipated future projects, and no significant cumulative impacts were identified as a result of that review. There would be cumulative impacts on housing and infrastructure caused by the projected population increase on Kwajalein Island due to GBR-T and other projects. However, building or providing dedicated housing for the GBR-T program would mitigate any cumulative effects to the potential housing shortage at USAKA.

Furthermore, control of the Kwajalein Island population is exercised by the USAKA Commander. Military and contractor personnel and their dependents are not given authorization to locate at USAKA unless approved housing is available.

There are existing sources of EMR at Kwajalein Island. When the antenna is operating, GBR-T would add to these existing electromagnetic fields. Potential cumulative impacts are addressed in the USAKA Draft Supplemental EIS (USASSDC 1993).

3.5 ENVIRONMENTAL CONSEQUENCES OF THE NO ACTION ALTERNATIVE

If the no action alternative is selected, no additional environmental consequences associated with the GBR family of radars DEM/VAL activities are anticipated. Present activities would continue at the installations with no change in operations. Under the no action alternative, sensor concept exploration activities would continue without progressing to the DEM/VAL stage. The no action alternative would preclude timely validation of GBR technology and would risk loss of important information required for future decisions regarding the GBR technology.

3.6 CONFLICTS WITH FEDERAL, REGIONAL, STATE, LOCAL, OR INDIAN TRIBE LAND USE PLANS, POLICIES, AND CONTROLS

All of the TMD-GBR DEM/VAL activities would be conducted at existing locations on WSMR and Fort Bliss that have been used previously for similar radar and/or defense operations. All of the proposed GBR-T DEM/VAL activities would take place at existing facilities with the exception of the remodel of Building 1500 at USAKA. However, Building 1500 may continue to be used as a warehouse once the GBR-T components are installed. Safety measures would be employed during testing of both the TMD-GBR and GBR-T to minimize the possibility of fire. Safety precautions would be enforced at all test sites to minimize risk of exposure to EMR. Overall, the proposed GBR family of radars DEM/VAL activities would present no conflicts with land use plans, policies, and controls.

3.7 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

Energy requirements of the TMD-GBR would be met by available commercial power and portable generators located on-site. Energy requirements would be subject to any established energy conservation practices at each installation. Anticipated energy requirements of the GBR-T would be provided by the power plants at USAKA.

3.8 NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS

Other than the various metallic and nonmetallic structural materials and fuel resources used in the proposed DEM/VAL activities, there are no significant natural or depletable resource requirements associated with the activities.

3.9 ADVERSE ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED

There are no known adverse environmental effects for any of the proposed DEM/VAL activities at any of the testing locations because appropriate mitigation measures are considered.

3.10 RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Activities at all locations involved in the proposed action would take advantage of existing facilities and infrastructure at WSMR/Fort Bliss and USAKA with the exception of the Building 1500 improvements at USAKA. However, Building 1500 originally was designed to accommodate large radar. These upgrades would not interfere with the use of the site as a warehouse. Furthermore, any construction activities near the perimeter of the building would be minimal and of short duration. Therefore, the proposed action does not eliminate any options for future use of the environment for any of the locations under consideration.

3.11 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

The proposed action would result in no loss of habitat for plants or animals, no loss or impact on threatened or endangered species, and no loss of cultural resources such as archaeological or historic sites. Moreover, there would be no changes in land use nor preclusion of development of underground mineral resources that were not already precluded. In addition, the GBR DEM/VAL program activities are not permanent but would be expected to end in about five years.

The amount of materials required for any program-related activities and energy used during the project would be small. Although the GBR DEM/VAL activities program would result in some irreversible and irretrievable commitment of resources, such as various metallic and nonmetallic structural materials, fuel, and labor, this commitment of resources is not significantly different from that necessary for many other radar and defense research and development programs. The proposed action is similar to the activities that have been carried out in previous aerospace programs over the past several years.

3.12 CONDITIONS NORMALLY REQUIRING AN EIS

The potential impacts arising from the proposed GBR DEM/VAL activities were evaluated specifically in the context of the criteria for actions normally requiring an EIS, described in Paragraph 6-2 of AR 200-2, *Environmental Effects of Army Actions*. The evaluation indicated that the proposed activities, as described in this EA, did not meet any of those criteria.

Specifically, the proposed GBR DEM/VAL activities were evaluated for their potential to:

- significantly affect environmental quality or public health or safety;
- significantly affect historic or archaeological resources, public parks and recreation areas, wildlife refuge or wilderness areas, wild and scenic rivers, or aquifers;
- adversely affect properties listed or meeting the criteria for listing on the National Register of Historic Places or the National Register of Natural Landmarks;
- significantly affect prime and unique farm lands, wetlands, or ecologically or culturally important areas or other areas of unique or critical environmental concern;
- result in significant and uncertain environmental effects or unique or unknown environmental risks;
- significantly affect a species or habitat listed or proposed for listing on the federal list of endangered or threatened species;
- establish a precedent for future actions;
- adversely interact with other actions so that cumulative environmental effects result; and
- involve the use, transportation, storage, and disposal of hazardous or toxic materials that may have significant environmental impact.

CHAPTER FOUR
SUMMARY OF CONCLUSIONS

chapter four

SUMMARY OF CONCLUSIONS

This chapter provides the results of the analyses of each environmental component presented in Chapter 3. These results or conclusions are briefly stated in Sections 4.1 and 4.2 and are summarized in separate tables.

4.1 TMD-GBR

The conclusions derived from the analyses of potential environmental impacts resulting from implementation of the TMD-GBR program at the alternative sites at WSMR and Fort Bliss Military Reservation are described according to individual environmental components. Appropriate mitigation measures are included for potentially significant but mitigable impacts. All potential significant impacts from the TMD-GBR program would be mitigated to a level of nonsignificance (Table 4-1).

4.1.1 Air Quality

Air quality impacts from fugitive dust from site preparation activities would be minimal due to the short duration of activities and because the dust primarily is composed of large particles that would settle close to the site. No adverse air quality impacts from the emissions of generators and transport vehicles are anticipated because commercial power would be used to the maximum extent possible. However, if generators are used, emissions would not exceed federal or state ambient air quality standards.

4.1.2 Biological Resources

Impacts to the Aplomado falcon (*Falco femoralis septentrionalis*), a federal endangered species, from the TMD-GBR EMR would not be significant because the falcon's foraging habitat is not in the area of the proposed test sites. Potential impacts to the Texas horned lizard and Baird's sparrow, a federal Category 2 species, are not significant because these species are not expected to use the highly disturbed areas immediately in front of the radar antenna at any of the test sites.

The effects of EMR are not expected to be significant for several reasons: the power density values of potential concern occur only within approximately 1 km (0.6 mi) as measured from the face of the antenna along any given radar main beam; the radar beam would normally be in

Table 4-1
Summary of conclusions for environmental consequences of the TMD-GBR demonstration and validation activities

Environmental Component	Potential Environmental Impacts That Are Not Significant	Environmental Impacts Potentially Significant but Mitigable	Mitigation Measures to Bring Potential Impact to Level of Nonsignificance	Potentially Significant Environmental Impacts That Are Not Mitigable
Air Quality	Not significant	—	—	—
Biological Resources				
• Aplomado falcon	Not significant	—	—	—
• Texas horned lizard	Not significant	—	—	—
• Baird's sparrow	Not significant	—	—	—
Cultural Resources	—	Digging and trenching for utility/communication lines and septic tanks	Preconstruction archaeological survey of selected sites, on-site monitoring during construction, and educational literature	—
Hazardous Materials/ Waste	—	Asbestos in Building 24068	Inspection and abatement program	—
Infrastructure	Not significant	—	—	—
Land Use	Not significant	—	—	—
Noise	Not significant	—	—	—

(table continues)

Table 4-1 (continued).

Environmental Component	Potential Environmental Impacts That Are Not Significant	Environmental Impacts Potentially Significant but Mitigable	Mitigation Measures to Bring Potential Impact to Level of Nonsignificance	Potentially Significant Environmental Impacts That Are Not Mitigable
Public Health and Safety	—	EMR potential hazard to personnel and airspace control	System designed to control power densities, operate main beam at 4 degrees above horizontal, warning fence designating EMR safety zone, warning lights, and coordination with White Sands Missile Range/Fort Bliss airspace control	—
Socioeconomics	Not significant	—	—	—
Water Quality	Not significant	—	—	—

motion and not concentrated in one spot for a long time; the size of the beam is rather small close to the antenna where EMR values would be the greatest; and the potential for a bird to perch on the pole at LC 39 would be eliminated by removal of the pole.

4.1.3 Cultural Resources

Cultural resource sites have not been identified or recorded at the test locations. Potentially significant but mitigable impacts could result from the trenching and digging required for the installation of additional power and communication lines and septic facilities. Preconstruction archaeological surveying and testing of selected sites and on-site monitoring during construction are sufficient measures to mitigate the impacts to a level of nonsignificance.

4.1.4 Hazardous Materials/Waste

Potential impacts from hazardous materials and waste used and generated by the TMD-GBR program are not significant due to compliance with appropriate installation guidelines.

The asbestos in Building 24068 is a potentially significant but mitigable impact because an asbestos abatement program would be implemented, as appropriate, in compliance with federal guidelines.

4.1.5 Infrastructure

Impacts to WSMR/Fort Bliss infrastructure would not be significant because program-related activities would be conducted in existing facilities and mobile trailers. A portable latrine and a septic system would be provided. Power demands would be met by commercial power and portable generators.

4.1.6 Land Use

Changes to the current land uses at WSMR or Fort Bliss would not be significant because the proposed activities would not alter land use patterns.

4.1.7 Noise

No significant noise impacts from the generators are expected because they would be fitted with noise shields. Due to the short duration of the proposed activities, no other noise impacts are anticipated.

4.1.8 Public Health and Safety

Potentially significant but mitigable impacts to program-related personnel and aircraft resulting from EMR would be brought to a level of nonsignificance based upon an extensive mitigation program that includes numerous safety measures such as operation of the main beam at least 4 degrees above horizontal, computer safety controls, identified safety zones, and TMD-GBR coordination with range air control.

4.1.9 Socioeconomics

No significant socioeconomic impacts to the region are anticipated due to the limited number of personnel required and the limited duration of stay (approximately three years).

4.1.10 Water Quality

No significant impacts to water quality are anticipated. Runoff should be minimal due to the limited amount of rainfall. Wastes would be disposed of in portable latrines and septic tanks, proper permits would be obtained, water would be trucked to the sites, and accidental discharges of hazardous and nonhazardous waste would be remediated immediately.

4.2 GBR-T

The conclusions of the analyses of potential environmental impacts from the GBR-T program proposed for Kwajalein Island at USAKA are described for each environmental component. Appropriate mitigation measures are included for potentially significant but mitigable impacts. All potential significant impacts from the GBR-T program would be mitigated to a level of nonsignificance (Table 4-2).

4.2.1 Air Quality

GBR-T would use existing power at Kwajalein Island. Emissions from the power plants at Kwajalein Island, in connection with the GBR-T test activities, have been considered in the Draft Supplemental EIS for USAKA (USASSDC 1993). Minimal fugitive dust or construction equipment emissions are anticipated. No significant impacts to air quality are anticipated.

Although the use of the refrigerant R-22 to cool Building 1500 would be eliminated by the year 2020 pursuant to the Clean Air Act (Appendix B), the DEM/VAL phase of GBR-T is anticipated to be conducted from 1993 to 1997, which is within the time frame that would permit the use of R-22.

4.2.2 Biological Resources

There would be no significant impacts to birds or other wildlife from EMR because the probability of birds entering and remaining within the potentially hazardous region of the GBR-T transmitted beam is extremely low.

4.2.3 Cultural Resources

Potentially significant impacts to cultural resources may occur as a result of construction activities associated with the installation of additional utility, communication, and sewage lines; the building of two new masonry structures for fire protection and transformers; and the placement of EMR sensors around Kwajalein Island. These potential impacts would be mitigated to a level of nonsignificance by the implementation of a mitigation program. Mitigation measures would include preconstruction surveying and testing, avoidance of the original area of Kwajalein Island by limiting construction activities to the fill area, and on-site archaeological monitoring during the construction phase. The mitigation program would be coordinated in consultation with the HPO of the RMI and the ACHP.

4.2.4 Hazardous Materials/Waste

No significant impacts from hazardous materials and waste are anticipated from the GBR-T program. Petroleum products would be handled and disposed of properly.

Table 4-2
Summary of conclusions for environmental consequences of the GBR-T demonstration and validation activities

Environmental Component	Potential Environmental Impacts That Are Not Significant	Environmental Impacts Potentially Significant but Mitigable	Mitigation Measures to Bring Potential Impact to Level of Nonsignificance	Potentially Significant Environmental Impacts That Are Not Mitigable
Air Quality	Not significant	—	—	—
Biological Resources	Not significant	—	—	—
Cultural Resources	—	Digging and trenching for utility/communication lines, two new masonry buildings, and electromagnetic radiation (EMR) sensors	Preconstruction archeological sampling; on-site monitoring during construction; placement of utilities, in the fill area to the maximum extent possible; and avoidance of known sites	—
Hazardous Materials/ Waste	Not significant	—	—	—
Infrastructure	Not significant	—	—	—
Land Use	Not significant	—	—	—
Noise	Not significant	—	—	—
Public Health and Safety	—	EMR	Main beam of GBR-T operated at least 2 degrees above horizontal or at a reduced duty cycle	—

(table continues)

Table 4-2 (continued).

Environmental Component	Potential Environmental Impacts That Are Not Significant	Environmental Impacts Potentially Significant but Mitigable	Mitigation Measures to Bring Potential Impact to Level of Nonsignificance	Potentially Significant Environmental Impacts That Are Not Mitigable
Socioeconomics	—	Limited available housing	Reserve housing for GBR-T personnel	—
Water Quality	—	—	—	—

4.2.5 Infrastructure

No significant impacts to Kwajalein Island infrastructure are expected as a result of the GBR-T test activities because existing power and other utilities have adequate capacity to accommodate the program. However, installation of additional utility and sewage lines to connect Building 1500 to the existing system would be required.

4.2.6 Land Use

Existing building height limitations associated with the use of the Air Navigation Criterion have no effect on GBR-T because Building 1500 is outside the height limitation envelope (Army Technical Bulletin TBS-803-4). Operation of the GBR-T would not impact any known plans to construct buildings on Kwajalein Island. Therefore, no significant impacts to land use are anticipated.

4.2.7 Noise

Noise from construction activities associated with the installation of GBR-T at Building 1500 would not create significant impacts because activities would be of a short duration and the majority of construction would occur inside Building 1500. Any noise from computers and electrical equipment for the operation of GBR-T would be minimized with appropriate soundproofing material and would be restricted to the area within Building 1500.

4.2.8 Public Health and Safety

Potential significant health and safety impacts from GBR-T EMR would be mitigated to a level of nonsignificance with implementation of a comprehensive mitigation program. This program includes numerous elements such as system design to control power densities, operation of the main beam at least 2 degrees above horizontal, EMR sensors on Kwajalein Island, coordination and notification with air traffic control, notification with air traffic control, appropriate administrative notices to personnel traveling to Kwajalein Island to inform people with cardiac pacemakers of the presence of high-intensity EMR fields near the GBR-T, and continued studies by ECAC.

4.2.9 Socioeconomics

Potentially significant impacts to existing housing at Kwajalein Island would be mitigated to a level of nonsignificance by construction of the currently proposed additional housing at USAKA (USASSDC 1993) and reservation of a portion of these units to house GBR-T personnel and contractors.

4.2.10 Water Quality

No significant water quality impacts from GBR-T are anticipated because project activities would be conducted in compliance with all existing regulations.

CHAPTER FIVE
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REFERENCES

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CHAPTER SIX
AGENCIES CONTACTED

AGENCIES CONTACTED

U.S. Department of the Interior

U.S. Fish and Wildlife Service
Pacific Islands Office
P.O. Box 50167
Honolulu, HI 96850

U.S. Fish and Wildlife Services
3530 Pan American Highway NE, Suite D
Albuquerque, NM 87107

Other Federal Agencies

U.S. Army White Sands Missile Range
STEWS-ES-E
Attn: Mr. Bob Andreoli
Building T150
White Sands, NM 88002-5048

U.S. Army Fort Bliss
Attn: Mr. Von Finger
1105 West Forest Road
Fort Bliss, TX 79916-0058

Advisory Council on Historic Preservation
Western Office of Project Review
Attn: Ms. Claudia Nissley, Director
730 Simms Street, Room 401
Golden, CO 80401

Federal Aviation Administration
Los Angeles Aircraft Certification Office
Attn: Mr. Harry Wasinger
3229 East Spring Street
Long Beach, CA 90806-2425

Federal Aviation Administration
Seattle Aircraft Certification Office
Advanced Avionics/Electrical
Attn: Mr. James J. Treacy
National Resource Specialist
ANM-103N
1601 Lind Avenue, S.W.
Renton, WA 98055-4056

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
2570 Dole Street
Honolulu, HI 96822-2396

State Agencies

New Mexico State Historic Preservation Officer
Office of Cultural Affairs
Historic Preservation Division
Villa Rivera Building
228 East Palace Avenue
Santa Fe, NM 87503

Dr. Richard Spellenberg
New Mexico State University
Herbarium
Las Cruces, NM 88003

New Mexico Department of Energy,
Minerals, and Natural Resources
Forestry and Resources Conservation
Division
P.O. Box 1948
Santa Fe, NM 87504-1948

State of New Mexico
Office of Cultural Affairs
Historical Preservation Division
Villa Rivera Building
228 East Palace Ave.
Santa Fe, NM 87503

Republic of the Marshall Islands

Republic of the Marshall Islands
Historic Preservation Office
Interior and Outer Island Affairs
Attn: Ms. Carmen Bigler
P.O. Box 18
Majuro, RMI 96960

DEPARTMENT OF THE ARMY
U.S. ARMY SPACE AND STRATEGIC DEFENSE COMMAND
POST OFFICE BOX 1500
HUNTSVILLE, ALABAMA 35807-3801

REPLY TO
ATTENTION OF

April 14, 1993

Environmental and
Engineering Office

Ms. Jennifer Fowler-Propst
Field Supervisor, Division of
Ecological Services
U.S. Fish and Wildlife Service
3530 Pan American Highway, Suite D
Albuquerque, New Mexico 87107

Dear Ms. Fowler-Propst:

In compliance with the National Environmental Policy Act (NEPA) and the Council on Environmental Quality regulations implementing NEPA, an Environmental Assessment (EA) is being prepared for the U.S. Army Program Executive Office, Global Protection Against Limited Strikes, for Ground Based Radar. A summary of the project description and activities proposed for White Sands Missile Range (WSMR) and Fort Bliss, including maps, is provided at enclosure 1.

The White Sands Missile Range (WSMR) and Fort Bliss are known to provide habitat for endangered/threatened species. The WSMR environmental office has provided us with a preliminary compliance species list. The available habitats at the alternative sites (enclosure 2) were compared with the habitat requirements of potential sensitive species from the species list.

The species listed at enclosure 3 are being addressed in the EA, and preliminary analyses indicate no adverse impacts would occur from the proposed activities. We would appreciate your concurrence with this determination. If you believe that additional species should be addressed, please provide an informal Endangered Species Act, Section 7, compliance list from your office within thirty days, fifteen days if possible, of the date of this letter.

We are prepared to meet with you, if you desire, to further explain the program and our preliminary analysis of potential impacts. If you have any questions regarding this matter, please contact Mr. Kenneth R. Sims of my staff at (205) 955-5075 or Mr. Bob Andreoli, WSMR Environmental Office, (505) 678-2224.

Sincerely,

Robert F. Shearer
Chief, Environmental
and Engineering Office

Enclosures

Copies Furnished:

Commander, U.S. Army White Sands Missile Range, Attention: STEWS-ES-E (Mr. Andreoli), Building T150, White Sands, New Mexico 88002-5048
Commander, Fort Bliss, Attention: ATZC-DOE (Mr. Von Finger), 1105 West Forest Road, Fort Bliss, Texas 79916-0058

SUMMARY OF
THEATER MISSILE DEFENSE-GROUND BASED RADAR PROGRAM AND
POTENTIAL IMPACTS TO ENDANGERED AND
THREATENED PLANTS AND ANIMALS,
WHITE SANDS MISSILE RANGE AND FORT BLISS WITHIN NEW MEXICO

The Theater Missile Defense (TMD) program is one aspect of the Department of Defense (DOD) Missile Defense Program. A requirement of the TMD program is the development of an improved sensor design to support interceptor missile technologies. A Ground Based Radar (GBR) system, designated as TMD-GBR, has been selected for further development and evaluation to determine if the radar can function as required.

The TMD-GBR would consist of a truck/trailer and military cargo-aircraft transportable, X-band, single-faced, phased-array radar system. The components of the system would be housed in vehicle or trailer-mounted shelters or can be mounted on specially configured flatbed trailers. The shelters provide environmental protection for the system components and personnel. The TMD-GBR system would be composed of five main subsystems or units that include an antenna equipment unit, an electronic equipment unit, an operator's console unit, a cooling equipment unit, and a prime power unit.

