U.S. Army Kwajalein Atoll Temporary Extended Test Range

Environmental Assessment

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The U.S. Army Kwajalein Atoll (USAKA) Temporary Extended Test Range program would be conducted to obtain sensor data on missiles with a range of 220 to 310 miles. Theater Missile Defense (TMD) interceptors would intercept the missiles to demonstrate the feasibility of TMD intercepts. Up to eight liquid and/or solid propellant missiles would be launched from Bigen Island, Aur Atoll, toward the USAKA. A PATRIOT missile would be launched from either Illeginni or Meck Island within the USAKA to intercept the target missile either over the mid-atoll corridor within the Kwajalein Lagoon or over the broad ocean area east of the USAKA. A variety of ground, ship, air, and satellite sensors would gather data on the flight test experiment. The proposed action would involve transport of target missiles and minimal site preparation activities to establish a temporary launch site on Bigen Island, Aur Atoll.

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U.S. ARMY KWAJALEIN ATOLL
TEMPORARY EXTENDED TEST RANGE PROGRAM

UNITED STATES ARMY SPACE AND STRATEGIC DEFENSE COMMAND

AGENCY: U.S. Army Space and Strategic Defense Command (USASSDC)

ACTION: Finding of No Significant Impact

BACKGROUND: Pursuant to the Council on Environmental Quality regulations for implementing the procedural provisions of the National Environmental Policy Act (40 CFR 1500-1508), Department of Defense Directive 6050.1, and Army Regulation 200-2, the USASSDC has been tasked to conduct an Environmental Assessment (EA) of the potential environmental consequences of the U.S. Army Kwajalein Atoll (USAKA) temporary extended test range program at the USAKA and at Bigen Island, Aur Atoll, Republic of the Marshall Islands (RMI). The assessment includes a classified annex which evaluates the potential environmental consequences of launching one of the alternative target missile systems. An agreement to use Bigen Island as an additional defense site (including use as a temporary launch site) was negotiated with landowners and the RMI. This agreement will remain in effect for the life of the Compact of Free Association Act of 1985. A no-action alternative was also considered. The USASSDC has the responsibility for conducting the USAKA temporary extended test range program.

DESCRIPTION OF THE PROPOSED ACTION: The purpose of the proposed action is to obtain sensor data on target missiles with a range of 350 to 500 kilometers (220 to 310 miles) toward the USAKA over the next 5 years. Theater Missile Defense (TMD) interceptors will be launched to intercept the target missiles to demonstrate the feasibility of TMD intercepts.

The proposed action is to launch up to eight liquid and/or solid propellant target missiles from Bigen Island, Aur Atoll toward the USAKA. PATRIOT missiles will be launched from either Illeginni or Meck Island within the USAKA to intercept the target missile either over the Mid-atoll Corridor within the Kwajalein Lagoon or over the Broad Ocean Area east of the USAKA. A variety of ground, ship, air, and satellite sensors will gather data on the flight test experiments. The PATRIOT radar will be placed on either Gellinam, Illeginni, Legan, Meck, or Omelek Island within the USAKA. The Theater High Altitude Area Defense (THAAD) radar, formerly known as the TMD ground-based radar, will be placed on Roi-Namur Island within the USAKA. The proposed action will involve transport of target missiles with minimal site preparation activities to establish a temporary launch site on Bigen Island, Aur Atoll.

ALTERNATIVES CONSIDERED: Three alternatives: USAKA-Bikini; Eglin Air Force Base, Florida; and Western Test Range, California, were initially considered but were not carried forward for detailed analysis because they did not meet one or more essential criteria for achieving program objectives. In addition, a no-action alternative was considered. Under the no-action alternative, the USASSDC will not proceed with the USAKA temporary extended test range program.

ENVIRONMENTAL EFFECTS: To assess the significance of potential environmental impacts, a list of activities necessary to accomplish the proposed action was developed. The affected environment at all USAKA and Aur Atoll locations was described and those activities with the potential for causing environmental impacts were identified.

Twelve broad environmental issues were evaluated to determine the potential effects of the proposed action and to provide a basis for assessing the level and significance of potential impacts. If a proposed activity was determined to present a potential for environmental impacts, then the activity was evaluated in greater detail by considering the intensity, extent, and context in which the impact will occur.

Program activities involving the use and operation of radars and launches of missiles could potentially cause impacts to human health and safety. However, these impacts are not expected to be significant due to the use of safety procedures. Electromagnetic radiation hazard zones will be established and clearly marked in accordance with standard operating procedures of the radars to protect range personnel and the public from hazardous exposure. Existing standard operating procedures for missile testing will also be followed to minimize any risk to range personnel or public health and safety including establishing ground hazard areas to exclude non-mission-essential personnel and the public from areas of debris impact and high noise levels. The ground hazard areas will also protect the public from combustion and exhaust products emitted during launches. Standard operating procedures will be followed during all USAKA temporary extended test range program activities to prevent spills of hazardous materials and wastes.

Ground-disturbing activities below 1 meter (3 feet) will be monitored by a qualified archaeologist. THAAD radar trench and pad placement on Roi-Namur Island will be coordinated with a qualified archaeologist and/or historian to avoid affecting subsurface features, and pre-ground-disturbing photographs will be taken. Personnel will be briefed regarding the significance of cultural resources and the penalties associated with their disturbance or collection, and legally required procedures will be followed in the event of the unexpected discovery of cultural remains.

CONCLUSION: Evaluation of the areas of environmental consideration for which a potential for impact was posed has shown that no significant impacts will occur from implementation of the proposed action for the USAKA temporary extended test range program, including launching of the classified target missile system from Bigen Island; therefore, the preparation of an Environmental Impact Statement is not required.

DEADLINE FOR RECEIPT OF WRITTEN COMMENTS: 24 Nov 95

POINT OF CONTACT: Submit written comments or requests for a copy of the USAKA Temporary Extended Test Range Environmental Assessment to:

U.S. Army Space and Strategic Defense Command
Attention: CSSD-EN-V, Linda Ninh
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10-13-95

J. R. Fisher — Date
Director, Missile Defense and Space Technology Center
U.S. Army Space and Strategic Defense Command

Executive Summary

EXECUTIVE SUMMARY

Introduction

The U.S. Army Space and Strategic Defense Command, as the executing agent for the Ballistic Missile Defense Organization, is the management office for the U.S. Army Kwajalein Atoll (USAKA) temporary extended test range program. The proposed program is to launch up to eight liquid and/or solid propellant target tactical ballistic missiles from Bigen Island, Aur Atoll toward the USAKA. The purpose of these Theater Missile Defense (TMD) flight test experiments is to obtain sensor data on target tactical ballistic missiles with a range of 350 to 500 kilometers (220 to 310 miles) toward the USAKA over the next 5 years. TMD interceptors will be launched to intercept the target tactical ballistic missiles to demonstrate the feasibility of TMD intercepts. A variety of ground, ship, air, and satellite sensors would gather data on the flight test experiments. The flight tests would involve target missile launches from Bigen Island, Aur Atoll, Republic of the Marshall Islands (RMI), with interceptor launches from the USAKA. An agreement to use Bigen Island as an additional defense site (including use as a temporary launch site) was negotiated with landowners and the RMI. This agreement will remain in effect for the life of the Compact of Free Association Act of 1985.

Test Program Activities

The proposed program activities would include transport of the target missiles from storage in the continental United States to Meck Island in the USAKA and then to Bigen Island within Aur Atoll for launch. No facility construction or modification on Meck Island is anticipated to support assembly and pre-flight checkout of a solid-propellant missile system. A temporary launch site would be established at Bigen Island which would include a marker buoy with passive navigation measures, minor ground leveling and placement of metal matting at the launch site, and the positioning of a mobile launch control van. If other temporary facilities are required, additional analysis and documentation would be completed prior to any construction.

A PATRIOT Fire Unit (Engagement Control Station, radar, tactical truck, Launching Station, and support trailers) and the Theater High Altitude Area Defense (THAAD) radar would be transported from the continental United States and placed within the USAKA. Existing sensors on Kwajalein Atoll would also collect data as part of program activities. The PATRIOT Launching Station would be located on either Illeginni or Meck Island. PATRIOT missile launches from Illeginni Island would intercept the target missile over the Mid-atoll Corridor within the Kwajalein Lagoon. PATRIOT launches from Meck Island would intercept the target missile over the Broad Ocean Area. The PATRIOT radar would be placed on either Gellinam, Illeginni, Legan, Meck, or Omelek Island. No facility construction or modification would be required to support the PATRIOT Fire Unit deployment. The THAAD radar, used to collect sensor data, would be located at one of two sites on Roi-Namur Island. Minimal construction for electrical power cables and a transformer pad would be required at either site.

Methodology

The purpose of this environmental assessment is to analyze the potential environmental consequences of the proposed USAKA temporary extended test range program activities in compliance with the National Environmental Policy Act; Department of Defense Directive 6050.1, *Environmental Effects in the United States of Department of Defense Actions;* and Army Regulation 200-2, *Environmental Effects of Army Actions*.

Twelve broad areas of environmental consideration were evaluated to provide a context for understanding the potential effects of the proposed action and a basis for assessing the significance of potential impacts. These areas are air quality, airspace, biological resources, cultural resources, geology and soils, hazardous material and hazardous waste, health and safety, infrastructure and transportation, land use, noise, socioeconomic resources, and water resources.

Air Quality – Program activities would result in exhaust products from portable generators and combustion products from rocket motors. Generator exhaust products would not be expected to exceed ambient air quality standards. Missile launches are brief, discrete events, and typical wind conditions in the region would rapidly disperse and dilute combustion and exhaust products.

Airspace – Airspace over the USAKA is routinely used in support of missile launch programs. Usage of airspace over Bigen Island is minimal due to its remote location. No changes to existing airspace coordination procedures, which include the issuance of Notices to Airmen and the selection of missile firing areas and trajectories, would be required.

Biological Resources – Studies indicate that birds may flush during sharp, loud noises but return to normal behavior within a short time. Vegetation is generally sparse at the proposed launch sites, although some vegetation clearing may be required. Any ground fire would be quickly extinguished. It is unlikely that birds would remain in a radar beam long enough to receive significant exposure to electromagnetic radiation. The likelihood of missile debris impacting marine mammals is considered remote. Threatened or endangered species have not been identified at any of the proposed construction sites or other activity locations.

Cultural Resources – Program activities have the potential to affect cultural resources as the result of ground disturbing activities on Roi-Namur Island. Ground-disturbing activities below 1 meter (3 feet) would be monitored by a qualified archaeologist (U.S. Army Space and Strategic Defense Command, 1994f). THAAD radar trench and pad placement on Roi-Namur Island would be coordinated with a qualified archaeologist and/or historian to avoid affecting subsurface features, and pre-ground-disturbing photographs will be taken. Personnel will be briefed regarding the significance of cultural resources and the penalties associated with their disturbance or collection, and legally required procedures would be followed in the event of the unexpected discovery of cultural remains.

Geology and Soils – The limited program-related construction is not expected to increase soil erosion because of the coarse-grained nature of soils at the construction sites and the lack of significant topographic relief to provide energy for soil movement. The amount of rocket motor emissions expected to fall on land would be very small due to the proximity of the launch locations to the shoreline and the relatively high prevailing wind speed. No measurable change in soil chemistry is expected to result from the proposed missile launches.

Hazardous Material and Hazardous Waste – Proposed USAKA temporary extended test range activities would create small amounts of hazardous materials and waste. Proper handling, use, and disposal of such materials is routine at the USAKA and addressed in existing standard operating procedures. Liquid propellants that reach the ocean would rapidly evaporate and/or be diluted in sea water. Missile hardware and debris are expected to dissolve very slowly and are not expected to produce metal ions in concentrations that would be harmful to marine life.

Health and Safety – Existing safety operation manuals and procedures for missile testing would be followed to minimize any risk to personnel health and safety. All missile transportation, storage, fueling, flight plans, trajectories, and debris impact areas would be approved by the USAKA Range Safety Office. Electromagnetic radiation hazard personnel exclusion zones would be established to minimize the potential for exposure of workers. Launch hazard areas and launch control locations approved by the USAKA Safety Office, from which all non-mission-essential personnel would be excluded, ensure the safety of all personnel.

Infrastructure and Transportation – The additional demand on electrical, wastewater, solid waste, and water systems to support the small number of project-related transient personnel is expected to be within the current capacity of the USAKA. The temporary infrastructure requirements at Bigen Island would be provided by ships and barges from the USAKA.

Land Use – USAKA temporary extended test range activities would be consistent with current operations and island uses within the USAKA. Temporary flight test activities at Bigen Island would not require permanent land use modification and could be scheduled to reduce or avoid any potential conflict with the existing land use, copra harvesting.

Noise – Noise effects from proposed program activities could result from portable generators and missile launches. Personnel working near generators would wear protective hearing devices as required. During missile launches, only personnel sheltered in protective structures would be inside the launch hazard area. Noise levels outside the launch hazard area would be below regulatory requirements for hearing protection. The nearest populated islands are located about 11 kilometers (7 miles), 16 kilometers (10 miles), and 31 kilometers (19 miles) from the proposed launch sites on Bigen, Meck, and Illeginni islands, respectively.

Socioeconomic Resources – The addition of a small number of transient personnel at Kwajalein Island in support of program activities is not expected to create substantive socioeconomic effects. The small increase in transient personnel is well within the normal month-to-month fluctuation in the island's population and employment level. There would be only a minimal increase in boat, barge, and air traffic.

Water Resources – The small increase in the number of transient personnel at the USAKA and Aur Atoll is expected to require little or no increase in groundwater withdrawal, depending on the amount of fresh water in storage and rainfall catchment during the period of program activity. Groundwater quality degradation that could result from a catastrophic missile failure would be expected to be offset by dilution in a relatively short period due to the high rainfall rate in the region and the high water infiltration rate of the soil. Missile hardware, debris, and propellants that would fall into the ocean are expected to have only a localized, short-term effect on water quality.

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1.0 Purpose of and Need for the Proposed Action

1.0 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

The United States Army Space and Strategic Defense Command (USASSDC), as the executing agent for the Ballistic Missile Defense Organization (BMDO), proposes to conduct flight test experiments at the U.S. Army Kwajalein Atoll (USAKA). The flight tests would involve target missile launches from Bigen Island, Aur Atoll, Republic of the Marshall Islands (RMI), with interceptor missile launches from a site at the USAKA.

1.1 BACKGROUND

The National Environmental Policy Act (NEPA) of 1969, as amended; the Council on Environmental Quality (CEQ) regulations implementing the NEPA (40 Code of Federal Regulations [CFR] 1500-1508); Department of Defense (DOD) Directive 6050.1, Environmental Effects in the United States of DOD Actions; and Army Regulation (AR) 200-2, Environmental Effects of Army Actions, require the DOD and U.S. Army decision makers to consider the potential environmental consequences of proposed actions. Accordingly, this Environmental Assessment (EA) analyzes the potential environmental consequences of a temporary extended test range using the USAKA and Bigen Island. The environmental resource areas analyzed herein reflect the unique features of the USAKA temporary extended test range and the environmental setting.

1.2 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.2.1 PURPOSE

The purpose of the Theater Missile Defense (TMD) flight test experiments being analyzed within this EA is to obtain sensor data on liquid and/or solid propellant missiles with a range of 350 to 500 kilometers (220 to 310 miles) toward the USAKA over the next 5 years. TMD interceptors will be launched to intercept the target ballistic missiles to demonstrate the feasibility of TMD intercepts.

1.2.2 NEED

The experience of the United States coalition forces and U.S. allies with ballistic missile attacks during the Gulf War of 1991 (Operation Desert Storm) has highlighted the need for a TMD component of Ballistic Missile Defense. A TMD system is intended to respond to these dangers of the post-Cold War era by providing protection for deployed United States and allied military forces and civilian assets against tactical ballistic missile attacks.

The proliferation of tactical missiles has involved the development and export of a number of missiles with a range of 350 to 500 kilometers (220 to 310 miles). Such missiles are now fielded by a large number of nations throughout the world. Flight test experiments are needed to obtain sensor data on liquid and/or solid propellant rocket motor ballistic missiles with a range of 350 to 500 kilometers (220 to 310 miles) to facilitate research and enable the development of TMD technologies to counter the threat presented by these types of missiles. A variety of ground, ship, and air sensors would be used to gather this flight test data, which would subsequently be used for the development of TMD sensor and interceptor technologies. TMD interceptors could also intercept the ballistic missiles near the end of their trajectory to demonstrate the feasibility of TMD intercepts.

1.2.3 DECISIONS TO BE MADE

The decisions to be made by the U.S. Army and supported by information contained in this EA are:

- Whether to conduct extended test range activities at the USAKA
- The selection of the target missile(s) that will be launched from Aur Atoll
- The selection of the location for the PATRIOT missile hardware and support equipment on either Illeginni or Meck Island
- Selection of the site location for a second PATRIOT radar system and support equipment on either Meck, Gellinam, Legan, or Omelek Island
- Selection of the site location for the TMD-Ground-based radar (TMD–GBR), now referred to as the Theater High Altitude Area Defense (THAAD) radar, and support equipment on Roi-Namur Island

2.0 Description of Proposed Action and Altrernatives

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

Based on initial program requirements for a missile test, three alternative test ranges were identified including Eglin Air Force Base (AFB), Western Test Range, and the USAKA. Criteria were applied to determine the capability of each range to meet the program requirements. The results of the application of the criteria showed that the USAKA–Aur Atoll alternative was the only alternative that could meet the program requirements and is therefore the proposed action. Further discussion of the alternatives to the proposed action is presented in section 2.9.

The proposed action is to launch up to eight liquid and/or solid propellant target missiles from Bigen Island, Aur Atoll, RMI toward the USAKA. An agreement to use Bigen Island as an additional defense site (including use as a temporary launch site) was negotiated with landowners and the RMI. This agreement will remain in effect for the life of the Compact of Free Association Act of 1985. A variety of ground, ship, air, and satellite sensors would gather data on the flight test experiments. PATRIOT missiles would be launched from either Illeginni or Meck Island within the USAKA to intercept the target missile either over the Mid-atoll Corridor within the Kwajalein Lagoon, or over the Broad Ocean Area (BOA). The initial TMD flight test is currently scheduled for the third quarter of calendar year 1996. The proposed action would involve minimal site preparation activities to establish a temporary launch site at Bigen Island, Aur Atoll. The airfield at Tabal Island, Aur Atoll may be used on a limited basis if emergency medical services are required. Table 2-1 provides a listing of the proposed action activities for the USAKA temporary extended test range and gives the locations where these activities would occur for the target and interceptor missiles, and sensor systems. Figure 2-1 shows the location of islands that may be used within Kwajalein and Aur Atolls. The proposed action is discussed in sections 2.1 through 2.8.

2.1 ASSEMBLY AND INTEGRATION OF FLIGHT TEST HARDWARE

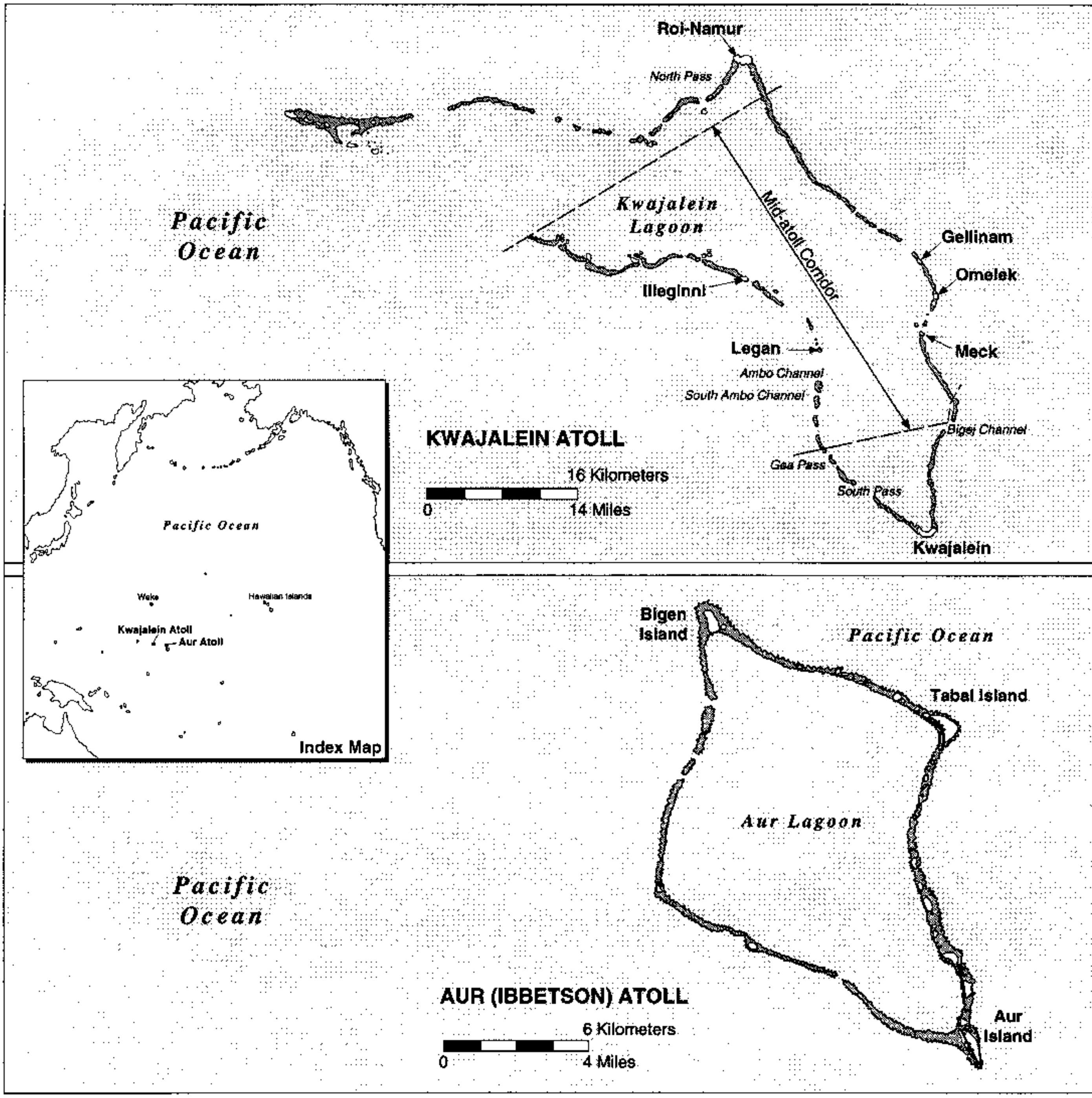
2.1.1 TARGET

The ballistic target missiles would use either solid or liquid propellant motors. Potential impacts associated with approximately eight target missile launches have been analyzed in order to evaluate the effects of these activities. The Hera solid propellant target missile and a notional Extended Range Lance (ERL) liquid propellant target missile are analyzed in this EA. Development of an ERL missile is not planned as part of the proposed action, although preliminary studies have indicated that this system is technically feasible using existing Lance motors (Loral Vought Systems, 1993). A notional ERL is analyzed to consider the environmental consequences of a threat representative liquid-fueled theater ballistic missile that could be developed for program use. A classified annex to this EA has been prepared to analyze the potential environmental effects of other, similar target missiles. In the future, if additional target missiles are identified that have a substantially different potential for environmental effects, additional analysis and documentation would be completed prior to those missiles being launched.

Table 2-1: Summary of USAKA Temporary Extended Test Range Activities and Their Associated Locations

Activities	Location: Generic Conus	USAKA	Roi-Namur	Meck	Aur	Illeginni	Gellinam, Legan Omelek	Broad Ocean Area
Assembly and Integration of Flight Test Hardware	▲ Target							
Transportation to USAKA	▲ Target, Interceptor, Sensors	▲ Target, Interceptor, Sensors	Sensors					Sensors
Final Assembly and Preflight Activities at USAKA		Sensors	Sensors	▲ Target, Interceptor		Interceptor, Sensors	Remote Interceptor Sensor	
Transportation to Temporary Launch Locations				▲ Target, Interceptor	▲ Target	Interceptor, Sensors	Remote Interceptor Sensor	▲ Target
Site Preparation and Establishment			Sensors	Interceptor	▲ Target	Interceptor, Sensors	Remote Interceptor Sensor	
Flight Test Activities			Sensors	Interceptor	▲ Target	Interceptor, Sensors	Remote Interceptor Sensor	▲ Target, Sensors, Interceptor

▲ Target — Interceptor — Sensors — Remote Interceptor Sensor



General Location

Kwajalein Atoll
Aur Atoll

Figure 2-1

Solid propellant target – The solid propellant target missile being analyzed is a Hera target. The Hera target is a two-stage, solid propellant rocket consisting of an SR19-AJ-1 first stage, an M57A-1 second stage, and a ballistic or maneuvering reentry vehicle. These motors were originally developed and manufactured for other missile programs. The Hera target is approximately 10 meters (40 feet) long overall with a diameter of 130 centimeters (4 feet 4 inches) and weighs approximately 10,000 kilograms (22,000 pounds) (U.S. Army Space and Strategic Defense Command, 1994b). Propellant constituents may include ammonium perchlorate, aluminum, polyurethane, polybutadiene, nitroglycerine, nitrocellulose, and cyclotetramethylenetetranitramine.

The Hera rocket motors are in storage at various U.S. Government installations. Assembly and integration of the Hera target missile have been addressed in the Theater Missile Defense Hera Target Systems EA (U.S. Army Space and Strategic Defense Command, 1994b). An inspection and refurbishment process would include performing technical inspections, tests on components and subsystems, and refurbishment of necessary components. These functions could be conducted at a number of U.S. Government installations where they would be considered to be routine activities. No modifications to existing facilities, unusual utility requirements, or additional personnel would be required. The assembly and integration activities would involve the use of solvents, cleaning materials, and adhesives (such as acetone and isopropyl alcohol). These materials are routinely used for such purposes and would be handled in accordance with data provided on the appropriate Material Safety Data Sheet (MSDS).

Liquid propellant target – The liquid propellant target missile being analyzed is a notional Lance missile referred to as the ERL. Constituents of existing Lance rocket motors analyzed for the notional ERL liquid propellant include approximately 400 kilograms (800 pounds) of unsymmetrical dimethylhydrazine (UDMH) fuel and approximately 1,100 kilograms (2,400 pounds) of inhibited red fuming nitric acid (IRFNA) oxidizer. Modification and refurbishment of any existing system would be performed at a designated government installation. Approximately 25 personnel would be involved in the process. This process typically includes tests on components and subsystems, and administrative functions. These functions could be conducted at a number of U.S. Government installations where they would be considered to be routine activities. The development of the liquid propellant launch vehicle would involve the use of solvents, cleaning materials, and adhesives (such as acetone and isopropyl alcohol). These materials are routinely used for such purposes and would be handled in accordance with data provided on the appropriate MSDS. No modifications to existing facilities, unusual utility requirements, or additional personnel would be required to support this kind of activity. Development of any new liquid propellant target would require separate environmental documentation.

2.1.2 INTERCEPTOR

A PATRIOT TMD interceptor would be used for the flight tests. Assembly and integration of the PATRIOT missile has been addressed in the PATRIOT Life Cycle EA (U.S. Department of the Army, 1990b). This interceptor would be obtained from contractor or government facilities and no additional assembly or integration would be required.

2.1.3 SENSOR

Sensor systems to be used in these flight tests are all existing sensors, which have already undergone assembly and integration and are functional systems. No assembly or integration would be required. Sensor systems include the THAAD radar and various existing USAKA Range sensors. The assembly and integration of THAAD radar has been previously described in the GBR Family of Radars EA (U.S. Army Space and Strategic Defense Command, 1993b). Aircraft and naval ships would also be present in the area to provide supplementary sensor support.

2.2 TRANSPORTATION TO U.S. ARMY KWAJALEIN ATOLL

Target missiles, interceptor components, and the THAAD radar would be transported from U.S. Government or contractor installations to a designated port for transport to the USAKA via ship or barge. Materials arriving via ship or barge would be received at the Kwajalein marine facilities (figure 2-2). Some equipment could be transported from U.S. Government or contractor installations to a designated U.S. Air Force Base for transportation to the USAKA by U.S. Air Force Air Mobility Command (AMC) C-5, C-17, C-130, or C-141 cargo aircraft. Materials arriving via aircraft would be received at Bucholz Army Airfield (AAF), Kwajalein Island.

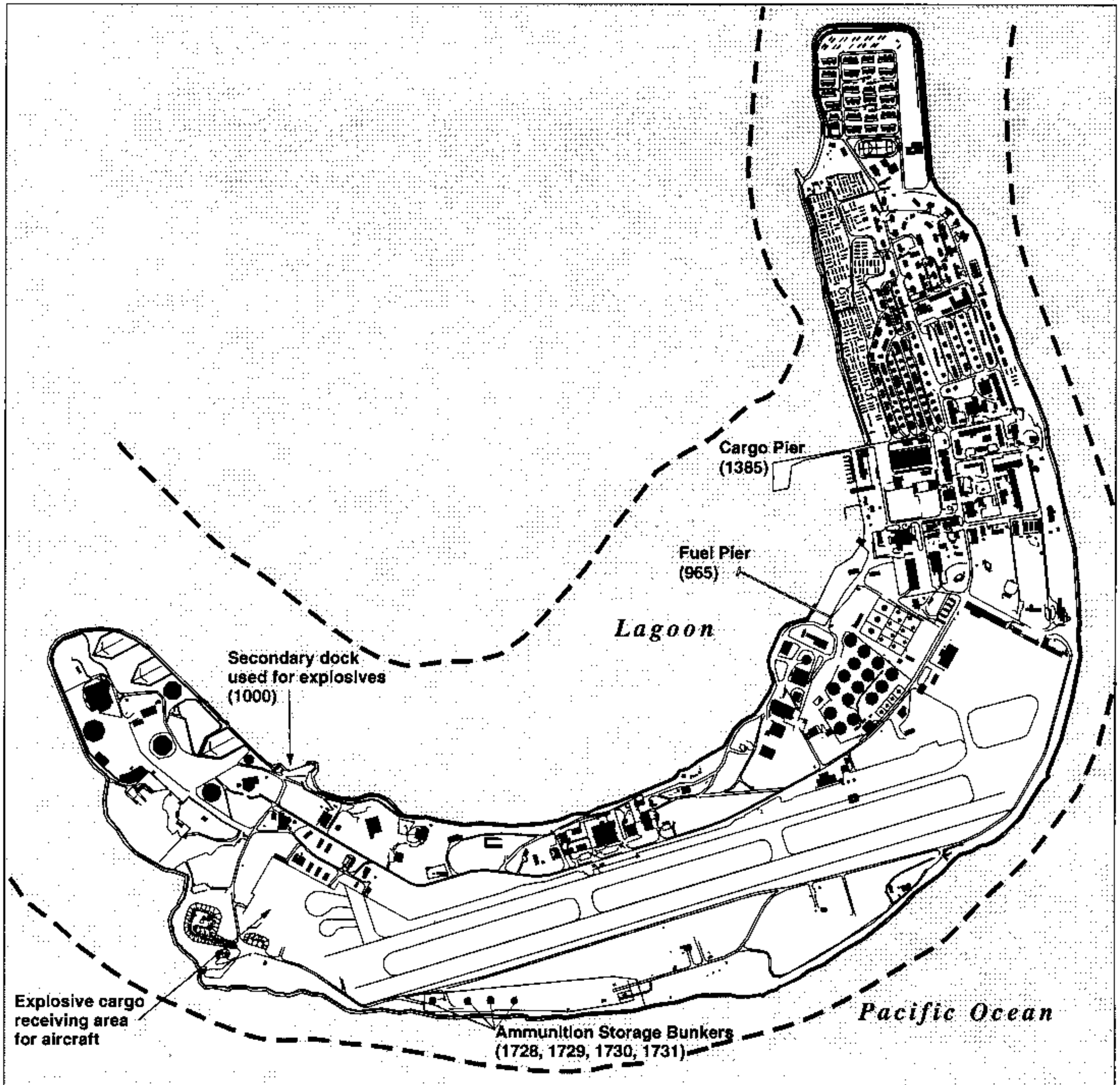
All transportation within the continental United States (CONUS) would be performed in accordance with U.S. Department of Transportation (DOT) approved procedures and routing as well as Occupational Safety and Health Act (OSHA) requirements and U.S. Army safety regulations. Liquid propellants would be transported in DOT approved containers. Appropriate safety measures would be followed during transportation of the propellants as required by the DOT and as described in the Bureau of Explosives (BOE) Tariff No. BOE 6000-I, *Hazardous Materials Regulations of the Department of Transportation* (Association of American Railroads, 1992). For ship or barge transportation, U.S. Coast Guard and/or applicable U.S. Army transportation safety regulations would also be followed. For aircraft transportation, Federal Aviation Administration (FAA) and/or applicable U.S. Air Force safety regulations would be followed.

2.3 FINAL ASSEMBLY AND PREFLIGHT ACTIVITIES AT USAKA

2.3.1 TARGET

The target missile components and rocket motors would arrive at USAKA's harbor and/or airfield approximately 90 days prior to the scheduled launch. The rocket motors and flight termination system ordnance would be temporarily stored in the existing ammunition storage bunkers on Kwajalein Island (figure 2-2), pending transportation to Meck Island by Landing Craft Utility (LCU).

Approximately 40 USAKA and up to 70 temporary duty personnel would be required for all of the USAKA operations for up to 90 days for each launch. These activities are routine for USAKA, and no additional permanent USAKA personnel would be required. No increases to Kwajalein Island or Meck Island infrastructure capacity demands would be required to support these operations.



Source: U.S. Army Space and Strategic Defense Command, 1993a.

EXPLANATION

- - Reef Edge

■ Structures

Note: This figure also represents the area of potential effects for cultural resources.

0 236.5 473 Meters
0 776.5 1,553 Feet

Potential Activity Locations

Kwajalein Island,
Kwajalein Atoll

Figure 2-2

Solid propellant target – Upon arrival at Meck Island, the solid propellant missile components and support equipment would be placed in the Missile Assembly Building (MAB) (Building 5080) for final preflight assembly and integration and necessary preflight tests. Within the MAB, the solid propellant rocket motors would be transferred to the Ground Handling and Launching Equipment (GHLE). The guidance and control section, aft skirt and fins, motor adapter, and other components would then be assembled to the rocket motors on the GHLE to comprise the integrated solid propellant missile.

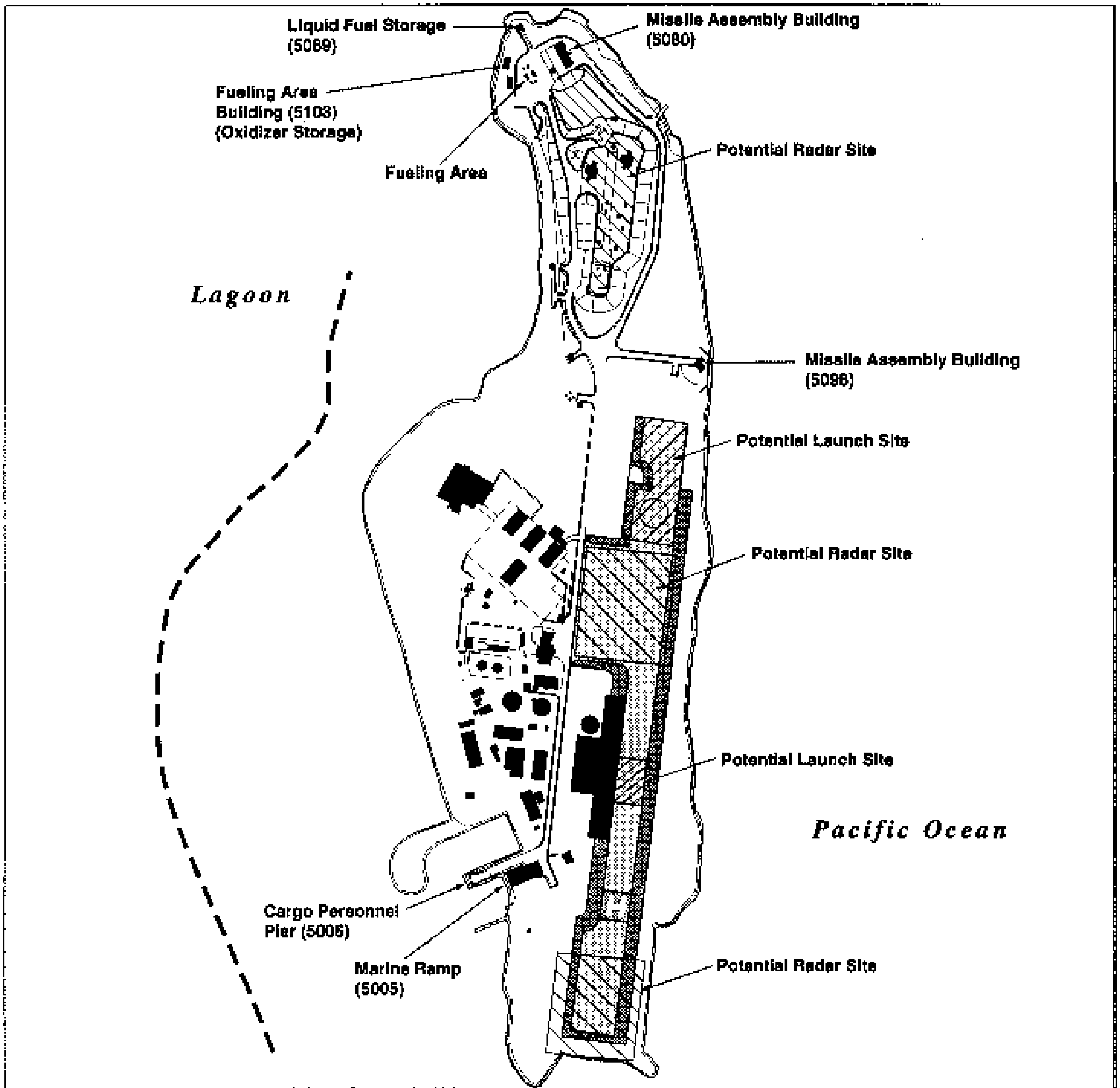
The batteries and flight termination ordnance for the solid propellant missile would then be installed on the missile. The flight termination ordnance would be installed in accordance with the Kwajalein Missile Range (KMR) Safety Office Standard Operating Procedures (SOPs). The fully assembled missile would then be moved to the Marine Ramp for LCU transportation to Aur Atoll.

Liquid propellant target – Upon arrival at Meck Island, the liquid propellant missile components and support equipment would be placed in the MAB (Building 5098) for final preflight assembly and integration and necessary preflight tests (figure 2-3). The GHLE would be co-located in the MAB for these preflight operations.

Specific, standardized procedures for fuel/oxidizer transfer would be developed in accordance with Army requirements for handling of liquid rocket propellants (Chemical Propulsion Information Agency, 1973). These procedures would incorporate measures to minimize both the amount of waste propellants generated during transfer operations and the potential for accidental spills.

The missile oxidizer would be stored on Meck Island in the existing fueling area (Building 5103). The missile fuels would be stored in the existing fuel storage building (Building 5089). Both of these facilities have been specifically sited, designed, and constructed for the handling of liquid rocket propellants.

Propellant transfer operations (from storage vessels to the missile) would take place on the concrete pad in front (west side) of the MAB (Building 5080). All personnel involved in these operations would wear protective clothing ensembles and receive specialized training in liquid propellant safety and handling and spill containment and cleanup. It is anticipated that only very minor amounts (approximately 10 grams [0.4 ounce]) of oxidizer vapors would be released to the atmosphere during the oxidizer transfer operation. A negligible amount of fuel vapors would be released into the atmosphere during the fuel transfers. After completion of the transfer operations, the oxidizer transfer system would be flushed with water. This operation is expected to yield approximately 5 grams (0.2 ounce) of nitric oxide gas released to the atmosphere and 218 liters (55 gallons) of a mild nitric acid solution ($<$0.05 percent) that will be collected and disposed of per applicable regulations. The fuel transfer system would be flushed with 218 liters (55 gallons) of ethyl alcohol, and the waste alcohol (with approximately 40 grams [1.4 ounces] of fuel in solution) would be collected and disposed of per applicable regulations. The fully assembled and fueled missile would then be moved to the Marine Ramp (figure 2-3) for LCU transportation to Aur Atoll.



Source: U.S. Army Space and Strategic Defense Command, 1993a.

EXPLANATION

- Potential Interceptor Launch Location
- Potential Interceptor Radar Location
- Reef Edge
- Structures
- Helicopter Pad

Note: This figure also represents the area of potential effects for cultural resources.

0 81 162 Meters
0 265 530 Feet

Potential Activity Locations

Meck Island, Kwajalein Atoll

Figure 2-3

Spill response supplies, equipment, and trained personnel would be available both at Meck Island and Bigen Island. Bulk fuel for vehicles and equipment would be stored aboard the LCU. Empty bulk liquid propellant containers would be placed on Bigen Island for use in the event that de-tanking of the missile became necessary.

2.3.2 INTERCEPTOR

Final assembly and preflight testing of the PATRIOT system elements would occur at the USAKA launch site(s) identified in section 2.5.2.

The PATRIOT hardware and equipment that would be located on site include the following:

- Information and Coordination Central – a truck-mounted weapon control computer that performs the processing of data received from the Fire Unit(s)
- PATRIOT Fire Unit, comprising an Engagement Control Station, an AN/MPQ-53 multifunction phased-array radar, a heavy expanded mobility tactical truck, a small repair parts trailer, a maintenance center, and the PATRIOT Launching Station(s)
- Remote PATRIOT radar sites would consist of a PATRIOT Fire Unit without the PATRIOT Launching Station
- Miscellaneous test equipment, including a mobile instrumentation van and portable data recorders
- Optional relay equipment consisting of an Antenna Mast Group, a Communications Relay Group, an Electric Power Unit, and an Electric Power Plant (The mobile antenna mast system would be used to carry the amplifiers and antennas associated with the ultra high frequency communication equipment. The Communications Relay Group is a multi-routed, secure, two-way relay capability between the Information and Coordination Central and the Fire Unit.)

The Electric Power Unit would be the prime power source for the Information and Coordination Central and Communications Relay Group and consists of two EMU-30, 60-kilowatt, 400-hertz turbine engine generator sets mounted on a mobile trailer. The Electric Power Plant would be the prime power source for the Engagement Control Station and radar set and consists of two 150-kilowatt, 400-hertz turbine engines mounted on a mobile trailer bed. The Launching Station is powered by a 15-kilowatt, 400-hertz diesel-fueled generator.

2.3.3 SENSOR

Sensor systems involved in this flight test are all existing sensors which would require final checkout and calibration. The final checkout and calibration of the various USAKA sensor systems would be considered to be routine activities at the USAKA. System testing of the THAAD radar has been previously described in the GBR Family of Radars EA (U.S. Army Space and Strategic Defense Command, 1993b), and the EA for TMD GBR Testing

Program at Fort Devens, Massachusetts (U.S. Army Space and Strategic Defense Command, 1994e).

2.4 TRANSPORTATION TO TEMPORARY LAUNCH LOCATIONS

2.4.1 TARGET

The LCU containing the GHLE and target missile would transit from Meck Island, USAKA, directly to Aur Atoll Lagoon utilizing the most direct ocean route.

2.4.2 INTERCEPTOR

From Bucholz AAF, Kwajalein Island, the PATRIOT system would be taken to the Kwajalein Port vicinity, where it would be loaded into Kwajalein LCUs and/or other existing marine transportation assets for transportation to Illeginni or Meck as appropriate. If Meck Island is the launcher location, then a remote PATRIOT radar site could be utilized and a second PATRIOT radar would be loaded into Kwajalein LCUs and/or existing marine transportation assets for transportation to Omelek, Legan, or Gellinam Island as appropriate. If Illeginni Island is the launcher location, then a remote PATRIOT radar site would not be used.

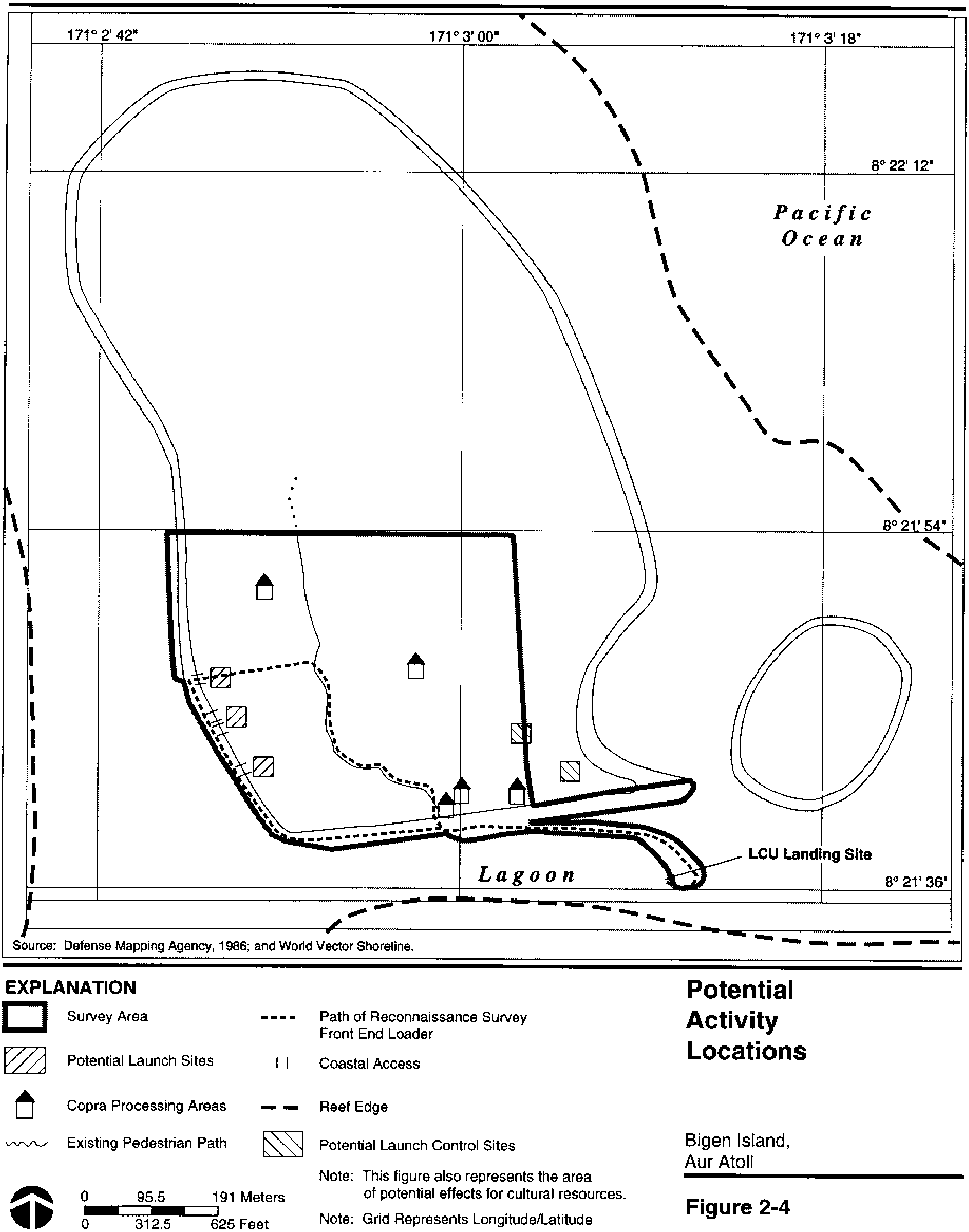
2.4.3 SENSOR

THAAD radar components would be transported from Kwajalein Island to Roi-Namur Island by air or by barge, and arrive at the cargo pier (8052 or 8086) or Dyess AAF. The THAAD radar components would then be taken to their operational site on Roi-Namur Island. The Kwajalein Mobile Range Safety System (KMRSS) would be loaded aboard an ocean-going vessel at Kwajalein Island for transit to the Aur Atoll Lagoon.

2.5 SITE PREPARATION AND ESTABLISHMENT

During site preparation and establishment for target, interceptor, and sensors, personnel would be instructed to avoid areas designated as avian nesting or roosting habitat and to avoid all contact with any nest that may be encountered. Should a sea turtle, turtle tracks, or turtle nests be harmed, personnel would notify the USAKA Environmental Office, and a representative of this office would in turn notify applicable agencies.

To ensure the protection of any prehistoric, historic, or traditional resources already identified within the project area from unauthorized artifact collection or vandalism, personnel will be briefed before activities commence on the significance of these types of resources and the penalties associated with their disturbance or collection. If, during the course of program activities cultural and/or historic materials (particularly human remains) are unexpectedly discovered, work in the immediate vicinity of the cultural materials shall be halted and the RMI Historic Preservation Officer (HPO) consulted through the USAKA Environmental Office.



Potential Activity Locations

Bigen Island, Aur Atoll

Figure 2-4

ed/USAKA/061-05/23/95

2.5.1 TARGET

To support launch operations from Bigen Island, Aur Atoll, a temporary launch site would be established on the island. The Bigen Island temporary launch site (figure 2-4) would include a temporary marker buoy with passive navigation measures for the LCU and a temporary 30-meter by 30-meter (100-foot by 100-foot) launch area with metal matting on leveled ground. Five concrete survey markers would also be established on Bigen Island. Four points would be approximately 0.3 meters (1 foot) in diameter on the surface and 0.6 meters (2 feet) in depth. The fifth point, used to give check angles, would be southwest of the other points and would be 0.3 meters (1 foot) in depth. Existing access routes for vehicles and personnel would be used. Vegetation clearance would be minimal, primarily transplanting a limited number of coconut palm seedlings in the immediate vicinity of the launch area. Marshallese land owners would be notified of this action, and the trees would be transplanted or the owners would be compensated for the loss of each tree. If other temporary facilities are required, additional analysis and documentation would be completed prior to any construction.

The launch site would be established by USAKA contractor personnel. This preparation crew would be transported by LCU from the USAKA to Aur Atoll. The LCU would anchor at a designated beach landing site on Bigen Island. All personnel for the launch site establishment team would live on the LCU. This crew would utilize earth moving equipment as necessary to level and prepare the 30-meter by 30-meter (100-foot by 100-foot) launch area. Local Marshallese labor may supplement the USAKA contractor personnel to prepare the proposed launch area.

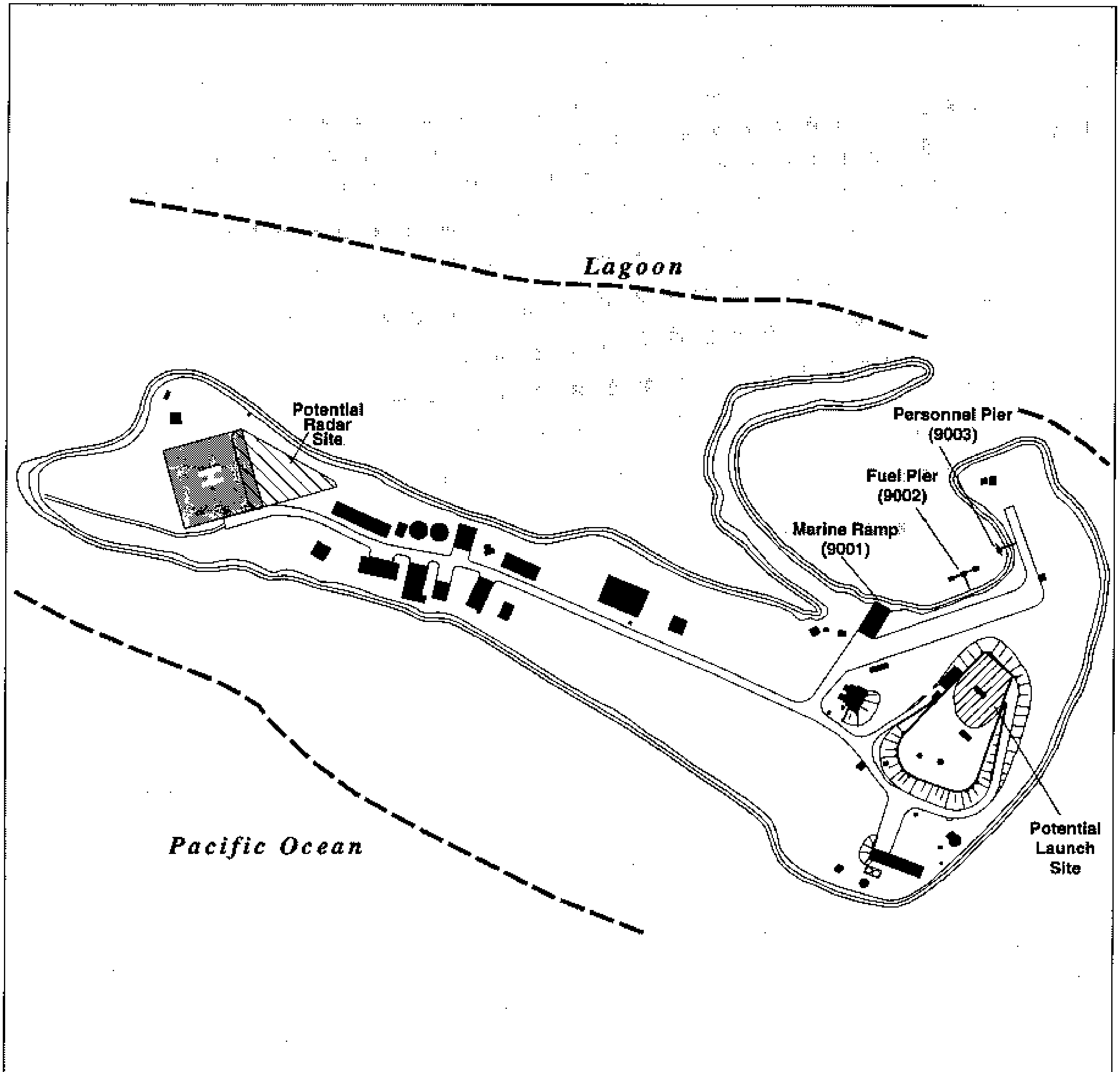
2.5.2 INTERCEPTOR

The PATRIOT would be launched from the existing "launch hill" on Illeginni Island or hard-surfaced areas on Meck Island. This "launch hill" is a large, elevated concrete pad which has been used for similar launch operations in the past. For launch from Meck Island, a second PATRIOT radar site could be operated on Meck or another island (Gellinam, Legan, or Omelek Island). Potential PATRIOT launch sites and radar sites on Meck and Illeginni Islands are shown in figures 2-3 and 2-5. Potential PATRIOT radar sites for Gellinam, Legan, and Omelek Islands are shown in figures 2-6, 2-7, and 2-8. If Illeginni Island is the launch location, then a remote PATRIOT radar site would not be used.

