

ENV 337-E

EUU - 334-F

61

WAKE ISLAND EA

TMD



Wake Island

Environmental Assessment

January 1994

MEMORANDUM

To: Mr. Carlos Rubio

From: Mike Osburn, The Earth Technology Corporation

Date: 16 February 1994

Subject: Wake Island Environmental Assessment

Per your request to Ms. Linda Ninh, CSSD-EN-V, enclosed are five copies of the subject report.

cc: Ms. Linda Ninh, CSSD-EN-V

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188		
1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b. RESTRICTIVE MARKINGS			
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT				
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE		On Request; Distribution F				
4. PERFORMING ORGANIZATION REPORT NUMBER(S)			5. MONITORING ORGANIZATION REPORT NUMBER(S)			
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Space and Strategic Defense Command		6b. OFFICE SYMBOL (If applicable) CSSD-EN-V	7a. NAME OF MONITORING ORGANIZATION			
6c. ADDRESS (City, State, and ZIP Code) P.O. Box 1500 Huntsville, Alabama 35807-3801			7b. ADDRESS (City, State, and ZIP Code)			
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Ballistic Missile Defense Organization		8b. OFFICE SYMBOL (If applicable) GST	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER			
8c. ADDRESS (City, State, and ZIP Code) 7100 Defense Pentagon Washington, DC 20301-7100			10. SOURCE OF FUNDING NUMBERS			
			PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) Wake Island Environmental Assessment (Unclassified)						
12. PERSONAL AUTHOR(S) Wake Island Environmental Assessment Team, Ms. Linda Ninh, Chairperson						
13a. TYPE OF REPORT		13b. TIME COVERED FROM 1994 TO 2000	14. DATE OF REPORT (Year, Month, Day) January 1994		15. PAGE COUNT 250	
16. SUPPLEMENTARY NOTATION						
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Environmental Assessment, Wake Island				
FIELD	GROUP					SUB-GROUP
19. ABSTRACT (Continue on reverse if necessary and identify by block number) <p>The proposed action is to conduct extended range tests of target missiles, defense missiles, and sensor systems at Wake Island. The purpose of these test activities is to provide realistic test situations for ground-based defenses to operate within a simulated theater of operation, which includes engaging and intercepting notional target missiles. Approximately 100 flight tests would occur during the period 1994 to 2000.</p> <p>The Final Environmental Assessment addresses the potential environmental effects that would result from test site modifications, launch preparation requirements, missile flights along the proposed flight paths, and intercepts of target missiles over the open Pacific Ocean. Environmental resource topics evaluated include air quality, airspace, biological resources, cultural resources, hazardous materials/ waste, health and safety, infrastructure and transportation, land use, noise, physical resources, socioeconomics, and water resources. The potential for cumulative effects for each component has also been addressed.</p>						
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified			
22a. NAME OF RESPONSIBLE INDIVIDUAL Ms. Linda Ninh		22b. TELEPHONE (Include Area Code) (205) 955-1154		22c. OFFICE SYMBOL CSSD-EN-V		



REPLY TO
ATTENTION OF

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

January 6, 1994

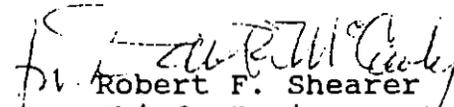
Environmental and
Engineering Office

TO WHOM IT MAY CONCERN:

Enclosed for your information and use is a copy of the final Wake Island Environmental Assessment, January 1994, and the associated Finding of No Significant Impact. Publication of the Notice of Availability in the affected local areas is scheduled for January 7, 1994.

Point of contact for this document is Ms. Linda Ninh, CSSD-EN-V, U.S. Army Space and Strategic Defense Command, Post Office Box 1500, Huntsville, Alabama 35807-3801, or (205) 955-1154.

Sincerely,


Robert F. Shearer
Chief, Environmental
and Engineering Office

Enclosures

**FINDING OF NO SIGNIFICANT IMPACT
U.S. ARMY SPACE AND STRATEGIC DEFENSE COMMAND
DEPARTMENT OF DEFENSE**

AGENCY:

U.S. Army Space and Strategic Defense Command

SUMMARY OF PROPOSED ACTION:

The U.S. Army Space and Strategic Defense Command (USASSDC) at the request of the Ballistic Missile Defense Organization has conducted an assessment of the potential environmental consequences of proposed Theater Missile Defense (TMD) launch activities on Wake Island as well as other reasonably foreseeable program-related facilities.

The proposed test activities would include tests of targets and defensive missiles to provide realistic test situations for ground-based defenses designed to operate within a simulated theater of operations. This would include engaging and intercepting notional target missiles. These long-distance missile flight tests would support the need to develop and validate system design and operational effectiveness of Army TMD missile and sensor systems. The related infrastructure improvements on the island would be limited to those required to support proposed TMD activities. They would include hardening of the existing Launch Support Building and one dormitory building; refurbishment of the Peale Island bridge; construction of a new Missile Assembly

Building, new Missile Storage Building, and new incinerator; deployment of mobile range support equipment; and modifications to the existing launch facilities.

ALTERNATIVES CONSIDERED:

The only alternative to the proposed TMD launch activities on Wake Island is the no-action alternative. The no-action alternative would be to not proceed with any new TMD launch activities on Wake Island and no new TMD infrastructure improvements would be accomplished. However, other test range alternatives are being considered in the TMD Extended Test Range Environmental Impact Statement. The environmental impact of the test activities on Wake Island were evaluated in the Wake Island Environmental Assessment.

ANTICIPATED ENVIRONMENTAL EFFECTS:

Although potential cumulative health and safety impacts are possible, these are easily mitigated to a not significant level by using established safety procedures. In particular, hazardous materials will be handled and disposed of according to existing, compliant procedures. Employees will follow standard, established procedures for handling and disposing of hazardous materials during TMD launch activities.

FACTORS CONSIDERED IN THE DETERMINATION OF NO SIGNIFICANT IMPACT:

To assess the significance of potential environmental impacts, a list of site-specific activities necessary to accomplish the proposed action was developed. The areas of environmental consideration were air quality, airspace, biological resources, cultural resources, hazardous materials/waste, health and safety, infrastructure, land use, noise, physical resources, socioeconomics, and water resources. If a proposed activity was determined to present a potential for environmental impact, then the activity was evaluated by considering the context and intensity in which the impact would occur. As a result of the evaluation, impacts were assigned to one of three categories: No impact, not significant, or significant.

CONCLUSION:

Evaluation of the areas of environmental consideration has shown that no significant impacts would occur from implementation of the TMD launch activities on Wake Island and new TMD infrastructure improvements.

PUBLIC COMMENTS AND POINT OF CONTACT:

Written comments on the Finding of No Significant Impact for the Wake Island Environmental Assessment must be received on or before 7 February 1994 and may be provided to: Deputy Commander, U.S. Army Space and Strategic Defense Command, Attn: Ms. Linda Ninh, CSSD-EN-V, Post Office Box 1500, Huntsville, Alabama 35807-3801. Verbal comments and questions

regarding the Wake Island Environmental Assessment may be directed to Mr. Ed Vaughn, Public Affairs Officer, at (205) 955-3887.

APPROVED:

John M. Harnisch Chief Staff 1/05/94

J.A. Van Prooyen Date
J.A. Van Prooyen
Brigadier General, USA
Deputy Commander
U.S. Army Space and Strategic Defense Command

Executive Summary

EXECUTIVE SUMMARY

Introduction

Wake Island is a possession of the United States under the jurisdiction of the U.S. Department of the Air Force and administered by Detachment 1 of the 15th Logistics Group, 15th Air Base Wing, Hickam Air Force Base, Hawaii. The current mission of Wake Island is varied. The island supports trans-Pacific military operations and Western Pacific military contingency operations, serves as an in-flight emergency airfield, and provides transient military/civilian aircraft servicing and emergency sealift capability. In addition, Ballistic Missile Defense Organization (BMDO) activities have been taking place on Wake Island, requiring support from the staff and use of the facilities. This environmental assessment provides an analysis of the environmental consequences of conducting activities in support of the planned development tests of Theater Missile Defense (TMD) target and defensive missile systems on Wake Island as well as other reasonably foreseeable BMDO program-related facilities.

Testing Activities

TMD target and defensive missile systems are being considered for launch activities from Wake Island. The target system would be designed to deliver target vehicles toward the U.S. Army Kwajalein Atoll (USAKA) located within the Republic of the Marshall Islands. For target launches from Wake Island, the defensive missile would be launched from the USAKA. If defensive missiles are launched from Wake Island, the targets would be launched from the USAKA or from a Missile Launch Ship (MLS) located south of Wake Island. To meet the requirements of Article VII, paragraph 12 (d), of the Intermediate-Range Nuclear Forces Treaty, all target missiles launched from Wake Island or Kwajalein Atoll with a demonstrated flight range of 500 kilometers (km) (311 miles [mi]) but less than 5,500 km (3,418 mi) and will be launched from fixed, above-ground facilities. Target systems launched from a MLS will have a demonstrated range of less than 500 km (311 mi).

Purpose and Need

The proposed test activities would include target and defensive missile intercept tests to provide realistic test situations for ground-based defenses to operate within a simulated theater of operation, which includes engaging and intercepting notional target missiles. This requires conducting target and other missile system flights over long distances (i.e., in excess 1,150 kilometers [715 miles]). These long-distance missile flight tests would support the developmental and operational effectiveness of U.S. Army TMD missile and sensor systems. Currently, there are no operational overland ranges and few over-water ranges operated by the United States that provide realistic distances for testing within such a simulated theater of operations.

Methodology

Twelve broad environmental components were evaluated to provide a context for understanding the potential effects of the proposed actions and to provide a basis for assessing the significance of potential impacts. The areas of environmental consideration are air quality, airspace, biological resources, cultural resources, hazardous materials/waste, health and safety, infrastructure, land use, noise, physical resources, socioeconomics, and water resources. The evaluation indicated that implementation of the TMD test activities and related facility upgrades will not pose a potential for short- or long-term impacts to these components on Wake Island.

To assess the significance of any impact, a list of the activities necessary to accomplish the proposed action was developed. The affected environment on Wake Island was then described. Next, those activities with potential for causing environmental consequences were identified. If a proposed activity was determined to have potential for causing environmental impact, then it was evaluated by considering the intensity and context in which the impact would occur.

Results

This section summarizes the conclusions of the evaluations made for each of the areas of environmental consideration for the proposed TMD test activities on Wake Island based on the application of the above methodology. Table S-1 shows the land area and vegetation clearing required for each of the planned activities.

Air Quality

The hardening and interior modification of the Launch Support Building and a dormitory, refurbishment of Building 1203, and repair of the Peale Island bridge are activities that would have no potential for air emissions and thus no potential for air quality impacts. The proposed construction activities at launch pads 1 and 2 (including the utility, communication, and fiber optic cable trenching), the new incinerator pad, a new Missile Storage Building (MSB) and Missile Assembly Building (MAB), and a concrete radar pad would generate fugitive dust and mobile electric generator emissions. These emissions would be of short duration and represent only a minor increase in total emissions produced on the island. Operation of an additional incinerator would create a long-term, relatively small increase in total island emissions and would also have a beneficial effect in the elimination of wet refuse deposited in the landfill.

Launch operations constitute the largest sources of uncontrolled emissions on Wake Island. Air emissions from sea-based launches in the open ocean area south of Wake Island would be similar to the emissions from the ground-based launches. Flight testing of the TMD missile systems would involve the use of mobile and stand-alone radar systems. The mobile power generator used for the radar systems during missile launches would have emissions associated with its operation. All of these effects are small relative to current island emissions or are very transient, and the cumulative effects on air quality are considered to be not significant.

Table S-1: Area Affected by Theater Missile Defense-Related Programs

TMD Launch-Related Facility Requirements	Land area required in hectares (acres)	Vegetation clearing required in hectares (acres)
Missile Storage Building	0.04 (0.1)	0.04 (0.1)
Missile Assembly Building	0.04 (0.1)	0.04 (0.1)
Launch Support Building	none	none
Dormitory	none	none
Launch Facilities		
Pad 1	0.04 (0.1)	none
Pad 2	0.1 (0.3)	0.1 (0.3)
Range support equipment (mobile)	0.1 (0.3) to 0.8 (2.0)	none
Range support equipment (permanent)	0.04 (0.1)	0.04 (0.1)
Incinerator	0.04 (0.1)	none
Fiber optic cable trenches	0.04 (0.1)	0.04 (0.1)
Bridge repair	none	none

Airspace

The modification of existing facilities and construction of new facilities on Wake Island would have no impact on airspace and, thus, no potential for significant impacts. Wake Island is located in international airspace; therefore, there are no formal airspace restrictions surrounding it. Missile launches remaining clear of air route A-450, the only jet route that passes near the island, should pose no serious impacts. Missile launches from the MLS stationed in the open ocean area south of Wake Island would have no significant impacts to airspace. Since the number of aircraft flying over or near Wake Island is small, the impacts to airspace are considered not significant.

Biological Resources

The hardening and interior modification of the Launch Support Building and dormitory and *refurbishment of Building 1203* are activities that would occur within existing structures and thus have no potential for biological resource impacts. The proposed construction activities at launch pads 1 and 2 (including trenching for the utility, communication, and fiber optic cables), the new incinerator pad, a new MSB and MAB, and a concrete radar pad would have the potential to impact biological resources since some ground disturbance would be necessary.

Construction activities would require removal of less than one percent of the vegetation on Wake Island. Since proposed project actions will take place primarily on Wake Island and are located away from the primary bird nesting areas and no sensitive flora are located in the construction area, it is judged that impacts to botanical resources as a result of project implementation will be reduced to a not-significant level with implementation of the proposed mitigation measures.

Flight testing of the TMD defensive missile systems, involving the use of mobile and stand-alone radar systems that would be placed on existing paved or previously disturbed areas only, would not have any direct impacts to the island's flora and fauna, other than the potential for noise impacts from the missile launches and biological effects from electromagnetic radiation emissions from operation of the radars.

Protected sea turtles and marine mammals would be at risk from reef blasting associated with placement of the fiber optic cable and from falling flight vehicle boosters and debris, although the chance of this occurring is extremely remote. The taking of a protected species would be significant, but risks from off-shore blasting would be minimized by visual inspection prior to detonation, and the probability of an accidental taking due to falling debris is judged to be extremely remote; thus impacts are expected to be reduced to a not-significant level with the implementation of the proposed mitigation measures.

Cultural Resources

The hardening and interior modification of the Launch Support Building and a dormitory, refurbishment of Building 1203, and repair of the Peale Island bridge are activities that would occur within existing structures and thus have no potential for cultural resource impacts. The proposed construction activities at launch pads 1 and 2 (including trenching for the utility, communications, and fiber optic cables), the new incinerator pad, a new MSB and MAB, and a concrete radar pad have the potential for impacting cultural resources since some ground disturbance would be necessary.

The additional personnel on Wake Island as a result of TMD activities have the potential to impact cultural resources due to their presence, recreational activities, and incidental collecting of archaeological and historical resources while on the island. However, TMD-related personnel would be indoctrinated on the historic significance of structures and resources. Precautionary measures to be enacted for ground-disturbing activities and if cultural resources are inadvertently discovered will ensure that there would be no significant impact to cultural resources due to the implementation of this project.

Flight testing of the TMD defensive missile systems, involving the use of mobile and stand-alone radar systems that would be placed on existing paved or previously disturbed areas only would not have any direct impacts to the island's cultural resources other than the extremely remote potential for debris impacts from a launch abort or launch mishap. These impacts are similarly believed not to present significant impacts for the TMD defensive missiles. The potential for indirect impacts resulting from the increased human presence on the island is believed to be not significant.

Hazardous Materials/Waste

The hardening and interior modification of the Launch Support Building and a dormitory, refurbishment of Building 1203, and repair of the Peale Island bridge are activities that would have no hazardous materials/waste impacts since no hazardous materials usage associated with TMD target missile systems renovation/modification activities are identified. Although hazardous materials usage would not be expected as a result of proposed launch facility modification activities, modification of facility structures may

involve the removal of small quantities of asbestos-containing material. Electrical system upgrades may involve removal and disposal of equipment containing polychlorinated biphenyls. The quantities of waste generated during modification activities will be small and can easily be accommodated by the current waste disposal system or establishment of an independent system by the TMD program. The impact to hazardous materials/waste management at Wake Island due to facility upgrades will be not significant.

Activities involved with the preparation and launch of the TMD missile systems from Wake Island have the potential to increase the quantities and types of hazardous materials used at Wake Island and quantities and types of hazardous waste generated. TMD target missiles will utilize "off-the-shelf" solid-propellant rocket motors. Such systems contain large quantities of Class 1.1 explosives, which are considered relatively safe for normal handling. No wastes would be generated as a result of explosive-handling operations.

Operation of the additional equipment in the refurbished and newly constructed facilities should not have any direct adverse hazardous materials/waste impacts, with the exception of the use of small quantities of solvents and cleaning materials that may be required during launch preparation activities.

Minimal quantities of hazardous waste would be produced by launch activities and would consist of small quantities of used or excess solvents and cleaners. These materials are similar to wastes already generated and handled at Wake Island and can be accommodated within the current waste disposal system. Slight increases in quantities of hazardous waste generated as a result of launch activities will not adversely impact waste disposal activities.

Sea-based flight testing of the TMD target missiles would utilize much of the same hazardous materials (solvents and explosives) and generate similar minimal quantities of hazardous waste as would be utilized and generated by the ground-based system flight testing. Hazardous materials would be handled in accordance with applicable regulations and guidelines, and hazardous wastes generated aboard the MLS would be contained and appropriately disposed of when the MLS returns to port. Sea-based flight testing is expected to have hazardous materials/waste impacts that are not significant.

Health and Safety

The hardening and interior modification of the Launch Support Building and a dormitory, refurbishment of Building 1203, and repair of the Peale Island bridge are activities that would have no potential for health and safety impacts to the residents of Wake Island. The proposed construction activities would also have no potential for health and safety impacts to the residents of Wake Island. Building renovation/modification and new facility construction have the potential for construction-related accidents and injuries to the construction personnel themselves. Construction activities may involve the use of heavy equipment, work on elevated platforms, electrical safety hazards, and other hazards associated with general construction. Construction activities such as those proposed are considered to be routine renovation/construction operations, and the safety hazards associated with these operations are not considered to be significant. However, because

of the potential for uncovering buried World War II ordnance during ground-disturbing construction activities, explosive ordnance disposal personnel are required to be on site.

Target missile launches from the MLS stationed in the open ocean area would have the potential for health and safety impacts due to the potential of a missile launch failure.

Operation of the X-band phased-array TMD-GBR system and the C-band PATRIOT radar set during defensive missile test flights would produce electromagnetic radiation. While the potential for grating and side lobe illumination from the radar antennas would not exceed the permissible personnel exposure levels of 5 milliwatts (mW)/square centimeter (cm²) outlined in both the U.S. Army and U.S. Air Force regulations and standards for electromagnetic radiation, non-biological effects may occur. These include the potential for: interference with communication equipment, particularly airborne and shipborne weather radars; effects on avionics equipment; and effects on electroexplosives and refueling operations. With the exception of the potential for wide chirp interference with aircraft weather radars, all are believed to be mitigable by an appropriate Notices to All Mariners and Airmen.