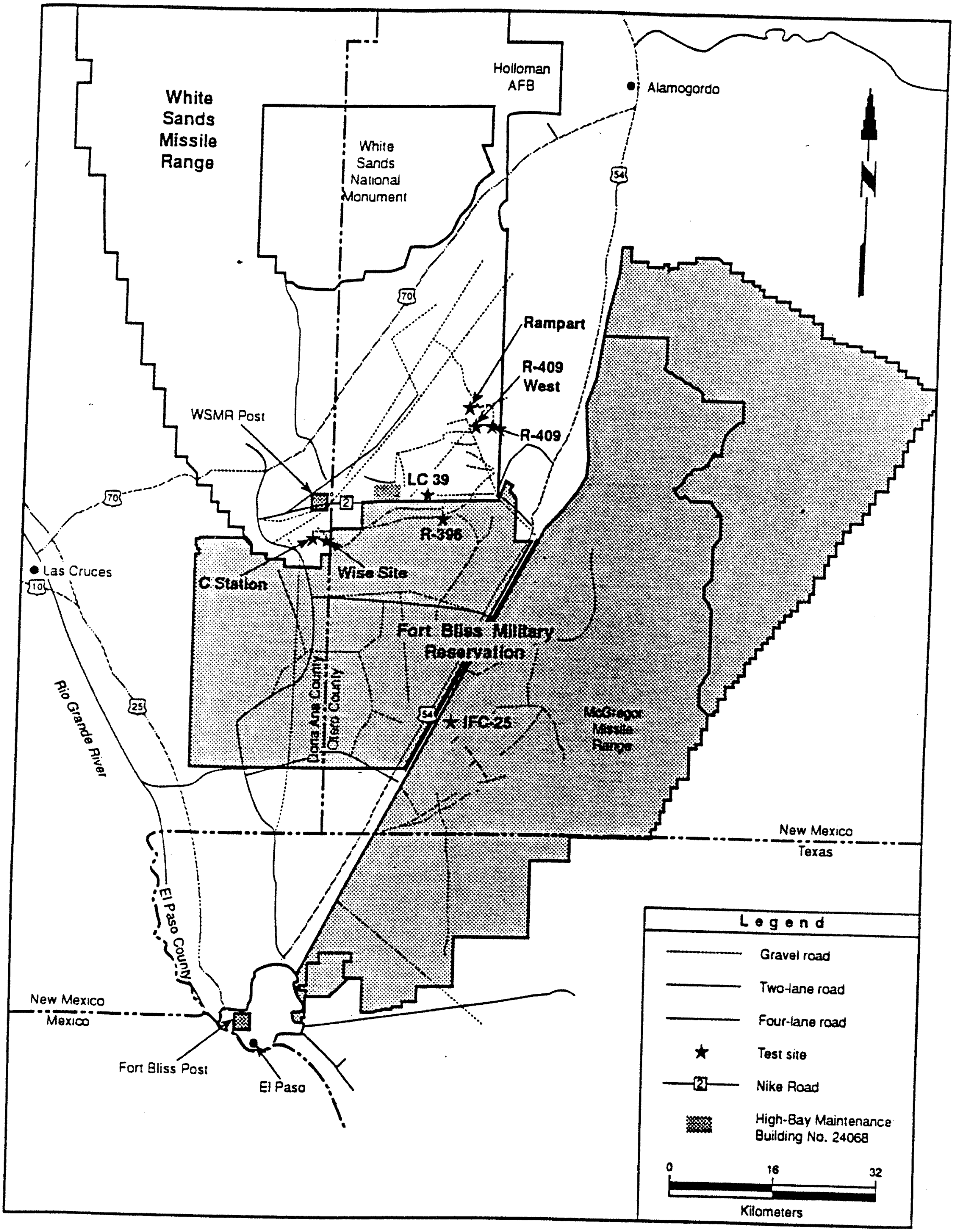
The TMD-GBR program has entered into the demonstration and validation (DEM/VAL) phase of the DOD System Acquisition Process. The TMD-GBR DEM/VAL proposed action includes various manufacturing and testing activities. The system would be designed, fabricated, integrated, and initially tested by the Raytheon Company Equipment Division at various company facilities in Massachusetts and New Hampshire. System testing would take place at White Sands Missile Range (WSMR) in New Mexico, and at test sites located on the Fort Bliss Military Reservation, McGregor Range, New Mexico. All test sites are situated within the state of New Mexico. It is planned that testing activities at WSMR/Fort Bliss would start approximately in January 1995 and continue for about 18 months.

Of the eight alternative sites (attachment 1 to enclosure 1) being considered, three are proposed for DEM/VAL testing activities at WSMR/Fort Bliss (attachment 2 to enclosure 1). All of the proposed sites consist primarily of previously disturbed areas. Site preparation activities would consist of clearing, leveling, compacting, and graveling. Electric power and communications lines and a septic system would be required. These facilities would be located to the extent possible along existing road or utility rights-of-way and in previously disturbed areas within the selected sites.

Enclosure 1

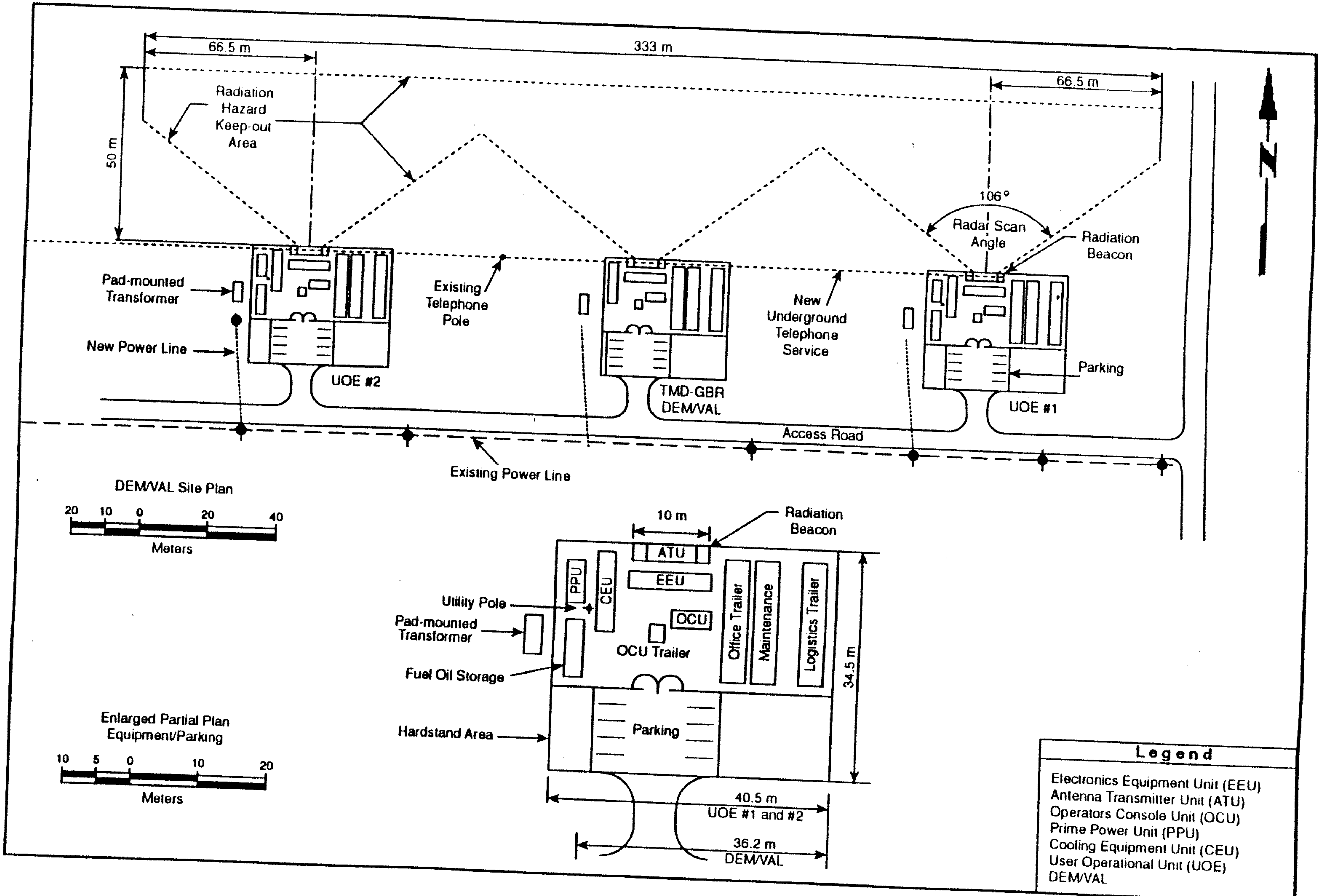
Reconnaissance walk-overs (100 percent coverage) of the alternative sites have not discovered the presence of any threatened or endangered plant species in these areas. In addition, no impacts to threatened and endangered wildlife species are anticipated due to a lack of suitable habitat. Also, the operational characteristics of the radar are such that the main beam would not normally go below two degrees to the ground. This would further prevent the possibility of adverse impacts from electromagnetic radiation (EMR).

Analysis and evaluation of the EMR environment generated by the radar indicates that it would be controlled within the applicable American National Standard Institute health and human safety standard of five milliwatts per square centimeter over a six-minute period. As an additional safety measure, a 100-meter hazard zone would be delineated in front of the antenna for human health and safety. This zone would be fenced and marked with appropriate warning signs. The hazard area for animals, especially perching birds, is estimated to be less than 15 meters. This distance was determined giving consideration to the metabolic rate of birds and other animals, their size and locomotion characteristics, and the probability of an animal entering and staying in the main radar beam or a side lobe for extended periods. Since the 15-meter distance consists of previously disturbed areas with little or no vegetation, the projected impact to wildlife from EMR is expected to be nonsignificant.



Expanded view of proposed TMD-GBR test sites at WSMR/Fort Bliss

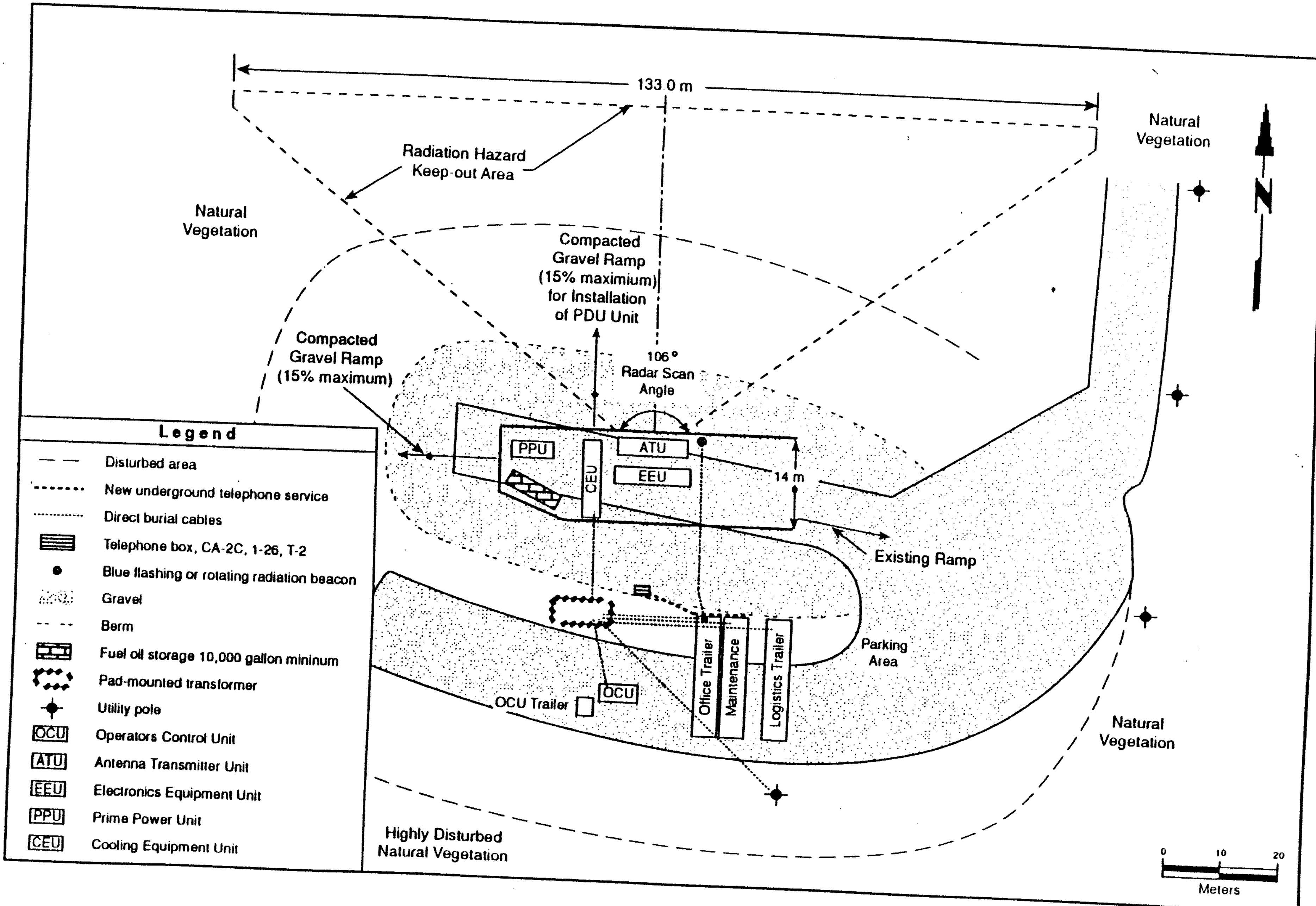
Attachment 1



Layout of TMD-GBR system at preferred site LC 39

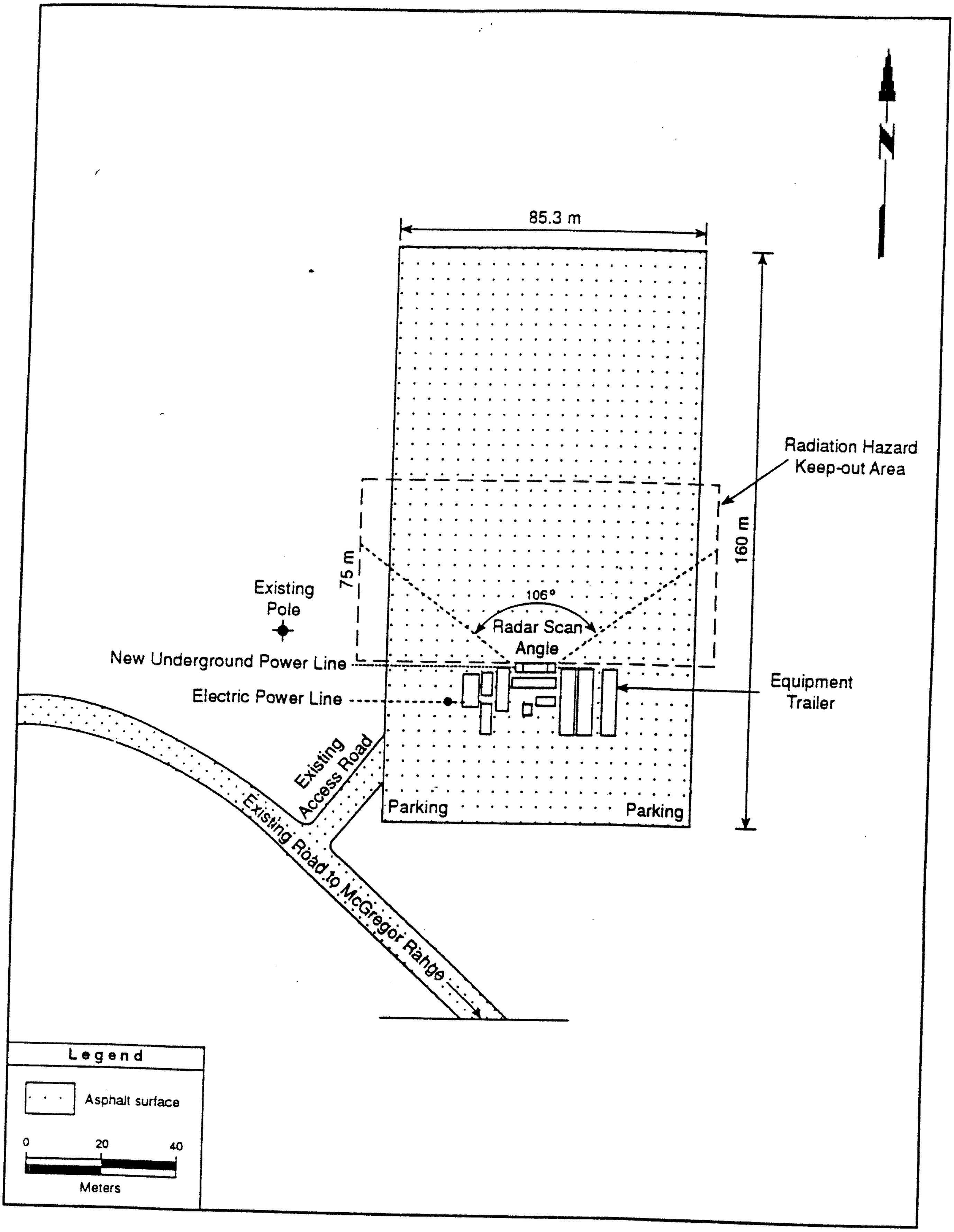
(All three radars initially tested at one location.
Only one radar would operate at a time.)

Attachment 2



User operational equipment located at R-396

(Relocated from LC-39)



User operational equipment located at IFC-25

(Relocated from LC-39)

RECONNAISSANCE AREA VERSUS MAXIMUM CONSTRUCTION AREA
EIGHT ALTERNATIVE SITES, GBR-TMD

ALTERNATIVE SITES	LOCATION	AREA MAX. CONST.	RECONNAISSANCE HABITAT	RECONNAISSANCE AREA
LC-39 *	WSMR	6 AC.	6 AC. CLEARED W/LARGE MOUND. MESQUITE DUNE W/SNAKEWEED.	15 AC.
R-409	WSMR	6 AC.	4 AC. CLEARED W/FOUR MOUNDS. CREOSOTE W/SNAKEWEED.	8 AC.
R-409 WEST	WSMR	2 AC.	3 AC. CLEARED. SNAKEWEED.	3 AC.
RAMPART	WSMR	2 AC.	2 AC. CLEARED. MESQUITE DUNE W/SNAKEWEED.	3 AC.
C STATION	WSMR	2 AC.	2 AC. CLEARED. PARKING LOT.	3 AC.
R-396 *	FT. BLISS	2 AC.	2 AC. CLEARED W/LARGE MOUND. MESQUITE DUNE.	3 AC.
WISE SITE (EAST OF C STATION)	FT. BLISS	2 AC.	2 AC. CLEARED W/LARGE MOUND.	3 AC.
IFC-25 *	FT. BLISS	2 AC.	2 AC. CLEARED & PAVED OVER.	3 AC.

* PROPOSED DEMONSTRATION/VALIDATION SITES.

Enclosure 2

PROPOSED SPECIES OF CONCERN
FOR THEATER MISSILE DEFENSE-GROUND BASED RADAR
DEMONSTRATION AND VALIDATION PROGRAM AT
WHITE SANDS MISSILE RANGE AND FORT BLISS IN NEW MEXICO

Taxonomic Name	Common Name
Falco femoralis septentrionalis	Aplomado falcon
Ammodramus bairdii	Baird's sparrow
Phrynosoma cornutum	Texas horned lizard

DEPARTMENT OF THE ARMY
U.S. ARMY SPACE AND STRATEGIC DEFENSE COMMAND
POST OFFICE BOX 1500
HUNTSVILLE, ALABAMA 35807-3801

REPLY TO
ATTENTION OF

April 15, 1993

Environmental and
Engineering Office

Mr. Bill Montoya, Director
New Mexico Department Game and Fish
Villagra Building
P.O. Box 25112
Santa Fe, New Mexico 87504

Dear Mr. Montoya:

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Sincerely,

ORIGINAL SIGNED BY

Robert F. Shearer
Chief, Environmental
and Engineering Office

Enclosures

Copies Furnished:

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Commander, Fort Bliss, Attention: ATZC-DOE (Mr. Von Finger), 1105 West Forest Road, Fort Bliss, Texas 79916-0058

SUMMARY OF
THEATER MISSILE DEFENSE-GROUND BASED RADAR PROGRAM AND POTENTIAL IMPACTS TO ENDANGERED AND THREATENED PLANTS AND ANIMALS, WHITE SANDS MISSILE RANGE AND FORT BLISS WITHIN NEW MEXICO

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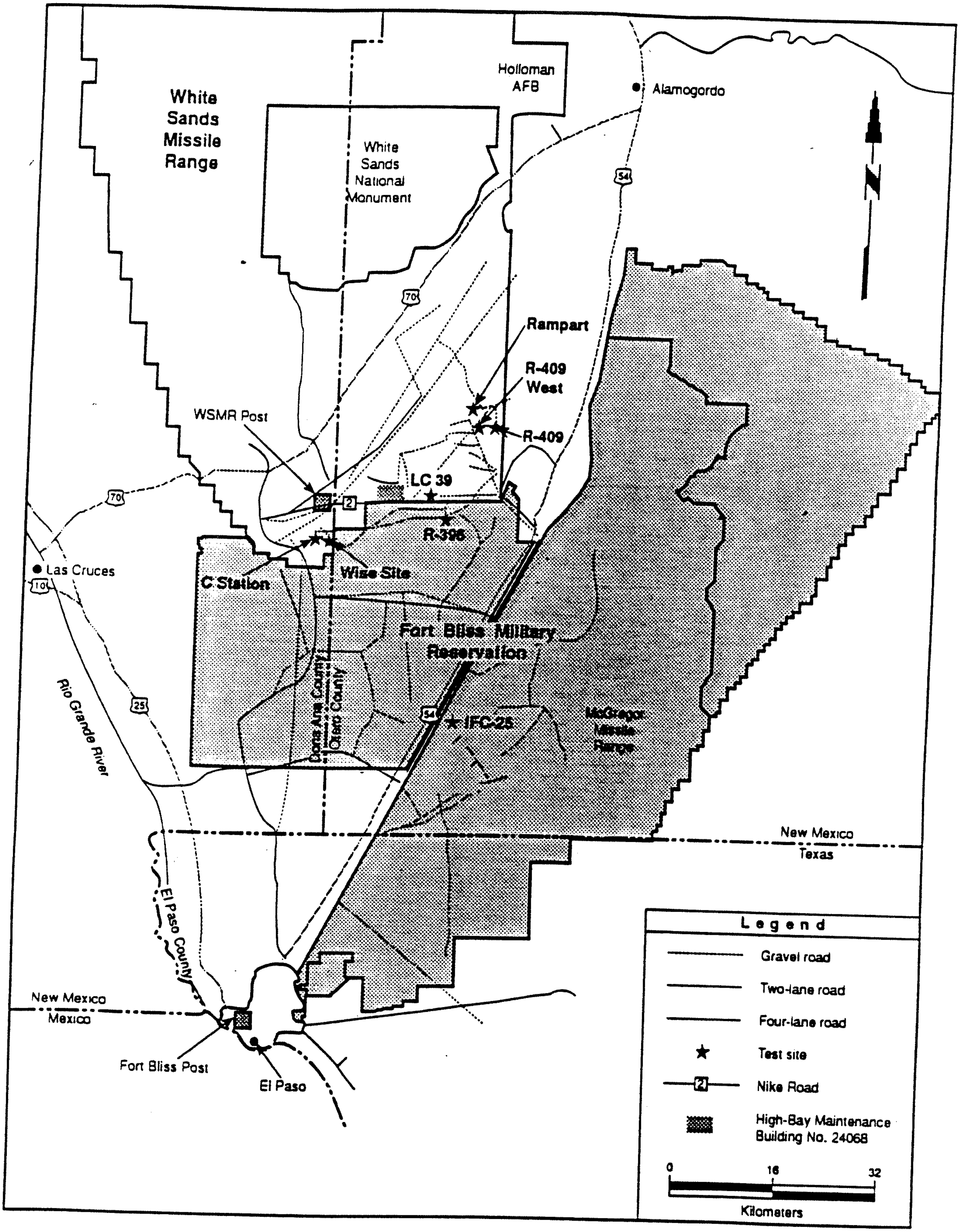
Encl. 1