No ground-disturbing site preparation activities would be required to support the placement and testing of PATRIOT equipment at the proposed locations. It has been suggested that a temporary berm running west across the southern end of Meck Island might be required to minimize electromagnetic radiation interference effects if two PATRIOT radar units are located on the island. If, in the future, construction of a berm is determined to be necessary, the action would be given appropriate environmental consideration when the construction requirements have been defined.

2.5.3 SENSOR

The THAAD radar would utilize a test site on Roi-Namur Island (figure 2-9). One site could be located within the fenced area at the Sounding Rocket Launch Facility (also known as the "Speedball" site), at the northwest corner of Roi-Namur Island. Another site could be



Source: U.S. Army Space and Strategic Defense Command, 1993a.

EXPLANATION

Potential Interceptor Launch Location

Potential Interceptor Radar Location

Reef Edge

Helicopter Pad

Structures

0 68.5 137 Meters

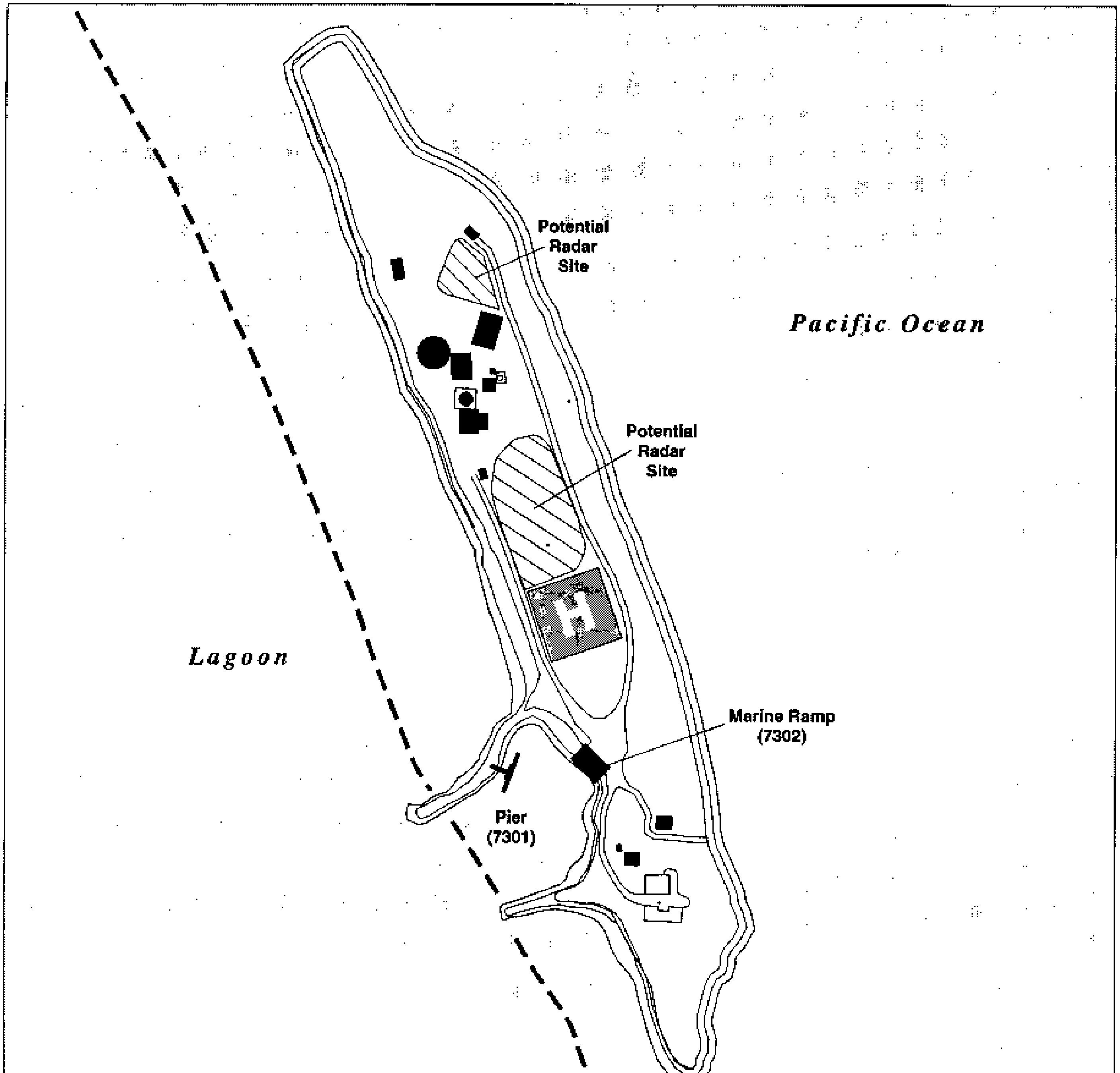
0 225 450 Feet

Note: This figure also represents the area of potential effects for cultural resources.

Potential Activity Locations

Illeginni Island, Kwajalein Atoll

Figure 2-5



Source: U.S. Army Space and Strategic Defense Command, 1993a.

EXPLANATION

Potential Interceptor Radar Location

Reef Edge

Helicopter Pad

Structures

0 37 74 Meters

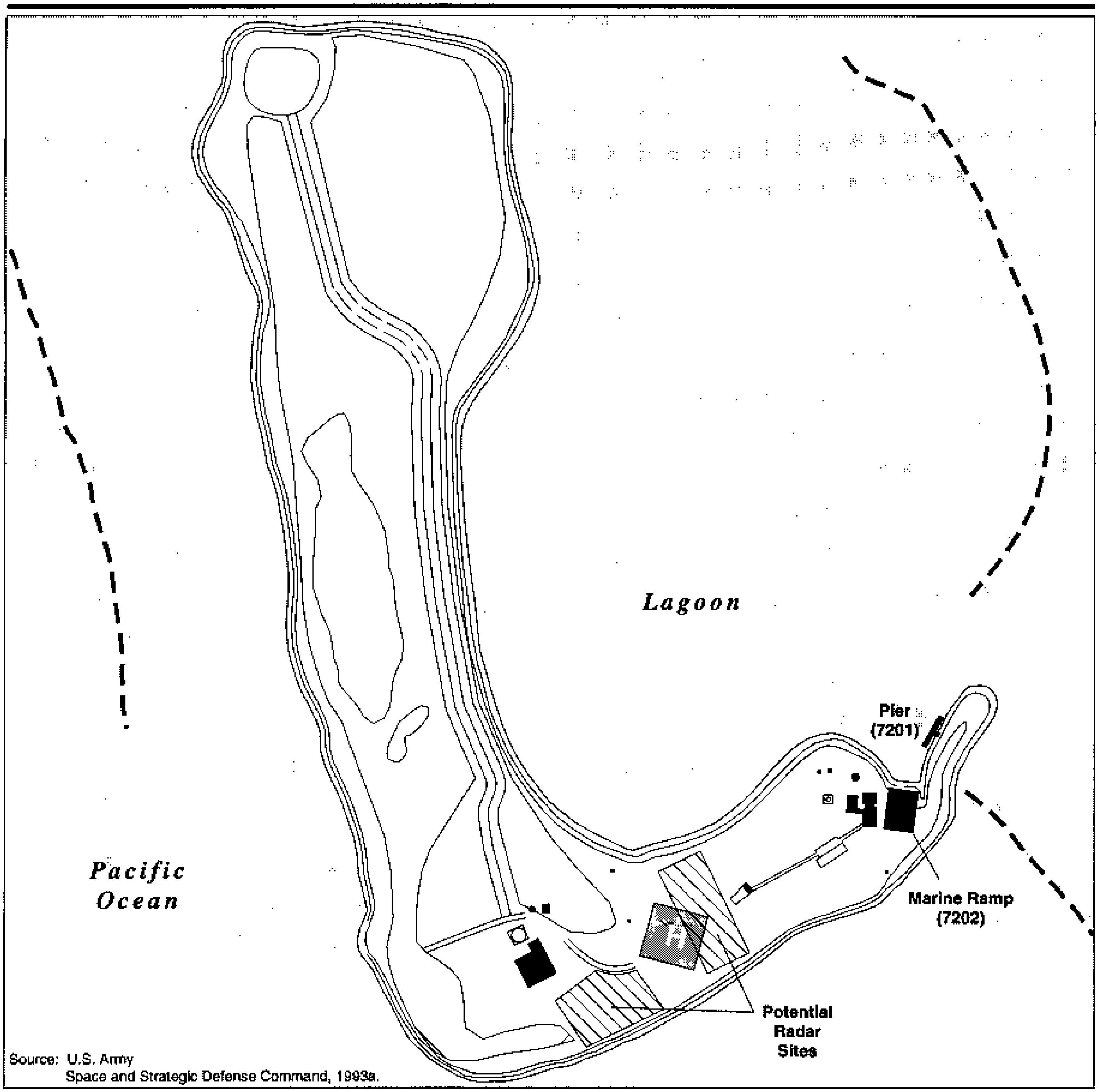
0 121 242 Feet

Note: This figure also represents the area of potential effects for cultural resources.

Potential Activity Locations

Gellinam Island, Kwajalein Atoll

Figure 2-6



EXPLANATION

- Potential Interceptor Radar Location
- Reef Edge
- Helicopter Pad
- Structures

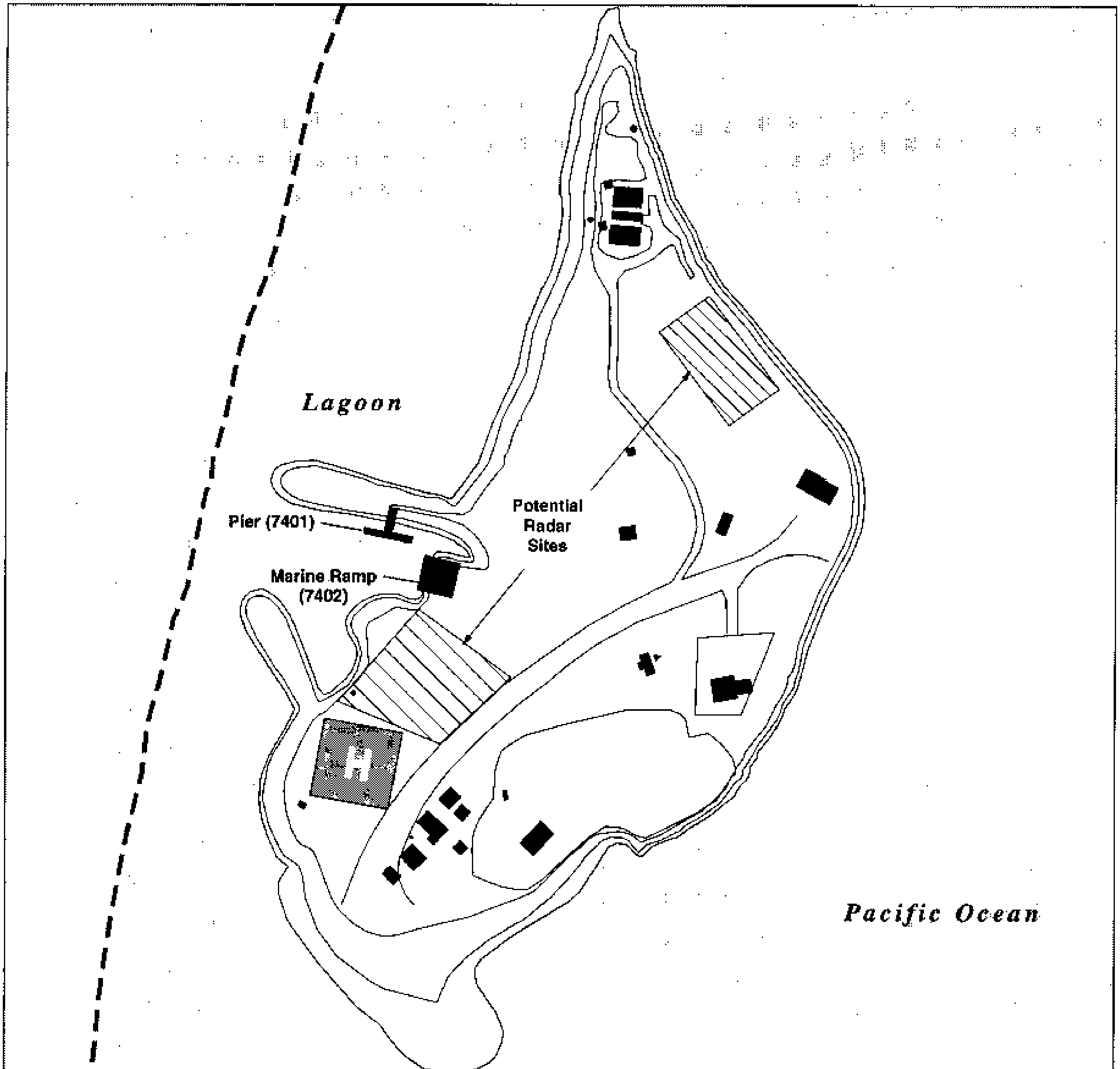
Note: This figure also represents the area of potential effects for cultural resources.

0 37 74 Meters
0 121 242 Feet

Potential Activity Locations

Legan Island, Kwajalein Atoll

Figure 2-7



Source: U.S. Army Space and Strategic Defense Command, 1993a.

EXPLANATION

Potential Interceptor Radar Location

Reef Edge

Helicopter Pad

Structures

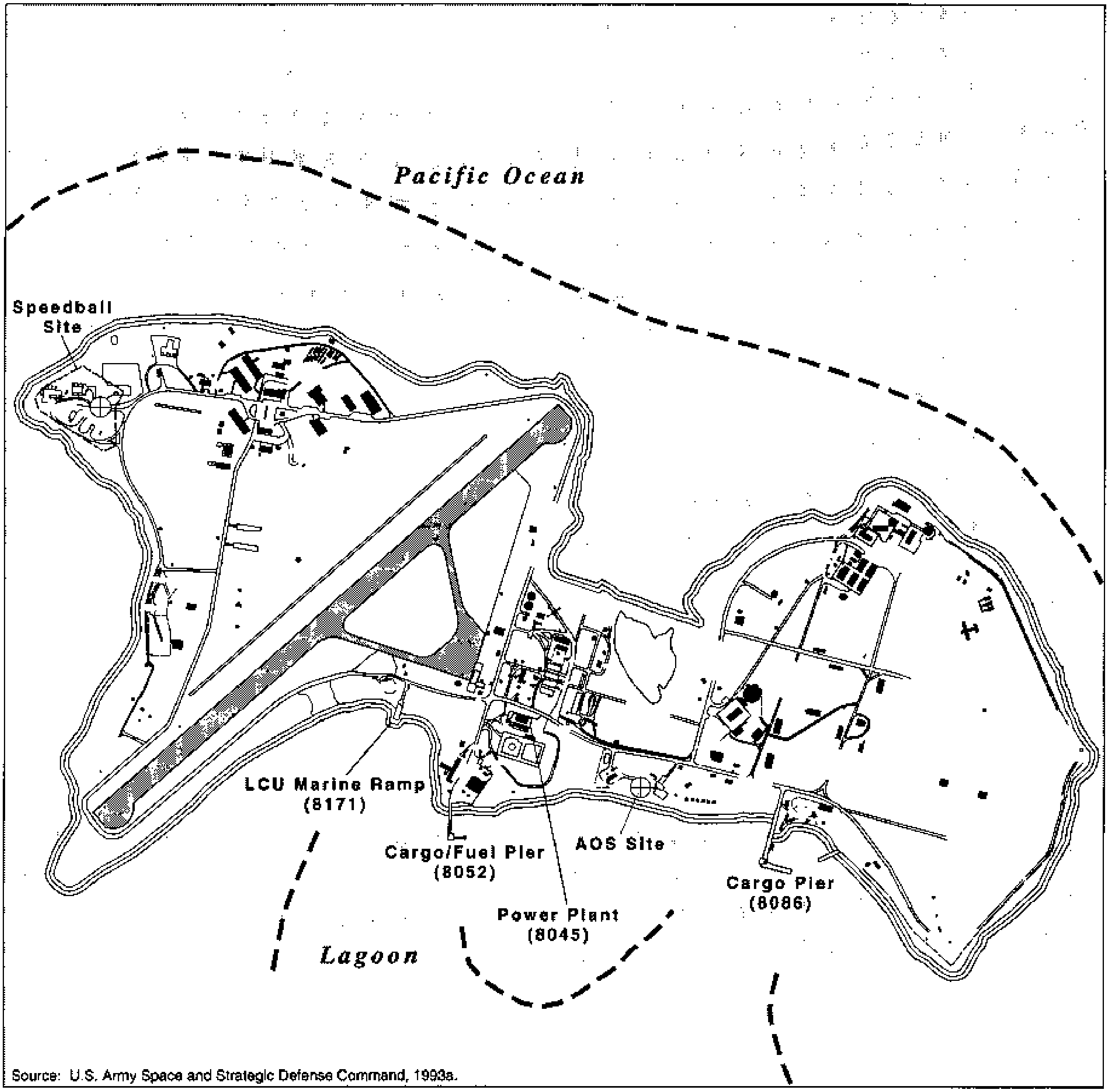
0 30 60 Meters
0 98 196 Feet

Note: This figure also represents the area of potential effects for cultural resources.

Potential Activity Locations

Omelek Island, Kwajalein Atoll

Figure 2-8



Source: U.S. Army Space and Strategic Defense Command, 1993a.

EXPLANATION

⊕ Potential THAAD Radar Sites

— — Reef Edge

■ Structures

– – – Fence

Note: This figure also represents the area of potential effects for cultural resources.

0 166.5 333 Meters
0 547 1,094 Feet

Potential Activity Locations

Roi-Namur Island, Kwajalein Atoll

Figure 2-9

located on the southern side of Roi-Namur Island (known as the Army Optical Site, [AOS]). The most significant utility demand for the THAAD radar would be 3 phase, 4,160 volt, 60 hertz electrical power, which would be provided by the associated Prime Power Unit (PPU) of the THAAD radar system. If existing power from Roi-Namur is used to supplement the PPU, then some trenching may be required. USAKA SOPs for explosive safety would be implemented and explosive disposal personnel would be onsite if trenching is necessary. Depth of the trench would be approximately 1 meter (3 feet); however, specific location of the trench will not be known until THAAD radar layouts are finalized. If existing transformers cannot be used, then a concrete pad (approximately 6.7-meter by 7.6-meter [22-foot by 25-foot]) would be constructed for new transformers. An aggregate pad (approximately 4.3-meter by 5.8-meter [14-foot by 19-foot]) may also be constructed to support a 20,000-liter (5,000-gallon) fuel storage tank. For any activities that require ground disturbance of greater than 1 meter (3 feet), a qualified professional archaeologist would monitor the activities (U.S. Army Space and Strategic Defense Command, 1994f). Trench and pad placement will be coordinated with a qualified archaeologist and/or historian to avoid affecting any subsurface features.

2.6 FLIGHT TEST ACTIVITIES

2.6.1 TARGET

Actual launch activities would begin with the arrival of the launch team at Aur Atoll, approximately 30 days prior to the scheduled launch. Miscellaneous flight readiness testing would occur during this time period. Property owners on Bigen Island would be notified of program activities 60 days in advance of the proposed launch date.

The launch team's equipment would consist of the target GHLE, launch control van, pad equipment shelter truck, three 60-kilowatt (kW) generators, a 9,000-kilogram (10-ton) crane, earth moving equipment, supporting light vehicles for equipment and supply transportation, and miscellaneous small equipment and supplies. Some equipment may have remained on the island from site preparation. For a maximum of 30 days, an average of approximately 25 personnel, up to a maximum of 45 people, would be on the island to perform prelaunch operations. Personnel would commute via small boats to their living quarters on the LCU. Some personnel may stay in temporary living quarters, known as a 10-person Mann Camp, that would be located in previously disturbed areas on Bigen Island. No food preparation facilities would be installed on the island. Food and bottled potable water would be brought ashore by Landing Craft Mechanized (LCM), or similar marine utility craft as required, on a daily or on an as-needed basis. Two portable biological toilets would be temporarily installed on the island. Hot meals would be prepared on board the LCU. Garbage would be removed by LCM on a daily or on an as-needed basis.

Only necessary, minor mechanical repairs would be performed on the island. The machine shop on board the LCU would be used to support maintenance activities. Diesel fuel refueling operations for the motorized vehicles and generators would also be performed on the island as necessary. All refueling operations would be performed within impermeable spill containment systems. Bulk fuel would be maintained aboard the LCUs. Spill control kits would be present on the island and onboard the LCU or other vessels. A Spill Prevention and Response Plan including transport and handling of fuels, in addition to fueling operations, would be formulated and implemented if necessary. In the event of a technical problem with the liquid propellants of the liquid propellant missile, bulk liquid storage containers would be available on the island for de-fueling of the liquid propellant launch vehicle. A saltwater pump would be available at the launch site for fire suppression.

Shortly before launch, all mission-essential personnel would be evacuated from the launch area to a launch control van (approximately 457 meters [1,500 feet] from the launcher) or the LCU. Non-mission-essential personnel would be evacuated from the launch hazard area (approximately 2,000 meters [6,562 feet] around the launcher). A small security vessel would sweep the launch hazard area for any personnel or water craft. After the launch hazard area is verified to be clear, the launch signal would be given from the launch control van or the LCU. Intercept debris impact zones, target vehicle impact zones (in the event of a failed intercept), and impact zones for scheduled jettisons (such as nozzle adapters and interstage adapters) would be confined either to open areas at sea or to existing range areas which have been verified clear of personnel.

2.6.2 INTERCEPTOR

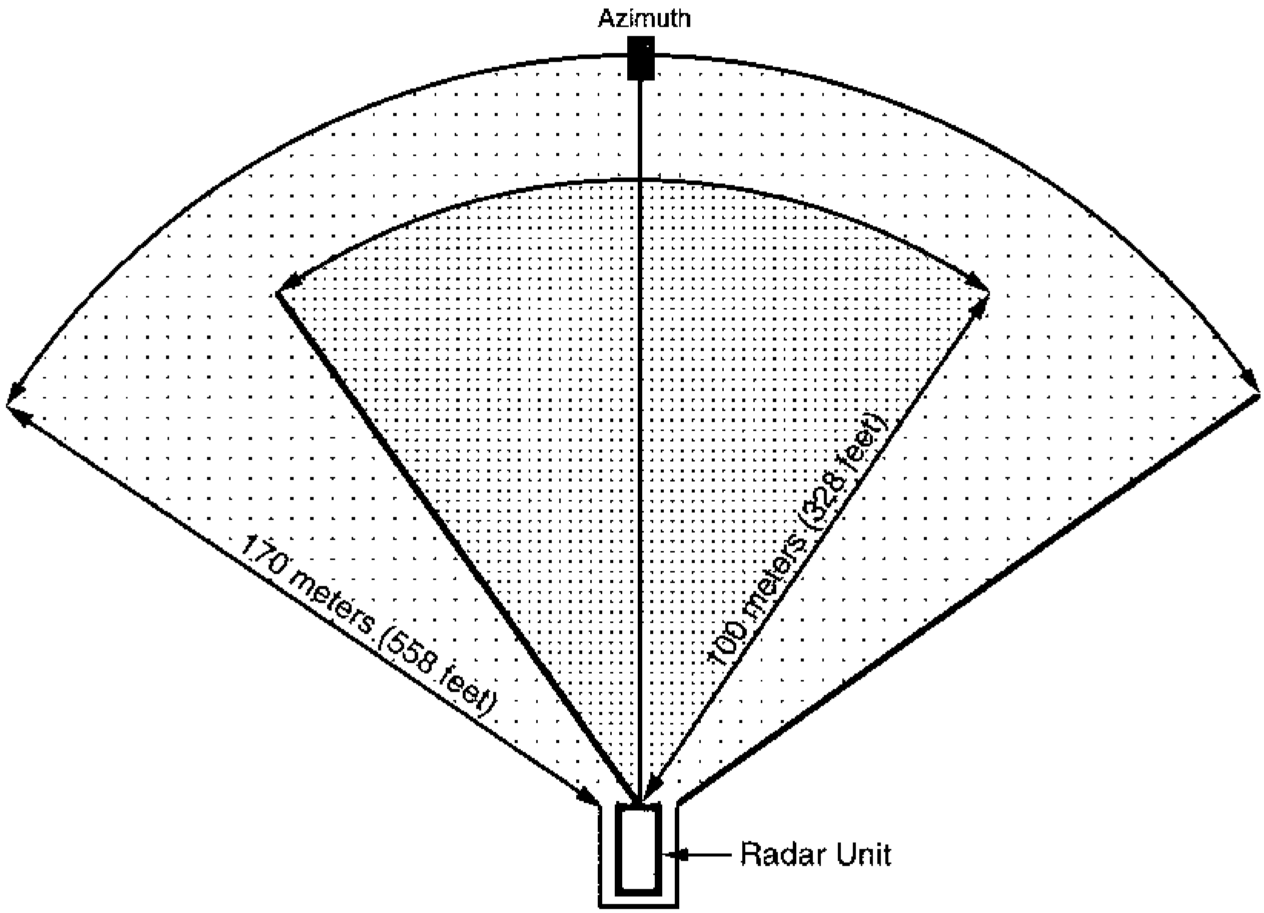
The PATRIOT missile would be used for missions involving intercepts. PATRIOT could be launched from Illeginni or Meck islands. The use of Illeginni and Meck islands by TMD interceptors was addressed in the USAKA Final Supplemental Environmental Impact Statement (EIS) (U.S. Army Space and Strategic Defense Command, December 1993a).

Approximately 35 to 50 people would be on the island to perform prelaunch and launch operations. The personnel radiation hazard keep-out area for the PATRIOT radar is approximately 170 meters (558 feet) to the front and sides of the radar face (figure 2-10).

As required by Army regulation, the radiation hazard keep-out area would be indicated by warning signs, prior to activating the radar a visual survey of the area would be conducted to verify that all personnel and wildlife are outside the hazard zone, and a warning beacon would be illuminated when the radar is operating. Some minor clearing of undergrowth or brush could be required in the immediate area of the radar. The launch hazard area for the PATRIOT Launching Station is approximately 2,000 meters (6,562 feet). This area would be cleared of all non-mission-essential personnel prior to each launch. PATRIOT would use existing sites at Illeginni or Meck Island, and no construction or facility modifications would be required.

The PATRIOT missile is supersonic and employs a conventional warhead. Flight termination is accomplished through command detonation of the missile's warhead using a tactical termination system. PATRIOT uses command guidance through midcourse, with terminal guidance provided by a concept called "track-via-missile."

The PATRIOT missile is 5.30 meters (17.4 feet) in length with a diameter of 0.40 meter (1.3 feet). The missile weighs approximately 900 kilograms (2,000 pounds). The PATRIOT missile consists of a single-stage solid propellant rocket motor; radome; guidance section; warhead section; propulsion section comprising the rocket motor, external heat shield, and two external conduits; and a control actuator section which positions the fins to steer and stabilize the missile flight. The PATRIOT is mounted within a canister that functions as a shipping and storage crate and as a launch tube.



Source: U.S. Army Space and Strategic Defense Command, 1993b.

EXPLANATION

Electromagnetic Radiation Hazard Zone for PATRIOT Radar

Electromagnetic Radiation Hazard Zone for THAAD Radar

Electromagnetic Radiation Hazard Zones for PATRIOT Radar and THAAD Radar

Figure 2-10

2.6.3 SENSOR

A variety of land-, water-, and air-based sensors would observe the Aur Atoll launches. At the time of the preparation of this EA, the specific sensors for each Aur Atoll launch have not been defined. However, a summary description of possible sensors has been provided for analytical purposes. If any sensors specifically deployed for the proposed action fall outside of the parameters described here, they would receive supplemental NEPA analysis and documentation as necessary.

Some or all of the USAKA Ground Optics, the USAKA MPS-36 Radars, the USAKA FPQ-19 Radar, and the Kiernan Reentry Measurement System (KREMS) Radars would observe the Aur Atoll launches. These systems are located at USAKA and have previously received comprehensive description and analysis in the USAKA EIS (U.S. Army Strategic Defense Command, 1989) and USAKA Supplemental EIS (SEIS) (U.S. Army Space and Strategic Defense Command, 1993a).

The KMRSS would remain aboard an ocean-going vessel located in the Aur Lagoon except for operational tests and the actual launch when it would be located in the Pacific Ocean west of Aur Atoll. The KMRSS consists of four equipment vans, a telemetry receiver, and two command destruct transmitters. The KMRSS provides flight safety data.

The THAAD radar could be operated from the northwest corner of Roi-Namur Island, in the vicinity of the Speedball Site, or at the AOS site on the southern portion of Roi-Namur Island. Approximately 20 to 25 people would be on the Island to perform pre-test operations and to operate the radar during the flight test. Power would be provided by the PPU of the THAAD radar system. Commercial electrical power would only be used to supplement the PPU. The required radiation hazard keep-out area for the THAAD radar is approximately 100 meters (328 feet) to the front and sides of the radar face (figure 2-10). As required by Army regulation, the radiation hazard keep-out area would be indicated by bilingual warning signs, prior to activating the radar a visual survey of the area would be conducted to verify that all personnel and wildlife are outside the hazard zone, and a warning beacon would be illuminated when the radar is operating.

2.7 FLIGHT TRAJECTORIES

2.7.1 TARGET

The target launch vehicle would follow a flight trajectory from Bigen Island approximately west-northwest toward Kwajalein Atoll (figure 2-1). Depending upon the specific mission configuration, the launch vehicle could be intercepted in flight or it would follow a ballistic course to water impact. Intercepts and ballistic impacts would occur in either a BOA east of Kwajalein Atoll, or in the Mid-atoll Corridor within the Kwajalein Lagoon. In the event of a BOA intercept or water impact, the debris would be lost in the Pacific Ocean. In the event of a Kwajalein Lagoon intercept or water impact, the missile debris would be recovered from the Kwajalein Lagoon in accordance with the U.S. Army Kwajalein Atoll Standard Practice Instruction 1345, Reentry Vehicle Recovery Procedures (U.S. Army Kwajalein Atoll, 1989a). Throughout the target missile's flight, a variety of land-, water-, and air-based sensors would obtain data on the missile's performance and characteristics.

2.7.2 INTERCEPTOR

Prior to the PATRIOT missile launch from Meck or Illeginni Island, the aim point and launch time to intercept the target would be computed. This information would then be downloaded to the PATRIOT missile. The missile would fly out using inertial and radar-provided guidance to intercept the target. When operating in tactical mode, a second PATRIOT missile would be launched within several seconds of the first missile. The system can also be operated in test mode to launch a single PATRIOT missile. At intercept, the target would be destroyed by warhead fragments.

For TMD intercepts in the Mid-Atoll Corridor within the Kwajalein Lagoon, the PATRIOT interceptor would be launched from Illeginni Island, USAKA. Figure 2-11 shows a representative debris pattern and trajectory for this scenario. For TMD intercepts in the BOA east of Kwajalein Atoll, the PATRIOT interceptor would be launched from Meck Island. Figure 2-12 shows a representative trajectory and debris pattern for this scenario. Any interceptor or target debris which would land in the Kwajalein Lagoon would be recovered in accordance with the USAKA Reentry Vehicle Recovery Procedures.

In the event of a missed intercept or other flight termination action, all debris would be contained within the Mid-atoll Corridor, the BOA, and/or outside protection circles established for any inhabited islands. The range safety officer would continuously monitor the flight of any launch vehicle to ensure it does not exceed its flight safety parameters. If the vehicle exceeds the limits of its flight safety parameters, then the range safety officer would terminate the vehicle's flight.

2.8 POST LAUNCH ACTIVITIES

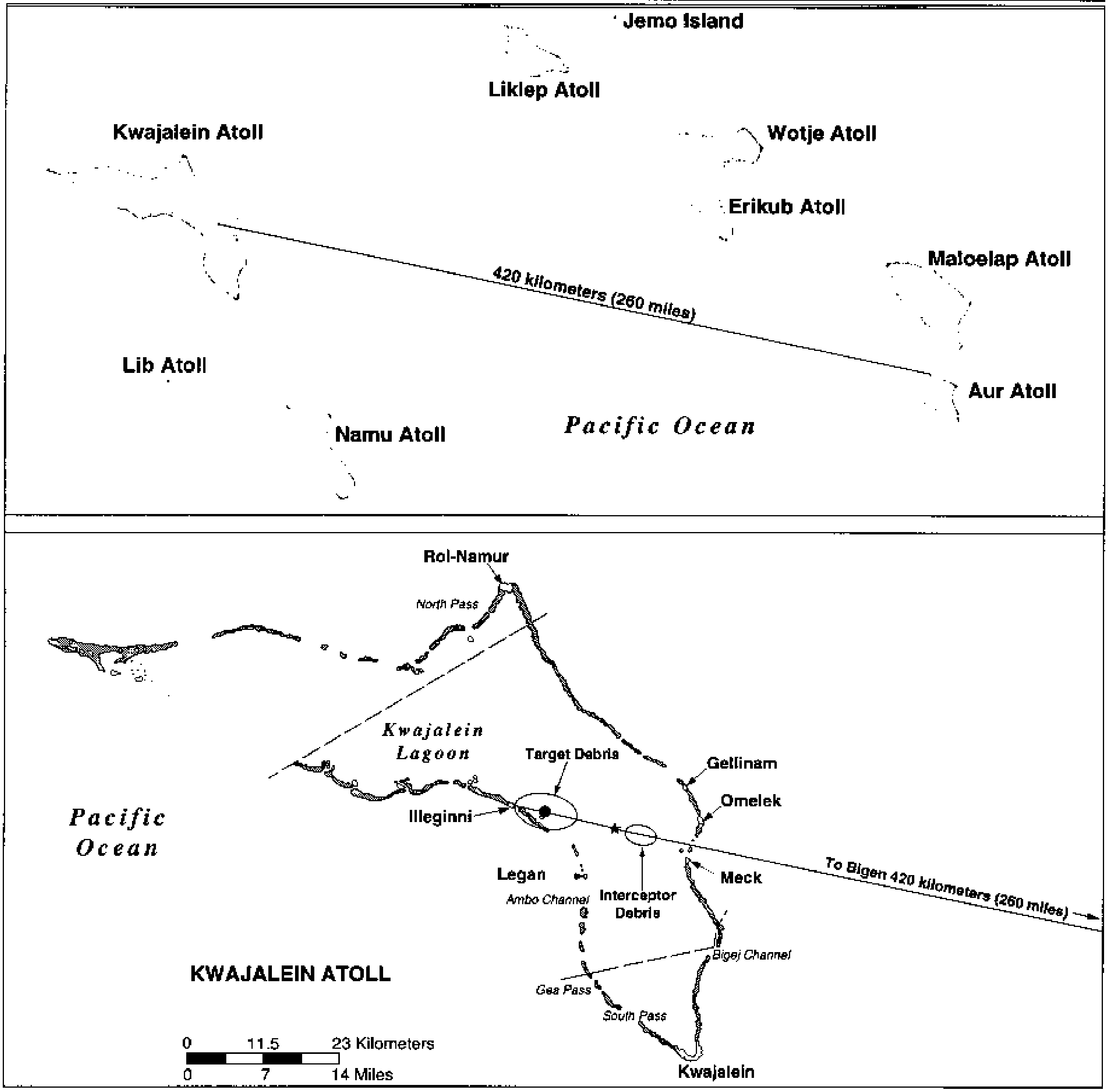
Following the completion of the launch program from Bigen Island, all associated vehicles and equipment would be returned to the USAKA. Metal matting at the launch site and miscellaneous launch equipment such as wires and portable latrines would be removed. Following completion of the interceptor program, all interceptor components would depart the USAKA as previously described for their deployment.

2.9 DESCRIPTION OF ALTERNATIVES TO THE PROPOSED ACTION

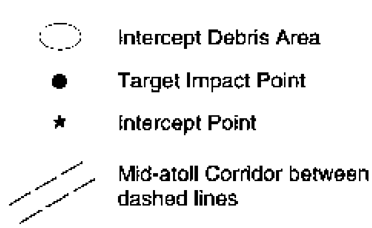
2.9.1 ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD

Three existing range areas were identified as having the potential to serve as a temporary extended test range within the schedule constraints of the proposed test program. These areas included the USAKA and neighboring atolls; Eglin AFB, Florida; and Western Test Range, California. Each area was evaluated using nine criteria:

- flight distance requirements
- engagement geometry
- instrumentation coverage
- logistical supportability
- public health and safety
- security
- environmental considerations
- political considerations
- cost

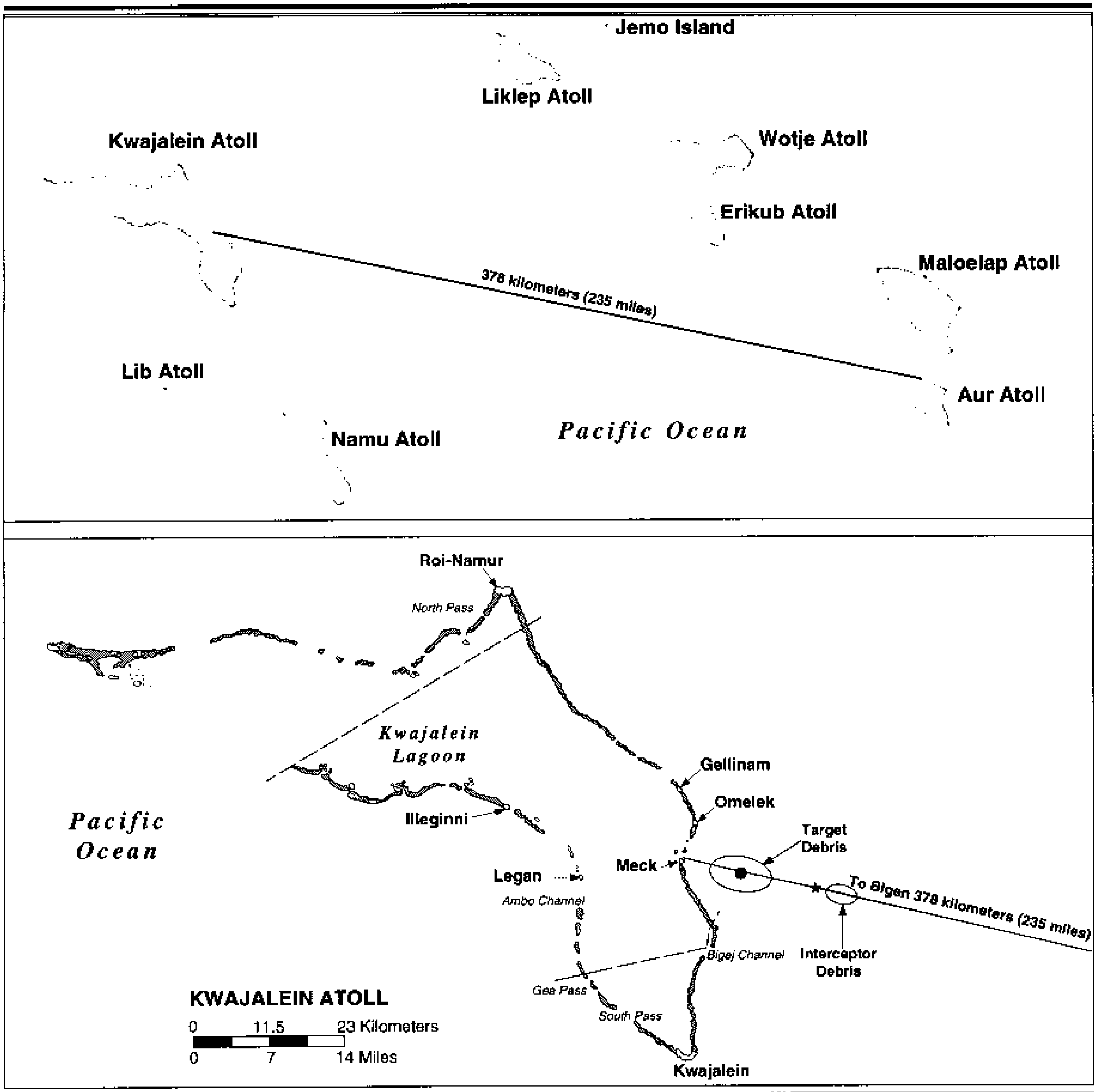


EXPLANATION



Kwajalein Lagoon Intercept Scenario

Figure 2-11



EXPLANATION

- Intercept Debris Area
- ● Target Impact Point
- ★ Intercept Point
- Mid-atoll Corridor between dashed lines

Broad Ocean Area Intercept Scenario

Figure 2-12

At the USAKA area a preliminary study evaluated fourteen target/interceptor launch options. Nine of the launch options included launching the target missile toward the USAKA, and five alternatives included launching the target missile between atolls in proximity to the USAKA. After evaluating the fourteen launch options against the nine criteria it was determined that two of the launch options were viable alternatives. These options were from Aur Atoll to the USAKA and from Bikini Atoll to the USAKA.

The two USAKA alternatives, Eglin AFB, and the Western Test Range were then evaluated against the nine criteria. A summary of the application of the criteria is presented in table 2-2 and is further discussed in the following paragraphs.

Although Bikini Atoll was determined to be geographically and technically feasible, it was excluded based upon public health and safety and political concerns. During the late 1940s and 1950s, Bikini Atoll was used extensively by the U.S. Government as a nuclear weapons test site. Remediation, scientific study, and clean-up efforts continue at Bikini Atoll to this date. Because flight test activities at Bikini Atoll could possibly interfere with these efforts, the USASSDC directed that Bikini Atoll be removed from any further consideration.

Flight tests at Eglin AFB, Florida would involve a barge launching of a target missile from the Gulf of Mexico toward Eglin AFB. Impact would occur in the Gulf of Mexico south of Eglin AFB. The technical requirements of target missile launches would require the construction of a specialized barge which could not be accomplished without significant schedule and cost impacts to the program. In addition, the relatively close proximity of populated areas could result in restrictive flight safety requirements.

Flight tests at Western Test Range, California would involve a launch from Guadalupe Island, Mexico toward the U.S. Navy impact area near San Nicolas Island, California. Impact would occur in the Pacific Ocean southwest of San Nicolas Island. Potential security problems and political concerns of launching a target from a foreign nation where government relationships for missile testing have not been established were two criteria that raised concerns for this alternative. In addition, the relatively close proximity of populated areas could result in restrictive flight safety requirements.

One additional launch alternative involved the launch of the target missile from a barge or LCU anchored in the lagoon of Aur Atoll. All launch operations would be conducted aboard the barge or LCU, and no activities would occur on Bigen Island. However, as mentioned for Eglin AFB, the technical requirements of a target missile launching from a barge or anchored LCU would result in significant schedule and cost impacts. Because of this, the alternative was eliminated from further analysis.

2.9.2 NO-ACTION ALTERNATIVE

Under the No-Action Alternative, the USASSDC would not proceed with the USAKA temporary extended test range program. Bigen Island at Aur Atoll would not have a temporary target launch site established on it, and launch activities would not be performed at Aur Atoll. Flight test data for tactical missiles, needed for development of TMD sensors, interceptors, and technology, would not be collected.

Table 2-2: Criteria Application - Temporary Extended Test Range

CRITERIA	ALTERNATIVE RANGES			
	Eglin AFB–Barge launch of target, interceptor from Cape San Blas	**USAKA-Bikini**–Target launch from Bikini Atoll, interceptor launch from USAKA	**USAKA-Aur**–Target launch from Aur Atoll, interceptor launch from USAKA	**Western Range**–Target launch from Guadalupe Island, Mexico, interceptor from San Nicolas Island
Flight Distance Requirements	L	M	M	L
Engagement Geometry	L	M	M	L
Instrumentation Coverage	L	M	M	L
Logistical Supportability	M	M	M	L
Public Health and Safety	L	L	M	L
Security	M	M	M	N
Environmental	M	L	M	L
Political Considerations	M	N	M	L
Cost and Schedule	N	L	L	L

M = Meets requirements
L = Some limitations
N = Does not meet requirements

3.0 Affected Environment

3.0 AFFECTED ENVIRONMENT

This section describes the environmental and socioeconomic characteristics that may be affected by the proposed action at the USAKA and Bigen Island. In order to provide a baseline point of reference for understanding any potential impacts, the affected environment is concisely described; any components of greater concern are described in greater detail.

Available reference materials, including EAs, EISs, and base master plans, were reviewed. Questions were directed to installation and facility personnel; Federal, state, and local regulatory agencies; and private individuals. Site visits were also conducted to gather the baseline data presented below.

3.1 AIR QUALITY

Air quality in a given location is described by the concentrations of various pollutants in the atmosphere, expressed in units of parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$). Pollutant concentrations are determined by the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and meteorological conditions related to prevailing climate. The significance of a pollutant concentration is determined by comparison with Federal and local ambient air standards. These standards establish limits on the maximum allowable concentrations of various pollutants in order to protect public health and welfare. A description of the appropriate air quality standards, the National Ambient Air Quality Standards (NAAQS), is provided in Appendix E.

Region of Influence

Identifying the region of influence (ROI) for an air quality assessment requires knowledge of the pollutant types, source emissions rates and release parameters, the proximity relationships of project emission sources to other emission sources, and local and regional meteorological conditions. For inert pollutants (all pollutants other than ozone and its precursors), the ROI is generally limited to an area extending no more than a few tens of miles downwind from the source.

The ROI for ozone may extend much further downwind than the ROI for inert pollutants; however, as the project areas have no heavy industry and very few automobiles, tropospheric ozone and its precursors are not of concern. Consequently, for the air quality analysis, the ROI for project operational activities is a circular area with a 24-kilometer (15-mile) radius centered on the site of activity on each of the islands.

3.1.1 BIGEN ISLAND

Climatological Conditions

Climate at Bigen Island affects the dispersion and dilution of air pollutants and the resulting air quality. No climatological information specific to Bigen Island is known to be available; however, Pacific Islands located at a latitude between the equator and 30° have similar climates. This maritime climate is dominated by the easterly trade winds that blow steadily from the northeast every month of the year with very little variation. Winds from other directions occur only rarely, such as during tropical storms. Furthermore, the land surface of Bigen Island has little effect on the climate of the locality due to its small area of 73 hectares (180 acres) and low average elevation. (Gale Research Company, 1981; Seinfeld, 1986)

Regional Air Quality

No ambient air quality data are known to exist for Bigen Island. However, there should be no air pollution problems at Bigen Island since there are only extremely minor sources of air pollution, and there should be good air pollution dispersion produced by strong persistent trade winds and lack of topographic features to inhibit dispersion. Therefore, the ambient air quality at Bigen Island is expected to be in compliance with all NAAQS.

Air Pollutant Emission Sources

The only known sources of air pollution on Bigen Island are the intermittent fires associated with the processing of copra. This activity produces minor amounts of carbon monoxide and particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM-10), both of which are criteria pollutants (see Appendix E). As there are no permanent inhabitants of Bigen Island, there are no other man-made sources of air pollutants.

3.1.2 USAKA ISLANDS

Specific to the USAKA, in 1989 the U.S. Army prepared an installation EIS for USAKA (U.S. Army Strategic Defense Command, 1989). That EIS, and the subsequent Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a), discuss the existing air quality in detail and are incorporated into this document by reference. This section summarizes the air quality affected environment sections of those two documents. Information from any other sources of data is specifically referenced.

Climatological Conditions

Climate at the USAKA affects the dispersion of air pollutants and the resulting air quality. While most of the detailed climatological information available is specific to Kwajalein Island, the other islands of the Kwajalein Atoll have very similar climates.

The land surface of the islands of the Kwajalein Atoll has little effect on the climate of the locality. This is due to their small area and low average elevation. For example, Kwajalein Island, which is the largest island, has an area of only 303 hectares (748 acres) and an average elevation of only 3 meters (10 feet) mean sea level (MSL).

Kwajalein, located less than 1,000 kilometers (600 miles) north of the equator, has a tropical marine climate characterized by relatively high annual rainfall and warm to hot, humid weather throughout the year. (Gale Research Company, 1981)

Temperatures are very equable from day to day and month to month. Because of the low latitude, there are only slight seasonal variations in the length of the daylight period and the altitude of the sun. As a result, the variation of the amount of solar energy received is small. The small variation in solar energy and the marine influences are the principal reasons for the uniform temperature in the area. The range of normal temperature between the coldest month and the warmest month averages about 1 Celsius degree (2 Fahrenheit degrees), and the average daily temperature range is less than 6 Celsius degrees (10 Fahrenheit degrees). Maximum temperatures occur in the early afternoon, and minimums occur with showers at any time of the day or in early morning if there are no showers (Gale Research Company, 1981).

The average monthly temperatures on Kwajalein Island range from 27 degrees Celsius (°C) (80 degrees Fahrenheit [°F]) to 29°C (85°F), depending on season. Over a yearly cycle, the lowest recorded temperatures are approximately 21°C (70°F), and the highest temperatures are approximately 32°C (90°F).

The average annual precipitation is 256 centimeters (101 inches). The principal rainfall season extends from mid-May to mid-December, with approximately 30 centimeters (10 inches) of rainfall per month. On the average, about 75 percent of the annual rainfall is recorded during this period. Light, easterly winds, almost constant cloudiness, and frequent moderate to heavy showers prevail during the wet season.

The dry season includes the period from mid-December to mid-May and is characterized by light showers of short duration. In this season the trade winds are persistent, blowing from the northeast at 27 to 37 kilometers (17 to 23 miles per hour) almost constantly. Cloudiness is at a minimum, and the sky is less than one-half covered most of the time; totally clear skies are rare. (Gale Research Company, 1981)

The relative humidity is uniformly high throughout the year, with values almost always between 70 and 85 percent.

The trade winds dominate most of the year, but are strongest from November to June. The prevailing winds blow from the east to northeast with an average speed of 26 kilometers (16 miles) per hour in the winter and 10 kilometers (9 miles) per hour in the summer.

Regional Air Quality

No ambient air quality data are known to exist for Roi-Namur, Illeginni, Meck, Omelek, Gellinam, or Legan islands; however, an ambient air quality study on Kwajalein Island was recently completed (U.S. Army Environmental Hygiene Agency, 1993). The concentration of the criteria air pollutants was measured both upwind and downwind of power plants 1 and 1A (table 3-1). The concentrations of sulfur dioxide, lead, and PM-10 were found to be below their NAAQS. Since there is no short-term NAAQS for nitrogen dioxide, the study compared the measured concentrations at Kwajalein to the 1-hour California ambient air quality standards for nitrogen dioxide; the concentrations at Kwajalein were below this standard. The concentrations measured at Kwajalein were below the 1-hour NAAQS for carbon monoxide, but downwind concentrations were greater than the 8-hour NAAQS for carbon monoxide.

Table 3-1: Ambient Air Quality at Kwajalein Island

Pollutant	NAAQS*	Measured Ambient Concentrations	
		Upwind	Downwind
Sulfur dioxide (SO_2)	3-hr max. – 0.5 ppm	0.05 ppm	0.14 ppm
	24-hr max. – 0.14 ppm	0.01 ppm	0.01 ppm
Nitrogen dioxide (NO_2)*	1-hr max. – 0.25 ppm[a]	0.05 ppm	0.10 ppm
PM-10	24-hr max. – 150 $\mu g/m^3$	114 $\mu g/m^3$	107 $\mu g/m^3$
Lead (Pb)	Quarterly – 1.5 $\mu g/m^3$	< 0.1 $\mu g/m^3$	< 0.1 $\mu g/m^3$
Carbon monoxide (CO)	1-hr max. – 35 ppm	13.9 ppm	27.9 ppm
	8-hr max. – 9 ppm	5.2 ppm	11.4 ppm

*As no short-term NAAQS exist for NO2, the California Ambient Air Quality Standard was used for comparison.
Source: U.S. Army Environmental Hygiene Agency, 1993.

The Supplemental EIS for USAKA predicts that Kwajalein Island has far more air pollutant emissions than all but one of the islands considered for USAKA temporary extended test range activities. Therefore, the ambient air quality for Illeginni, Meck, Omelek, Gellinam, and Legan islands is expected to be closer to that measured at the upwind location at Kwajalein Island. The Supplemental EIS for USAKA predicts that air pollutant emissions on Roi-Namur are comparable to those on Kwajalein; therefore, air quality on Roi-Namur Island is expected to be comparable to that of Kwajalein Island.

For all six USAKA islands considered for USAKA temporary extended test range activities there should be good pollution dispersion produced by strong persistent trade winds and lack of topographic features to inhibit dispersion. Therefore, the ambient air quality at Illeginni, Meck, Omelek, Gellinam, and Legan islands is expected to be in compliance with all NAAQS including carbon monoxide. The ambient air quality at Roi-Namur Island is expected to be in compliance with all NAAQS, except possibly the 8-hour NAAQS for carbon monoxide at locations directly downwind of its power plant.

The USAKA Supplemental EIS estimated the ambient air quality at the USAKA for the period through 1998. The estimate for concentrations of criteria pollutants for the Supplemental EIS's no-action alternative is given in table 3-2. The estimate for air toxics is given in table 3-3. These estimates are based on the assumption that the USAKA population would increase by 4.8 percent over 1990 conditions, and thus emission from all population-related sources would each increase by 4.8 percent (see U.S. Army Space and Strategic Defense Command, 1993a for details). These estimates, if correct, show that Kwajalein, Illeginni, Meck, Omelek, Gellinam, Legan, and Roi-Namur would be in attainment for the criteria pollutants PM-10, nitrogen dioxide, carbon monoxide, and sulfur dioxide.

Air Pollutant Emission Sources

The primary pollution sources at USAKA are power plants, fuel storage tanks, solid waste incinerators, and transportation. Rocket launches are generally a smaller source of emissions. Tables 3-4 and 3-5 present the emissions from these sources as estimated in the USAKA Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a).