Infrastructure and Transportation

The hardening and interior modification of the Launch Support Building and dormitory and refurbishment of Building 1203 are activities that would have no potential for significant impacts to infrastructure and transportation on the island. Repair of the Peale Island bridge would have a beneficial effect on the island's transportation network. The proposed construction activities at launch pads 1 and 2 (including trenching for the utility, communications, and fiber optic cables), the new incinerator pad, a new MSB and MAB, and a concrete radar pad would essentially have no or minimal potential for adverse direct impacts to infrastructure and transportation.

Both the renovation/modification and construction activities would draw on the island's power supply and generate some solid waste. However, both the power plant and Wake Island's landfill/burning pit are capable of handling any modification/construction-related requirements. The temporary personnel required to support TMD activities along with the present island population would still represent less than one-third of the population previously supported by the infrastructure on the island. Consequently, the direct impacts to infrastructure and transportation are not considered significant. Scheduling of the launch and launch-related activities would prevent cumulative impacts.

Flight testing of the TMD defensive missile systems, involving the use of mobile, stand-alone systems that would be placed on existing paved or previously disturbed areas only, would not have any direct impacts on Wake Island's infrastructure and transportation.

Land Use

The hardening and interior modification of the Launch Support Building and a dormitory, refurbishment of Building 1203, and repair of the Peale Island bridge are activities that would have no impacts on current or planned land use since they involve only changes or modifications to a facility or structure already in place. The proposed construction

activities at launch pads 1 and 2 (including trenching for the utility, communications, and fiber optic cables), the new incinerator pad, a new MSB and MAB, and a concrete radar pad would have no adverse impacts on current land use or land use plans, policies, and controls since they are all proposed for areas of the island that already are designated for these kinds of land uses. Therefore, no significant impacts to land use are anticipated. Operation of the additional equipment in the refurbished and newly constructed facilities and flight test operations would not have any direct or indirect adverse land use impacts over and above those noted for renovation and construction activities.

Noise

The hardening and interior modification of the Launch Support Building and dormitory and refurbishment of Building 1203 are activities that would have no or minimal impacts on the noise environment. The proposed construction activities at launch pads 1 and 2 (including trenching for the utility, communications, and fiber optic cables), the new incinerator pad, a new MSB and MAB, a concrete radar pad, and repair of the Peale Island bridge would have noise environment impacts.

Blasting of the reef area to lay fiber optic cables off shore has the potential for noise impacts. The higher-frequency portions of the pressure wave are audible and are the sound that accompanies a blast; the lower-frequency portion is not audible but excites structures and in turn can cause a secondary and audible rattle within structures. Sonic booms would occur with each TMD system launch after the vehicle exceeds the speed of sound. The sonic boom would be directed toward the front of the vehicle downrange of Wake Island over the ocean.

Flight testing of the TMD missile systems may involve the use of mobile, stand-alone radar systems or permanent radar systems located in renovated facilities. The mobile power generator, used during the defensive missile launches, would have generator noise associated with its operation. All noise impacts would be reduced to a not-significant level with the implementation of standard personnel protection procedures.

Physical Resources

All construction materials for the proposed action will be shipped to the island; no island resources will be required. Ground excavation and trenching during construction are not expected to cause any soil erosion or significant fugitive dust because of the very low relief of the island and the coarse-grained, porous nature of the soil. Therefore, there would be no direct or indirect physical resource impacts.

Socioeconomics

As a result of Wake Island's mission, socioeconomic issues are essentially confined to the availability of housing. The renovation/construction activities would employ approximately 40 unaccompanied transient construction workers over an 8-month period. Defensive missile launch activities, including the TMD-GBR, would require about 140 personnel for approximately 2 weeks. These transient personnel would be housed in existing USASSDC-controlled billets, in which up to 170 beds are available, with additional beds available in

U.S. Air Force-controlled billets. Consequently, there would be no significant housing and, thus, no socioeconomic impacts.

Water Resources

Other than the freshwater catchment basins that are located away from all proposed TMD activities, there are no freshwater bodies on the island. Construction and flight testing activities associated with TMD activities will likely require the desalination of additional renewable, brackish groundwater during the dry season. Consequently, there would be no potential for significant direct impacts on water resources.

Acronyms and Abbreviations

ACRONYMS AND ABBREVIATIONS

ac	acre(s)
ACM	Asbestos-containing Material
AFB	Air Force Base
AFOSH	Air Force Occupational Safety and Health
AFR	Air Force Regulation
AIT	Atmospheric Interceptor Technology
Al ₂ O ₃	Aluminum oxide
ANSI	American National Standards Institute
AR	Army Regulation
ARTCC	Air Route Traffic Control Center
BMDO	Ballistic Missile Defense Organization
BOE	Bureau of Explosives
BOS	Base Operating Support
BP	Brilliant Pebbles
BTV	Ballistic Target Vehicle
C	Celsius
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeter(s)
cm ²	square centimeter(s)

CO	Carbon monoxide
CY	Calendar Year
DAC	Divert and Attitude Control
dB	decibel(s)
dBA	A-weighted decibel(s)
DNL	Day-night average sound level
DOD	Department of Defense
DOT	Department of Transportation
EA	Environmental Assessment
ECAC	Electromagnetic Compatibility Analysis Center
EEGL	Emergency Exposure Guidance Level
EIS	Environmental Impact Statement
EMI	Electromagnetic Interference
EMR	Electromagnetic Radiation
EPA	Environmental Protection Agency
ERINT	Extended Range Interceptor
ESQD	Explosive Safety Quantity-distance
F	Fahrenheit
ft	foot (feet)
ft ²	square foot (feet)
ft ³	cubic feet
FAA	Federal Aviation Administration
FIR	Flight Information Region
FNSI	Finding of No Significant Impact

FTS	Flight Termination System
gal	gallon(s)
gpd	gallon(s) per day
GBR	Ground-based Radar
GSE	Ground Support Equipment
ha	hectare(s)
HAP	Hazardous Air Pollutant
HCl	Hydrogen Chloride
HIRF	High-intensity Radio Frequency
in	inch(es)
IRP	Installation Restoration Program
kg	kilogram(s)
KKV	Kinetic Kill Vehicle
km	kilometer(s)
KMR	Kwajalein Missile Range
KMRSS	Kwajalein Mobile Range Safety System
kw	kilowatt(s)
L	liter(s)
L_{eq}	equivalent sound level
lb	pound(s)
LD_{50}	That quantity of a substance, administered either orally or by skin contact, necessary to kill 50 percent of exposed animals in laboratory tests within a specified time (A substance having an LD_{50} of less than 50 milligrams/kilogram [0.0008 ounce/pound] of body weight is rated highly toxic by toxicologists.)
LEAP	Lightweight Exoatmospheric Projectile

LHA	Launch Hazard Area
Lpd	liter(s) per day
m	meter(s)
m ²	square meter(s)
mi	mile(s)
MAB	Missile Assembly Building
mg	milligram(s)
mg/m ³	milligram(s) per cubic meter
m ³	cubic meter(s)
MLS	Missile Launch Ship
MSB	Missile Storage Building
MTV	Maneuvering Target Vehicle
mW	milliwatt(s)
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NEWL	Net Explosive Weight Limit
NHL	National Historic Landmark
nm	nautical mile(s)
NRHP	National Register of Historic Places
OC	Oceanic Control
O ₂	Ozone
OSHA	Occupational Safety and Health Administration
oz	ounce(s)
PAC-3	PATRIOT Advanced Capability

PATRIOT	Phased Array Tracking to Intercept of Target
Pb	Lead
PCB	Polychlorinated Biphenyl
PM-10	Particulate matter with a hydrodynamic diameter less than or equal to 10 microns
ppm	part(s) per million
RCRA	Resource Conservation and Recovery Act
SAM	Surface-to-Air Missile
SAR	Specific Absorption Rate
SIP	State Implementation Plan
SOP	Standard Operating Procedure
SO ₂	Sulfur dioxide
SPEGL	Short-term Public Emergency Guidance Level
SRM	Solid-propellant Rocket Motor
TACMS	Tactical Missile System
TCMP	Theater Missile Defense Critical Measurements Program
TEP	Triethyl phosphate
THAAD	Theater High Altitude Area Defense
TMD	Theater Missile Defense
TSCA	Toxic Substances Control Act
TNT	Trinitrotoluene
UOE	User Operational Evaluation
USAKA	U.S. Army Kwajalein Atoll
USASSDC	U.S. Army Space and Strategic Defense Command
WSMR	White Sands Missile Range

THIS PAGE INTENTIONALLY LEFT BLANK

Table of Contents

3.1.1.2.2	Theater Missile Defense Defensive Missile Systems	3-33
3.1.2	SEA-BASED SYSTEMS	3-43
3.1.2.1	Sea-Launch Preparation	3-43
3.1.2.2	Sea-Based Flight Testing	3-43
3.2	CUMULATIVE IMPACTS OF THE PROPOSED ACTION	3-45
3.3	MITIGATION MEASURES	3-47
3.4	ENVIRONMENTAL CONSEQUENCES OF THE NO-ACTION ALTERNATIVE	3-48
3.5	CONFLICTS WITH FEDERAL LAND USE PLANS, POLICIES, AND CONTROLS	3-49
3.6	ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL	3-49
3.7	NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS AND CONSERVATION POTENTIAL	3-49
3.8	ADVERSE ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED	3-49
3.9	RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY	3-49
3.10	IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES	3-49
3.11	CONDITIONS NORMALLY REQUIRING AN ENVIRONMENTAL IMPACT STATEMENT	3-50
4.0	INDIVIDUALS AND AGENCIES CONTACTED	4-1
5.0	REFERENCES	5-1
6.0	LIST OF PREPARERS	6-1

APPENDICES

- A - List of Relevant Environmental Documentation
- B - Environmental Attributes, Applicable Laws and Regulations, and Compliance Requirements
- C - Distribution List
- D - Air Quality Modeling Analysis
- E - Ornithological Survey Report
- F - Botanical Survey Report
- G - Consultation Letters

Figures

1-1	Location Map, Wake Island	1-2
1-2	Existing Facilities Location Map, Wake Island	1-4
1-3	Proposed Actions Location Map, Wake Island	1-7
1-4	HERA A and HERA B Target Systems	1-11
1-5	Representative TMD Target Vehicles	1-13
1-6	Proposed Missile Storage and Missile Assembly Buildings, Wake Island	1-15
1-7	Launch Facilities, Wake Island	1-17
1-8	Incinerator Location, Wake Island	1-20
1-9	Conceptual Missile Launch Ship	1-22
1-10	ERINT Defensive Missile	1-25
1-11	Army TACMS Launch System	1-26
1-12	Defensive Missile Conceptual Configuration	1-28

1-13	TMD Ground-Based Radar Conceptual Configuration	1-31
1-14	TMD Ground-Based Radar EMR Safety Zone	1-34
1-15	Representative Flight Trajectory for TMD Target Launches, Wake Island	1-36
1-16	Representative Flight Trajectory for TMD Defensive Missile Launches, Wake Island	1-37
1-17	Flight Trajectory and Range Safety for TCMP Launches	1-41
2-1	Airspace Managed by Oakland Oceanic Control Area	2-8
2-2	Location Map, Bird Sitings, Wake Island	2-9
2-3	Seabird Nesting Locations, Wilkes Island	2-11
2-4	Vegetation Features, Wake Island	2-17
2-5	Locations of Recorded Surface Cultural Resources, Wake Island	2-22
2-6	Explosive Safety Quantity-Distances for Existing Facilities, Wake Island	2-25
2-7	Existing Land Use Plan, Wake Island	2-31
2-8	Sites of Potential Environmental Contamination, Wake Island	2-33
2-9	Maximum A-Weighted Sound Pressure Level Contours During TCMP Flight Vehicle Launch, Wake Island	2-36
3-1	Proposed Actions and World War II Cultural Resources at Peacock Point (as Recorded in 1945), Wake Island	3-9
3-2	Proposed Actions and World War II Cultural Resources on Peale Island (as Recorded in 1945), Wake Island	3-10
3-3	Predicted Maximum A-Weighted Sound Pressure Level Contours During a TMD Target System Launch, Wake Island	3-32

Tables

1-1	Proposed HERA Target and Defensive Missile Launch Schedule	1-9
1-2	Flight Vehicle Data	1-9
1-3	Representative TMD Motor Characteristics	1-12
2-1	National Ambient Air Quality Standards	2-4
2-2	Exposure Guidelines for Hydrogen Chloride and Aluminum Oxide	2-5
2-3	Combustion Products from TCMP Rocket Motors in Kilograms (Pounds)	2-7
3-1	Area Affected by Theater Missile Defense-Related Programs	3-15
3-2	Emission Estimates for Oil-Fired Electric Power Plants	3-21
3-3	Combustion Products for Selected Rocket Motors in Kilograms (Pounds)	3-22
3-4	Emission Factors for Gasoline- and Diesel-Powered Industrial Equipment	3-35

THIS PAGE INTENTIONALLY LEFT BLANK

1.0
Description of Proposed Action
and Alternatives

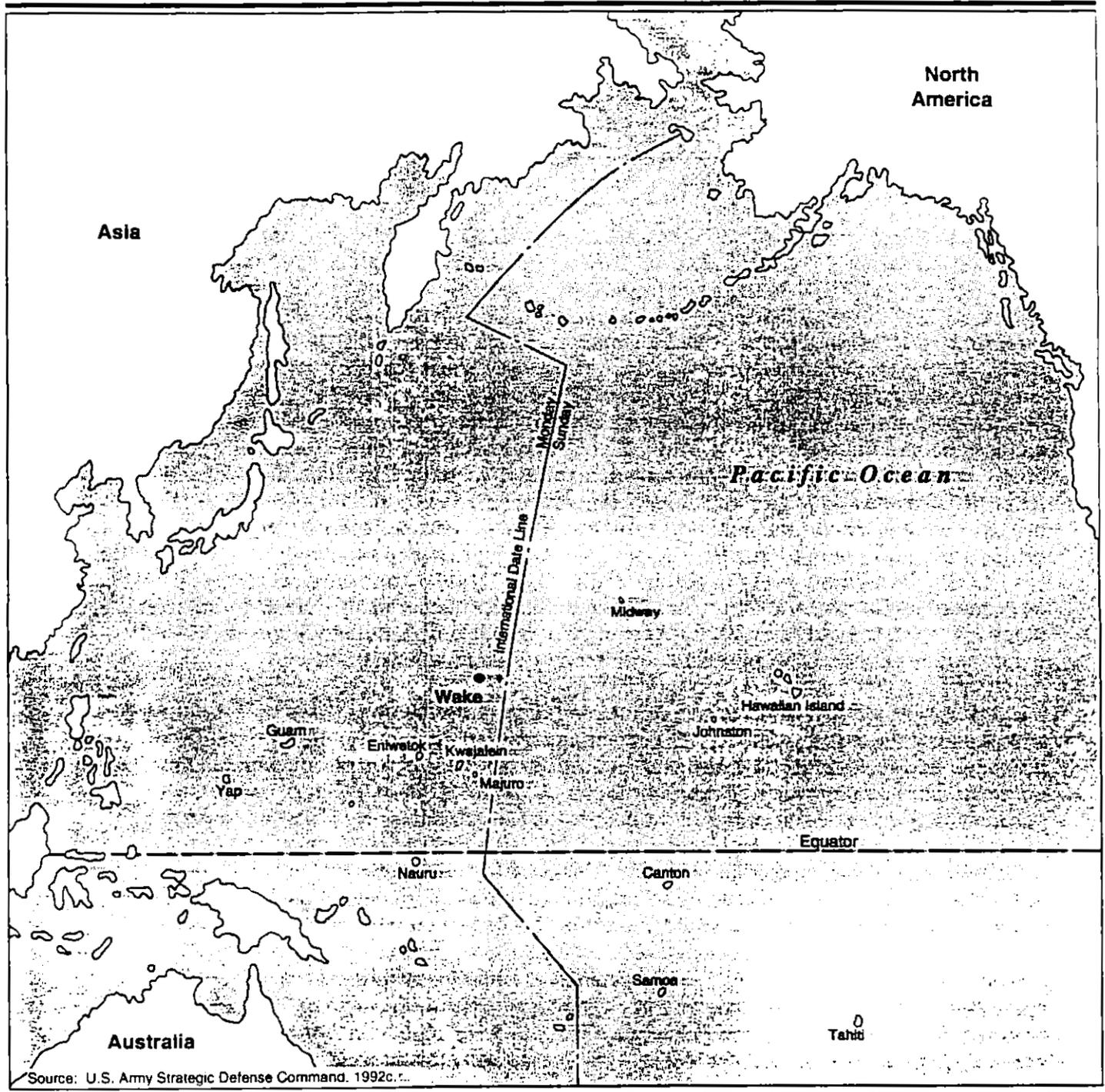
1.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

The National Environmental Policy Act (NEPA), the Council on Environmental Quality regulations implementing the NEPA (40 Code of Federal Regulations [CFR] 1500-1508), Army Regulation (AR) 210-20, *Master Planning for Army Installations*, Department of Defense (DOD) Directive 6050.1, *Environmental Effects in the United States of Department of Defense Actions* (U.S. Department of Defense, 1979), Air Force Regulation (AFR) 19-2, *Environmental Planning, Environmental Impact Analysis Process* (U.S. Air Force, 1987), and AR 200-2, *Environmental Effects of Army Actions*, direct that DOD officials take into account environmental consequences when authorizing or approving major Federal actions. The U.S. Army Space and Strategic Defense Command (USASSDC) needs to prepare an environmental assessment (EA) in support of the planned development tests of Theater Missile Defense (TMD) target and defensive missile systems at Wake Island as well as other reasonably foreseeable Ballistic Missile Defense Organization (BMDO) program-related facilities. Wake Island is located approximately 3,701 kilometers (km) (2,300 miles [mi]) west of Hawaii (figure 1-1). This EA presents an analysis of the environmental consequences of conducting activities in support of the TMD target and defensive missile systems on Wake Island. The disciplines represented in this EA reflect the unique features of the proposed action and its environmental setting.

Section 1.0 of this EA describes the proposed action and alternatives and the purpose of and need for the action. Section 2.0 describes the environment to be affected by the proposed action. Section 3.0 assesses the potential environmental consequences of the proposed activities on the environmental components identified in Section 2.0. If a particular activity has the potential to have a significant effect on the environment, mitigation measures have been incorporated into the proposal to reduce the potential significant effects to insignificant levels. These mitigation measures will be implemented as part of the proposal. Section 4.0 lists the individuals and agencies contacted during research efforts for this assessment. Section 5.0 lists references for this document. Section 6.0 contains the list of preparers of the EA. Appendix A contains a list of relevant, related documentation, and Appendix B contains environmental attributes, applicable laws and regulations, and compliance requirements. Appendix C contains the distribution list for this EA, and Appendix D contains air quality information. Ornithological and botanical survey reports for Wake Atoll are included as appendices E and F, respectively. Appendix G contains copies of agency correspondence letters.