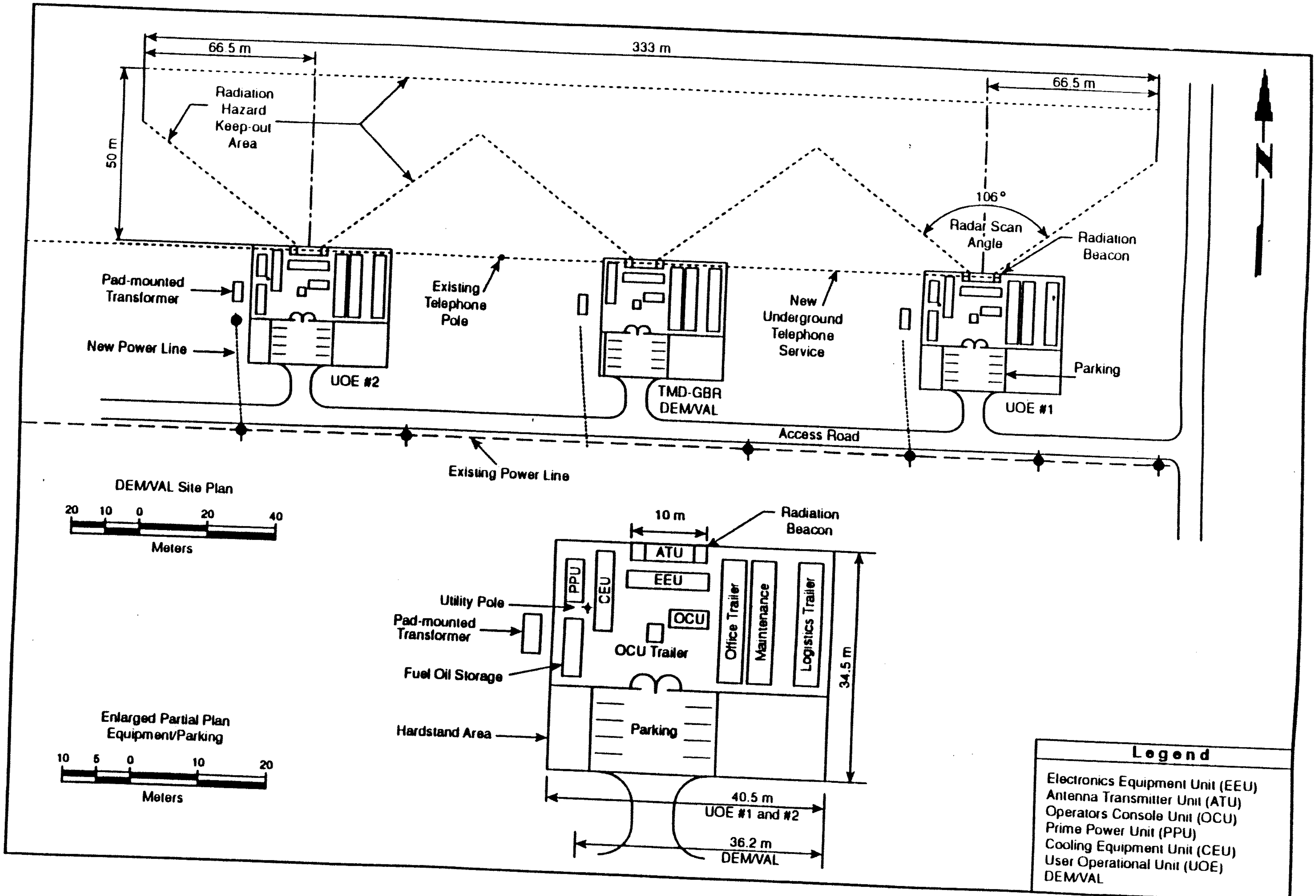
Reconnaissance walk-overs (100 percent coverage) of the alternative sites have not discovered the presence of any threatened or endangered plant species in these areas. In addition, no impacts to threatened and endangered wildlife species are anticipated due to a lack of suitable habitat. Also, the operational characteristics of the radar are such that the main beam would not normally go below two degrees to the ground. This would further prevent the possibility of adverse impacts from electromagnetic radiation (EMR).

Analysis and evaluation of the EMR environment generated by the radar indicates that it would be controlled within the applicable American National Standard Institute health and human safety standard of five milliwatts per square centimeter over a six-minute period. As an additional safety measure, a 100-meter hazard zone would be delineated in front of the antenna for human health and safety. This zone would be fenced and marked with appropriate warning signs. The hazard area for animals, especially perching birds, is estimated to be less than 15 meters. This distance was determined giving consideration to the metabolic rate of birds and other animals, their size and locomotion characteristics, and the probability of an animal entering and staying in the main radar beam or a side lobe for extended periods. Since the 15-meter distance consists of previously disturbed areas with little or no vegetation, the projected impact to wildlife from EMR is expected to be nonsignificant.



Expanded view of proposed TMD-GBR test sites at WSMR/Fort Bliss

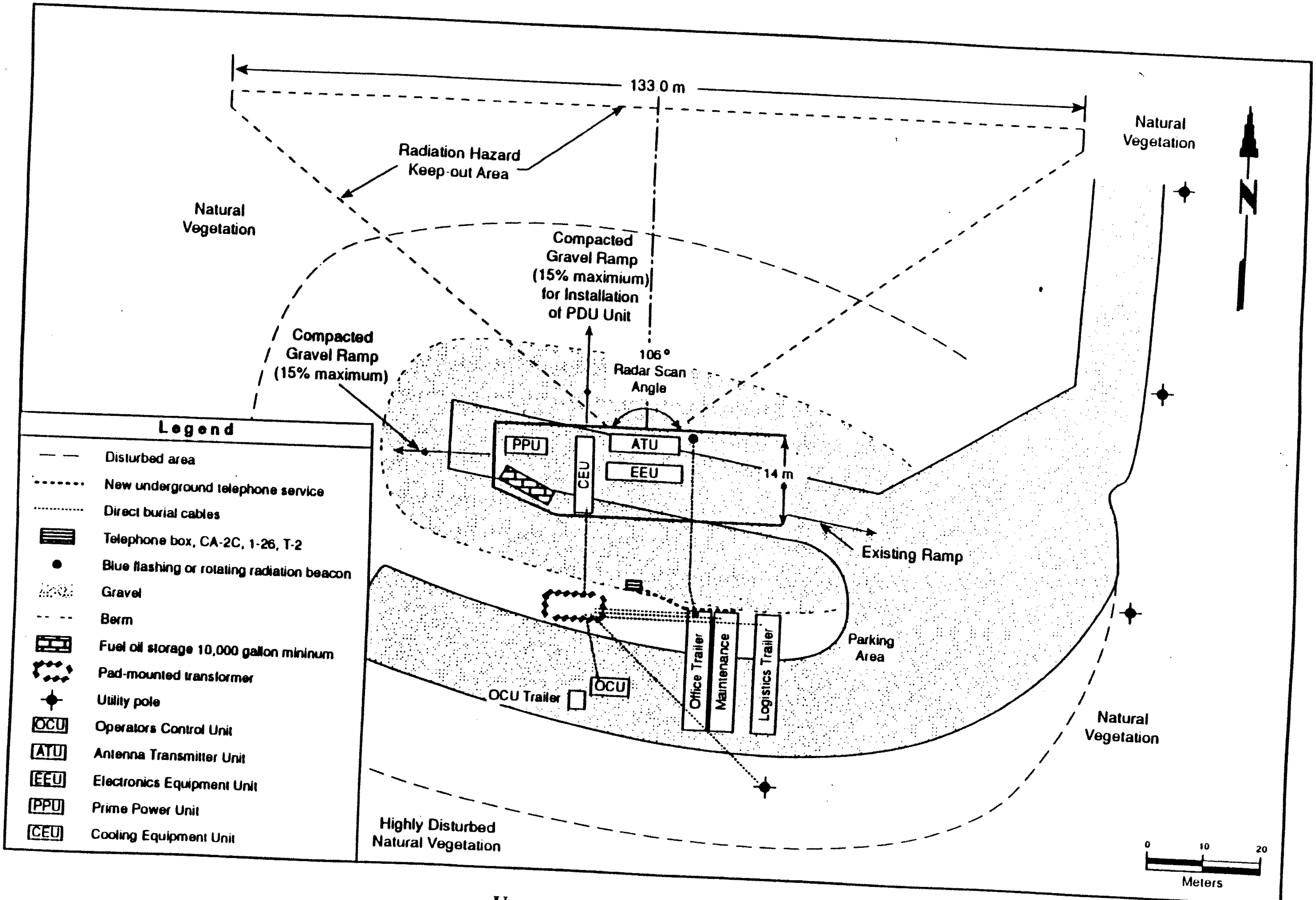
Attachment 1



Layout of TMD-GBR system at preferred site LC 39

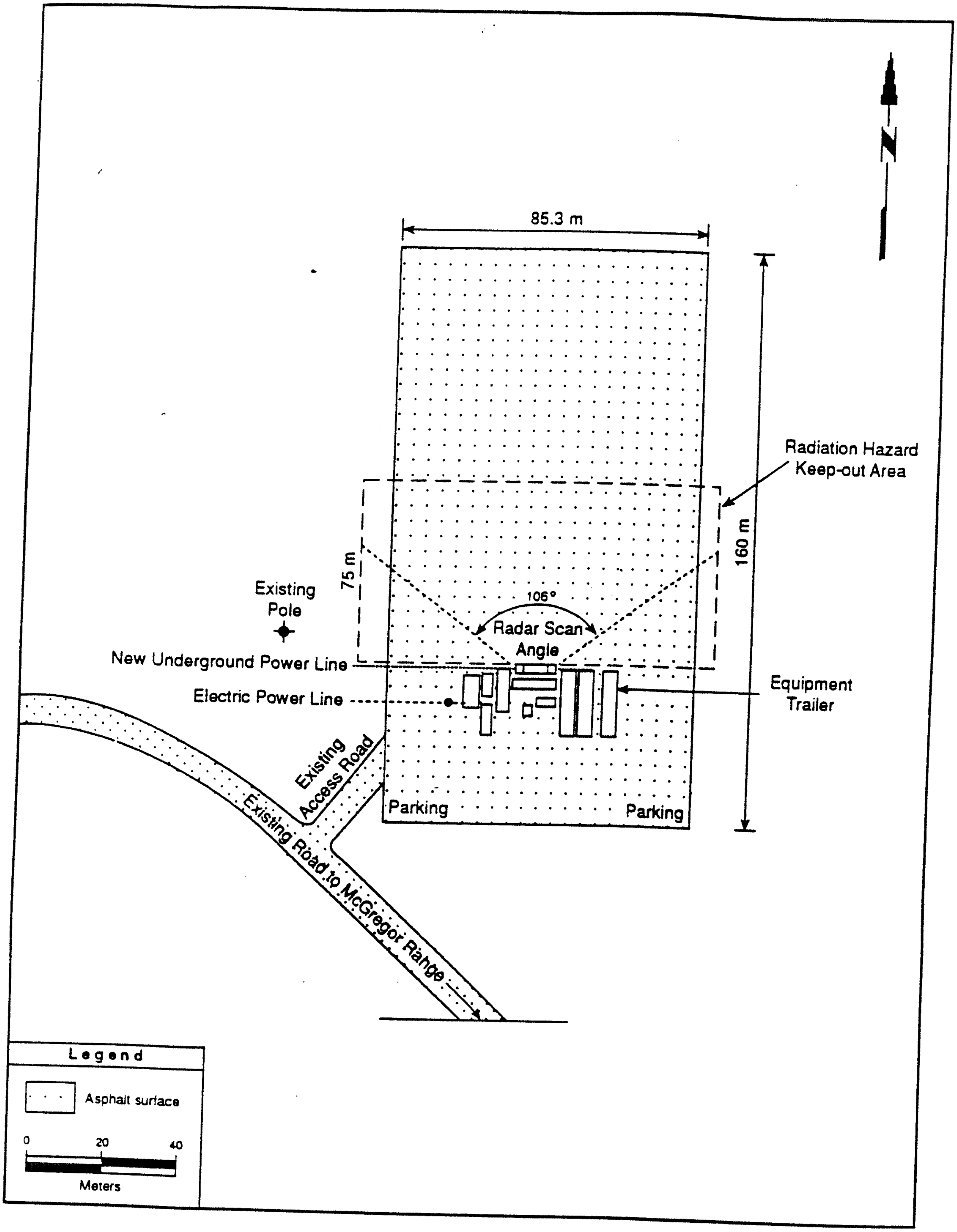
(All three radars initially tested at one location. Only one radar would operate at a time.)

Attachment 2



User operational equipment located at R-396

(Relocated from LC-39)



User operational equipment located at IFC-25

(Relocated from LC-39)

RECONNAISSANCE AREA VERSUS MAXIMUM CONSTRUCTION AREA
EIGHT ALTERNATIVE SITES, GBR-TMD

ALTERNATIVE SITES	LOCATION	AREA MAX. CONST.	RECONNAISSANCE HABITAT	AREA
LC-39 *	WSMR	6 AC.	6 AC. CLEARED W/LARGE MOUND. MESQUITE DUNE W/SNAKEWEED.	15 AC.
R-409	WSMR	6 AC.	4 AC. CLEARED W/FOUR MOUNDS. CREOSOTE W/SNAKEWEED.	8 AC.
R-409 WEST	WSMR	2 AC.	3 AC. CLEARED. SNAKEWEED.	3 AC.
RAMPART	WSMR	2 AC.	2 AC. CLEARED. MESQUITE DUNE W/SNAKEWEED.	3 AC.
C STATION	WSMR	2 AC.	2 AC. CLEARED. PARKING LOT.	3 AC.
R-396 *	FT. BLISS	2 AC.	2 AC. CLEARED W/LARGE MOUND. MESQUITE DUNE.	3 AC.
WISE SITE (EAST OF C STATION)	FT. BLISS	2 AC.	2 AC. CLEARED W/LARGE MOUND.	3 AC.
IFC-25 *	FT. BLISS	2 AC.	2 AC. CLEARED & PAVED OVER.	3 AC.

* PROPOSED DEMONSTRATION/VALIDATION SITES.

Enclosure 2

PROPOSED SPECIES OF CONCERN
FOR THEATER MISSILE DEFENSE-GROUND BASED RADAR
DEMONSTRATION AND VALIDATION PROGRAM AT
WHITE SANDS MISSILE RANGE AND FORT BLISS IN NEW MEXICO

Taxonomic Name	Common Name
Falco femoralis septentrionalis	Aplomado falcon
Ammodramus bairdii	Baird's sparrow
Phrynosoma cornutum	Texas horned lizard

DEPARTMENT OF THE ARMY
U.S. ARMY SPACE AND STRATEGIC DEFENSE COMMAND
POST OFFICE BOX 1500
HUNTSVILLE, ALABAMA 35807-3801

REPLY TO
ATTENTION OF

April 14, 1993

Environmental and
Engineering Office

Ms. Karen Lightfoot
New Mexico Department of Energy,
Minerals and Natural Resources
Forestry and Resources Conservation Division
P.O. Box 1948
Santa Fe, New Mexico 87504-1948

Dear Ms. Lightfoot:

In compliance with the National Environmental Policy Act (NEPA), and the Council on Environmental Quality regulations implementing NEPA, an Environmental Assessment (EA) is being prepared for the U.S. Army Program Executive Office, Global Protection Against Limited Strikes, for Ground Based Radar. A summary of the project description and activities proposed for White Sands Missile Range (WSMR) and Fort Bliss, including maps, is provided at enclosure 1.

The WSMR and Fort Bliss are known to provide habitat for endangered/threatened species. The WSMR environmental office has provided us with a preliminary compliance species list. The available habitats at the alternative sites (enclosure 2) were compared with the habitat requirements of potential sensitive species from the species list.

The species listed at enclosure 3 are being addressed in the EA, and preliminary analyses indicate no adverse impacts would occur from the proposed activities. We would appreciate your concurrence with this determination. If you believe that additional species should be addressed, please provide an informal Endangered Species Act, Section 7, compliance list from your office within thirty days, fifteen days if possible, of the date of this letter.

We are prepared to meet with you, if you desire, to further explain the program and our preliminary analysis of potential impacts. If you have any questions regarding this matter, please contact Mr. Kenneth R. Sims of my staff at (205) 955-5075 or Mr. Bob Andreoli, WSMR Environmental Office, (505) 678-2224.

Sincerely,

ORIGINAL SIGNED BY

Robert F. Shearer
Chief, Environmental
and Engineering Office

3 Enclosures

Copies Furnished:

Commander, U.S. Army White Sands Missile Range, Attention: STEWS-ES-E (Mr. Andreoli), Building T150, White Sands, New Mexico 88002-5048
Commander, Fort Bliss, Attention: ATZC-DOE (Mr. Von Finger), 1105 West Forest Road, Fort Bliss, Texas 79916-0058

SUMMARY OF
THEATER MISSILE DEFENSE-GROUND BASED RADAR PROGRAM AND
POTENTIAL IMPACTS TO ENDANGERED AND
THREATENED PLANTS AND ANIMALS,
WHITE SANDS MISSILE RANGE AND FORT BLISS WITHIN NEW MEXICO

The Theater Missile Defense (TMD) program is one aspect of the Department of Defense (DOD) Missile Defense Program. A requirement of the TMD program is the development of an improved sensor design to support interceptor missile technologies. A Ground Based Radar (GBR) system, designated as TMD-GBR, has been selected for further development and evaluation to determine if the radar can function as required.

The TMD-GBR would consist of a truck/trailer and military cargo-aircraft transportable, X-band, single-faced, phased-array radar system. The components of the system would be housed in vehicle or trailer-mounted shelters or can be mounted on specially configured flatbed trailers. The shelters provide environmental protection for the system components and personnel. The TMD-GBR system would be composed of five main subsystems or units that include an antenna equipment unit, an electronic equipment unit, an operator's console unit, a cooling equipment unit, and a prime power unit.

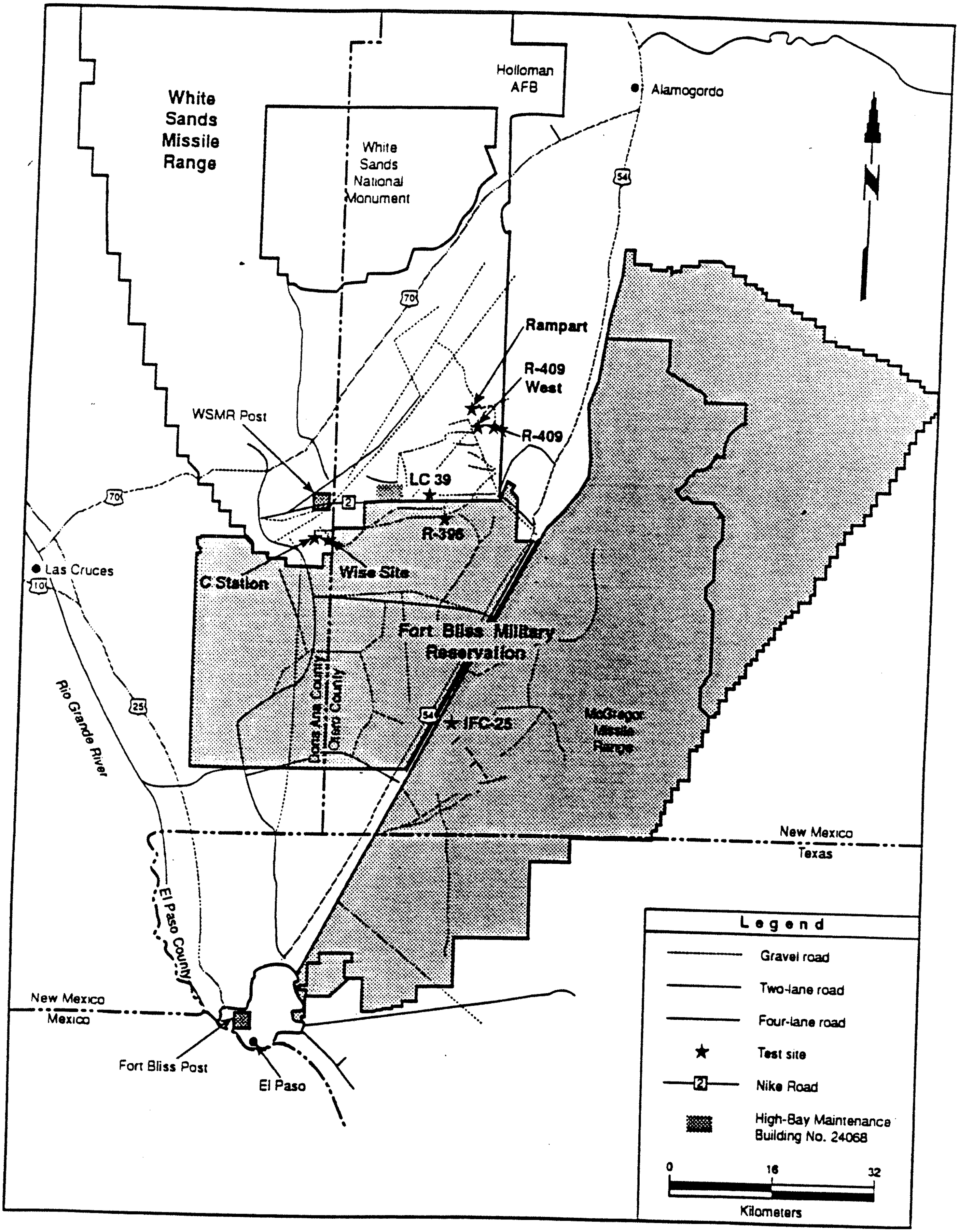
The TMD-GBR program has entered into the demonstration and validation (DEM/VAL) phase of the DOD System Acquisition Process. The TMD-GBR DEM/VAL proposed action includes various manufacturing and testing activities. The system would be designed, fabricated, integrated, and initially tested by the Raytheon Company Equipment Division at various company facilities in Massachusetts and New Hampshire. System testing would take place at White Sands Missile Range (WSMR) in New Mexico, and at test sites located on the Fort Bliss Military Reservation, McGregor Range, New Mexico. All test sites are situated within the state of New Mexico. It is planned that testing activities at WSMR/Fort Bliss would start approximately in January 1995 and continue for about 18 months.

Of the eight alternative sites (attachment 1 to enclosure 1) being considered, three are proposed for DEM/VAL testing activities at WSMR/Fort Bliss (attachment 2 to enclosure 1). All of the proposed sites consist primarily of previously disturbed areas. Site preparation activities would consist of clearing, leveling, compacting, and graveling. Electric power and communications lines and a septic system would be required. These facilities would be located to the extent possible along existing road or utility rights-of-way and in previously disturbed areas within the selected sites.