Table 3-2: Baseline Ambient Air Concentrations of Criteria Pollutants for the Kwajalein Atoll ($\mu g/m^3$)

Pollutant	Averaging Period	Island								
		Kwajalein	Meck	Roi-Namur	Legan	Gellinam	Omelek	Illeginni	Background[a]	EPA Ambient Air Quality Standards
PM-10[b]	24-hr	52.6	1.01	16.1	2.15	0.365	0.453	0.741	N/A	150
	Annual	8.35	0.162	5.76	0.06	0.045	0.00501	0.0467	N/A	50
Nitrogen dioxide	Annual	67.4	3.45	18.0	1.11	2.29	0.0544	1.09	9.4	100
Carbon monoxide	1-hr	2,110	111	2,010	291	43.7	92.7	117	15,912	40,000
	8-hr	1,060	41.1	1,210	61.4	8.09	11.6	18.0	5,953	10,000
Sulfur dioxide	3-hr	104	21.2	69.4	15.7	9.1	5.57	15.9	130	1,300
	24-hr	47.5	6.07	34.6	3.06	2.13	1.21	3.92	26	365
	Annual	11.2	1.07	9.28	0.270	0.395	0.0156	0.368	3	80
VOC[c]	1-hr	2,390	244	2,720	133	34.6	42.3	52.6	N/A	N/A

[a] Background concentration results from sources at all twelve islands (Kwajalein, Roi-Namur, Meck, Omelek, Ennylabegan, Legan, Illeginni, Gagan, Gellinam, Eniwetak, Ennubirr, and Ebeye).

[b] Particulate matter with an aerodynamic diameter less than or equal to 10 microns.

[c] Volatile organic compounds

Source: U.S. Army Space and Strategic Defense Command, 1993a.

Table 3-3: Baseline Ambient Air Concentrations of Criteria Pollutants for the Kwajalein Atoll ($\mu g/m^3$)

Pollutant	Averaging Period	Island							
		Kwajalein	Meck	Roi-Namur	Legan	Gellinam	Omelek	Illeginni	TLV[a]
Butane	1-hr	1,015.9	100.2	1,116.9	56.0	14.7	17.4	22.1	1,900,000
Xylene	1-hr	86.7	8.5	98.8	3.5	0.8	1.5	1.9	434,000
Toluene	1-hr	48.3	4.8	55.2	1.9	0.5	0.8	1.1	377,000
Benzene	1-hr	12.4	1.2	14.2	0.5	0.1	0.2	0.3	32,000
Formaldehyde	1-hr	12.4	1.2	14.2	0.5	0.1	0.2	0.3	1,200

[a] TLVs (threshold limit values) are taken from the American Conference of Governmental Industrial Hygienists (ACGIH) and are used as guidelines only. There are no applicable emission standards under the *Clean Air Act* for these air toxins

Source: U.S. Army Space and Strategic Defense Command, 1993a.

Table 3-4: Summary of Calculated Annual Air Pollutant Emissions in Metric Tons (Tons) Per Year

	CO	NO_x	SO_2	TSP	PM-10	Pb	VOCs
Kwajalein							
Power Plant 1	220 (240)	673 (741)	279 (307)	76 (84)	76 (84)	0.009 (0.01)	0.09 (0.1)
Power Plant 1A	105 (116)	1,261 (1,390)	88 (97)	31 (34)	15 (17)	0.0009 (0.001)	37 (41)
Power Plant 2	57 (63)	140 (154)	43 (47)	5 (6)	5 (6)	–	0.05 (0.05)
Solid waste incinerator	38 (42)	0.09 (0.1)	7 (8)	9 (10)	18 (20)	0.03 (0.03)	0.9 (1)
Commercial boilers	0.09 (0.1)	0.27 (0.3)	2 (2)	0.03 (0.03)	0.02 (0.02)	–	0.005 (0.005)
Fuel tank farm	–	–	–	–	–	–	674 (743)
Aircraft operations	134 (148)	31 (34)	5 (5)	41 (45)	14 (15)	–	115 (127)
Motor vehicles	54 (59)	13 (14)	–	56 (62)	19 (21)	–	9 (10)
Marine vessels	1.8 (2)	9 (10)	58 (64)	6 (7)	2 (2)	–	0.9 (1)
Maintenance/photo lab	–	–	–	–	–	–	32 (35)
Bakery	–	–	–	–	–	–	0.9 (1)
Roi-Namur							
Power Plant	517 (569)	475 (523)	264 (291)	43 (47)	43 (47)	–	0.9 (1)
Solid waste incinerator	45 (49)	0 (0)	0.9 (1)	5 (5)	5 (5)	0.003 (0.003)	0.9 (1)
Maintenance	–	–	–	–	–	–	5 (6)
Aircraft operations	90 (99)	19 (21)	3 (3)	33 (36)	11 (12)	–	85 (94)
Meck							
Power plant	39 (43)	149 (164)	18 (20)	15 (16)	7 (8)	–	4 (4)
Aircraft operations	40 (44)	9 (10)	2 (2)	0.9 (1)	–	–	20 (22)
Other Islands							
Illeginni power plant	5 (5)	19 (21)	0.9 (1)	2 (2)	0.9 (1)	–	2 (2)
Legan power plant	3 (3)	13 (14)	0.9 (1)	0.9 (1)	0.4 (0.5)	–	0.9 (1)
Gellinam power plant	5 (5)	19 (21)	0.9 (1)	2 (2)	0.9 (1)	–	2 (2)
Omelek power plant	2 (2)	6 (7)	0.4 (0.5)	0.9 (1)	0.3 (0.3)	–	0.9 (1)

Source: U.S. Army Space and Strategic Defense Command, 1993a.

CO = Carbon monoxide
NO_x = Nitrogen oxides
SO_2 = Sulfur dioxide
TSP = Total suspended particulates
PM-10 = Particulate matter with an aerodynamic diameter less than or equal 10 microns
Pb = Lead
VOCs = Volatile organic compounds

Table 3-5: Rocket Launch Estimated Emissions, No-action Alternative

Rocket	Island	Number of launches per year	Carbon monoxide per launch kg (lb)	Hydrogen chloride per launch kg (lb)	Aluminum oxide per launch kg (lb)	Lead per launch kg (lb)
Meteorological	Kwajalein	24	8.2 (18)	3 (6)	3 (6)	0 (0)
	Roi-Namur	24	8.2 (18)	3 (6)	3 (6)	0 (0)
	Omelek	24	8.2 (18)	3 (6)	3 (6)	0 (0)
Sounding	Roi-Namur	8	461 (1,017)	0 (0)	0 (0)	22 (48)
Strategic launch vehicle	Meck	4	7,145 (15,752)	5,178 (11,416)	9,273 (20,444)	0 (0)
	Omelek	4	7,145 (15,752)	5,178 (11,416)	9,273 (20,444)	0 (0)

Source: U.S. Army Space and Strategic Defense Command, 1993a.

3.1.3 FLIGHT TEST CORRIDOR

As there are no known data on air quality baseline characteristics for the open ocean area between Bigen Island and the USAKA, it is assumed for the purposes of this document that the salient characteristics are the same as for the atmosphere above Bigen Island.

3.2 AIRSPACE

Airspace, while generally viewed as being unlimited, is finite in nature. It can be defined dimensionally by height, depth, width, and period of use (time). The FAA is charged with the overall management of airspace and has established criteria and limits for use of various sections of this airspace in accordance with procedures of the International Civil Aviation Organization (ICAO).

Region of Influence

The ROI for airspace includes the airspace over and surrounding the launch hazard areas and the airspace beneath and surrounding the debris containment corridors.

3.2.1 AFFECTED ENVIRONMENT

The USAKA temporary extended test range is located in international airspace. Therefore, the procedures of the ICAO (outlined in ICAO Document 444, Rules of the Air and Air Traffic Services) are followed (International Civil Aviation Organization, 1985; 1994). ICAO Document 4444 is the equivalent air traffic control manual to the FAA Handbook 7110.65, Air Traffic Control. The ICAO is not an active air traffic control agency and has no authority to allow aircraft into a particular sovereign nation's Flight Information Region or Air Defense Identification Zone and does not set international boundaries for air traffic control purposes. The ICAO is a specialized agency of the United Nations whose objective is to develop the principles and techniques of international air navigation and to foster planning and development of international civil air transport.

The FAA acts as the U.S. agent for aeronautical information to the ICAO, and air traffic in the ROI is managed by the Oakland Air Route Traffic Control Center in its Oceanic Control-5 Sector, the boundaries of which are shown in figure 3-1.

Although relatively remote from the majority of jet routes that cross the Pacific, the USAKA temporary extended test range ROI and vicinity has several jet routes passing through it (figure 3-2). An accounting of the number of flights using each jet route is not maintained. However, during a recent 24-hour period there were 241 overflights of Oceanic Control Sector 5 (U.S. Army Space and Strategic Defense Command, 1994a).

Although not depicted on either the North Pacific Route Chart, Southwest Area or Composite (National Ocean Service, 1994a;b), there are low altitude airways carrying commercial traffic between the various islands of the RMI, particularly between the Marshall Islands International Airport at Majuro and Bucholz AAF on Kwajalein Island. During the first half of 1993, there was an average of 75 flights per month to Wake Island from Hickam AFB in Hawaii (U.S. Army Space and Strategic Defense Command, 1994c), most of which passed through Bucholz AAF. Bucholz AAF had a reported 1,674 operations for the month of April, 1993, an average of over 55 per day (U.S. Army Space and Strategic Defense Command, 1994a). Many of the 55 flights per day are aircraft and helicopter flights to other USAKA islands. Currently, Wake Island Airfield is maintained for BMDO activities in a caretaker status, and flight activity through Bucholz AAF is reduced.

3.3 BIOLOGICAL RESOURCES

Biological resources include two major categories: flora (plants) and fauna (animals). Existing information on the flora, fauna, and habitat types known to exist in the ROI was reviewed, with special emphasis on the known or expected presence of any species listed by U.S. or RMI regulatory agencies as rare, threatened, or endangered. Current regulatory species lists for the affected area are included in Appendix D. A discussion of applicable laws and regulations are included in Appendix C.

Coordination and informal consultation with the RMI Environmental Protection Agency has been initiated, and copies of all correspondence are located in Appendix F.

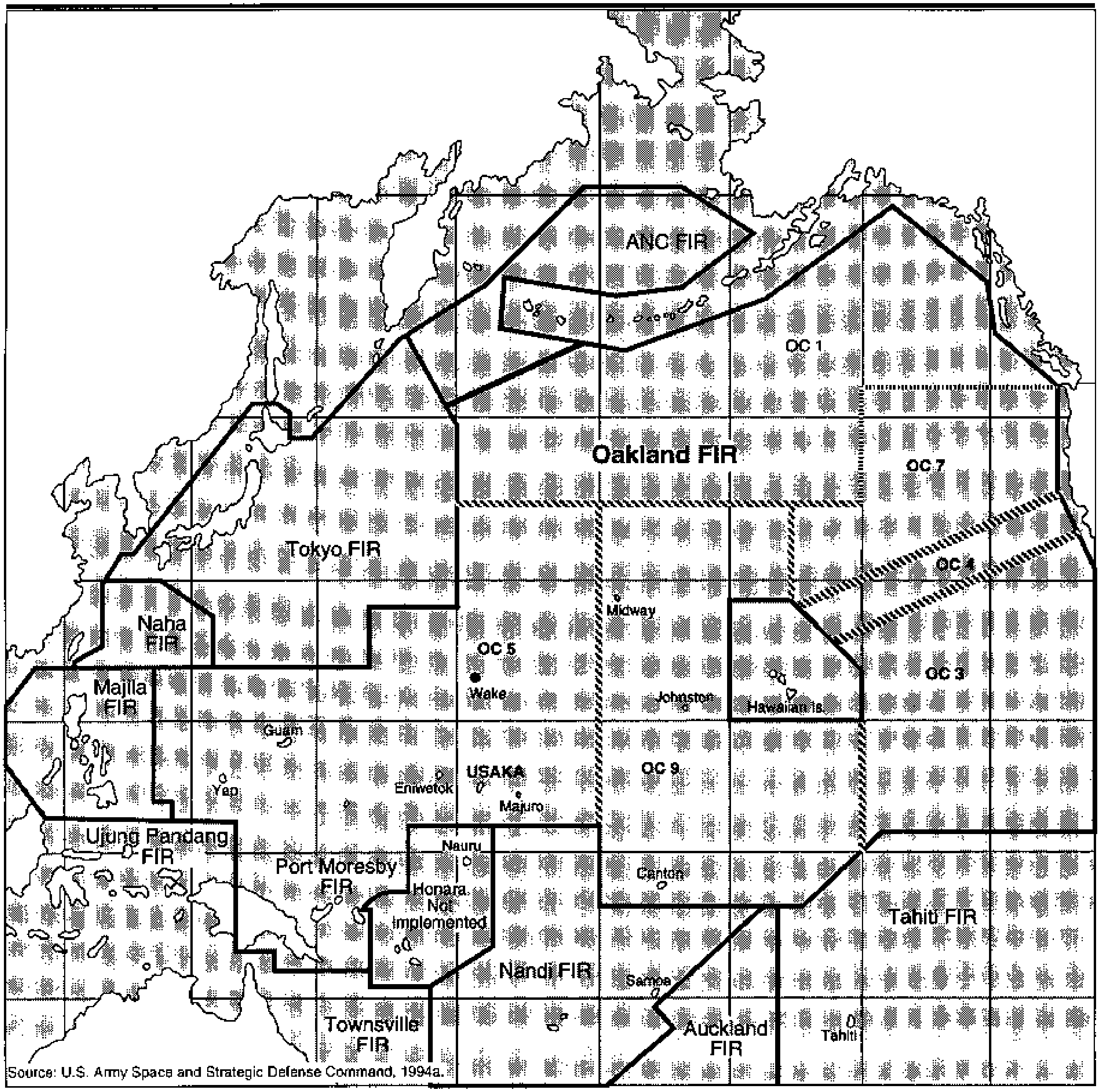
Region of Influence

The ROI for biological resources includes the entire island and near-shore reef area for islands where target and interceptor missiles would be launched. For islands where only sensors would be placed, the ROI would be limited to the sites where program activities are conducted and the electromagnetic radiation (EMR) hazard area. The ROI for the flight test corridor includes the missile over-flight area and the potential debris impact areas over the BOA or Kwajalein Lagoon within the Mid-atoll Corridor.

3.3.1 BIGEN ISLAND

Figure 3-3 shows the biological resources of Bigen Island and the surrounding reef flat.

A reconnaissance survey was conducted at Bigen Island on 1 and 2 December 1994 (U.S. Army Space and Strategic Defense Command, 1995a).



Source: U.S. Army Space and Strategic Defense Command, 1994a.

EXPLANATION

Oceanic Control Area Boundary

Sector Boundary

FIR Flight Information Region

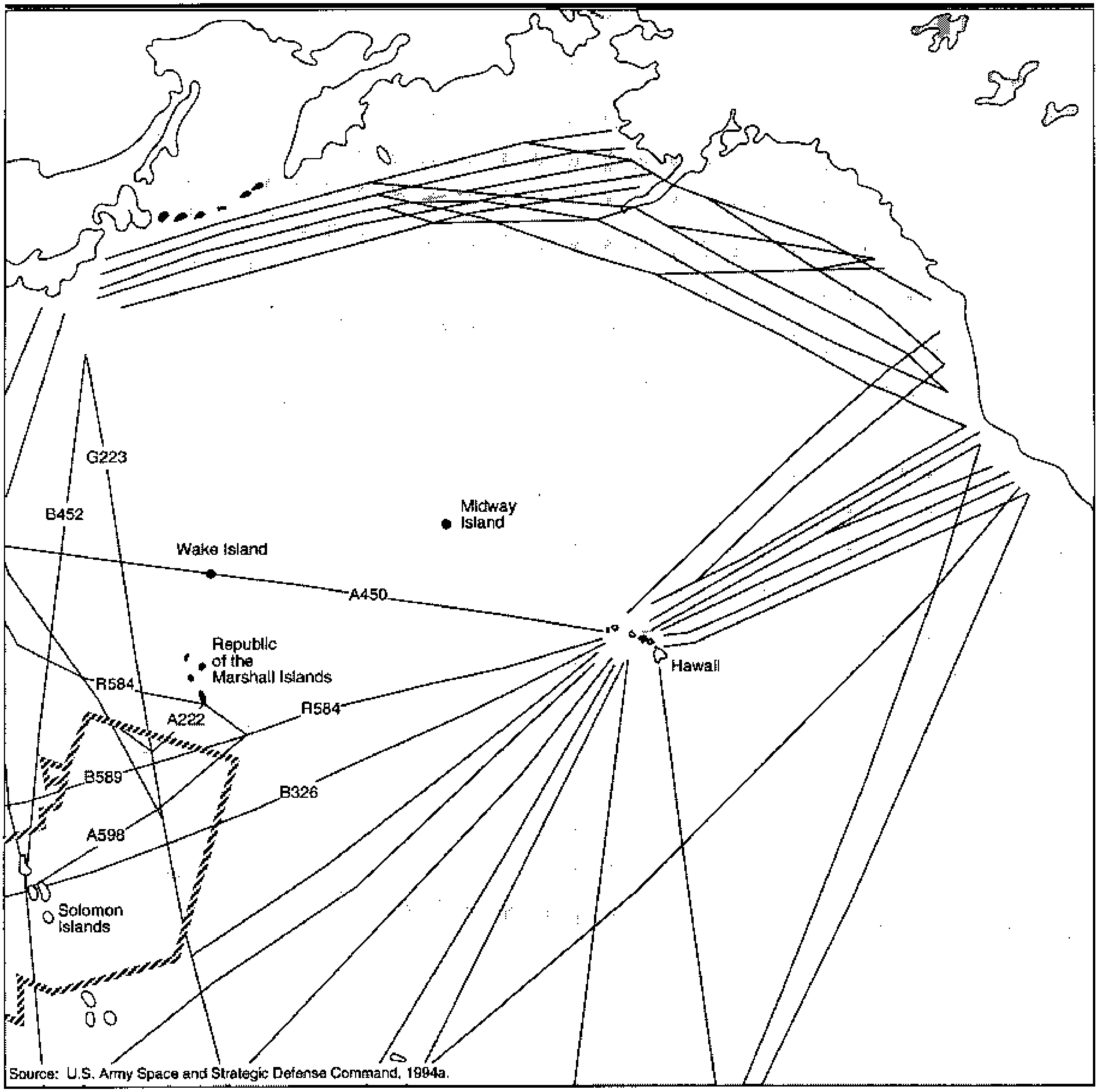
OC Oceanic Control

Not To Scale

Airspace Managed by Oakland Oceanic Control Area

Northern Pacific Ocean

Figure 3-1



EXPLANATION

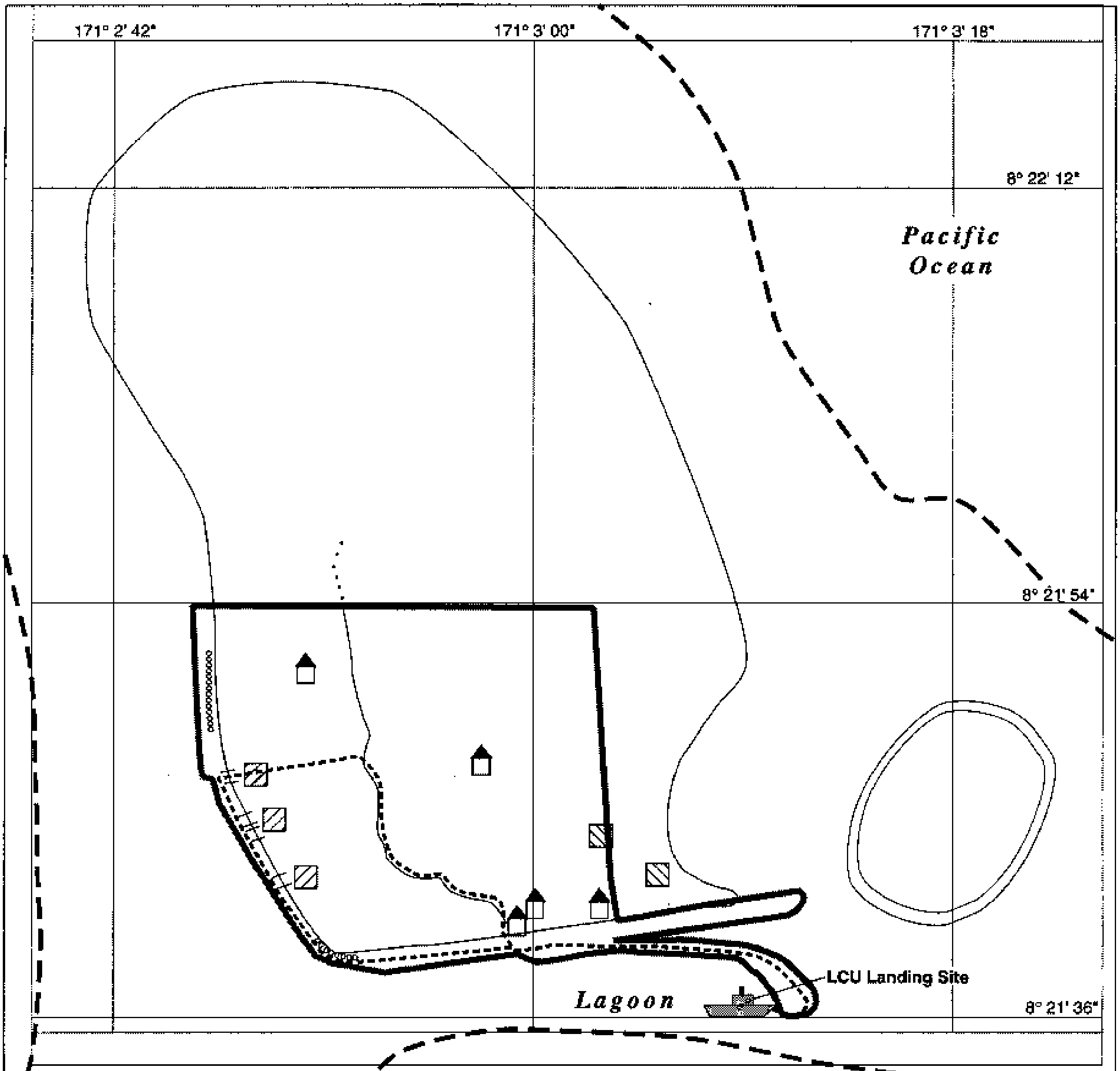
Uncontrolled Airspace Boundaries

High Altitude Jet Routes

Northern Pacific Ocean

Figure 3-2

Not To Scale



Source: Defense Mapping Agency, 1986; and World Vector Shoreline.

EXPLANATION

- Survey Area
- Potential Launch Sites
- Potential Launch Control Sites
- Copra Processing Areas
- Existing Pedestrian Path
- Path of Reconnaissance Survey Front End Loader
- Coastal Access
- Reef Edge
- Potential Sea Turtle Nesting Habitat

Note: Grid Represents Longitude/Latitude

0 95.5 191 Meters
0 312.5 625 Feet

Biological Resources

Bigen Island,
Aur Atoll

Figure 3-3

Flora – Bigen Island is a typical coral islet in Aur Atoll. The reefs and islands of Aur Atoll are the remains of coral reef rock and sediments lying on top of submarine volcanoes formed millions of years ago. As the volcanoes subsided, coral reefs grew upward to remain close to the surface of the ocean and formed the ring of islands that create the lagoon (Stevenson and Talbot, 1994). Islands created in this fashion have soils with low fertility because of three major factors: the soil particles are generally coarse, organic content is low, and the soil is alkaline (U.S. Army Space and Strategic Defense Command, 1993a).

The entire island is planted and maintained as a copra plantation. Much of the original vegetation has been cleared, and the remaining habitat is typical of a low coral atoll. (U.S. Army Space and Strategic Defense Command, 1995a)

Bigen Island has a dominant canopy of planted coconut palm with breadfruit and pandanus also appearing in the overstory. Understory vegetation is being regularly cleared by the Marshallese through the use of controlled burns. Evidence of numerous fires, both recent and past, was observed. Recent burning in the project area (figure 3-3) allowed for excellent visibility due to the near total lack of understory vegetation. Growth of ground cover was inhibited in some areas of the ROI by the litter of palm fronds. Refuse from the harvest of copra, such as coconut husks and shells, was found gathered in numerous piles or buried/burned in shallow pits. (U.S. Army Space and Strategic Defense Command, 1995a)

The following is a list of the more dominant vegetation noted on Bigen Island.

Cocos nucifera	Coconut palm
Pandanus tectorius	Pandanus (screwpine)
Artocarpus altilis	Breadfruit
Tournefortia argentea	Messerschmidia (tree heliotrope)
Scaevola sericea	Scaevola
Ipomoea pes-caprae	Beach morning-glory
Terminalia sp.	Pacific almond
Cuscuta sandwichiana	Hawaiian dodder

The alternative project sites being considered are located along the southwestern perimeter on the lagoon side of the island. All three sites are nearly devoid of vegetation with very little ground cover. Numerous newly rooted coconut palm seedlings were observed at each site. A few individual breadfruit trees occur within the ROI, although no groves of breadfruit are located near the alternative project sites. (U.S. Army Space and Strategic Defense Command, 1995a)

Fauna – Numerous geckos (*Hemidactylus* sp.) were observed in the underbrush and near the copra processing areas. A few fairy terns (*Gygis alba candida*) were also present in the project area and may nest in some of the hollow limbs of the pandanus within the ROI. A single dead coconut crab (*Birgus latro*) was observed. (U.S. Army Space and Strategic Defense Command, 1995a)

Potential habitat for the green sea turtle (*Chelonia mydas aggazizi*) (Federally listed as threatened) and/or hawksbill turtle (*Eretmochelys imbricata*) (Federally listed as endangered) was identified. However, there was no indication that the habitat has been used in the past or is currently being utilized. The areas would be difficult to reach, as the sea turtles would have to cross the fringe of reef flat and many lengths of beach are strewn with coral rubble. The potential habitat is not adjacent to the alternative project sites. (U.S. Army Space and Strategic Defense Command, 1995a)

While the reef flat surrounding the southwestern portion of Bigen Island is an active ecosystem, there appears to be very little coral growth or active marine life due to a build-up of silt along the perimeter of the island. The naturally-occurring siltation may be due to a prevailing wind, resulting in silt along the shoreline. At low tide, several small seeps or springs were observed. (U.S. Army Space and Strategic Defense Command, 1995a)

3.3.2 GELLINAM ISLAND

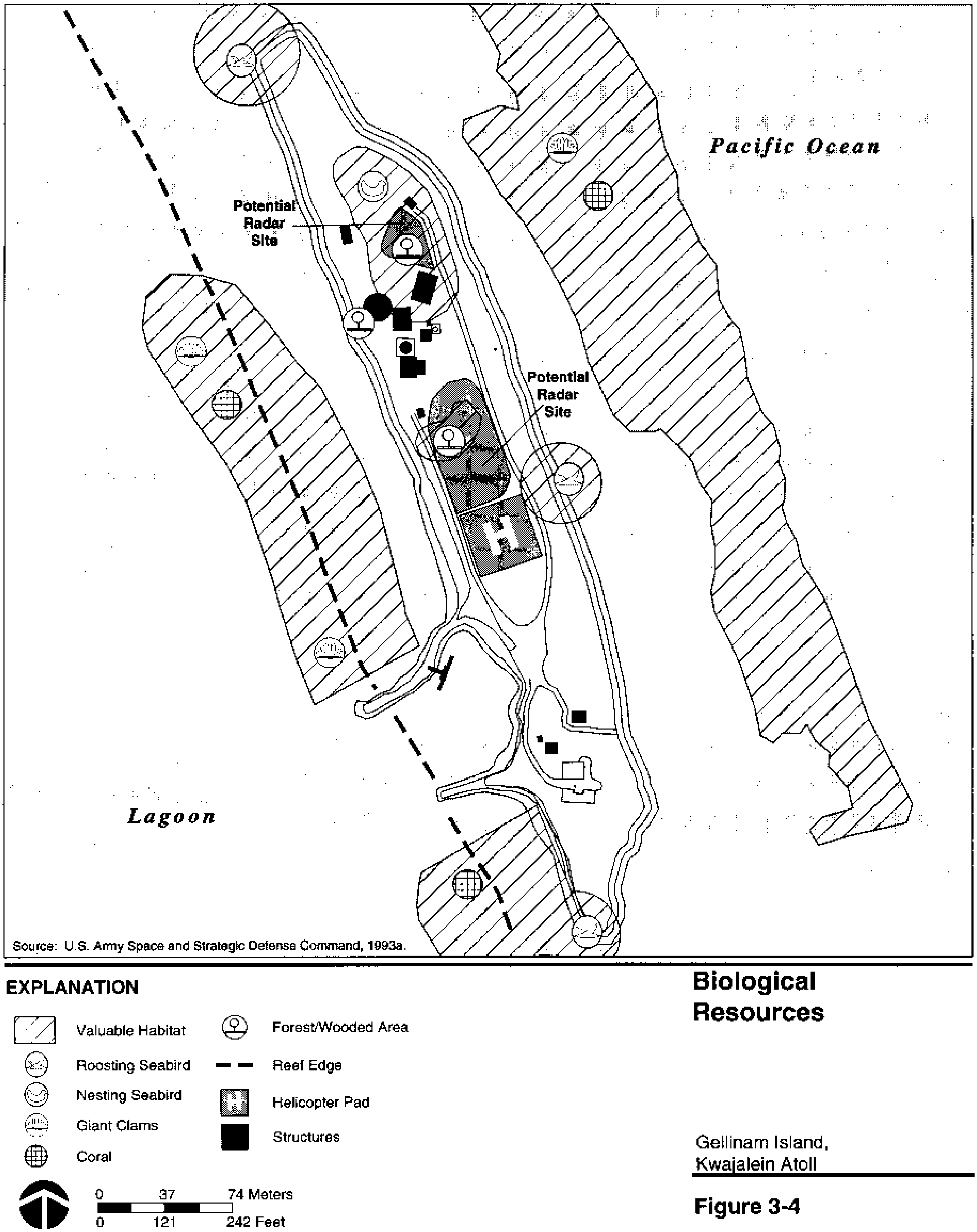
Figure 3-4 shows the biological resources of Gellinam Island and the surrounding reef flat.

Flora – A March 1988 study of the flora of several USAKA islands, including all the islands potentially affected by the proposed action, found a low species diversity common to coral atolls (Herbst, 1988). Only seventeen percent of the species found are considered native to the Marshall Islands, and none are endemic. No rare, threatened, endangered, or candidate species were identified. Natural vegetation on all the islands has been disturbed by some combination of coconut plantations, Japanese occupation, fighting and bombing during World War II, and USAKA operations. The most notable change to the natural vegetation of Gellinam Island was the result of the establishment of a permanent launch support facility by the U.S. Army Corps of Engineers. (Herbst, 1988; U.S. Army Strategic Defense Command, 1989)

Most of Gellinam Island has been cleared and is maintained by mowing. There is a small wooded patch of *Pisonia grandis* on the northern half of the island (figure 3-4). Much of the *Pisonia* grove was cleared in 1990, but is in the process of being re-established. (Herbst, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Fauna – A baseline wildlife survey of all the islands of Kwajalein Atoll, with the exception of Ennugarret Island, was conducted by the U.S. Fish and Wildlife Service in 1988 (Clapp, 1988). Particular emphasis was placed on avian resources and protected sea turtle species. No rare, threatened, endangered, or candidate avian or terrestrial species were identified on any of the islands of Kwajalein Atoll. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

The birds common to Kwajalein Atoll can be grouped together as either migratory shorebirds that winter on the Pacific islands and nest in the Arctic or resident seabirds that nest on the ground or in island vegetation. Greater vulnerability of chicks and eggs to disturbances from USAKA activities makes the nesting seabirds the more critical of the two categories. Clearing of native vegetation on many of the islands has resulted in a decline in the population of resident seabirds. Conversely, the clearing and maintenance of open



Biological Resources

Gellinam Island, Kwajalein Atoll

Figure 3-4

areas may have benefited migratory shorebirds by increasing forage and roost habitat. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Terrestrial fauna on the islands of Kwajalein Atoll are fairly limited and consist primarily of coconut crabs and assorted lizards, rodents, and domestic animals. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

The small wooded patch of *Pisonia* on Gellinam Island supports a breeding population of black noddies (*Anous minutus*) (figure 3-4). The noddy rookery was destroyed in 1990 when the grove was cleared and is slowly recovering as the *Pisonia* is re-established. Breeding and roosting habitat for the black-naped tern (*Sterna sumatrana*) exists in the large pile of rocks on the north end of the island and in several sandpits. Ruddy turnstones (*Arenaria interpres*) are migrants known to utilize the open areas of Gellinam Island. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

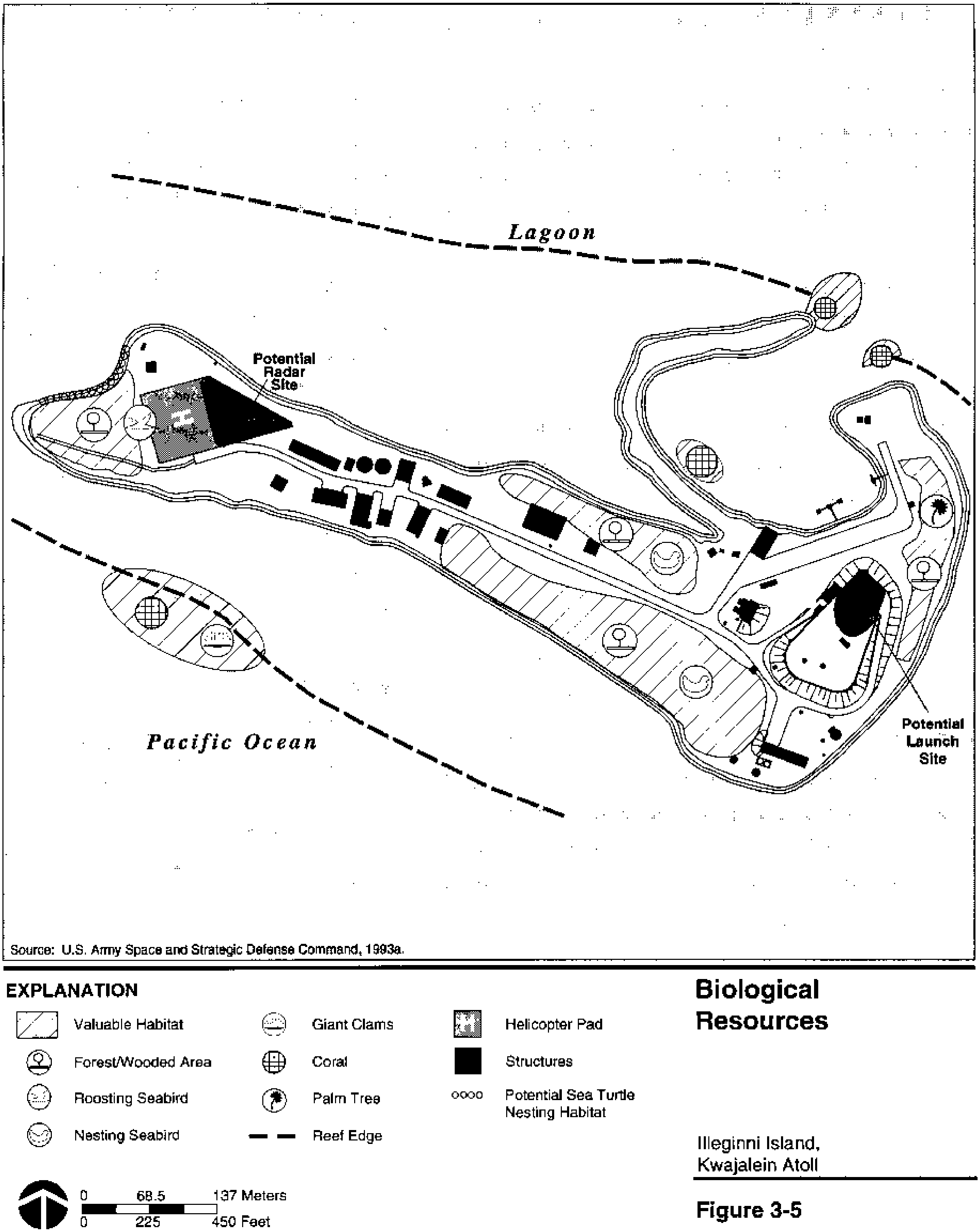
A study was conducted of the marine biology in areas potentially affected by USAKA activities (Titgen, 1988) at all USAKA island shoreline, reef, and marine quarry sites except those of Ennugarret Island. The marine environment surrounding the USAKA facilities was determined to be of good quality. Of particular interest was the well-developed coral assemblage in the lagoon off Gellinam Island. (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Valuable marine habitat off Gellinam Island includes lagoon reefs and shallow reef flats. The harbor area has been dredged, but does support giant clams among the rocks of the jetties. The reefs on both sides of the harbor do not appear to have been affected by USAKA activities at Gellinam Island. The diversity of marine species is high and includes the only reproductively viable population of the largest and most rare of the giant clams (*Tridacna gigas*). Five species of giant clam are found in limited numbers throughout the RMI and are being considered for protection by the RMI government and the U.S. National Marine Fisheries Service. (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

The green sea turtle (Federally listed as threatened) and the hawksbill turtle (Federally listed as endangered) are commonly sighted in the Kwajalein lagoon. However, the RMI does not extend a protected status to these sea turtles, which are a traditional food source for the Marshallese. An intense survey of USAKA beaches (Clapp, 1988) failed to identify likely sea turtle nesting beaches on any of the islands potentially affected by the proposed action. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

3.3.3 ILLEGINNI ISLAND

Figure 3-5 illustrates biological resources of Illeginni Island and the surrounding reef flat. A general discussion of the biological resources of Kwajalein Atoll is provided in section 3.3.2.



Biological Resources

Illeginni Island, Kwajalein Atoll

Figure 3-5

Flora – The launch and harbor areas have been cleared and paved and are maintained by mowing. Non-native grasses and weeds dominate the roadside and open areas within the potential radar site. A small wooded area with coconut palm in the overstory borders the eastern edge of the launch site (figure 3-5). (Herbst, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Fauna – Shorebirds may be found roosting in open areas within the ROI (figure 3-5). (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Potential sea turtle nesting habitat exists at the extreme western end of the island (figure 3-5). However, no evidence of nesting has been observed. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Although the harbor and channel areas at Illeginni Island have previously been dredged, a high diversity of marine life and coral growth has been noted at the entrance to the harbor and across the basin to the west of the dock (figure 3-5). (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

3.3.4 KWAJALEIN ISLAND

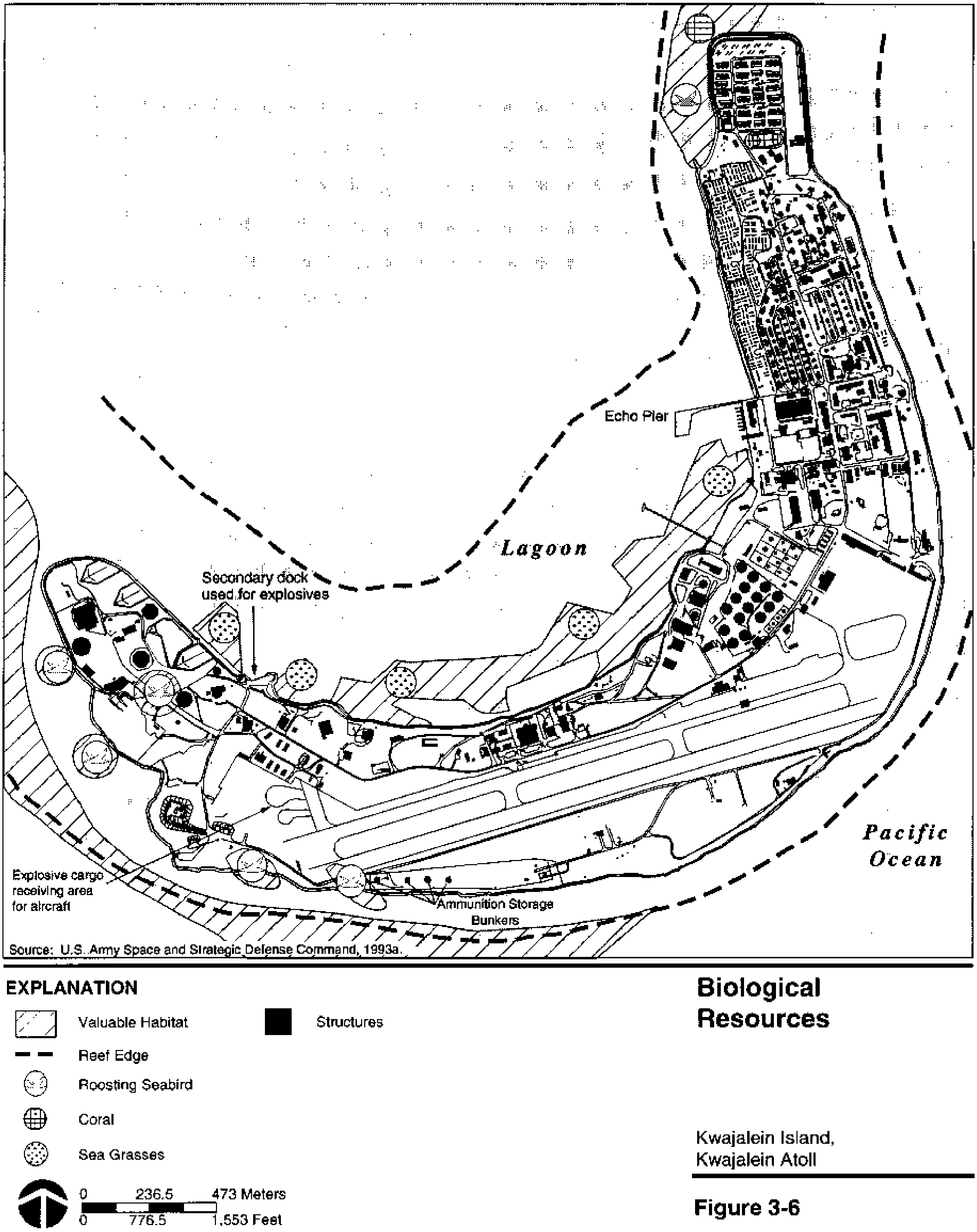
Figure 3-6 shows the biological resources of Kwajalein Island and the surrounding reef flat. A general discussion of the biological resources of Kwajalein Atoll is provided in section 3.3.2.

Flora – Much of Kwajalein Island has been cleared and paved, including the large runway occupying the entire center (southern) portion of the island (figure 3-6). Nonnative grasses and weeds dominate the open areas and are maintained by mowing. The island has been enlarged over the years with dredged landfill since the 1930s and consequently exhibits vegetation characteristic of heavily disturbed areas. (Herbst, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Previously existing lagoon and nearshore marine habitat along the lagoon shoreline is now buried under landfill. However, along the northern edge of the island on the lagoon floor are several small communities of the rare seagrass *Halophila minor* (figure 3-6). (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Fauna – Numerous small parcels of seabird roosting habitat have been identified on the western end of the island within the ROI (figure 3-6). Large numbers of migrating shorebirds have been observed at Kwajalein Island, including the lesser golden plover (*Pluvialis dominica*) and the ruddy turnstone. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Although very little sea turtle nesting activity has been documented in recent years, a single green sea turtle nest was established approximately 0.21 kilometers (0.13 miles) inland in 1993 (Ott, 1995a).



Biological Resources

Kwajalein Island, Kwajalein Atoll

Figure 3-6

Extensive dredge and fill activities since the 1930s have degraded the marine habitat surrounding Kwajalein Island, particularly on the lagoon side. A remnant of the original reef flat is located just north of Echo Pier, outside the harbor. (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

3.3.5 LEGAN ISLAND

Figure 3-7 shows the biological resources of Legan Island and the surrounding reef flat. A general discussion of the biological resources of Kwajalein Atoll is provided in section 3.3.2.

Flora – The southern end of Legan Island has been cleared and the open areas are dominated by nonnative grasses and weeds. The remainder of the island supports mixed broadleaf forest (figure 3-7). These forests are the most common vegetation type on undisturbed sites in the Marshall Islands and are usually indicative of good soils. (Herbst, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Fauna – A salt pond in the center of the island attracts numerous breeding birds and shorebirds (figure 3-7). The broadleaf forest provides nesting habitat for most of the white terns (*Gygis alba*) found at Kwajalein Atoll. Breeding populations of brown noddies (*Anous stolidus*) and black noddies also utilize the forested areas of Legan Island. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

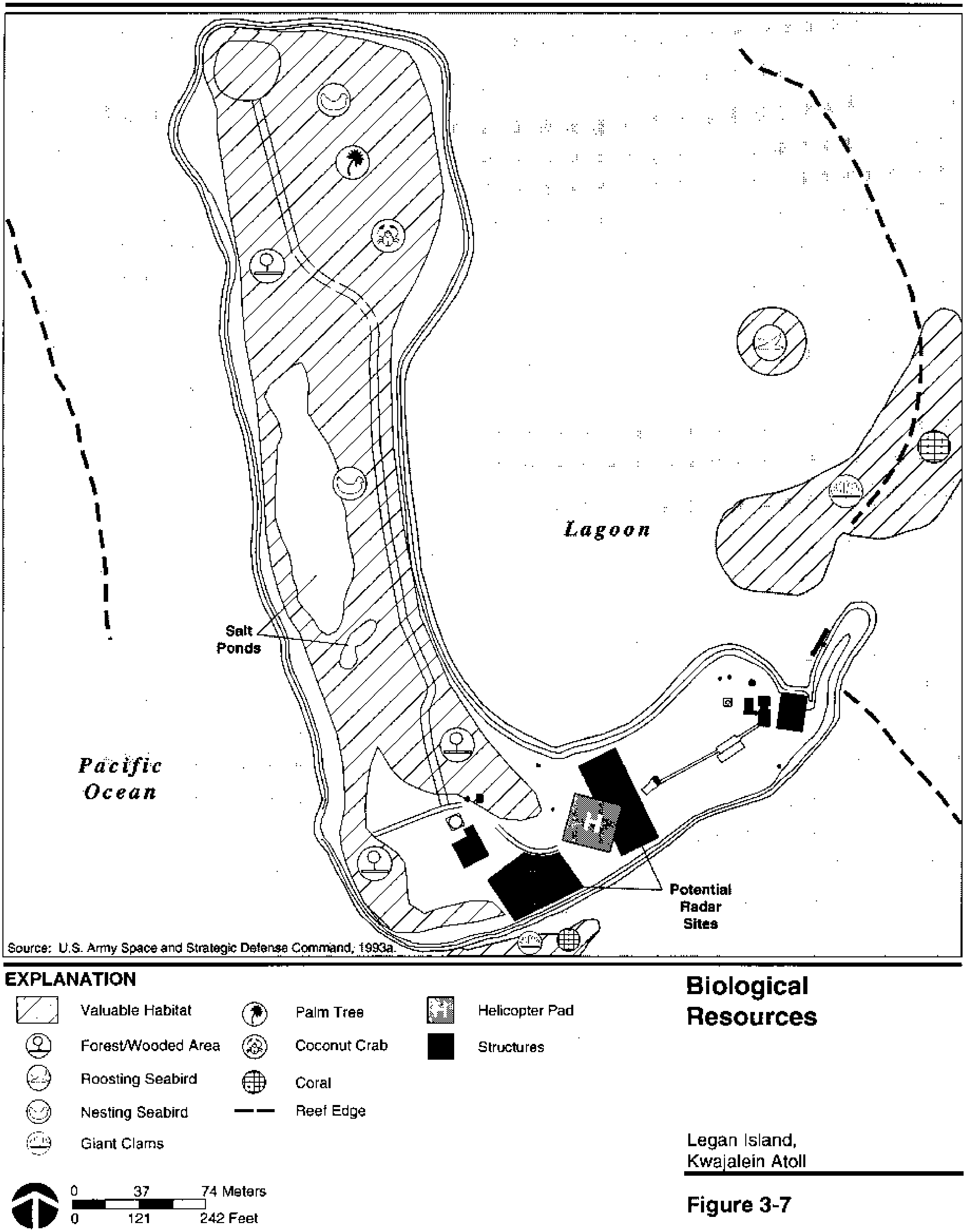
Coconut crabs have been observed at Legan Island (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a). The East-West Center and the South Pacific Regional Environmental Program (Thomas, 1989) have recommended coconut crabs for special protection within the RMI.

The limestone bench outside the harbor supports a well-developed coral reef assemblage. The harbor area has been dredged. Coral and giant clams have been observed just north of the harbor and at the southern heel of the island. (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

3.3.6 MECK ISLAND

Figure 3-8 shows the biological resources of Meck Island and the surrounding reef flat. A general discussion of the biological resources of Kwajalein Atoll is provided in section 3.3.2.

Flora – Much of Meck Island has been cleared and paved (figure 3-8). Nonnative grasses and weeds dominate the open areas and are maintained by mowing. A few native trees still exist on the northern end of the island within the ROI. The island has been enlarged with dredged fill material. (Herbst, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)



Biological Resources

Legan Island,
Kwajalein Atoll

Figure 3-7

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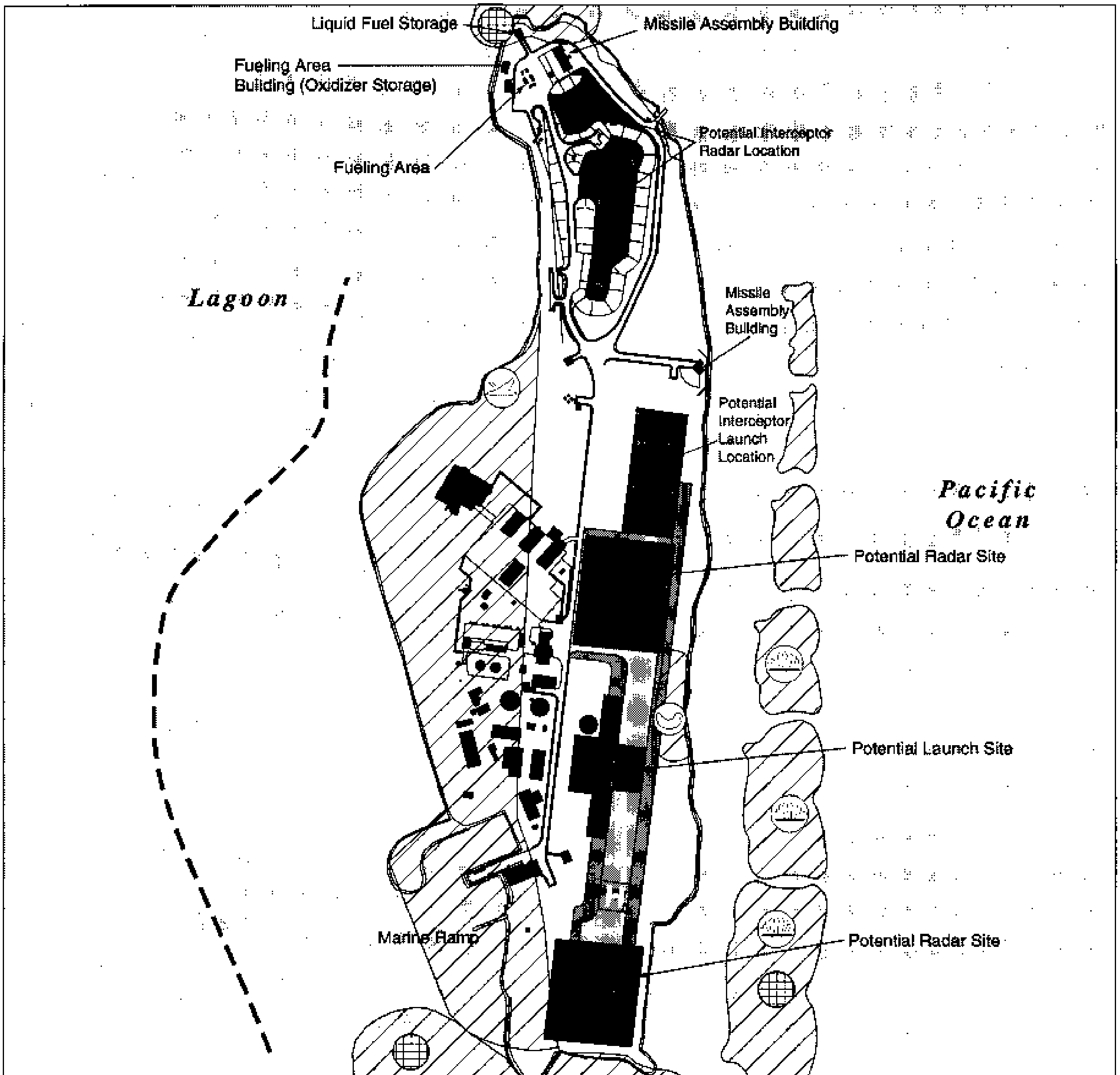


Source: U.S. Army Space and Strategic Defense Command, 1993a.

EXPLANATION

Valuable Habitat

Roosting Seabird

Coral

Giant Clams

Nesting Seabird

Reef Edge

Helicopter Pad

Structures

0 81 162 Meters

0 215 530 Feet

Biological Resources

Meck Island, Kwajalein Atoll

Figure 3-8

Fauna – Seabirds have been observed nesting along the eastern perimeter of the runway (figure 3-8). Habitat for seabird roosting exists to the southwest of the launch site in the fill area at the edge of the ROI. Black-naped terns regularly roost at the southeast corner of the runway. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Extensive dredging and the deposition of fill on the lagoon reef flat have greatly altered the marine environment of Meck Island (figure 3-8). Most of the island is surrounded by riprap intended for shoreline protection. The only remaining undisturbed reef flats occur at the north and south tips of the island. Giant clams have been observed along the quarry sites. (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

3.3.7 OMELEK ISLAND

Figure 3-9 shows the biological resources of Omelek Island and the surrounding reef flat. A general discussion of the biological resources of Kwajalein Atoll is provided in section 3.3.2.