1.1 BACKGROUND

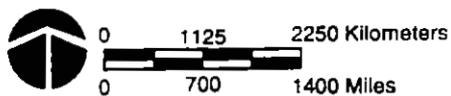
Wake Island is a possession of the United States under the jurisdiction of the U.S. Department of the Air Force and administered by Detachment 1 of the 15th Logistics Group, 15th Air Base Wing, Hickam Air Force Base (AFB), Hawaii. Wake Island has been claimed by the United States since 1899 and has remained under U.S. control with the exception of late 1941 through late 1945 when it was controlled by Japan during World



Location Map

Wake Island

Figure 1-1



War II. Wake Island was under U.S. military control from late 1945 until 1947. At that time, responsibility for the island was given to the Federal Aviation Administration (FAA), which retained control until 1972 when the U.S. Air Force was given administrative control. (U.S. Department of the Air Force, 1992)

Wake Atoll is a typical Pacific coral atoll consisting of three islands (Wake, Wilkes, and Peale) connected by bridge (Wake and Peale) and causeway (Wake and Wilkes) (figure 1-2). The v-shaped atoll is approximately 14.5 km (9 mi) long (from the tip of Wilkes Island around to the tip of Peale Island) and 3 km (2 mi) wide (from approximately Heel Point to the south portion of Wake Island). Total landmass is approximately 739 hectares (ha) (1,826 acres [ac]). It has been designated a historic landmark. (U.S. Department of the Air Force, 1992)

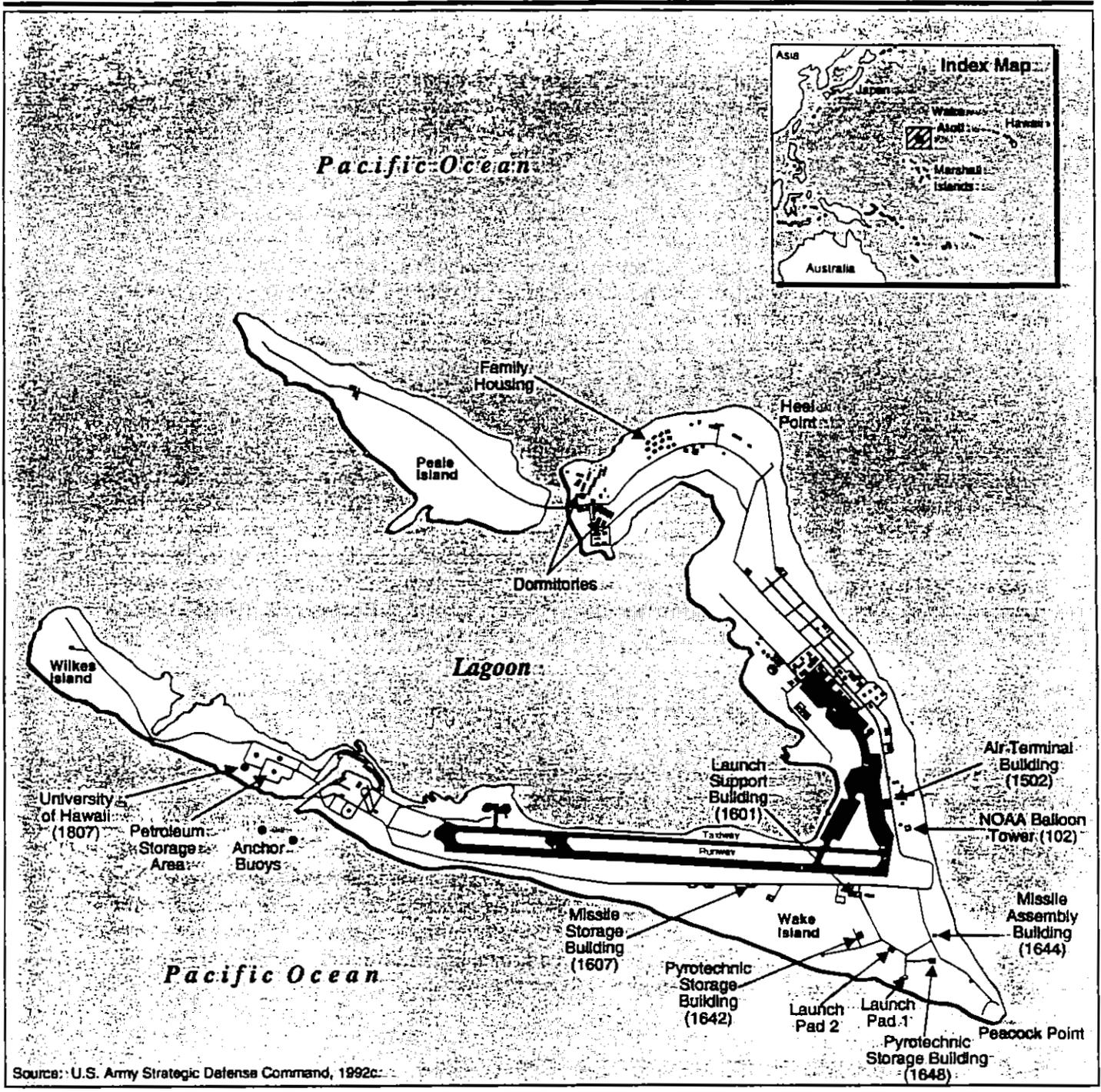
The current mission of Wake Island is varied. The island supports trans-Pacific military operations and Western Pacific military contingency operations, serves as an in-flight emergency airfield, and provides transient military/civilian aircraft servicing and emergency sealift capability (U.S. Department of the Air Force, 1992). In addition, BMDO activities have been taking place on Wake Island, requiring support from the staff and use of the facilities. The BMDO was created in part to determine the feasibility of developing an effective ballistic missile defense system. The program includes research of tactical or theater missile defense technologies necessary to protect U.S. forces, as well as U.S. friends and allies throughout the world, from future missile threats.

1.2 PURPOSE OF AND NEED FOR THE ACTION

The proposed test activities would include target and defensive missile intercept tests to provide realistic test situations for ground-based defenses to operate within a simulated theater of operation, which includes engaging and intercepting notional target missiles. This requires conducting target and other missile system flights over long distances (i.e., in excess 1,150 kilometers [715 miles]). These long-distance missile flight tests would support the developmental and operational effectiveness of U.S. Army TMD missile and sensor systems. Currently, there are no operational overland ranges and few over-water ranges operated by the United States that provide realistic distances for testing within such a simulated theater of operations.

1.3 ALTERNATIVES CONSIDERED

The following sections discuss the proposed action and the no-action alternative at Wake Island. However, other test range alternatives are being considered in the TMD Extended Test Range Environmental Impact Statement.



Existing Facilities Location Map

Wake Island

Figure 1-2



0 159.5 319 Meters
0 523.5 1,047 Feet

1.3.1 PROPOSED ACTION

This EA describes and addresses the potential environmental impacts of conducting proposed additional TMD program activities and alternate booster systems under consideration for future flight tests of the Theater Missile Defense Critical Measurements Program (TCMP) (formerly the Theater Missile Defense Countermeasures Mitigation Program). The initial TCMP test activities were evaluated in an EA completed in 1992 (U.S. Army Strategic Defense Command, 1992c).

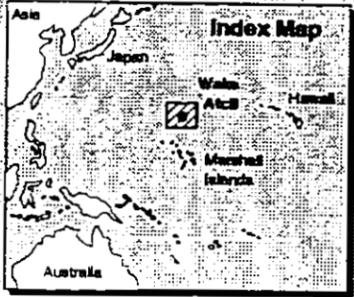
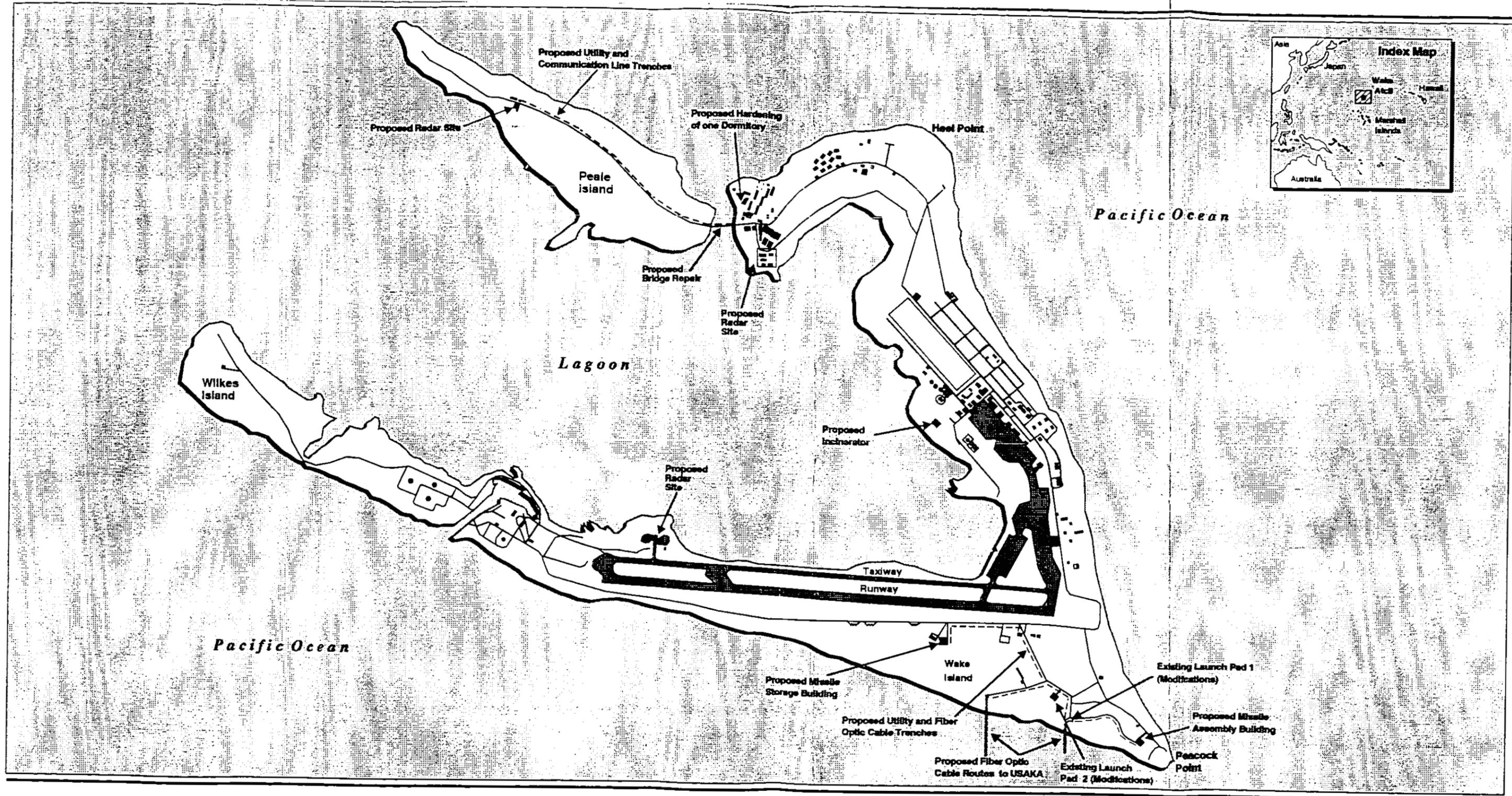
In order to evaluate the potential cumulative impacts of the proposed actions, as required by the NEPA, the U.S. Air Force host command was consulted for planned mission changes that along with the proposed TMD-related activities could have cumulative impacts on the island environment. The U.S. Air Force has no planned mission changes or new facility programs. Therefore, only TMD-related programs are evaluated in this EA. Figure 1-3 shows the locations for all proposed facility modifications and new construction sites.

TMD target and defensive missile systems are being considered for launch activities from Wake Island. Table 1-1 lists the proposed missile launch schedule. This schedule was used to evaluate potential impacts in this EA. However, if necessary to meet program objectives, the schedule could be delayed or extended without increasing any potential effects from the proposed action as determined in this assessment.

The purpose of the TMD program is to provide a realistic quantification of intercept lethality against chemical, biological, and nuclear/conventional weapons. No chemical or biological agents would be used, but a simulant may be used. The TMD target vehicle would consist of a booster system and a payload. The target system may include existing or new booster systems. The target system would be designed to deliver a single or multiple payload toward the U.S. Army Kwajalein Atoll (USAKA). The USAKA is within the Republic of the Marshall Islands. For target launches from Wake Island, the defensive missile would be launched from the USAKA. If defensive missiles are launched from Wake Island, the targets could be launched from the USAKA or from a missile launch ship (MLS) located south of Wake Island. Data for several representative flight vehicles are summarized in table 1-2.

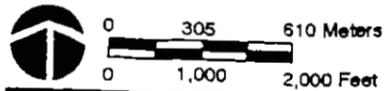
This assessment considers all activities on Wake Island and the missile flight corridor over the open ocean. The missile intercept point and allowable debris and whole-body miss impact areas will not be within the territorial waters of the Republic of the Marshall Islands; therefore, the Compact of Free Association, 48 United States Code 1648, does not apply except for launches from the USAKA. The environmental impacts of both defensive and target missile launch options from the USAKA are addressed in the *Draft Supplemental Environmental Impact Statement: Proposed Actions at U.S. Army Kwajalein Atoll* (U.S. Army Space and Strategic Defense Command, 1993a).

THIS PAGE INTENTIONALLY LEFT BLANK



Proposed Actions Location Map

Wake Island
Figure 1-3



THIS PAGE INTENTIONALLY LEFT BLANK

Table 1-1: Proposed HERA Target and Defensive Missile Launch Schedule

	Calendar Year/Quarter																			
	1995				1996				1997				1998				1999			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Extended Range Interceptor (ERINT)/ Phased Array Tracking to Intercept of Target (PATRIOT)			1	1	2	2	2	2	2	1	1	1	1	1	1	1	1			
Theater High Altitude Area Defense (THAAD)			3		3	3	2	2	2	2	1	2	2	2	2	2	2			1
Theater Missile Defense Ground-Based Radar (TMD-GBR)			1		1															
Corps Surface-to-Air Missile (Corps SAM)			1			1			1		1									

Table 1-2: Flight Vehicle Data

Name	Length	Diameter	Launch Weight
Target Boosters:			
M56A-1	3.95 m (12.97 ft)	1.13 m (3.711 ft)	5,171 kg (11,400 lb)
SR19-AJ-1	4.123 m (13.527 ft)	1.325 m (4.347 ft)	7,024 kg (15,485 lb)
Castor IV	9.07 m (29.76 ft)	1.02 m (3.35 ft)	10,488 kg (23,122 lb)
Castor IVB	8.98 m (29.46 ft)	1.02 m (3.35 ft)	11,523 kg (25,404 lb)
M57A-1	2.17 m (7.10 ft)	0.965 m (3.166 ft)	1,927 kg (4,248.2 lb)
Orbis I	1.28 m (4.20 ft)	0.70 m (2.30 ft)	471 kg (1,038 lb)
Defensive Missiles			
PATRIOT	5.43 m (17.82 ft)	0.41 m (1.33 ft)	918.5 kg (2,025 lb)
ERINT	4.6 m (15.2 ft)	0.255 m (0.84 ft)	304 kg (670 lb)
THAAD	6.2 m (20.2 ft)	0.37 m (1.21 ft)	Classified
Corps SAM	Undefined	Undefined	Undefined
PATRIOT Advanced Capability (PAC)-3	5.43 m (17.82 ft)	0.41 m (1.33 ft)	918 kg (2,025 lb)
Army Tactical Missile System (TACMS)	3.98 m (13.06 ft)	0.61 m (1.99 ft)	1,236 kg (2,628 lb)

Source: U.S. Army Space and Strategic Defense Command, 1992c,b, 1993 c,d, 1991.

1.3.1.1 Target Missile Systems

The TMD target system would be designed to support several defensive missile programs. A total of up to approximately 75 long-range boosters could be used. The target vehicle booster would be a one- or two-stage system using existing Government-furnished rocket motors. The primary target system under consideration for TMD program tests is the HERA system, but other target systems may be used.

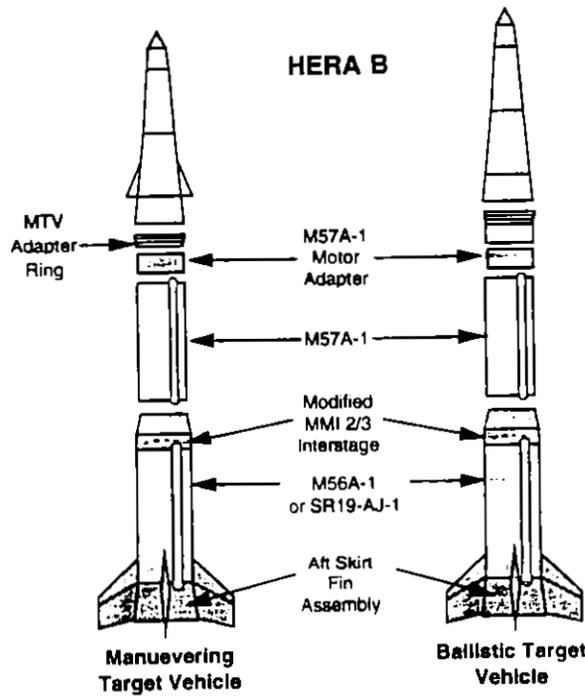
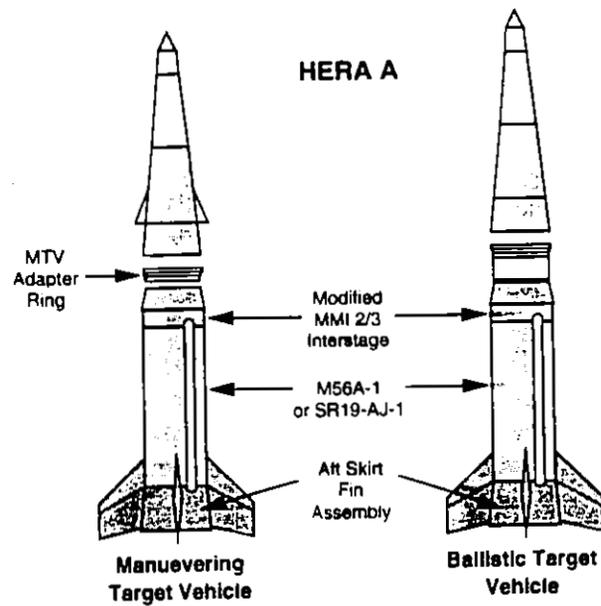
Target Missile System Launch Vehicles

Typical solid-fuel launch vehicles include the HERA family of target vehicles (figure 1-4). The HERA A is a single-stage launch vehicle while the HERA B is a two-stage launch vehicle. The specific rocket motors to be used for each stage are not yet determined. Boosters under consideration for the HERA A and first stage of the HERA B include the M56A-1 and the SR19-AJ-1. The M57A-1 solid rocket motor is under consideration for the second stage of the HERA B launch vehicle. Data on these booster systems are shown in table 1-2. Other rocket motors and components may be used in modified versions of the HERA launch vehicles. All solid-propellant rocket motor's (SRMs) under consideration for HERA boosters are surplus motors that were originally developed for other DOD missile programs and are currently stored at existing DOD bases and depot facilities in the United States. Some target system components (e.g., fairings and interstage adapters) will be developed and fabricated specifically for the HERA Target Systems program (U.S. Army Space and Strategic Defense Command, 1993a). The primary propellant constituents and major exhaust gas constituents for SRMs that may be launched from Wake Island are listed in table 1-3. The HERA Target Systems EA (in progress) will address all activities associated with the manufacture, test, and demonstration test flights of the HERA A and HERA B systems.