Enclosure 1

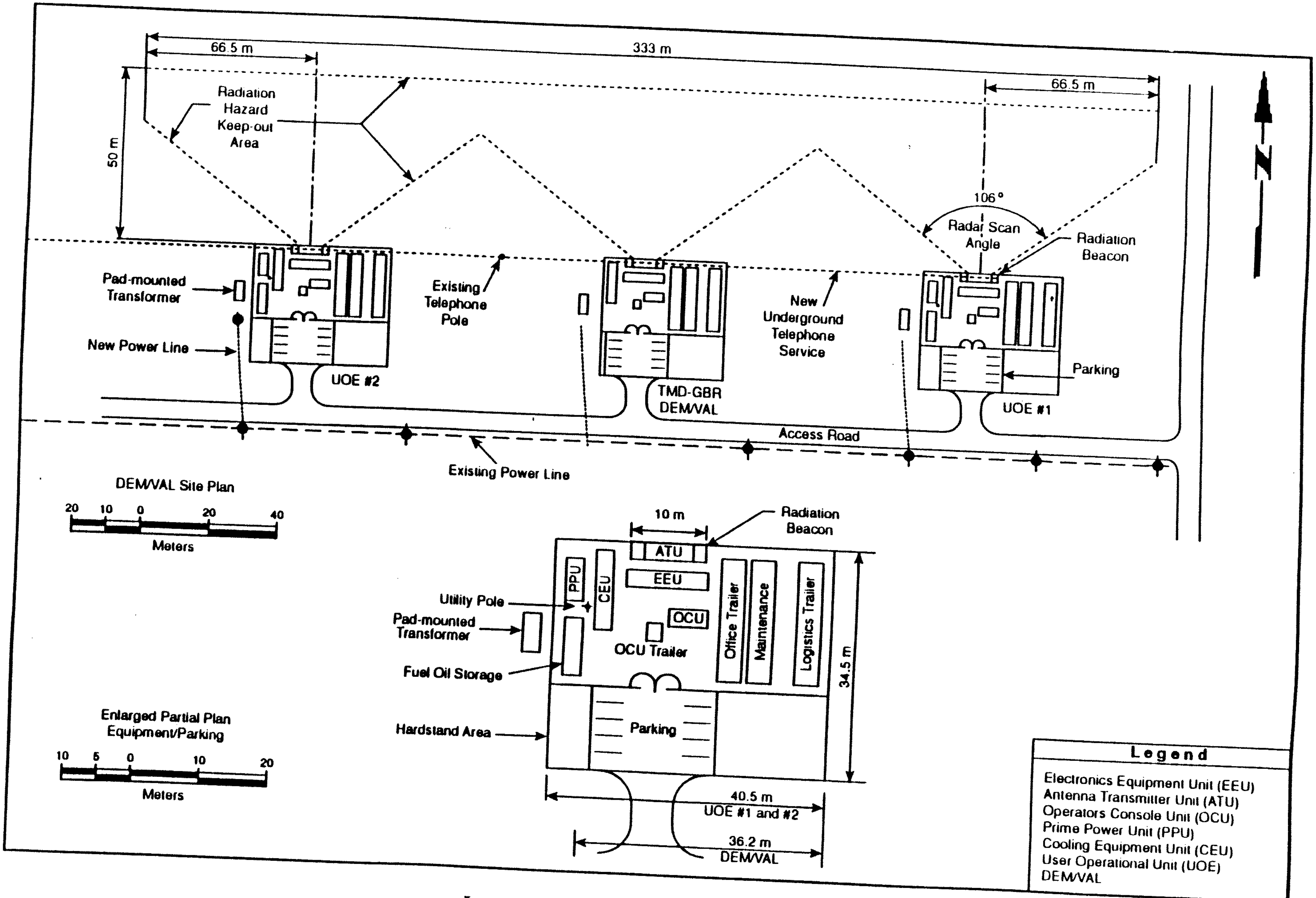
Reconnaissance walk-overs (100 percent coverage) of the alternative sites have not discovered the presence of any threatened or endangered plant species in these areas. In addition, no impacts to threatened and endangered wildlife species are anticipated due to a lack of suitable habitat. Also, the operational characteristics of the radar are such that the main beam would not normally go below two degrees to the ground. This would further prevent the possibility of adverse impacts from electromagnetic radiation (EMR).

Analysis and evaluation of the EMR environment generated by the radar indicates that it would be controlled within the applicable American National Standard Institute health and human safety standard of five milliwatts per square centimeter over a six-minute period. As an additional safety measure, a 100-meter hazard zone would be delineated in front of the antenna for human health and safety. This zone would be fenced and marked with appropriate warning signs. The hazard area for animals, especially perching birds, is estimated to be less than 15 meters. This distance was determined giving consideration to the metabolic rate of birds and other animals, their size and locomotion characteristics, and the probability of an animal entering and staying in the main radar beam or a side lobe for extended periods. Since the 15-meter distance consists of previously disturbed areas with little or no vegetation, the projected impact to wildlife from EMR is expected to be nonsignificant.



Expanded view of proposed TMD-GBR test sites at WSMR/Fort Bliss

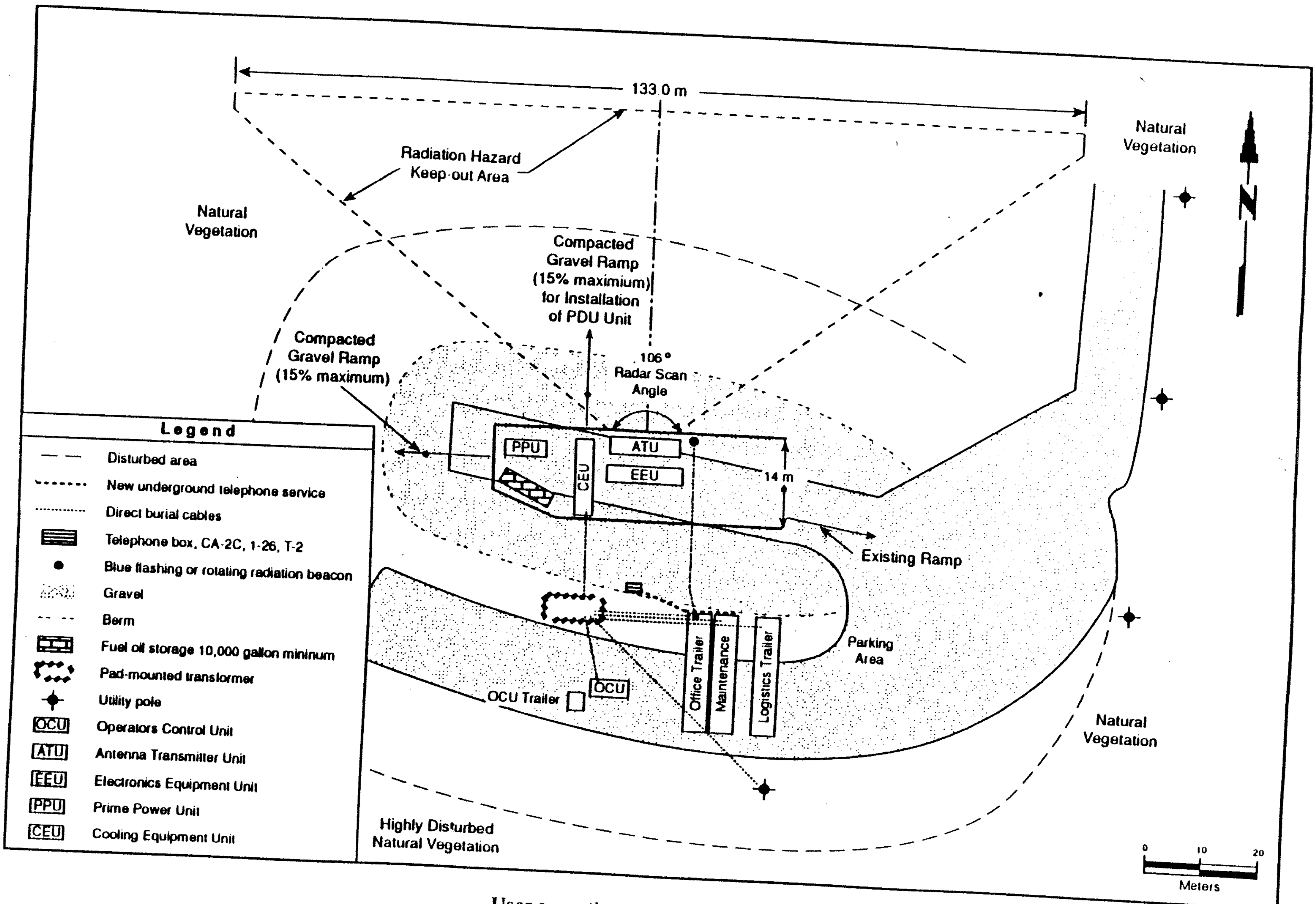
Attachment 1



Layout of TMD-GBR system at preferred site LC 39

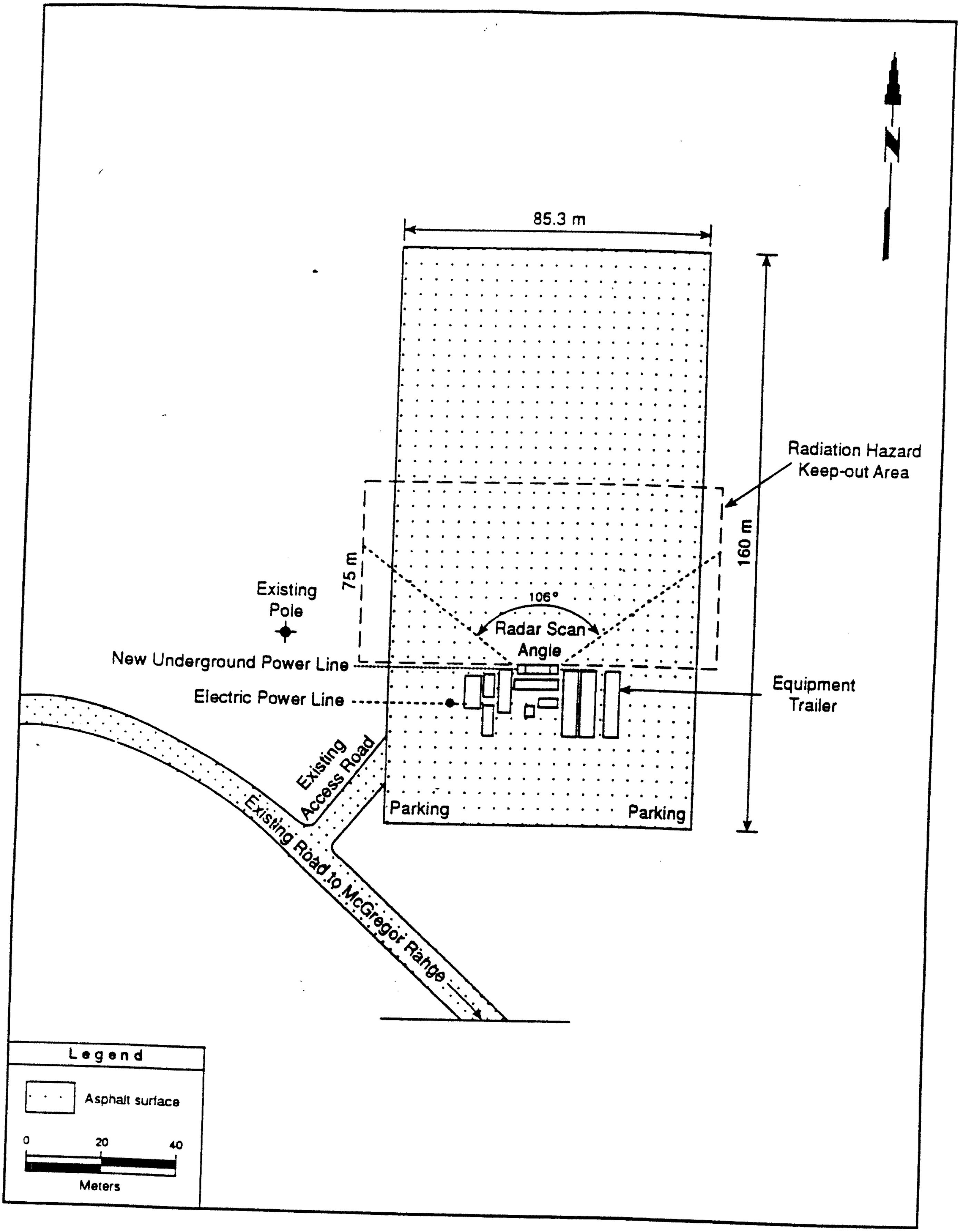
(All three radars initially tested at one location.
Only one radar would operate at a time.)

Attachment 2



User operational equipment located at R-396

(Relocated from LC-39)



User operational equipment located at IFC-25

(Relocated from LC-39)

RECONNAISSANCE AREA VERSUS MAXIMUM CONSTRUCTION AREA
EIGHT ALTERNATIVE SITES, GBR-TMD

ALTERNATIVE SITES	LOCATION	AREA MAX. CONST.	RECONNAISSANCE HABITAT	RECONNAISSANCE AREA
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* PROPOSED DEMONSTRATION/VALIDATION SITES.

Enclosure 2

PROPOSED SPECIES OF CONCERN
FOR THEATER MISSILE DEFENSE-GROUND BASED RADAR
DEMONSTRATION AND VALIDATION PROGRAM AT
WHITE SANDS MISSILE RANGE AND FORT BLISS IN NEW MEXICO

Taxonomic Name	Common Name
Falco femoralis septentrionalis	Aplomado falcon
Ammodramus bairdii	Baird's sparrow
Phrynosoma cornutum	Texas horned lizard

STATE OF NEW MEXICO
OFFICE OF CULTURAL AFFAIRS
HISTORIC PRESERVATION DIVISION

BRUCE KING
GOVERNOR

VILLA RIVERA BUILDING
228 EAST PALACE AVENUE
SANTA FE, NEW MEXICO 87503
(505) 827-6320

HELMUTH J. NAUMER
CULTURAL AFFAIRS OFFICER

THOMAS W. MERLAN
DIRECTOR

May 10, 1993

Major Thomas A. Ladd
Director
Environment and Safety
Environmental Services Division
U.S. Army White Sands Missile Range
ATTN: STEWS-ES-E (Robert J. Burton)
White Sands Missile Range, New Mexico 88002-5048

Re: Theater Missile Defense Ground Based Radar (TMD-GBR)

Dear Major Ladd:

At your request, I have reviewed the preliminary final draft of *Ground-Based Radar (GBR) Family of Strategic and Theater Demonstration and Validation Radars Environmental Assessment* in order to determine what effect proposed activities at three locations on White Sands Missile Range and Fort Bliss may have on significant cultural resources.

I concur with your determination that testing the Theater Missile Defense Ground Based Radar at the three preferred sites (Launch Complex 39, R-396, and IFC-25) will have no effect on any properties entered in or eligible for inclusion in the National Register of Historic Places. An archaeological reconnaissance of the three preferred sites and five alternative locations confirmed that all areas have been subjected to grading and disturbance from previous activities. I agree that the occurrence of intact archaeological resources within the disturbed areas is highly unlikely.

I also agree that a 40 acre inventory survey of the areas surrounding the selected locations will permit the collection of any surface artifacts that may be subject to unauthorized removal and the location and identification of archaeological sites that may be located within these areas. The survey data can be used to locate communication lines and other ancillary construction to avoid sites or to facilitate further consultation with this office if site avoidance is not feasible.

Thank you for the opportunity to consult with you on the TMD-GBR environmental assessment. Provided that there are no significant changes in the scope or locations of the described undertaking and that additional construction in the vicinity of the selected project locations will avoid recorded archaeological resources, this determination of no effect should conclude our consultation on this matter.

Please contact the Historic Preservation Division with any questions you may have regarding this matter.

Sincerely,

Lynne Sebastian

Lynne Sebastian, Deputy
State Historic Preservation Officer

LS:DER:bc/Log 39601

U.S. Army Kwajalein Atoll

Ms. Carmen Bigler
Republic of the Marshall Islands
Historic Preservation Office
Interior and Outer Island Affairs
P.O. Box 1322
Majuro, Republic of the Marshall Islands 96960

Dear Ms. Bigler:

The United States Army Space and Strategic Defense Command is intending to perform demonstration and validation (DEM/VAL) testing of the Ground Based Radar-Test (GBR-T) equipment at Kwajalein Island, United States Army Kwajalein Atoll (USAKA), Republic of the Marshall Islands (RMI). The following information is provided for your review in accordance with the National Historical Preservation Act, as amended and as implemented in 36 CFR 800.

a. A description of the GBR-T activities on Kwajalein Island (enclosure 1);

b. A map showing the area of potential effect (enclosure 2);

c. A summary description of the historic properties subject to effect (enclosure 3);

d. The USASSDC reasons for believing that the GBR-T undertaking will have no adverse effect on historic properties (enclosure 4); and

e. Description of Mitigation Measures (enclosure 5).

The possibility of adverse impacts to cultural resources by construction-related ground-disturbing activities in areas of potential subsurface cultural deposits would be mitigated by an archaeological survey, sampling, and data recovery program prior to any construction. In addition, an archaeologist would monitor construction-related excavation, would conduct testing and data recovery, as necessary.

Through application of the Criteria of Effect and Adverse Effect as per 36 CFR § 800.9 of the National Historic Preservation Act, we have determined that this undertaking would have no adverse effect on historic properties. This determination is based upon the special exceptions set forth in 36 CFR § 800.9(c)(1).

Your concurrence with this Finding of No Adverse Effect is requested. To carry out this program in an expeditious manner, we request your response within thirty days, fifteen days if possible, of your receipt of this correspondence. Should you have any questions, please contact Dr. Donald Ott, Environmental Coordinator, USAKA, at (805) 238-7994, extension 4218.

Sincerely,

Crosby E. Hazel
Colonel, U.S. Army
Commanding

Enclosures

DESCRIPTION OF THE GBR-T DEM/VAL ACTIVITIES ON KWAJALEIN ISLAND, USAKA, RMI

The GBR-T components would be assembled on top of and inside of Building 1500, which is located at the western end of Kwajalein Island. Building 1500 is also known as the Defense Center Control Building (DCCB). Installing GBR components would require structural improvements to Building 1500, including the construction of an internal support tower and foundation to support the gravity, wind, dynamic, and seismic loads of the radar. Within Building 1500, electrical power substations, power distribution equipment, air condition and ventilation units, and compressed air and fire protection equipment would be installed on various floors. Computer facilities, office space, a mission control room, and storage rooms would be constructed within the building, and an elevator would be added in a shaft extending through the existing roof to provide access to the radar unit. Additional modifications would be required for utilities, communications, fire protection, security, and air conditioning. Two small masonry buildings would be constructed to house transformers and fire pumps.

The GBR-T equipment would be connected to existing power and utility lines. Specifically, the improvements are as follows:

- Addition of a 121 meter (400 feet) non-potable water line to an existing line;

- Addition of a 609-meter (2,000 feet) non-potable seawater line to an existing line;

- Placement of 2,316 meters (7,700 feet) of underground electrical feeder lines; and

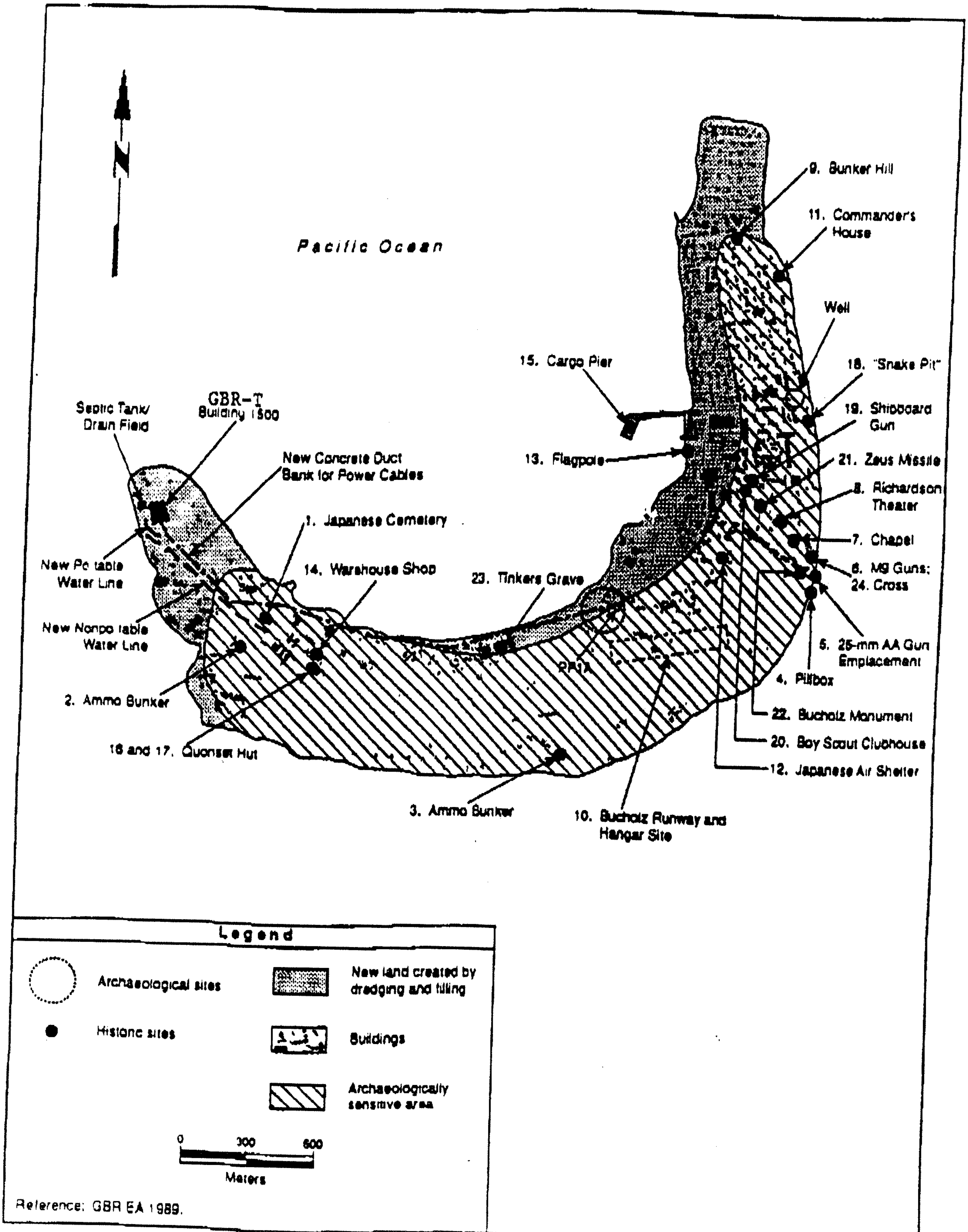
- Construction of a 4,000-gallon holding tank for sewage from Building 1500.