Flora – Approximately two-thirds of Omelek Island has been cleared and is dominated by nonnative grasses and weeds. The remaining habitat is contained in three separate parcels of native forest (figure 3-9). (Herbst, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

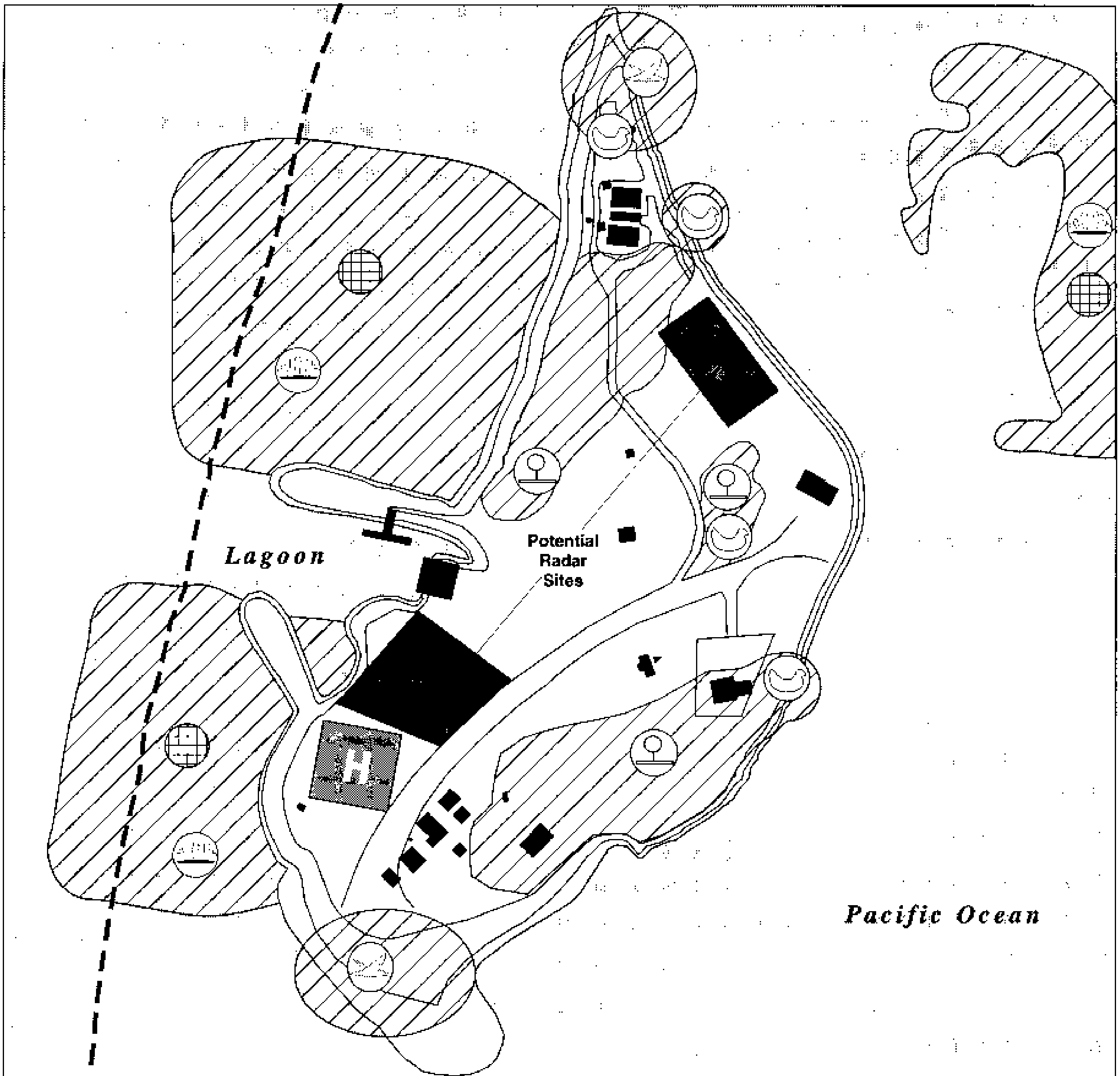
Fauna – The remaining native forest parcels provide nesting habitat for a variety of seabirds (figure 3-9). Additional nesting habitat occurs at the extreme northern end of Omelek Island and at several open areas along the eastern coast. Occasional black-naped terns have been observed at the north and south tips of the island. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Although the harbor area has been dredged, the lagoon reef flat on either side of the jetties provides good quality marine habitat with thriving coral and giant clams (figure 3-9). The large quarried area on the ocean side also exhibits a diversity of marine life, including coral and giant clams. (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

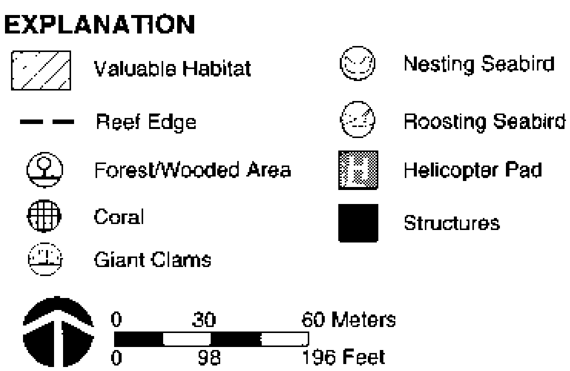
3.3.8 ROI-NAMUR ISLAND

Figure 3-10 shows the biological resources for Roi-Namur Island and the surrounding reef flat. A general discussion of the biological resources of Kwajalein Atoll is provided in section 3.3.2.

Flora – Much of Roi-Namur Island was cleared during World War II and subsequently paved, including the large runway area occupying the western side of the island (figure 3-10). Nonnative grasses and weeds dominate the open areas and are maintained by mowing. A relatively large forested area with coconut palm in the overstory, covering nearly two-thirds of the island, has been allowed to recover on the eastern shore since approximately 1945.



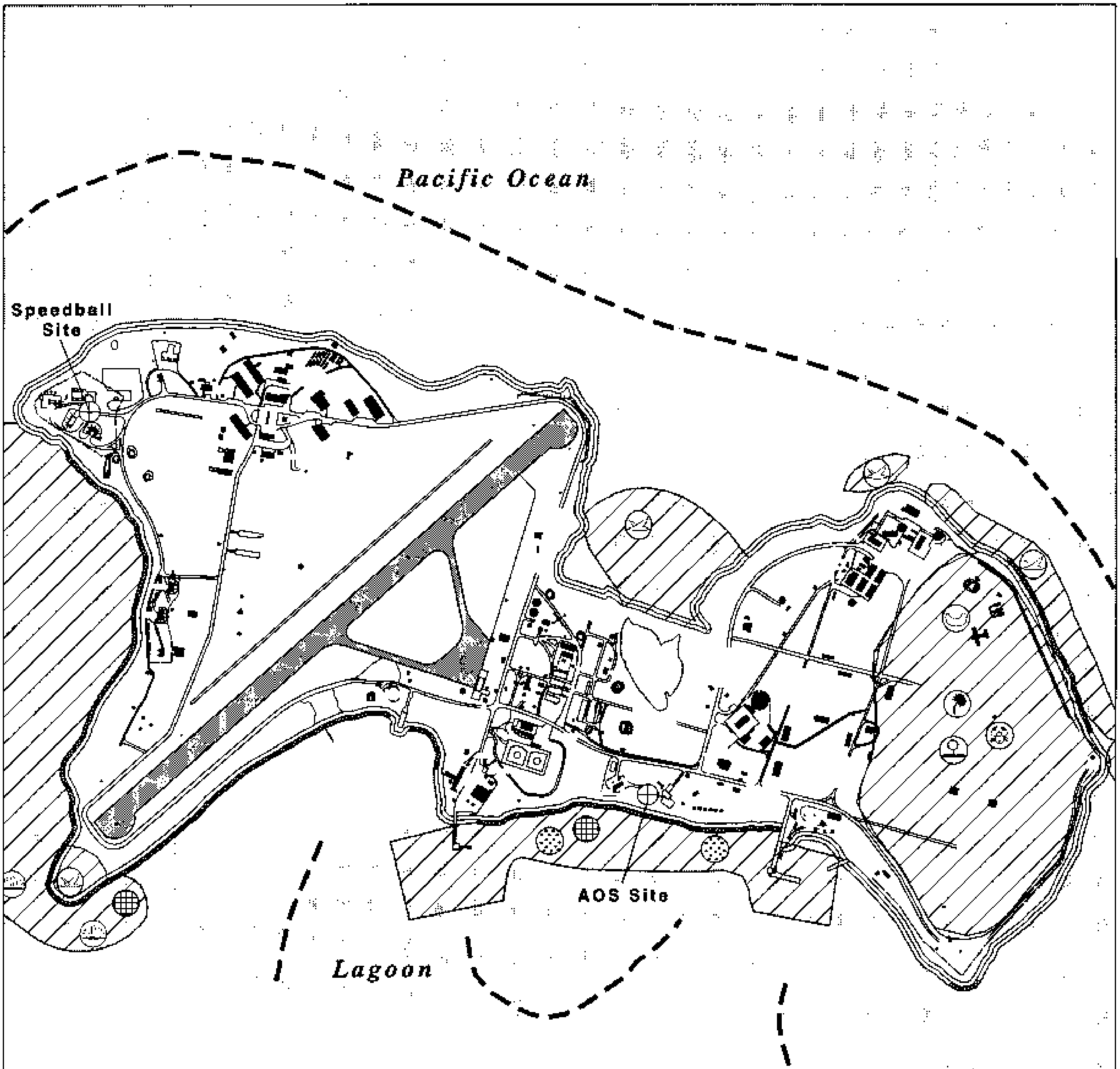
Source: U.S. Army Space and Strategic Defense Command, 1993a.



Biological Resources

Omelek Island, Kwajalein Atoll

Figure 3-9



Source: U.S. Army Space and Strategic Defense Command, 1993a.

EXPLANATION

- Valuable Habitat
- Coconut Crab
- Sea Grasses
- Roosting Seabird
- Nesting Seabird
- Palm Tree
- Forest/Wooded Area
- Giant Clams
- Coral
- Potential Sea Turtle Nesting Habitat
- Structures
- Potential THAAD Radar Site
- Reef Edge

0 166.5 333 Meters
0 547 1,094 Feet

Biological Resources

Roi-Namur Island, Kwajalein Atoll

Figure 3-10

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(Herbst, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Although the harbor area on the lagoon side of the island has been dredged, the area supports the largest known community of the rare seagrass *Halophila minor* at Kwajalein Atoll. (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Fauna – Nesting terns use the southern tip of the island and assorted shorebirds roost in the shrubs along the western shore (figure 3-10). Reef herons (*Egretta sacra*) breed in the shore flats and tidepools east of the runway and along the eastern shore. The forested area on the east side supports habitat for a variety of nesting seabirds. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

The sandy beaches along the east, south, and western shores of Roi-Namur Island provide potential nesting habitat for the green sea turtle and the hawksbill turtle. While these sea turtles have been sighted in Kwajalein Lagoon, no evidence of nesting has been reported on Roi-Namur Island in recent years. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Coconut crabs occur in the forested area on the east side of the island. Additional non-avian fauna includes rodents, lizards, and domestic dogs and cats. (Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

The reef flats at the east and west ends of Roi-Namur Island support coral and giant clams, but do not exhibit high coral coverage due to the strong current. More active coral growth was observed on the southwestern corner of the island along the lagoon side. The seagrass beds along the lagoon side may serve as a juvenile fishery ground. (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

3.3.9 FLIGHT TEST CORRIDOR

Flora – No vegetation resources are known to exist within the flight test corridor.

Fauna – The green sea turtle and the hawksbill turtle are commonly sighted in the Kwajalein lagoon and are expected to occur occasionally in the BOA. (U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Five species of giant clam are found at Kwajalein Atoll along the surrounding reef on the lagoon side, ocean side, and between several of the islands. The largest species (*T. gigas*) has been significantly reduced in number, and all are being examined by the RMI government and the U.S. National Marine Fisheries Service for listing as threatened or endangered species. (Titgen, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

Threatened, endangered, and candidate marine species that may possibly occur in and around Kwajalein Atoll include the blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter coaptation*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), and olive ridley sea turtle (*Lapidochelys olivacea*). These marine mammals and sea turtles are widely distributed, open-water species and are not likely to be found near the USAKA or Aur Atoll. (U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a)

3.4 CULTURAL RESOURCES

Cultural resources are prehistoric and historic sites, structures, districts, artifacts, or any other physical evidence of human activity considered important to a culture, subculture, or community for scientific, traditional, religious, or any other reason. For ease of discussion, cultural resources have been divided into archaeological resources (prehistoric and historic), historic buildings and structures, and traditional resources (e.g., Native Hawaiian, American Indian, Asian). For the purposes of this analysis, cultural resources are also defined to include paleontological resources (see definition below).

Numerous laws and regulations require that possible effects to cultural resources be considered during the planning and execution of Federal undertakings (see Appendix C).

Because all areas of the ROI are leased from a foreign nation (the RMI), the applicable provisions of the RMI Historic Preservation Act of 1991 and all other applicable statutes, regulations, and guidelines described in section 2.2 of the Final Supplemental EIS, Proposed Actions at the U.S. Army Kwajalein Atoll (U.S. Army Space and Strategic Defense Command, 1993a) would also apply. Additionally, a Programmatic Agreement among the USASSDC, the USAKA, the Advisory Council on Historic Preservation, and the RMI Historic Preservation Officer (HPO) (U.S. Army Space and Strategic Defense Command, 1994f) regarding the operations, maintenance, and mission activities at USAKA, effects the protection and preservation of historic properties at USAKA. The Programmatic Agreement has been signed by the USAKA and the RMI and is in final coordination with the Advisory Council. The USAKA is currently applying the provisions of the Programmatic Agreement as if it were in effect.

Only those cultural resources determined to be potentially significant under the given legislation are subject to protection from adverse impacts resulting from an undertaking. To be considered significant, cultural resources must meet one or more of the criteria established by the National Park Service that would make that resource eligible for inclusion in the National Register of Historic Places (National Register). The term "eligible for inclusion in the National Register" includes all properties that meet the National Register listing criteria which are specified in Department of Interior regulations at 36 CFR 60.4. Therefore, sites not yet evaluated may be considered potentially eligible to the National Register and, as such, afforded the same regulatory consideration as nominated properties. Whether prehistoric, historic, or traditional, significant cultural resources are referred to as "historic properties."

Region of Influence

The ROI for cultural resources (for the purposes of this EA, synonymous with the area of potential effect [APE] under cultural resources legislation) encompasses Bigen Island, Aur Atoll, RMI, and Gellinam, Illeginni, Kwajalein, Legan, Meck, Omelek, and Roi-Namur Islands, USAKA (see figures 2-2 to 2-9).

Archaeological Resources (Prehistoric and Historic)

Although an exact date for the first habitation of the Marshall Islands (including the USAKA) is not known, archaeological research indicates that settlement of the eastern part of Micronesia, including the Caroline and Marshall Islands, occurred sometime during the first millennium AD (Christiansen, 1994). Little is known of early Marshallese lifeways, however, as indigenous languages did not take written form until the 19th century (Nolan, 1994).

European knowledge of the Marshall Islands was first noted during the 1500s when Spanish expeditions passed through the area on their way to the Philippines. Sporadic visits by explorers and traders from various countries continued during the next two centuries; however, contact with inhabitants of the Marshall Islands was not substantial until the 1850s when Christian missionaries were sent to the islands from Hawaii. Between 1887 and 1914, Germany controlled the islands, first administered by German trading companies and later as a colony under the German Empire (Christiansen, 1994).

In 1914, control of the Marshall Islands transferred to the Japanese as a part of that country's expansion into the South Pacific during World War I (Nolan, 1994); however, control was not formally recognized until 1922, when Japan was awarded Micronesia as a mandate under the League of Nations. Schools, fortifications, ports, and runways were constructed, and the Japanese culture and lifeways dominated the Marshall Islands until U.S. Armed Forces seized the Marshall Islands in the Eastern Mandates campaign of February - March 1944.

Forming Japan's eastern-most perimeter of defense, the Marshall Islands played a key role during World War II. Assaults on Wake Island were staged from Kwajalein Atoll, and Marshall Islands' airfields and harbors supported Japanese operations throughout the South Pacific (Nolan, 1994). By 1944, extensive American military campaigns (most notably Operation Flintlock) against the Japanese in the Marshall Islands resulted in the U.S. gaining control of the islands and developing a strategic foothold in the South Pacific.

Because the Marshall Islands were politically, socially, and economically unstable at the end of World War II, the United Nations established the Trust Territory of the Pacific Islands (including the Marshall Islands) and granted administration of the islands to the United States (Nolan, 1994) as a Strategic Trust. This relationship continued uninterrupted until 1986, when the trust status for the RMI was replaced by the Compact of Free Association.

Historic Buildings and Structures

As briefly described above, the RMI has played a key role in the political and social development of the South Pacific for many years, most particularly since 1914, when the

Japanese expanded into the area during World War I. By 1943, Japan had fortified the RMI extensively, and there were military bases on Kwajalein, Roi, and Namur Islands through which shipping, supplies, and reinforcements flowed to the outer Marshall Islands (U.S. Army Strategic Defense Command, 1989). At that time, Kwajalein Island contained Japanese communication and weather observation units and an airstrip, and a seaplane base was situated at Ebeye. In addition, a major airstrip and a submarine base were located at Roi.

In January 1944, the United States launched an extensive air, land, and sea invasion of Kwajalein Atoll. Known as Operation Flintlock, the invasion displaced the Japanese stronghold in the Pacific. The American seizure of the Kwajalein Atoll was a significant accomplishment, and made an important contribution to Admiral Chester Nimitz's Central Pacific Campaign. Kwajalein Atoll's subsequent use by the U.S. Armed Forces as a logistical and weapons support base was integral to American strategy and operations in the Central Pacific (see Panamerican Consultants, Inc., 1994 for a detailed discussion).

Since World War II, portions of Kwajalein Atoll (11 leased islands) have been continuously used by the United States military. Initially a refueling and communications base, the USAKA (renamed from the Kwajalein Missile Range in 1987), has also been a support facility for the testing of nuclear weapons and a test site for the Nike-Zeus Anti-Ballistic Missile program. The USAKA's current mission is ground and flight test support of the Theater and National Missile Defense programs.

Traditional Resources

Traditional resources can include archaeological sites, burial sites, ceremonial areas, caves, mountains, water sources, plant habitat or gathering areas, or any other natural area important to a culture for religious or heritage reasons. Significant traditional sites are subject to the same regulations, and afforded the same protection as other types of historic properties. By their nature, traditional resources sites often overlap with (or are components of) archaeological sites. As such, some of the recorded and unrecorded sites identified within the ROI could also be considered traditional sites or contain traditional resources elements.

Traditional resources within the ROI are expected to be associated with the Marshallese culture; however, because of lengthy occupations of the Marshall Islands, German or Japanese traditional sites could also be present. Although a comprehensive survey and inventory of traditional cultural properties have not as yet been undertaken, such sites are known to occur in the Marshall Islands, some of which have been identified on Arno and Majuro Atolls (U.S. Army Space and Strategic Defense Command, 1993a).

Paleontological Resources

Paleontological resources consist of the physical remains of extinct life forms or species that may have living relatives. These physical remains include fossilized remains of plants and animals, casts or molds of the same, or trace fossils such as impressions, burrows, and tracks. Geological studies indicate that the reefs and atolls of the Marshall Islands formed 70 to 80 million years ago; however, the natural processes from which atolls are built (see section 3.5 and section 3.2.1 of the Supplemental EIS, Proposed Actions at the U.S. Army

Kwajalein Atoll [U.S. Army Space and Strategic Defense Command, 1993a]) preclude the occurrence of paleontological remains. There are no National Natural Landmarks.

Status of Cultural Resources Investigations

The focus of cultural resources surveys within the RMI has been Kwajalein Atoll and, in particular, Kwajalein and Roi-Namur Islands (Beardsley, 1994; Shun and Athens, 1990; Panamerican Consultants, Inc., 1994). Although recent efforts have included other atolls as well (Christiansen, 1994; Look and Spennemann, 1993), portions of the 11 USAKA-controlled islands, as well as much of the RMI, remain unsurveyed.

To date, there are two significant cultural properties listed in the National Register: the Kwajalein Island Battlefield and the Roi-Namur Battlefield; both have also been designated as National Historic Landmarks. Additional features and structures contributing to the significance of the two battlefields were identified during a survey in 1994 (Panamerican Consultants, Inc.) and are considered potentially eligible for listing, pending revision of the nomination forms by the National Park Service. Currently, there are no other National Register-listed properties within the USAKA.

No comprehensive surveys and/or inventories of traditional cultural properties or properties that could be significant under the Cold War historic context (1946 to 1991) have been undertaken.

Consultation with the RMI HPO regarding program activities has been initiated, and a copy of the Bigen Island Survey Report has been forwarded to the HPO for review. In addition, because program activities have the potential to affect areas of the USAKA that are designated a National Historic Landmark, the Advisory Council on Historic Preservation will be consulted. Negotiations and consultation with the Marshallese government are ongoing.

Specifics of the cultural resources identified within the ROI are described below by location.

3.4.1 BIGEN ISLAND, AUR ATOLL

Aur Atoll – Aur Atoll (most specifically Tabal and Aur Islands) has supported a human population for many years (Fosberg, 1990), and records indicate inhabitants on the atoll as early as 1817 (Christiansen, 1994). Statistics for the years 1935 and 1948 indicate atoll populations of approximately 279 and 388, respectively (Williamson and Sabath, 1982); the most recent census of Aur Atoll indicates approximately 438 inhabitants (Stanley, 1992). Tabal and Aur Islands are the only known permanently inhabited islands in the atoll. The remaining islands and islets are exploited for foods (coconut, breadfruit, pandanus) and for materials to make a variety of household products and crafts (e.g., pandanus used for mats, fans, etc.). Bigen Island, which is at the northeastern extreme of the atoll, is believed to have been continuously uninhabited, although it is currently, and has been in the past, used intermittently for the harvesting of coconuts and the processing of copra.

There is little recorded information about Aur Atoll, and within that small body of literature, no references to Bigen Island. Passages from the records of Marshallese scouts during

World War II indicate that some individuals from Maloelap Atoll fled to Piken Island, Aur Atoll, in 1945 to escape the Japanese (Christiansen, 1994); however, there was no reference to any World War II activity on Bigen Island, and no physical evidence has been found to support any World War II occupation or battles. Look and Spennemann (1993) also indicate that during the period of the Japanese Mandate, shipping connections in the Marshall Islands were in Japanese hands and connected Kobe, Japan with Saipan, Truk, Ponape, Kusaie, and Jaluit. Marshall Islands inter-atoll shipping centered on Jaluit but also serviced Arno, Maloelap, and Aur.

Bigen Island – Bigen Island is believed to have been continuously uninhabited, although it is currently, and has been in the past, exploited for foods (coconut, breadfruit, pandanus) and for materials to make a variety of household products and crafts (e.g., pandanus used for mats, fans). Marshallese access to the food and craft resources is facilitated through the use of controlled burns. A cultural resources survey conducted on Bigen Island in December 1994 (U.S. Army Space and Strategic Defense Command, 1995a) identified no historic properties.

With the exception of Marshallese copra processing areas (consisting of between one and four sheds or lean-tos), there are no buildings or structures on Bigen Island. No World War II or Cold War features, structures, or artifacts or evidence of German or Japanese occupation were identified during the December survey (U.S. Army Space and Strategic Defense Command, 1995a).

3.4.2 GELLINAM ISLAND

Gellinam Island has been disturbed by construction and operational activities. Most of the island has been graded and modified, and vegetative cover is minimal. Cultural resources surveys and testing conducted in 1988 (Schilz) and 1994 (Panamerican Consultants, Inc.), identified no historic properties (U.S. Army Strategic Defense Command, 1989).

All of the buildings and structures on Gellinam Island were constructed between 1967 and 1990 (U.S. Army Space and Strategic Defense Command, 1994d); as such, they are associated with the Cold War historic context. None of these properties have been evaluated for eligibility for inclusion in the National Register. Among the properties are a splash detection radar and a Hydro-Acoustic Impact Timing System, both used for the detection of re-entry vehicles as they splash into the lagoon.

3.4.3 ILLEGINNI ISLAND

Illeginni Island has been disturbed by construction and operational activities; much of the island has been graded and modified. Vegetative cover is moderate to dense in areas; most of the vegetation represents regrowth since construction of facilities in the early 1970s. Cultural resources surveys and testing conducted in 1988 (Schilz) identified no prehistoric, historic, or traditional resource sites or artifacts (U.S. Army Strategic Defense Command, 1989). Additional surveys in 1994 (Panamerican Consultants, Inc.) identified one possible prehistoric midden (trash pile) containing charcoal fragments (along the north shore of the island); however, this site could also represent more recent activity.

All of the buildings and structures on Illeginni Island were constructed between 1971 and 1990 (U.S. Army Space and Strategic Defense Command, 1994d); among them are Spartan and Sprint missile launch sites. As such, the properties on Illeginni are associated with the Cold War historic context. None of these properties have been evaluated for eligibility for inclusion in the National Register.

3.4.4 KWAJALEIN ISLAND

Kwajalein Island has been disturbed by construction and operational activities. As a result of landfilling, the island has nearly doubled in size. Several comprehensive cultural resources surveys have been conducted on Kwajalein Island (Beardsley, 1994; Shun and Athens, 1990; Panamerican Consultants, Inc., 1994), and subsurface prehistoric and historic remains have been identified in dispersed areas within the original island boundary. Soil and pollen analyses indicate that the original center of the island may have contained a marsh area that could have supported early Marshallese populations.

All of the buildings and structures on Kwajalein Island were constructed between 1944 and 1992 (U.S. Army Space and Strategic Defense Command, 1994d); existing Japanese structures predate 1945; however, exact construction dates have not been verified. In addition, several new facilities are currently being constructed. Facilities constructed before 1946 (including the Japanese structures) are associated with the World War II historic context and considered part of the Kwajalein Island Battlefield National Historic Landmark. Facilities constructed between 1946 and 1991 are associated with the Cold War historic context; none of the Cold War-era properties have as yet been evaluated for eligibility for inclusion in the National Register.

3.4.5 LEGAN ISLAND

Only the southern end of Legan Island has been disturbed by construction and operational activities; the remainder of the island is dense forest surrounding two interior marshes. Cultural resources investigations of Legan in 1987 (Streck), 1988 (Craib, et al.), and 1994 (Panamerican Consultants, Inc.) indicate the presence of a prehistoric archaeological site within the forested area. Artifacts and features include shell adze fragments, shell fishhooks and beads, earth oven features, and possible house and wall features. Radiocarbon testing indicates that the site is approximately 600 years in age. In addition, it has been rumored that a World War II aircraft crashed in the Legan forest. No evidence of the aircraft has been found to date.

All of the buildings and structures on Legan Island were constructed between 1967 and 1990 (U.S. Army Space and Strategic Defense Command, 1994d); as such, they are associated with the Cold War historic context. None of these properties have been evaluated for eligibility for inclusion in the National Register. Among the properties are a splash detection radar building and a ground optics building.

3.4.6 MECK ISLAND

Meck Island has been substantially disturbed by construction and operational activities. As a result of landfilling, the island has increased in size by about 5.7 hectares (14 acres). All of Meck Island has been graded and modified, and vegetative cover is minimal. Cultural resources surveys and testing conducted in 1988 (Schilz) and in 1994 (Panamerican Consultants, Inc.), identified no historic properties (U.S. Army Strategic Defense Command, 1989).

All of the buildings and structures on Meck Island were constructed between 1967 and 1991 (U.S. Army Space and Strategic Defense Command, 1994d); as such, they are associated with the Cold War historic context. None of these properties have been evaluated for eligibility for inclusion in the National Register. The southern half of the island houses facilities related to power generation, maintenance, supply, and waterfront and air operations. The central and northern half of the island consists of research and development operations and launch complexes, including missile and payload assembly buildings (U.S. Army Strategic Defense Command, 1989). As on Illeginni Island, there are also Sprint and Spartan missile sites on Meck Island.

3.4.7 OMELEK ISLAND

Omelek Island has been disturbed by construction and operational activities. Most of the island has been graded and modified; however, there are three small remnants of mixed broadleaf forest. Cultural resources surveys and testing conducted in 1989 (Craib) indicated the presence of features possibly indicative of a traditional Marshallese cemetery, but no human remains have been identified. Located within one of the forested areas, the features include coral slabs, two of which are situated nearly vertically within the site. Additional archaeological investigation in 1994 (Panamerican Consultants, Inc.) relocated this site and additional subsurface testing was performed. Small fragments of charcoal and burned coral were identified, but do not provide definitive conclusions as to the possible purpose of the site. Because coral slabs occur naturally on adjacent beaches, this site may represent a naturally occurring phenomenon.

All of the buildings and structures on Omelek Island were constructed between 1962 and 1990 (U.S. Army Space and Strategic Defense Command, 1994d); among them are meteorological rocket launch pads and associated facilities. Buildings and structures on Omelek are associated with the Cold War historic context, none of which have been evaluated for eligibility for inclusion in the National Register.

3.4.8 ROI-NAMUR ISLAND

Since the time of the Japanese occupation, disturbance to Roi-Namur has been substantial. Once three separate islands (Roi, Namur, and Enedrikdrik), Roi-Namur has been expanded through landfilling to create a single island. Vegetation, which consists primarily of pandanus, coconut palms, and dense patches of beach morning glory and wedelia, represents regrowth subsequent to extensive military actions during World War II.

Because of the extensive disturbance and landfilling, and the potential for subsurface unexploded ordnance to occur, no systematic cultural resources survey and testing have been conducted on Roi-Namur. No prehistoric archaeological sites have been identified; however, because survey and testing have not been conducted, the presence of intact sites in original island areas cannot be entirely ruled out (U.S. Army Strategic Defense Command, 1989).

All of the buildings and structures on Roi-Namur Island were constructed between 1940 and 1993 (U.S. Army Space and Strategic Defense Command, 1994d); existing Japanese structures may predate 1940; however, exact construction dates have not been verified. Facilities constructed before 1946 (including the Japanese structures) are associated with the World War II historic context and considered part of the Roi-Namur Island Battlefield National Historic Landmark (see details above). Facilities constructed between 1946 and 1991 are associated with the Cold War historic context; none of the Cold War-era properties have as yet been evaluated for eligibility for inclusion in the National Register.

3.4.9 FLIGHT TEST CORRIDOR

The flight test corridor extends entirely over the Pacific Ocean. No historic properties are known to exist within this area.

3.5 GEOLOGY AND SOILS

Geology and soils, or natural resources, include those aspects of the natural environment related to the earth which may be affected by the proposed project. To provide background information and context for the impact analysis, the physical resources discussed include regional geologic history and soil characteristics. Other than reef materials dredged to increase land area of the islands and armor them against high sea conditions, there are no known economic resources on Kwajalein or Aur atolls.

Region of Influence

The ROI for geology and soils includes all of the islands in Kwajalein Atoll that may be used in support of program activities and Bigen Island within Aur Atoll.

3.5.1 GEOLOGY

The reefs and islands of the RMI consist entirely of the remains of coral reef rock and sediments to a thickness of several thousand feet atop submarine volcanoes, which formed 70 to 80 million years ago. As the volcanoes became extinct and began to subside, living coral reefs grew upward to remain close to the sea's surface and formed atolls (U.S. Army Strategic Defense Command, 1989).

The reef rock is formed entirely from the remains of marine organisms (reef corals, coralline algae, mollusks, echinoderms, foraminiferans, and green sand-producing algae) that secrete external skeletons of calcium and magnesium carbonates. As these organisms grew and died, their remains were either cemented in place to form hard reef rock, or were eroded and carried down slopes to accumulate as sediment deposits. Only the upper thin veneer of the reef structure is alive and growing, accreting over the remains of prior generations of reef organisms (U.S. Army Strategic Defense Command, 1989).

The major reef-building organisms are all marine and cannot grow above average sea level because of the need for immersion. Land areas on reefs that project above high tide are formed by large waves breaking loose reef materials and throwing them on shallow flats and/or a lowering of sea level (U.S. Army Strategic Defense Command, 1989). As a result, the maximum elevation of atolls above sea level is generally less than 4.6 meters (15 feet).

Both of these processes may have contributed to the formation of Kwajalein and Aur Atolls.

3.5.2 SOILS

The soils of Kwajalein Atoll have poor fertility and are particularly deficient in three major constituents, nitrogen, potash, and phosphorous. The generally low fertility of the atoll soils is due to three factors: the soil particles are generally coarse, the content of organic matter is low, and the soils are alkaline. The first two factors impair the water-holding capacity of the soil and the retention of elements essential for plant growth. The alkalinity of the soils inhibits the absorption of iron, manganese, zinc, boron, and aluminum. All three factors severely inhibit plant growth (U.S. Army Strategic Defense Command, 1989). No soil surveys have been made of Aur Atoll. However, because of its similar geologic history and based on information collected during a site visit of Bigen Island in December 1994, the soils on this atoll are expected to be very similar to those soils on Kwajalein Atoll.

3.6 HEALTH AND SAFETY

Health and safety includes consideration of any activities, occurrences, or operations which have the potential to affect one or more of the following:

The well-being, safety, or health of workers – Workers are considered to be persons directly involved with the operation producing the effect or who are physically present at the operational site.

The well-being, safety, or health of members of the public – Members of the public are considered to be persons not physically present at the location of the operation, including workers at nearby locations who are not involved in the operation and the off-base population. Also included within this category are hazards to equipment, structures, flora, and fauna.

Region of Influence

The ROI for health and safety at Bigen Island includes all areas within the approximately 1,500-meter (5,000-foot) launch hazard area (LHA) for liquid-fuel missiles and the 1,600 to 5,100-meter (5,300 to 17,000-foot) LHA for solid-fuel missiles to be established around each launch site. The ROI for health and safety also includes all locations where explosive missile components or fuel storage devices are handled during prelaunch activities. The ROI for health and safety at the USAKA includes those areas of the islands where program activities would occur or that could be affected by program activities. The potential for health and safety impacts is greatest in areas where explosive devices and/or liquid fuels are stored and handled (Kwajalein, Meck, and Illeginni Islands) and where launch activities occur (Meck and Illeginni Islands). The ROI for the flight corridor consists of all areas beneath the proposed flight track where there is the potential for impact of missile components during planned activities or abnormal flight termination and the BOA or Mid-atoll Corridor where missile debris would impact.

The potential for impact on communications systems exists, due to so-called high-power effects and the number of undesired pulses that might be detected by the radars leading to objectionable obscuring of the visual images presented on the radar screens of airborne weather radar systems (U.S. Army Space and Strategic Defense Command, 1993b). While such weather radar interference represents a possible, but not certain significant impact, any possible impact would be reduced to a not significant level by ensuring that aircraft activity within the region of the tracking radars would be subject to the publishing of an appropriate Notice to Airmen (NOTAM) to advise avoidance of the radar area during use of the USAKA temporary extended test range.

3.6.1 BIGEN ISLAND

At the present time there are no activities sponsored by the U.S. Army or other Federal organization on Bigen Island. Activities are limited to the growth and harvesting of coconuts by Marshallese natives on interior sections of the island. No significant activities presently occur in the ROI.

3.6.2 USAKA ISLANDS

The USAKA has the unique mission of serving as the target for a wide variety of missile launch operations from Vandenberg AFB, California, and the Pacific Missile Range Facility, Hawaii. These missions are conducted with the approval of the USAKA Commander. A specific procedure is established to ensure that such approval is granted only when the safety of all proposed tests has been adequately addressed.

All program operations must receive the approval of the KMR Safety Office. This is accomplished by the user through presentation of the proposed program to the Safety Office. All safety analyses, SOPs, and other safety documentation applicable to those operations affecting the USAKA must be provided, along with an overview of mission objectives, support requirements, and schedule. The Safety Office evaluates this information and ensures that all USAKA safety requirements, as specified in the KMR Safety Manual and supporting regulations, are followed. (U.S. Army Kwajalein Atoll, 1989b; Kwajalein Missile Range, 1992)

Prior to operations which may involve impact of objects within the range, an evaluation is made to ensure that populated areas, critical range assets, and civilian property susceptible to damage are outside predicted impact limits (Mosely, 1993). A Notice to Mariners (NOTMAR) and a NOTAM are published and circulated in accordance with established procedures to provide warning to personnel (including natives of the Marshall Islands) concerning any potential hazard areas which should be avoided (Mosely, 1993). Radar and visual sweeps of hazard areas are accomplished immediately prior to operations to assist in the clearance of noncritical personnel (Kwajalein Missile Range, 1992). Only mission-essential personnel are permitted in hazard areas (Kwajalein Missile Range, 1992).

Prior to flight operations, proposed trajectories are analyzed and a permissible flight corridor is established. A flight which strays outside its corridor is considered to be malfunctioning and to constitute an imminent safety hazard. A flight termination system (FTS), installed on all flight vehicles capable of impacting inhabited areas, is then activated. This effectively halts the continued powered flight of the hardware, which falls to the sea along a ballistic trajectory (Kwajalein Missile Range, 1991).

In addition to the above requirements, launch operations which originate out of the USAKA must also observe additional safety procedures. Any prelaunch hazardous operations (e.g., handling of explosives) must have established SOPs which have received approval from the KMR Safety Office and must be conducted in accordance with USAKA safety directives (e.g., USAKA Regulation 385-75, *Explosive Safety*, 1989). At launch time, the launch vehicle can be armed only after all required safety evacuations, sufficient to ensure that no unauthorized personnel are present in hazardous areas, have been accomplished. Following arming, positive control of the hazard area on the launch island is established. Unauthorized entry into this hazard area will result in delay of the operation until the "ALL CLEAR" has been re-established (Kwajalein Missile Range, 1992). Launch operations are conducted by the user organization, with the support and oversight of the USAKA, including the USAKA Safety Office (Kwajalein Missile Range, 1992).

3.6.3 FLIGHT TEST CORRIDOR

The USAKA controls all flight corridor operations as part of the KMR. All operations are thus conducted in accordance with safety procedures which are consistent with those implemented at the USAKA (section 3.6.2).

3.7 HAZARDOUS MATERIALS AND HAZARDOUS WASTE

A variety of regulatory agencies (e.g., Environmental Protection Agency [EPA], DOT) have promulgated differing definitions of a hazardous material as applied to a specific situation. Of these definitions, the broadest and most applicable is the definition specified by the DOT for regulation of the transportation of these materials. As defined by the DOT, a hazardous material is a substance or material which is capable of posing an unreasonable risk to health, safety, or property when transported in commerce and has been so designated (49 CFR 171.8).

Waste materials are defined in 40 CFR 261.2 as "any discarded material (i.e., abandoned, recycled, or 'inherently waste-like')" that is not specifically excluded. This can include materials that are both solid and liquid (but contained). Hazardous waste is further defined in 40 CFR 261.3 as any solid waste not specifically excluded which meets specified concentrations of chemical constituents or has certain toxicity, ignitability, corrosivity, or reactivity characteristics.

Region of Influence

Since operations at Bigen Island would be limited to site preparation and launching of target missiles, the ROI for potential impacts related to hazardous materials/wastes would be limited to areas in the southwest portion of the island to be used for launch activities (launch area(s)) and prelaunch site preparation.

At the USAKA islands the potential for hazardous materials impacts is greatest in areas where hazardous materials are stored and handled (e.g., Kwajalein and Meck Island storage facilities). The ROI for the flight test corridor consists of all areas beneath the proposed flight track where there is the potential for impact of missile components during planned activities or abnormal flight termination, and the BOA or Mid-atoll Corridor where missile debris would impact.

3.7.1 BIGEN ISLAND

At the present time no significant activities sponsored by the U.S. Army or other Federal organization occur on Bigen Island. Activities are limited to the growth and harvesting of coconuts by Marshallese natives on interior sections of the island. Harvesting practices may include currently undetermined hazardous materials, such as solvents and lubricants, used in small quantities. No hazardous materials/hazardous wastes are known to be present within the ROI.

3.7.2 USAKA ISLANDS

Hazardous Materials Activities

The use of hazardous materials at the USAKA is limited primarily to materials used in facility infrastructure support and flight operations, with some additional quantities of hazardous materials used by various test operations at the range. The use of these materials must conform with Federal, DOD, and Army hazardous materials management requirements (Ott, 1993).

Hazardous materials used in base infrastructure support activities include various cleaning solvents (chlorinated and non-chlorinated), paints, cleaning fluids, pesticides, motor fuels and other petroleum products, freons (for air conditioning), and other materials. These materials are shipped to the USAKA via ship or by air (Ott, 1993). Upon arrival at the USAKA, hazardous materials to be used by USAKA assets are distributed, as needed, to various satellite supply facilities, from which they are distributed to the individual users. This is coordinated through the base supply system; however, the issue of such materials requires prior authorization by the USAKA Environmental Office in order to prevent unapproved uses of hazardous materials. Hazardous materials to be used by organizations utilizing the test range and its facilities (i.e., range users) are under the direct control of the user organization, which is responsible for ensuring that these materials are stored and used in accordance with local and Federal requirements. At this time the USAKA is seeking to increase control over use of hazardous materials on the range by user organizations by requiring approval of all uses as part of pre-operation safety review procedures (Ott, 1993).

Users provide storage of all materials in accordance with established procedures applicable to individual operations. The use of all hazardous materials is subject to ongoing inspection by USAKA environmental compliance and safety offices to ensure the safe use of all materials. The majority of these materials are consumed in operational processes (including small losses to the air and water).

Aircraft flight operations conducted at the USAKA consist primarily of flights between Bucholz AAF on Kwajalein Island and Dyess AAF at Roi-Namur Island, as well as flights using the USAKA as a trans-Pacific stopover. Helicopters also operate at the USAKA. These flight operations involve the use of various grades of jet propellant, which are refined petroleum products (kerosenes). Fuels are stored in above-ground storage tanks located at several islands in the USAKA. Fuels are transported to the USAKA by ship (Ott, 1993). Significant quantities of waste fuels are not normally generated since fuels are used up in flight operations.

Hazardous Waste Activities

Hazardous waste, whether generated by USAKA activities or range users, is handled in accordance with the procedures specified in the CFR Part 40, sections 260 through 280 (Ott, 1993). Hazardous wastes are collected at individual worksites in waste containers. These containers are labeled in accordance with the waste which they contain and are dated the day that the first waste is collected in the container. Containers are kept at the generation site until full or until a specified time limit is reached. Once full, containers are collected from the generation point within 72 hours and are brought to a central collection area maintained on each island. Each of these collection areas is designed to handle hazardous waste and provide the ability to contain any accidental spills of material, including spills of full containers, until appropriate cleanup can be completed. For the staging area on Roi-Namur, hazardous wastes are removed on the weekly barge to Kwajalein (Ott, 1993; 1995a).

From the collection areas, all hazardous waste is transferred to the USAKA Hazardous Waste Collection Point (Building 1521), located on Kwajalein Island. At the collection point any sampling of waste is performed (for waste from uncharacterized waste streams), and waste is prepared for final off-island shipment for disposal. All waste is shipped off-island within 90 days of the start of accumulation (as indicated by the date on the waste container), in accordance with 40 CFR requirements; therefore, the facility does not require a treatment, storage, or disposal permit. As a Generator of Hazardous Wastes, the USAKA has the required Resource Conservation and Recovery Act (RCRA) Part A permit (Ott, 1993; 1995a).

3.7.3 FLIGHT TEST CORRIDOR

At the current time the areas proposed for the flight test corridor are not in use for that purpose. While shipping traffic can occur on open ocean areas beneath proposed flight tracks, no significant uses or releases of hazardous materials/hazardous waste occur.

3.8 LAND USE

This section briefly characterizes existing land use patterns on the islands which are being considered for the proposed action.

Region of Influence

The ROI for land use is limited to Bigen Island in the Aur Atoll and seven of the USAKA islands.

3.8.1 BIGEN ISLAND

Bigen Island is approximately 73 hectares (180 acres) in size. The only standing structures on the island are copra processing sheds. There is no standing water on the island. The island is basically used for harvesting coconuts and breadfruit. There are no permanent inhabitants on the island. The harvesters are the only people that visit the island (U.S. Army Space and Strategic Defense Command, 1994d).

3.8.2 USAKA ISLANDS

Gellinam, Illeginni, Legan, and Omelek Islands – Gellinam Island has a land area of 2 hectares (5 acres) and is the smallest of the USAKA islands. Most of it is developed with facilities to conduct sensing and tracking for military testing. Illeginni Island is approximately 13 hectares (31 acres) in size and houses telemetry equipment, a fixed camera tower, and a multistatic measurement system. It has two dozen abandoned buildings including a launch pad. Small areas of the island are forested. Legan Island has a land area of 7 hectares (18 acres). All of the island's facilities are located on the southern end of the island and are used for optical sensing and radar. Omelek Island has a land area of 3 hectares (8 acres). The island houses research and development operations including a meteorological rocket launch facility. (U.S. Army Space and Strategic Defense Command, 1993a)

Kwajalein Island – Kwajalein Island has a land area of 303 hectares (748 acres) and is the headquarters island of the USAKA. It is extensively developed with housing and community facilities toward the eastern end of the island; air operations, supply, and utilities near the center of the island; and research, development, and communications operations toward the western end of the island. Structures are set back from the ocean side of the island in order to minimize the potential adverse effects of high wave action.

The predominant land uses on the island are flight operations, family housing, research and development operations, communications operations, supply (which includes high explosives magazine, petroleum, oils, and lubricants, and disposal), community support and unaccompanied personnel housing (UPH), outdoor recreation, utilities, maintenance, sanitary landfill, waterfront operations, and administration.

Meck Island – Meck Island has a land area of 22 hectares (55 acres). Facilities related to power generation, maintenance and supply, waterfront and air operations, and limited community support are located on the southern half of the island (U.S. Army Space and Strategic Defense Command, 1993a). The rest of the island is used for research and development operations that include missile launch complexes (U.S. Army Space and Strategic Defense Command, 1993a).

Roi-Namur Island – Roi-Namur Island has a land area of approximately 161 hectares (398 acres), and is the only USAKA island other than Kwajalein with a resident nonindigenous population (U.S. Army Space and Strategic Defense Command, 1993a). The general land use pattern of the island is divided by the island's airfield runway. Community and support facilities are located on one side of the runway leaving flight, radar, and technical operations on the other side of the island with a few exceptions (U.S. Army Space and Strategic Defense Command, 1993a).

The predominant land uses on the island are research and development operations, flight operations, outdoor recreation, community support/UPH, maintenance, utilities, high-explosive supply, supply, base support, and administration (U.S. Army Strategic Defense Command, 1989).

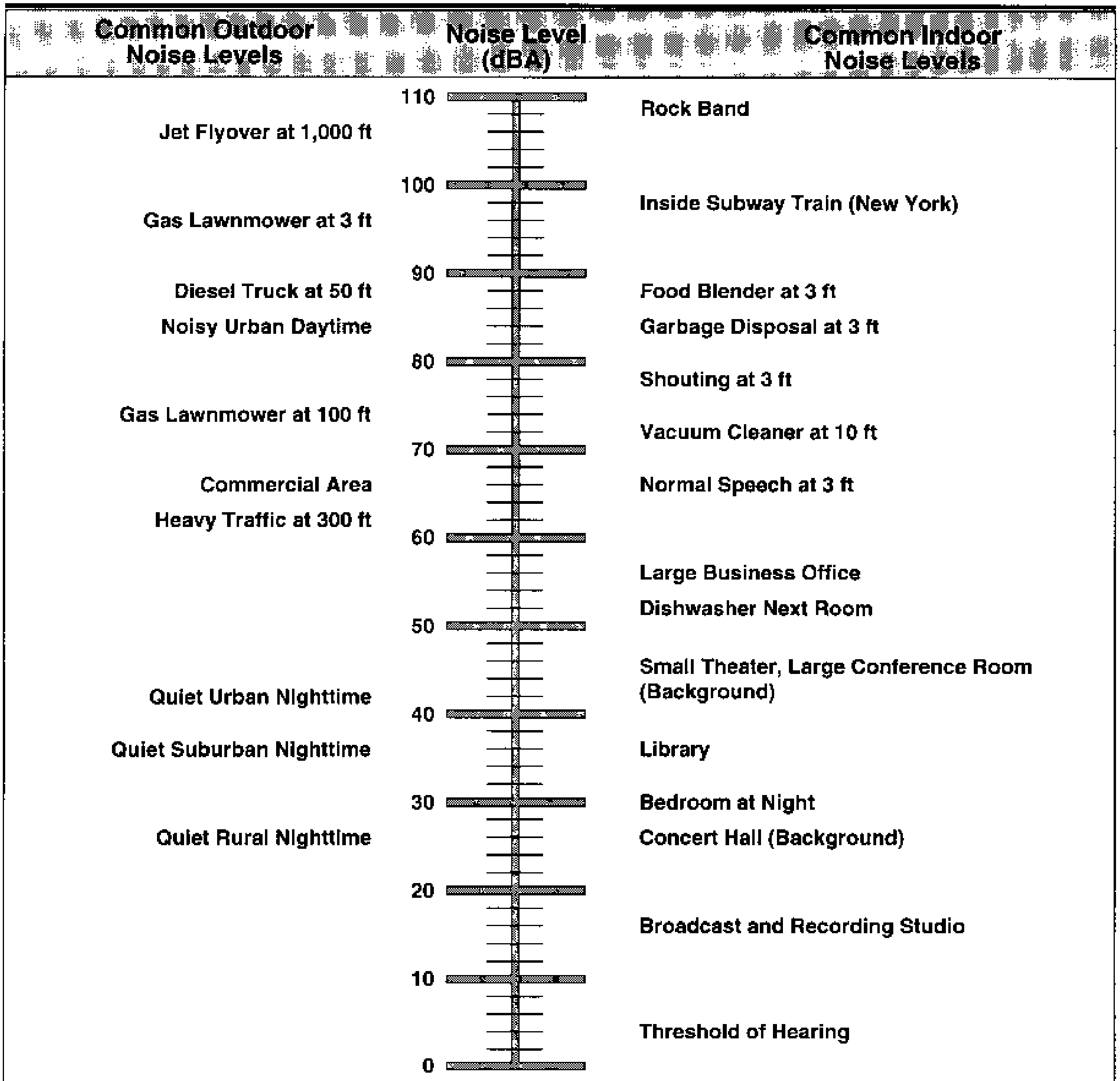
3.9 NOISE

The characteristics of sound include parameters such as amplitude, frequency, and duration. Sound can vary over an extremely large range of amplitudes (figure 3-11). The decibel (dB), a logarithmic unit that accounts for the large variations in amplitude, is the accepted standard unit for the measurement of sound. Different sounds may have different frequency contents. Sound levels which incorporate frequency-dependent amplitude adjustments established by the American National Standards Institute (American National Standard Institute, 1983) are called weighted sound levels. When measuring typical sources of noise, such as transportation or equipment, to determine its effects on a human population, A-weighted sound levels are often used to account for the frequency response of the human ear. When high-intensity impulsive noise is evaluated to determine its effects on a human population, C-weighted sound levels are used so that the low-frequency effects of the noise are considered. The low-frequency content of impulsive noise contributes to effects such as window rattle that influence people's perception of and reaction to the noise.

Noise is usually defined as sound that is undesirable because it interferes with speech communication and hearing, is intense enough to damage hearing, or is otherwise annoying. Noise levels often change with time; therefore, to compare levels over different time periods, several descriptors were developed that take into account this time-varying nature. Two common descriptors include the annual average day-night sound level (L_{dn}) and maximum sound level (L_{max}). These descriptors are used to assess and correlate the various effects of noise on humans and animals, including land use compatibility, sleep interference, annoyance, hearing loss, speech interference, and startle effects.

There are no legally established national standards for noise outside of the work environment. The OSHA Act of 1970 (Public Law 91-596) was established to "assure safe and healthy working conditions for working men and women." It delegated implementation and enforcement of the law to the OSHA of the U.S. Department of Labor. Title 29 CFR Section 1910.95 of the law pertains to the protection of workers from potentially hazardous occupational noise exposure. OSHA regulations establish a maximum noise level of 90 A-weighted decibels (dBA) for a continuous 8-hour exposure during a working day and higher sound levels for shorter exposure time (table 3-6). Protection against the effects of noise exposure must be provided when sound levels exceed those in table 3-6. Under OSHA regulations, exposure to impulse or impact noise should never exceed a 140 dB peak sound pressure level.

A consideration in Army policy is to equate different kinds of noise on the basis of equal annoyance. Army researchers found that heavy weapons noise (impulsive noise) had to be measured in a different way than aircraft noise and that an aircraft flyover and blast noise of the same sound level were not equally annoying. In order to set the upper limit of an acceptable blast noise exposure to be comparable with the existing upper limit of an acceptable aircraft noise exposure, the Army followed the recommendation of the National Research Council (1981) by adopting Army Regulation 200-1 which defines three noise zones (shown in table 3-7) in terms of annual average L_{dn}.



Source: U.S. Army Space and Strategic Defense Command, 1994a.

Comparative Sound Levels

Figure 3-11

Table 3-6: Permissible Noise Exposures*

Duration (hours) per day	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 to 1.5	102
1	105
0.5	110
0.25 or less	115

*Exposure to impulsive on impact noise should not exceed 140dB peak sound pressure level.
Source: 29 CFR 1910.95, Table G-16.

Table 3-7: Definition of Land Use Zones for Noise

Noise Zone	Compatibility with Noise Sensitive Land Uses	Percent of Population Highly Annoyed	C-weighted Annual Average Day-Night Sound Level (L_{dn})
I	Acceptable	Less than 15%	Less than 62 dB
II	Normally unacceptable	15% - 39%	62 - 70 dB
III	Unacceptable	More than 39%	More than 70 dB

Source: U.S. Department of the Army, 1990a.

Region of Influence

Under 29 CFR 1910.95, employers are required to monitor employees whose exposure to hazardous noise could equal or exceed an 8-hour time-weighted average of 85 dBA. For this reason the minimum ROI for noise analysis is the area within the L_{max} = 85 dB contours generated by USAKA temporary extended test range program activities. As a conservative approach, the ROI for Bigen Island is a circular area with a 27-kilometer (17-mile) radius, centered on the target launch site in order to include the nearest noise sensitive receptors at Aur and Tabal Islands.