The HERA booster systems were selected because they meet the necessary range and payload weight requirements and are currently available. However, alternate booster systems may be used if any of the proposed rocket motors are not available. Alternate booster systems for TMD targets as well as for the ongoing TCMP flight tests are listed below:

- Castor IV/M57A-1
- Castor IV/Orbis I
- Castor IVB/M57A-1
- Castor IVB/Orbis I
- M56A-1/Orbis I
- SR19-AJ-1/Orbis I

Launches of the Castor IV and Orbis I rocket motors were previously evaluated in the TCMP EA with a finding of no significant impact at Wake Island.



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

HERA A and HERA B Target Systems

Figure 1-4

Table 1-3: Representative TMD Motor Characteristics

Propellant Constituents	Major Exhaust Gas Constituents
Solid-Fuel Motors	
Ammonium perchlorate, Aluminum, Polyurethane, Polybutadiene, Nitroglycerine, Nitrocellulose, Cyclotetramethylenetetranitramine	CO ₂ , CO, H ₂ O, H ₂ , HCl, N ₂ , NO _x , Al ₂ O ₃ (solid)

Target system launch vehicles may contain a flight termination system (FTS). The purpose of the FTS is to safely terminate the flight of the launch vehicle in the event of an unsafe condition developing during flight (such as an off-course flight). The FTS is activated by range safety personnel. The proposed FTS technique is to detonate an explosive charge which ruptures the SRM casing. The resulting loss of pressure terminates SRM thrust. The launch vehicle then falls to the ground or into the ocean.

Appropriate safety measures would be used during the handling, shipment, and storage of propellants and other ordnance as required by the DOD and the Department of Transportation (DOT). Solvents and other materials would be required for flight preparation activities. The user will be required to follow appropriate safety/health regulations regarding such materials. (U.S. Army Strategic Defense Command, 1992a)

Target Missile System Payloads

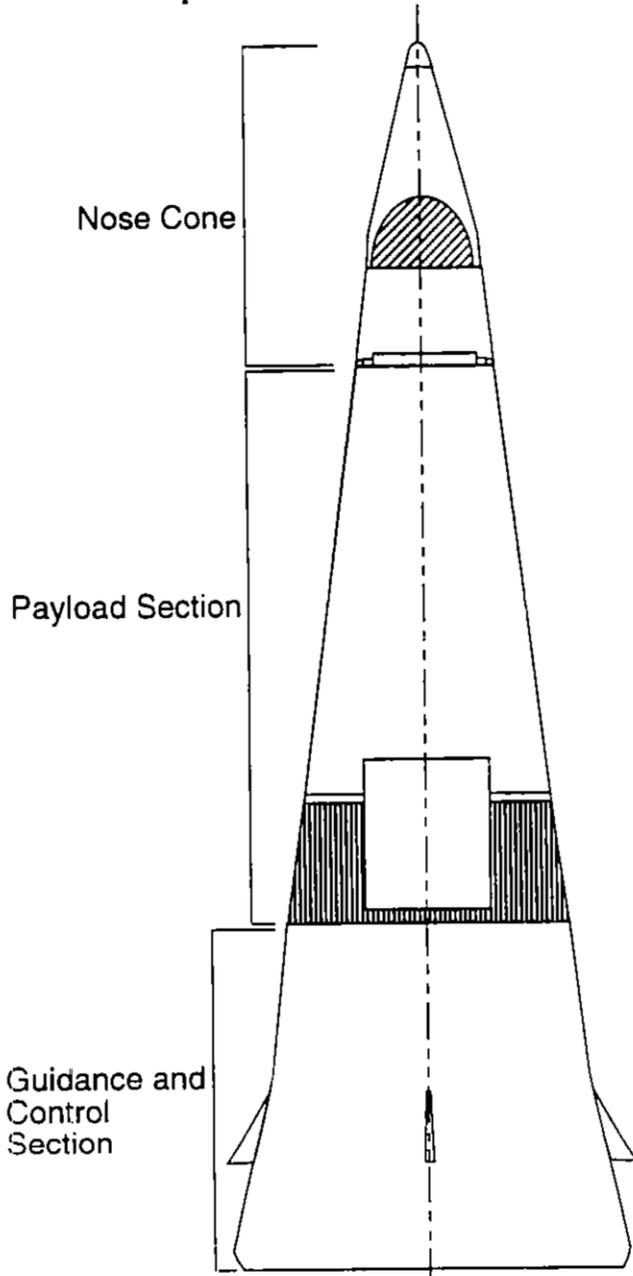
Target missile systems would consist of either ballistic target vehicles (BTVs) or maneuvering target vehicles (MTVs). Examples of these BTVs and MTVs are shown in figure 1-5. Both BTV and MTV payloads would be delivered by the HERA or an alternate launch vehicle. These target vehicles may separate from the launch vehicle prior to intercept or surface impact.

The target vehicle would consist of a steel housing assembly, which may contain a radar section, optical sensors, guidance and control electronics, radio transmitters and receivers, power supply (normally batteries), and a payload section to hold simulant materials in a bulk container or submunitions. The MTV would also be equipped with stabilizer fins and cold-gas (nitrogen) thrusters to control roll, pitch, and yaw during final flight.

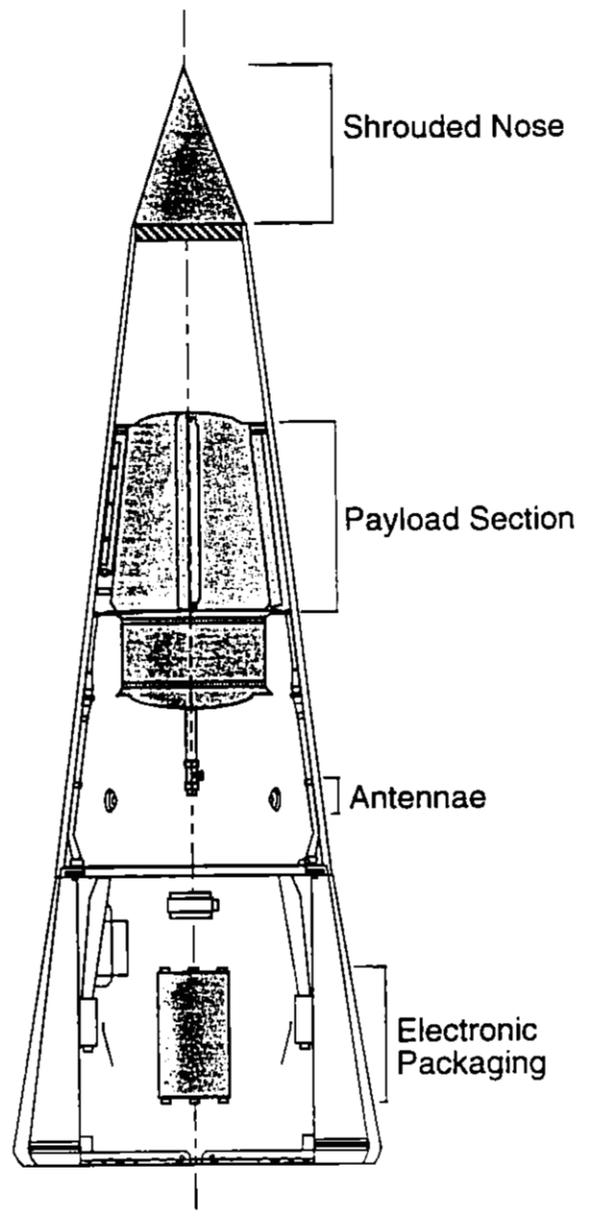
The target vehicle would contain a FTS that is used to safely terminate the flight of the launch vehicle in the event of an unsafe condition developing during flight (such as an off-course flight). Should a target vehicle carrying a simulant payload not be intercepted, vehicle flight may also be terminated at an appropriate altitude in order to disperse the payload before impacting on the ground or in a water body.

Simple penetration aids are being considered for TMD test flights. Penetration aids are used by offensive missile systems to increase the probability that the warheads will penetrate missile defenses and reach their targets. This is accomplished by overwhelming the defensive sensor and command and control systems with a large number of apparent warheads and by confusing the defensive systems as to the number and location of incoming warheads. Penetration aids would be housed in the target vehicle separation module. One penetration aid technique is for an offensive missile to carry several decoy

Maneuvering Target Vehicle Components



Ballistic Target Vehicle Components



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

Representative TMD Target Vehicles

Figure 1-5

payloads. These decoys, when released, appear to be actual payloads. They will then be engaged by defensive missiles, thereby wasting the scarce defensive missile assets and increasing the probability that actual payloads will reach their targets. In addition to decoys, chaff and radar (active and passive) may be used to defeat defensive sensor and command and control systems. These penetration aids would be fabricated out of graphite, stainless steel, and tungsten.

Simulants

The purpose of using simulants in TMD target vehicles is to assess the effectiveness of TMD defensive missiles against threat missiles carrying chemical and biological agents as payloads. In order to adequately simulate this threat in testing, it is necessary to use materials which closely replicate the physical characteristics of actual chemical agents yet are not as hazardous. Use of actual chemical and biological agents in testing would present the potential for unacceptable hazards. The only chemical simulant currently proposed for use in target vehicle payloads and evaluated in this document is triethyl phosphate (TEP). Each payload would contain up to a maximum of 133 liters (L) (35 gallons [gal]) of the simulant when used. Other chemical simulants could be used. The TMD Lethality Program EA (U.S. Army Space and Strategic Defense Command, 1993c) discusses in some detail the properties and some potential uses of various simulants proposed for use in TMD target vehicles would be conducted. Submunitions, if used, would contain water.

Target Missile System Launch Requirements

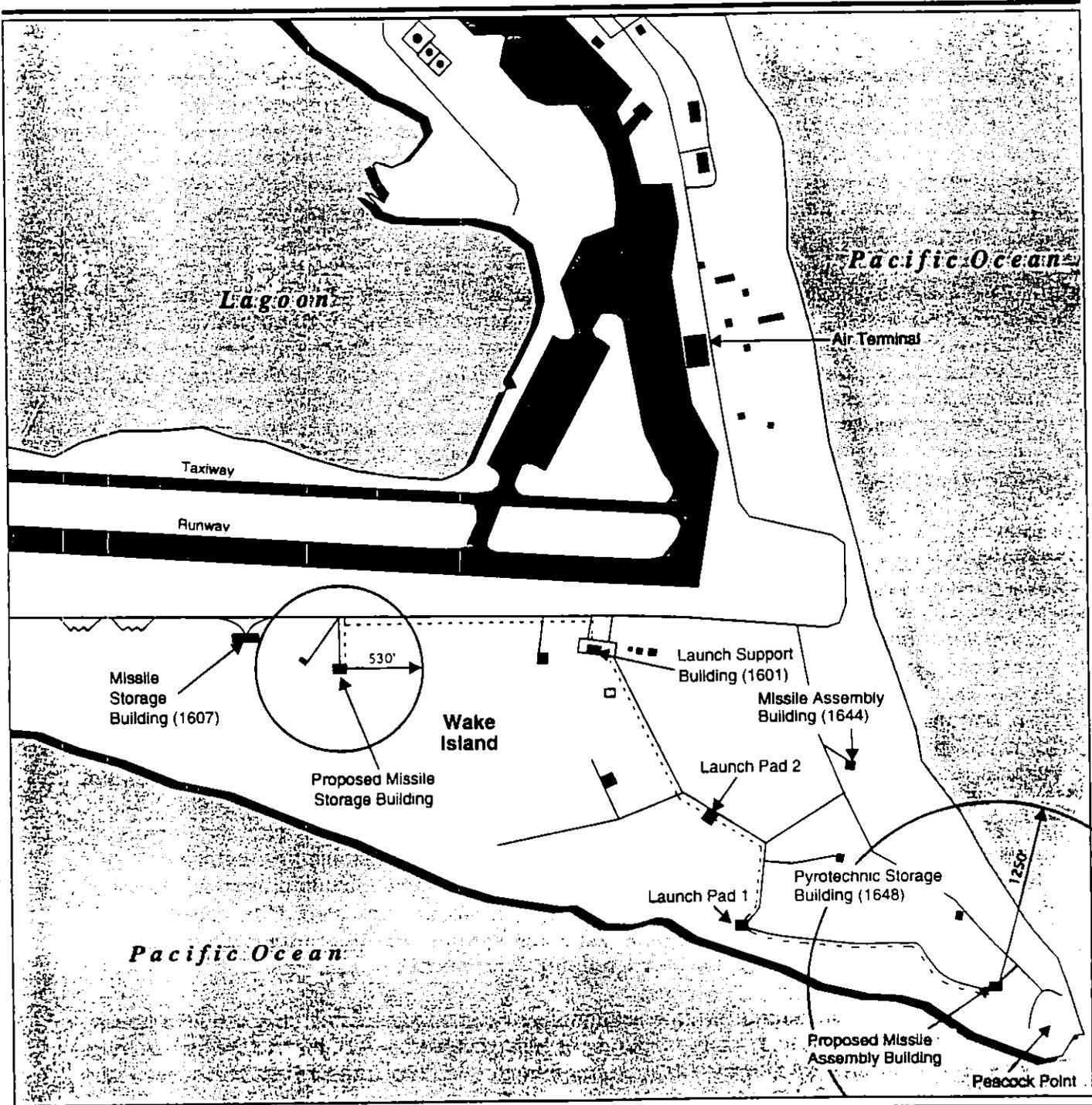
Ground-Based Launch Preparation – Target boosters, payloads, and support equipment would be transported by aircraft or ship from Government storage depots or contractor facilities to Wake Island, where they would be placed in secure storage until assembly and launch preparation. Applicable safety regulations would be observed in the transport, handling, and storage of hazardous materials.

A maximum of 70 personnel (contractor, military, and Government civilian) may be required on site for a period of up to 2 weeks in order to support a single land-launched target mission. These personnel would be in addition to existing personnel at test sites (Williams, 1993).

Facility Requirements

The following facility modifications and new construction would be required to support target system launch requirements.

Proposed Missile Storage Building – A new missile storage building (MSB) is proposed for Wake Island to complement the existing MSB. The new MSB would allow storage of Class 1.1 explosives contained in the HERA or alternate booster systems. The proposed location of the new MSB is shown in figure 1-6. It is sited between the fire training burn pit and a scrap yard of abandoned vehicles. The site would require an area of previously disturbed but revegetated land approximately 0.04 ha (0.1 ac) in size.



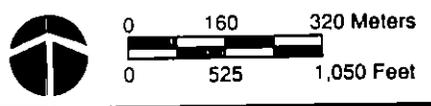
Proposed Missile Storage and Missile Assembly Buildings

Wake Island

Figure 1-6

EXPLANATION

- Proposed Project Location
- Explosive Safety Quantity-Distance
- - - Utility and Communication Lines



gr/Waku106 mm-1/3/94

Proposed Missile Assembly Building – A new missile assembly building (MAB) is proposed for Wake Island to complement the existing MAB. The new MAB would allow for simultaneous assembly of missiles to meet projected launch schedules. The proposed location of the new MAB is shown in figure 1-6. It is sited between the pump house which discharges waste treatment plant effluent and a site being used as a landfill. The site would require an area of previously disturbed but partially revegetated land approximately 0.04 ha (0.1 ac) in size.

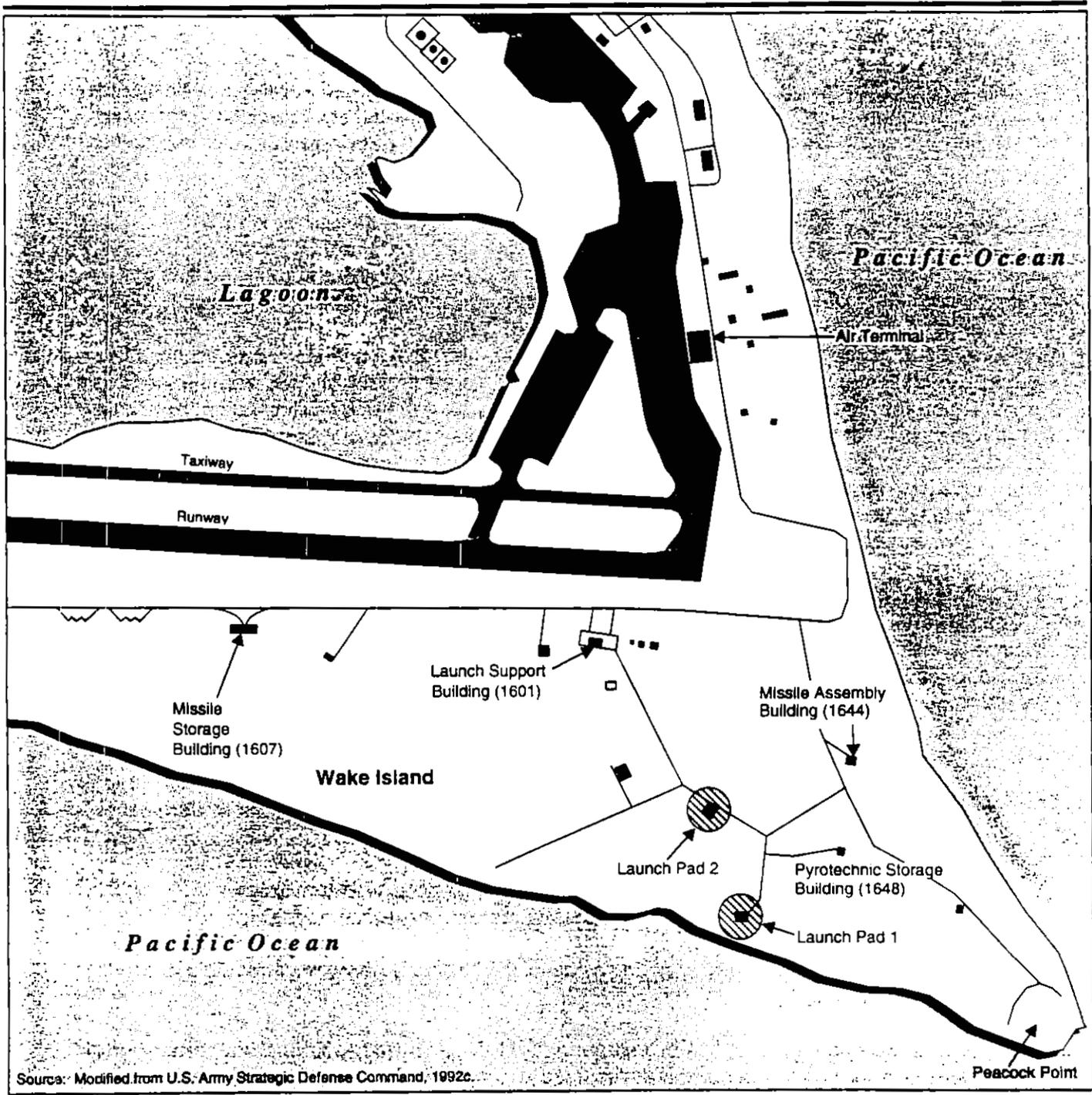
Launch Support Building – The Launch Support Building (Building 1601) will require additional hardening to provide personnel with protection in the event of catastrophic failure of a target flight vehicle. Hardening and structure modification requirements have not been evaluated but would likely consist of the addition of concrete or concrete-filled masonry units or sandbags on one or more of the exterior walls. Interior modifications may also be required to allow the addition of launch and range support equipment for the TMD mission. Building modifications would not require additional land area or the removal of any vegetation.