Approximately 90 percent of the construction would take place in areas previously disturbed by fill material.

As part of an electromagnetic radiation monitoring and safety system, a minimum of ten radio frequency sensors would be sited at strategic locations at appropriate distances from the GBR-T. The exact location and number of these sensors would be determined during installation and testing of the radar when actual low-level radio frequency measurements are taken. The sensors would be mounted a minimum of three meters (ten feet) high. Maximum use of existing structures, power sources, utility/cable runs, and previously disturbed areas would be made. However, some trenching for power sources for these sensors might be performed in areas where archaeological resources could be located.

A map depicting Building 1500, and major utility lines, in relationship to Kwajalein Island cultural resources is provided as enclosure 2.

CULTURAL RESOURCE SITES AND NEW POWER AND UTILITY LINES, KWAJALEIN ISLAND, USAKA, RMI



Reference: GBR EA 1989.

SUMMARY OF KWAJALEIN ISLAND HISTORIC PROPERTIES

Kwajalein Atoll has served as a home to Micronesian culture for at least 2,000 years. Archaeological resources on Kwajalein Island have been dated to circa 350 B.C. The Spanish explorer, Alvaro de Saavedra, was the first westerner to make contact with the atoll dwellers in the Marshall Islands in 1528. European contact over the next 350 years was relatively limited, and was comprised primarily of occasional scientific expeditions, explorers, traders, and missionaries. German desires to establish a worldwide empire resulted in annexation of the islands by Germany in 1885. Some historians believe that the establishment of copra plantations was the first significant European impact upon the Marshall Islands. Bottles dated to the 1880-1920 period have been discovered on Kwajalein Island. Following Imperial Germany's defeat in World War I, the Marshall Islands were mandated to Japan. In the late 1930s the Japanese initiated military construction on Kwajalein Island. In February 1944, United States land, air, and sea forces seized the Kwajalein Atoll from Japan. The heavy fighting on Kwajalein Island resulted in an estimated 5,000 Japanese casualties. The Kwajalein Island Battlefield is listed on the U.S. National Register of Historic Places as a National Historic Landmark. Since 1944, Kwajalein Island has been utilized as a logistics base, radar tracking facility, and weapons research and testing facility by the United States. To accommodate these activities, the island's size has been enlarged by dredging and filling at its western and northern ends, as well as along its lagoon side. A layer of dredged fill, approximately one meter (3.2 feet) deep, covers most of the island surface today.

Despite extensive ground disturbances, previous archaeological investigations on the island suggest a high probability for discontinuous, intact prehistoric (350 B.C. to A.D. 1500) and/or historic era (circa A.D. 1500 to present) sedimentary/cultural deposits and remains throughout the island's original (pre-1944) surface. Study areas that have been examined for archaeological resources are located on the present taxiway and aircraft maintenance hanger sites, and along a saltwater lined trench that parallels Ocean Road.

Prehistoric resources could include permanent living sites, subsistence sites, and temporary occupation-exploitation sites. Historic resources could include sites and artifacts from various Spanish explorers of the 16th century, from the German and Japanese occupation periods, and from World War II. Surviving World War II structures are indicated on the map provided as enclosure 2.

REASONS FOR BELIEVING THAT THE GBR-T PROJECT WILL HAVE NO ADVERSE EFFECT ON USAKA HISTORIC PROPERTIES

All utility lines would be routed to avoid known cultural resources, such as the 7th Infantry Division Memorial, the Japanese Memorial, "Tinker's" Grave, and a World War II Japanese Ammunition Bunker along Olympus Drive.

Preconstruction sampling/data recovery, and a construction monitoring program, including the presence of an on-site archaeologist, would be conducted along all utility routes to avoid adverse effects to archaeological resources.

No known historically significant structures would be impacted by this undertaking. The GBR activities in and around Building 1500 would have no impact upon cultural resources because the building is located on the "fill" portion of Kwajalein Island. In addition, Building 1500 has no potential Cold War significance. Building 1500 was originally designed as an antiballistic missile command and control structure. However, construction on this facility was never completed, nor was Building 1500 operated for its intended purpose.

Enclosure 4

DESCRIPTION OF MITIGATION MEASURES TO BE IMPLEMENTED FOR GBR-T PROJECT AT USAKA

The United States Army Space and Strategic Defense Command (USASSDC) would ensure, as much as is practicable, that utility lines would be routed to avoid all known cultural resources. Resources specifically avoided include the 7th Infantry Division Memorial, the Japanese Memorial, "Tinker's" Grave, and a World War Two Japanese Ammunition Bunker along Olympus Drive.

The areas of Kwajalein that conform to the original island surface, as well as those that were created during the Japanese occupation period, have been identified as potentially sensitive for archaeological and subsurface cultural resources. Therefore, any new subsurface disturbances in those portions of the island would be mitigated by implementing a surface and subsurface archaeological resources identification program.

Prior to carrying out a preconstruction sampling/data recovery program for any of the proposed subsurface utility corridor routes, the utility line areas would be examined for unexploded subsurface ordnance using geophysical methods (ground-penetrating radar, electromagnetic detectors, etc.). By assuring the identification of potentially hazardous ordnance prior to commencement of any field work, both the archaeological survey team and the construction crew can take measures to avoid these areas or to have them cleared before any data sampling or excavation is conducted. Archaeological preconstruction sampling would be conducted only in those areas that have been found to be "clear" of any potentially hazardous materials.

The number of archaeological sample units and/or trenches to be excavated in the area of proposed utility corridors would be determined by a certified, on-site archaeologist. Criteria to be used in making this determination include the location of the site; the expected probability of finding cultural/historical sites; and the spacial relationship of a site to other known cultural/historical sites.

The USASSDC would ensure that all archaeologists conducting the field work related to this project comply with the U.S. Department of Interior's Professional Qualifications Standards (48 FR 4473-9). All archaeological efforts would be conducted in accordance with accepted professional practices. All documentation, analysis, and curation of any cultural materials discovered and/or recovered as a result of sample testing and construction monitoring would be conducted in accordance with 36 CFR Part 79.

The USASSDC will ensure that all cultural resource construction personnel involved in utility line construction be knowledgeable of:

- Identification of potentially hazardous situations that could develop as a result of the discovery of unexploded ordnance within the proposed utility corridors.

- Procedures to be put in place if unexploded ordnance is encountered during construction excavation (i.e., immediate notification to USAKA Ordnance Disposal Unit).

- The significance and importance of potential historical resources that might be encountered during construction excavation.

- Procedures to be put in effect should archaeological resources be discovered.

Should the Army archaeologist determine that any discovered cultural resources have the potential to be historically significant as per 36 CFR § 60.4, the archaeologist would be authorized to temporarily halt and/or redirect construction activities, and then must notify the USAKA Commander before data recovery can be accomplished. Should a cultural resource be discovered as a result of construction activities, the USAKA Commander, if practicable, reroute the utility lines in order to avoid further disturbance of the resource. The unexpected discovery of historically significant cultural resources would be treated in accordance with the provisions set forth in the National Historical Preservation Act of 1966 as amended, 36 CFR 800.11(a), and the Archaeological and Historic Preservation Act, 16 U.S.C. §§ 469 (a)-(c).

CHAPTER SEVEN
LIST OF PREPARERS

LIST OF PREPARERS

Sarah J. Battelle, Waste Management Group Director
Advanced Sciences, Inc.
M.S., 1980, Geology, San Diego State University
B.S., 1978, Geology, Oregon State University
Area of Responsibility: Hazardous Waste Management
Years of Experience: 11

Stan Berryman, Operations Manager, San Diego
B.A., 1970, Anthropology, San Diego State University
Area of Responsibility: Cultural Resources
Years of Experience: 18

Anita Boyd, Senior Production Editor
Advanced Sciences, Inc.
B.A., 1979, English, University of California, San Diego
Area of Responsibility: Senior Production Editor
Years of Experience: 7

Philip M. Bunch, Senior Biologist
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Area of Responsibility: Biological Resources
Years of Experience: 10

Joneen S. Cockman, Senior Environmental Scientist
Advanced Sciences, Inc.
M.S., 1992, Range Science, New Mexico State University
B.S., 1980, Natural Resources, Humboldt State University
Area of Responsibility: Biological Resources
Years of Experience: 10

James F. Corr, Senior Environmental Scientist
Advanced Sciences, Inc.
B.S., 1962, Engineering, United States Military Academy, West Point
Area of Responsibility: Noise and Air Space
Years of Experience: 16

Eloise M. Emery, Senior Environmental Land Use Specialist
Advanced Sciences, Inc.
Juris Doctor, 1983, Western State University
BFA, 1974, Fine Arts, Stephens College
Area of Responsibility: Task Manager
Years of Experience: 16

Ron Freeman, Natural Resources Group Director
Advanced Sciences, Inc.
B.S., 1971, Wildlife Management, Humboldt State University
Area of Responsibility: Biological Resources
Years of Experience: 19

Tirzo González, Cultural Resources Group Director
Advanced Sciences, Inc.
B.A., 1976, Interdisciplinary Sciences, University of California, San Diego
Area of Responsibility: Cultural Resources
Years of Experience: 13

Terry L. Knight, Senior Archaeologist
Advanced Sciences, Inc.
B.S., 1979, Anthropology, New Mexico State University
Area of Responsibility: Cultural Resources
Years of Experience: 16

Keith Lusk, Socioeconomist
Advanced Sciences, Inc.
M.A., 1985, Economics, State University of New York, Binghamton
B.A., 1983, Economics, San Diego State University
Area of Responsibility: Socioeconomics
Years of Experience: 6

George M. Mathews, Jr., Senior Air Quality Specialist
Advanced Sciences, Inc.
M.S., 1990, Mineral Resources Ecology, Colorado School of Mines
B.S., 1968, Zoology, Colorado State University
Area of Responsibility: Air Quality
Years of Experience: 14

John R. McDowell, Professional Engineer
Advanced Sciences, Inc.
M.S., 1975, Environmental Engineering, University of Tennessee
B.S., 1950, Mechanical Engineering, University of Tennessee
Area of Responsibility: Air Quality
Years of Experience: 41

John R. Mittauer, Geologist
Advanced Sciences, Inc.
B.S., 1986, Geology, Virginia Technological University
Area of Responsibility: Hazardous Waste Management
Years of Experience: 5

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APPENDICES

APPENDIX A
ELECTROMAGNETIC RADIATION EXPOSURE ISSUES AND APPROACHES FOR ASSESSING POTENTIAL IMPACT

APPENDIX A

Electromagnetic Radiation Exposure Issues and Approaches for Assessing Potential Impact

INTRODUCTION

This appendix provides a brief technical description of the Ground Based Radar (GBR) systems, the issues relative to possible electromagnetic radiation (EMR) hazards that have been or are being addressed, applicable standards, and the results of the pertinent analyses.

Both the GBR-T and TMD-GBR are high-powered radar systems using a pulsed microwave beam to detect and track missile targets. High transmitter power levels combined with state-of-the-art antenna technology provide the systems with increased performance characteristics for the detection of targets at long range and moving with high velocities. Because of the relatively high transmitted power and antenna pointing directions that may be within a few degrees of horizontal, depending on the mission, it is of practical interest to examine the potential for high intensity electromagnetic fields that will be produced by the GBR. These EMR levels have been addressed through extensive analyses and continue to be examined in depth.

The proposed GBR-T and TMD-GBR are similar to many other conventional radars in that they transmit a microwave signal that is pulsed on and off at a rapid rate. Through analysis of the time required for a transmitted pulse of microwave energy to reach a given target and return to the radar system, precise determinations of the location, trajectory, and speed of objects are made. Like virtually all other high-performance radars, these radars enhance their detection characteristics through the use of very high transmitted signal strengths but also have the ability to instantaneously change the directional properties of the transmitted microwave beam. Because each of these systems has the potential for exposing various regions in their vicinity to high-intensity microwaves, or EMR, extensive consideration has been given to the evaluation of the potential for any adverse impact that EMR may have on the environment.

EMR

EMR pertains to the transmission of electromagnetic energy from the two GBR systems in which electric and magnetic fields are interrelated in the form of an electromagnetic wave. In the vicinity of these systems, the predominant electromagnetic aspect of the environment will be the transmitted microwave signals at the proposed operating frequency in the 8,000 – 10,000-megahertz (MHz) or 8 – 10-gigahertz (GHz) band (X-band). However, the electromagnetic spectrum encompasses a vast range of frequencies, beginning at 0 hertz (Hz) and extending to frequencies beyond 10^{22} Hz, corresponding to gamma rays. Figure A-1 illustrates the electromagnetic spectrum and identifies the operating frequency range for the GBR systems. Within this spectrum, innumerable man-made sources of EMR operate and natural sources abound. For example, the electromagnetic environment at any given geographical point consists

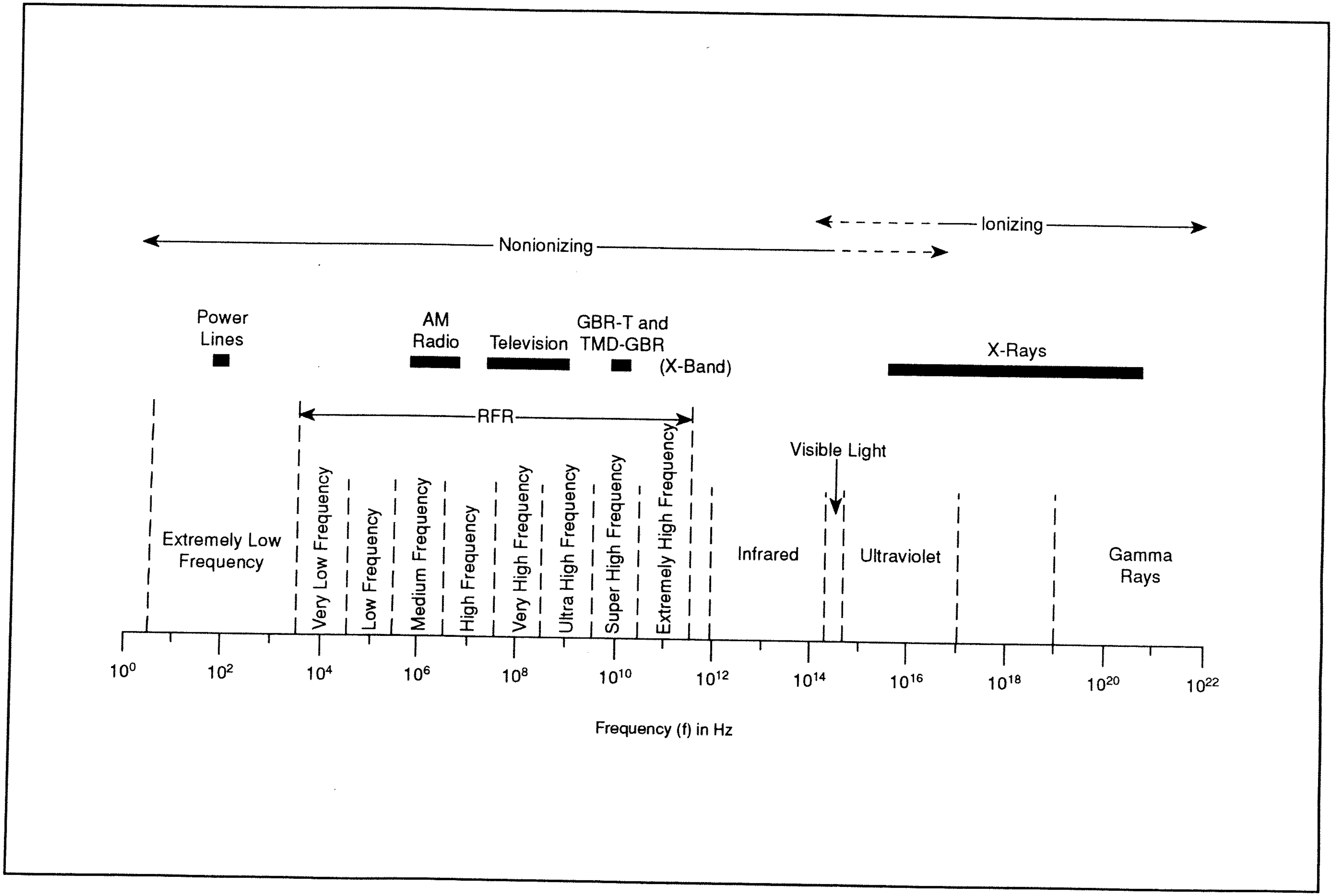

Figure A-1. The electromagnetic spectrum

of signals from radio and television (TV) broadcasting stations, satellites that relay TV and data signals across the nation, and short-wave radio signals from amateur, citizen band, and international broadcasting stations. Many of the resulting fields produced by these sources originate from emitters located thousands of miles away through the phenomenon of ionospheric reflection of signals (sky-wave propagation).

The term EMR, for the purposes of this document, is used to refer to what may otherwise be called radio frequency (RF) emission, electromagnetic or RF fields, and, sometimes, nonionizing radiation (NIR) or nonionizing electromagnetic radiation (NIER). In practical terms, radio and TV signals are a form of EMR; signals are transmitted from a radio or TV broadcast station's antenna, providing signals for listeners or viewers to receive in their homes. The signals, in the form of energy, actually leave the antenna and are transmitted into the environment. In the case of a broadcasting station, these signals are continuous, at least for most of the day, and often transmitted in an omnidirectional pattern about the antenna to the community of interest such that the station's signal may be adequately received regardless of specific location within the community. The transmitted signal, or EMR, consists of interrelated electric (E) and magnetic (H) fields propagated through space, which oscillate at the same frequency as the transmitting station and travel at the speed of light, or approximately 3×10^8 meters (m) per second (s) (187,000 miles per second).

The concept of an E or an H field may appear abstract but fields are produced whenever and wherever electric charges exist. A field is an entity that occupies space, that exerts a specific type of force, and that diminishes in strength with increasing distance from its source. E fields are related to the forces that exist between electric charges and are specified in terms of electric field strength. H fields are related to the movement of electrical charge, such as when an electric current flows in a conductor. In the case of a power line, for example, E fields are related to the voltage of the power line while H fields are related to the current flowing in the line. In both cases, while the field strengths decrease with increasing distance from the line, energy is not intrinsically transmitted. The term electric and magnetic fields (EMF) refers to E and H fields in the sense that they may exist independent of one another. For the proposed GBR-T and TMD-GBR radar systems, the radars will create EMR in which both the E and H fields are related to one another in a known way and the energy of which is transmitted from (actually leaves) the radar antenna structure.

All electromagnetic waves carry energy and the science of physics shows how such waves may be represented as packets of energy called photons. The energy of a photon (U) is expressed as

$$U=hv$$

where h = 6.63×10^{-34} joule (J) seconds (Planck's constant)

v = frequency of the wave (Hz)

This relationship illustrates the direct dependence of photon, or wave, energy on the frequency of the transmitting. Ultraviolet (UV) radiation has a frequency of approximately 3×10^{15} Hz and UV photons carry, accordingly, an energy of approximately 2×10^{-18} J that is equivalent to about 12.4 electron volts. This value of energy is approximately equal to the binding energy of electrons to atoms and, hence, EMR at UV frequencies and higher carries the potential for ionization of atoms (ejection of electrons from atoms) contained in biological tissue. Such radiation, which includes cosmic radiation from space, X-rays from medical diagnostic and therapeutic machines, gamma rays as emitted by radioactive materials, and UV radiation from the sun and UV lamps for suntanning, is commonly referred to as ionizing radiation. For EMR at microwave frequencies, like that proposed for the GBRs, and used by broadcasting stations, the associated fields normally possess energy levels several orders of magnitude less than those that can cause ionization in biological tissue. Thus, the EMR discussed in this appendix can be correctly described as nonionizing in nature. This fundamental distinction in physical interaction with tissue represents the most common public misunderstanding about the potential environmental significance of EMR associated with radar. As a point of comparison, the equivalent energy of the waves is about 4×10^{-5} electron volts for a frequency of 10,000 MHz or 10 GHz. This photon energy level is 300,000 times less than the minimum value needed to induce ionization in tissue. Microwave ovens, commonly found in household kitchens, operate at a frequency of 2,450 MHz (or 2.45 GHz), somewhat lower in frequency than the proposed GBR.

While EMR is not capable of ionizing biological tissues, the absorbed energy associated with exposure does lead to molecular agitation.. This action, when carried to the extreme, can lead to sufficient molecular friction such that tissue can become heated; if the energy absorption rate exceeds the body thermoregulatory capacity, then the exposed tissue temperature can rise. When the EMR exposure terminates, there is no longer the input of energy converted to heat so that the heat induced in the body by repeated low-level EMR exposures at short intervals is not cumulative in a thermal sense; upon termination of the EMR exposure, the body tissues will slowly resume their preexposure temperatures. These comments are relevant, however, only to the case of very intense EMR exposures, typically well above the limits contained in various exposure standards.

Current Issues and Concerns About EMR

The subject of biological effects of EMR, though studied extensively during the past thirty years, has always tended to be controversial. Perhaps, a major ingredient to this controversial atmosphere has been the long-standing issue of substantive differences between western developed EMR exposure limits for humans and the extremely stringent Russian standards for EMR. An often asked question relates to what information on biological effects might be known to the Russians, not known in the United States, that could drive standards to such restrictive levels. The widely publicized incident of microwave radiation of the U. S. embassy in Moscow during the 1970s exacerbated the curiosity of the American public about what effects, if any, EMR could have on humans. Subsequent interaction with the Soviets through a long-term cooperative agreement on the exchange of scientific information between the two countries significantly assisted in obtaining a better understanding of the Russian approach to EMR standards. For example, a basic difference in considering biological effects exists; the Russians have historically not made the distinction, commonly made in the West, between effects and hazardous effects. Also, much of the older Soviet scientific literature contained questionable statistical treatment of the data. But despite extreme conservatism and an apparent lack of written documentation of the Russian approach to setting EMR limits, considerable discussion still persists on the apparent discrepancies between exposure standards; this has become especially so in the context of popularized accounts of what is and is not understood about potential health effects of EMR.