For the defensive missiles modeled in the TMD Extended Test Range EIS, which included the PATRIOT, the L_{max} = 85 dB contour extended out to as much as 12 kilometers (7.5 miles) from the launch site. As a conservative approach, the ROI for Meck and Illeginni islands is a circular area with a 12-kilometer (7.5-mile) radius centered at the PATRIOT launch site.

Since no USAKA temporary extended test range project missiles will be launched from Roi-Namur, Omelek, Gellinam, Kwajalein, and Legan islands, the ROI at these islands will be the area within the L_{max} = 85 dBA contour of the noise generated by USAKA temporary extended test range project equipment and activities. No such L_{max} = 85 dBA contour should extend beyond 20 meters (50 feet) of USAKA temporary extended test range project equipment.

3.9.1 BIGEN ISLAND

There are no permanent inhabitants and no continuous man-made sources of noise on Bigen Island. Natural background sound levels on Bigen Island are relatively high because of wind and surf. On similar Pacific Islands, such background sounds mask the approach of trucks on roads and the landings of aircraft (Strategic Defense Initiative Organization, 1991).

The nearest inhabited islands to Bigen Island are Tabal and Aur islands, which are approximately 12 kilometers (7.5 miles) and 23 kilometers (14 miles) distant, respectively. Thus, they are within the ROI.

3.9.2 USAKA ISLANDS

Specific to the USAKA, in 1989 the U.S. Army prepared an installation EIS for the USAKA (U.S. Army Strategic Defense Command, 1989). That EIS and the subsequent Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a) discuss the existing noise levels at the USAKA in detail, and are incorporated into this document by reference. This section summarizes the noise-affected environment sections of those two documents. Information from any other sources of data is specifically referenced.

Gellinam, Illeginni, Legan, and Omelek Islands – The primary noise sources on each of these islands are a small power plant and helicopter operations. Meteorological rockets have been launched infrequently from Illeginni and Omelek islands (U.S. Army Space and Strategic Defense Command, 1994g). Since the islands are developed as launch support facilities and have no inhabitants occupied in unrelated activities, no noise-sensitive receptors have been identified. The nearest inhabited island to Gellinam is Gugeegue Island, which is approximately 27 kilometers (17 miles) distant, and is outside the ROI. The nearest inhabited island to Illeginni is Ennubirr Island, which is approximately 31 kilometers (19 miles) distant, and is outside the ROI. The nearest inhabited island to Legan is Ennylabegan Island, which is approximately 19 kilometers (12 miles) distant, and is outside the ROI. The nearest inhabited island to Omelek is Gugeegue Island, which is approximately 21 kilometers (13 miles) distant, and is outside the ROI.

Kwajalein Island – The primary sources of noise on Kwajalein Island are aircraft, power plants, marine sandblasting and service, air conditioning units, and small diesel engine generators. Noise-sensitive receptors, such as family housing and schools, exist at various locations on Kwajalein Island. Additionally, the nearest inhabited island is Ebeye Island, which is approximately 3 kilometers (2 miles) distant, and is outside the ROI.

Meck Island – The primary noise sources on Meck Island are a 350-kW diesel engine generator, helicopter operations, and air conditioning units. Missiles have been launched infrequently from Meck Island (U.S. Army Space and Strategic Defense Command, 1994g). Since the island is developed as a launch facility and has no inhabitants occupied in unrelated activities, no noise-sensitive receptors have been identified on the island. The nearest inhabited island is Gugeegue Island, which is approximately 26 kilometers (16 miles) distant, and is outside the ROI.

Roi-Namur Island – The primary noise sources on Roi-Namur Island are missile launches, aircraft, power plants, and air conditioning units. All personnel on Roi-Namur are workers involved with USAKA activities who are provided with appropriate hearing protection to reduce exposure to allowable levels. The nearest inhabited island is Ennubirr Island, which is approximately 2.6 kilometers (1.6 miles) distant, and is outside the ROI.

3.9.3 FLIGHT TEST CORRIDOR

As there are no known data on sound level baseline characteristics for the open ocean area between Bigen Island and the USAKA, it is assumed for the purposes of this document that the salient characteristics are the same as for Bigen Island itself.

3.10 SOCIOECONOMICS

Socioeconomics typically comprises the demographic and economic characteristics of a community and the related housing, public services, and public finance attributes. This usually involves the consideration of population composition, employment and income, housing, public facilities and services, and the fiscal characteristics of a community. However, given the fact that USAKA temporary extended test range-related personnel would be unaccompanied, present on the USAKA for relatively short periods of time, and more importantly, living in government-provided housing rather than local motels and hotels, socioeconomic issues are essentially confined to population, employment and income, and the availability of housing.

Region of Influence

The region of influence for socioeconomics is limited to Kwajalein Island since this is the only location that has the potential for program-related population, employment, income, and housing impacts. As no change is expected in the work force of the Marshallese population (either on Kwajalein Island or on nearby islands) as a result of program activities, further discussion of socioeconomic effects on the Marshallese population will not take place. The assembly and integration of flight test hardware at various CONUS Government installations, and their transportation to the USAKA, would involve only existing personnel and thus would not generate any net, new socioeconomic impacts. The personnel involved in the final assembly and preflight activities, transportation to the temporary launch locations, site preparation, and establishment, and flight test activities on other USAKA islands would commute from Kwajalein Island. Personnel involved in site preparation and establishment and flight test activities at the uninhabited Bigen Island, would live on and operate out of an LCU anchored offshore. Self-contained Mann Camps may also be set-up on the island for temporary living quarters. Although the harvesting of copra takes place on Bigen Island about 3–4 days per month, in consideration of the proposed 60-day notice for program activities and the maximum period of 30 days on the island for project-related personnel for any launch event, no loss to the copra harvest or other adverse effects are expected from planned activities and the copra harvest will not be discussed further in the socioeconomics section.

Affected Environment

Population and Employment. The USAKA strictly regulates access to Kwajalein Island, thereby controlling its resident population. The nonindigenous population of Kwajalein Island fluctuates from year to year and from month to month, depending on program activity, but totaled 2,488 in 1994 (U.S. Army Space and Strategic Defense Command, 1994d). This number consisted of military, civil service, and contractor personnel and their dependents. In 1994 a total of 1,397 nonindigenous personnel associated with operations, construction, and short-term (transient) operations were employed at the USAKA (U.S. Army Space and Strategic Defense Command, 1994d).

Income. Precise data concerning the total income earned by USAKA nonindigenous personnel are not available. However, an estimate of the total income of USAKA nonindigenous contract employees can be derived from data on the 5 percent income tax paid to the RMI government by all contract employees. In 1991, income tax receipts amounted to $2,357,491, corresponding to a total income of approximately $47 million (U.S. Army Space and Strategic Defense Command, 1993a).

Housing. Housing for USAKA's personnel is located on Kwajalein and Roi-Namur islands and consists of family housing, UPH, and transient housing. Construction workers are usually housed in temporary trailers (Mann Camps) provided by the construction contractor (U.S. Army Space and Strategic Defense Command, 1993a). Of relevance to the USAKA temporary extended test range program is the available transient lodging, which totals 482 beds on Kwajalein Island (U.S. Army Space and Strategic Defense Command, 1994a).

3.11 INFRASTRUCTURE AND TRANSPORTATION

Infrastructure elements include transportation routes and facilities and systems that provide power, water, wastewater treatment, and disposal of solid waste.

Region of Influence

The region of influence for infrastructure and transportation is limited to seven of the USAKA islands, Bigen Island in the Aur Atoll, and the flight test corridor that has been established.

3.11.1BIGEN ISLAND

Bigen Island does not have any paved roads or any utility facilities. There are well established footpaths on the islands that are used by coconut and breadfruit harvesters (U.S. Army Space and Strategic Defense Command, 1994d).

Bigen Island is not capable of accepting air traffic because it has neither a helipad nor airstrip (U.S. Army Space and Strategic Defense Command, 1994d). The airstrip on Tabal Island could be used for emergency purposes such as medical transport. The Tabal airstrip is approximately 2,000 meters (6,562 feet) in length with a crushed coral surface.

Bigen is without active, developed potable water systems, making it necessary for personnel working on this island to carry water for consumption and other uses (U.S. Army

Space and Strategic Defense Command, 1994d). The island is also without an established wastewater treatment and disposal facility.

There is currently no source of power on the island.

3.11.2 USAKA ISLANDS

Gellinam, Illeginni, Legan, and Omelek Islands - Gellinam, Legan, and Omelek Islands do not have any paved roads nor do they house any motor vehicles. Illeginni Island has approximately 0.8 kilometer (0.5 mile) of paved roads and other unpaved roads that are utilized by island personnel. The harbors of all four islands are periodically dredged and are therefore capable of accepting marine transport. All four islands also have a 900-square meter (10,000-square foot) helipad and are serviced by UH-1H helicopters. (U.S. Army Strategic Defense Command, 1989)

Gellinam, Illeginni, Legan, and Omelek Islands are without active, developed potable water systems, making it necessary for personnel working on the islands to carry water for consumption and other uses. A network of communication lines and underground electrical lines is found on Omelek Island. Generator buildings are located on Gellinam and Legan Islands which are capable of producing 210 kilovolts (kv) and 180 kv of power respectively. A power plant capable of producing 1,200 kv of power is located on Illeginni Island. (U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1994d)

Kwajalein Island – There are approximately 21 kilometers (13 miles) of paved roads and 11 kilometers (6.5 miles) of unpaved roads on Kwajalein Island (U.S. Army Space and Strategic Defense Command, 1993a). Bicycles are the principal means of transportation and travel on the same paths used by pedestrians as well as on roads used by motor vehicles (U.S. Army Space and Strategic Defense Command, 1993a). Vehicular transportation to and from work and school is provided by island shuttle buses.

Marine transport facilities are concentrated at Kwajalein Island, which serves as a base for receiving cargo and fuel to the USAKA (U.S. Army Space and Strategic Defense Command, 1993a). Passenger fleets, consisting of two catamaran ferries, a LCM that can carry up to 190 passengers, and a personnel boat that can carry up to 73 passengers, are also located at Kwajalein (U.S. Army Space and Strategic Defense Command, 1993a).

Kwajalein Island also has air transportation capabilities and houses the Bucholz AAF which serves as a refueling point for a wide variety of military and civilian aircraft. Aircraft ranging from Learjets to military C-5 transports use Kwajalein as an en route stop (U.S. Army Strategic Defense Command, 1989).

Utilities found on Kwajalein include permanent facilities for water supply; wastewater collection, treatment, and disposal; solid and hazardous waste disposal; and power generation (U.S. Army Strategic Defense Command, 1989).

Meck Island – Meck Island has about 2 kilometers (1 mile) of paved road (U.S. Army Space and Strategic Defense Command, 1993a).

Meck Island has a concrete pier that accepts both personnel and cargo. Meck Island has a runway that no longer accepts fixed-wing aircraft but is capable of accepting helicopter transportation. (U.S. Army Strategic Defense Command, 1989)

The source of potable water on Meck Island is a rainwater catchment (U.S. Army Strategic Defense Command, 1989). Two tanks store raw freshwater that is filtered and chlorinated before being pumped to the system. No treated water storage is provided (U.S. Army Strategic Defense Command, 1989). Wastewater is treated through the use of one of three septic tank/leach field systems (U.S. Army Strategic Defense Command, 1989). Island power is provided by five 565 kW diesel powered engine generators (U.S. Army Strategic Defense Command, 1989).

Roi-Namur Island – Roi-Namur Island has approximately 10 kilometers (8 miles) of paved roads and 2 kilometers (1 mile) of unpaved roads (U.S. Army Space and Strategic Defense Command, 1993a). Vehicular transportation to and from work is provided by island shuttle buses; bikes are used by many of the residents (U.S. Army Space and Strategic Defense Command, 1993a).

Roi-Namur has a cargo pier, cargo/fuel pier, and marine ramp. Roi-Namur also has air transportation capabilities and is home to the Dyess AAF which provides service to a variety of aircraft and helicopters. (U.S. Army Strategic Defense Command, 1989)

Utilities found on Roi-Namur include permanent facilities for water supply; wastewater collection, treatment, and disposal; solid and hazardous waste disposal; and power generation (U.S. Army Strategic Defense Command, 1989).

3.11.3 FLIGHT TEST CORRIDOR

The proposed flight test corridor includes the BOA between Aur Atoll and Kwajalein Atoll and a portion of the Mid-atoll Corridor within the Kwajalein Lagoon.

Ships and smaller craft carry sea cargo and fuel to the USAKA and deliver workers and cargo, including fuel, between the islands in the atoll. Local marine transport is provided under contract by Raytheon Corporation. Kwajalein has the largest concentration of marine transport facilities and serves as a base for most of the fleet. Cargo handling facilities on Kwajalein Island have more capacity than is currently needed, even though only one cargo ship at a time can be docked for unloading. Passenger facilities are being used at near-full capacity (U.S. Army Space and Strategic Defense Command, 1994d).

3.12 WATER RESOURCES

Water resources include those aspects of the natural environment related to the availability and characteristics of water. Water resources include consideration of surface water and groundwater. Surface water includes surface runoff, changes to surface drainage, and surface water quality. Groundwater includes aquifer characteristics, water quality, and water supply.

In general, coral atolls do not contain surface water bodies or well defined drainage channels because of the high porosity and permeability of the soils or surface sediments.

Rainwater falling on atolls rapidly infiltrates into the ground with little overland flow except for man-made impervious surfaces.

Of the islands under consideration for the proposed action, only Legan Island contains surface water. This small (approximately 0.4 hectare [1 acre]) tidal pond area in the center of Legan Island likely formed during the creation of the island, not as a result of erosion by running water. Water in this tidal pond is brackish in quality.

The permeable materials that compose most atoll islands are readily infiltrated by recharge from rainfall. The less dense freshwater forms a lens, somewhat like an iceberg floating in the ocean. Fresh groundwater moves readily outward under gravity head toward the coastal margin of the island to discharge into the sea. Some of the freshwater mixes with underlying sea water to form a transition zone of mixed or brackish water. The actual thickness of fresh groundwater is influenced by the recharge and discharge rates, size and shape of the island, and the hydraulic characteristics of the aquifer. The thickness of the transition zone is affected by mixing induced by tidal fluctuations, variations in recharge rate, and the rate and direction of groundwater flow (United Nations Educational, Scientific and Cultural Organization, 1991).

Groundwater withdrawal occurs on Kwajalein, Roi-Namur, and potentially on Bigen islands to supply potable water requirements. On Kwajalein and Roi-Namur islands, groundwater withdrawal only provides a small portion of the potable water used. All of the potable water on Meck, and most of the potable water on Roi-Namur and Kwajalein islands is supplied by rainfall catchment. A lens of fresh groundwater has not developed on Illeginni, Gellinam, Legan, or Omelek islands, presumably because of their small areal extent. Potable water for these islands is transported from Kwajalein Island.

Region of Influence

The ROI for potable water resources includes Kwajalein, Roi-Namur and Meck islands where potable water would be obtained to supply program requirements. For islands being considered for launching target and defensive missiles, and islands being considered for defensive missile radar systems, the ROI is limited to that portion of the islands that may be impacted by emission products resulting from launches, or by unburned liquid or solid propellants from fuel spills or early flight termination. The Mid-atoll Corridor and open ocean under the flight corridor define the ROI for sea water resources.

3.12.1 BIGEN ISLAND

No studies or site specific water resource data for Bigen Island or for Aur Atoll have been identified. However, the occurrence and quality of groundwater are expected to be similar to other atolls in the pacific region. One possible water well was identified on Bigen Island during the site visit in December 1994. The quantity of water withdrawn and the water use are unknown. It may be used to supply potable water for the transient copra processing workers who are on the island 3 to 4 days per month.

No groundwater withdrawal is planned at Bigen Island. All water required to support program activities and personnel would be transported to Bigen Island from Kwajalein Atoll.

3.12.2 USAKA ISLANDS

Kwajalein Island – Potable water on Kwajalein Island is supplied by a combination of groundwater wells and capture of rainwater in catchment areas located adjacent to the runway. During periods of drought, such as occurred in 1984-1985, the average capture volume of rainwater can be less than one-third of the daily demand (U.S. Space and Strategic Defense Command, 1993a). The fresh groundwater storage capacity has been estimated at about 1,060 million liters (279 million gallons), with fluctuations of greater than 20 percent in response to recharge or pumping (Hunt and Peterson, 1980). A 570,000 liter-per-day (150,000 gallon-per-day) capacity water desalination plant will reduce the groundwater withdrawal requirement and provide a stable source of potable water during periods of drought. Raw water is stored in fourteen 4-million liter (1-million gallon) aboveground storage tanks.

Roi-Namur Island – Like Kwajalein Island, a combination of groundwater wells and the capture of rainwater in catchment basins is used to supply potable water on Roi-Namur. A calibrated model of the groundwater system indicates that at least 13 million liters (3.5 million gallons) per year of sustainable yield can be expected from the existing well system. This amount was approximately 50 percent more yield than demand in 1993 (U.S. Army Space and Strategic Defense Command, 1993a).

Meck – Potable water requirements on Meck Island are provided by a rainwater catchment area adjacent to the airfield runway. Raw water storage includes one 950,000-liter (250,000-gallon) and two 2-million liter (500,000-gallon) tanks.

3.12.3 FLIGHT TEST CORRIDOR

The waters around Kwajalein Atoll are well mixed and are not affected by nearby large land masses and continents. Around Kwajalein and other atolls in the Marshall Islands, the Pacific Ocean is deep and its waters are considered pollution-free, pristine, and transparent (U.S. Army Space and Strategic Defense Command, 1993a).

The prevailing tradewinds cause strong currents to enter the Kwajalein lagoon and passes. These currents are a major source of sea water exchanging with lagoon water, and they help to keep the lagoon relatively well mixed. Water quality in the nearshore and lagoon waters is generally of very high quality, with high dissolved oxygen and pH at levels typical of mid-oceanic conditions (U.S. Space and Strategic Defense Command, 1993a). Open sea waters are typically alkaline, and have a pH of greater than 8.0, which allows the buffering of acidic rocket emissions without significant long-term change to water chemistry (Brown and LeMay, 1977).

Around Kwajalein Atoll the ocean depth is as much as 2,000 meters (6,000 feet) within two miles of the atoll, and 4,000 meters (13,200 feet) within 8 kilometers (5 miles) (U.S. Army Strategic Defense Command, 1989). Water depth in the Kwajalein Atoll lagoon is generally less than 61 meters (200 feet).

4.0 Environmental Consequences

4.0 ENVIRONMENTAL CONSEQUENCES

This section of the EA examines potential environmental consequences associated with the proposed action. Potential impacts are assessed by comparing proposed program activities with potentially affected environmental components. Sections 4.1 through 4.12 provide discussions of the potential environmental consequences for each resource. The amount of detail presented in each section is proportional to the potential for impacts. Sections 4.13 through 4.18 provide discussions of the following with regard to proposed USAKA temporary extended test range activities: environmental consequences of the no-action alternative; adverse environmental effects that cannot be avoided; conflicts with Federal, state, and local land use plans, policies, and controls; energy requirements and conservation potential; irreversible or irretrievable commitment of resources; and the relationship between the short-term uses of the human environment and the maintenance and enhancement of long-term productivity.

Proposed Actions Excluded from Further Analysis

The proposed action includes assembly and integration of flight test hardware in the CONUS and transportation of components to the USAKA.

The Hera target vehicle/payload development, rocket motor refurbishment/modification, system integration, and engineering/manufacturing activities were documented in the TMD Hera Target Systems EA and are incorporated herein by reference (U.S. Army Space and Strategic Defense Command, 1994b). The liquid propellant target missile being analyzed is a notional ERL. Although no ERL will be built, if it were, the necessary modification and refurbishment of any existing missile motors would require approximately 25 personnel. The process would include performing modifications to the bulkhead structure, tests on components and subsystems, and administrative functions. These functions could be conducted at a number of U.S. Government installations where they would be considered to be routine activities. The modification and refurbishment of the liquid propellant launch vehicle would involve the use of solvents, cleaning materials, and adhesives (such as acetone and isopropyl alcohol). These materials are routinely used for such purposes and would be handled in accordance with data provided on the appropriate MSDSs. No modifications to existing facilities, unusual utility requirements, or additional personnel would be required to support this kind of activity.

A PATRIOT TMD interceptor would be used for the flight tests. Assembly and integration of the PATRIOT missile have been addressed in the PATRIOT Life Cycle EA (U.S. Department of the Army, 1990b) which resulted in a Finding of No Significant Impact. This interceptor would be obtained from contractor or government facilities, and no additional assembly or integration would be required.

Assembly and integration of the THAAD radar have been addressed in the GBR Family of Strategic and Theater Radars EA (U.S. Army Space and Strategic Defense Command, 1993b) which resulted in a Finding of No Significant Impact.

Sensor systems to be used in these flight tests are all existing sensors, which have already undergone assembly and integration and are functional systems. Sensor systems include the THAAD radar and various existing USAKA Range sensors. Aircraft and naval ships would also be present in the area to provide supplementary sensor support. These systems have previously received comprehensive description and analysis in the USAKA EIS (U.S. Army Strategic Defense Command, 1989) and USAKA SEIS (U.S. Army Space and Strategic Defense Command, 1993a).

All surface transportation would be performed in accordance with DOT approved procedures and routing, and all liquid propellants would be transported in DOT approved or waivered containers. Appropriate safety measures would be followed during transportation of the propellants as required by the DOT and as described in the Bureau of Explosives Tariff No. BOE 6000-I, *Hazardous Materials Regulations of the Department of Transportation* (Association of American Railroads, 1992). For boat or barge transportation, U.S. Coast Guard and/or applicable U.S. Army transportation safety regulations would be followed.

Some or all of the USAKA Ground Optics, the USAKA MPS-36 Radars, the USAKA FPQ-19 Radar, and the KREMS Radars would observe the Aur Atoll launches. These systems are located at USAKA and have previously received comprehensive description and analysis in the USAKA EIS (U.S. Army Space and Strategic Defense Command, 1989), and USAKA SEIS (U.S. Army Space and Strategic Defense Command, 1993a).

The KMRSS would remain aboard an ocean-going vessel located in the Aur Lagoon except for operational tests and the actual launch when it would be located in the Pacific Ocean west of the Atoll. The KMRSS consists of four equipment vans, a telemetry receiver, and two command destruct transmitters. The KMRSS provides flight safety data.

4.1 AIR QUALITY

Potential impacts to air quality from USAKA temporary extended test range program activities include combustion emissions from portable generators used to power the THAAD radar and PATRIOT support equipment, exhaust products from the target missile's and the PATRIOT missile's rocket motors, and plumes of volatilized liquid propellants from accidental spills.

4.1.1 BIGEN ISLAND

Potential impacts to air quality from the USAKA temporary extended test range program activities at Bigen Island include exhaust products from the target missile's rocket motor and spills of liquid propellant. Rocket motor emissions are generated in the ground cloud at lift-off and along the launch trajectory. Emissions are associated with the oxidation of fuel. Emission composition is determined by the type and composition of the various propellants (fuels and oxidizers).

The target missiles launched from Bigen Island as part of the USAKA temporary extended test range program activities would be either a solid or liquid propellant launch vehicle. As mentioned in Section 2, the solid propellant launch vehicle would be similar to the Hera missile, and the liquid propellant launch vehicle would be similar to the notional ERL missile.

The Hera missile's rocket motor combustion products are shown in table 4-1 (U.S. Army Space and Strategic Defense Command, 1994b). The notional ERL missile's rocket motor combustion products are shown in table 4-2 (U.S. Army Corps of Engineers, 1993). Air quality analysis has been conducted for these two representative target missile configurations. Details of this analysis are given in Appendix E.

The major emission products from the Hera rocket motors are carbon monoxide, aluminum oxide (Al_2O_3), and hydrogen chloride (HCl). The major emission products from the notional ERL rocket motors are water, carbon dioxide, nitrogen, and carbon monoxide. Carbon monoxide is a criteria pollutant and is compared to the NAAQS (table E-1). Water, nitrogen, and carbon dioxide are environmentally benign except in massive amounts.

Al_2O_3 is a naturally occurring mineral that has a very low toxic potential (Lewis, 1993). The Al_2O_3 in the rocket exhaust is a solid dust. Thus, as the most conservative estimate, all of the Al_2O_3 was assumed to be PM-10, and was then compared to the corresponding NAAQS. Also, the Al_2O_3 concentrations were compared to the 8-hour American Conference of Government Industrial Hygienists (1992) standard for dust.

HCl is not a criteria pollutant but is one of the 189 Hazardous Air Pollutants (HAPs) listed in Title III of the Clean Air Act. Concentrations of HCl are compared to the guidelines from the National Research Council (1987) and the U.S. Environmental Protection Agency (1992).

The analysis of potential ambient air quality impacts from proposed launch activities considers both normal launch and early flight termination scenarios. It is assumed that during either scenario the only air pollutant emitted is the exhaust from the rocket motor combustion products.

The short-term air quality impacts caused by the launch of an individual USAKA temporary extended test range program missile were modeled with the TSCREEN PUFF computer model (U.S. Environmental Protection Agency, 1990). Screening techniques use simplifying assumptions and generate estimates which are generally upper bounds on expected pollutant concentrations. Details of the analysis and computer modeling are given in Appendix E.

The results from the modeling show that for both a normal launch and an early flight termination scenario of a notional ERL missile the 1-hour NAAQS for carbon monoxide is not exceeded for distances equal to or greater than 1 kilometer (0.6 miles) from the launch site. The nearest inhabited islands to Bigen Island are Tabal Island and Aur Island, which are 12 kilometers (7.5 miles) and 23 kilometers (14 miles) from Bigen, respectively.

The impacts on air quality from the launch of target missiles were analyzed in the TMD Hera Target Systems EA (U.S. Army Space and Strategic Defense Command, 1994b). This analysis showed that with only one exception neither the NAAQS for carbon monoxide or PM-10 nor the HCl guideline values would be expected to be exceeded for distances greater than 1 kilometer (0.6 mile) from the launch site.

Table 4-1: Hera Missile Rocket Motor Exhaust Products In Kilograms (Pounds)

Species	SR19-AJ-1 (first stage)	M57A-1 (second stage)
Aluminum oxide (Al_2O_3)	1,763 (3,886)	533 (1,174)
Carbon monoxide (CO)	1,324 (2,919)	420 (927)
Hydrogen chloride (HCl)	1,399 (3,084)	332 (731)
Nitrogen (N_2)	544 (1,200)	135 (297)
Water (H_2O)	775 (1,708)	147 (325)
Hydrogen (H_2)	117 (257)	39 (87)
Carbon dioxide (CO_2)	287 (633)	48 (106)
Others	74 (164)	4 (8)
Total	6,283 (13,851)	1,658 (3,655)

Source: U.S. Army Space and Strategic Defense Command, 1994b.

Table 4-2: Notional Missile Rocket Motor Exhaust Products in Kilograms (Pounds)[a]

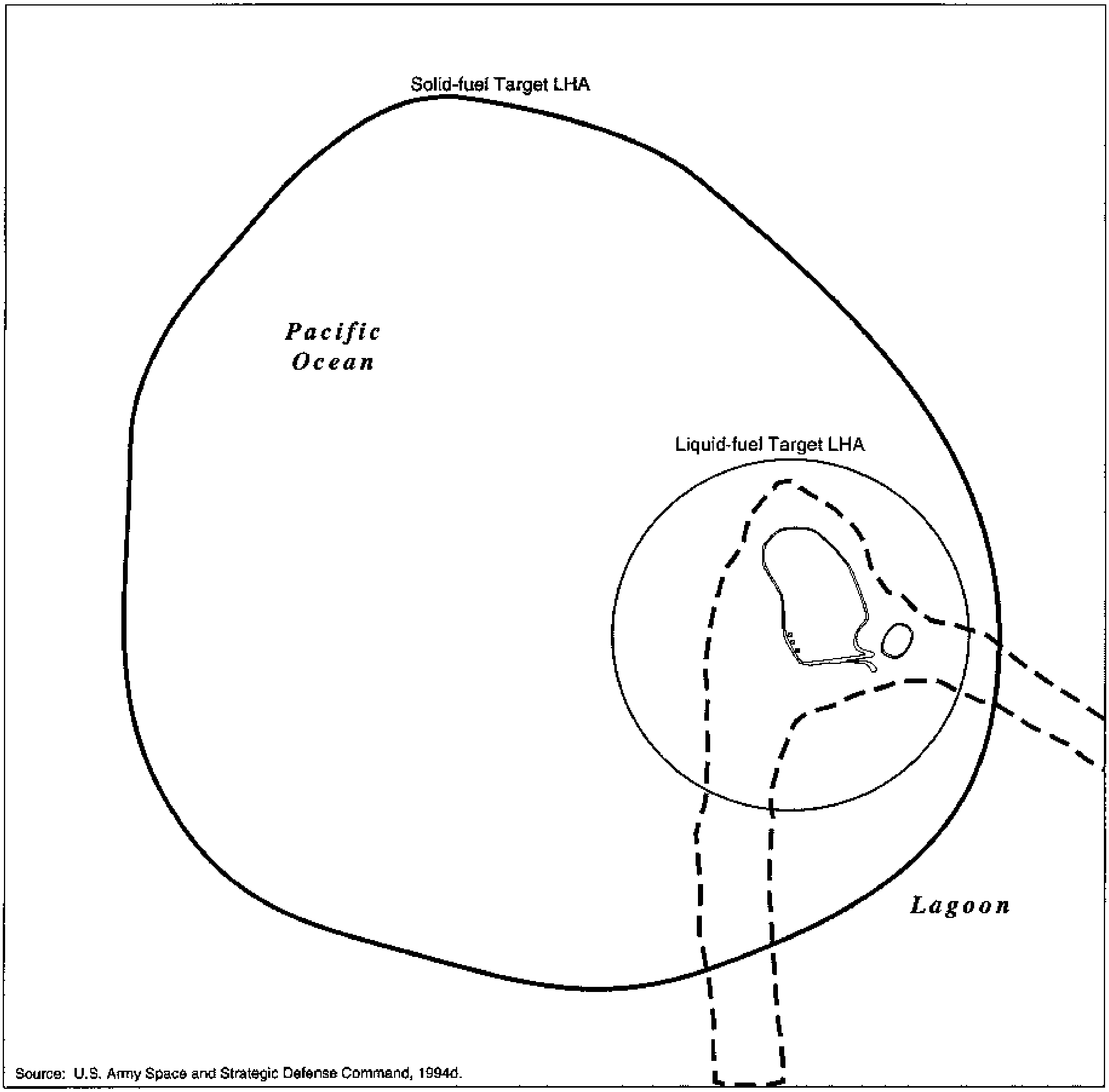
Species	First Stage	Second Stage
Water (H_2O)	273 (602)	273 (602)
Carbon dioxide (CO_2)	222 (489)	222 (489)
Nitrogen (N_2)	204 (450)	204 (450)
Carbon monoxide (CO)	14 (30)	14 (30)
Oxygen (O_2)	7 (16)	7 (16)
Hydroxide Ion (OH)	3 (7)	3 (7)
Nitric Oxide (NO)	2 (4)	2 (4)
Others	1 (2)	1 (2)
Total	726 (1,600)	726 (1,600)

[a]Derived from U.S. Army Corps of Engineers, 1993.

The one exception occurs in the case of a near-pad/on-pad missile failure in which the solid propellant from both rocket motors burns. In this case, for distances up to 6 kilometers (4 miles) downwind from the launch site, the Short-term Public Emergency Guidance Level (SPEGL) for HCl (1.5 milligrams per cubic meter [mg/m^3]) would be exceeded. However, since all nonessential personnel would be cleared from the launch area during launch (figure 4-1), it would not be expected that the public would be exposed to concentrations greater than 1.5 mg/m^3 of HCl.

Tabal Island is within 12 kilometers (7.5 miles) of Bigen Island but is not downwind of Bigen Island. As noted in section 3.1.2, with rare exception, the winds on Bigen Island are from the northeast, and thus blow emissions downwind to the southwest. In contrast, both Tabal Island and Aur Island are southeast of Bigen Island. For these reasons, the early flight termination of a Hera missile at Bigen Island would not be expected to cause ambient air concentrations of HCl to exceed the SPEGL at Tabal or Aur islands.

For a liquid propellant launch vehicle, such as the notional ERL, both liquid fuel and liquid oxidizer may be removed at Bigen Island. Normally, as an upper bound, the maximum credible release of a liquid propellant during a spill is taken to be the amount within one



Source: U.S. Army Space and Strategic Defense Command, 1994d.

EXPLANATION

- Potential Launch Sites
- Reef Edge
- Liquid-fuel Target Launch Hazard Area
- Solid-fuel Target Launch Hazard Area

0 0.56 1.12 Kilometers

0 0.35 0.7 Miles

Target Missile Launch Hazard Area

Bigen Island,
Aur Atoll

Figure 4-1

shipping container. For the notional ERL the liquid fuel is UDMH, which is shipped in 200-liter (55-gallon) drums, and the liquid oxidizer is IRFNA, which would be shipped in containers not larger than 800 liters (200 gallons).

The Air Force Toxic Chemical Dispersion Model (AFTOX) was used to determine the sizes of the areas that may experience concentrations of UDMH and IRFNA equal to or greater than emergency exposure limits from the spill of 200 liters (55 gallons) of UDMH and the spill of 800 liters (200 gallons) of IRFNA. Details of the analysis are given in Appendix E. The emergency exposure limits used in the analysis are a 10-minute time-weighted average concentration of 30 ppm for IRFNA and a 10-minute time-weighted average concentration of 100 ppm for UDMH (Chemical Propulsion Information Agency, 1984).

For a 200-liter (55-gallon) spill of UDMH the AFTOX modeling predicted the area to extend less than or equal to 90 meters (300 feet) downwind. Similarly, for an 800-liter (200-gallon) spill of IRFNA the AFTOX modeling predicted the area to extend less than or equal to 0.8 kilometer (0.5 mile). While the width to length ratio of these areas depends on the meteorological conditions, the width of these areas is typically one sixth of their length.

Only USAKA temporary extended test range project personnel would be on Bigen Island and in the nearby waters during project activity. Project personnel would be following health and safety measures appropriate to the handling of UDMH and IRFNA (see section 4.6).

The closest inhabited islands to Bigen Island are Tabal Island, which is within 12 kilometers (7.5 miles), and Aur Island, which is within 23 kilometers (14 miles). As both of these islands are beyond the maximum distance either area extends downwind from the spill, no member of the public would be exposed to concentrations of UDMH or IRFNA above their emergency exposure limits.

4.1.2 USAKA ISLANDS

The temporary storage of rocket motors and flight termination systems in existing ammunition storage bunkers on Kwajalein Island would essentially have no potential air emissions and thus no potential to impact air quality.

Potential impacts to air quality from USAKA temporary extended test range program activities at the USAKA islands include combustion emissions from portable generators used to power PATRIOT support equipment. Emission estimates for PATRIOT Air Defense System generators are shown in table 4-3 (U.S. Army Space and Strategic Defense Command, 1993b). Potential impacts to air quality from the operation of similar support equipment for strategic launch vehicles at Omelek and Gellinam islands were addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a).

Potential impacts to air quality from USAKA temporary extended test range program activities at Illeginni and Meck islands include combustion emissions from portable power generators used to power PATRIOT launch equipment and exhaust emissions from the PATRIOT missile's rocket motors. The rocket motor combustion products for one PATRIOT

Table 4-3: Emission Estimates for PATRIOT Diesel Generators in Kilograms (Pounds) per Hour

Pollutant	Base Rate[a] (g/kw-hr)	Electrical Power Plant (two 150-kilowatt generators)	Electrical Power Unit (30-kilowatt generator)	Launching Station (15-kilowatt generator)
Carbon monoxide (CO)	4.06	1.22 (2.68)	0.12 (0.27)	0.059 (0.13)
Nitrogen oxides (NO_x)	18.80	5.638 (12.43)	0.562 (1.24)	0.28 (0.62)
Sulfur oxides (SO_x)	1.25	0.38 (0.83)	0.04 (0.08)	0.02 (0.04)
Particulates (PM-10)	1.34	0.40 (0.89)	0.04 (0.09)	0.02 (0.04)
Exhaust hydrocarbons	1.50	0.45 (0.99)	0.05 (0.10)	0.02 (0.05)

[a]U.S. Environmental Protection Agency, 1985.

Table 4-4: PATRIOT Missile Rocket Motor Exhaust Products

Species	Kilograms	(Pounds)
Aluminum oxide (Al_2O_3)	184	(406)
Carbon monoxide (CO)	148	(327)
Hydrogen chloride (HCl)	190	(421)
Water (H_2O)	135	(298)
Nitrogen (N_2)	74.4	(164)
Hydrogen (H_2)	12	(26)
Carbon dioxide (CO_2)	65.8	(145)
Others (including chlorine, iron chlorides, iron, ferrous oxide, sulfur oxides, and chromium chlorides)	3	(6)
Total	812	(1,793)

Source: U.S. Department of the Army, 1995.

missile are shown in table 4-4 (U.S. Department of the Army, 1995). For USAKA temporary extended test range program activities, most likely two PATRIOT missiles would be fired within a matter of seconds. Potential impacts to air quality from the launches of strategic launch vehicles (including TMD missiles) and the operation of their support equipment at Meck and Illeginni islands were addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a). The SEIS concluded that the resulting air pollution emissions would be less than ambient air quality and hazardous/toxic emissions standards.

For a liquid propellant launch vehicle, such as the notional ERL, both liquid fuel and liquid oxidizer would be stored at Meck Island. As discussed in section 4.1.1, the AFTOX model was used to predict the hazard area that would result from a 200-liter (55-gallon) spill of UDMH and a 800-liter (200-gallon) spill of IRFNA.

Only USAKA temporary extended test range project personnel would be on Meck Island and in the nearby waters during project activity. Project personnel would be following health and safety measures appropriate to the handling of UDMH and IRFNA (see section 4.6).

The closest inhabited island to Meck Island is Gugeegue Island, which is within 26 kilometers (16 miles). As this is beyond the maximum distance for both hazard areas, no member of the public would be exposed to concentrations of UDMH or IRFNA above their emergency exposure limits.

During each fueling of a liquid-propellant launch vehicle, small gaseous releases would occur. For example, approximately 10 grams (0.4 avoirdupois ounce) of nitrogen dioxide would be released during each fueling with IRFNA. Such small amounts would be quickly dispersed and diluted to safe levels. The safe levels would be reached within a few meters (feet) of the release point. As noted above, project personnel would be following health and safety measures appropriate for the handling of liquid propellants.

Potential impacts to air quality from USAKA temporary extended test range program activities at Roi-Namur Island are limited to combustion emissions arising from the electrical power requirements of the THAAD radar. Electrical power would be supplied either from the existing Roi-Namur commercial power system or from the associated PPU of the radar system. The PPU would be run on either DF-2 diesel fuel or JP-8 jet fuel (table 4-5).

Potential impacts to air quality from the operation of a THAAD radar (and its associated generators) at Meck, Illeginni, Omelek, Gellinam, and Legan islands were addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a). The SEIS concluded that the resulting air pollution emissions would be less than ambient air quality and hazardous/toxic emissions standards. Since the air quality environment at Roi-Namur Island is comparable to that at the islands for which the analysis was done, the operation of the THAAD radar portable generators on Roi-Namur Island should be similarly limited.

4.1.3 FLIGHT TEST CORRIDOR

Potential impacts to air quality from USAKA temporary extended test range program activities along the flight test corridor include exhaust products from the target missile's rocket motor. These emissions are generated in the ground cloud at lift-off and along the launch trajectory. Emissions are associated with the oxidation of fuel. Emission composition is determined by the type and composition of the various propellants (fuels and oxidizers).

Generally, emissions along the target missile's trajectory will be dispersed into the upper atmosphere, and thus will be diluted in large volumes of air to concentrations well below the relevant NAAQS or HCl guideline values.

It has been speculated that exhaust products from both solid and liquid propellant rocket motors may contribute to the loss of stratospheric ozone. It has not yet been shown whether or not this occurs in the stratosphere. A number of studies have shown that even assuming that rocket motor exhaust products do contribute to the loss of stratospheric ozone, the amount of ozone depletion that occurs from the largest rocket motors (i.e., those of the space shuttle) is negligible compared to losses of ozone from other sources. (Prather, et al., 1990, American Institute of Aeronautics and Astronautics, 1991; Congressional Research Service, 1991; Bennett, et al., 1992)

Table 4-5: Emission Estimates for THAAD Radar Diesel Generator

Pollutant	Rate in kilograms per hour (pounds per hour)	
	Diesel fuel (DF-2)[a]	Jet fuel (JP-8)[b]
Nitrogen oxides (NO_x)	15.0 (33.1)	7.593 (16.74)
Carbon monoxide (CO)	3.9 (8.6)	1.65 (3.64)
Sulfur dioxide (SO_2)	1.7 (3.7)	0.5053 (1.114)
Particulate matter	1.5 (3.3)	0.5425 (1.196)
Volatile Organic Compounds (VOCs)	0.43 (0.95)	0.517 (1.14)

[a]Derived from U.S. Army Space and Strategic Defense Command, 1993b.

[b]U.S. Army Space and Strategic Defense Command, 1995b.

4.1.4 CUMULATIVE IMPACTS

Missile launches and launch support equipment are air pollution sources that are brief and discrete events in time. Air pollutants do not accumulate at any of the locations under consideration because winds effectively disperse them between launches.

The Final Supplemental EIS for the Proposed Actions at USAKA (U.S. Army Space and Strategic Defense Command, 1993a) addresses the environmental impacts of ongoing and future programs at the USAKA. The USAKA temporary extended test range activities would be most appropriately represented by either the USAKA EIS's low level of activity or intermediate level of activity. In either case, no cumulative impacts would be expected.

There is the potential that Roi-Namur's ambient air may be very slightly degraded due to cumulative impacts if the AOS site is chosen for the THAAD radar. This is because Roi-Namur's power plant is approximately 200 meters (600 feet) west of the AOS site. The USAKA SEIS shows that the power plant is by far the largest source of air pollutants on the island. Therefore, if the wind on Roi-Namur were blowing directly from the east and the THAAD radar were operating at this time, then there is the potential for a cumulative impact.

However, the wind on Roi-Namur is expected to be blowing from the east less than 25 percent of the time (U.S. Department of the Air Force, 1995). Also, as mentioned, the THAAD radar would be operating on only eight occasions in connection with USAKA temporary extended test range program activities. Finally, and most importantly, meteorological conditions on Roi-Namur are such that air pollutant emissions from the THAAD radar generators would not be expected to return to ground level before moving offshore (i.e., the air pollutant plume from the generator would not reach landfall) (Ott, 1995b). Therefore, no cumulative impacts to air quality on Roi-Namur would be expected.

Both the level of activity and the number of air pollution sources at Bigen Island are far less than at any of the USAKA islands. Since the USAKA temporary extended test range activity at Bigen Island would consist primarily of only eight missile launches, no cumulative air quality impacts would be expected at this location either.

4.2 AIRSPACE

4.2.1 IMPACTS

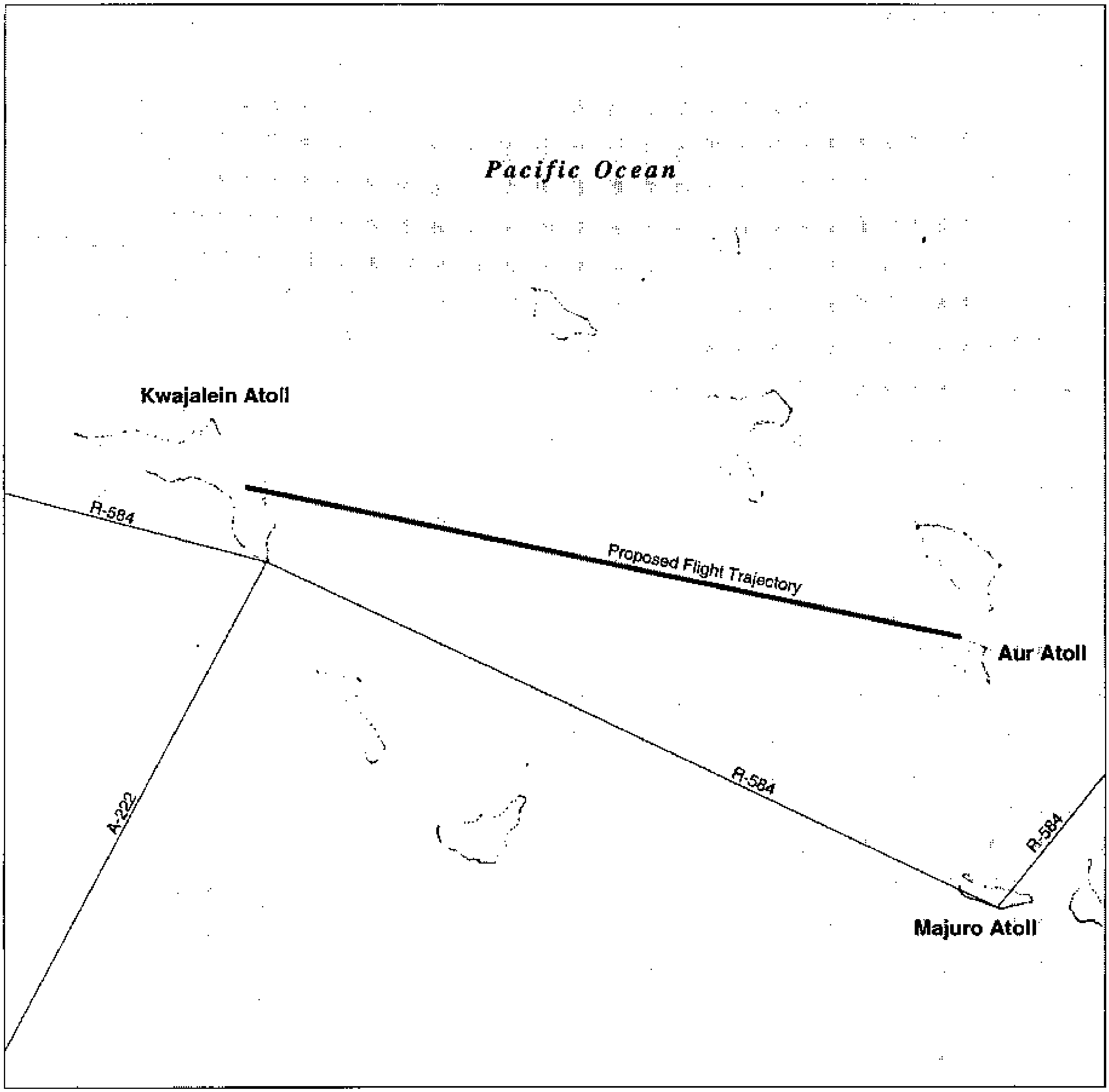
Potential airspace impacts, that is interference with aeronautical operations in the navigable airspace, from implementation of the proposed action arise from two distinct effects: (1) the need to segregate nonparticipating aircraft from the launch hazard area and debris containment corridor in the event of a launch or in-flight mishap; and (2) the need to advise nonparticipating aircraft to avoid the tracking radar areas and the associated electromagnetic radiation emissions.

The proposed flight trajectory from Bigen Island, Aur Atoll, north-northwest to the BOA east of Kwajalein Atoll or inside the Kwajalein Mid-atoll Corridor is north of Pacific oceanic route R584 between Majuro Atoll and Kwajalein Island. It is also well to the northwest of R584 between Majuro and Johnston Atoll and well to the north of R584 between Kwajalein Island and Pohnpei and oceanic route A222 between Kwajalein Island and Kosrae Island (figure 4-2). Therefore, target missiles launched from Bigen Island in a northwest direction for intercepts or water impacts within the BOA or the Mid-atoll Corridor would be in compliance with DOD Directive 4540.1. This directive specifies that missile "firing areas shall be selected so that trajectories are clear of established oceanic air routes or areas of known surface or air activity" (Department of Defense, 1981). No other oceanic air routes or established inter-island air routes are in the vicinity (see figure 4-2).

The USAKA temporary extended test range is located under international airspace and, therefore, has no formal airspace restrictions governing it. Before the launching of the target missile from Bigen Island and the interceptor missiles from either Meck or Illeginni islands, NOTAMs would be sent in accordance with the conditions of the directive specified in AR 95-10, Operations: The U.S. NOTAM System. Sections 3-2n(1)(a) and (b) deal with operations/exercises over the high seas, host nation territory, international airspace, and bare-base locations, and specifies the International NOTAM office coordination requirements and procedures (Army Regulation 95-10, 1990).

To satisfy airspace safety requirements in accordance with AR 385-62 the responsible commander will obtain approval from the Administrator, FAA, through the appropriate Army airspace representative as required by AR 95-50. Provision will be made for surveillance of the affected airspace in accordance with AR 385-62 (1983). In addition, safety regulations dictate that launch operations would be suspended when it is known or suspected that any unauthorized aircraft have entered any part of the surface danger zone until the unauthorized entrant has been removed or a thorough check of the suspected area has been performed (Army Regulation 385-62, 1983).

The need to advise nonparticipating aircraft to avoid the tracking radar areas and the associated electromagnetic radiation emissions is the second potential airspace use impact. Operation of the missile acquisition radars, or sensors, particularly the ground-based sensors on Roi-Namur (THAAD and KREMS radars), has the potential for some interference with airborne weather radar systems and other electrical devices. Since this has implications for aircraft safety, rather than airspace use as such, it is discussed in more detail in the Health and Safety section below. However, airspace use would still be



EXPLANATION

Proposed Flight Trajectory

High Altitude Jet Routes

Proposed Flight Trajectory and High Altitude Jet Routes

Not To Scale

Figure 4-2

affected by issuances of NOTAMs to advise avoidance of the tracking radar areas during activation of the USAKA temporary extended test range.

Air operations into and out of Bucholz AAF on Kwajalein Island, recently averaging approximately 55 per day including military flights to other USASSDC-controlled islands in the Kwajalein Atoll, are not likely to be impacted by the proposed action. Illeginni Island is approximately 50 kilometers (30 miles) north-northwest and Meck Island is approximately 30 kilometers (20 miles) north of Bucholz AAF. Thus both interceptor missile launch sites and their launch hazard areas would be well north of Bucholz AAF and its standard instrument approach and departure procedures (Department of Defense, 1993). The water impact area and the debris containment area for intercepts, both inside the Mid-atoll Corridor and the BOA east of Kwajalein Atoll are well north of Bucholz AAF and its standard instrument approach and departure procedures (Department of Defense, 1993). Military flights to and from Bucholz AAF and the other USASSDC-controlled islands in the Kwajalein Atoll would all be under the control of the Bucholz AAF Control Tower, and regular scheduling and coordination procedures would minimize the potential for airspace use impacts.

4.2.2 CUMULATIVE IMPACTS

All missile launches, missile intercepts, and debris impacts would take place in international airspace. There is no airspace segregation method such as a warning or restricted area to ensure that the area would be cleared of nonparticipating aircraft. However, missile launches are short-term, discrete events. The use of the required scheduling and coordination process for international airspace, and adherence to applicable DOD directives and Army regulations concerning issuance of NOTAMs and selection of missile firing areas and trajectories, obviates the potential for significant incremental, additive, cumulative impacts.

4.3 BIOLOGICAL RESOURCES

The biological resources analytical approach involved evaluating the potential impacts of the proposed action, such as preflight activities and target and PATRIOT interceptor launches, on the vegetation, wildlife, threatened and endangered species, and sensitive habitat within the ROI. Impacts that could result from preflight activities include vegetation disturbance and removal and disturbance to wildlife from the accompanying noise and presence of personnel. Impacts could also result from launch-related activities such as noise, air emissions, debris impacts, and the use of radar equipment.

4.3.1 BIGEN ISLAND

The primary proposed activities that may have a potential effect on the vegetation and wildlife of Bigen Island include preflight activities, vehicle fueling, and launch of the target missile.

During a recent reconnaissance survey of Bigen Island (U.S. Army Space and Strategic Defense Command, 1995a), no species of flora or fauna listed as threatened, endangered, or candidates for such listing were identified. No sensitive habitat was observed, and no protected species are expected to occur within the proposed project area. While a small area of potential sea turtle nesting habitat exists on Bigen Island near the proposed project area, it is unlikely that the habitat is utilized due to the surrounding fringe of shallow reef flat and the rubble-strewn beach. Therefore, no adverse effect to listed species is anticipated.

The LCU transporting personnel and equipment would be required to moor on the lagoon side of the island for loading and unloading. A small berm of coral rubble may need to be piled on the gravel bar extending from the lagoon-side beach in order to support the LCU ramp. The reef flat surrounding Bigen Island is an active ecosystem, but very little recent coral growth or marine life was observed during the recent reconnaissance survey (U.S. Army Space and Strategic Defense Command, 1995a). This lack of growth may be due to a build-up of natural siltation. Any additional siltation from project activities would be minimal.

Should excessive siltation result from project activities, those activities would be halted while appropriate silt screens were installed. SOPs at the USAKA call for the use of one or two silt curtains or scheduling of the activities during conditions when the silt curtain would be most effective (U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a).

Preflight activities would include preparation of one of the three alternative project sites as a temporary launch site. Equipment and materials would be transported to the site using either an existing path through the interior of the island or the beach area. Use of the interior island path may require the removal of a small number of trees and/or the transplantation of coconut palm seedlings. The existing pathway extends through a planted and maintained coconut palm plantation.

Some vegetation within the launch hazard area may need to be cleared for safety and to establish line-of-sight communication with the LCU. This clearing would be conducted in previously disturbed areas maintained by the Marshallese as a copra plantation through the use of regular controlled burns. The clearing operations would be no different from the maintenance activities normally performed at the site by the Marshallese. Concrete Defense Mapping Agency survey markers would also be required.

Utility lines between the support site and the temporary launch site would be placed on the ground or hung from trees in a non-intrusive manner along the established pathway and completely removed at the conclusion of the project. No vegetation or habitat would be damaged.