Launch Facilities – Launch facilities are necessary for the research, development, and testing of missiles and other vehicles used for space flight in support of the mission of Wake Island. Launch pads 1 and 2 (figure 1-7) are adequate to meet the current launch activities at Wake Island; however, they require improvements and modifications to adequately support proposed TMD launch activities. A proposal has been made to construct a launch equipment building at each launch pad to protect equipment from the harsh environment. Each building would be about 46.5 square meters (m²) (500 square feet (ft²)) and would require a concrete foundation of slightly larger dimensions. The area of land disturbance required for building construction will depend on the exact site location. Final building locations will be selected to minimize or avoid land disturbance, but in no case will more than 0.04 ha (0.1 ac) be required for each structure.

Launch Pad 2 will be used for target vehicle launches and may be used for defensive missile launches. Additional new construction at this site could include a vertical launch stool and trenches to Building 1601 for utility and communication lines. The total area potentially disturbed by this construction would be up to 0.1 ha (0.3 ac) including the launch equipment building site and a cleared area for fire safety.

There will be no displacement of organizations, activities, or personnel as a result of these proposed projects; however, construction scheduling would have to be closely coordinated to the extent possible with missile launch programming and the seabird nesting season at Wake Island.

Range Support Equipment – Portable or permanent range equipment for radar and telemetry may be sent to Wake Island to provide those range activities previously provided by the U.S. Naval Ship Redstone. Proposed radar and telemetry sites for TMD launch activities are shown in figure 1-3. It is intended that sites would be located in existing level areas such as roadways, parking lots, or other areas that have been previously cleared and graded. The total area of these sites is expected to be about 0.1 ha (0.3 ac).



EXPLANATION

 Proposed Project Locations

Launch Facilities



0 160 320 Meters
0 525 1,050 Feet

Wake Island

Figure 1-7

The Kwajalein Mobile Range Safety System (KMRSS) may be initially deployed for use on Wake Island to provide the Wake Island Flight Safety Officer with the capability to ensure that potential hazards to local areas are avoided or mitigated during missile launches and operations.

The KMRSS is a fully self-contained, 100-percent redundant mobile system that is transportable by ground, sea, and air (via U.S. Air Force C-141 and C-5 aircraft). All functions, including acquiring, processing, displaying, interpreting, and using command transmission and verification data, are redundant in support of the safety mission.

The KMRSS consists of three main subsystems: a destruct transmitter subsystem, a telemetry subsystem, and a flight safety control subsystem. The KMRSS receives and records simultaneously up to three different telemetry data links including telemetry data from the missile. The KMRSS is also capable of receiving and processing data from dual inertial maneuvering units through telemetry and data from the optical acquisition system. The processed information is used to provide tracking data for the antennae (both telemetry and command destruct), to provide graphic display of the best estimate of trajectory, and to provide other parameters as required.

The AN/MPS-36 C-band general-purpose instrumentation tracking radars consist of a 3.7-meter (12.1-foot) diameter antenna and microwave system, an electronics van, a maintenance van, and a boresight tower. The system is designed to rapidly acquire and automatically track either skin or beacon targets. The system is fully digitized and includes its own digital computer for calibration, acquisition aid, tracking aid, and data output.

The AN/MPS-36 system performs several functions:

- Provides metric data on incoming missions and local launches in either skin or beacon track modes
- Provides real-time acquisition and tracking data to other range instrumentation sensors on local launches or reentry missions
- Furnishes tracking data on weather balloons and meteorological rocket payloads

The AN/MPS-36 radar operates in the frequency range of 5,400 to 5,900 megahertz with a peak power output of 1 megawatt. It is used primarily as a beacon tracking radar due to the limited radar loop-gain inherent to the system. Corresponding beacon track ranges are much greater and depend upon the beacon power output.

The proposed site for the location of permanent range support sensors is the abandoned U.S. Coast Guard facility on Peale Island (figure 1-3). This location might also be used for mobile equipment. Site preparation would include the refurbishment of Building 1203 for electronic equipment, construction for a concrete foundation approximately 9.8 by 9.8 m (30 by 30 ft) for a radar antenna, and trenching along the existing road to the billeting area for utility and communication lines.

It would also be necessary to refurbish the bridge connecting Wake and Peale islands to support transportation of the radar and other telemetry equipment to the proposed site at the abandoned U.S. Coast Guard facility. The bridge currently has a 2-ton weight limitation (Andel, 1993). Engineering studies to determine the best construction methods have not been initiated, but it is believed that the present structure can be strengthened without impeding water circulation under the bridge during tidal changes.

Fiber Optic Cable – A fiber optics cable has been proposed that would link Wake Island and Kwajalein Island. The cable could be trenched and laid along the south side of Wake Island and brought on shore near Launch Pad 1. From there a likely route would be in existing utility trenches along the access road to the Launch Support Building (1601) (figure 1-3).

The fringing reef that surrounds the island is very narrow on the south side and would require the least amount of offshore trenching. This route would also provide the shortest overland route to the Launch Support Building and the least ground disturbance if previously trenched areas for utility cables were used.

Incinerator – A new incinerator is proposed for Wake Island. It would be located adjacent to the existing incinerator on previously disturbed land. The existing incinerator is operating at capacity and would be overburdened with the increase in activity planned for TMD-related programs. The site would require an area approximately 0.04 ha (0.1 ac) in size (figure 1-8).

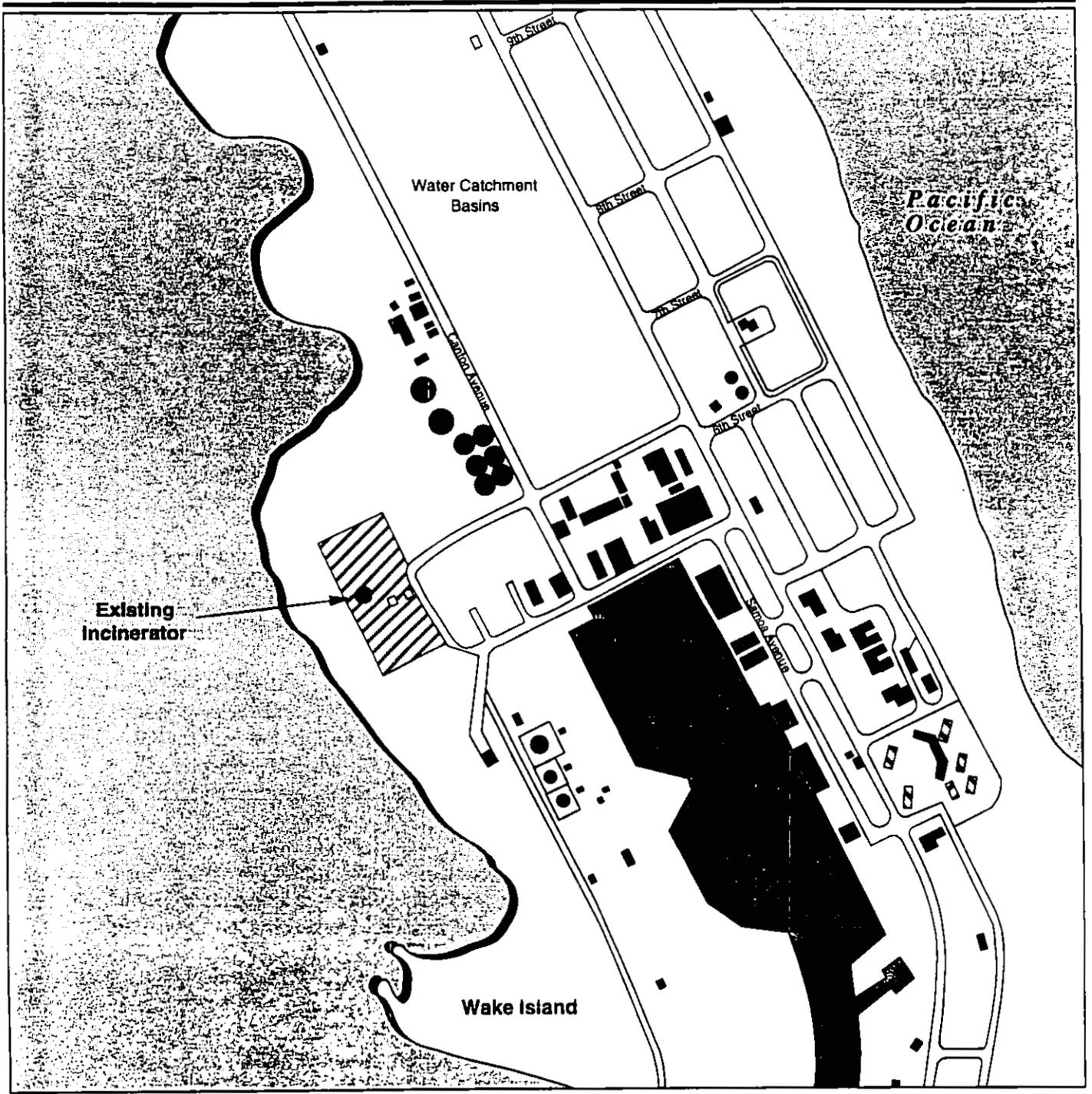
Dormitory Hardening – One of the existing dormitories in the billeting area may require hardening to provide adequate shelter for non-mission-essential personnel during TMD target missile launches. If required, hardening could include removal of windows and exterior wall modification but would not require ground disruption or construction of new structures.

Construction Schedule – The construction or renovation of all the facilities would require about 40 personnel for 8 months. However, the construction has not been scheduled and may allow for a smaller workforce over a longer period of time, depending on the launch schedule.

Ground-Based Flight Testing

Target missile systems would be launched from fixed launch stools or rails. The systems would be flown on trajectories which simulate threat missile flight paths. Flight test profiles would vary greatly in trajectory and range. Target payloads may reach altitudes of up to 550 km (342 mi) and ranges of 1,150 km (715 mi) (U.S. Army Space and Strategic Defense Command, 1993c).

Target system flight tests will require either temporary evacuation of some land areas and air corridors or sheltering of personnel on Wake Island. A launch hazard area (LHA) within which non-mission-essential personnel are excluded during launch preparations and flight testing will be established. LHAs for missile systems launched within the Kwajalein Missile Range (KMR) are configured to provide the maximum protection for personnel and take



EXPLANATION

 Proposed Location for Additional Incinerator

Incinerator Location



0 90 180 Meters
0 290 580 Feet

Wake Island

Figure 1-8

into account the ability to control access to the hazard areas. Consequently, the LHAs are usually larger than the predicted hazardous area. The tentative LHA for a HERA target launch from Wake Island is a 7.2-kilometer (4.5-mile) corridor around the launch site. This LHA would cover the entire atoll, requiring the sheltering of personnel in hardened structures during the evacuation period.

Sea and air corridors along the target flight path will also be verified as clear. Impact study areas for expended boosters, target vehicles, and defensive missile debris resulting from a successful intercept and intact target and defensive missile payloads (in the event of a failed intercept) will be determined by the KMR Range Safety Office for each flight test based on detailed launch planning and trajectory modeling. These areas would be monitored and verified as clear of personnel, boats, and aircraft.

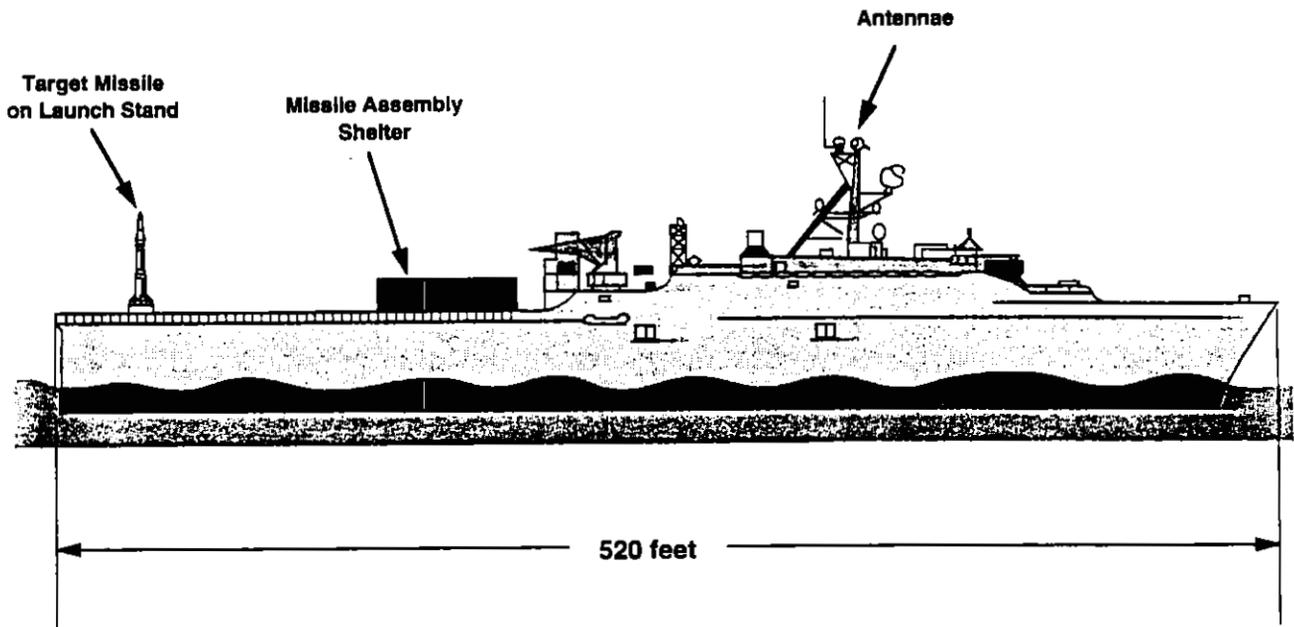
Flight testing requires collection and analysis of flight data. Target vehicle flights would be supported by telemetry receivers, optical sensors, and radars. Telemetry data will be transmitted from the target vehicle to ground stations during flight for recording and analysis. Most of these data collection systems are existing fixed or mobile range assets and would not be constructed specifically to support the TMD program. Ground-based optical sensors, radars, and telemetry stations may be supplemented by ship-based or airborne sensors.

Radio communication with the target vehicle would be required in order to receive telemetry data and transmit commands and data to and from the flight vehicle. Ground-based, ship-based, or airborne radio transceivers would provide this communication link. Most communication facilities would likely be existing range assets.

Sea Launch Preparation and Flight Testing

Sea Launch Preparation – Sea launches of target missiles could be conducted from a specially configured ship. A conceptual MLS configuration is shown in figure 1-9. The MLS could be obtained by modifying an existing surplus ship, such as an Amphibious Transport Dock. Modifications to the ship will include installation of facilities and support equipment functionally similar to that required for a ground-based launch. This will include launch stools, erectors, missile assembly and checkout facilities, and crew accommodations. A gyroscope-controlled platform for missile launch operations may also be required. The MLS will be capable of launching up to two target vehicles on one mission. The sea launch option is under consideration for the single-stage HERA A configuration with a demonstrated range of less than 500 km (311 mi).

Boosters, payloads, and other target vehicle components will be transported by air, rail, or over-the-road common carrier truck from Government storage facilities or contractor facilities to the port of debarkation where they will be placed in secure storage until loading onto the MLS. Port facilities must have berthing facilities sufficient to handle ships of the MLS class and must be authorized to store and handle explosive ordnance. Applicable safety regulations will be observed. Special explosive handling permits may be required.



Source: U.S. Army Space and Strategic Defense Command, 1992c.

Conceptual Missile Launch Ship

Figure 1-9

All missile components and support equipment will be loaded on board the MLS in port, and the MLS will then be towed to the launch location by an ocean tug. Final assembly and checkout of the target flight vehicle will be accomplished on board the MLS. The MLS will remain at sea for approximately 10 days in order to support one mission.

Approximately 30 on-board personnel will be required to support one sea launch mission (U.S. Army Strategic Defense Command, 1992d). This manpower requirement is significantly less than for a land-launched target vehicle because much of the missile assembly and flight preparation would be performed before leaving port.

Before proceeding with development of a MLS or other sea platform and port operations for target missile handling, supplemental environmental documentation, in addition to this EA, may be required.

Sea-Based Flight Testing – In all cases, sea launch safety criteria and mitigation will comply with the lead range requirements for the mission launch activities. Flight hazard analysis will be conducted on a mission-by-mission basis. Personnel will be evacuated from flight hazard areas and the areas monitored before and during the mission to prevent inadvertent encroachment. If required, remote launch control will be provided by another ship, possibly an ocean tug, stationed at several hundred meters from the MLS. Other support ships may also be required.

Flight testing requires collection and analysis of flight data. Target vehicle flights will be monitored by telemetry receivers, optical sensors, and radars. Telemetry data will be transmitted from the target vehicle during flight for recording and analysis. Ground-based optical sensors, radars, and telemetry stations may be supplemented by ship-based or airborne sensors.

Radio communication with the target vehicle will be required in order to receive telemetry data and transmit commands and data to and from the flight vehicle. Ground-based, ship-based, or airborne radio transceivers would provide this communication link.

1.3.1.2 Defensive Missile Systems

Approximately 75 to 100 surface-to-air and surface-to-surface defensive missiles may be launched from Wake Island as part of the TMD program. Most would be launched for planned intercept with a TMD target. However, some surface-to-air and all surface-to-surface defensive missiles may be launched without an opposing target. Defensive surface-to-air missiles being considered for TMD testing include but are not limited to: Theater High Altitude Area Defense (THAAD), Phased Array Tracking to Intercept of Target (PATRIOT), Extended Range Interceptor (ERINT), PAC-3, and Corps Surface-to-Air Missile (Corps SAM). The Atmospheric Interceptor Technology (AIT) program may also be included in TMD testing. The objective of the AIT program is to develop advanced technology for the hit-to-kill destruction of missiles within the atmosphere. AIT testing under the TMD Extended Test Range program could include flight testing and target intercept testing of prototype advanced atmospheric kill vehicles (Jones, 1993).

Surface-to-surface missile systems are employed to prevent the launch of hostile missiles by attacking the launch sites and damaging or destroying the missiles and their support elements prior to launch. The Army Tactical Missile System (TACMS), a surface-to-surface system, is being considered for TMD testing at Wake Island. The launch schedule for this system has not been determined.