Historically, different issues related in some fashion to EMR have resulted in significant attention being given to specific questions about the safety of EMR exposure. These issues have tended to provoke the residual debate over EMR, leading to a heightened concern on the part of the public. Such concerns clearly and rightfully require as complete, accurate and unbiased, as possible, accounts of our present understanding of the subject of EMR associated with the proposed GBR projects. In recent times, public attention has been focused on at least four notable instances of concerns about EMR and the fields found near power lines, often referred to as EMFs (for electric and magnetic fields). These are the possibility that EMFs produced by computer video display terminals (VDTs) may be associated with increased miscarriage rates; the possibility that long-term exposure to magnetic fields found in certain homes adjacent to particular power line wiring configurations may be linked to an increased incidence of childhood leukemia; the possibility that microwaves produced by traffic radar systems used by police officers may be related to an excess occurrence of cancer, in particular testicular cancer; and, most recently, allegations that cellular telephones may be linked to the development of brain tumors. While the scientific evidence to validate any of these four hypothetical relationships is presently lacking, newspaper and magazine descriptions of the relevant studies have tended to exaggerate any public concerns that may have already existed. Thus, it is fair to say that a major concern among the public is whether long-term, continuous exposure to relatively modest, or even low-level fields, can be shown in a scientifically defensible fashion to be an actual cancer factor.

While certainly the vast majority of research work that has taken place over the past 30-plus years has failed to produce any credible support for some kind of mechanism by which EMR or EMFs could interact in a way resulting in cancer, even anecdotal reports can take on a more serious aura than reality may corroborate.

Through the years of EMR/EMF biological effects studies, probably the singular, most frequently raised topic of debate has been whether these physical factors can act on biological systems via nonthermal effects. That is, can EMFs produce any biologically significant effect on living organisms through any mechanism of interaction other than heating of tissue? Although an extremely limited number of papers in the technical literature would appear to support such a hypothesis, the overwhelming view at present is that such interactions are not significant.

Very important, however, is the necessity to recognize the existence of numerous standards, regulations, and guidelines pertinent to controlling human exposure to EMR and the basis for accepting such criteria as relevant measures of the potential for adverse health effects on the public. It is useful to note that virtually all exposure standards are developed on the basis of scientific consensus among informed participants in ongoing research on biological effects and dosimetry of EMR and EMF. The standards represent a consensus in the context of general agreement among, typically, a large number of committee members, not all of whom may agree on every detail contained in the standard that eventually evolves from the group. Hence, standards should be viewed as the "best effort" product from experts on the subject that is available in today's imperfect world. While disagreement may exist as to the implications that certain specific pieces of research have for public health, general consensus standards still represent our best approach to balancing scientific opinion. In spite of arguments by some that committees can become unbalanced in terms of members with specific vested interests, the fact that most standards committees are composed of individuals with wide-ranging opinions from significantly different backgrounds tends to ensure that the standards setting process is reflective of mainstream thinking.

While the potential for any type of EMR-induced adverse health effects within the population residing near the proposed GBR systems at Kwajalein and White Sands Missile Range (WSMR) is the principal concern addressed by this appendix, there are other possible environmental consequences that must be considered. Phenomena also related to the production of EMR that are addressed include the possible impact of high-intensity radiated fields (HIRF) on aircraft, the potential for indirect impacts on human safety resulting from electromagnetic interference with other devices including electroexplosive devices (EEDs) and cardiac pacemakers, possible hazardous effects encountered during fuel-handling activities when exposed to high-intensity EMR, and the potential for high-intensity microwaves to adversely affect wildlife, in particular birds that may perch in or fly through the main beam or lobes of either system. Although not normally considered an issue related to health or safety, this appendix also will briefly examine those considerations relevant to assessing possible impacts of the proposed GBR signals on disruption of radio and TV reception and radio communications in the area.

GBR Antennas

Each of the radars makes use of phased-array type antennas. Phased arrays provide for electronic control of the pointing direction of the radar beam. The GBR-T antenna system consists of a circular array approximately 10-m in diameter filled with many small radiating elements. The antenna itself will be mounted on a structure which permits mechanical rotation and elevation of the array. The center of the antenna would be located approximately 47 m aboveground. The antenna assembly will allow rotation in azimuths of up to ± 178 degrees and in elevation from 0 to 90 degrees above the horizontal. Through a combination of mechanical and electronic control of the antenna EMR pattern, the radar beam may be directed essentially instantaneously at incoming targets. The antenna array will be composed of a total of some 60,000 elements creating an array area of about 80 m^2.

The TMD-GBR antenna, designed for portability in the field, uses a rectangular phased array with an area of approximately 9.2 m^2. The antenna, which would be mounted on a large trailer, can be changed mechanically in elevation between 10 and 60 degrees. It cannot be mechanically reoriented in azimuth. During operation, when the radar is operating, the mechanical elevation will remain fixed. Once situated at a given elevation angle, the radar beam will be electronically slewed in elevation and azimuth to accommodate different incoming targets.

Both GBRs will use phased-array antennas for transmitting the pulsed microwave radar signal. Phased-array technology refers to the use of multiple transmitting elements to make up the antenna system, with carefully controlled electrical phase relationships of the transmitter signals delivered to each of the array elements. By controlling the phase relationships, the radiation pattern of the antenna can be controlled. The radar transmitting pattern of an antenna is related to the manner in which the antenna transmits the radar signal in various directions. By controlling the direction in which the radar transmits, targets at different locations can be discriminated.

Commonly, radars use mechanical beam steering to change the transmitted direction of the beam. The GBRs will make use of both mechanical and electronic beam steering. A major advantage to electronic beam steering is that it is essentially instantaneous. There is no mechanical movement, thus beam direction can be changed extremely rapidly, a desirable characteristic for target detection and tracking. The control of a phased-array antenna is performed through computer programming (software). Thus, significant engineering work has been expended in the development of specialized software for operating both of the GBRs, and it is, to a large extent, through the application of specific algorithms that the EMR levels in the vicinity of the GBRs can be controlled.

Any microwave antenna can be characterized by describing its EMR pattern in terms of its main beam. This is the beam of transmitted energy that is intended for use in communications, or target identification as in the case of radars. The EMR pattern of the antenna also includes side lobes. Side lobes consist of EMR transmitted by the antenna but at directions not intended for the antenna's application. The design approach used in the GBR-T antenna, which produces a better cost-to-performance ratio in overall system performance, introduces the presence of a particular category of side lobes, caused largely by the selection of the spacing distance between the many elements (phase shifters) that make up the entire phased-array antenna. These grating (side) lobes are the principal source of EMR to which analyses of potential EMR impact have been directed, because the main beam illumination (EMR) would not be directed at the ground. The main beam of the GBR-T would diverge from the antenna in a conical pattern. Normally, the GBR-T would not transmit at less than 2 degrees above horizontal, while the TMD-GBR would not transmit at less than 4 degrees above horizontal.

EMR Hazard Issues

High-intensity EMFs must be evaluated for compliance with applicable standards for human and wildlife exposure and the possibility of fuel ignition, inadvertent detonation of explosives and ordnance, interference to electronic devices such as communications systems and cardiac pacemakers, and the possibility of impact on critical avionics systems. Analyses have been conducted to determine the expected intensities of EMF to evaluate the potential for excessive exposure to the GBR emissions and to help identify appropriate mitigating techniques, where necessary.

EMR Standards for Human Exposure

Parameters of Exposure

Fundamental to the concept of EMR or EMF exposure is the presence of a person or susceptible device in a field of a given magnitude. Hence, computations or measurements of fields, in and of themselves, are not necessarily accurate estimates of exposure. However, because the assessment of where individuals may be at any given instant is generally very difficult, the field levels that exist in certain areas where people may have access are taken as "potential exposure" values. Also, since EMR or EMF does not accumulate or remain after the source is turned off, exposure cannot occur by entering an area where EMR or EMF previously existed. In reality, if a person is not present, then exposure does not occur and the simplified approach described above usually results in overly conservative estimates of actual exposure. In performing exposure assessments, therefore, it is helpful if some information is available that provides estimates of the probability that individuals may reside in certain areas where the EMR or EMF levels have been determined. Unfortunately, this type of information is most often not known when attempting to perform an exposure assessment and the results tend to be very conservative.

Another factor important to assessing exposure is determining how long an individual is exposed to a given field level. In the case of the GBRs discussed here, this requires information on how long the beam of the radar may exist at a given point in space. With mechanically steered beams, similar to more conventional air traffic control radars with physically rotating antennas, such information can be ascertained in a relatively straightforward manner. But with electronically steered beams, such as the phased array of the GBR-T and the TMD-GBR, and especially in the case where the beam may assume different orientations instantly in time, this assessment becomes much more complex. In some cases, considerable uncertainties may be attached to the estimates of the fraction of time that the beam may be at some specific direction. Again, a conservative approach is often taken whereby assumptions are made, such as assuming that the beam may be stationary while pointing at some area in which individuals may have access.

EMR Exposure Standards for Microwaves

Microwave transmission levels may be put in perspective by comparing them to those values that have been recommended in various standards and guidelines for human exposure. While numerous standards or guidelines exist for human exposure, most standards share a fundamental common characteristic in their origins. That characteristic is that virtually all of the standards derive from the same data base of research information on biological effects of EMR (i.e., the underlying basis for the exposure limits reflects the same findings). Differences among the various standards and guidelines have resulted mainly from differences in opinion as to an acceptable margin of safety to apply, not a difference in opinion as to the exposure that might be associated with an obvious adverse effect.

Several human exposure standards are relevant to evaluating the potential microwave fields near the GBR-T and TMD-GBR. These include those of the U.S. Army (Technical Guide 153, *Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation*), the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE) (1991), and the regulations of the Commonwealth of Massachusetts (1983, 1986). The basis for these standards are outlined below.

EMR Metrics for Determining Exposure

EMR is commonly characterized in terms of its power density or the strength of the electric and magnetic fields that make up the electromagnetic wave propagating from the EMR source through space. In so-called free space, a medium in which there is nothing to reflect, refract, or absorb energy, electromagnetic waves diverge uniformly away from the source. In the idealistic case, the resulting wave front surface is spherical and the power density of the wave originating from a point source can be described by the ratio of the total power transmitted by the source to the spherical surface area enclosing the source. Hence, the power density associated with an

EMR source varies inversely with the square of the distance from the source according to the relation

$$S = \frac{P}{4\pi r^2}$$

where P is the source power in watts (W) and r is the distance from the source in meters (m). S, the power density, is given in units of watts per square meter (W/m^2), but more commonly is expressed in units of milliwatts per square centimeter (mW/cm^2). This relationship, for example, would hold for a perfect point source light bulb in describing the power density transmitted in any direction. But real-world microwave antennas possess direction and transmit the signal in preferred directions, which are functions of the antenna design and operation. For the GBR antenna, the radar power is very carefully controlled in its spatial distribution and is concentrated in the direction of its main beam. The ability of the antenna to concentrate the EMR is related to the antenna gain, a numerical factor by which the actual antenna input power is multiplied to obtain an apparent effective transmitted power (ETP). Hence, when calculating the power density of an electromagnetic wave from a microwave source, the antenna gain that is applicable to the specific direction of interest must be known to accurately assess the power density that will be incident at the point of interest. For example, if the gain of the antenna is 1,000 along the axis of its main beam (i.e., the ETP is equal to 1,000 times the actual antenna input power), the gain may well be less than unity in other directions, only a few degrees off the main beam axis. This means that even though the power density in the main beam of the radar may be very high, the power density at other locations could be very low.

Electromagnetic waves also are described in terms of electric field strength (E), specified in volts per meter (V/m), and magnetic field strength (H), specified in amperes per meter (A/m). In some cases, the magnetic flux density (B) is use to describe the magnetic field. In free space, the electric field, magnetic field, and power density are all related by the expression

$$S = \frac{E^2}{Z_0} = H^2 Z_0$$

The term Z_0 is called the intrinsic impedance of free space and is equal to a value of 377 ohms. When sufficiently far from the antenna to be within the far field, the ratio of the electric to magnetic field strengths will always be equal to 377 ohms. Thus, when in the far field, the field can be fully characterized as to intensity or strength by measurement of either the electric or magnetic field alone. In the far field, the antenna beam is fully formed and the power density decreases in inverse proportion to the square of the distance from the antenna.

Close to the antenna, the antenna beam is not fully formed as it is in the far field, the beam is much wider in its dispersion characteristics and the gain is lower. In this region, the calculation of EMR power densities becomes much more complicated. The power density typically will be observed to oscillate in magnitude with distance such that at some points, the power density may be very high while at locations either slightly closer or farther away the power density will be substantially less.

This behavior of the transmitted power density comes about because of the phenomenon of interference of electromagnetic waves transmitted by various portions of the antenna. In the near field, the power density at any given point is made up of contributions of radar signals arriving at that point from all points on the antenna surface. Because the fields arriving from each point on the antenna surface will have their own specific electrical phase, there is the possibility of constructive and destructive interference and, hence, increases or decreases in the resultant power density.

Generally, a transition region exists between the near and far fields in which the power density may decrease inversely proportional to the distance from the antenna. The boundaries between the near and transition fields and the transition and far fields may be defined in various ways but, from a practical perspective, may be described in terms of how the power density varies with distance from the antenna.

Electromagnetic fields also are characterized in terms of their polarization. Polarization is the orientation of the electric field vector with respect to the ground, or with respect to the long axis of the body when referring to the coupling between EMR and exposed individuals.

Another aspect of EMR relevant to exposure assessment is its modulation properties. EMR that is pulsed, such as the GBR, consists of fields that have very high instantaneous peak field strengths or power densities but significantly lesser average values. So, in defining the magnitude of an EMR field, one must distinguish between the peak and average power densities in as much as most present-day exposure standards to protect against adverse health effects in humans are derived in terms of the time-averaged value of the fields. This is important for the GBR since the EMR it produces is represented by a pulse train of short pulses, fractions of a second, with a ratio of average to peak power density (duty cycle) of about 0.25. Thus, peak power densities may be up to about four times the average value at a given point. For purposes of evaluating the GBR, however, knowledge of both peak and average power densities is required since some field criteria related to interference and other safety-related phenomena based on limitation of the instantaneous peak field levels exist.

C95.1-1982 ANSI Standard

In 1966, ANSI issued its first standard recommending maximum exposure values for electromagnetic fields. This early guide on exposures was relatively simplistic in that it set a power density limit of 10 mW/cm^2 across the frequency range of 10 MHz to 100 GHz. Since 1966, the ANSI standard has been revised three times to reflect new research findings that are relevant to the setting of realistic and accurate EMR exposure standards. In addition to the ANSI standard, numerous standards, guidelines, ordinances, exposure policies, and recommendations by federal, state, and local governments have been developed which are patterned after the ANSI standard. Hence it is relevant to review the basis of the ANSI standard (C95.1-1982) to better understand other exposure guidelines.

In the quest to find a suitable dosimetric parameter to quantify biological effects of EMR, the concept of the specific absorption rate (SAR) has been used extensively for many years. This parameter, the result of the complicated manner by which EMR interacts with the body, expresses the rate at which energy from the incident fields is absorbed in units of watts per kilogram (W/kg) of body mass. Durney et al. (1986) compiled a major compendium of information on SAR, providing graphical representations of the SAR variation with frequency. SAR data applicable to the GBRs' frequency indicates that the SAR is relatively independent of the body orientation in contrast to frequencies nearer the body resonance range.

Based on SAR data indicating the rate at which energy is absorbed within the body from a known incident power density, several exposure standards have been developed. Virtually all modern day EMR exposure limits are frequency dependent, reflecting the fact that the human body exhibits a frequency response much like a radio antenna, absorbing EMR more effectively in its resonance range, and not absorbing as well at other frequencies. The standard specifies EMR intensities in two different ways: the permitted electric and magnetic field strengths (or squares of field strengths as actually given in the standard) and the power densities that would be associated with plane waves having the same electric and magnetic field strengths (plane wave equivalent power density).

The limiting values of EMR strengths, or power densities, given by the 1982 version of the ANSI standard represent those values that limit the rate of energy absorption, or SAR, in the body of an individual exposed to the fields. When the C95.1-1982 RF protection guide (RFPG) was developed, the ANSI subcommittee suggested that energy absorption rates greater than 4 W/kg in laboratory animals used in experiments with EMR, if maintained for protracted periods of time, could eventually be hazardous to the animals. In deriving the RFPG, the subcommittee elected to assume that man would respond much like the laboratory animals. To take into account the many variabilities in translating from animal to man, and the range of susceptibilities that individuals might exhibit to EMR exposures, a 10-fold margin of safety was introduced to obtain the working limits of the ANSI RFPG. Thus, the specified limits in the ANSI RFPG for EMR are designed to keep the energy absorption rate, when averaged over the whole body, to less than 0.4 W/kg, 10 times less than the presumed hazard level. Since absorption of EMR within the body is highly nonuniform, ANSI also prescribed limits intended to limit the local SAR value to no more than 8 W/kg in any one gram of tissue.

One measure of EMR absorption by biological tissue is the so-called penetration depth. Depth of penetration is defined as the depth in tissue at which the electric and magnetic fields have decayed to 36.8 percent of their values at the surface of the body or the power density has decayed to 13.5 percent of its surface value. Penetration depth is related to the EMR frequency (Durney et al, 1986). For example, at 100 MHz, comparable to the FM radio broadcast band, the penetration depth is about 8 cm; at 2,450 MHz, the frequency at which microwave ovens operate, the penetration depth is about 2 cm; at X-band, the frequency range within which the GBR radars would operate, the penetration depth is about 0.4 cm. Thus, most of the energy from the incident EMR produced by the GBR radars is absorbed near the surface.

Because the ANSI standard was based on the concept of limiting the rate at which energy is absorbed by the body from the external EMR fields, usually expressed in terms of the SAR, it is often more convenient to think in terms of the plane wave equivalent power density of the fields expressed in units of W/m^2 or mW/cm^2. The plane wave equivalent power density of EMR and the associated electric and magnetic fields are related as shown in the following expression:

$$S(W/m^2)=\frac{E^2}{377}=377H^2$$

where S is the power density, expressed here in W/m^2, and E and H represent the electric and magnetic field strengths in units of V/m and A/m, respectively. The factor of 377 ohms represents the impedance of free space. For convenience, ANSI chose a value for the impedance of free space equal to 400 ohms rather than the actual value of 377 ohms. For this reason, in the ANSI (C95.1-1982) (ANSI 1982), 1 mW/cm^2 is equated to a squared electric field strength of 4,000 V^2/m^2 rather than 3,770 V^2/m^2. If S is to be expressed in units of mW/cm^2, then the above relationship becomes:

$$S(mW/cm^2)=\frac{E^2}{3770}=37.7H^2$$

For exposure to 10 GHz microwaves, the ANSI (C95.1-1982) RFPG recommended a maximum continuous exposure not to exceed 5 mW/cm^2. This value applied to everyone in the population.

There are three additional qualifications of the limiting values of EMR exposure given in the ANSI standard. The first is that in relating the limiting power densities to SAR in the ANSI RFPG, it is assumed that the polarization of the electromagnetic field is aligned with the long axis of the body; in other words, an EMR with a power density of 10 mW/cm^2 must be electric field polarized with the body's longest dimension for a whole-body average SAR of 0.4 W/kg to occur. If there is significant energy contained in other polarization directions, e.g., horizontal polarization, at lower frequencies, then a significantly lower SAR would be developed. At higher frequencies, such as at the GBRs frequency, such differences are not necessarily as significant.

In the interest of being conservative, ANSI elected not to differentiate between the various polarizations of EMR fields that might be encountered in the day-to-day world of EMR exposure situations. Consequently, EMR fields measured as being equal to the ANSI limit would normally incorporate a significant degree of additional safety since it is generally unlikely that the body would be exactly aligned with the polarization of the incident fields.

A second qualification is that of the uniformity of the power density over the body. The ANSI RFPG makes the assumption that the specified power density limits apply equally to all parts of the body (i.e., the fields cannot result in a whole-body SAR of 0.4 W/kg unless the entire extent of the body is exposed to a uniform power density equal to the limiting value).

The third qualification of the limiting values of EMR exposure is that the power density and the squares of the field strengths are to be time-averaged over any six-minute period of time. Thus, the limits given in the ANSI RFPG are applicable to long-term exposure of indefinite extent. But, when the exposure duration can be controlled to shorter periods than six minutes, then higher levels are permitted. This means that EMR fields higher than the values given as continuous exposure limits in the standard are acceptable, providing that the exposure time is controlled in such a way as to keep the average value over any six-minute window of time to no more than that given by the standard. For example, at 10,000 MHz, where a power density of 5 mW/cm^2

is allowed, if the exposure time can be controlled to only 3 minutes in any 6-minute period, then the power density can rise to 10 mW/cm^2; during the remaining 3 minutes of the 6-minute period, however, no exposure would be permitted.

Since the permitted exposure is directly related to the fraction of the averaging time that the field is present, very short exposures, similar to those that might be experienced as one passes through an area adjacent to a radar antenna, are associated with very high permitted field levels. In practical circumstances, however, one must realize that exposure management by controlling exposure times can become very difficult, sometimes resulting in considerable uncertainty in the actual time-averaged exposure values. However, in the case of computer control of the GBR antennas, it is possible to maintain precise information on the time-averaged values of the microwave fields in those areas subject to access by individuals.

This averaging provision, applicable in the microwave frequency band can be expressed by the following relationship:

$$S(mW/cm^2)t(\text{min}) \leq 30 mW\text{-min}/cm^2$$

In the earlier example of short-duration, high-level exposure, no exposure would be permitted during the remaining part of the 6-minute period. This provision is helpful in those instances where transient exposures may occur as in passing momentarily through elevated field areas. Often, application of the averaging provision will show what was originally judged to be an excessive exposure may, in fact, be in compliance with the ANSI RFPG.

In the ANSI standard, the instantaneous peak power during individual pulses of electromagnetic energy is limited only by the time-averaging provision within the standard. This means that, conceptually, for infinitely short pulses, the instantaneous peak power could be infinite.

IEEE Revision of ANSI C95.1-1982

On September 26, 1991, the IEEE adopted a major revision of the ANSI RFPG developed in 1982 (C95.1-1982). This revised standard, developed under sponsorship of the IEEE, is designated IEEE C95.1-1991 and will now be forwarded to the ANSI for endorsement and possible issuance as a revised ANSI standard carrying the same designation. This revision, developed during the period from 1982 to 1991, resulted in a considerably more complex standard that specifies field strength and induced current limits (for frequencies below 100 MHz) for both controlled and uncontrolled environments. Recognition of the fact that magnetic fields do not couple as effectively with the body as electric fields led to a relaxation in the permissible magnetic field limits. The new IEEE limits for controlled and uncontrolled environments are summarized in Table A-1.