All vehicle fueling operations and minor mechanical repairs would be performed on impermeable barriers using containment measures routinely utilized by the USAKA. Spill control kits would be available on Bigen Island. Bulk fuel would be stored aboard the LCU. However, empty bulk liquid storage containers would be placed on the island for use in the event that de-fueling of the liquid propellant target vehicle became necessary. Defueling would use a closed-loop system and would occur on an impermeable surface. In the event of a leak or spill, as described in section 4.7.1, the material would be collected, containerized, and transported to Kwajalein Island for disposal in accordance with USAKA hazardous waste management policy.

Wildlife is known to exhibit a startle effect when exposed to short-term noise impacts, such as the launch of an interceptor missile or target missile. Recent studies (Manci et al., 1988) indicate that birds usually show signs of disturbance, such as the fluttering of wings, when the noise occurs, but quickly return to normal behavior after the event.

HCl is emitted during solid fuel missile launches and is known to cause leaf injury to plants and affect wildlife as a result of launching very large flight vehicles such as the space shuttle. However, results of a monitoring program conducted following a Strategic Target System launch indicated that no significant impact on vegetation due to HCl emissions is likely to occur. Studies on representative birds and mammals reviewed in the Final EIS for the Strategic Target System (U.S. Army Strategic Defense Command, 1992) indicate that low-level, short-term exposure to HCl would not adversely affect threatened or endangered species or other wildlife. The amount of HCl produced by the Strategic Target System booster is much greater than that of the largest proposed TMD booster.

Fire from a launch mishap or early flight termination could impact vegetation and wildlife near the launch site. However, there is very little ground cover near the proposed launch sites, and the Marshallese maintain the area with frequent controlled burns.

A launch mishap or early flight termination could result in the release of nitric acid from the target vehicle. The reaction of nitric acid and sea water would initially cause spattering, an increase in water temperature, and substantial lowering of the pH value in the local area, as described in section 4.12.3. However, the natural buffering capacity of sea water and the strong ocean current would neutralize the reaction in a relatively short period of time. There is potential for the reef flat adjacent to the candidate launch sites to be affected in the event of a mishap; however, the reef system is not extensive, and there is very little evidence of coral growth or marine activity.

4.3.2 USAKA ISLANDS

The following proposed activities may have a potential effect on the vegetation and wildlife of the islands of Kwajalein Atoll:

- Gellinam – siting and operation of the PATRIOT missile radar and the associated presence of personnel
- Illeginni – preflight activities, the launch of a PATRIOT missile, and the siting and operation of a PATRIOT radar
- Kwajalein – preflight activities such as storage and transportation
- Legan – siting and operation of the PATRIOT missile radar and the associated presence of personnel
- Meck – preflight activities for both target missiles and PATRIOT systems, fueling , and launch of a PATRIOT missile
- Omelek – siting and operation of the PATRIOT missile radar and the associated presence of personnel
- Roi-Namur – siting and operation of the THAAD radar

No additional vegetation would be cleared, and equipment for both the launch and radar operation would be placed in previously cleared or paved areas. No forested areas or the salt pond habitat on Legan Island would be affected. No sensitive habitat or protected species would be adversely affected.

No species of flora or fauna listed as threatened, endangered, or candidate for such listing have been identified in the project areas (Herbst, 1988; Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a). No sensitive habitat occurs in the area of the existing liquid propellant storage buildings. No adverse effect to protected species is anticipated.

Although potential sea turtle nesting habitat has been identified along the beach near the AOS site on Roi-Namur Island, there is no indication that the habitat has been utilized for nesting in the past several years. No sensitive habitat or protected species would be adversely affected by the placement of the radar equipment.

Personnel would be instructed to avoid areas designated as avian nesting or roosting habitat and to avoid all contact with any nest that may be encountered. Sea turtles or turtle nests would be avoided. The USAKA Environmental Office would be notified if any sea turtles are harmed, and a representative of this office would in turn notify applicable agencies.

Wildlife is known to exhibit a startle effect when exposed to short-term noise impacts such as the launch of an interceptor missile or target vehicle. Recent studies (Manci et al., 1988) indicate that birds usually show signs of disturbance, such as the fluttering of wings, when the noise occurs but quickly return to normal behavior after the event.

One of the potential launch sites on Meck Island is located near an area of seabird nesting habitat along the eastern perimeter of the old runway. The habitat is located among the coastal riprap below the level of the pavement. The current level of activity at Meck Island would be similar to that of proposed preflight activity, and a startle effect would be expected if launches take place from this particular proposed site. No adverse effect to sensitive habitat or protected species would be anticipated.

During a recent reconnaissance survey of Kwajalein Atoll (Herbst, 1988; Clapp, 1988; U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a), no species of flora listed as threatened, endangered, or candidates for such listing were identified. No sensitive habitat was observed, and no protected species are expected to occur within the proposed project area. Therefore, no adverse effect to listed species is anticipated.

All transportation of equipment and materials such as fuels would be conducted in accordance with U.S. DOT regulations as described in Bureau of Explosives Tariff No. BOE 6000-L (Association of American Railroads, 1992). SOPs for spill prevention, containment, and control measures while transporting equipment and materials would preclude impacts to biological resources.

Operation of the PATRIOT missile radar and THAAD radar would be conducted in accordance with USAKA regulations. Several factors significantly reduce the potential

EMR exposure for birds and other wildlife. The main radar beam would normally be located several degrees above horizontal, which limits the probability of energy absorption by wildlife on the ground. The radar beam is relatively small and would normally be in motion, making it extremely unlikely that a bird would remain within the most intense area of the beam for any meaningful length of time. The radiation hazard area (figure 2-10) would be visually surveyed for birds and other wildlife prior to the activation of the THAAD radar antenna unit.

HCl, which is emitted during missile launches, is known to cause leaf injury to plants and affect wildlife as a result of launching very large flight vehicles such as the space shuttle. However, results of a monitoring program conducted following a Strategic Target System launch indicated that no significant impact on vegetation due to HCl emissions is likely to occur. Studies on representative birds and mammals reviewed in the Final EIS for the Strategic Target System (U.S. Army Strategic Defense Command, 1992) indicate that low-level, short-term exposure to HCl would not adversely affect threatened or endangered species or other wildlife. The amount of HCl produced by the Strategic Target System booster is much greater than that of the PATRIOT missile.

Fire from a launch mishap or early flight termination could impact vegetation and wildlife near the launch site. However, the proposed launch sites are located in cleared, disturbed areas with very little ground cover.

4.3.3 FLIGHT TEST CORRIDOR

The primary proposed activity that may have a potential effect on the vegetation and wildlife within the flight test corridor is the intercept of the target missile.

Debris impact areas for both the target and interceptor vehicles would be located over the Mid-atoll Corridor of the Kwajalein Lagoon or the BOA (figures 2-11 and 2-12). Boosters from the target missile would drop in the open ocean area west of Bigen Island.

Debris impact and booster drops in the BOA are not expected to adversely affect marine mammal species protected by the Marine Mammal Protection Act of 1972. The probability is rather low that migratory whales and other marine species such as the green sea turtle and hawksbill turtle would be within the area to be impacted by falling debris and boosters. Should marine mammals or sea turtles be observed during prelaunch survey flights of the hazard areas, flight tests would be delayed until these species vacate the area.

Intercept debris from intercepts within the Kwajalein Mid-atoll Corridor is expected to land in the Kwajalein Lagoon in approximately 50 meters (164 feet) of water and would be recovered. The debris is not expected to contain hazardous materials. Were hazardous materials to leach out of the intercept debris, the great volume of water in the Kwajalein Lagoon would dilute the contaminant to acceptable levels.

An early flight termination or mishap could result in debris impact along the flight corridor. Sensitive marine species are widely scattered, and the probability of debris striking a threatened or endangered species is considered remote.

4.3.4 CUMULATIVE IMPACTS

The Final Supplemental EIS for Proposed Actions at USAKA (U.S. Army Space and Strategic Defense Command, 1993a) has addressed the environmental impacts of ongoing and future programs at the USAKA and concluded that impacts to biological resources would be not significant under the intermediate level of activity alternative, which meets or exceeds the increase represented by the proposed action, for activities included in this project.

4.4 CULTURAL RESOURCES

Typical project activities that could result in adverse effects on historic properties include ground disturbance of prehistoric, historic, or traditional sites; alterations or visual changes to historic vistas, landscapes, or terrains; modification of historically significant buildings or structures; and unauthorized artifact collection or vandalism. The majority of activities associated with establishment of the proposed USAKA temporary extended test range are expected to be non-invasive and temporary in nature.

Because of the remote possibility that subsurface cultural materials may exist at any location within the RMI, all project sites where ground disturbing activities are expected to occur would require monitoring by a qualified, professional archaeologist. In addition, to ensure the protection of any prehistoric, historic, or traditional resources already identified within the project area from unauthorized artifact collection or vandalism, personnel will be briefed before project activities commence on the significance of these types of resources and the penalties associated with their disturbance or collection. In accordance with the RMI Historic Preservation Act and all regulations implementing that act (specifically, Regulations Governing Land Modification Activities, Part IV, Section 9, Stipulation 14), as well as the National Historic Preservation Act (implemented by 36 CFR Part 800.11), if, during the course of program activities cultural and/or historic materials (particularly human remains) are unexpectedly discovered, work in the immediate vicinity of the cultural materials shall be halted and the RMI HPO consulted through the USAKA Environmental Office.

The potential for direct or indirect impacts to cultural resources is described below by location. Consultation with the RMI HPO regarding program activities is in progress. Consultation with the Advisory Council on Historic Preservation will be initiated.

4.4.1 BIGEN ISLAND

A survey of Bigen Island conducted in December 1994 identified no historic properties. Although there is a remote possibility that subsurface materials are present, proposed project activities require only minimal ground disturbance, primarily associated with leveling the launch pad area and the installation of the five permanent survey markers described in section 2.5.1. In addition, there are no existing significant buildings or structures on the island that would require modification. Because of the lack of identified cultural remains, the minor nature of project-related ground disturbance, and the temporary nature of program activities on Bigen Island, no adverse effects on cultural resources are expected.

4.4.2 GELLINAM ISLAND

Surveys of Gellinam Island have not identified historic properties. Although there is a remote possibility that subsurface materials are present, proposed project activities on Gellinam require no ground disturbance.

Although there are existing facilities on Gellinam that may ultimately be determined to possess significance under the Cold War historic context, no buildings or structures on this island are currently proposed for use and/or modification; therefore, no adverse effects on cultural resources on Gellinam Island are expected.

4.4.3 ILLEGINNI ISLAND

Surveys of Illeginni Island have identified one potential prehistoric archaeological site that is located some distance from where project activities are expected to take place. In addition, proposed project activities on Illeginni Island require no ground disturbance.

Although there are existing facilities on Illeginni Island that may ultimately be determined to possess significance under the Cold War historic context, no buildings or structures on this island are currently proposed for modification; therefore, no adverse effects on cultural resources on Illeginni Island are expected.

4.4.4 KWAJALEIN ISLAND

Surveys of Kwajalein Island have identified prehistoric and historic archaeological remains in several locations throughout the original island boundary. Most of the island is designated as the Kwajalein Island Battlefield, a National Historic Landmark significant under the World War II historic context. However, proposed project activities on Kwajalein Island require no ground disturbance; therefore, no adverse effects on archaeological resources are expected.

Many of the existing facilities on Kwajalein Island are associated with the National Historic Landmark. In addition, there are many other facilities that may ultimately be determined to possess significance under the Cold War historic context. However, no buildings or structures on this island are currently proposed for modification; therefore, no adverse effects on historic resources are expected.

4.4.5 LEGAN ISLAND

Surveys of Legan Island have identified one discontiguous prehistoric archaeological site that is located within the forested area of the island. As activities are currently proposed, this site is removed from where project activities are expected to take place. In addition, proposed project activities on Legan Island require no ground disturbance.

Although there are existing facilities on Legan Island that may ultimately be determined to possess significance under the Cold War historic context, no buildings or structures on this island are currently proposed for use or modification; therefore, no adverse effects on cultural resources on Legan Island are expected.

4.4.6 MECK ISLAND

Surveys of Meck Island have not identified significant prehistoric, historic, or traditional resources, and project activities on Meck require no ground disturbance.

There are existing facilities on Meck Island that may ultimately be determined to possess significance under the Cold War historic context; however, no buildings or structures on this island are currently proposed for modification. Therefore, no adverse effects on cultural resources on Meck Island are expected.

4.4.7 OMELEK ISLAND

Surveys of Omelek Island have identified one potential archaeological/traditional resources site that is located within one of the forested areas of the island. As activities are currently proposed, this site is removed from where project activities are expected to take place. In addition, proposed project activities on Omelek Island require no ground disturbance.

Although there are existing facilities on Omelek Island that may ultimately be determined to possess significance under the Cold War historic context, no buildings or structures on this island are currently proposed for use or modification; therefore, no adverse effects on cultural resources on Omelek Island are expected.

4.4.8 ROI-NAMUR ISLAND

For the reasons described in section 3.4.8, systematic prehistoric, historic, and traditional resources surveys of Roi-Namur Island have not been conducted, and the presence of sites in original island areas cannot be ruled out. Ground disturbance on Roi-Namur is expected to be minimal; however, proposed program activities do include possible trenching or clearing of sites to support the THAAD radar near sites where Medals of Honor were earned.

Many of the existing facilities on Roi-Namur Island are associated with the National Historic Landmark. In addition, there are other facilities that may ultimately be determined to possess significance under the Cold War historic context. However, no buildings or structures on this island are currently proposed for modification.

Adverse effects on cultural resources on Roi-Namur Island are not expected. Ground-disturbing activities below 1 meter (3 feet) associated with possible trenching or clearing for the THAAD radar would be monitored by a qualified archaeologist (U.S. Army Space and Strategic Defense Command, 1994f), and pre-trenching/clearing photographs will be taken. Trench and pad placement will be coordinated with a qualified archaeologist and/or historian to avoid affecting any subsurface features.

4.4.9 FLIGHT TEST CORRIDOR

No significant cultural resources are known to exist within the flight test corridor, which extends entirely over the Pacific Ocean. Therefore, no adverse effects on cultural resources are expected.

4.4.10 CUMULATIVE IMPACTS

Due to the non-invasive, temporary nature of program activities, cumulative effects on cultural resources when reviewed against past, present, and future actions are not expected.

4.5 GEOLOGY AND SOILS

The proposed program activities have the potential to increase soil erosion during construction and vehicle traffic on unpaved surfaces and to affect the chemical composition of soils as a result of target and defensive missile launches.

4.5.1 GEOLOGY

There are no known geologic resources at any of the proposed program locations, and no effects are anticipated.

4.5.2 SOILS

Bigen Island – The movement of mobile equipment onto and around Bigen Island would be expected to result in little or no increase in erosion. The island's soils consist primarily of gravel, cobbles, and very coarse-grained sand-sized particles which are not prone to wind erosion, and there is little topographic relief to provide energy for water erosion.

The potential for soil contamination would depend largely on the fuel type of the target missile launched. During nominal launches of a solid propellant missile such as the Hera system, the primary emission products would include HCl, carbon dioxide, carbon monoxide, nitrogen, and water. Of these, HCl is the only emission product that is expected to react strongly with the predominately calcium carbonate island soils. This reaction would produce calcium chloride, carbon dioxide gas, and water. Nominal launches of the liquid-fueled notional ERL missile would primarily produce nitrogen, carbon monoxide, carbon dioxide, and water. These gasses and water vapor are not expected to adversely alter soil chemistry. Additionally, because of the launch location on the western side of the island, the launch trajectory away from the island, and the strong persistent wind conditions, it is expected that very little of these emissions will be deposited on Bigen Island.

In the unlikely event of an on-pad fire or early flight failure over land of a solid propellant missile, most or all of the fuel would likely burn up before being extinguished. Any remaining fuel would be collected and disposed of as hazardous waste as described in Section 4.7, Hazardous Materials and Hazardous Waste. Soil contamination which could result from such an incident is expected to be very localized at the point of the fire.

An on-pad spill or catastrophic missile failure of the notional ERL missile over land would result in the release of UDMH fuel and IRFNA oxidizer. UDMH is heavier than air, and if not oxidized when airborne will react and/or possibly ignite with the porous earth or will form dimethylamine and oxides of nitrogen. All of these substances are soluble in water. On further oxidation of the dimethylamine the amino substances serve as nutrients to plant life. Airborne nitrogen dioxide would return to earth as nitric acid rains in precipitation events and would react with the calcium carbonate soil to form the nitrates which are used in fertilizer for plant life (Chemical Propulsion Information Agency, 1984).

Likewise, IRFNA that reached the ground would react with the calcium carbonate soils to form calcium nitrates (Chemical Propulsion Information Agency, 1984). Calcium nitrate, a strong oxidizer, is a dangerous fire risk in contact with organic materials, and may explode if shocked or heated (Lewis, 1993). Therefore, depending on the amount of the propellant and/or oxidizer released, soils contaminated with these liquid propellants may require removal to prevent subsequent fires or explosions. Calcium nitrate is also water soluble, so it is anticipated that any residual material or unreacted fuel would be washed into the groundwater or directly out to sea. Spill containment kits suitable for the liquid fuel and oxidizer being used and a qualified accident response team will be required on Bigen Island to negate or minimize any adverse effects to soil in the unlikely event of a spill.

USAKA Islands – The movement of the PATRIOT Fire Unit and the placement of portable sensors on the proposed USAKA islands are not expected to result in any increase in soil erosion for the same reasons as described for Bigen Island.

Liquid fuel spills could occur on Meck Island during the fueling process for the notional ERL missile. The effects to soils, if they are contacted by the liquids, would be the same as described above for Bigen Island. Spill containment kits and a qualified accident response team would also be available on Meck Island to negate or minimize any adverse effects in the event of a liquid-propellant spill.

No adverse changes to soil chemistry are predicted to occur as a result of HCl, or Al_2O_3, or other rocket motor emission products deposited on soil from PATRIOT missile launches. As described in Section 4.1, Air Quality, deposition of HCl and Al_2O_3 are expected to be very minimal during nominal launches because they disperse rapidly in the air. Any HCl falling on land would be buffered by contact with the calcium carbonate reef material. The minimal amount of Al_2O_3 that could reach land would be in the form of dust that would not adversely affect the soil, which contains much less aluminum than non-coralline soils.

In the event of an early flight termination, burning fuel may reach the ground. If the solid fuel continues to burn it may start fires. Controlling fires may require ground-disturbing activities in the launch hazard area. Identifiable unburned fuel or residual burned fuel will be recovered during the debris recovery process. The impact of this activity is expected to be short-term. The recovered fuel and residue will be disposed of following standard USAKA hazardous waste management procedures.

4.5.3 CUMULATIVE IMPACTS

No cumulative adverse effects to soils are anticipated from program activities. Emission products from nominal launches would be rapidly buffered by the soil. Hazardous byproducts from any spill would be removed and any residual accumulation of nitrogen compounds would be ultimately washed out to sea or taken up by plants.

4.6 HEALTH AND SAFETY

Bigen, Meck, and potentially Illeginni islands would be used for the prelaunch set-up and launching of target and interceptor missiles. These operations would involve hazards in three broad categories of safety concern:

- Explosive safety
- Liquid fuel handling safety
- Launch safety

Explosive Safety – All proposed target missiles will be equipped with various explosive actuation devices, as well as a FTS. Explosives associated with these systems are considered Class 1.1 explosive, and are vulnerable to detonation in the event of shock, static electrical discharge, or extreme heat (fire). In addition solid fuels are considered Class 1.3 explosive, which although much less sensitive than Class 1.1, can still ignite or detonate due to static electrical discharge or fire.

All handling and use of explosive materials at the USAKA, or under its jurisdiction (such as operations at Bigen Island), must be conducted in accordance with the requirements of KMR Regulation 385-75, *Explosive Safety* (U.S. Army Kwajalein Atoll, 1993). This regulation specifies that all operations involving explosives (including packaging and handling for movement) would require implementation of a written procedure which has been approved by the USAKA Safety Office. These procedures must specify adequate means for preventing static electrical build-up/discharge, fire safety, and handling techniques to prevent accidental detonation/ignition of the explosives.

In accordance with 385-75, all operations involving the handling of explosives must be conducted under the supervision of an approved ordnance officer, and all personnel involved must be explosive-certified. All storage and handling of explosives is required to take place in facilities or locations designed to handle explosives and which have been sited in accordance with the requirements of 385-75. The regulation specifies the required explosive safety quantity-distances (ESQDs) for each facility to ensure safety in the event of explosion, based upon the maximum quantity of explosive material permitted for the facility. This will serve to prevent propagation of explosions to nearby facilities where explosives are also stored.

The handling of explosives similar to those proposed for use in this program is accomplished routinely at USAKA locations. In the event of an accident, hazards would be limited to personnel directly involved in handling of the explosives. Localized fires could be ignited in the event of an accidental detonation; however, these fires would have no significant potential to spread since operations would occur in areas where little vegetation exists.

Liquid Fuels Handling – All liquid-fueled target missile fueling operations would be completed at Meck prior to transport to Bigen Island for launch.

Fueled target missiles would be handled in accordance with approved SOPs. Such handling is routinely accomplished and would not be expected to present a significant potential for fuel release. Certain prelaunch emergency conditions could require the defueling of a target missile at the launch site. The transfer of propellants in such cases would be accomplished in accordance with standardized transfer procedures. These procedures would address the methods to be employed for propellant transfer, specify the container requirements for propellants downloaded from the target missile, and establish the size of the safety hazard zone necessary to protect personnel against exposure to propellant splash and inhalation hazards. Personnel within the hazard zone, engaged in transfer operations, would be required to utilize approved skin and respiratory protection to provide acceptable protection against propellant hazards. At the conclusion of each transfer operation personnel and equipment would be thoroughly decontaminated to remove all traces of any released propellants.

Launch Safety – During launch there is the potential for missile malfunction, resulting in explosion, fire, and debris impact in the vicinity of the launch site. To provide protection for mission-essential personnel involved in launch operations, all launch activities occurring at Bigen Island would require the establishment of LHAs for each test flight mission. The LHA is an area around a launch point within which it is determined that all debris will fall in the event of an unplanned flight termination during launch. The requirements for establishing the boundaries of a LHA are dependent both upon the characteristics of the missile system, the flight trajectory, and the capabilities of the launching range.

At launch the missile proceeds in the direction it is initially pointed but can then change direction within the limits of its ability to turn without tumbling. In order to prevent a missile from proceeding out of control, each range specifies minimum tracking and response capabilities, which determine the maximum amount of time required for a flight safety officer to recognize a flight anomaly and respond by actuating the FTS. The response time can be decreased dependent upon mission characteristics and missile performance parameters; however, range safety requirements specify the maximum acceptable time. By knowing the maximum response time and the maximum travel distance of the missile from launch attitude in all directions (360°) within that time, the LHA is then determined by projecting the debris pattern from all locations and determining the outer limits. Due to launch attitudes and missile performance characteristics, LHAs are rarely perfect circles but are generally skewed in the direction of the launch azimuth.

For all USAKA and USAKA-controlled activities, the size of the LHA is approved by the Safety Office based upon specific mission parameters, the capabilities of the USAKA and Test Range instrumentation, and the requirements found in the KMR *Range Safety Manual* (Kwajalein Missile Range, 1991) and KMR 385-4, *Protection of Personnel During Missile Operations*. The LHA represents the area which bounds all potential debris impact points in the event of a launch pad or near-launch anomaly or termination. Implementation of LHA procedures allows management of the population which can be affected by a launch, thereby reducing any hazards associated with unplanned flight termination.

During launch activities, only mission-essential personnel are allowed within LHAs. Nonessential personnel are evacuated prior to launch, and access is controlled to ensure that only authorized personnel remain. At launch time, personnel within LHAs would be located in an area pre-approved by the USAKA Safety Office, and all occupied areas maintain the capability to directly contact emergency response personnel in the event of an anomalous launch. It has been determined that safety requirements during launch activities at Bigen Island would require that no Marshallese citizens or unprotected U.S. personnel be on the island during launch activities (Shady, 1995).

In contrast to launch anomalies, successful launch activities involve only small potential hazards, mainly for personnel in the immediate area of the launch site due to potential inhalation of missile exhaust gasses. Since personnel are protected or evacuated from within the LHA (see above), this potential hazard is controlled.

Since no Marshallese or other non-U.S. personnel would be present at Bigen Island during launch activities, there is no hazard to the public associated with launch activities.

4.6.1 BIGEN ISLAND

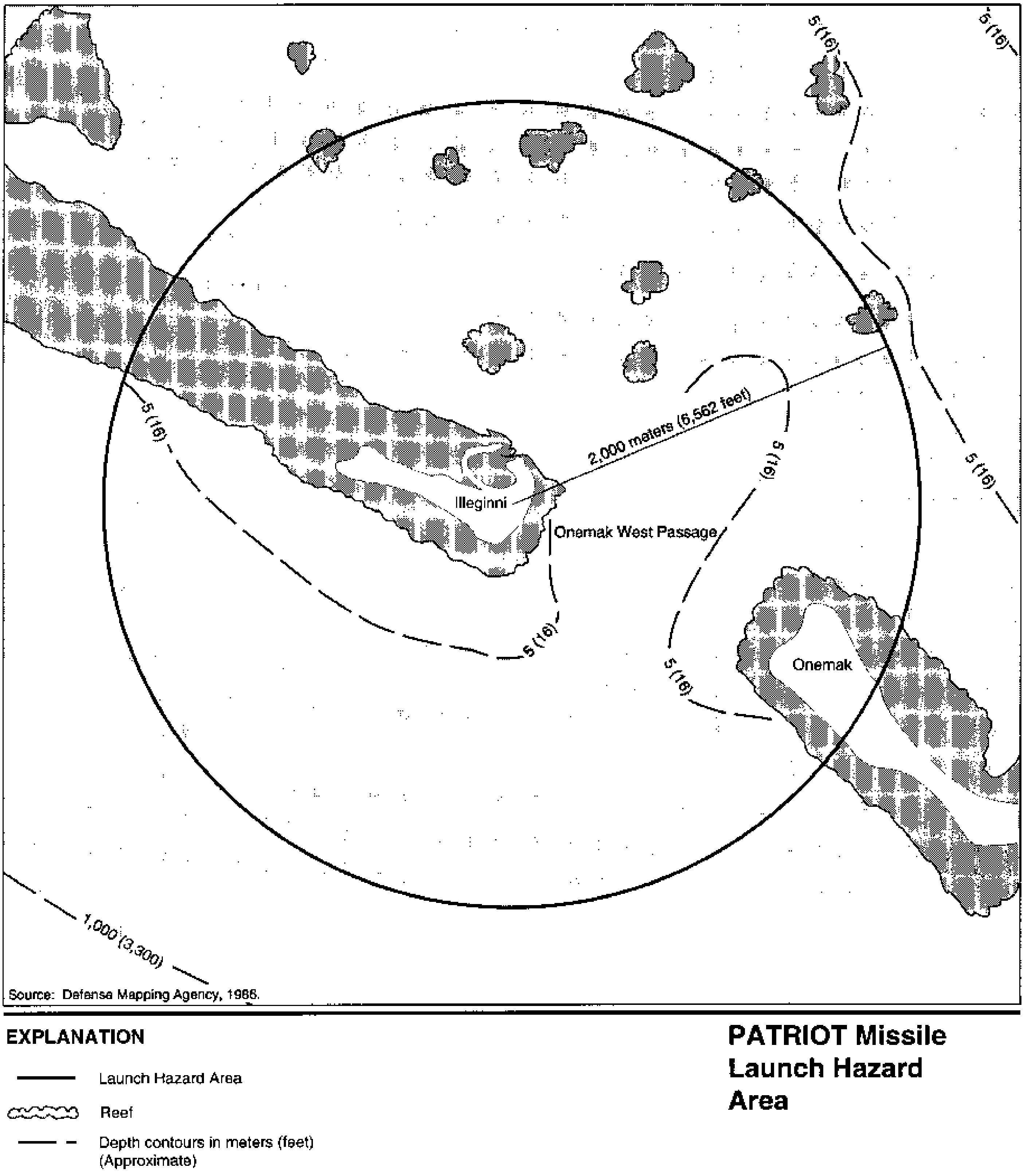
Fuel handling at Bigen would be accomplished only in rare, emergency situations. All handling would be accomplished in accordance with SOPs intended to ensure the safety of all personnel at the fuel transfer location. For purposes of planning for target missile launch activities, a preliminary LHA radius of 1,500 meters (5,000 feet) for liquid-fuel targets, and 5,000 meters (17,000 feet) for solid-fuel targets has been assumed, which provides a sufficient area to encompass any mission-specific LHAs (figure 4-1). Launch safety operations on Bigen Island would follow the general requirements and procedures described above.

4.6.2 USAKA ISLANDS

The proposed action includes the launch of PATRIOT missiles from Illeginni Island for over-lagoon intercepts or from Meck Island for BOA intercepts of the target missile. Hazards associated with launch operations would be limited to launch hazards on these islands and the nearby waters. A LHA would be established for each launch to ensure that unauthorized personnel are outside the area which might be impacted by missile debris. Implementation of LHAs will ensure the safety of members of the public. LHAs for Illeginni and Meck islands used for analysis purposes are shown in figures 4-3 and 4-4, respectively.

The PATRIOT missile has been extensively tested and operated at many locations throughout the world. Launch activities are considered routine, and would be conducted in accordance with long-established operational procedures, thus ensuring the safety of launch site personnel (workers).

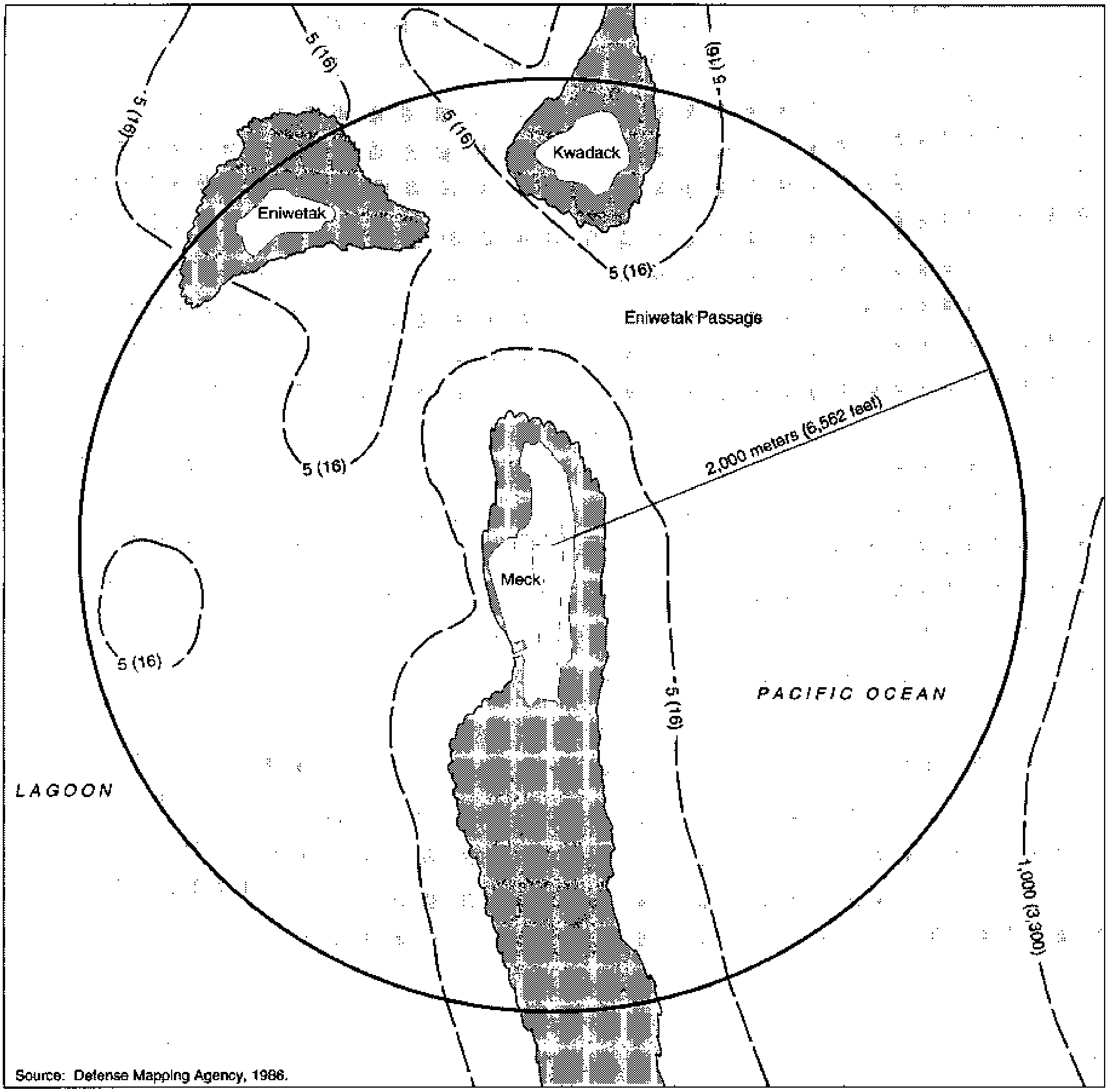
The health and safety hazards associated with temporary set-up and operation of the PATRIOT missile radar would involve the potential for exposure to radiofrequency (RF) radiation. This activity could occur at Gellinam, Meck, Illeginni, Legan, or Omelek islands. RF radiation is a form of non-ionizing radiation whose primary effect is to cause heating as it interacts with various materials. This action is similar to the action produced through operation of a microwave oven, though the intensity of the heating effect is considerably reduced when associated with typical radar units. The primary health effect observed in exposed personnel is body overheating, possibly leading to heat stress-related effect (e.g., headache, nausea, profuse sweating) in extreme cases. This is due to the increased heat load produced by the RF exposure, for which the body is unable to quickly compensate. The U.S. OSHA and the U.S. Army have each promulgated standards for exposure to RF



PATRIOT Missile Launch Hazard Area

Illeginni Island,
Kwajalein Atoll

Figure 4-3



EXPLANATION

Launch Hazard Area

Reef

Depth contours in meters (feet) (Approximate)

0 305 610 Meters
0 1,000 2,000 Feet

PATRIOT Missile Launch Hazard Area

Meck Island, Kwajalein Atoll

Figure 4-4

radiation in order to prevent excess heat loading. Areas where RF intensity levels might exceed these standards are limited to areas directly within the radar "beam" in the vicinity of the emitter, and areas immediately surrounding the transmitter site. Exposure control can be achieved through limitation of ground areas "illuminated" by the beam, and restrictions on occupancy of those areas during radar operation.

All of the potential PATRIOT radar sites are located within the Mid-atoll Corridor. These islands are not occupied by Marshallese citizens or other non-U.S. personnel; therefore, only worker exposure needs to be considered. Sensor systems could include both PATRIOT radar and communication link equipment. Operation of the radar would be in accordance with designated Army safety procedures, which have been developed to prevent inadvertent exposure to emitted RF radiation. Under these procedures, electromagnetic radiation hazard zones are established within the beam's tracking space and near emitter equipment (figure 2-10). Prior to activating the THAAD Radar, visual survey of the area will be conducted to verify that all personnel are outside the hazard zone. Personnel may not enter these hazard zones while the radar unit is in operation. The radar is prevented from illuminating in a designated cutoff zone, in which operators and all other system elements would be located. For communication link equipment, associated RF emissions are considered to be of sufficiently low power so that there is no exposure hazard. All sensor systems would be sited prior to operation to ensure that no occupied structures or accessible travel areas are within any hazard area necessitated by RF emissions. Through the use of these procedures, it has been previously determined that proper exposure control would be achieved, and that operation of these systems would not present a significant health and safety hazard (U.S. Army Space and Strategic Defense Command, 1993b).

Kwajalein Island – Under the proposed action Kwajalein Island would be used for temporary storage of target and interceptor missile components upon initial arrival at USAKA. Kwajalein Island would also be used as the storage location for all consumable materials (e.g., solvents/cleaners, small parts, tools) that would be used during test flight prelaunch and launch operations. The primary hazard related to these storage operations would be the potential for explosion/fire of solid fuel motors and/or small explosive actuation devices (used in missile control and FTS systems). At Kwajalein Island, as at all other USAKA locations, all operations involving explosives (including packaging and handling for movement) would require implementation of a written procedure which has been approved by the USAKA Safety Office. These operations must be conducted under the supervision of an approved ordnance officer using explosive-certified personnel. All storage and handling of explosives is required to take place in facilities designed to handle explosives and which have been sited in accordance with the requirements of KMR Regulation 385-75, *Explosive Safety* (U.S. Army Kwajalein Atoll, 1993). The regulation specifies the required ESQDs for each facility to ensure safety in the event of explosion, based upon the maximum quantity of explosive material permitted for the facility. This will serve to prevent propagation of explosions to nearby facilities where explosives are also stored.

The explosive devices and materials proposed for use with proposed operations are very similar to those currently stored and in use at the USAKA. Storage operations would not entail any specialized procedures beyond those already in use. Storage facilities (magazines) are available at Kwajalein Island for proper storage of all explosive materials.

Meck Island – All propellant storage and loading operations for liquid-fueled target missiles would be performed at Meck Island prior to transport to Bigen Island for launch. Propellants would arrive at USAKA packaged in approved storage/transportation containers and be immediately transported to Meck for storage. Oxidizer (IRFNA) would be stored in the existing fueling area building and fuel (UDMH) in the Liquid Fuel Storage Building. Each of these facilities has been designed for the bulk handling of liquid propellants. Under the proposed action the volumes of liquid propellants required for the flight test program are 9,500 kilograms (21,000 pounds)of oxidizer and 3,000 kilograms (7,000 pounds) of fuel. These facilities would be able to safely handle all required liquid propellant quantities.

All fueling operations would be conducted in accordance with standardized procedures which have been approved by USAKA Safety. Each target missile would require 1,100 kilograms (2,400 pounds) of oxidizer and 360 kilograms (800 pounds) of fuel. Personnel engaged in fueling operations would utilize supplied air respirators and a fully-enclosed protective ensemble to prevent inhalation or skin exposure to the fuels. All personnel would be decontaminated using water rinse at the completion of fueling operations and prior to removal of the protective equipment. This procedure would be conducted in an area or equipment designed to contain the rinse water which would be collected and treated as a hazardous waste unless determined otherwise by analysis. These measures would provide adequate safety for fueling personnel to prevent significant exposure to UDMH or IRFNA.

Fueling operations would require the establishment of a safety hazard area in the vicinity of the propellant transfer point(s). The dimensions of all hazard areas would conform with the guidance found in *Chemical Rocket Propellant Hazards* (Chemical Propulsion Information Agency, 1973), based upon the transfer methods to be used. Personnel inside these hazard areas would be required to utilize the protective clothing discussed above as protection against inhalation and splash hazard during a spill.

Roi-Namur Island – Operations at Roi-Namur Island would be limited to set-up and operation of the THAAD radar system during flight test operations. The health and safety hazards for this radar unit are similar to those already discussed for the PATRIOT radar.

Hazards associated with operation of the THAAD radar were analyzed in both the *Ground Based Radar Family of Radars Environmental Assessment* (U.S. Army Space and Strategic Defense Command, 1993b) and the *Environmental Assessment for Theater Missile Defense Ground Based Radar Testing Program at Fort Devens, Massachusetts* (U.S. Army Space and Strategic Defense Command, 1994e). In both assessments it was concluded that due to the implementation of controlled areas (figure 2-10), and limitations in the areas subject to illumination by the THAAD radar units, no safety hazard would be produced to either the public or the workforce. Operation of the radar would be in accordance with designated Army safety procedures, which have been developed to prevent inadvertent exposure to emitted RF radiation. Under these procedures, electromagnetic radiation hazard zones are established within the beam's tracking space and near emitter equipment (figure 2-10). Prior to activating the THAAD radar, visual survey of the area will be conducted to verify that all personnel are outside the hazard zone. Personnel may not enter these hazard zones while the radar unit is in operation. The radar is prevented from illuminating in a designated cutoff zone, in which operators and all other system elements would be located. Potential safety consequences associated with THAAD radar interference with other electronic and emitter units (flight navigation systems, tracking radars, etc.) were also examined and found to produce no safety hazard to either the public or the workforce.

The specific hazards associated with use of the THAAD radar at the USAKA were considered in the *U.S. Army Kwajalein Atoll Final Supplemental Environmental Impact Statement* (U.S. Army Space and Strategic Defense Command, 1993a). The analysis considered both program operational requirements and restrictions and USAKA-required safety procedures (see section 4.6). It was concluded that the required implementation of all operational safety procedures would preclude any potential for adverse worker exposure to RF radiation.

At Roi-Namur, as at other radar unit operational locations at the USAKA, hazards associated with the proposed action would be limited to worker exposure to RF radiation, but also, the potential exists for disturbance of unexploded ordnance, if trenching is necessary. USAKA has SOPs for explosive safety in place and has explosive ordnance disposal personnel onsite (see the hazard discussion in section 4.6). The RF radiation hazard would be controlled through the implementation of programmatic and USAKA-required safety procedures, which would limit areas which might be illuminated by the radar, the periods during which the radar could be operated, and which would require that appropriate hazard zones (figure 2-10) be established and kept clear of personnel during radar operation. Based on the conclusions in previous assessments, and use of safety procedures to limit exposure hazards, the use of the THAAD radar at Roi-Namur is considered to present no safety hazards to the workforce.

4.6.3 FLIGHT TEST CORRIDOR

Potential safety hazards associated with proposed operations within the flight corridors could include:

- Impact of missile debris in the BOA (including target missile flight termination)
- Impact of missile debris at USAKA (including interceptor missile flight termination)
- Secondary effects of missile debris

Missile Debris in the BOA - Certain flight test missions may involve interception of the target missile over the BOA, with subsequent impact of debris in the BOA. In addition, there is the potential for impact of target missile debris at any point along the flight corridor due to missile malfunction and/or termination of a missile flight by the FTS.

The missile systems utilized for the proposed operations are highly accurate and have only a small potential to deviate from established flight paths due to the possibility of a malfunction. During missile flights, the flight path would be continuously monitored by range tracking equipment, and flight would be terminated if the missile course exceeds defined flight corridor boundaries. The resulting debris follows a ballistic trajectory and would impact within open sea waters. Since an exact point of termination cannot be determined, the potential-effects footprint is determined by considering the limits of debris fallout based on destruction of a test missile at the boundaries of the acceptable flight corridor, along with additional flight time based on the time required to initiate the FTS. For missions between USAKA and Bigen Island all flight corridors would be over open sea waters, and debris footprints will not include any land areas.

Standard safety procedures for the operations in the KMR require that a NOTMAR be disseminated to warn boaters of test operations and the potential hazards and that all efforts are made to ensure that the flight corridor is clear of all personnel. However, there is only a very small probability of debris impacting at any point along this corridor, and there is only limited occupancy of the KMR area by marine traffic.

Missile Debris at USAKA - Certain flight test missions may involve intercept of the target missile over the USAKA Lagoon, with the resulting impact of debris within the USAKA Mid-atoll Corridor. The USAKA utilizes several procedures to ensure that no unauthorized personnel are within this Corridor during operational situations. These procedures include the issuance of a NOTMAR prior to each test operation, public notification in local newspapers and on radio/television, and use of a visual operational hazard signal at Kwajalein Island (a red flag on the Kwajalein Pier). Immediately prior to the operation a reconnaissance airplane would be used to provide visual confirmation that the lagoon is clear of unauthorized personnel (Shady, 1995).

As part of USAKA Range requirements, it is required that a 5.6-kilometer (3-nautical mile) no-impact zone be maintained around all populated islands at the USAKA (Shady, 1995). This will preclude the impact of missile debris at any inhabited portions of the Corridor.

Secondary Effects - Burning solid propellant has the potential to produce fires only in the event of impact onto an island location (impact into the USAKA Lagoon or the BOA has no fire potential). The potential for such an impact is judged extremely remote.

4.6.4 CUMULATIVE IMPACTS

The increased use of liquid propellants, explosives, and other prelaunch activities represents a small increase in potential safety risk at the USAKA. Flight operations associated with the proposed action would also increase the safety risk at the USAKA. However, safety standards are high at the USAKA and would serve to keep the cumulative safety impacts attributable to all USAKA operations within acceptable standards to both workers and the public.

4.7 HAZARDOUS MATERIALS AND HAZARDOUS WASTE

4.7.1 BIGEN ISLAND

Under the proposed action, a temporary launch site would be established on Bigen Island for the launch of target missiles. The use of hazardous materials at the temporary launch site would include:

- Liquid rocket propellants IRFNA and UDMH if defueling operations are necessary

- Small amounts of cleaning solvents (e.g., acetone, isopropyl alcohol) for use during prelaunch activities

- Motor fuels (diesel) for fueling of vehicles and operation of generator equipment

Liquid Rocket Propellants - As discussed in section 4.6.2, the target missile systems would arrive from Meck already fueled (1,100 kilograms [2,400 pounds] of IRFNA and 400 kilograms [800 pounds] of UDMH). For normal prelaunch and launch operations there would be no handling of liquid propellants, nor any release/collection of propellants. Established USAKA procedures for liquid rocket propellant defueling would be followed. Certain emergency actions may occur which would require the defueling of a target missile. Spill control kits would be present on Bigen Island, and a Spill Prevention and Response Plan would be formulated and implemented if necessary. Unloaded propellants would be containerized into approved containers. Containerized propellants would be tested to determine if they could be reused, would require off-site reprocessing (at the manufacturing facility on the mainland) before reuse, or would be unusable and need to be disposed of as hazardous waste. Additionally, small quantities of waste propellants could be produced during defueling operations due to leakage, post-operation line drainage, and/or small quantity spills. Propellant transfers would occur on a non-permeable surface, and all spills/wastes would be collected and containerized.

Except for immediately reusable propellants, all containerized materials/wastes would be loaded aboard the transporting LCU for removal to Kwajalein Island. At Kwajalein, wastes would be placed at the USAKA Hazardous Wastes Collection Point (Building 1521) in accordance with USAKA hazardous waste management policy, while recyclable propellants would be transported to Meck for storage at the Liquid Oxidizer/Fuels Storage Buildings pending shipment to the mainland. From Kwajalein, materials/wastes would be prepared and shipped to their final destination (recycle or disposal facility). Reusable propellants would be reloaded into the target missile as appropriate (small quantities of waste propellants would be generated, collected and containerized during refueling, similar to defueling operations).

Cleaning Solvents - The proper handling and use of many types of cleaning solvents are routine in many types of military operations, including field exercises at primitive locations. In the case of prelaunch activities for target missile systems, the solvents would be employed in tasks addressed under SOPs.

Motor Fuels - Like cleaning solvents, motor fuels are handled routinely during military activities world-wide. Storage would be accomplished using existing containers, and transfers accomplished using standard pumping and fueling equipment. All fueling operations would be accomplished on impermeable barriers designed to collect all spills, to prevent any release to the environment.

Hazardous wastes generated as a result of site preparation, prelaunch, and launch activities at Bigen Island would consist of hazardous materials used as discussed above that are spilled or otherwise collected during the work operations. For motor fuels and cleaning solvents, the collection and disposal of these materials are routinely accomplished. For liquid rocket propellants it is anticipated that the volumes of wastes would be small, since the high volatility of both IRFNA and UDMH would result in the airborne loss of most spilled material. Any remaining liquid propellants would be diluted with water, which could then be containerized and handled similarly to motor fuel wastes.

4.7.2 USAKA

The proposed action includes prelaunch set-up of PATRIOT missile systems and launch of those missiles from either Illeginni or Meck islands. The use of hazardous materials during these operations will be limited to small amounts of solvent cleaners (e.g., acetone, isopropyl alcohol), ethylene glycol coolant in the THAAD radar, and some handling and storage of motor fuels for use in motor vehicle and/or generator systems. The proper handling and use of such materials are routine in many types of military operations, including field exercises at primitive locations. In the case of PATRIOT missile systems, the materials would be employed in tasks addressed under SOPs.

Since proposed site activities for the PATRIOT radar system and the THAAD radar would be limited to temporary placement at existing facilities, there would be very limited usage of hazardous materials or generation of hazardous wastes.

Wastes from the small amounts of the hazardous materials used would be collected in accordance with the SOPs discussed above. Collected wastes would be sent first to the central waste collection point on the island where it is used, and then on to the USAKA Hazardous Wastes Collection Point (Bldg. 1521) on Kwajalein Island for final disposition. This is in accordance with the established USAKA policy on hazardous wastes.

Kwajalein Island – Target missile components would be brought to Kwajalein Island as the initial arrival point at the USAKA, as will the PATRIOT missile systems. Temporary storage of these components/systems would be accomplished, but no preflight assembly or check-out operations will be undertaken. Storage and handling operations would involve no use of hazardous materials, nor would any hazardous wastes be generated.

Kwajalein Island would also serve as the supply point for consumable materials to be employed during target and interceptor vehicle preflight assembly and checkout operations, and consumable supplies needed for the maintenance of the THAAD radar and other sensor systems. Some of the materials in these supplies are considered to be hazardous materials (e.g., acetone and isopropyl alcohol for target systems, and contact cleaners for sensor systems). These materials would be stored on Kwajalein Island in appropriate warehouse facilities prior to issuance for use on other islands. These materials are similar to materials employed for other operations already occurring at Kwajalein Island (including standard facility maintenance activities), and represent only a small increase in the total amounts of materials to be handled at Kwajalein Island. Since no actual operational activities would occur on Kwajalein Island, there would be no usage of hazardous materials on the island related to the proposed action.

There would be no generation of hazardous wastes due to operations on Kwajalein Island related to the proposed action; however, hazardous wastes generated during activities on other island locations would eventually be collected on Kwajalein Island for final disposition off of the USAKA. As discussed in section 3.7, Building 1521 serves as the USAKA Hazardous Waste Collection Point. Hazardous wastes produced at other locations under the proposed action could include small amounts of waste solvents (e.g., acetone, isopropyl alcohol), waste motor fuels (potentially several liters [gallons], from spills collected at the temporary site on Bigen Island), waste liquid rocket propellants (from notional ERL target missile fueling operations), and collected solid propellant and other explosive materials from debris recovery out of the Kwajalein Atoll Lagoon. All of these hazardous wastes are similar to hazardous wastes already generated and handled at the USAKA and Building 1521, and can be handled within the existing hazardous waste disposal operations. The quantities of all hazardous wastes which could be produced under the proposed action are expected to be substantially less than those already being handled at the USAKA.

Meck Island – Meck Island would serve as the location for all target missile build-out (and fueling operations for liquid-fueled target missiles), as well as a possible launch location for Interceptor missiles.

The use of hazardous materials during target missile build-out operations would be limited to small amounts of solvent cleaners (acetone, isopropyl alcohol, etc.). The proper handling and use of such materials are routine in many types of military operations, including similar build-out operations for other missile systems already performed at Meck. All tasks would be performed in accordance with SOPs, and would include provisions for proper handling of hazardous materials/wastes and waste minimization.

Some small quantities of the hazardous materials may be used and would be collected in accordance with the SOPs discussed above. Collected wastes would be sent first to the central waste collection point on Meck, and on to the USAKA Hazardous Wastes Collection Point (Bldg. 1521) on Kwajalein Island for final disposition. This is in accordance with the established USAKA policy on hazardous wastes.

As discussed in section 4.6, liquid propellants would arrive at USAKA packaged in approved storage/transportation containers and be immediately transported to Meck, where all storage of liquid fuels would occur. Approximately 9,500 kilograms (21,000 pounds) of IRFNA would be required for the proposed test program, and would be stored at the fueling area building. Approximately 3,200 kilograms (7,000 pounds) of UDMH would be required for the proposed flight test program, and would be stored at the Liquid Fuel Storage Building. Storage would take place in the shipping containers, which would be properly secured on storage pads to collect spilled material in the event of an accident.

Each liquid-fueled target missile would be fueled with 1,100 kilograms (2,400 pounds) of IRFNA and 400 kilograms (800 pounds) of UDMH. Specific, standardized procedures for fuel/oxidizer transfer would be developed in accordance with Army requirements for handling of liquid rocket propellants (Chemical Propulsion Information Agency, 1973). These procedures would incorporate measures to minimize both the amount of waste propellants generated during transfer operations and the potential for accidental spills.

Possible sources of wastes include drainage from transfer lines following transfer completion, small transfer system leaks, and accidents. Propellant transfers would occur on a non-permeable surface, and all spills/wastes would be collected and containerized. Except in cases of accident, fueling operations would involve generation of only small quantities (up to 10 grams [0.4 ounces]) of wastes. Oxidizer and fuel wastes would be segregated due to their incompatibility (they chemically react when mixed, and hence are considered to be incompatible waste types). Water used to decontaminate workers and to flush the fueling system would be collected and handled as hazardous waste until it is determined by analysis to be safe for release.

4.7.3 FLIGHT TEST CORRIDOR

During normal flight operations there would be no hazardous materials/waste issues associated with flight corridors. However, as a result of successful intercepts, debris from both the target and defensive missiles would be produced. If an in-flight malfunction occurs, the range safety officer may initiate flight termination, resulting in missile debris being deposited beneath the flight path. Debris impacts may occur within either the BOA or the Mid-atoll Corridor within the Kwajalein Atoll Lagoon. The potential effects to the ocean environment of hazardous materials associated with missile debris are described in Section 4.12, Water Resources.

Missile debris would not be recovered following BOA impacts; however, recovery would be accomplished for all lagoon impacts. The quantity of such debris is not expected to be excessive (several hundred kilograms [pounds]), and is similar in nature to debris already recovered during other test and evaluation operations. Most debris would consist of metal parts and other solid fragments, although some quantities of hazardous wastes may also be recovered (primarily solid fuel fragments).

4.7.4 CUMULATIVE IMPACTS

The types of hazardous materials which would be required for completion of the proposed action are similar to hazardous materials already in use at the USAKA. The quantities required by the program would represent only a small fractional increase above those already in use, and the increase could easily be accommodated by the current hazardous materials control systems at the USAKA.

Similarly, the types of hazardous wastes which would be generated under the proposed action are similar to wastes already encountered at the USAKA, and the quantities related to the test program represent only a small increase above the amounts of such hazardous wastes already handled. The small increase in waste amounts could be easily accommodated within the existing hazardous waste disposal system.