The environmental impacts associated with research and development, fabrication, and assembly of individual defensive missile systems are addressed in program-specific environmental documentation for many of the systems, including the THAAD EA (U.S. Army Space and Strategic Defense Command, 1993d), the ERINT EA (U.S. Army Strategic Defense Command, 1991), the Army TACMS Life-Cycle EA (U.S. Army White Sands Missile Range, 1991), and the PATRIOT Life-Cycle EA (Department of the Army, 1990). If actions are considered with impacts beyond the scope of these documents, additional environmental evaluation and documentation may be required.

Defensive Missile Launch Vehicles

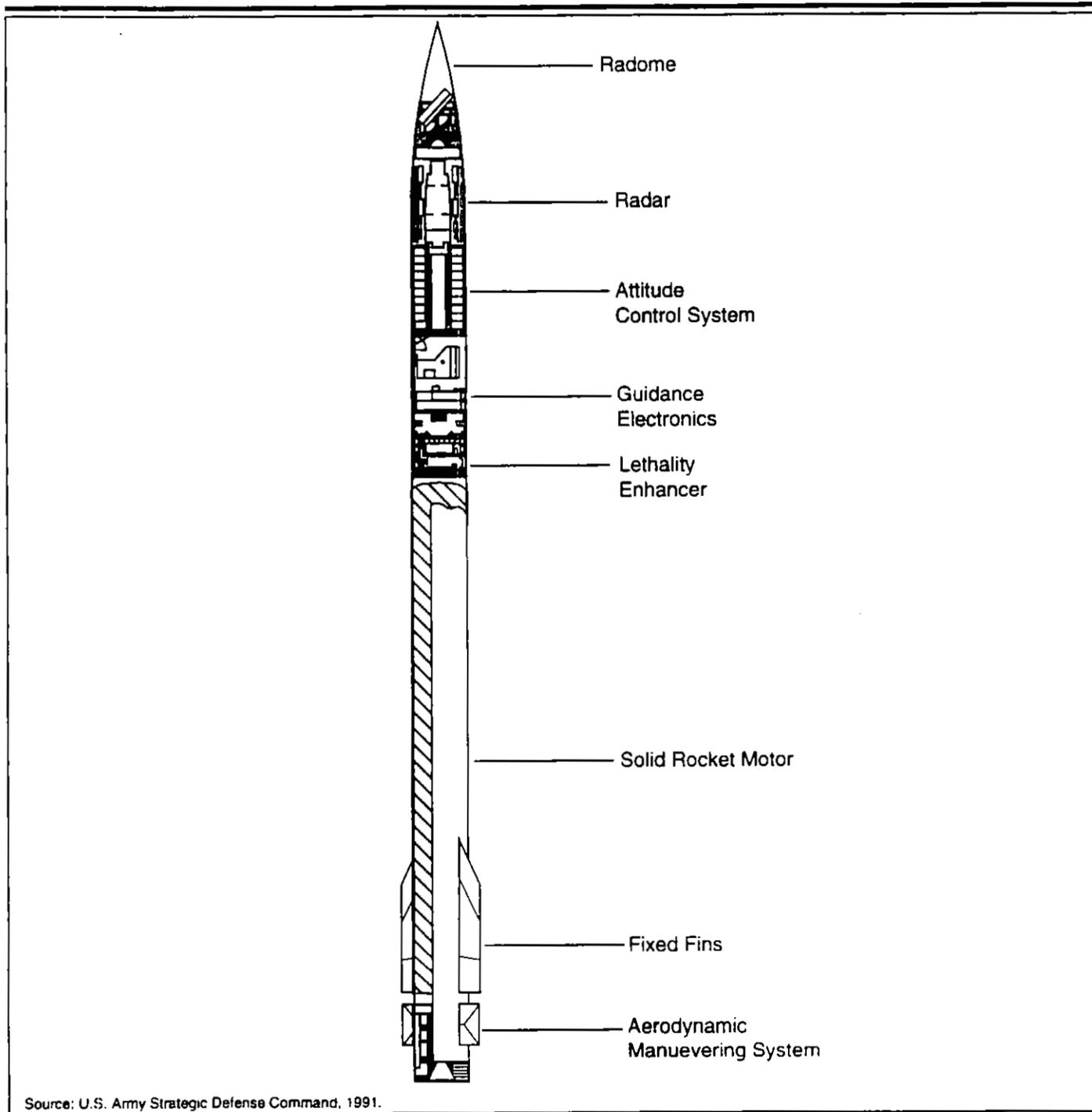
Defensive missiles would be flown on trajectories designed to intercept target missiles. Flight test profiles will vary greatly in trajectory and range. Defensive missiles may reach altitudes in excess of 60 km (35 mi) and ranges in excess of 100 km (62 mi). A typical interceptor, the ERINT system, is shown in figure 1-10. The Army TACMS system is shown in figure 1-11.

Any or all of the TMD program defensive missiles could be launched from mobile launchers at various ground sites on Wake Island in lieu of TMD target systems. Defensive missiles may be single- or multi-stage and would use solid fuel. Major exhaust gas constituents from defensive missile motors would be the same as for target booster motors (table 1-3). Flight vehicle data for candidate defensive missile systems are summarized in table 1-2.

Defensive missile launch vehicles may contain a FTS. The purpose of the FTS is to terminate the flight of the launch vehicle in the event of an unsafe condition developing during flight (such as an off-course flight). The FTS may be activated by range safety personnel. One FTS technique is to detonate an explosive charge which ruptures the SRM casing. The resulting loss of pressure terminates SRM combustion. The launch vehicle then falls to the ground or into the ocean. The Army TACMS test missile system features a FTS in which cutting charges separate the payload section from the launch vehicle. The payload section then falls intact, without dispensing submunitions. (Nelson, 1993)

Defensive Missile Payloads

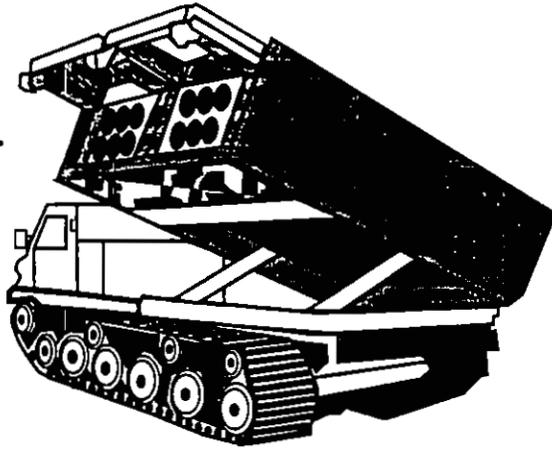
Defensive missile payloads are designed to destroy threat missiles in flight. The kill mechanisms may include high-explosive warheads, which destroy the target by detonating near it, or kinetic kill vehicles (KKV), in which the defensive missile payload destroys the target by colliding with it at high speed. Lethality enhancers may also be employed and may include the use of a fragmenting warhead or structural cutters to increase the kill area and probability of an intercept (Strategic Defense Initiative Organization and U.S. Army Space and Strategic Defense Command, 1993).



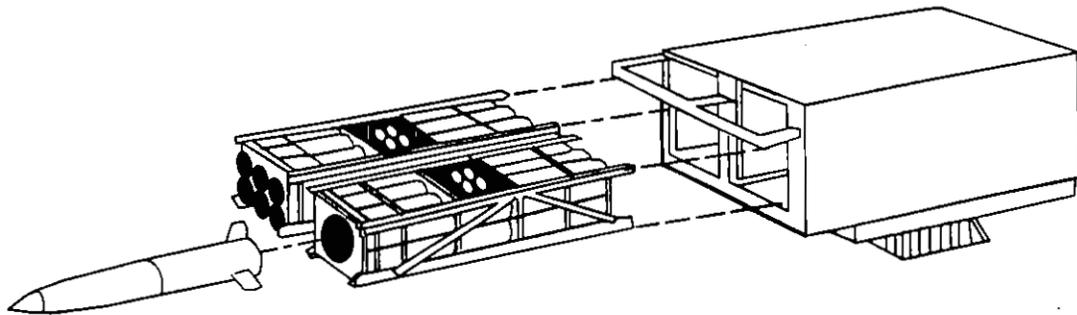
**ERINT
Defensive Missile**

Figure 1-10

M270 Launcher

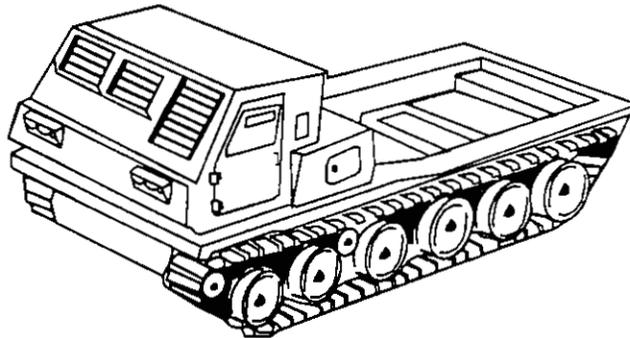


Launcher Loader Module



Missile

Chassis



Source: U.S. Army White Sands Missile Range, 1991.

**Army TACMS
Launch System**

Figure 1-11

Defensive missile system payloads may also contain radars or optical sensors, guidance and control electronics, radio transmitters and receivers, small SRMs for separating payloads from boosters, and power supplies (normally batteries). Defensive missile payloads may be equipped with divert and attitude control (DAC) propulsion systems which control the missile attitude and trajectory or control the payload after separation from the launch vehicle. DAC systems may use small liquid hypergolic propellant systems or consist of a battery of miniature solid-propellant rocket motors (U.S. Army Space and Strategic Defense Command, 1993e).

Defensive Missile Systems Launch Requirements

Launch Preparation – Defensive missile boosters, payloads, and support equipment will be transported by air or ship from Government storage depots or contractor facilities to Wake Island, where they will be placed in secure storage until assembly and launch preparation. Applicable safety regulations will be followed in the transport and handling of hazardous materials. An appropriate explosive safety quantity-distance (ESQD) will be established and maintained by KMR safety personnel with approval from the DOD Explosive Safety Board around facilities where ordnance is stored or handled.

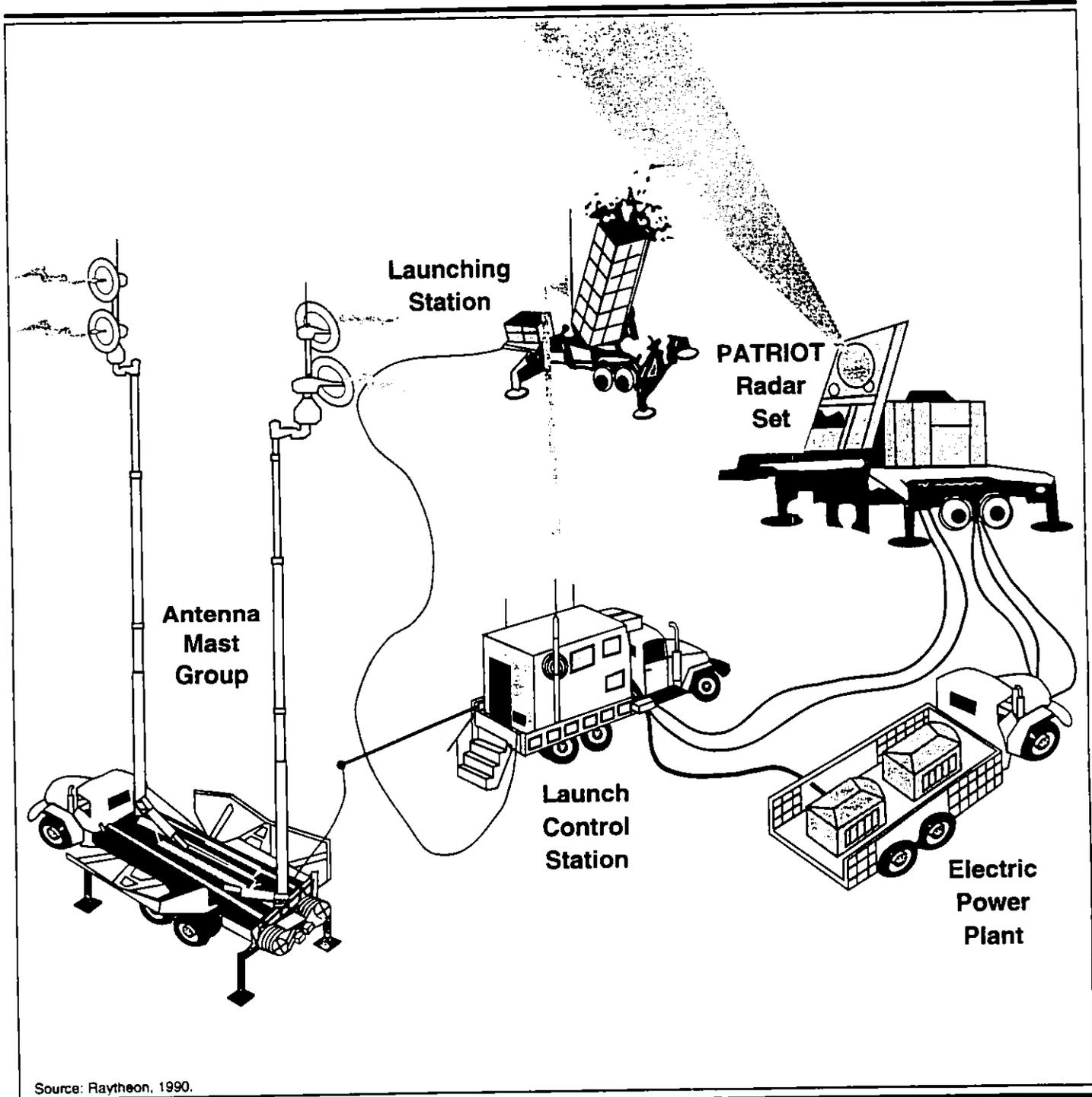
Most TMD defensive missile systems are envisioned to be completely mobile and stand-alone systems. A typical defensive missile ground-based launch site is illustrated in figure 1-12. During some test scenarios, however, some ground support equipment (GSE) elements may not be available. Portable GSE that might be used to support defensive missile testing may include launchers, launch control stations, telemetry vans, personnel trailers, and power generators.

A maximum of 110 personnel (contractor, military, and Government civilian) will be required on site for a period of up to 2 weeks in order to support a defensive missile launch. This figure does not include up to 30 personnel that would be required to support TMD-GBR testing.

Facility Requirements – Defensive missile launches would require the deployment of mobile range support equipment on the island. Proposed sites for the deployment of mobile systems are shown in figure 1-3.

As stated in Section 1.3.1.1, it would be necessary to refurbish the bridge connecting Wake and Peale islands to support transportation of the radar and other telemetry equipment to the proposed site at the abandoned U.S. Coast Guard facility. Engineering studies to determine the best construction methods have not been initiated, but it is believed that the present structure can be strengthened without impeding water circulation under the bridge during tidal changes.

The existing MAB (1644) and Launch Support Building (1601) would require minor interior modification to support the defensive missile launch program. The construction of a new MSB and MAB and the hardening of structures and other building modifications required for target missile launches would not be needed to support defensive missile launches. A new incinerator to support the increased island population would be required to support either system.



**Defensive Missile
Conceptual
Configuration**

Figure 1-12

Flight Testing – Defensive missile systems will be launched from mobile launchers at ground sites in the Peacock Point area. Flight profiles would vary greatly in trajectory and range, but would generally be to the south away from the unhabitated areas on Wake Island.

LHAs for each of the proposed defensive missile systems have not been defined by KMR range safety personnel to provide the maximum protection for personnel and take into account the ability to control access to the hazard areas. It is expected that the LHAs for defensive missiles will be about 3,658 m (12,000 ft) which is equivalent to the LHA presently used for TCMP flight tests.

Defensive missile flights will be supported by telemetry receivers, optical sensors, and radars for the acquisition of flight data. Telemetry data will be transmitted during flight from the defensive missile vehicle to ground stations for recording and analysis. Most of these data collection systems are existing fixed or mobile range assets and would not be constructed specifically to support the TMD program. Ground-based optical sensors, radars, and telemetry stations may be supplemented by ship-based or airborne sensors.

Radio communication with the defensive missiles will be required in order to receive telemetry data and transmit commands and data to and from the flight vehicle. Ground-based, ship-based, or airborne radio transceivers would provide this communication link. Most communication facilities would likely be existing range assets. Some new and/or modified communication facilities may be required.

Range Support Equipment

Sensor systems are used to acquire, record, and process data on targets and defensive missiles in order to detect and track targets, direct defensive missiles, and assess whether a target has been destroyed. Sensor systems are composed of sensor elements and signal-processing components.

Sensor elements collect raw data from the target. Technologies used in sensor elements may include but are not limited to optical (visual and infrared), acoustic, and radar. Optical and acoustic sensors are classified as passive sensors. This means that these sensors do not emit energy themselves but only measure energy emitted by the target. Radar sensor systems are categorized as active since they do emit energy.

Signal processing components receive the raw data collected by the sensor elements and process it, using computer hardware and software, into useable information such as target location, velocity, and attitude. These and other relevant characteristics can then be used to plan and control intercept engagements.

Sensor systems which may be used in Army TMD testing include existing ground-based sensors (such as the PATRIOT radar set) and newly developed (or modified) sensor systems. Some sensors planned for use will be standard range assets (fixed and portable units) routinely used to support flight tests. Potentially, airborne sensors, ship-based sensors, and space-based sensors may also be used for surveillance and tracking support as part of these proposed TMD missile tests.