Compared to the earlier issued ANSI limit, these newer exposure limits include a relaxed value for both controlled and uncontrolled environments, reflecting a more precise examination of the dosimetry information relevant at higher frequencies. The new power density limit for uncontrolled environments is based on averaging times of 7.5 to 11.3 minutes, depending on the exact frequency; for controlled environments, a fixed 6 minute averaging period is used.

Table A-1
Summary of IEEE C95.1-1991 standard for X-band microwaves

Environment	Power Density (mW/cm^2)	Averaging Time (minutes)
Controlled		
8 GHz	10.0	6.0
10 GHz	10.0	6.0
12 GHz	10.0	6.0
Uncontrolled		
8 GHz	5.3	11.3
10 GHz	6.7	9.0
12 GHz	8.0	7.5

In developing this revision of the ANSI standard, the IEEE committee placed a specific peak pulse power limitation on pulsed fields. A peak electric field strength of 100,000 V/m is not ever to be exceeded. For pulsed fields with pulse widths less than 100 milliseconds (ms), the IEEE standard also specifies limits on the peak power density for single pulse and a 100-ms average power density according to the following relationships:

$$Peak\ MPE = \frac{MPE\ x\ Avg\ Time\ \text{(sec)}}{5\ x\ Pulsewidth\ \text{(sec)}}$$

$$MPE\ Averaged\ over\ 100\ ms = \frac{MPE\ x\ Avg\ Time\ \text{(sec)}}{0.5}$$

In effect, for high frequencies and longer pulses, the peak power density limit is more conservative than the peak electric field strength of 100,000 V/m. For example, a 1-ms pulse at an X-band frequency would be allowed to have a peak power density of 720,000 mW/cm^2, which is the limiting factor as compared to the peak limit of 100,000 V/m (2,652,520 mW/cm^2). The allowed 100-ms average at an X-band frequency would be 7,200 mW/cm^2.

Army Standard

The U.S. Army standard (U.S. Army 1987) was derived from the older ANSI RFPG but incorporates a different frequency dependency based on assumptions about the physical height of individuals entering high EMR field areas. Restricted areas are those areas to which access is controlled to exclude entry of persons less than 140 centimeters (55 inches) in stature. The Army standard permits a maximum power density of 5 mW/cm^2 in nonrestricted areas, the same as the 1982 ANSI RFPG.

Commonwealth of Massachusetts

In 1983, the state of Massachusetts adopted a regulation (Massachusetts 1983) that is essentially the same as the 1986 recommendation by the National Council on Radiation Protection and Measurements (NCRP 1986), with levels equal to one-fifth the ANSI RFPG (C95.1-1982) for members of the general public (i.e., 1 mW/cm^2 at the GBR frequency). In this case, the averaging time is 30 minutes. For those occupationally exposed, the state of Massachusetts (Massachusetts 1986) has set a limit identical to the ANSI RFPG (C95.1-1982) that has a 6-minute averaging time (i.e., 5 mW/cm^2) at the GBR frequency.

The existence of the Massachusetts regulations is particularly relevant in the case of the GBR-T and the TMD-GBR systems in as much as the contractor, Raytheon, has its production facilities located within the state of Massachusetts. Raytheon policy is to abide strictly by the Massachusetts code relative to exposure of both their workers and the general public residing within the vicinity of their facilities (Raytheon). Raytheon's Electromagnetic Energy (Nonionizing) Exposure Control policy also contains a provision for using exposure action levels in controlling EMR exposures equal to 0.5 mW/cm^2 averaged over any 6-minute period in the X-band.

Application of Standards in Assessing Environmental Impact

Analytic assessments of the potential for EMR hazards were performed by comparing computed values of electromagnetic field power densities to those values specified by the U.S. Army (Technical Guide No. 153, Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation). This document (Army 1987), which reflects the 1982 recommendations of the ANSI radio frequency protection guide (ANSI 1982), specifies a maximum microwave EMR power density exposure level of 5 mW/cm^2 for a frequency of approximately 10,000 MHz or 10 GHz. In addition, comparisons were made to the added criteria defined in section 1.4.4 including 50 mW/cm^2 as averaged over any 1-second period and 1 mW/cm^2 as averaged over any 6-minute period at distances greater than 2 km in the case of the GBR-T and 1 km in the case of the TMD-GBR.

No federal standard has yet been promulgated for public exposure to electromagnetic fields. The U.S. Environmental Protection Agency (EPA) has attempted to decide on an acceptable exposure limit but, to date, has not yet promulgated any such guidelines. Those limiting power densities for which the EPA sought public comment (EPA 1986) ranged from 0.5 mW/cm^2 to 5 mW/cm^2; the higher end of this range being the same as the 1982 ANSI standard.

Time-Averaging Aspects of the GBR-T and TMD-GBR

The above-described guides, as well as most all microwave protection guides, are based on the time-averaged value of exposure, i.e., the value of power density when averaged over any 6-minute, 30-minute, or other specified time period. The 30-minute averaging time specified in the Massachusetts standard for the general public implies that the microwave power density is not to exceed a value of 1 mW/cm^2 as averaged over any 30-minute period.

The concept of time averaging is important in consideration of the potential exposures that might occur near the GBR-T installation in Kwajalein and the TMD-GBR at the White Sands Missile Range in New Mexico. Because the beam of either radar moves rapidly, depending on the particular mission, it is very unlikely that environmental exposures will ever consist of continuous, constant values of power density. Some special circumstances, such as system calibration, may result in limited periods within which the beam is held constant in a particular direction. But, almost universally, exposures will be intermittent and, when the radars are transmitting, the electromagnetic fields will be constantly changing in intensity. Thus, microwave exposure analyses for the GBR systems that do not take into account the fact that the beam will be commonly moving will significantly overestimate the actual power densities that will occur during normal operation.

Potential EMR Impacts on Wildlife

The EMR protection standards developed for humans are all based on research studies in which animals of various types, principally mammals, have been exposed to microwave fields. Hence, at least for those animals for which adverse effects have been noted in the laboratory, the standards used for humans should apply equally well for lower animals. If environmental exposures are maintained to less than those values given in human exposure standards, then those animals should not be adversely impacted. This situation is applicable to ground level areas around the radars but does not apply necessarily to birds in flight. In this case, birds may fly into the main beam from either of the radars and be subjected, at least momentarily, to very high power densities.

The vast majority of the scientific literature on biological effects in animals does not include much information on birds. However, thermal effects on migrant birds are a matter of concern given the possible power densities associated with either of the GBRs. One approach to evaluating possible adverse impacts of the GBR EMR fields on birds is to analyze the possible power densities to which birds could be exposed and, based on this value, determine the SAR that would be associated with that power density. By comparing the thermal loading imposed on the bird, in terms of SAR, to its metabolic rate expressed in the same unit of W/kg body mass, an estimate of the potential for adverse effects may be obtained.

Though the magnitude of additional thermal load that can be safely compensated for in birds is not known, it is known that birds typically expend energy at up to 10 to 20 times their resting metabolic rate during flight. In normal flight, the metabolic rate of birds is commonly in the range of 7 to 10 times their resting rate. It is not known if birds can tolerate an additional thermal burden equal to the resting metabolic rate or some multiple of this. For purposes of impact analysis, it may be assumed that an additional load equal to the resting metabolic rate, when added to the in-flight metabolic load, may pose a problem.

SARs for birds have not been determined but estimates may be made by assuming that the SARs of small mammals are approximately equivalent to similarly sized birds. When the range of bird sizes is considered, the analysis suggests that there will be an intersection of two functional relationships; one relates the variation in SAR for a given power density as a function of bird size, the other relates the resting metabolic rate of the bird as a function of its size. The qualitative result of this intersection of SAR and metabolic relationships is that for a particular bird size, the ratio of the imposed SAR from microwave exposure at a given frequency to the bird's metabolic rate will be a maximum. A preliminary analysis of these relationships suggests that the greatest potential effects most likely would occur for birds ranging in size from medium-sized songbirds (passerines) to small ducks and hawks.

For birds in the weight range of 25 grams to 3.5 kg, SAR and resting metabolic calculations indicate that EMR power densities that would deliver an energy input rate equivalent to the resting rate would range between approximately 38 mW/cm^2 and 61 mW/cm^2. An analysis for the Aplomado falcon, in particular, resulted in a projected hazard power density of 42 mW/cm^2.

Care must be used in assessing possible adverse impact on birds in this fashion, however, since the SARs in the heads of larger birds may closely approximate the whole body SARs of the small birds. If this were the case, then lower power densities than projected for controlling only whole-body SAR in the birds might be required to ensure safety. When birds are in flight, their metabolic rates are significantly elevated; therefore, it might be possible that birds can tolerate higher local SARs when at rest than when in flight.

Several important mitigating aspects of the exposure of birds include the fact that the radar beams are relatively small in the near vicinity of the radars where the beam power density will be greatest. To remain in the beam for any period of time requires that the bird fly directly toward the radar along the beam trajectory path, or that it hover for a significant time in the beam. Another factor is whether or not the beam remains stationary. This is contrary to the normal operation of both radar systems in which the beam is constantly moving, covering a relatively wide angle of space. Although there is insufficient information to make a quantitative estimate of the joint probability of such an occurrence, it is probably low. Thus, although the potential for significant effects on birds exists, the probability that it can occur with any frequency is judged to be low.

One approach to deriving a quantitative estimate of the probability of a bird receiving an exposure to EMR that could pose a hazard is to consider the percentage of the volumetric space near the radar that will contain potentially hazardous power densities. For example, if the instantaneous volume of space within which the projected power density can reach a hazard threshold is divided by the total volume of space within which this instantaneous hazard volume (beam) may exist, based on scan and elevation angles, the resulting fraction may be thought of as an expression of probability that a hazard volume exists at any given moment. An analysis of this type, performed for the TMD-GBR and based on a presumed hazard power density of approximately 42 mW/cm^2 (271 mW/in^2), determined that the ratio of the instantaneous hazard volume to the total possible affected area would range between 0.00014 and 0.00025, depending on the particular elevation of the radar beam. Hence, at any given moment, for a bird in flight in front of the radar, the likelihood that the bird would be exposed to a potentially hazardous power density is in the range of only one part in 4,000 to 7,000 or, alternatively, 0.014 to 0.025 percent of the time. When this finding is combined with the knowledge that the bird would have to remain continuously within the hazard volume for a protracted period of time of approximately 6-minutes, the overall probability for adverse impact is extremely small.

A similar analysis of microwave absorption characteristics for wildlife mammals, such as rats, mice, rabbits and dogs determined that EMR power densities in the range of 20 mW/cm^2 to 42 mW/cm^2 would be required to deliver an SAR equivalent to their metabolic rate. Since these animals will be found at ground level, and all 6-minute time-averaged power densities along the ground will be controlled to less than 5 mW/cm^2, this analysis also supports the position that such wildlife will not be adversely affected, since, at maximum, the greatest SAR that would be projected as possible would be only one-fourth of the animal's resting metabolic rate.

Consideration of Nonbiological Impacts

Beyond the evaluation of possible hazards to humans exposed to the GBR EMR, additional consideration must be given to the potential for nonbiological impacts such as electromagnetic interference and inadvertent detonation of EEDs. These possible impacts may be assessed by referring to applicable guidelines and policies.

Aircraft Avionics Systems

In recent years, the introduction of high technology digital avionics systems that control critical functions in aircraft has raised the issue of possible interference with these systems by HIRF. Critical systems are defined as those that would result in the aircraft crashing, if they were to be rendered inoperative by HIRF. Examples of these types of systems include the Electronic Flight Instrument System (EFIS), Full Authority Digital Engine Control (FADEC), Inertial Reference System (IRS), and the Auxiliary Control System (ACS). The use of digital electronics in these systems may make them particularly vulnerable to HIRF. Present Federal Aviation Administration (FAA) regulations do not contain adequate or appropriate safety standards for the protection of these systems from the effects of HIRF (FAA 1992a).

Airplane designs that use metal skins and mechanical means to command and control the airplane and engines have traditionally been immune to the effects of HIRF from ground-based transmitters. However, with the trend toward increased HIRF levels from these sources, plus the advent of space and satellite communications coupled with digital electronic command and control of airplane engines, the airplane's immunity to HIRF is in question.

The FAA, in attempting to address this issue, began several years ago to develop criteria by which manufacturers could certify their avionic equipment and systems to be free of potential HIRF interference. The approach taken by the FAA and which continues to evolve involves the development of so-called envelopes of normal and severe HIRF environments representing the kind of HIRF environments that aircraft will experience.

The normal environment represents the magnitude of electric fields, in terms of peak and average values, that may commonly be found near large airports. In fact, data were obtained by field studies at between 10 and 20 airports both within the United States and at some selected airports in other countries. The envelopes consist of the maximum anticipated electric field strengths within various frequency bands beginning at very low frequencies and extending into the microwave band. For the normal HIRF environment, the electric field strength values specified by the envelope applicable to the GBR emissions are 1,100 V/m peak (equivalent to a peak power density of 321 mW/cm^2) and 230 V/m average (equivalent to an average power density of 14.0 mW/cm^2).

In addition to the normal HIRF environment, the FAA has defined a severe HIRF environment, which takes into account a wider range of possible high power emitters than those found only in the region of airports. Correspondingly higher values of electric field strengths are specified in some of the frequency bands. For the GBR frequency band, these limits are 3,820 V/m peak (equivalent to a peak power density of 3,871 mW/cm^2) and 1,270 V/m average (equivalent to an average power density of 428 mW/cm^2) (FAA 1992b). While these envelopes of normal and severe HIRF environments still have not been codified in an official FAA regulation, they are being used by the FAA in the interim to qualify aircraft avionic systems.

Presently, manufacturers are permitted two methods to qualify their avionic equipment: either the equipment is tested in some manner such that when the exterior of the aircraft is exposed to the above-listed fields there is no failure of the critical systems, or when directly exposed to a field of 100 V/m without the shielding afforded by the protective skin of the aircraft there must be no equipment interference.

A proposed revision of Military Standard 461D for EMR susceptibility limits (RS-102) contains specifications for various categories of environments. This draft standard specifies a 200-V/m average electric field strength limit for fields external to military aircraft.

Recently, it was announced that the National Transportation Safety Board and the FAA would conduct tests to determine if HIRF could have caused autopilot excursions that led to the inflight breakup of seven Piper Malibu business aircraft (Phillips 1991). The testing was to be done because of the observation that antennas of various types were located in the general area of all seven crash sites; such an observation may have been purely coincidental.

These standards and equipment qualification field strength limits specify those field values to which equipment is to be hardened. They represent measures of performance of the equipment, not limits on the environments within which aircraft may fly. The issue remains as to how to avoid the potential for interference with aircraft critical systems if the environment exceeds the limits of the so-called severe HIRF envelope. Such might be the possibility for aircraft transiting the region where the GBR may be installed when flying through the main beam.

Other Nonbiological Impact Considerations

Assessing the potential for other nonbiological environmental impacts of the GBR electromagnetic fields requires consideration of several factors including possible impact on electroexplosives, refueling operations, and interference with communications electronics equipment. These factors may be investigated by comparing projected radar power densities to values contained in various standards relevant to each issue.

The GBR-T is about 2.1 km from Bucholz Army Airfield on Kwajalein Island, and electromagnetic radiation from the radar that might impact personnel and aircraft activities at the airport will be controlled. In addition to the potential hazard to personnel identified above, large electromagnetic fields can detonate electroexplosive devices (EEDs) or induce malfunctions in avionics equipment on aircraft. Actions similar to those described above for mitigating personnel exposure will limit EMR power density at the airport, except that power density criteria for human exposure and for EED safety will be applied. Currently, the limit for EEDs is an instantaneous power density of 10 mW/cm^2.

If aircraft in flight are illuminated at close range by the radar, malfunctions induced in avionics equipment or EED detonations are possible. Prior permission from the commander of USAKA is required to land at Bucholz and the airspace out to 180 nmi is controlled by the tower or the FAA Air Route Traffic Control Center (ARTCC) at Oakland, California, so aircraft without the knowledge and permission of an air traffic control authority are not permitted to fly within the controlled airspace zone of GBR-T. Local flights are managed by the tower and USAKA flight operations. Because all GBR-T operations that involve transmitting EMR energy would be considered Kwajalein Missile Range (KMR) operations, GBR-T operations would be coordinated with other activities, including range safety and flight safety, through the range scheduling organization. The range schedule is therefore the probable vehicle for coordinating GBR-T operation with flight operations to avoid illuminating aircraft at close range. In addition, communication procedures will be established with the tower and the range safety organization to inhibit EMR immediately, should an unplanned penetration of a hazard zone occur. Additional safety measures to be developed in cooperation with FAA and USAKA flight safety personnel would be designation of any aviation hazard areas needed, publication of Notices To Airmen (NOTAM), and briefings to local aviators about any safety procedures that may be needed regarding GBR-T.

The potential for impact on communications electronics systems is suggested by recent studies conducted by the Electromagnetic Compatibility Analysis Center (ECAC, 1993a; 1993b) for both the GBR-T and the TMD-GBR. These studies examined the potential for interference from the GBR-T and TMD-GBR to communications-electronics systems which operate both within and outside of the GBR frequency band due to so-called high power effects (HPE) and, for other radar systems, the number of undesired pulses that might be detected by the radars leading to objectionable obscuring of the visual images presented on the radar screen.

In the ECAC analyses, information on the GBR-T antenna gains for the main beam, the peak grating lobes and the typical side lobes were used to compute expected field magnitudes in the vicinity of the GBR-T. Their analysis, conducted for the actual systems present at USAKA, revealed the potential for HPE to AM, FM, and TV reception due to the presence of grating lobes in the distance range of 2.1 to 4.5 km. With systems such as walkie talkies, ECAC estimated that some degree of interference could exist within 30 km, under the maximum grating lobe condition. Additional analyses, based on an assumption of the average side lobe level of radiation from the GBR-T antenna, showed greatly reduced distances within which potential interference might occur. For example, the interference distance for broadcast reception was reduced to only 0.04 km, and that was found to extend only to 0.79 km for walkie talkies.

The most significant finding from the ECAC studies of the GBR-T and TMD-GBR pertained to airborne and shipboard weather radars that operate within the X-band frequency range. For the GBR-T analysis, ECAC examined four different frequency shifts (chirps) and three pulse widths for each shift, which represents a range of possible operating conditions for the radar. Using a criterion developed from the experience of air traffic controllers of 100 pulses displayed on the radar screen, during any sweep on the screen, as being obstructive to performing air controller tasks, ECAC analyzed the number of pulses that might be observed for each GBR-T operating condition. Their preliminary results indicated that aircraft weather radars might be subject to wide chirp interference out to 461 km (249 nautical miles ([nmi]) under normal propagation conditions and out to 629 km (340 nmi) under ducting conditions. It also was concluded, however, that storm systems may not be obscured by interference, as defined by the 100-pulses-displayed criteria. This conclusion is based on the apparent greater need for detail in viewing an air traffic control radar screen and identifying aircraft as compared to being able to clearly observe specific detail on a weather radar screen.

The ECAC preliminary study results for GBR-T were separated among in-band, adjacent-band and out-of-band systems and included the following findings:

(1) SDR. The results indicated a potential for GBR-T interference to the Splash Detection Radar (SDR) located on the island of Gellinam. When the SDR is being used for the detection of the splash from a test missile in the KMR lagoon, the number of displayed GBR-T pulses would exceed the 10 pulse per sweep threshold for 9 of the 12 waveforms examined in the analysis. (A lower threshold of only 10 pulses per sweep was established for the more critical SDR functions of observing a missile). When the SDR is used for monitoring ship traffic in the lagoon, typically prior to the start of a mission, the analysis indicated that the number of displayed GBR-T pulses would exceed the 100 pulse per sweep threshold for 4 of the 12 waveforms but only for the relatively wide chirp widths when the GBR-T is operated at its maximum duty cycle for each waveform. ECAC noted that these particular waveforms are not the predominant ones that will be used by GBR-T and may have limited use at the maximum pulse repetition frequency used for the analysis.

(2) Marine Navigation Radar. The average number of GBR-T pulses displayed on the typical marine navigation radar (located at 5 km from the GBR-T) would exceed the threshold of 100 pulses per sweep for most of the waveforms examined (8 of 12 waveforms). The distance separation required to reduce the number of displayed pulses below the threshold ranged from 7 to 25 km for the narrow and medium chirp waveforms to 39 to 73 km for the wideband waveforms. ECAC noted that the use of slightly lower than maximum PRFs would reduce the number of displayed pulses to less than 100 per sweep.

These results were applied to the four fixed marine navigation radars that are used by the KMR for range security. The 100 pulses per sweep threshold would be exceeded at the fixed radar located on Kwajalein Island for all of the cases examined except the long pulse width waveforms. The 100 pulse threshold would not be exceeded at the fixed radars located on Meck and Illeginni for any of the narrow or medium chirp waveforms, but would be exceeded at the short and medium pulse width cases for the wideband chirp waveforms. The pulse display count at the fixed radar located on Roi-Namur would not exceed the threshold for any of the GBR-T waveforms.

(3) Aircraft Weather Radar. The average number of GBR-T pulses displayed on the typical aircraft weather radar examined would exceed the threshold of 100 pulses per sweep for 6 of the 12 waveforms examined in the analysis. The distance

separation required to reduce the number of displayed pulses below the threshold ranges from 21 km for the medium chirp waveforms to between 137 and 461 km for the wideband waveforms. ECAC again noted that if the duration of the use of the wideband waveforms is short, as suggested by Raytheon, the impact on airplane flights would be minimal. ECAC determined that the only air routes in the vicinity of the KMR that are within 466 km of the GBR-T site are bound for (or leaving) KMR or Marshall Island International Airport.

(4) Out-of-band Equipment. For other types of equipment in the KMR area, that operate on frequency ranges neither within or adjacent to the GBR-T frequency range, ECAC examined the potential for so-called high power effects (HPE). HPE typically occurs in receivers located close to high power transmitters. HPE is inherently a non-linear effects and is difficult to predict. ECAC used two different threshold to evaluate the potential for HPE to out-of-band equipment; a power density of 1 mW/cm^2 was used for military equipment and a power density of 0.1 mW/cm^2 for civilian equipment when no measured data were available. The results of the ECAC analysis are summarized in Table A-2.

These preliminary findings are subject to revision as ECAC continues to study the issue of possible interference from the GBR-T, including the possibility that the magnitude of possible impact may be significantly reduced. However, these findings are clearly suggestive of the potential for some interference with airborne weather radar systems and, possibly, with marine navigation radars. At this point, it must be concluded that such weather radar interference represents a possible, but not certain, impact. Accordingly, pending additional data on the degree of actual impact, aircraft activity within the region of the GBR-T will be subject to the publishing of an appropriate NOTAM (Notice to Airmen) to advise avoidance of the area.

Additional study will be necessary before more definitive statements about broadcast interference can be made.