4.8 LAND USE

4.8.1 BIGEN ISLAND

The proposed action would involve minimal site preparation activities to establish a temporary launch site for target missiles. The island would also be occupied for approximately 30 days for each launch. Land use agreements have been entered into with the owners of the island. Based on the temporary nature of the launch site, the anticipated minimal disturbance, the fact that all temporary facilities would be removed, and the advance notification to land owners, impacts to the land use of Bigen Island would be minor.

The establishment and activation of a LHA (see figure 4-1) would require the temporary clearance of the adjoining Pacific Ocean and Aur Lagoon. An appropriate LHA would be established by the KMR Safety Office for each launch event.

4.8.2 USAKA ISLANDS

Gellinam, Illeginni, Legan, and Omelek Islands – The use of existing facilities on Gellinam, Legan, and Omelek Islands to establish and operate the PATRIOT radar would not change the land use and management of the islands. The islands are under U.S. Army management and would continue to be used for missile research. Missile tracking using PATRIOT radar is entirely consistent with the mission of the islands and would not conflict with any land use plans, policies, or controls of the USAKA.

The PATRIOT interceptor could be launched from Illeginni Island. PATRIOT would use existing sites on Illeginni Island, and no construction or facility modifications would be required.

The use of existing facilities on Illeginni Island to launch PATRIOT missiles would not change the land use and management of the island. The island is under U.S. Army management, and the island would continue to be used for missile research. PATRIOT missile launches are entirely consistent with the mission of the island and would not conflict with any land use plans, policies, or controls of the USAKA.

The establishment and activation of a LHA (see figure 4-3) would require the temporary clearance of Kwajalein Lagoon in front of the launch site. An appropriate LHA would be established by the KMR Safety Office for each launch event. Temporary clearance of this LHA would not affect recreational or commercial use of these waters since the area off the island is not used by commercial fishermen or for recreational use by residents of the USAKA (all of whom work for the U.S. Government or U.S. Government contractors). As part of the Mid-atoll Corridor, Illeginni Island is maintained as a closed area with all boat traffic prohibited for a period encompassing any flight test activity (U.S. Army Strategic Defense Command, 1989).

Kwajalein Island – For the proposed action, target missile components and PATRIOT missile system components would arrive at Kwajalein Island from the CONUS. Temporary storage of these components/systems would be accomplished using facilities that currently handle similar components.

The use of existing facilities on Kwajalein Island would not change the land use and management of the island. The island is under U.S. Army management, and it would continue to be used for missile research. The uses for the proposed action are entirely consistent with the mission of the island and would not conflict with any land use plans, policies, or controls of the USAKA.

Meck Island – The PATRIOT interceptor could be launched from Meck Island. PATRIOT would use existing sites on Meck Island, and no construction or facility modifications would be required.

The use of existing facilities on Meck Island to launch PATRIOT missiles would not change the land use and management of the island. The island is under U.S. Army management, and the island would continue to be used for missile research. PATRIOT missile launches are entirely consistent with the mission of the island and would not conflict with any land use plans, policies, or controls of the USAKA.

The establishment and activation of a LHA (see figure 4-4) would require the temporary clearance of the adjoining Pacific Ocean in front of the launch site. An appropriate LHA would be established by the KMR Safety Office for each launch event. Temporary clearance of this LHA would have no impacts on recreational or commercial use of these waters since the area off the island is not used by commercial fishermen or for recreational use by residents of the USAKA (all of whom work for the U.S. Government or U.S. Government contractors). As part of USAKA range safety practices, the Mid-atoll Corridor, in which all the island is located is maintained as a closed area, with all boat traffic prohibited for a period encompassing any flight test activity (U.S. Army Strategic Defense Command, 1989).

Roi-Namur Island – The proposed action at Roi-Namur Island would involve the temporary set-up and operation of the THAAD radar at one of two existing work areas: Speedball site or AOS site.

The use of existing facilities on Roi-Namur Island would not change the land use and management of the island. The island is under U.S. Army management, and it would continue to be used for missile research. The uses for the proposed action are entirely consistent with the mission of the island and would not conflict with any land use plans, policies, or controls of the USAKA.

4.8.3 CUMULATIVE IMPACTS

At this time, there are no ongoing or foreseeable future programs taking place on any of the islands in the ROI that when added to the proposed action will have an impact on land use; therefore, no cumulative impacts are anticipated.

4.9 NOISE

Potential noise impacts from USAKA temporary extended test range program activities at the USAKA and Bigen Island include noise generated by portable generators and noise from the launch and flight of PATRIOT and target missiles.

4.9.1 BIGEN ISLAND

Potential noise impacts from proposed action activities at Bigen Island include noise from the launch and flight of target missiles.

The short range target missiles launched from Bigen Island as part of the program activities would be either a solid or liquid propellant launch vehicle. As mentioned in section 2, the solid propellant launch vehicle would be similar to the Hera missile, and the liquid propellant launch vehicle would be similar to the notional ERL missile analyzed.

The C-weighted maximum noise levels for a single launch of a notional ERL missile are shown in figure 4-5.

A peak sound pressure level of 147 dBA has been measured at a distance of 89.9 meters (295 feet) from a Lance missile launch (U.S. Army Corps of Engineers, 1993). Noise levels for the notional ERL would be expected to be the same.

When measured noise levels at several locations are not available, the standard assumption is a 6-decibel decrease for every doubling of distance plus an additional decrease of 1 dB per 30 meters (100 feet) due to atmospheric adsorption (Golden et al., 1979). Using this method on the available Lance data yields sound pressure levels of 140 dB, 115 dB, and 85 dB at 157 meters (514 feet), 574.2 meters (1,884 feet), and 1,280 meters (4,190 feet) from the launch site, respectively.

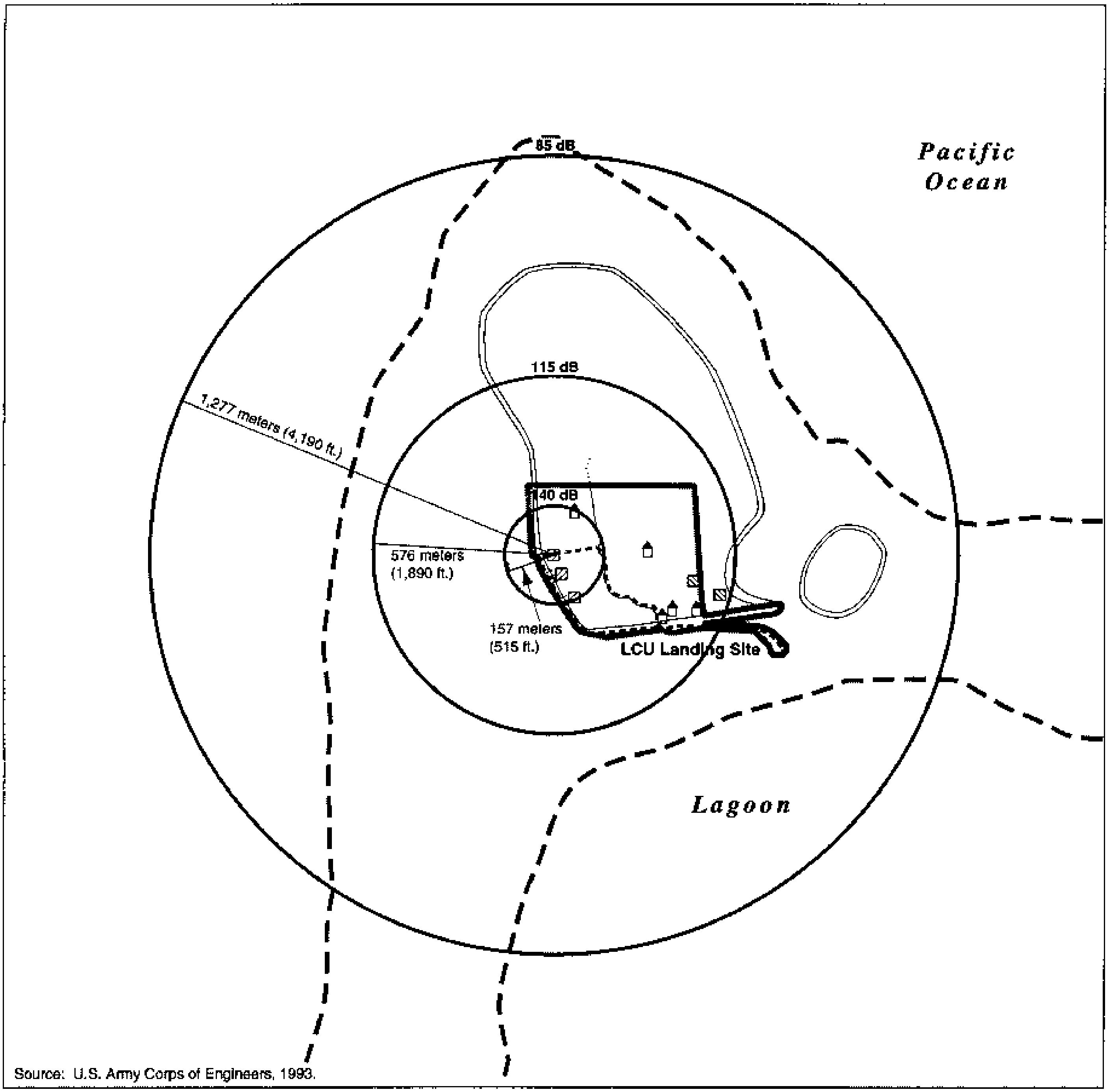
The nearest noise sensitive communities would be on Tabal and Aur islands, which are 12 kilometers (7.5 miles) and 27 kilometers (17 miles) from Bigen, respectively. These communities are far from the 85 dB contours predicted to be produced by the launch of a notional ERL. The noise from the launch of a notional ERL target missile from Bigen Island would be barely audible or inaudible on Tabal and Aur islands.

The C-weighted maximum noise levels for a single launch of a Hera missile are shown in figure 4-6 (U.S. Army Space and Strategic Defense Command, 1994b). It is shown in the Theater Missile Defense Extended Test Range EIS (U.S. Army Space and Strategic Defense Command, 1994g) that for 48 Hera missile launches per year from one site, with all launches occurring during the daytime (7 a.m. to 10 p.m.), areas beyond the L_{max} contour of 108 dB would experience L_{dn} values of less than 62 dB. Furthermore, it is also shown that if 5 of the 48 launches occurred at night (10 p.m. to 7 a.m.), then areas beyond the L_{max} contour of 104 dB would experience L_{dn} values of less than 62 dB. This noise level corresponds to Land Use Category I (table 3-7), which Army Regulation 200-1 defines as compatible with noise-sensitive land uses.

Since no more than eight Hera missiles would be launched as part of the USAKA temporary extended test range program, it can be concluded that all areas beyond the L_{max} contour of 110 dB contour in figure 4-6 would experience L_{dn} values of less than 62 dB. No noise-sensitive receptors were identified within the L_{max} contour of 105 dB; therefore, the launching of eight Hera missiles in one year at Bigen Island would not interfere with noise-sensitive land use.

The OSHA limits impulsive or impact noise exposure to less than 140 dB and exposure to a continuous noise of 115 dBA to less than 15 minutes. As shown above, these levels would occur on Bigen Island and the nearby waters. Only USAKA temporary extended test range project personnel would potentially be within these noise contours. Impacts to such persons would be minimized by using personal noise protection devices. Therefore, launch operations would be accomplished in accordance with OSHA standards.

Potential noise impacts from the flight of a target missile includes sonic booms. Sonic booms would occur with each target missile launch after the vehicle speed exceeded the speed of sound. The sonic boom would be directed toward the front of the vehicle



EXPLANATION

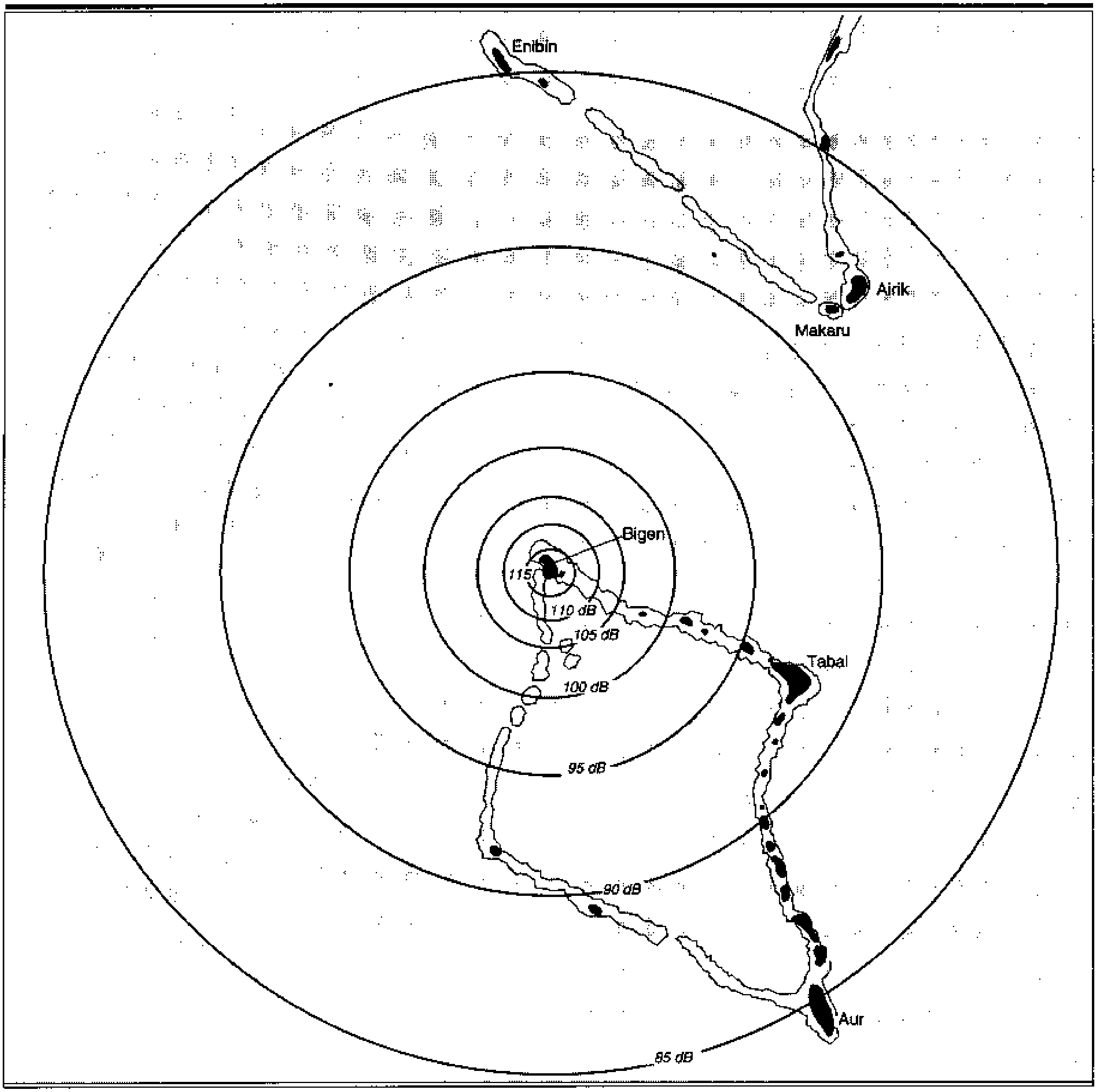
- Survey Area
- Potential Launch Sites
- Potential Launch Control Sites
- Copra Processing Areas
- Existing Pedestrian Path
- Path of Reconnaissance Survey Front End Loader
- Coastal Access
- Reef Edge
- Launch Hazard Area

0 239.5 479 Meters
0 785 1,570 Feet

C-weighted Maximum Noise Levels, Notional Extended Range Lance Missile

Bigen Island,
Aur Atoll

Figure 4-5



EXPLANATION

*L_{max} is presented in 5 dB increments to illustrate the momentary noise levels during launches. The C-weighted annual average day night level (L_{dn}) was used to determine impacts.

Reef

0 4.4 8.8 Kilometers
0 2.75 5.5 Miles

C-Weighted Maximum Noise Levels, Hera Missile Launch

Bigen Island,
Aur Atoll

Figure 4-6

downrange of the launch site and thus would be located over the Pacific Ocean. No noise-sensitive receptors are known to be located in this area.

4.9.2 USAKA ISLANDS

Potential noise impacts from proposed activities at Illeginni and Meck islands include noise from the portable generators used to power PATRIOT launch equipment and noise from the launch of the PATRIOT missiles. Potential noise impacts from the launches of strategic launch vehicles (including TMD missiles) and the operation of their support equipment on Meck and Illeginni islands were addressed in the USAKA SEIS (U.S. Army Space and Strategic Defense Command, 1993a). The USAKA SEIS concluded that the resulting sound pressure levels would cause neither workplace standards to be violated nor noise sensitive communities to experience maximum short-term noise levels greater than 92 dBA.

Furthermore, the potential noise impacts from the launches of up to 48 TMD defensive missiles (including PATRIOT missiles) per year, and the operation of their support equipment, on Meck and Illeginni islands was addressed in the Theater Missile Defense Extended Test Range EIS (U.S. Army Space and Strategic Defense Command, 1994g). The EIS concluded that impacts were expected to be not significant.

Potential noise impacts from proposed activities at Omelek and Gellinam islands include noise from the portable generators used to power PATRIOT support equipment. Potential noise impacts from the launches of strategic launch vehicles (including TMD missiles) and the operation of their support equipment at Omelek and Gellinam islands were addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a). The SEIS concluded that the resulting sound pressure levels would cause neither workplace standards to be violated nor noise sensitive communities to experience maximum short-term noise levels greater than 92 dBA.

Kwajalein Island – The temporary storage of rocket motors and flight termination systems in existing ammunition storage bunkers on Kwajalein Island are activities that would essentially have no potential for causing noise and thus no potential to impact the local noise environment.

Legan Island – Potential noise impacts from proposed activities at Legan Island include noise from portable generators used to power PATRIOT support equipment. Potential noise impacts from the operation of a THAAD radar (and its associated generators) and the operation of four 130-kilowatt generators at Legan Island were addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a). The SEIS concluded that the resulting sound pressure levels would cause neither workplace standards to be violated nor noise sensitive communities to experience maximum short-term noise levels greater than 92 dBA.

Roi-Namur Island – Potential noise impacts from proposed activities at Roi-Namur Island include noise arising from the electrical power requirements of the THAAD radar. Electrical power would be supplied either from the existing Roi-Namur commercial power system or from the associated Prime Power Unit of the radar system. Potential noise impacts from the operation of a THAAD radar (and its associated generators) at Meck, Illeginni, Omelek, Gellinam, and Legan islands were addressed in the USAKA Final Supplemental EIS (U.S.

Army Space and Strategic Defense Command, 1993a). The SEIS concluded that the resulting sound pressure levels would cause neither workplace standards to be violated nor noise sensitive communities to experience maximum short-term noise levels greater than 92 dBA. Similar to Meck, Illeginni, Omelek, Gellinam, and Legan islands, as stated in section 3.9.2, all personnel on Roi-Namur are workers involved with USAKA activities and who are provided with appropriate hearing protection to reduce exposure to allowable levels. Furthermore, the island nearest to Roi-Namur that is inhabited by non-USAKA personnel is Ennubirr Island, which is approximately 2.6 kilometers (1.6 miles) distant. Therefore, the operation of the THAAD radar portable generators on Roi-Namur Island is anticipated to cause neither the violation of workplace standards nor the exposure of noise sensitive communities to maximum short-term noise levels greater than 92 dBA.

4.9.3 FLIGHT TEST CORRIDOR

Potential noise impacts from USAKA temporary extended test range program activities along the flight test corridor include sonic booms. Sonic booms would occur with each missile launch after the vehicle speed exceeded the speed of sound. The sonic boom would be directed toward the front of the vehicle downrange of the launch site and thus would be located over the Pacific Ocean. No noise-sensitive receptors are known to be located along the flight test corridor.

4.9.4 CUMULATIVE IMPACTS

The Final Supplemental EIS for the Proposed Actions at USAKA (U.S. Army Space and Strategic Defense Command, 1993a) addresses the environmental impacts of ongoing and future programs at the USAKA. The SEIS concluded that for all three levels of activity considered, the resulting sound pressure levels would cause neither workplace standards to be violated nor noise sensitive communities to experience maximum short-term noise levels greater than 92 dBA. Increases in the level of activity at the USAKA that would be caused by the proposed action would be most appropriately represented by either the USAKA EIS's low level of activity or intermediate level of activity. In either case, no cumulative impacts would be expected.

Both the level of activity and the number of noise sources at Bigen Island are far less than at any of the USAKA islands. Since the USAKA temporary extended test range activity at Bigen Island would consist primarily of only eight missile launches, no cumulative noise impact would be expected at this location either.

In both cases it is assumed that in-place regulations would be used during launches and operation of noise producing equipment, such as the PATRIOT Launching Station, Engagement Control Station, radar set, and electric power plant to provide hearing protection to workers.

4.10 SOCIOECONOMICS

4.10.1IMPACTS

The assembly and integration of flight test hardware at various CONUS Government installations, and their transportation to USAKA, would involve only existing personnel at those installations and thus would not generate any net, new socioeconomic impacts. The personnel involved in the final assembly and preflight activities, transportation to the temporary launch locations, site preparation and establishment, and flight test activities on other USAKA islands would commute from Kwajalein Island, and thus any potential for socioeconomic impacts would be limited to Kwajalein Island. These impacts are discussed below.

Personnel involved in site preparation and establishment and flight test activities at Aur Atoll would either commute via small boats to their living quarters on one of the LCUs anchored offshore or live on Bigen Island in Mann Camps. Bigen Island would experience a small beneficial socioeconomic impact as a result of the proposed action.

Population and Employment. Approximately 40 USAKA and up to 20 temporary duty personnel would be required for the final assembly and preflight activities at USAKA for up to 90 days for each of the proposed eight target launches. The approximately 40 USAKA personnel would already be living on Kwajalein Island and otherwise engaged in other ongoing programs, the population and employment impacts of which are addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a).

The up to 20 temporary duty personnel would nominally constitute a 0.8 percent increase in the nonindigenous population and a 1.4 percent increase in employment during the proposed 90-day launch periods. This is well within the normal month-to-month fluctuation in the island's population and employment levels.

The approximately 35 to 50 personnel that would be involved in prelaunch operations associated with flight test activities on either Illeginni or Meck islands would already be living on Kwajalein Island and otherwise engaged in other ongoing programs. The associated population and employment impacts are addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a).

Income. Approximately 40 USAKA personnel required for the final assembly and preflight activities at USAKA for up to 90 days for each of the proposed eight target launches would already be living on Kwajalein Island and otherwise engaged in other ongoing programs, the income impacts of which are addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a). Similarly, the approximately 35 to 50 personnel that would be involved in prelaunch operations associated with flight test activities on either Illeginni or Meck islands would already be living on Kwajalein Island and otherwise engaged in other ongoing programs. Their associated income impacts are addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a).

The up to 20 temporary duty personnel associated with the final assembly and preflight activities at USAKA would nominally constitute a 1.4 percent increase in employment, and thus income (assuming similar wage structures) during the proposed 90-day launch periods. This is well within the normal month-to-month fluctuation in the island's employment and income levels. Consequently, income impacts from the final assembly and preflight activities at USAKA are not expected.

Housing. Approximately 40 USAKA personnel required for the final assembly and preflight activities at the USAKA for up to 90 days for each of the proposed eight target launches would already be living on Kwajalein Island and otherwise engaged in other ongoing programs, the housing impacts of which are addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a). Similarly, the approximately 35 to 50 personnel that would be involved in prelaunch operations associated with flight test activities on either Illeginni or Meck islands would already be living on Kwajalein Island and otherwise engaged in other ongoing programs. Their associated housing impacts are addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a).

The up to 20 temporary duty personnel associated with the final assembly and preflight activities at the USAKA can readily be accommodated in the available transient lodging that totals 482 beds on Kwajalein Island. Their transient lodging demand would represent 4.15 percent of the available transient lodging supply. Since temporary, transient personnel are not allowed on the USAKA without confirmed lodging reservations, which must be scheduled well in advance, potential impacts to transient lodging are considered not significant.

4.10.2 CUMULATIVE IMPACTS

The potential for additive, incremental socioeconomic impacts when the USAKA temporary extended test range program is added to other known and reasonably foreseeable programs is addressed in the USAKA Final Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a) for the existing USAKA personnel that would be involved in the program. The potential for cumulative population, employment, income, and housing impacts from the 20 temporary duty personnel associated with the final assembly and preflight activities is considered not significant, given that their numbers are well within the normal month-to-month fluctuation in numbers of temporary, transient personnel on Kwajalein Island.

4.11 INFRASTRUCTURE AND TRANSPORTATION

4.11.1 BIGEN ISLAND

All personnel would live on the LCU or in 10-person Mann Camps. Bottled potable water would be brought ashore by LCM on a daily or as-needed basis. Two portable biological toilets would be installed temporarily. Garbage would be removed by LCM on a daily or as-needed basis. Three 60-kW generators would be used for power.

No impacts to infrastructure or transportation from proposed action activities at Bigen Island would occur since there are no infrastructure facilities or any established transportation system (water or air) on the island.

4.11.2 USAKA ISLANDS

Potential impacts to infrastructure from proposed action activities at Gellinam, Legan, and Omelek islands include the use of existing generators to operate tracking equipment. The anticipated amount of power that would be used is considered normal usage on Gellinam, Legan, and Omelek islands. Omelek Island would likely require refurbishment and/or maintenance to some existing facilities to support mission requirements due to the very low level of current; however, this would be considered as standard operations and maintenance. No facility modification or construction would be required.

Gellinam, Legan, and Omelek do not have established land transportation systems, but the harbors and helipads may be used during proposed action activities on each island. These activities would be considered normal usage. Portable biological toilets would be installed temporarily.

Potential impacts to infrastructure from proposed action activities on Illeginni Island include the use of the island's power plant. The anticipated amount of power that would be used is considered normal usage. Portable biological toilets would be installed temporarily. The established land transportation system, made up of paved and unpaved roads, harbor, and helipad may be used during proposed action activities. Use of the facilities to support program activities would be considered normal to the island. Kwajalein Missile Range currently has sufficient capacity to support ferrying personnel and supplies to Illeginni on a daily basis without significant impact to other programs. Additionally, boats used to ferry personnel could also be used to transport waste materials generated by the program personnel back to Kwajalein, if necessary.

Kwajalein Island – Potential impacts to infrastructure from proposed action activities at Kwajalein Island include the use of the island's water system, wastewater collection, treatment, and disposal; solid and hazardous waste disposal; and power generation from its many power plants. The anticipated amount of power that would be used is considered normal usage on Kwajalein Island.

Kwajalein's established land transportation system, harbor, and airfield may be used during proposed action activities. These activities would be considered normal usage.

Meck Island – Potential impacts to infrastructure from proposed action activities at Meck Island include the use of the island's rainwater catchment system, wastewater septic tank/leach field system, and power generation from its generators and power plant. The anticipated usage is considered normal on Meck Island.

Meck's established land transportation system, harbor, and runway may be used during proposed action activities. These activities would be considered normal usage.

Roi-Namur Island – Potential impacts to infrastructure from proposed action activities at Roi-Namur Island include the use of the island's water system, wastewater collection, treatment, and disposal; solid and hazardous waste disposal; and power generation. The anticipated usage is considered normal on Roi-Namur Island.

Roi-Namur's established land transportation system, harbor, and airfield may be used during proposed action activities. These activities would be considered normal usage.

4.11.3 FLIGHT TEST CORRIDOR

Potential impacts to infrastructure from proposed action activities in the flight test corridor are limited because no infrastructure facilities have been identified.

Potential impacts to transportation from proposed action activities in the flight test corridor include temporarily stopping all marine transportation that would take place in the BOA and the Mid-atoll Corridor within the Kwajalein Lagoon. Because marine transportation has been interrupted in conjunction with other Army programs in the past, this activity would be considered normal.

4.11.4 CUMULATIVE IMPACTS

At this time, there are no ongoing or foreseeable future programs taking place on any of the islands in the ROI other than those discussed previously that would have an added impact on infrastructure and transportation; therefore, no cumulative impacts are anticipated.

4.12 WATER RESOURCES

This section discusses the environmental consequences to surface water, groundwater, and sea water resources as a result of USAKA temporary extended test range program and cumulative USAKA activities.

4.12.1 BIGEN ISLAND

There is no permanent surface water on Bigen Island. Potable water for mission personnel would be transported from Kwajalein Island.

Missile fueling would not occur on Bigen Island. There is a remote potential for groundwater contamination as a result of an early flight failure. Any release of liquid fuel on Bigen Island as a result of an on-pad or early flight failure would likely result in most or all of the fuel being consumed by combustion before reaching groundwater. An accident response team would be required on Bigen Island to mitigate any potential effects of a propellant spill. The potential for contamination of groundwater on Bigen Island as a result of program activities is considered very remote.

4.12.2 USAKA ISLANDS

About 35 to 40 personnel would be required for PATRIOT Fire Unit operation on one or more USAKA islands, and about 20 to 30 personnel would be required to conduct THAAD radar operations on Roi-Namur Island. The increased potable water requirement to support these transient personnel is not anticipated to exceed the long-term water supply capability on Kwajalein, Roi-Namur, and Meck islands. The potable water supply is primarily obtained from catchment of rainfall on paved surfaces.

As described in Section 3.12, Water Resources, the only standing surface water in the ROI is a small, brackish tidal pond on Legan Island (figure 3-7). The only proposed program activity for this island is the PATRIOT radar. The exhaust emission products from the generators that would be used to power the radar are not expected to pose any measurable change in the water chemistry of the wetland. The amount of emission products would be minor, and the persistent prevailing winds would rapidly disperse the emissions.

Similarly, exhaust emissions from electric power generators used in support of potential program activities on Kwajalein, Roi-Namur, and Meck islands would not be expected to substantially degrade the quality of water collected from the rainwater catchment basins.

As part of the missile fueling process at Meck Island, up to about one liter (one quart) of IRFNA oxidizer may remain in the fuel lines. The acidity of any oxidizer remaining in the lines would be neutralized by adding it to an appropriate quantity of sodium bicarbonate dissolved in water and disposed of in the ocean near Meck Island. The primary reaction products of these agents are water, carbon dioxide, and sodium and nitrate ions. These products could be safely disposed of in the ocean around Meck Island without a significant effect to the environment. Sodium and carbonate ions are major constituents (concentrations greater than 1 milligram/liter or 50 micromols/kilogram) in sea water, while nitrate is a minor natural constituent found in concentrations between 0.05 and 50 micromols/kilogram (Kennish, 1994). Carbon dioxide dissolved in sea water, as part of the carbon dioxide-carbonate-bicarbonate chemical system, forms a buffer that regulates the environment against rapid shifts in acidity and alkalinity and therefore, is of fundamental importance to life processes in the ocean. Additionally, fluoride, a very minor constituent in IRFNA as an inhabiting agent, is a major chemical species in sea water occurring as a fluoride ion or magnesium fluoride (Kennish, 1994).

There is a potential for groundwater contamination as a result of a fuel and/or oxidizer spill during fueling of a notional ERL missile. However, the fuel handling and transfer procedures, as discussed in section 4.7, would reduce the potential for a liquid fuel spill to very unlikely. Also, all rinse water used to decontaminate workers and to flush the fueling system after the fueling process would be collected and handled as a hazardous waste until it is determined by analysis to be safe for release. If a spill did occur, depending on the volume, UDMH and/or IRFNA could reach the groundwater table. No data are known of the effect of UDMH in groundwater. A half-life of 14 days for hydrazine in groundwater has been suggested based upon the unacclimated aqueous biodegradation half-life (Howard, et.al, 1991). If concentrated nitric acid reaches groundwater an exothermic reaction and the formation of toxic nitrogen dioxide gas may occur. Nitrates, primarily calcium nitrate, and other byproducts would also be expected to form in the groundwater. Nitrates are a common constituent of groundwater, but are regulated in potable water supplies because of health effects (Chemical Propulsion Information Agency, 1984). As previously discussed in Section 4.5, Geology and Soils, liquid-propellant spill containment kits along with a qualified accident response team would be stationed at Meck Island to negate or reduce the environmental effect in the unlikely event of a spill.

The highest potential for a liquid fuel spill, through remote, is expected to be on Meck Island during fueling of a notional ERL missile. Groundwater is not withdrawn on Meck Island, and a liquid fuel spill would have no effect on potable water supplies.

While the exact number of transient personnel that would be required on Kwajalein Atoll is unknown, based on the existing storage capacity of potable water it is anticipated that little or no additional groundwater withdrawal would be required to support the proposed program.

A lens of fresh groundwater is known to occur under Roi-Namur Island. As described in Section 4.5, Geology and Soils, the amount of electric power generator emissions produced during THAAD radar operations that is anticipated to fall on the island would be minimal. Therefore, little if any of these emission products would be likely to reach the fresh groundwater lens. Other USAKA islands where PATRIOT equipment generators may be placed have no known freshwater lens. Thus, there is no potential for generator emissions to contaminate potable groundwater.

4.12.3 FLIGHT TEST CORRIDOR

The possibility of water pollution is associated primarily with toxic materials which may be released to and are soluble in the water environment. Rocket propellants are the dominant source of such materials, although consideration must be given also to soluble materials originating from hardware and miscellaneous materials and to certain toxic combustion products.

Solid Propellants – Solid propellants are primarily composed of plastics or rubbers such as polyvinylchloride, polyurethane, polybutadiene, polysulfide, etc., mixed with ammonium perchlorate. The plastics and rubbers are generally considered nontoxic and, in the water, would be expected to decompose and disperse at a very slow rate.

The ammonium perchlorate found in solid propellants is contained within the matrix of rubber or plastic and would dissolve slowly. The toxicity is expected to be relatively low. As a most conservative case, toxic concentrations of ammonium perchlorate would be expected only within a few meters (yards) of the source. This would have no effect on sea life if the missile propellants fall into the ocean more than 2 or 3 kilometers (1.2 to 1.9 miles) from shore where the ocean depth is generally greater than 3,000 meters (10,000 feet). If propellants fall in shallow water near Bigen Island, marine animals attached to the substrate in this area could be affected. Due to high mixing rates of the ocean waters in the near shore area and the slow dissolution rate of solid propellants, swimming animals are not likely to be affected.

No significant effects on sea water quality due to solid fuel emissions, solid fuel debris, or missile debris are expected. The primary PATRIOT and Hera missile emission products (see Section 4.1, Air Quality) that would be expected to fall into the ocean include Al_2O_3, HCl, carbon monoxide, and sulfur dioxide. Al_2O_3 is expected to slowly fall through the water column because of the very small particle size and is not expected to have any measurable effect on water quality. HCl emission products would be rapidly buffered by the natural alkalinity of the ocean. The amount of carbon monoxide and sulfur dioxide that may fall on any given area is expected to be negligible as a result of persistent wind conditions in the region.

In the event that not all of the PATRIOT or Hera missile's solid propellant is burned, the hard rubber-like solid fuel of the missile would dissolve slowly and develop a spongy outer layer that would further reduce the rate at which it dissolves. The small amount of any potentially toxic materials (ammonia and chloride) would be rapidly dispersed to nontoxic levels by ocean currents (U.S. Army Strategic Defense Command, 1992).

Liquid Propellants – The primary motor emission products from nominal launches of the notional ERL target missile would be carbon monoxide, carbon dioxide, nitrogen, and water vapor. These gases are common in the atmosphere and are not expected to result in any measurable degradation in sea water quality.

If unburned UDMH fuel and IRFNA oxidizer are released into the ocean as a result of an inflight failure or residual fuel remaining in the system at missile impact, acute short-term degradation of the water quality would be expected in the immediate vicinity. UDMH mixes readily with water and is toxic and injurious to plant and lower animal life if present in sufficient concentrations (Chemical Propulsion Information Agency, 1984). No data are available on the degradation rate or products of UDMH in sea water. The half-life of hydrazine in surface water is estimated to be 7 days based upon the unacclimated aqueous aerobic biodegradation half-life (Howard, et.al, 1991).

The nitric acid is soluble in water in all proportions. However, the rapid addition of nitric acid propellant to sea water would be expected to produce a large evolution of heat and spattering. The reaction of nitric acids and sea water would release large quantities of toxic nitrogen oxides to the air and result in the substantial lowering of the local sea water pH value (U.S. Department of the Air Force, 1973). After this initial reaction, it is expected that nitric acid in sea water would be neutralized by the natural buffering capacity of sea water and mixed by the ocean currents in the region to background levels in a few hours.

Missile Hardware – Hardware will corrode and, thus, contribute various metal ions to the water environment. The majority of missile hardware consists of aluminum, steel, plastics, fiber-reinforced plastics, and electronic components. A large number of different compounds and elements are used in small amounts in missiles and rocket vehicles and their payloads; for example, lead and tin in soldered electrical connections, silver in silver soldered joints, cadmium from cadmium-plated steel fittings, and copper from wiring. The rate of corrosion of such materials is slow in comparison with the mixing and dilution rates in the water environment, and hence, toxic concentrations of metal ions are not expected to result. The miscellaneous materials (e.g., battery electrolytes) are present in such small quantities that only extremely localized and temporary effects would be expected.

4.12.4 CUMULATIVE IMPACTS

No cumulative effects to water resources are anticipated as a result of the proposed action. The effect of any electric generator or rocket motor emission products deposited in the open ocean would be very transient due to the buffering capacity of sea water and dilution by current mixing and would not be expected to result in any cumulative effects with ongoing USAKA activities. The potential for any liquid missile fuel being released to the environment is considered very remote because of the fuel handling and transfer procedures that would be implemented. In the unlikely event of a liquid fuel or oxidizer spill on Meck Island or Bigen Island, the resultant groundwater contamination would be expected to be diluted by subsequent rainfall infiltration and discharged out to sea. Fresh groundwater does not occur on Meck Island. No other activities are known to occur on Bigen Island that could result in cumulative effects to groundwater.

4.13 ENVIRONMENTAL CONSEQUENCES OF THE NO-ACTION ALTERNATIVE

If the no-action alternative is selected, no environmental consequences associated with the USAKA temporary extended test range are anticipated. Present activities would continue with no change in current operations. Under the no-action alternative, a temporary launch site at Bigen Island would not be established, and flight test data for short range tactical missiles would not be collected. Data would not be available for TMD sensor, interceptor, and technology development.

4.14 ADVERSE ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED

Adverse environmental effects that cannot be avoided include the release of small amounts of rocket motor exhaust pollutants to the atmosphere, ocean, and island soils; PATRIOT and target missile components and fuels falling into the ocean; and minor noise impacts on wildlife. However, these adverse effects will not result in any long term effect on the environment.

4.15 CONFLICTS WITH FEDERAL, STATE, AND LOCAL LAND USE PLANS, POLICIES, AND CONTROLS FOR THE AREA CONCERNED

Activities at all islands within the USAKA are compatible with the mission and land uses for each island. All activities would comply with Federal laws and regulations, the Compact of Free association between the RMI and the U.S., and with regional and local land uses, policies, and regulation agreements. No formal land use plans developed by the RMI are known for Aur Atoll. Because program personnel and equipment are only expected to be on Aur Atoll for about 30 days per launch event, and copra harvesters are typically only on Bigen Island 3 to 4 days per month, the 60-day advance notice that would be provided to land owners prior to program activities is expected to obviate any land use conflicts.

4.16 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

Anticipated energy requirements of each program activity would be within the energy supply capacity of each island. Energy use requirements would be subject to any established energy conservation practices.

4.17 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

Although the proposed activities would result in some irreversible or irretrievable commitment of resources such as various metallic materials, minerals, fossil fuels and labor, the amount of materials and energy required for any proposed action-related activities would be small. The USAKA temporary extended test range proposed action would not commit natural resources in significant quantities.

4.18 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG TERM PRODUCTIVITY

The USAKA has been dedicated to military use since 1944. The proposed action does not eliminate any options for future use of the environment for the locations under consideration.

4.19 FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS (EXECUTIVE ORDER 12898)

The USAKA extended test range program would be conducted in a manner that would not substantially affect human health or the environment. The USAKA extended test range program has identified no disproportionate or adverse human health or environmental effects on minority or low-income population in the area. The program activities would also be conducted in a manner that would not exclude persons from participation in, deny persons the benefits of, or subject persons to discrimination under the USAKA extended test range program because of their race, color, or national origin.

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5.0 REFERENCES

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Appendix A
List of Relevant Environmental Documentation

LIST OF RELEVANT ENVIRONMENTAL DOCUMENTATION

Strategic Defense Initiative Organization, 1991. *Environmental Assessment for the Lightweight Exoatmospheric Projectile (LEAP) Test Program*, July.

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Appendix B
Distribution List

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Appendix C
Applicable Laws and Regulations, and Compliance Requirements

APPLICABLE LAWS AND REGULATIONS, AND COMPLIANCE REQUIREMENTS

Federal environmental laws and regulations were reviewed to assist in determining the significance of environmental impacts under the National Environmental Policy Act. Other applicable U.S. Army Kwajalein Atoll (USAKA) and Republic of the Marshall Islands laws and regulations were also reviewed in the same context. Proposed USAKA Environmental Standards and Procedures were reviewed in the USAKA Supplemental Environmental Impact Statement (SEIS). Under these proposed standards, a comprehensive set of environmental standards and procedures tailored to the unique environmental conditions at the USAKA would be adopted. The proposed standards and procedures would address seven functional areas of environmental concern that are associated with the unique environment of the area: air quality, water quality and reef protection, drinking water quality, wildlife (including rare, threatened, and endangered species), ocean dumping, hazardous material and waste management, and cultural resources. A comparison between existing standards and these new standards is contained in Appendices B (Regulatory Effect Comparison) and D (Cost Effect Comparison) of the USAKA SEIS. The conclusion of the regulatory effects comparison was that for almost all citations and regulations reviewed, the proposed USAKA standards were equal to or more comprehensive than the existing standards. Because the USAKA standards have not been officially adopted, the applicable Federal laws and regulations are presented in this appendix. Should the USAKA standards be finalized and adopted, they will be complied with.

The following discussion provides a brief review of Federal laws and regulations.

Air Quality – The Clean Air Act seeks to achieve and maintain air quality to protect public health and welfare (42 United States Code [USC] 7401 et seq). To accomplish this, Congress directed the Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS). Primary standards protect public health; secondary standards protect public welfare (e.g., vegetation, property damage, scenic value). NAAQS address six criteria pollutants: carbon monoxide, nitrogen oxides, lead, sulfur dioxides, ozone, and particulates.

Primary responsibility to implement the Clean Air Act rests with each state. However, each state must submit a state implementation plan (SIP) outlining the strategy for attaining and maintaining the NAAQS within the deadlines established by the act. If the state does not provide a SIP that is acceptable to the EPA, the EPA will provide a SIP which the state is then required to enforce.

The Clean Air Act mandates establishment of performance standards, called New Source Performance Standards, for selected categories of 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 National Emission Standards for Hazardous Air Pollutants for beryllium, mercury, asbestos, vinyl chloride, and other hazardous materials including radioactive materials.

The Clean Air Act also seeks to prevent significant deterioration of air quality in areas where the air is cleaner than that required by the NAAQS. Areas subject to prevention of significant deterioration regulations 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. The most widespread violation of the NAAQS is related to ozone. For ozone, urban areas are sorted into five categories: marginal, moderate, serious, severe, and extreme. Additionally, stratospheric ozone and climate protection policies have been established. Interim reductions in the phaseout of chlorofluorocarbons, methyl chloroforms, and halons have been mandated. Hydrochlorofluorocarbons must be phased out of production beginning in 2015, with production elimination set for 2030. State and local governments are required to implement policies which 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.

The Clean Air Act Amendments of 1990 represent the first significant revisions to the Clean Air Act in the past 13 years (42 USC 7401 et seq). The amendments strengthen and broaden earlier legislation by setting specific goals and timetables for reducing smog, airborne toxins, acid rain, and stratospheric ozone depletion over the next decade and beyond.

The Clean Air Act Amendments of 1990 contain 11 major titles which address various issues of the National Air Pollution Control Program. Title I, Attainment and Maintenance of National Ambient Air Quality Standards, mandates technology-based emissions control for new and existing major air pollution sources. Title II, Mobile Sources, deals with emissions control for motor vehicles in the form of tailpipe standards, use of clean fuels, and mandatory acquisition of clean-fuel vehicles. Hazardous Air Pollutants, Title III, mainly addresses the control of hazardous air pollutants (HAPs) and contingency planning for the accidental release of hazardous substances. There are 189 HAPs identified in the new amendments. Title IV, Acid Rain, focuses on the reduction of sulfur dioxide and nitrogen oxides in the effort to eliminate acid rain. Permits, Title V, establishes a nationwide permit program for air pollution sources. The permits will clarify operating and control requirements for affected stationary sources. Stratospheric Ozone Protection, Title VI, restricts the production and use of chlorofluorocarbons, halons, and other halogenated solvents which, when released into the atmosphere, contribute to the decomposition of stratospheric ozone. Title VII, Enforcement, describes civil and criminal penalties which may be imposed for the violation of new and existing air pollution control requirements. Title VIII of the 1990 amendments contains various miscellaneous provisions concerning the outer continental shelf, international border areas, grants, secondary standards, renewable energy incentives, and visibility. Information and rules related to clean air research can be found in Title IX. The EPA is to conduct studies on improved methods and techniques for measuring individual air pollutants, health effects associated with exposure to air pollutants, improvements in predictive models and response technology for accidental releases of dense gas, acid precipitation, clean fuels, and improved studies on the ecosystem, among others. Title X requires that a certain percentage of Federal funds, set aside for research required under the act, be made available to disadvantaged businesses. Title XI contains laws pertaining to Clean Air Employment Transition Assistance. Topics covered in this title include the Job Partnership Training Act provisions, funding, benefits, and eligibility requirements.

Airspace – The Federal Aviation Act of 1958 gives the Federal Aviation Administration (FAA) sole responsibility for the safe and efficient management of all airspace within the continental United States, a responsibility that must be executed in a manner that meets the needs of all airspace users, both civil and military. The FAA's policy on airspace is implemented by FAA Order 1000.1A and is stated in FAA Handbook 7400.2C, Procedures for Handling Airspace Matters, as follows:

> The navigable airspace is a limited national resource, the use of which Congress has charged the FAA to administer in the public interest as necessary to insure the safety of aircraft and the efficient utilization of such airspace. Full consideration shall be given to the requirements of national defense and of commercial and general aviation and to the public right of freedom or transit through the airspace. Accordingly, while a sincere effort shall be made to negotiate equatable [sic] solutions to conflicts over its use for non-aviation purposes, preservation of the navigable airspace for aviation must receive primary emphasis.
>
> (FAA Order 7400.2C CHG 4 § 1006, 1991)

The FAA regulates military operations in the National Airspace System through the implementation of FAA Handbook 7400.2 and FAA Handbook 7610.4G, Special Military Operations. The latter was jointly developed by the Department of Defense (DOD) and FAA to establish policy, criteria, and specific procedures for air traffic control planning, coordination, and services during defense activities and special military operations.

Part 7 of FAA Handbook 7400.2 contains the policy, procedures, and criteria for the assignment, review, modification, and revocation of special use airspace. Special use airspace, including prohibited areas, restricted areas, military operations areas, alert areas, and controlled firing areas, is airspace of defined dimensions wherein activities must be confined because of their nature and/or wherein limitation may be imposed upon aircraft operations that are not a part of those activities (FAA ORDER 7400.2C CHG 4, 1991).

DOD policy on the management of special use airspace is essentially an extension of FAA policy, with additional provisions for planning, coordinating, managing, and controlling those areas set aside for military use. Airspace policy issues or interservice problems that must be addressed at the DOD level are handled by the DOD Policy Board on Federal Aviation, a committee composed of senior representatives from each service. However, airspace action within the DOD is decentralized, with each service having its own central office to set policy and oversee airspace matters.

Executive Order 10854 extends the responsibility of the FAA to the overlying airspace of those areas of land or water outside the jurisdiction of the United States. Under this order, airspace actions must be consistent with the requirements of national defense, must not be in conflict with any international treaties or agreements made by the United States, nor be inconsistent with the successful conduct of the foreign relations of the United States.

Accordingly, actions concerning airspace beyond U.S. jurisdiction (19 kilometers [12 miles]) require coordination with the DOD and State Department, both of which have preemptive authority over the FAA (FAA Order 7400.2C CHG 4, § 1009, 1991).

Part 7 of FAA Handbook 7400.2 contains the policy, procedures, and criteria for the assignment, review, modification, and revocation of special use airspace overlying water, namely, warning areas. A warning area is airspace of defined dimensions over international waters that contains activity which may be hazardous to nonparticipating aircraft. Because international agreements do not provide for prohibition of flight in international airspace, no restriction of flight is imposed. The term "warning area" is synonymous with the International Civil Aviation Organization (ICAO) term "danger area" (FAA Order 7400.2C CHG 4, § 7400, 1991).

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 (16 USC 1531 et seq). Further, the act directs Federal agencies to use their authorities in furtherance of the purposes of the act.

Under the Endangered Species Act, 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.

A key provision of the Endangered Species 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 execution) is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat of such species.

Through the Fish and Wildlife Coordination 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 promote conservation of nongame fish and wildlife and their habitats (16 USC 2901 et seq). Further, the act encourages each state to develop a conservation plan.

The Fish and Wildlife Coordination Act requires a Federal department or agency that proposes or authorizes the modification, control, or impoundment of the waters of any stream or body of water (greater than 4.1 hectares [10 acres]), including wetlands, to first consult with the USFWS. 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 (16 USC 703-712). 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 affected Federal agency or department must consult with the USFWS to evaluate ways to avoid or minimize adverse effects on migratory birds.

The Marine Mammal Protection Act (16 USC 1361 et seq.) establishes a moratorium on the taking and importation of marine mammals and marine mammal products. The act also provides for penalties for the use of fishing methods in contravention of any regulations or limitations enacted by the governmental agencies to achieve the purposes of the Marine Mammal Act. The Marine Mammal Commission, which was established under the act, reviews laws and international conventions, studies world-wide populations, and makes recommendations to Federal officials concerning marine mammals.

The National Marine Sanctuaries Act (16 USC 1431), which is Title III of the Marine Protection, Research, and Sanctuaries Act of 1972, seeks to enhance both public awareness and conservation of the marine environment. The purposes and policies of the act are to identify areas of national significance, to provide coordinated management of these marine areas, to support scientific research of these areas, to enhance public awareness of the marine environment, and to facilitate public use of marine resources when not in conflict with the other policies.

Cultural Resources – The Archaeological Resources Protection Act of 1979 (P.L. 96-95; 93 STAT. 722; 16 U.S.C. 470aa-47011) provides guidelines for dealing with archaeological resources on public and Native American land. It details the permit procedures necessary for excavation and outlines the criminal and civil penalties for the illegal removal of archaeological materials from Federal land.

The Historic Sites Act of 1935 (P.L. 74-292; 49 STAT. 666; 16 U.S.C 461-467) declares it to be "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." It establishes the National Park Service (through the Secretary of the Interior) as the caretaker of the Nation's cultural resources and empowers them to execute the Act's policies, including criminal sanctions. It also establishes a general advisory board, known as the "Advisory Board on National Parks, Historic Sites, Buildings, and Monuments," to advise on any matter relating to national parks, historic and archaeological sites, buildings, and properties.

The National Historic Preservation Act of 1966, amended through 1992 (P.L. 89-665; 80 STAT. 915; 16 U.S.C. 470; 36 CFR 800) establishes a program for the preservation of historic properties throughout the nation. The Act authorizes the Secretary of the Interior to "expand and maintain a national register of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture, hereinafter referred to as the National Register. . ." This Act also establishes an independent Agency of the U.S. Government, the Advisory Council on Historic Preservation, to "advise the President and the Congress on matters relating to historic preservation" and to implement and monitor the Historic Preservation Act. The most commonly cited sections of this Act are Section 106 and Section 110:

Section 106 requires each agency to take into account the effects of its actions on historic properties and afford the Advisory Council on Historic Preservation an opportunity to comment on any undertaking.

Section 110 requires that all Federal agencies carry out their programs in accordance with national historic preservation policy, designate historic preservation officers, identify and preserve historic properties under their ownership, and minimize harm to National Historic Landmarks.

In addition, the Fowler Amendment (Public Law 102-575, November 1992) to the National Historic Preservation Act (NHPA) specifically extended coverage to the RMI and resolved ambiguities concerning the applicability of the NHPA to USAKA undertakings.

The National Natural Landmarks Program (P.L. 74-292; 36 CFR 62) sets forth the processes and criteria used to identify, study, designate, recognize, and monitor National Natural Landmarks.

Hazardous Materials and Waste – Under the Resource Conservation and Recovery Act (RCRA), Congress declares the national policy of the United States to be, whenever feasible, the reduction or elimination, as expeditiously as possible, of hazardous waste (42 USC 6901 et seq). 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.

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

The RCRA also establishes a specific permit program for the treatment, storage, and disposal of hazardous waste. 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.

The RCRA defines solid waste as any garbage, refuse, or 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, the RCRA provides for the development of state plans for waste disposal and resource recovery. The RCRA encourages and affords assistance for solid waste disposal methods that are environmentally sound, maximize the utilization of valuable resources, and encourage resource conservation. The 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 (42 USC 9601 et seq).

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 CERCLA-mandated program (Superfund) 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 (SARA) (42 USC 9601 et seq) is a freestanding legislative program known as the Emergency Planning and Community Right to Know Act of 1986. The act requires immediate notice for accidental releases of hazardous substances and extremely hazardous substances; provision of information to local emergency planning committees for the development of emergency plans; and availability of Material Safety Data Sheets, emergency and hazardous chemical inventory forms, and toxic release forms. (Emergency Planning and Community Right-to-Know Act of 1986, 42 USC 11001 et seq)

The Emergency Planning and Community Right to Know Act (EPCRA) of 1986 requires each state to designate a state emergency response commission. In turn, the state must designate emergency planning districts and local emergency planning commissions (42 USC 11001 et seq). The primary responsibility for emergency planning is at the local level.