Theater Missile Defense Ground-Based Radar

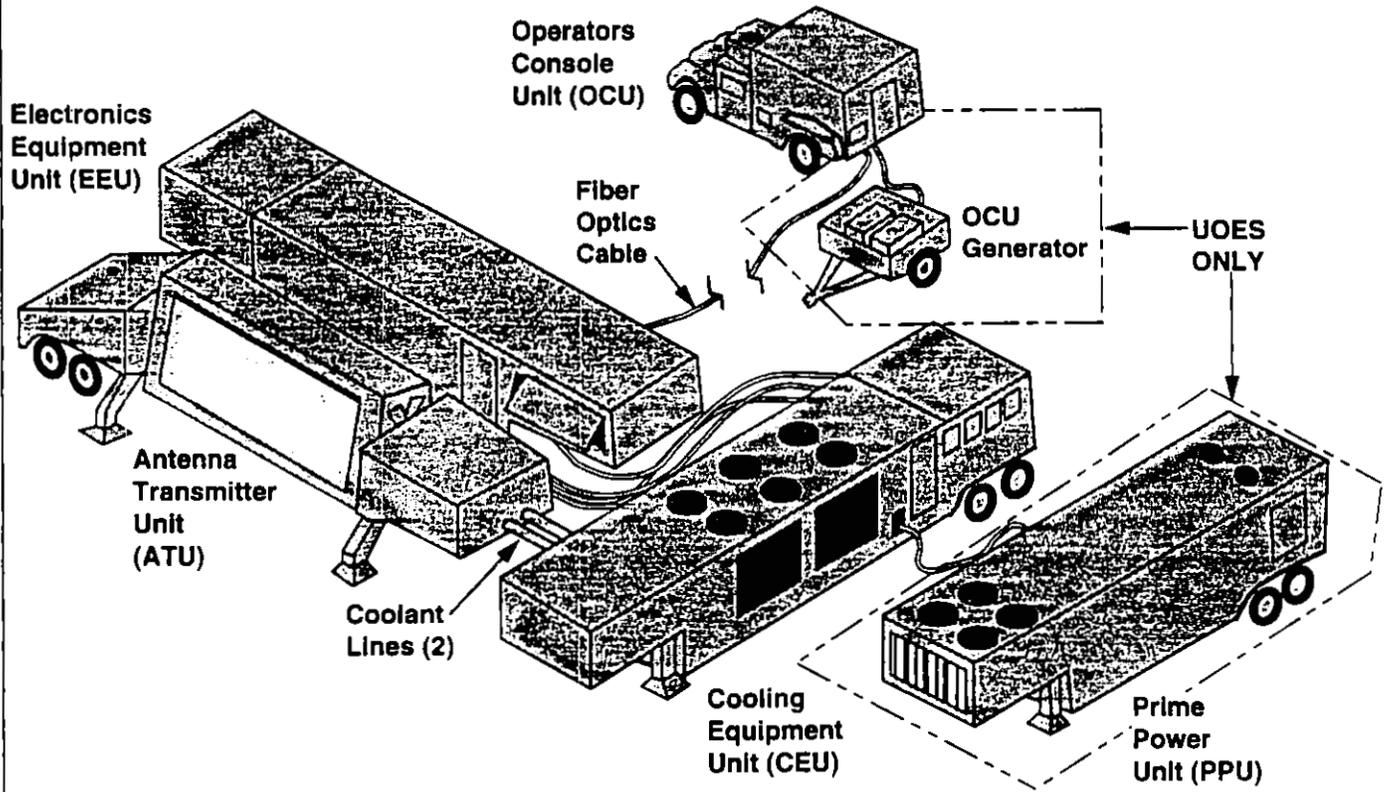
A new, mobile, TMD ground-based radar (TMD-GBR) system would be used in some testing. The TMD-GBR is currently being developed as an integral part of the TMD system and would provide surveillance, target detection, target acquisition, fire control support, and kill assessment for TMD defensive missile systems. The TMD-GBR will be a road- and aircraft-transportable, solid-state, X-band phased-array radar system of modular design. The components of the system will be housed in trailer-mounted shelters or on specially configured flatbed trailers and will be interconnected with power and cabling as required. The shelters will provide environmental protection for the system components and personnel.

The TMD-GBR system is composed of the five main subsystems shown in figure 1-13. The Antenna Transmitter Unit is the phased-array antenna which actually transmits and receives electromagnetic energy. The Electronics Equipment Unit contains the digital hardware and software necessary to control the antenna direction, power levels, and frequency. The Electronics Equipment Unit also processes sensor data received by the Array Transmitter Unit. The Cooling Equipment Unit is a closed-loop liquid cooling system which removes and radiates heat generated by the Array Transmitter Unit and Electronics Equipment Unit. The Cooling Equipment Unit uses a mixture of water and ethylene glycol. The Operator Control Unit is a manned unit with two operator consoles packaged in a climate-controlled shelter mounted to a High Mobility Multipurpose Wheeled Vehicle. The Operator Control Unit provides for control of the entire TMD-GBR system and for communication between GBR and other theater defense systems. The Operator Control Unit has its own power source consisting of one 15-kilowatt diesel generator. The Prime Power Unit, which will be a component of the User Operational Evaluative and Objective systems, is a diesel-powered, 3-phase, 60-hertz, 1,000-kilowatt generator which will be used to provide power to the Array Transmitter Unit, Electronics Equipment Unit, and Cooling Equipment Unit (U.S. Army Space and Strategic Defense Command, 1993g).

TMD-GBR testing would require dedicated areas ranging from 0.8 ha (2 ac) to 2.5 ha (6.2 ac) for the electromagnetic radiation (EMR) hazard zone and mobile unit parking areas (U.S. Army Space and Strategic Defense Command, 1993g). A radiation hazard warning sign and blue radiation flashing or rotating beacon are to be in place at any GBR test location. These are required to prevent hazards while the system is radiating. TMD-GBR test activities will require approximately 30 temporary dedicated TMD-GBR personnel (military, civil servant, and contractor) in addition to existing personnel at test sites (U.S. Army Space and Strategic Defense Command, 1993f).

PATRIOT Radar Set

PATRIOT and ERINT test flights may be supported by the PATRIOT AN/MPQ-53 phased-array radar set. The PATRIOT radar set is an element of the PATRIOT firing battery. It is mounted on a semi-trailer towed by a standard Army tactical truck. The PATRIOT radar set operates in the C band of the electromagnetic spectrum on the order of several hundred kilowatts at peak power (exact power level is classified). (Department of the Army, 1990)



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

TMD Ground-Based Radar Conceptual Configuration

Figure 1-13

The PATRIOT radar set is a component of a completely mobile, self-contained weapon system. TMD testing of the PATRIOT radar set will likely require no fixed facilities.

Electromagnetic Radiation

Operation of phased-array radars results in the generation of EMR. The EMR fields generated by phased-array radars vary based on the power generated by the antenna and the distance from the antenna. EMR fields can have adverse effects which fall into three general categories:

- Safety hazards to humans and wildlife resulting from exposure to high EMR fields
- Electromagnetic interference (EMI) with other users of the electromagnetic spectrum, to include communications equipment, other radars (e.g., weather, navigation), aircraft avionics, and cardiac pacemakers
- Potential detonation of electroexplosive devices exposed to high levels of EMR

Radar test locations would be sited and radar operations would be controlled to ensure that these hazards would be minimized. (U.S. Army Space and Strategic Defense Command, 1993f)

Human hazard keep-out zones for the various versions of radars used in TMD testing would be established such that EMR levels outside these zones would not exceed 5 milliwatts (mW)/square centimeter (cm²). This permissible exposure level also complies with U.S. Air Force Regulation 161-9, *Exposure to Radiofrequency Radiation* (Payne, 1993). Analytic assessments of the potential for EMR hazards were performed by comparing computed values of electromagnetic field power densities to those values specified by the U.S. Army (Technical Guide No. 153, Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation). This document (U.S. Army Environmental Hygiene Agency, 1987), which reflects the 1982 recommendations of the American National Standards Institute (ANSI) radio frequency protection guide, specifies a maximum microwave radiation power density exposure level of 5 mW/cm² for continuous exposure at the GBR frequency.

The power density value of 5 mW/cm² was based on limiting the energy absorption rate in the body to a value of 0.4 watts per kilogram (w/kg) of body mass. This specific absorption rate (SAR) was derived from biological effects research demonstrating that SARs of 4 w/kg, if maintained for long periods, could be hazardous in laboratory animals, (i.e., they represent the threshold for hazardous effects). The radiation protection guide incorporates a safety factor of 10 based on these observations. This permissible exposure level also complies with U.S. Air Force Regulation AFOSH Standard 161-9, *Exposure to Radiofrequency Radiation* (Payne, 1993).

Keep-out zones may be fenced with warning signs posted. Warning lights (beacons) will also be used when radars are operating. The TMD-GBR human safety keep-out zone is illustrated in figure 1-14. The dimensions of this keep-out zone are based on preliminary analysis of EMR levels produced by the TMD-GBR and will be validated by field measurements at low power levels prior to full-scale field testing (U.S. Army Space and Strategic Defense Command, 1993g). The PATRIOT radar set EMR keep-out zone extends to a distance of 120 meters (m) (394 feet [ft]) along the radar boresight and 2 m (6.6 ft) to the left and right of the radar set (Pledger, 1993).

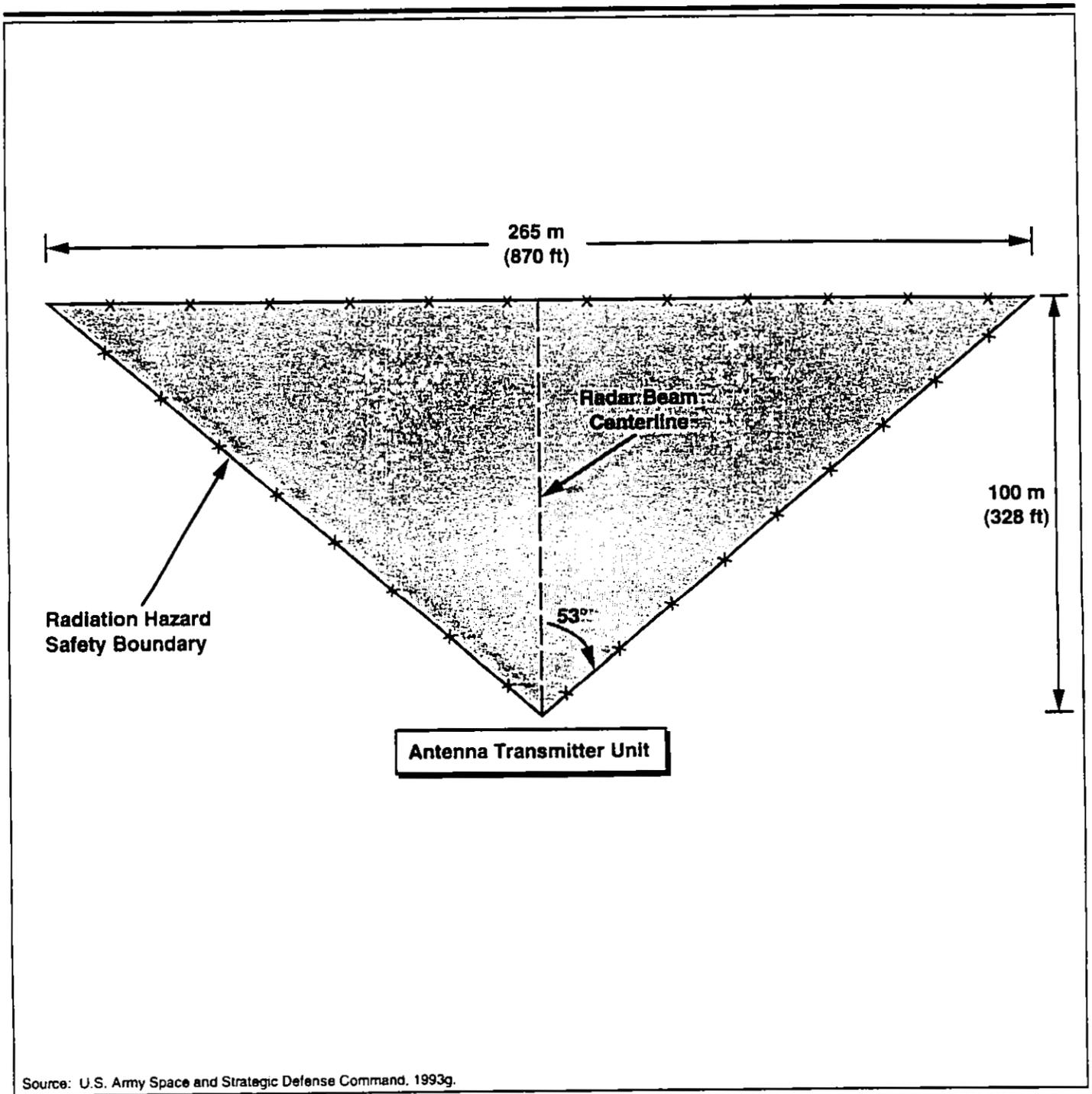
In order to preclude non-biological hazards associated with EMR/EMI, TMD radar test locations would be sited and radar operations would be controlled such that hazard threshold levels to the following would not be exceeded:

- Electroexplosive devices, ordnance, and fuel storage and handling
- Cardiac pacemakers
- Aircraft avionics
- Other radar operations

Full discussion of the development and initial testing of the TMD-GBR system and an assessment of potential environmental impacts is presented in the *Ground Based Radar (GBR) Family of Strategic and Theater Radars Environmental Assessment* (U.S. Army Space and Strategic Defense Command, 1993g). An assessment of potential environmental impacts resulting from system development and testing of the PATRIOT system, including the phased-array radar set, is presented in the *PATRIOT Life Cycle Environmental Assessment* (Department of the Army, 1990).

1.3.1.3 Meteorological Rockets

Up to four meteorological rockets may be launched in support of each TMD target or defensive missile system test. Meteorological rockets are routinely used for determining meteorological conditions and for calibrating and testing radar and other ground-based sensing instrumentation prior to other missile system test launches. A wide variety of Government-furnished meteorological rockets could be used at Wake Island. The specific rockets to support TMD-related launch activities have not been identified. The PWN11 and PWN12A payloads with a Viper IIIA solid-propellant motor are frequently used meteorological rockets launched from the USAKA and are typical of the rockets that may be launched from Wake Island (U.S. Army Strategic Defense Command, 1989; U.S. Army Space and Strategic Defense Command, 1993a). These solid-fuel rockets are relatively small, typically containing less than 45 kg (100 lb) of propellant. The Viper IIIA motor



**TMD Ground-Based
Radar EMR
Safety Zone**

Figure 1-14

contains approximately 26 kg (57 lb) of polysulfide fuel polymer with an ammonium perchlorate oxidizer and has an approximate burn time of 2.2 seconds.

Meteorological rockets will be transported to Wake Island by air from Government storage depots or contractor facilities where they will be placed in secure storage until launch preparation. As with the TMD-related target and defensive missile motors, applicable safety regulations will be observed in the transport and handling of meteorological rockets.

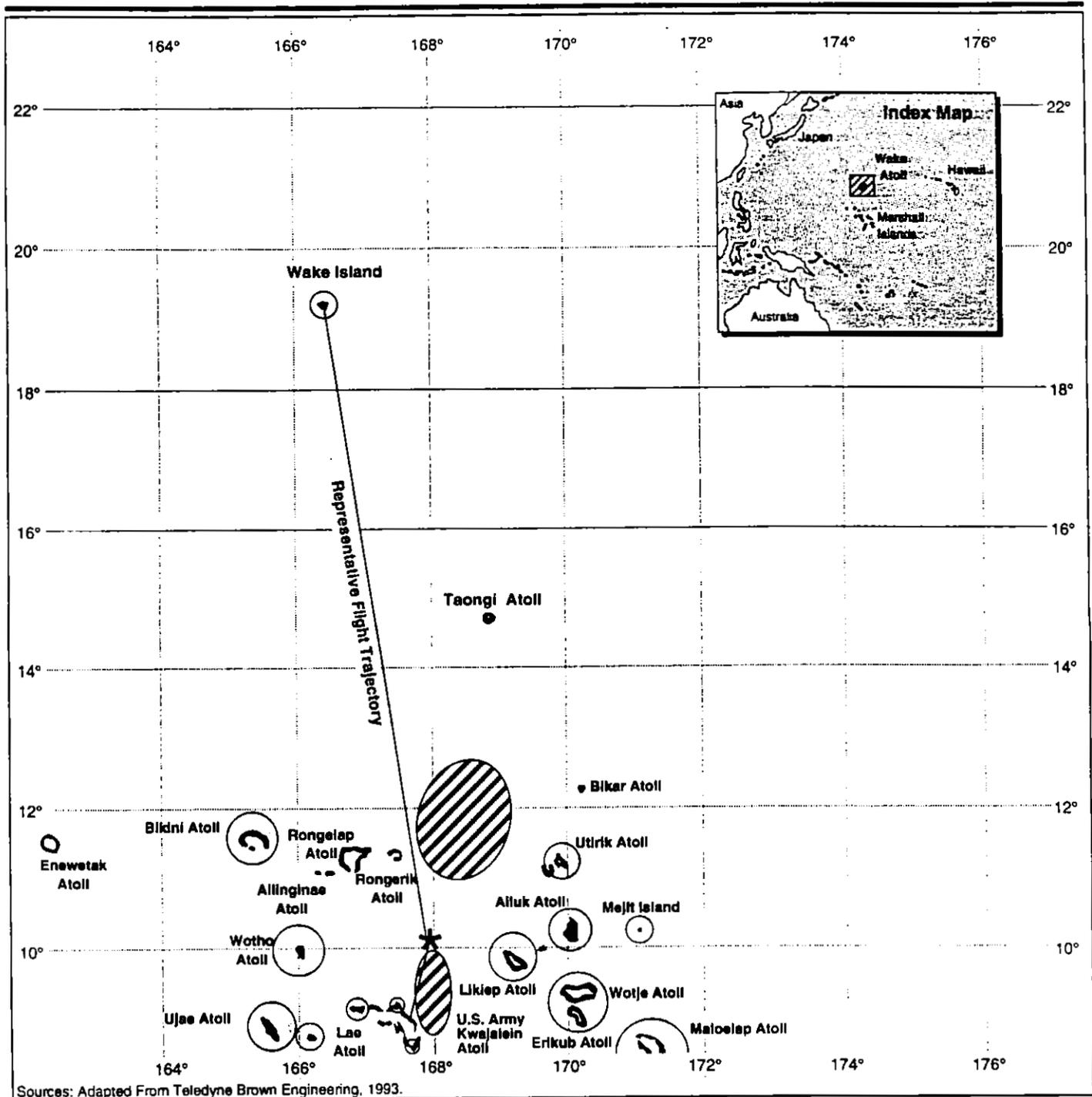
No new facilities will be required for meteorological rocket launches. A small concrete pad located near the target or defensive missile flight vehicle is the only launch facility requirement. Several existing concrete surfaces in the Peacock Point area could serve this function. An appropriate explosive safety quantity-distance will be established and maintained around the launch site.

Flight profiles will be determined such that all rockets will descend into the open ocean area, not on the island or within the lagoon. Kwajalein Missile Range range safety personnel will evaluate and approve all flight profiles before launch and will monitor all launches.

About three to four personnel are required to launch and perform data retrieval functions for meteorological rockets. Data retrieval will be performed by one person stationed in the Launch Support Building (1601). (Williams, 1993b).

1.3.1.4 Launch and Flight

The TMD flight profiles and azimuths will vary with test requirements and flight vehicles. Figures 1-15 and 1-16 show examples of representative flight azimuths, missile intercept locations, and missile debris impact areas for TMD program launches from Wake Island. Target flight vehicles launched from Wake Island toward the USAKA would have a flight azimuth of about 170°. The first- and second-stage target motor burn times are 60 to 67 seconds and 57 seconds, respectively. Exact motor impact areas cannot be precisely determined, but it is anticipated that the first- and second-stage motor impact areas would be about 50 km (31 mi) and 765 km (475 mi) south of Wake Island for the M56A-1 and M57A-1 boosters. The first- and second-stage motor impact areas would be about 240 km (149 mi) and 1,150 km (715 mi) south of Wake Island for the SR19-AJ-1 and M57A-1 boosters. Defensive missile flight vehicles for this test scenario would be launched from Meck Island. The missile intercept point and allowable debris and whole-body miss impact areas will be outside of the territorial waters of the Republic of the Marshall Islands; therefore, the Compact of Free Association, 48 United States Code 1648, does not apply except for launches from the USAKA that are addressed and evaluated in the *Draft Supplemental Environmental Impact Statement Proposed Actions at U.S. Army Kwajalein Atoll* (U.S. Army Space and Strategic Defense Command, 1993a).