A similar analysis has been prepared for the White Sands Missile Range, with particular attention being given to the possibility of interference to the various radars found on the range. Again, using several scenarios of pulse widths and pulse repetition frequencies, for a total of nine different waveforms, the ECAC found that there was a potential for disruptive interference to several radars.

The ECAC study (ECAC 1993b) resulted in the following highlights:

(1) Aircraft Weather Radar (AN/APN-158). The results of the analysis indicated that the average number of interference pulses displayed on a radar scope might exceed the 100 pulses per sweep threshold for the wide chirp widths. For two of the nine waveforms, an average of 889 pulses and 277 pulses per sweep were predicted. Distance separations (based on an aircraft altitude of 30,000 feet and line-of-sight propagation) of 202 km and 249 km, respectively, were required to preclude interference. An examination of the navigation charts for the WSMR area indicates a large number of air-routes which would bring aircraft closer than the distance separation requirements specified for this weather radar. Reduction in interference could be reduced by reducing the PRF for the wide band waveforms.

Table A-2
Summary of separation distances within which HPE from the GBR-T is possible as determined by ECAC (1993a)

Receiver Type	Distance Separations in km for Given Coupling Conditions: Main Beam	Max GL	Average Side Lobe
Commercial AM	__[a]	4.0	0.04
Commercial FM	__[a]	4.5	0.04
TV	__[a]	2.1	0.02
VOR	2.5	__[b]	__[b]
Glideslope	1.4	__[b]	__[b]
Marker/beacon	5.6	0.4	__[b]
IFF	28	3.0	0.03
AN/ARN-52	56	6.0	0.06
DME-70	18	1.8	0.02
AN/VRC-12	__[a]	0.7	__[b]
Land mobile UHF	__[a]	3.0	0.03
Land mobile VHF	__[a]	20	0.18
Walkie talkie	__[a]	30	0.79
Other commercial systems	__[a]	25	0.22
Other military	__[a]	7.0	0.07

[a] Main beam coupling not expected.
[b] Power density below threshold at all distances.

(2) Precision Approach Radar (AN/FPN-62). No interference to this radar was predicted from the eight potential TMD-GBR test sites as WSMR.

(3) Fire Control Radars (AN/AWG-9). The results of the ECAC analysis indicated that the potential for interference was only predicted for the use of the wide chirp widths. Distance separations of 280 km, 395 km and 499 km for three of the waveforms, respectively, might be required to preclude potential interference to these radars. The distance separations for two of these waveforms could be significantly reduced by lowering the PRF.

(4) Mortar Locating Radars (AN/TPQ-36). The ECAC results indicated that interference from the TMD-GBR is predicted for all pulse widths of the wide chirp waveforms and for the medium pulse width of the narrow chirp. Distance separations of 21 km and 29 km would be required for three of the waveforms to preclude the potential for interference. Since the AN/TPQ-36 radar is transportable, it was not possible to compute the propagation loss using a terrain dependent propagation model.

Instead, a smooth-earth model was used. ECAC noted that it might be possible to substantially reduce the required distance separation using the effects of terrain shielding.

(5) Terrain Avoidance Radars (AN/APQ-170). The ECAC results indicated that the potential for interference was only predicted for the use of the wide chirp widths. Distance separations (based on an aircraft altitude of 30,000 feet and line-of-sight propagation) of 340 km and 404 km for four of the nine waveforms may be required to preclude potential interference to these radars. These distance separations can be significantly reduced by lowering the PRF. As more detailed information regarding the typical expected PRF for the wide band waveforms are made available to ECAC, the potential for interference to this radar will be reevaluated.

(6) CW Illuminator (Hawk AN/MPQ-57) and Fire Control Radars (Hawk AN/MPQ-55). The results of the ECAC analysis indicated that interference from the TMD-GBR was predicted for all pulse widths of the wide chirp waveforms and for the medium pulse width of the narrow chirp. Distance separations of from 20 to 30 km were determined to be required for three of the waveforms to preclude the potential for interference. For either of these two radar types, since they are mobile, it may be possible to substantially reduce the required distance separation using the effects of terrain shielding.

While the above described analysis would suggest the potential for an interference problem, the reality of normal, very small beam dwell times, in the range of only 10-20 milliseconds, argues for an extremely low likelihood of the number of pulses estimated by ECAC to actually show up on a given radar screen.

For the TMD-GBR, however, it also appears that airborne weather radar in the region could experience interference when the TMD system is operating. Coordination of activities with the FAA would mitigate the airborne weather radar equipment interference problems.

APPENDIX B
ENVIRONMENTAL ATTRIBUTES, APPLICABLE LAWS AND REGULATIONS, AND COMPLIANCE REQUIREMENTS

APPENDIX B

Environmental Attributes, Applicable Laws and Regulations, and Compliance Requirements

The following Federal environmental laws and regulations were reviewed to assist in determining the significance of environmental impacts under the NEPA. This is not intended to be an all-inclusive list of federal and state regulations.

Air Quality – The Clean Air Act seeks to achieve and maintain air quality to protect public health and welfare. To accomplish this, Congress directed the EPA to establish National Ambient Air Quality Standards (NAAQS). Primary standards protect public health; secondary standards protect public welfare (vegetation, property damage, scenic value, etc.). Standards cover sulfur dioxide, particulates, carbon monoxide, ozone, hydrocarbons, and nitrogen dioxide. The NAAQS for these pollutants are described in Table B-1.

Primary responsibility to implement the Clean Air Act rests with each state. However, each state must submit a state implementation plan outlining the state's strategy for attaining and maintaining the NAAQS within the deadlines established by the Act.

The Clean Air Act mandates establishment of performance standards, called New Source Performance Standards, for new and modified stationary sources to keep new pollution to a minimum. Under the Act, the EPA can establish emission standards for "hazardous" air pollutants for both new and existing sources. So far, the EPA has set air emission standards for beryllium, mercury, asbestos, vinyl chloride, and other hazardous materials including radioactive materials.

The Clean Air Act also seeks to "prevent significant deterioration" (PSD) of air quality in areas where the air is cleaner than that required by the NAAQS. Areas subject to PSD regulation have a Class I, II, or III designation. Class I allows the least degradation.

Nonattainment policies also exist. A nonattainment area is one where monitoring data or air quality modeling demonstrates a violation of the NAAQS. Nonattainment policies prevent construction or modification of any source that will "interfere with" attainment and maintenance of ambient standards. A new source must demonstrate a net air quality benefit. The source must secure "offsets" from existing sources to achieve the air quality benefit.

Biological Resources – The Endangered Species Act declares that it is "the policy of Congress that all federal departments and agencies shall seek to conserve endangered species and threatened species." Further, the Act directs federal agencies to "use their authorities in furtherance of the purposes of the Act."

Table B-1
National Ambient Air Quality Standards

Pollutant	Averaging Time	Primary Standard[a]	Secondary Standard[b]	General Objectives
Ozone	1 hr	235 μg/m^3 (0.12 ppm)	235 μg/m^3 (0.12 ppm)	To prevent eye irritation and possible impairment of lung functions in persons with chronic pulmonary disease, and to prevent damage to vegetation.
Carbon monoxide	8 hr	10 mg/m^3 (9 ppm)	10 mg/m^3 (9 ppm)	To prevent interferences with the capacity to transport oxygen in the blood.
	1 hr	40 mg/m^3 (35 ppm)	40 mg/m^3 (35 ppm)	
Nitrogen dioxide	Annual average	100 μg/m^3 (0.05 ppm)	100 μg/m^3 (0.05 ppm)	To prevent possible risk to public health and atmospheric discoloration.
Sulfur dioxide	Annual average	80 μg/m^3 (0.03 ppm)	—	To prevent pulmonary irritation.
	24 hr	365 μg/m^3 (0.14 ppm)		
	3 hr	—	1,300 μg/m^3 (0.5 ppm)	To prevent odor.
Suspended particulate matter (PM_{10})	Annual average	50 μg/m^3	—	To prevent health effects attributable to long continued exposures.
	24 hr	150 μg/m^3	—	

Sources: Rau, J.G. and D.C. Wootan (editors). 1980. *Environmental Impact Analysis Handbook.* McGraw Hill.
U.S. Department of the Air Force. 1989. *Draft Environmental Impact Statement, Construction and Operation of Space Launch Complex 7 Vandenberg Air Force, California.* July 20.

[a] National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect public health.
[b] National Secondary Standards: The levels of air quality necessary to protect public welfare from any known or anticipated adverse effects of a pollutant in the ambient air.

The Secretary of the Interior creates lists of "endangered" and "threatened" species. The term "endangered species" means "any species which is in danger of extinction throughout all or a significant portion of its range." The Act defines a "threatened species" as any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

The key provision of the Act for federal activities is Section 7 Consultation. Under Section 7 of the Act, every federal agency must consult with the Secretary of the Interior, U.S. Fish and Wildlife Service (USFWS), to ensure that any agency action (authorization, funding, or carrying out) is "not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species."

The Bald and Golden Eagle Protection Act establishes penalties for the unauthorized taking, possession, selling, purchase, or transportation of bald or golden eagles, their nests, or their eggs. Any federal activity that might disturb eagles requires consultation with the USFWS for appropriate mitigation.

The Marine Mammal Protection Act restricts the taking and importing of marine mammals. although it has no direct effect on federal activities, the Act reflects Congress' intent to afford protection to "certain species and population stocks of marine mammals [which] are, or may be, in danger of extinction or depletion as a result of man's activities."

In the Fish and Wildlife Conservation Act, Congress encourages "all federal departments and agencies to utilize their statutory and administrative authority, to the maximum extent practicable and consistent with each agency's statutory responsibilities, to conserve and to promote conservation of nongame fish and wildlife and their habitats." Further, the Act encourages each state to develop a conservation plan.

Whenever a federal department or agency proposed or authorized the modification, control, or impoundment of the waters of any stream or body of water (greater than 10 acres), including wetlands, that agency must first consult with the USFWS under the Fish and Wildlife Coordination Act. Any such project must make adequate provision "for the conservation, maintenance and management of wildlife resources." The Act requires a federal agency to give full consideration to the recommendations of the USFWS and to any recommendations of a state agency on the wildlife aspects of a project.

The Migratory Bird Treaty Act protects many species of migratory birds. Specifically, the Act prohibits the pursuit, hunting, taking, capture, possession, or killing of such species or their nests and eggs. The Act further requires that any affect federal agency or department must consult with the USFWS to evaluate ways to avoid or minimize adverse effects on migratory birds.

Cultural Resources – Under the National Historic Preservation Act, the Secretary of the Interior has authority "to expand and maintain a National Register of Historic Places composed of districts, sites, buildings, structures and objects significant in American history, architecture, archeology, engineering and culture." Section 106 of the National Historic Preservation Act requires federal agencies to consider the effects of their action and seek comments from an independent reviewing agency, the President's Advisory Council on Historic Preservation. The purpose of the section 106 consultation is to avoid unnecessary harm to historic properties from federal actions.

By Executive Order, federal agencies must "Initiate measures and procedures to provide for the maintenance or restoration of federally owned and registered sites." Specifically, a federal agency must consult with the Secretary of the Interior, the Advisory Council on Historic Preservation, and the State Historic Preservation Officer when a project or activity involves an historic site.

The Historic Sites Act declares that it is "a national policy to preserve for public use historic sites, buildings and objects of national significance for the inspiration and benefit of the people of the United States." In administering the Act, the Secretary of the Interior "may seek and accept the assistance of any federal, state, or municipal department or agency."

Under the National and International Monuments Act, the President may declare historic landmarks and structures on federal government-controlled land to be national monuments. As part of the designation, the President may reserve a further area "compatible with the proper care and management of the objects to be protected."

The Antiquities Act permits the Secretaries of the Interior, Agriculture, and Army to issue permits "for the examination of ruins, the excavation of archaeological sites and the gathering of objects of antiquity upon lands under their respective jurisdictions." Such permits must serve educational or scientific purposes.

The American Indian Religious Freedom Act states that it is the policy of the United States to protect and preserve the rights of American Indians to believe, express, and exercise tribal religious beliefs.

The Archaeological and Historic Preservation Act provides for the preservation of historical and archaeological data that might otherwise be lost as a result of "any alternation of the terrain caused as a result of any federal construction project or federally licensed activity or program." Under the Act, the Secretary of the Interior can require a survey of an affected site and can require the recovery, protection, and preservation of data.

The Archaeological Resources Protection Act's (ARPA) purpose is "to secure for the present and future benefit of the American people the protection of archaeological resources and sites which are on public lands and Indian lands." ARPA provides for the excavation and removal of archaeological resources prior to surface-disturbing activities. A cultural resources management survey or plan may precede a removal.

The ARPA requires a permit from the Department of the Interior for any excavation or removal of archaeological resources from public or Indian lands. Excavations must be undertaken for the purposes of furthering archaeological knowledge in the public interest. On Indian lands, the Indian tribe must grant consent prior to issuance of a permit, and can request that the permit contain certain conditions.

Hazardous Materials and Wastes – Under the Resource Conservation and Recovery Act (RCRA), Congress declares the national policy of the United States to be that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste that is nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment.

RCRA defines wastes as "hazardous" through four characteristics: ignitability, corrosivity, reactivity, or toxicity. Once defined as a "hazardous" waste, RCRA establishes a comprehensive "cradle to grave" program to regulate hazardous wastes from generation through proper disposal or destruction.

RCRA also establishes a specific permit program for the treatment, storage, and disposal of hazardous wastes. Both interim status and final status permit programs exist.

Any underground tank containing hazardous waste is also subject to RCRA regulation. Under the Act, an underground tank is one with 10 percent or more of its volume underground. Underground tank regulations include design, construction, installation, and release detection standards.

RCRA defines solid waste as "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining and agricultural operations and from community activities." To regulate solid waste, RCRA provides for the development of state plans for waste disposal and resource recovery. RCRA encourages and affords assistance for solid waste disposal and resource recovery. RCRA encourages and affords assistance for solid waste disposal methods that are environmentally sound, maximize the utilization of valuable resources, and encourage resource conservation.

RCRA also regulates mixed wastes. A mixed waste contains both a hazardous waste and radioactive component.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) – commonly known as Superfund – provides for funding, cleanup, enforcement authority, and emergency response procedures for releases of hazardous substances into the environment.

The CERCLA covers the cleanup of toxic releases at uncontrolled or abandoned hazardous waste sites. By comparison, the principal objective of the RCRA is to regulate active hazardous waste storage, treatment, and disposal sites to avoid new Superfund sites. The RCRA seeks to prevent hazardous releases: a release triggers the CERCLA.

The goal of the Superfund program is to clean up sites where releases have occurred or may occur. A trust fund supported, in part by a tax on petroleum and chemicals supports the Superfund. The Superfund allows the government to take action now and seek reimbursement later.

The CERCLA also mandates spill reporting requirements. The Act requires immediate reporting of a release of a hazardous substance (other than a Federally permitted release) if the release is greater than or equal to the reportable quantity for that substance.

Title III of the Superfund Amendments and Reauthorization Act is a freestanding legislative program known as the Emergency Planning and Community Right-to-Know Act of 1986. The Act requires (1) immediate notice for accidental releases of hazardous substances and extremely hazardous substances; (2) information to local emergency planning committees for the development of emergency plans; and (3) material Safety Data Sheets, emergency and hazardous chemical inventory forms, and toxic release forms.

The law requires each state to designate a state emergency response commission. In turn, the state must designate emergency planning districts and local emergency planning commissions. The primary responsibility for emergency planning is at the local level.

The Toxic Substances Control Act authorizes the Administrator of the EPA to protect health and the environment from harmful chemicals and mixtures. The Act regulates chemicals without regard to specific use or area of application.

Health and Safety – The Occupational Safety and Health Act's (OSHA) purpose is to "assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources."

The Act further provides that each federal agency has the responsibility to "establish and maintain" an effective and comprehensive occupational safety and health program that is consistent with national standards. Each agency must:

- provide safe and healthful conditions and places of employment;
- acquire, maintain, and require use of safety equipment;
- keep records of occupational accidents and illnesses; and
- report annually to the Secretary of Labor.

Finally, the Superfund Amendments and Reauthorization Act requires the Occupational Safety and Health Administration to issue regulations specifically designed to protect workers engaged in hazardous waste operations. The OSHA hazardous waste rules include requirements for hazard waste operations. The OSHA hazardous waste rules include requirements for hazard communication, medical surveillance, health and safety programs, air monitoring, decontamination, and training.

Land Use – Congress enacted the Coastal Zone Management Act to stimulate land use planning in coastal areas. The statute provides federal grants as a voluntary inducement to the development and adoption of state management programs. Under the Act, the Secretary of Commerce through the Office of Coastal Zone Management in the National Oceanic and Atmospheric Administration exercises federal administrative responsibility for the program.

The Act specifies that any federal agency conducting activities, supporting activities, or undertaking any development project within the coastal zone must ensure that those activities or projects are "to the maximum extent practicable, consistent with approved state management programs."

Executive Order 11990, Protection of Wetlands, seeks "to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative."

In particular, the President directs each federal agency to minimize the loss or degradation of wetlands when: (1) acquiring, managing, and disposing of federal lands and facilities;

(2) providing federally financed or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use.

Executive Order 11988 (Amended by Executive Order 12148), Floodplain Management, seeks "to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative."

In particular, the President directs each federal agency to take action to reduce the risk of flood loss when: (1) acquiring, managing, and disposing of federal lands and facilities; (2) providing federally financed or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use.

Before taking an action, a federal agency must determine whether the proposed action will occur in a floodplain. If so, the agency must consider alternatives to avoid adverse effects and incompatible development in the floodplains. If an agency will be undertaking new construction, the agency must apply accepted flood-proof and other flood-protection measures.

Noise – The federal Noise Control Act directs all federal agencies "to the fullest extent within their authority" to carry out programs within their control in a manner that furthers the promotion of "an environment for all Americans free from noise that jeopardizes their health or welfare."

The Act requires a federal department or agency engaged in any activity resulting in the emission of noise to comply with "federal, state, interstate, and local requirements respecting control and abatement of environmental noise."

Water Quality – The objective of the Clean Water Act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

The Clean Water Act prohibit any discharge of pollutants into any public waterway unless authorized by a permit. The National Pollutant Discharge Elimination System (NPDES) permit establishes precisely defined requirements for water pollution control.

The EPA is the principal permitting and enforcement agency for NPDES permits. This authority may be delegated to the states.

The Clean Water Act requires all branches of the federal government involved in an activity that may result in a point source discharge or runoff of pollution to waters of the United States to comply with applicable federal, interstate, state, and local requirements.

NPDES permit requirements typically include (1) effluent limitations (numerical limits on the quantity of specific pollutants allowed in the discharge); (2) compliance schedules (abatement program completion dates); (3) self-monitoring and reporting requirements; and (4) miscellaneous provisions governing modifications, emergencies, etc.

The Clean Water Act also creates a permit system for the discharge of dredge and fill material in waters of the United States, including their wetlands. The U.S. Army Corps of Engineers administers the Dredge and Fill Permit program.

The Rivers and Harbors Act of 1899 is one of our country's oldest pollution laws. The Act prohibits the unauthorized obstruction or alternation of any navigable water. Moreover, the Act prohibits the discharge of "any refuse matter of any kind or description" into any navigable water.

The Safe Drinking Water Act sets primary drinking water standards for owners/operators of public water systems and seeks to prevent underground injection that can contaminate drinking water sources.

The EPA has adopted National Primary Drinking Water Regulations, 40 CFR 141, that define maximum contaminant levels in public water systems. Further, the EPA may adopt a regulation that requires the use of a treatment technique in lieu of a maximum contaminant level. The EPA may delegate primary enforcement responsibility for public water systems to a state.

The Marine Sanctuaries Act regulates ocean dumping. The Act regulates the dumping of material into ocean waters "which would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities." Any ocean dumping requires an Ocean Dumping Permit from the EPA. Additionally, this Act designates and protects "areas of the marine environment of special national significance due to their resource or human-use values." Activity within a national marine sanctuary requires a Special Use Permit from the Secretary of Commerce.

The Compact of Free Association between the United States and the Republic of the Marshall Islands. This agreement declares a mutual policy to promote efforts to prevent or eliminate damage to the environment and biosphere and to enrich the understanding of the natural resources of the Marshall Islands. More specifically, under Section 161(a), the United States agreed to the following:

- Section 161(a)(1)—Apply pre-Compact environmental controls to its continuing activities.
- Section 161(a)(2)—Apply NEPA of 1969 to its activities under the Compact as if the RMI were the United States.
- Section 161(a)(3)—Comply with standards substantively similar to those required by six enumerated U.S. environmental laws to any of its activities requiring the preparation of an EIS under NEPA:
    - Endangered Species Act, 16 U.S.C. 1531, et seq.
    - Clean Air Act, 42 U.S.C. Supp. 7401, et seq.
    - Clean Water Act, 33 U.S.C. 1251, et seq.
    - Ocean Dumping Act, 33 U.S.C. 1401, et seq.
    - Toxic Substances Control Act, 15 U.S.C. 2601, et seq.
    - Resources Conservation and Recovery Act, 42 U.S.C. 6901, et seq.
    - Such other environmental protection lays of the United States as may be mutually agreed upon from time to time with the government of the Marshall Islands or the Federated States of Micronesia.
- Section 161(a)(4)—Develop appropriate mechanisms, including regulations or other judicially reviewable standards and procedures to regulate its activities in the RMI in participation with federal agencies designated to administer those laws.

Section 161(c) recognizes the right of the respective governments to modify or supersede such standards or procedures by mutual agreement. Section 161(e) permits the President of the United States to exempt United States activities from environmental standards or procedures only if in the paramount interests of the United States to do so (Table B-2).

Table B-2
Environmental laws of the United States applicable to USAKA activities

7 U.S.C. 131-136y	Federal Insecticide, Fungicide, and Rodenticide Act
15 U.S.C. 2601	Toxic Substances Control Act
16 U.S.C. 470	National Historic Preservation Act
16 U.S.C. 469	Archaeological and Historic Preservation Act
16 U.S.C. 1531	Endangered Species Act of 1973
33 U.S.C. 1251	Clean Water Act
33 U.S.C. 1401-1445	Ocean Dumping Act
42 U.S.C. 300f-300j	Safe Drinking Water Act
42 U.S.C. 4901-4918	Noise Control Act
42 U.S.C. 6901-6992k	Resource Conservation and Recovery Act/Solid Waste Disposal Act
42 U.S.C. 7401	Clean Air Act
42 U.S.C. 9601-9675	Comprehensive Environmental Response, Compensation, and Liability Act
42 U.S.C. 1801	Hazardous Material Transportation Act

Source: USASSDC 1993

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