The Pollution Prevention Act of 1990 established that pollution should be prevented at the source, recycled or treated in an environmentally safe manner, and disposed of or otherwise released only as last resort. Executive Order 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," commits Federal agency planning, management, and acquisition to the Pollution Prevention Act of 1990. It also requires all Federal facilities to comply with the EPCRA, develop a written pollution prevention strategy emphasizing source reduction, and develop voluntary goals to reduce total releases and off-site transfers of Toxic Release Inventory toxic chemicals by 50 percent by 1999.

The Toxic Substances Control Act (TSCA) authorizes the administrator of the EPA broad authority to regulate chemical substances and mixtures which may present an unreasonable risk of injury to human health or the environment (15 USC 2601 et seq).

Under the TSCA the EPA may regulate a chemical when the administrator finds that there is a reasonable basis to conclude that the manufacture, processing, distribution in commerce, use, or disposal of a chemical substance or mixture poses or will pose an unreasonable risk of injury to health or the environment.

Under the TSCA the EPA administrator, upon a finding of unreasonable risk, has a number of regulatory options or controls. The EPA's authority includes total or partial bans on production, content restrictions, operational constraints, product warning statements, instructions, disposal limits, public notice requirements, and monitoring and testing obligations.

The TSCA Chemical Substance Inventory is a database providing support for assessing human health and environmental risks posed by chemical substances. As such, the inventory is not a list of toxic chemicals. Toxicity is not a criterion used in determining the eligibility of a chemical substance for inclusion on the inventory.

Health and Safety – The purpose of the Occupational Safety and Health Act is to assure, so far as possible, every working man and woman in the nation safe and healthful working conditions and to preserve human resources (29 CFR, Parts 1900-1990, as amended).

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
- Report annually to the Secretary of Labor

Finally, the SARA (42 USC 9601 et seq) requires the Occupational Safety and Health Administration to issue regulations specifically designed to protect workers engaged in hazardous waste operations. The hazardous waste rules include requirements for hazard communication, medical surveillance, health and safety programs, air monitoring, decontamination, and training.

Executive Order 12898 directs Federal actions to address environmental justice in minority and low-income populations. Each Federal agency must conduct its programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that they do not exclude persons from participation or benefit. Persons will also not be discriminated against under such programs, policies, or activities because of their race, color, or national origin.

Land Use – The Coastal Zone Management Act of 1972 (16 USC 1451 et seq.) is designed to preserve and develop the resources of the coastal zone. The act seeks to do so by providing funds to states that develop and implement programs for management of land and water uses consistent with the act's standards.

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 free from noise that jeopardizes the health or welfare of any American (42 USC 4901 et seq). 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 (33 USC 1251 et seq).

The Clean Water Act prohibits any discharge of pollutants into any public waterway unless authorized by a permit (33 USC 1251 et seq). Under the Clean Water Act the National Pollutant Discharge Elimination System (NPDES) permit establishes precisely defined requirements for water pollution control.

NPDES permit requirements typically include effluent limitations (numerical limits on the quantity of specific pollutants allowed in the discharge); compliance schedules (abatement program completion dates); self-monitoring and reporting requirements; and miscellaneous provisions governing modifications, emergencies, etc.

Under the Clean Water Act 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 U.S. waters to comply with applicable Federal, interstate, state, and local requirements.

The Safe Drinking Water Act sets primary drinking water standards for owners or operators of public water systems and seeks to prevent underground injection that can contaminate drinking water sources (42 USC 300f et seq).

Under the Safe Drinking Water Act, the EPA has adopted National Primary Drinking Water Regulations (40 CFR, Part 141) that define maximum contaminant levels in public water systems. In addition, under the Safe Drinking Water Act 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.

Appendix D
Kwajalein Atoll Endangered Species

KWAJALEIN ATOLL ENDANGERED SPECIES

Table D-1: Federally Listed Threatened and Endangered Species Known or Expected to Occur at the USAKA

Common Name	Scientific Name	Status
Dugong	*Dugong dugon*	E[a]
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E
Leatherback Sea Turtle	*Dermochelys coriacea*	E
Green Sea Turtle	*Chelonia mydas*	T
Loggerhead Sea Turtle	*Caretta caretta*	T[b]
Olive Ridley Sea Turtle	*Lapidochelys olivacea*	T
Blue Whale	*Balaenoptera musculus*	E
Finback Whale	*Balaenoptera physalus*	E
Humpback Whale	*Megaptera novaeangliae*	E
Sperm Whale	*Physeter catodon*	E

[a] E = endangered
[b] T = threatened
Source: U.S. Army Space and Strategic Defense Command, 1993

Table D-2: Species Protected Under the Republic of the Marshall Islands Statutes Known or Expected to Occur at the USAKA

Common Name	Scientific Name	Statute*
Blue Whale	*Balaenoptera musculus*	1[a]
Sperm Whale	*Physeter catodon*	1
Ratak Micronesian Pigeon	*Ducula oceania ratakensis*	1
Hawksbill Sea Turtle	*Eretmochelys imbricata*	1,4[d]
Leatherback Sea Turtle	*Dermochelys coriacea*	1
Green Sea Turtle	*Chelonia mydas*	4
Loggerhead Sea Turtle	*Caretta caretta*	4
Olive Ridley Sea Turtle	*Lapidochelys olivacea*	4
Offshore Spotted Dolphin	*Stenella attenuata attenuata*	2[b]
Coastal Spotted Dolphin	*Attenuata graffmani*	2
Eastern Spinner Dolphin	*Stenella longirostris orientalis*	2
Whitebelly Spinner Dolphin	*Stenella longirostris longirostris*	2
Costa Rican Spinner Dolphin	*Stenella longirostris centroamericana*	2
Common Dolphin	*Delphinus delphis*	2
Striped Dolphin	*Stenella coeruleoalba*	2
Any small-toothed cetacean	Various spp.	2
Trochus	*Trochus niloticus*	3[c]
Trochus	*Trochus maximus*	3
All sponges	Various spp.	4
Black-lip Mother-of-Pearl Oyster	*Pinctada margaritifera*	4

* RMI Statutes:

[a] 1) Republic of the Marshall Islands Endangered Species Act, COM P.L. 6-55(1975) 45 TTC 1980

[b] 2) Republic of the Marshall Islands Marine Mammal Protection Act 0f 1990, P.L. 1990-84

[c] 3) Republic of the Marshall Islands Marine Resources (Trochus) Act of 1983, P.L. 1983-15, 1

[d] 4) Republic of the Marshall Islands Marine Resources Act, TTC 1966, 45 TTC 1970, COM P.L. 4C-35 (1972), COM P.L. 4C-57 (1972), 45 TTC 1980

Source: U.S. Army Space and Strategic Defense Command, 1993

Table D-3: Species Protected Under the U.S. Marine Mammal Protection Act Known or Expected to Occur at the USAKA

Common Name	Scientific Name	Status
Spinner Dolphin	*Stenella longirostris*	Resident
Pacific Bottlenose Dolphin	*Tursiops gilli*	Resident
Pygmy Sperm Whale	*Kogia breviceps*	Migratory
Pilot Whale	*Globicephala macrorhynehus*	Migratory
Humpback Whale	*Megaptera novaeangliae*	Migratory
Sperm Whale	*Physeter catodon*	Resident
Blue Whale	*Balaenoptera musculus*	Migratory
Finback Whale	*Balaenoptera physalus*	Migratory
False Killer Whale	*Pseudorca crassidens*	Migratory
Melon Headed Whale	*Peponocephala electra*	Resident
Pygmy Killer Whale	*Feresa attenuata*	Resident
Risso's Dolphin	*Grampus griseus*	Resident
Bottlenose Dolphin	*Tursiops* sp.	Resident
Killer Whale	*Orcinus orca*	Resident
Blainville's Beaked Whale	*Mesoplodon densirostris*	Migratory

Source: U.S. Army Space and Strategic Defense Command, 1993

Table D-4: Species Protected Under the U.S. Migratory Bird Conservation Act Known or Expected to Occur at the USAKA (Page 1 of 2)

Common Name	Scientific Name	Status
Mottled Petrel	*Pterodroma inexpectata*	Rare Migrant
Wedge-tailed Shearwater	*Puffinus pacificus*	Uncommon Visitor
Sooty Shearwater	*Puffinus griseus*	Common Migrant
White-tailed Tropicbird	*Phaethon lepturus*	Rare Visitor
Red-tailed Tropicbird	*Phaethon rubricauda*	Rare Visitor
Brown Booby	*Sula leucogaster*	Uncommon Resident
Red-footed Booby	*Sula sula*	Uncommon Resident
Great Frigatebird	*Fregata minor*	Uncommon Resident
Pacific Reef Heron	*Egretta sacra*	Common Resident
Cattle Egret	*Bubulcus ibis*	Rare Vagrant
Canada Goose	*Branta canadensis*	Accidental Vagrant
Green-winged Teal	*Anas crecca*	Uncommon Migrant
Mallard	*Anas platyrhyncos*	Rare Migrant
Nothern Pintail	*Anas acuta*	Uncommon Migrant
Garganey	*Anas querquedula*	Accidental Vagrant
Northern Shoveler	*Anas clypeata*	Uncommon Migrant
Tufted Duck	*Aythya fuligula*	Accidental Vagrant
Black-bellied Plover	*Pluvialis squatrarola*	Uncommon Migrant
Lesser Golden Plover	*Pluvialis dominica*	Abundant Migrant
Mongolian Plover	*Charadrius mongolus*	Uncommon Migrant
Common Ringed Plover	*Charadrius hiaticula*	Accidental Migrant
Semipalmated Plover	*Charadrius semipalmatus*	Accidental Migrant
Greater Yellowlegs	*Tringa melanoleuca*	Accidental Migrant
Lesser Yellowlegs	*Tringa flavipes*	Accidental Migrant
Marsh Sandpiper	*Tringa haemastica*	Accidental Migrant
Wood Sandpiper	*Tringa glareola*	Accidental Migrant
Wandering Tattler	*Heteroscelus incanus*	Common Migrant
Grey-tailed Tattler	*Heteroscelus brevipes*	Uncommon Migrant
Whimbrel	*Numenius phaeopus*	Common Migrant
Bristle-thighed Curlew	*Numenius tahitiensis*	Uncommon Migrant
Black-tailed Godwit	*Limosa limosa*	Rare Migrant
Hudsonian Godwit	*Limosa haemastica*	Accidental Migrant
Bar-tailed Godwit	*Limosa lapponica*	Uncommon Migrant
Ruddy Turnstone	*Arenaria interpres*	Abundant Migrant
Sanderling	*Calidris alba*	Uncommon Migrant
Pectoral Sandpiper	*Calidris melanotos*	Accidental Migrant
Sharp-tailed Sandpiper	*Calidris acuminata*	Uncommon Migrant
Curlew Sandpiper	*Calidris ferruginea*	Accidental Migrant

Table D-4: Species Protected Under the U.S. Migratory Bird Conservation Act Known or Expected to Occur at the USAKA (Page 2 of 2)

Common Name	Scientific Name	Status
Black-naped Tern	*Sterna sumatrana*	Common Resident
Little Tern	*Sterna albifrons*	Accidental Visitor
Sooty Tern	*Sterna fuscata*	Uncommon Visitor
Brown Noddy	*Anous stolidus*	Common Resident
Black Noddy	*Anous minutus*	Abundant Resident
White Tern	*Gygis alba*	Common Resident
Fork-tailed Swift	*Apus pacificus*	Accidental Vagrant

Source: U.S. Army Space and Strategic Defense Command, 1993

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U.S. Army Space and Strategic Defense Command, 1993. *Final Supplemental Environmental Impact Statement for Proposed Actions at U.S. Army Kwajalein Atoll*, December.

Appendix E
Air Quality Standards and Modeling

AIR QUALITY STANDARDS AND MODELING

Air Quality Standards

In compliance with the Clean Air Act (CAA), the U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM-10), and sulfur dioxide (SO_2) (table E-1). The primary NAAQS are designed to protect public health with an adequate margin of safety, and the secondary NAAQS are designed to address harm to environmental and economic interests.

Prior to the 1990 Amendments to the CAA, Federal regulation of hazardous air emissions was limited. However, Title III of the CAA requires the EPA to define categories and sources of hazardous air pollutants (HAPs), determine how to control these sources using maximum achievable control technology, and establish accidental release prevention programs.

Specifically, Section 112(r) of Title III of the CAA requires facilities that use hazardous substances in quantities above specific threshold levels to prepare risk management plans to prevent and control accidental HAP releases. The types of substances and threshold quantities are given in 40 Code of Federal Regulations (CFR) Part 68.130.

The regulatory requirements of Section 112(r) of the CAA and the requirements of the Emergency Planning and Community Right-to-Know Act (EPCRA), commonly known as Superfund Amendments and Reauthorization Act Title III, both come from EPA's Chemical Emergency Preparedness Program, began in 1985 as part of EPA's Air Toxics Strategy. However, the requirements of these two programs differ in a number of ways. First, neither the substances nor their threshold quantities are the same for the two programs. The most important difference between EPCRA and 112(r) comes from the fact that under EPCRA it is state and local emergency planning groups that are required to develop emergency response plans for each community based on information provided to them by facilities on the hazardous chemicals they have on-site. Under 112(r), however, it is the facilities themselves that must develop detailed Risk Management Plans, that include a hazard assessment, a prevention program, and an emergency response program.

At present the CAA is applicable to activities at the U.S. Army Kwajalein Atoll (USAKA) and Bigen Island as defined by the Compact of Free Association between the Republic of the Marshall Islands (RMI) and the United States. A proposed new set of standards, the Environmental Standards and Procedures for United States Army Kwajalein Atoll Activities in the Republic of the Marshall Islands, are delineated and their environmental consequences analyzed in the USAKA Supplemental Environmental Impact Statement (EIS) (U.S. Army Space and Strategic Defense Command, 1993). For both the present and proposed conditions, the NAAQS are applicable standards.

Table E-1: National Ambient Air Quality Standards

Pollutants	Averaging Time	National Standards[a] Primary[b,c]	Secondary[b,d]
Ozone	1-hour	0.12 ppm (235 μg/m^3)	Same as primary standard
Carbon monoxide	8-hour	9 ppm (10 μg/m^3)	–
	1-hour	35 ppm (40 μg/m^3)	–
Nitrogen dioxide	Annual	0.053 ppm (100 μg/m^3)	Same as primary standard
Sulfur dioxide	Annual	80 μg/m^3 (0.03 ppm)	–
	24-hour	365 μg/m^3 (0.14 ppm)	–
	3-hour	–	1,300 μg/m^3 (0.5 ppm)
PM-10	Annual 24-hour	50 μg/m^3[e] 150 μg/m^3	Same as primary standard
Lead	Quarterly	1.5 μg/m^3	Same as primary standard

Notes:

(a) National standards, other than ozone and those based on annual averages or annual arithmetic means, are not to be exceeded more than once a year. The ozone standard is attained when the expected number of days per calendar year, with maximum hourly average concentrations above the standard, is equal to or less than 1.

(b) Concentration expressed first in units in which it was promulgated. Equivalent units given in parenthesis are based on a reference temperature of 25 degrees Celsius (°C) (77 degrees Fahrenheit [°F]) and a reference pressure of 760 millimeters of mercury. All measurements of air quality are to be corrected to a reference temperature of 25°C (77°F) and a reference pressure of 760 millimeters of mercury (1,013.2 millibar); ppm in this table refers to ppm by volume, or micromols of pollutant per mole of gas.

(c) National Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health. Each state must attain the primary standards no later than 3 years after that state's implementation plan is approved by the U.S. EPA.

(d) National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after the implementation plan is approved by the U.S. EPA.

(e) Calculated as arithmetic mean.

Source: Clean Air Act, 42 USC 7401 et seq.

Other relevant requirements of the CAA are discussed in the USAKA EIS and USAKA Supplemental EIS (U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993).

Air Quality Analysis

Launch operations constitute the largest source of uncontrolled emissions into the atmosphere for the USAKA temporary extended test range project. These emissions are generated in the ground cloud at lift-off, and along the launch trajectory. Emissions are associated with the oxidation of fuel and propellants. Emission composition is determined by the type and composition of the various propellants (fuels and oxidizers).

USAKA temporary extended test range activities would include the launch of target missiles from Bigen Island and potentially the launch of PATRIOT missiles from either Meck Island or Illeginni Island. The short range target missiles launched from Bigen Island may be either solid or liquid propellant. The solid propellant missile being analyzed is the Hera missile, and the liquid propellant missile being analyzed is the notional Extended Range Lance (ERL) missile.

The Hera missile consists of the SR19-AJ-1 rocket motor as a first stage and the M57A1 rocket motor as the second stage (U.S. Army Space and Strategic Defense Command, 1994). The total combustion products from these rocket motors are given in table 4-1. The chemical species listed in table 4-1 are those that occur shortly after the exhaust exits the rocket motor nozzle. It is likely that due to the high temperature of the exhaust chemical reactions continue to occur in the exhaust. This will naturally cause some changes in the relative amounts, and even the occurrence, of the various chemical species. However, data is not known to exist for the exhaust cloud once it reaches equilibrium, and it is not anticipated that the species or their amounts will differ significantly from those given. The analysis in this document of a solid propellant launch vehicle uses the emissions given in table 4-1.

The major emission products from solid propellant rocket motors are carbon monoxide, aluminum oxide, and hydrogen chloride. Carbon monoxide is a criteria pollutant, and will be compared to its corresponding NAAQS (see table E-1).

Aluminum oxide has a very low toxic potential. The aluminum oxide in the rocket exhaust is a solid dust. Thus, as the most conservative estimate all of the aluminum oxide can be assumed to be PM-10, and then compared to that NAAQS. Also, the aluminum oxide concentrations will be compared to the 8-hour American Conference of Governmental Industrial Hygienists standard given in table E-2. This standard is also not specific to aluminum oxide, but is a standard for dust.

Hydrogen chloride is not a criteria pollutant, but is one of the 189 HAPs listed in Title III of the CAA. Its concentrations will be compared to the guidelines from the National Research Council (1987) and the U.S. Environmental Protection Agency (1992), as given in table E-2.

Typical constituents of the notional ERL liquid propellant rocket motors include approximately 360 kilograms (800 pounds) of unsymmetrical dimethylhydrazine (UDMH) and approximately 1,100 kilograms (2,400 pounds) of inhibited red fuming nitric acid (IRFNA). The total combustion products from these propellants are given in table 4-2. The analysis in this document of a liquid propellant launch vehicle uses the emissions given in table 4-2.

The major emission products from liquid propellant rocket motors are water, carbon dioxide, nitrogen, carbon monoxide, oxygen, and nitric oxide. Carbon monoxide is a criteria pollutant, and will be compared to its corresponding NAAQS (see table E-1).

Flight Scenarios

The analysis of potential ambient air quality impacts from proposed USAKA temporary extended test range activities considers both normal launch and early flight termination scenarios. For the most part, it is assumed that during either scenario the only air pollutants emitted are the exhaust from the rocket motor combustion products.

Table E-2: Exposure Guidelines for Hydrogen Chloride and Aluminum Oxide

Pollutant	Exposure Duration	Guideline	Exposure Term	Application	Organization
HCl	10 minutes	100 ppm (150 mg/m^3)	Emergency Exposure Guidance Level (EEGL)[a]	Workplace	National Research Council (NRC)[b]
	15 minutes	20 mg/m^3	Maximum Likelihood Estimate (MLE)[c]	Public	EPA[d]
	30 minutes	100 ppm (150 mg/m^3)	Immediately dangerous to life and health[e]	Workplace	National Institute for Occupational Safety and Health[f]
	1 hour	20 ppm (30 mg/m^3)	EEGL	Workplace	NRC[b]
	1 hour	6 mg/m^3	MLE[c]	Public	EPA[d]
	1 hour	1 ppm (1.5 mg/m^3)	Short-term Public Emergency Guidance Level (SPEGL)[g]	Public	NRC[b]
	24 hours	20 ppm (30 mg/m^3)	EEGL[a]	Workplace	NRC[b]
	24 hours	1 ppm (1.5 mg/m^3)	SPEGL[g]	Public	NRC[b]
	8-hour days for 40-hour/week	5 ppm (7 mg/m^3)	Permissible exposure limit – ceiling[h]	Workplace	Occupational Safety and Health Administration (29 CFR 1910.1000)
	8-hour days for 40-hour/week	5 ppm (7.5 mg/m^3)	Threshold limit value – ceiling[h]	Workplace	American Conference of Governmental Industrial Hygienists[i]
	90 days	0.5 ppm (0.7 mg/m^3)	Continuous Exposure Guidance Level[j]	Workplace	NRC[b]
Aluminum oxide (Al_2O_3) as aluminum dust	8 hours	10 mg/m^3	Threshold limit value – time-weighted average	Workplace	American Conference of Governmental Industrial Hygienists[i]

[a] Concentration that will permit continued performance of specific tasks during rare emergency conditions

[b] National Research Council, 1987

[c] Concentration at which the Maximum Likelihood Estimate predicts only a 1 percent probability that any adverse effects will be observed (and a 99 percent probability that no adverse effect will be observed); derived from Figure 4 of U.S. Environmental Protection Agency, 1992

[d] U.S. Environmental Protection Agency, 1992

[e] Concentration from which one could escape within 30 minutes without a respirator and without experiencing any escape-impairing or irreversible health effects.

[f] U.S. Department of Health and Human Services, 1990

[g] Suitable concentration for unpredicted, single, short-term, emergency exposure of the general public

[h] Ceiling value which should not be exceeded at any time for the duration of the exposure

[i] American Conference of Government Industrial Hygienists, 1992

During a normal launch scenario the missile accelerates while the rocket motors of the missile's stage or stages burn. This boost stage normally lasts only a few minutes. While the rocket motors are burning the missile is accelerating; therefore a higher concentration of combustion products occurs near the launch site than along the rest of the flight path.

Only a part of the exhaust products emitted during a normal flight will have any effect on the ambient air quality. Under the CAA, ambient is that portion of the atmosphere that is both external to buildings and to which the general public has access (40 CFR 50.1). Only that portion of the exhaust products that are emitted while the missile is in the troposphere has the potential to affect the ambient air quality. This is because air and pollutants above the troposphere mix extremely slowly with the air in the troposphere (Seinfeld, 1986). The troposphere exists from ground level to an altitude of approximately 14 kilometer (9 miles) (Seinfeld, 1986).

The combustion products exhaust is much hotter than the ambient air (typically a few thousand degrees Celsius). Because of this, buoyancy causes the cloud of rocket exhaust that was released near the ground to rise until it reaches an equilibrium height. For the Aries missile, whose propellant mass is approximately equal to that of the Hera missile, the ground cloud is expected to rise to heights of 100 to 400 meters (329 to 1,312 feet) (Strategic Defense Initiative Organization, 1991). This process is discussed in detail in the Supplemental Final Environmental Impact Statement for the Space Shuttle Advanced Solid Rocket Motor Program (National Aeronautics and Space Administration, 1990).

In addition to pollutants above the troposphere being essentially excluded from affecting ground-level air quality, pollutants that are above the top of the mixing layer, which exists below the top of the troposphere, are also excluded from affecting ground-level air quality. The mixing height (or depth) is defined as the height above the surface through which relatively vigorous vertical mixing occurs; the value of the mixing height is set primarily by the atmosphere's local vertical temperature profile (U.S. Environmental Protection Agency, 1972). The reason that pollutants emitted above these excluding layers have little or no effect on ambient air quality is that the pollutants become diluted in the very large volume of air in these layers before they are very slowly transported down to ground level.

Normally higher mixing heights lead to better air quality because they afford a larger volume of air in which emitted pollutants may diffuse, and thus reach lower ground level concentrations. This is always the case for normal sources of pollutants, such as smoke stacks. However, depending on how high a missile's ground cloud rises before reaching its equilibrium height, the reverse may be the case. If the ground cloud rises above the height of the mixing layer then, due to the excluding effect, essentially none of the rocket emissions will affect the ambient air quality. (National Aeronautics and Space Administration, 1990)

The other flight scenario considered is missile failure. This includes vehicle destruction on the pad, in-flight failure, and command vehicle destruction. Emissions from these scenarios would be the same as those during a normal launch, with the exception of a launch pad accident or one very shortly after liftoff. Otherwise the emissions would occur at an altitude that would allow significant dilution of the pollutants before they reached ground level.

Air Quality Modeling of Missile Flight Scenarios

The short-term air quality impacts caused by the launch of an individual target missile were modeled with the TSCREEN PUFF computer model. TSCREEN PUFF is part of TSCREEN, which is an Environmental Protection Agency application package of three screening dispersion computer models (U.S. Environmental Protection Agency, 1990). More specifically, TSCREEN automates the screening techniques from "A Workbook of Screening Techniques for Assessing the Impacts of Toxic Air Pollutants" (U.S. Environmental Protection Agency, 1988). Screening techniques use simplifying assumptions and generate estimates which are generally upper bounds on expected pollutant concentrations. The Environmental Protection Agency recommends that screening models be used first, and if the results exceed applicable concentration limits then a more refined model should be used (U.S. Environmental Protection Agency, 1978).

Most sources of air pollution are continuous sources (e.g., emissions from stacks or equipment leaks); however, emissions from missile launches are essentially instantaneous. The TSCREEN PUFF model is designed for use with instantaneous releases of pollutants, such as equipment openings or relief valve discharges. TSCREEN PUFF is programmed to select the atmospheric stability class that yields the maximum ground-level pollutant concentration. (U.S. Environmental Protection Agency, 1988; 1978).

As inputs TSCREEN PUFF requires the mass of the puff of material released and the elevation at which the puff was released. As mentioned, for normal flights only a portion of the missile exhaust would be released below the top of the mixing layer. Using a conservative approach, for all modeling performed, the mass of the puff released during a normal flight was assumed to equal the total emissions from the first stages for the target missile.

For the TSCREEN model calculations the puff of emissions was assumed to be released at its final ground cloud height. Although this assumption tends to under predict concentrations very near the launch site, it will not significantly affect concentrations at points beyond the distance at which final ground cloud rise is reached. This assumption is generally made for these types of analyses (Strategic Defense Initiative Organization, 1991; U.S. Department of the Air Force, 1988). As mentioned earlier, the final altitude for ground clouds for Aries missiles are expected to be 100 to 400 meters (328 to 1,312 feet) (Strategic Defense Initiative Organization, 1991). Following the example of the previous analysis (Strategic Defense Initiative Organization, 1991), the conservative values of 100 meters (328 feet) and 200 meters (656 feet) were chosen for the release heights of the notional ERL and Hera target missiles' puff of emissions, respectively.

Furthermore, the TSCREEN PUFF model uses the conservative values of 320 meters (1,050 feet) for the mixing height, which is above the assumed release height. Therefore all the material in the puff will affect the calculated ground-level concentrations. Furthermore, the TSCREEN PUFF model uses the very conservative value of 3.7 kilometers per hour (2.3 miles per hour) for the wind speed. Stronger wind speeds such as those typical in the Central Pacific tend to more quickly disperse, and thus dilute, the emitted pollutants.

For the missile failure, it is assumed that the mass of the puff equals all of the emissions from the target first stage rocket motor plus all emissions from the second stage rocket motor. For a missile failure that involved this type of total conflagration the final rise height of the ground cloud would be greater than that for a normal launch due to the greater amount of energy released, and thus greater temperature of the exhaust (Strategic Defense Initiative Organization, 1991). However, in keeping with choosing values that will give conservative estimates for the air quality impacts, the same values as for normal launches, 100 meters (328 feet) and 200 meters (656 feet), were used for the computations.

Results of the Air Quality Modeling

The TSCREEN PUFF computer model provides ground-level pollutants in terms of peak instantaneous concentrations and time-mean concentrations of up to 60 minutes. Time-mean concentrations for time periods longer than 1 hour are customarily estimated by a power law equation (U.S. Department of Health, Education, and Welfare, 1970). The power law equation used is $x_S = x_K * (t_K / t_S)^p$, where x_S is the time-mean concentration for the desired longer time t_S, x_K is the time-mean concentration at the known time t_K, and p is the "power" to which you are raising the ratio of the times. The value of p between 0.17 and 0.20 is normally used (U.S. Department of Health, Education, and Welfare, 1970). This method is more reliable for shorter than for longer time periods, and for continuous than for instantaneous sources. Thus, for missile launches extrapolating to even 8-hour time-mean concentrations is of questionable utility. For this reason, an aluminum oxide 24-hour time-mean concentration was not calculated for comparison to the 24-hour PM-10 NAAQS. In the 8-hour time-mean calculations a value of $p = 0.20$ was used in order that the most conservative, that is largest, time-mean concentrations were calculated. Local background concentrations need to be added to the time-mean concentrations calculated for missile launches. This is most applicable to carbon monoxide and aluminum oxide (as PM-10).

Results from the air quality modeling for the normal launch scenario of a Hera missile are given in table E-3. The results are clearly below the corresponding NAAQS and guideline values. Results from the air quality modeling for the missile failure accident scenario of a Hera missile are given in table E-4. Again, with only one exception, the computed values are well below the applicable NAAQS and guideline values.

The one exception is that for distances of up to 6 kilometers (4 miles) downwind of the launch site the Short-term Public Guideline Level for HCl is exceeded. However, because of the prevailing northeasterly trade winds at Bigen Island, no islands lie within 6 kilometers (4 miles) downwind of the launch site. Therefore, it is not expected that the public will be exposed to concentrations greater than 1.5 milligrams per cubic meter of HCl in the case of an accident involving an on-pad missile conflagration.

Results from the air quality modeling for the normal launch scenario of a notional ERL missile are given in table E-5. The results are clearly below the corresponding NAAQS for carbon monoxide. Results from the air quality modeling for the missile failure accident scenario of a notional ERL missile are given in table E-6. Again, the computed values are well below the applicable NAAQS for carbon monoxide.

Table E-3: Estimated Concentration from Normal Launch of Storm Missile (mg/m³)[a,b]

Pollutant	Release kg (lb)	Average Period	Guideline (mg/m³)	Exposure Term	Distance Downwind km (mi) 1 (0.6)	3 (1.9)	5 (3.1)	7 (4.3)	10 (6.2)	30 (18.6)
Hydrogen	1,401.8	1 hour	6	MLE[c]	0.963	1.684	1.371	1.006	0.719	0.465
Chloride	(3,090.4)	15 minutes	20	MLE[c]	3.854	6.453	4.365	2.611	1.727	0.821
Carbon	1,327.0	8 hours	10	NAAQS[d]	0.602	1.052	0.856	0.628	0.449	0.291
Monoxide	(2,925.5)	1 hour	40	NAAQS[d]	0.912	1.594	1.298	0.952	0.681	0.441
Sulfur	1,766.6	3 hours	10	TLV-TWA[e]	0.801	1.400	1.140	0.836	0.598	0.387
Dioxide	(3,894.6)	1 hour	–	–	1.214	2.122	1.727	1.267	0.906	0.587

[a]Emissions from SR19-AJ-1 rocket motor
[b]Values used in TSCREEN PUFF model (U.S. Environmental Protection Agency, 1990):
release height = 200 meters (656 feet)
wind speed = 1 meter per second (2.3 miles per hour)
mixing height = 320 meters (1,050 feet)
[c]Maximum Likelihood Estimate (Environmental Protection Agency, 1992)
[d]National Ambient Air Quality Standards (40 CFR 50.109)
[e]Threshold Limit Value – Time-weighted Average (American Conference of Government Industrial Hygienists, 1992)

Table E-4: Estimated Concentration from Two-Stage Accident of Storm Missile (mg/m³)[a,b]

Pollutant	Release kg (lb)	Average Period	Guideline (mg/m³)	Exposure Term	Distance Downwind km (mi) 1 (0.6)	3 (1.9)	5 (3.1)	7 (4.3)	10 (6.2)	30 (18.6)
Hydrogen	1,733.2	1 hour	30	EEGL[c]	1.191	2.082	1.695	1.243	0.889	0.576
Chloride	(3,821)	1 hour	1.5	SPEGL[d]	1.191	2.082	1.695	1.243	0.889	0.576
Carbon	1,747.5	8 hours	10	NAAQS[e]	0.792	1.384	1.128	0.827	0.592	0.383
Monoxide	(3,852)	1 hour	40	NAAQS[e]	1.201	2.099	1.709	1.254	0.897	0.580
Aluminum	2,299.3	8 hours	10	TLV-TWA[f]	1.042	1.822	1.483	1.088	0.778	0.503
Oxide	(5,069)	1 hour	–	–	1.580	2.762	2.248	1.649	1.180	0.763

[a]Emissions from SR19-AJ-1 and M57A1 rocket motors
[b]Values used in TSCREEN PUFF model (U.S. Environmental Protection Agency, 1990):
release height = 200 meters (656 feet)
wind speed = 1 meter per second (2.3 miles per hour)
mixing height = 320 meters (1,050 feet)
[c]Emergency Exposure Guidance Level (National Research Council, 1987)
[d]Short-term Public Emergency Guidance Level (National Research Council, 1987)
[e]National Ambient Air Quality Standards (40 CFR 50.109)
[f]Threshold Limit Value – Time-weighted Average (American Conference of Government Industrial Hygienists, 1992)

Table E-5: Estimated Concentration from Normal Launch of a Notional ERL Missile (mg/m^3)[a,b]

Pollutant	Release kg (lb)	Average Period	Guideline (mg/m^3)	Exposure Term	Distance Downwind km (mi) 1 (0.6)	3 (1.9)	5 (3.1)	7 (4.3)	10 (6.2)	30 (18.6)
Carbon	14	8 hours	10	NAAQS[c]	0.103	0.100	0.064	0.045	0.026	0.028
Monoxide	(30)	1 hour	40	NAAQS[c]	0.156	0.151	0.097	0.064	0.040	0.042

[a] Emissions from representative first-stage rocket motor

[b] Values used in TSCREEN PUFF model (U.S. Environmental Protection Agency, 1990):
release height = 100 meters (328 feet)
wind speed = 1 meter per second (2.3 miles per hour)
mixing height = 320 meters (1,050 feet)

[c] National Ambient Air Quality Standards (40 CFR 50.109)

Table E-6: Estimated Concentration from Two-Stage Accident of a Notional ERL Missile (mg/m^3)[a,b]

Pollutant	Release kg (lb)	Average Period	Guideline (mg/m^3)	Exposure Term	Distance Downwind km (mi) 1 (0.6)	3 (1.9)	5 (3.1)	7 (4.3)	10 (6.2)	30 (18.6)
Carbon	27	8 hours	10	NAAQS[c]	0.198	0.192	0.123	0.082	0.050	0.054
Monoxide	(60)	1 hour	40	NAAQS[c]	0.300	0.291	0.187	0.124	0.076	0.082

[a] Emissions from representative first- and second-stage rocket motors

[b] Values used in TSCREEN PUFF model (U.S. Environmental Protection Agency, 1990):
release height = 100 meters (328 feet)
wind speed = 1 meters per second (2.3 miles per hour)
mixing height = 320 meters (1,050 feet)

[c] National Ambient Air Quality Standards (40 CFR 50.109)

Results from the screening model, if the assumptions made are valid, should be significantly greater than the actual concentrations. In review, the conservative assumptions made were: (1) all of the emissions from the first stage rocket motors were assumed to be released near the ground for the normal launch scenario, (2) all of the emissions from both the first and second stage rocket motors were assumed to be released near the ground for the missile failure accident scenario, (3) all of the aluminum oxide released was assumed to be PM-10, (4) a very low wind speed of 3.7 kilometers per hour (2.3 miles per hour) was used, and (5) a fairly low mixing height of 320 meters (1,050 feet) was used.

AFTOX Modeling

The Air Force Toxic Chemical Dispersion (AFTOX) model is a Gaussian puff dispersion model for uniform terrain and wind conditions. It was developed to evaluate the extent of the hazard area resulting from the atmospheric dispersion of toxic vapors. (Kunkel, 1991)

The AFTOX model was used to determine the sizes of the areas that may experience concentrations of UDMH and IRFNA equal to or greater than emergency exposure limits from the spill of 208 liters (55 gallons) of UDMH and the spill of 757 liters (200 gallons) of IRFNA. Input parameters were chosen to be representative of Meck and Bigen islands: air temperature of 30°C (86°F), wind direction of 45 degrees (i.e., wind blowing from the northeast), and average surface roughness of 3 centimeters (1 inch). Calculations were made for the bounding conditions of noon and midnight, and for wind speeds ranging from 0.5 to 5 meters per second (1.6 to 16 feet per second).

The emergency exposure limits used in the analysis are a 10-minute time-weighted average concentration of 30 parts per million (ppm) for IRFNA and a 10-minute time-weighted average concentration of 100 ppm for UDMH (Chemical Propulsion Information Agency, 1984). Using these values, for a 208 liter (55 gallon) spill of UDMH the AFTOX modeling predicted toxic corridors less than or equal to 91 meters (300 feet) in distance from the spill site. Similarly, for a 757 liter (200 gallon) spill of IRFNA the modeling predicted toxic corridors less than or equal to 804 meters (2,640 feet).

The areas used are the 90 percent hazard area and represent the area within which the plume is confined 90 percent of the time. The width to length ratio of the hazard area is dependent on the details of the meteorological conditions used for each calculation; however, the width is typically one sixth of the length (Kunkel, 1991).

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Appendix F
Agency Consultation Letters

DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY KWAJALEIN ATOLL
BOX 26, APO AP 96555

July 29, 1995

Office of the Commander
Engineering, Housing and
Environmental Branch

Ms. Carmen M. Bigler
Secretary of Interior and Outer Island
Affairs and Historic Preservation Officer
P.O. Box 1454
Majuro Atoll, Republic of the Marshall Islands 96960

Dear Ms. Bigler:

The United States Army Space and Strategic Defense Command (USASSDC) is in the process of preparing an environmental assessment (EA) for the United States Army Kwajalein Atoll (USAKA) Temporary Extended Test Range program. A copy of the Preliminary Final EA is enclosed for your review. Activities for the program will primarily take place within USAKA; however, a temporary launch site has been proposed for Bigen Island, Aur Atoll, Republic of the Marshall Islands (RMI). Proposed program activities are expected to start in late 1996.

On December 1 and 2, 1994, a biological and cultural resources survey of Bigen Island was conducted; the survey report was forwarded to you earlier this year. Between February 7 and 17, 1995, a visit to the USAKA project sites was conducted, including all areas of proposed ground disturbance. A qualified, professional archaeologist participated in both the Aur Atoll and USAKA field efforts.

Based on the minor amount of ground disturbance and building modification required; the temporary, mobile nature of program activities; and the mitigation measures proposed in Section 4.4 of the EA, USASSDC has determined that there will be no adverse effects on historic properties.

Your written concurrence with this finding of no adverse effects will be greatly appreciated. If you have any questions, please do not hesitate to contact Dr. Don Ott, USAKA Environmental Engineer 805-238-7994, Extension 4218, or Ms. Linda Ninh, USASSDC, CSSD-EN-V, Huntsville, Alabama, 205-955-5971.

Sincerely,

David E. Spaulding
Colonel, U.S. Army
Commanding

Enclosure

DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY KWAJALEIN ATOLL
BOX 26, APO AP 96555

July 29, 1995

Office of the Commander
Engineering, Housing and
Environmental Branch

Mr. Jiba Kabua
Republic of the Marshall Islands
Environmental Protection Authority
P.O. Box 1322
Majuro, Republic of the Marshall Islands 96960

Dear Mr. Kabua:

The United States Army Space and Strategic Defense Command (USASSDC) is in the process of preparing an environmental assessment (EA) for the United States Army Kwajalein Atoll (USAKA) Temporary Extended Test Range program. A copy of the Preliminary Final EA is enclosed for your review. Activities for the program will primarily take place within USAKA; however, a temporary launch site has been proposed for Bigen Island, Aur Atoll, Republic of the Marshall Islands (RMI). Proposed program activities are expected to start in late 1996.

On December 1 and 2, 1994, a biological and cultural resources survey of Bigen Island was conducted; the survey report was forwarded to you earlier this year. In addition, between February 7 and 17, 1995, a visit to the USAKA project sites was conducted.

Bigen Island is currently an uninhabited copra plantation. Vegetation is consistent with that of a typical low coral atoll, but much of the understory has been removed through the Marshallese use of controlled burns. No threatened or endangered plant or animal species were identified during the survey, and none are expected to occur on the island.

Based on the survey results and the temporary, non-intrusive nature of this program, no significant impacts would occur from implementation of the program as described in the EA. USASSDC requests your written concurrence with this determination.

Your assistance in this matter is greatly appreciated. If you have any questions, please do not hesitate to contact Dr. Don Ott, USAKA Environmental Engineer 805-238-7994, Extension 4218, or Ms. Linda Ninh, USASSDC, CSSD-EN-V, Huntsville, Alabama, 205-955-5971.

Sincerely,

David E. Spaulding
Colonel, U.S. Army
Commanding

Enclosure

Appendix G
Glossary of Terms

GLOSSARY OF TERMS

Air Quality Control Region – a contiguous geographic area designated by the Federal government in which communities share a common air pollution problem.

Air Toxins – any air pollutant for which a national ambient air quality standard does not exist (i.e., excluding ozone, carbon monoxide, particulate matter, sulfur dioxide, nitrogen dioxide) that may reasonably be anticipated to cause cancer, development effects, reproductive dysfunctions, neurological disorders, heritable gene mutations, or other serious irreversible chronic or acute health effects in humans.

Ambient Air Quality Standards – standards established on a state or Federal level that define the limits for airborne concentrations of designated "criteria" pollutants (nitrogen dioxide, sulfur dioxide, carbon monoxide, particulate matter, ozone, and lead) to protect public health with an adequate margin of safety (primary standards) and to protect public welfare, including plant and animal life, visibility, and materials (secondary standards).

Aquifer – a body of rock that contains sufficient saturated permeable material to conduct groundwater and to yield economically significant quantities of groundwater to wells and springs.

Attainment Area – an area considered to have air quality as good as or better than the National Ambient Air Quality Standards as defined in the Clean Air Act.

Best Available Control Measure – a term referring to the "best" measures (according to Environmental Protection Agency guidance) for controlling small or dispersed sources of particulate matter, such as roadway dust, wood stoves, and open burning.

Best Available Control Technology – an emissions limitation based on the maximum degree of emission reduction which (considering energy, environmental, and economic impacts, and other costs) is achievable through application of production processes and available methods, systems, and techniques. In no event does Best Available Control Technology permit emissions in excess of those allowed under any applicable Clean Air Act provision. Use of the Best Available Control Technology concept is allowable on a case-by-case basis for major new sources or modifications in attainment areas, and it applies to each regulated pollutant.

C-weighted Day-night Average Sound Level – the 24-hour energy average C-weighted sound level with 10 decibels added to the nighttime levels (10 p.m. to 7 a.m.); it is the sound level which is modified to limit the amplitude of the low- and high-frequency components of the noise. The weighting employed is established by the American National Standards Institute (ANSI S1.4-1983). It was developed to measure and report sound levels in a way that closely approximates how people perceive high-level or impulsive sounds.

Candidate Species – Federal "Notice of Review" species for which information supports the biological appropriateness of proposing to list as endangered or threatened.

Carbon Monoxide (CO) – a colorless, odorless, poisonous gas produced by incomplete fossil-fuel combustion; it is one of the six pollutants for which there is a national ambient standard (see Criteria Pollutants).

Chlorofluorocarbons (CFCs) – a family of inert, nontoxic, and easily liquefied chemicals used in refrigeration, air conditioning, packaging, or insulation or as solvents or aerosol propellants. CFCs drift into the upper atmosphere where the chlorine is released and destroys ozone.

Copra – dried coconut meat, the source of coconut oil.

Class I, II, and III areas – under the Clean Air Act, clean air areas are divided into three classes. The act allows very little pollution increase in Class I areas, some increase in Class II areas, and more in Class III areas. Certain national parks and wilderness areas receive mandatory Class I protection. All other areas start out as Class II. States can reclassify Class II areas up or down, subject to Federal requirements.

Criteria Pollutants – pollutants identified by the Environmental Protection Agency (required by the Clean Air Act to set air quality standards for common and widespread pollutants) after preparing "criteria documents" summarizing scientific knowledge on their health effects. Today there are standards in effect for six criteria pollutants: sulfur dioxide, carbon monoxide, particulate matter less than 10 microns in diameter, nitrogen dioxide, ozone, and lead.

Cultural Resources – prehistoric and historic sites, structures, districts, artifacts, or any other physical evidence of human activity considered important to a culture, subculture, or community for scientific, traditional, religious, or any other reason.

Emission Inventory – a listing, by source, of the amount of air pollutants discharged into the atmosphere of a community; it is used to establish emission standards.

Endangered Species – a species that is threatened with extinction throughout all or a significant portion of its range.

Habitat – The area or type of environment in which an organism or biological population normally lives or occurs.

Historic Resources – physical properties or locations postdating the advent of written records in a particular culture and geographic region including archaeological sites, structures, artifacts, documents, and other evidence of human behavior and locations associated with events that have made a significant contribution to history or that are associated with the lives of historically significant persons.

Hydrocarbons – any of a vast family of compounds containing hydrogen and carbon, used loosely to include many organic compounds in various combinations. Most fossil fuels are composed predominately of hydrocarbons. When hydrocarbons mix with nitrogen oxides in the presence of sunlight, ozone is formed; hydrocarbons in the atmosphere contribute to the formation of ozone.

Hypergolic – a property of various combinations of chemicals which will self-ignite upon contact with each other without a spark or other external initiation.

Impacts – an assessment of the meaning of changes in all attributes being studied for a given resource; an aggregation of all the adverse effects, usually measured using a qualitative and nominally subjective technique. In this Environmental Impact Statement, as well as in the Council on Environmental Quality regulations, the word impact is used synonymously with the word effect.

International Civil Aviation Organization – a specialized agency of the United Nations whose objective is to develop the principles and techniques of international air navigation and to foster planning and development of international civil air transport.

Inversion – an increase of temperature with height through a layer of air.

Jet Routes – a route designed to serve aircraft operating from 5,486 meters (18,000 feet) up to and including flight level 450, referred to as J routes with numbering to identify the designated route.

Lead (Pb) – a heavy metal used in many industries which can accumulate in the body and cause a variety of negative effects; it is one of the six pollutants for which there is a national ambient air quality standard (see Criteria Pollutants).

Low-altitude Airway Structure – the network of airways serving aircraft operations up to but not including 5,486 meters (18,000 feet) mean sea level.

Maximum Achievable Control Technology – emissions limitations based on the best demonstrated control technology or practices in similar sources to be applied to major sources emitting one or more of the listed toxic pollutants.

Montreal Protocol – an international environmental agreement to control chemicals that deplete the ozone layer. The protocol calls for a phase-out of chlorofluorocarbons, halons, and carbon tetrachloride by the year 2000 and chloroform by 2005 and provides financial assistance to help developing countries make the transition from ozone-depleting substances.

National Ambient Air Quality Standards – nationwide standards for widespread air pollutants set by the Environmental Protection Agency under Section 109 of the Clean Air Act. Currently, six pollutants are regulated by primary and secondary NAAQS: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide (see Criteria Pollutants).

Nitrogen Dioxide (NO_2) – gas formed primarily from atmospheric nitrogen and oxygen when combustion takes place at high temperatures. Nitrogen dioxide emissions contribute to acid deposition and formation of atmospheric ozone. One of the six pollutants for which there is a national ambient standard (see Criteria Pollutants).

Nitrogen Oxides (NO_X) – gasses formed primarily by fuel combustion which contribute to the formation of acid rain. Hydrocarbons and nitrogen oxides combine in the presence of sunlight to form ozone, a major constituent of smog.

Nonattainment Area – an area that has been designated by the Environmental Protection Agency or the appropriate state air quality agency as exceeding one or more of the national or state ambient air quality standards.

Overpressure – the pressure, exceeding ambient pressure defined in pounds per square foot (psf), manifested in the shock wave of an explosion or sonic boom.

Ozone – a compound consisting of three oxygen atoms that is the primary constituent of smog. It is formed through chemical reactions in the atmosphere involving volatile organic compounds, nitrogen oxides, and sunlight. Ozone can initiate damage to the lungs as well as damage to trees, crops, and materials. There is a natural layer of ozone in the upper atmosphere which shields the earth from harmful ultraviolet radiation (see Criteria Pollutants).

Ozone-depleting Substances – a group of chemicals that are inert under most conditions but within the stratosphere react catalytically to reduce ozone to O_2. These chemicals include chlorofluorocarbons, halons, hydrochlorofluorocarbons, methyl chloroform (1,1,1-trichloroethane), and carbon tetrachloride. Title VI of the Clean Air Act requires the phase-out of production of ozone-depleting substances.

Paleontological Resources – the physical remains of extinct life forms or species that may have living relatives. These physical remains include fossilized remains of plants and animals, casts or molds of the same, or trace fossils such as impressions, burrows, and tracks.

Particulate Matter – particles of various diameters, small enough to be airborne, such as dust or smoke; particulate matter is one of the six pollutants for which there is a national ambient air quality standard (see Criteria Pollutants).

pH – refers to the concentration of the H^+ ions in a solution. $pH = -\log[H^+]$.

PM-10 – a new standard for measuring the amount of solid or liquid matter suspended in the atmosphere ("particulate matter"). This refers to the amount of particulate matter less than or equal to 10 micrometers in diameter. The smaller PM-10 particles penetrate to the deeper portions of the lungs, affecting sensitive population groups such as children and people with respiratory diseases.

Prehistoric Archaeological Resources – physical remnants of human activity that predate the advent of written records in a particular culture and geographic region including archaeological sites, structures, artifacts, and other evidence of prehistoric behavior.

Prevention of Significant Deterioration – in the 1977 Amendments to the Clean Air Act, Congress mandated that areas with air cleaner than required by National Ambient Air Quality Standards must be protected from significant deterioration. The Prevention of Significant Deterioration program, created by the Clean Air Act, consists of two parts – requirements for best available control technology on major new or modified sources and compliance with an air quality increment system.

Reasonably Available Control Measures – a broadly defined term referring to technologies and other measures that can be used to control pollution. In the case of PM-10, it refers to approaches for controlling small or dispersed source categories such as road dust, wood stoves, and open burning.

Reasonably Available Control Technology – an emission limitation on existing sources in non-attainment areas, defined by the Environmental Protection Agency in a Control Techniques Guideline and adopted and implemented by states.

Sensitive Species – species for which more scientific information is needed to determine its current biological status.

Sulfur Dioxide (SO_2) – a toxic gas that is produced when fossil fuels, such as coal and oil, are burned. Sulfur dioxide is the main pollutant involved in the formation of acid rain. Sulfur dioxide can also irritate the upper respiratory tract and cause lung damage. The major source of sulfur dioxide in the United States is coal-burning electric utilities (see Criteria Pollutants).

Threatened Species – a species likely to become endangered in the foreseeable future.

Traditional Resources – archaeological sites, burial sites, ceremonial areas, caves, mountains, water sources, plant habitat or gathering areas, or any other natural area important to a culture for religious or heritage reasons.

Volatile Organic Compound – one of a group of chemicals that react in the atmosphere with nitrogen oxides in the presence of heat and sunlight to form ozone; it does not include methane and other compounds determined by the Environmental Protection Agency to have negligible photochemical reactivity. Examples of volatile organic compounds include gasoline fumes and oil-based paints.

Appendix H
Acronyms and Abbreviations

ACRONYMS AND ABBREVIATIONS

$\mu g/m^3$	microgram(s) per cubic meter
AAF	Army Airfield
AFB	Air Force Base
AFTOX	Air Force Toxic Chemical Dispersion Model
Al_2O_3	Aluminum oxide
AMC	Air Mobility Command
AOS	Army Optical Site
APE	Area of Potential Effect
AR	Army Regulation
BMDO	Ballistic Missile Defense Organization
BOA	Broad Ocean Area
BOE	Bureau of Explosives
C	Celsius
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CONUS	Continental United States
CO	Carbon monoxide
dB	decibel(s)
dBA	A-weighted Decibel
DOD	Department of Defense
DOT	Department of Transportation
EA	Environmental Assessment
EEGL	Emergency Exposure Guidance Level

EIS	Environmental Impact Statement
EMR	Electromagnetic Radiation
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ERIS	Exoatmospheric Reentry Interceptor System
ERL	Extended Range Lance
ESQD	Explosive Safety Quantity-Distance
F	Fahrenheit
FAA	Federal Aviation Administration
FTS	Flight Termination System
GBR	Ground-based Radar
GHLE	Ground Handling and Launching Equipment
HAP	Hazardous Air Pollutant
HCl	Hydrogen chloride
HPO	Historic Preservation Officer
ICAO	International Civil Aviation Organization
IRFNA	Inhibited Red Fuming Nitric Acid
KMR	Kwajalein Missile Range
KMRSS	Kwajalein Mobile Range Safety System
KREMS	Kiernan Reentry Measurement System
kv	kilovolt(s)
kW	kilowatt(s)
L_{dn}	Day-night Average Sound Level
L_{max}	Maximum Sound Level
LCM	Landing Craft Mechanized
LCU	Landing Craft Utility

LHA	Launch Hazard Area
MAB	Missile Assembly Building
mg/m^3	milligram(s) per cubic meter
MLE	Maximum Likelihood Estimate
MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NO_2	Nitrogen dioxide
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
O_3	Ozone
OSHA	Occupational Safety and Health Administration
Pb	Lead
PM-10	Particulate matter with an aerodynamic diameter less than or equal to 10 microns
ppm	part(s) per million
PPU	Prime Power Unit
RCRA	Resource Conservation and Recovery Act
RF	Radiofrequency
RMI	Republic of the Marshall Islands
RMI HPO	Republic of the Marshall Islands Historic Preservation Officer
ROI	Region of Influence
SARA	Superfund Amendments and Reauthorization Act

SEIS	Supplemental Environmental Impact Statement
SIP	State Implementation Plan
SO_2	Sulfur dioxide
SOP	Standard Operating Procedure
SPEGL	Short-term Public Emergency Guidance Level
THAAD	Theater High Altitude Area Defense
TLV-TWA	Threshold Limit Value - Time-weighted Average
TMD	Theater Missile Defense
TMD-GBR	Theater Missile Defense Ground-based Radar
TSCA	Toxic Substances Control Act
UDMH	Unsymmetrical dimethylhydrazine
UPH	Unaccompanied Personnel Housing
USAKA	U.S. Army Kwajalein Atoll
USASSDC	U.S. Army Space and Strategic Defense Command
USC	United States Code
USFWS	U.S. Fish and Wildlife Service