Sources: Adapted From Teledyne Brown Engineering, 1993.

EXPLANATION

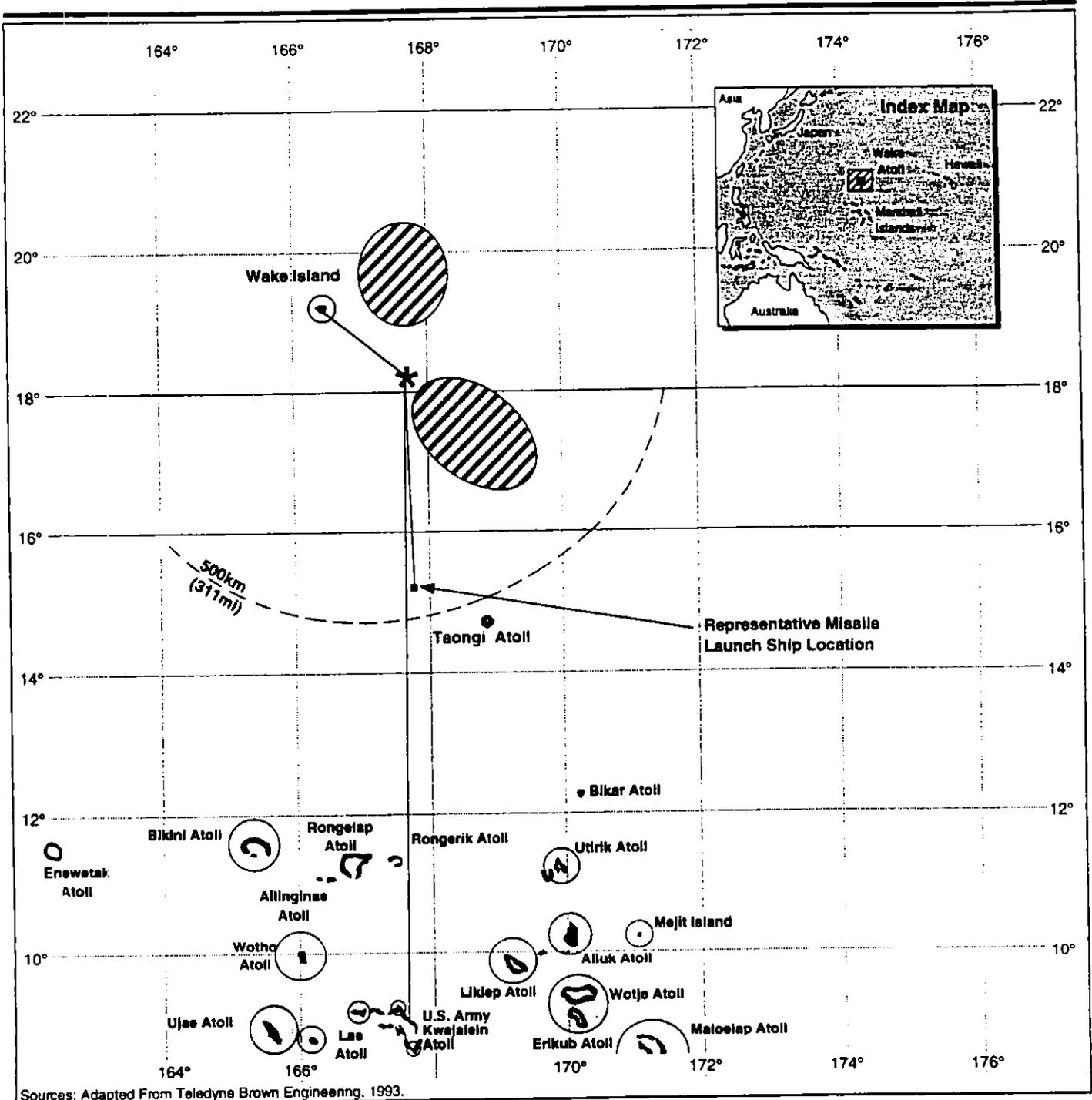
-  Protection Circle for Populated Islands
-  Representative Intercept Point
-  Representative Target and Defensive Missile Debris Impact Areas

Representative Flight Trajectory for TMD Target Launches

Wake Island



Figure 1-15



Sources: Adapted From Teledyne Brown Engineering, 1993.

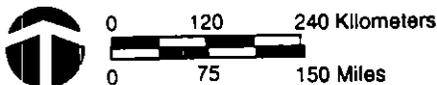
EXPLANATION

-  Protection Circles for Populated Islands
-  Representative Intercept Point
-  Representative Target and Defensive Missile Debris Impact Areas

Representative Flight Trajectory for TMD Defensive Missile Launches

Wake Island

Figure 1-16



Wake Island could support a broad range of flight azimuths for TMD defensive missile flight tests. If defensive missile flight vehicles are launched from Wake Island, the target missiles would be launched from a fixed, above-ground facility at the USAKA or from a sea launch platform. Target missiles launched from a platform at sea will also have a maximum demonstrated range of less than 500 km (311 mi). In either case, target and defensive missile flight azimuths and test profiles will be designed so that no lethal debris would fall on Wake Island or any other land mass as a result of nominal flight tests.

Supporting each TMD flight test, the USAKA Range Safety Office would oversee ground safety and downrange flight operations at both Wake Island and the USAKA, including debris impact areas. Range operations would be conducted in accordance with Range Safety Manual regulations (U.S. Army Kwajalein Atoll, 1991).

To ensure safety on Wake Island, the LHA would be cleared of all nonessential personnel prior to launch. The LHA represents the region of highest danger from launch operations. The only mission-essential personnel permitted in this area would be those inside the Launch Support Building (1601). This building has been hardened to withstand expected blast overpressures greater than would be encountered from the catastrophic failure of a TMD defensive missile, but additional hardening would be required to provide adequate protection in the event of the catastrophic failure of a target missile. Impact limit lines will be established for defensive and target missiles, respectively, by range safety personnel. The impact limit line is based on the area beyond which no debris from a launch anomaly would be expected to fall. Hardening of a structure in the billeting area to provide shelter for nonessential island personnel would also be required for solid-fuel target launches. Security police would be responsible for establishing appropriate roadblocks and identity checks to ensure that only authorized personnel are permitted access to the LHA prior to the commencement of launch operations.

1.3.1.5 Flight Test Operations and Safety

Rocket motors will be transported by military aircraft or ship to Wake Island. All other launch-related components, expendables, tools, and test equipment will be shipped from the continental United States to Wake Island by air or sea. All materials containing solid propellants or flight ordnance will be shipped, handled, and used in accordance with Bureau of Explosives (BOE)-6000-L (Association of American Railroads, 1993), AFR 127-100 (U.S. Department of the Air Force, 1990), and other applicable DOD and DOT regulations.

Flight tests for TMD targets or defensive missiles would be suborbital and would be conducted from Wake Island toward the KMR. Ground and flight safety operations would be performed by KMR personnel. The USAKA would also provide a variety of radar and optical sensor support for the programs. (U.S. Army Space and Strategic Defense Command, 1992b)

Flight vehicles have been launched from Wake Island within a range of southeasterly flight trajectories. These trajectories ranged from approximately 140° for Lightweight Exoatmospheric Projectile (LEAP) flight activities (now cancelled) to 174° for Theater Missile Defense Critical Measurements Program (TCMP) flight activities (U.S. Army Strategic Defense Command, 1992d; Strategic Defense Initiative Organization, 1991). Supporting each flight test, the USAKA Range Safety Office oversees downrange flight and ground safety operations at the USAKA (U.S. Army Strategic Defense Command, 1992d).

In order to mitigate potential harm to populated or other sensitive areas, the range safety officer will continuously monitor the flight of any launch vehicle to ensure it does not exceed its flight dispersion pattern. If the vehicle exceeds the limits of its flight operations, then the range safety officer will terminate the vehicle's flight.

For all launches scheduled to take place on Wake Island, range safety personnel (through the Federal Aviation Administration [FAA] and the U.S. Coast Guard) will notify commercial and private aircraft and watercraft of all launches in advance. This would be accomplished through a Notice to Airmen and a Notice to Mariners, respectively. They can then reschedule their activities or choose alternate routes during the launch vehicle flights. These notices are in effect for a certain period of time as specified when the notices are issued.

1.3.2 NO-ACTION ALTERNATIVE

The only alternative to the proposed TMD launch activities on Wake Island is the no-action alternative. The no-action alternative would be not to proceed with any new TMD launch activities or related infrastructure improvements on Wake Island. However, new TMD launch activities might occur at other test range alternatives being considered. The baseline activities described in the following sections, however, would continue as scheduled.

Theater Missile Defense Launch Programs

There is currently one active launch program on Wake Island – the TCMP. Environmental assessments for this program as well as for the Brilliant Pebbles (BP) program and the LEAP test program have all resulted in a Finding of No Significant Impact (FNSI). The BP and LEAP test programs have been cancelled.

TCMP activities involve launching a series of flight vehicles. Each flight vehicle would consist of a one- or two-stage solid-propellant booster system with an experimental payload. Flight tests would be suborbital. The payloads would consist of test objects, which include reentry bodies and booster hardware, as well as on-board sensors and other electronics. The flight tests are needed to obtain the required sensor information for the

discrimination of various tactical missile threat objects in support of the TMD program. (U.S. Army Strategic Defense Command, 1992b)

The TCMP activities could consist of up to eight separate flight campaigns. Each campaign would consist of up to four flights separated by approximately 2 weeks. The initial TCMP flight campaign was conducted during the first quarter of calendar year (CY) 1993. At present, four launches are scheduled in each of the following CY quarters: first quarter of 1995, third quarter of 1996, first quarter of 1998, and third quarter of 1999. (U.S. Army Strategic Defense Command, 1992b; Bowles, 1993)

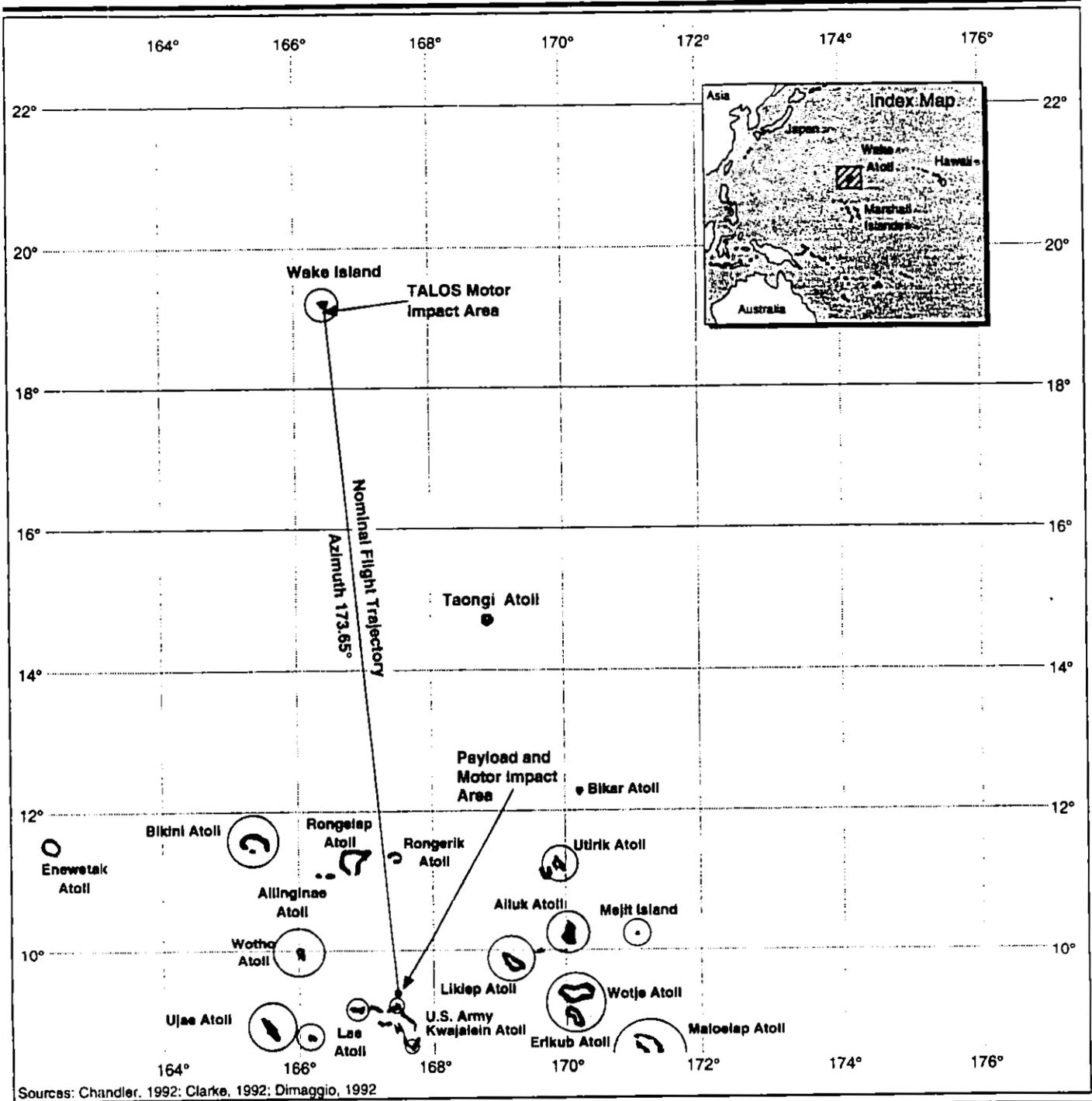
These suborbital flight tests would also be from Wake Island toward the Kwajalein Atoll, impacting about 20 km (12 mi) north of Roi-Namur (figure 1-17). The USAKA would provide the necessary radar and optical sensor support. The launch time of each flight would depend on the specific mission objectives, and the flight tests would carry a payload consisting of decoy devices. Later TCMP test flights would also be launched from Wake Island pending the availability of range support for flight safety and radar tracking. (U.S. Army Strategic Defense Command, 1992b)

The initial TCMP flights utilized a Talos/M56A-1 booster system. This system was selected because it met the necessary range and payload weight requirements. It represents existing hardware currently available and can be obtained under existing Government contracts. The follow-on TCMP flight experiments may use alternative rocket motors if additional Talos motors are not available. The four flights conducted under Campaign 2 planned for the first quarter of CY 1995 will utilize Castor IVB motors. Alternative booster systems for the TCMP are listed as follows:

- M56A-1/M57A-1
- Castor IV/M57A-1
- Castor IVB/M57A-1
- Castor IV/Orbis I
- Castor IVB/Orbis I
- M56A-1/Orbis I
- SR19-AJ-1/M57A-1
- SR19-AJ-1/Orbis I

(U.S. Army Strategic Defense Command, 1992b; Bowles, 1993)

A discussion of system development and flight testing for the TCMP at Wake Island and an assessment of potential environmental impacts are presented in the TCMP EA (U.S. Army Strategic Defense Command, 1992b).



EXPLANATION

○ Protection Cicles for Populated Islands

Flight Trajectory and Range Safety for TCMP Launches



0 120 240 Kilometers
0 75 150 Miles

Figure 1-17

1.3.3 TRANSPORTATION

For TMD program test activities, boosters, payloads, and other launch-related components will need to be transported to Wake Island. These components will be transported by air or barge from the continental United States to Wake Island following all appropriate and applicable regulatory requirements to ensure their safe transportation. The regulations governing the transportation of hazardous materials consist of the general Federal regulations administered by the DOT and more specific safe operating procedures and contingency plans established for hazardous activities by the DOD.

The BOE Tariff No. BOE-6000-L, *Hazardous Materials Regulations of the Department of Transportation, by Air, Rail, Highway, and Water Including Specifications for Shipping Containers* (Association of American Railroads, 1993), is the Federal document used by the DOT to regulate transportation of hazardous materials in the United States. These DOT regulations are listed in 49 CFR Parts 100-199. BOE-6000-L specifies that technical personnel involved in the transportation of hazardous material must be familiar with the regulations governing hazardous shipments, including the definitions of hazardous materials as defined by the DOT. This document also specifies the proper shipping name, hazard class, and identification number to be used for each material shipped. This information is necessary to ensure proper handling by shipping personnel and identification by emergency personnel if an accident involving hazardous materials should occur. In addition, this document sets guidelines specifying containers suitable for the quantity and chemical characteristics of the hazardous materials that are used.

Appropriate safety measures as described in AR 385-64, *Ammunition and Explosives Safety Standards* (U.S. Department of the Army, 1987) will be used during the transportation of all hazardous materials. This regulation covers DOD ammunition and explosive safety standards. It incorporates waiver/exemption authority and review channels for DOD explosives safety submission.

2.0
Affected Environment

2.0 AFFECTED ENVIRONMENT

This section describes the affected environment (i.e., the environmental characteristics that may be changed by implementation of the proposed action) at Wake Island. Available literature (EAs, Environmental Impact Statements [EISs], facility Standard Operating Procedures [SOPs], and permits) was obtained and data omissions (i.e., questions that could not be answered from the literature) were identified. To fill the data omissions and to verify and update available information, contractor personnel and Federal and local regulatory agencies were contacted. A listing of the cited literature, telephone interviews, and other appropriate references noted in this document are presented in Section 5.0.

Site visits to Wake Island were conducted to review existing facilities proposed for use during the program and to collect baseline data.

Twelve broad environmental components were evaluated to provide a context for understanding the potential effects of the proposed action and to provide a basis for assessing the significance of potential impacts. The areas of environmental consideration are air quality, airspace, biological resources, cultural resources, hazardous materials/waste, health and safety, infrastructure and transportation, land use, noise, physical resources, socioeconomics, and water resources.

The data presented are commensurate with the importance of the potential impacts, with attention focused on key issues. Federal environmental statutes (Appendix B), many of which set specific guidelines, regulations, and standards, provide a benchmark that assists in determining the significance of environmental impacts under the NEPA evaluation process. The status of compliance of each proposed Wake Island action with respect to environmental requirements was included in the information collected on the affected environment. The areas of environmental consideration are described briefly below.

Air Quality – Air quality at Wake Island was reviewed, with particular attention paid to background ambient air quality compared to the primary National Ambient Air Quality Standards (NAAQS). The facility's compliance with air emissions permits required to conduct activities was ascertained by contacting the appropriate regulatory agencies. Compliance with air emissions permits indicates that a facility is not in violation of Clean Air Act requirements (Appendix B).

Airspace – Existing data was collected from the FAA through regional offices. Air Route Traffic Control Centers (ARTCCs) provided additional data. The extent of effects of both air and ground operations on en route high- and low-altitude jet routes and local air traffic, including aircraft arrivals and departures, was reviewed.

Biological Resources – Existing information on plant and animal species and habitat types on the island was reviewed, with particular attention paid to the presence of any species that is protected or on Federal lists of threatened or endangered species.

Cultural Resources – The specific location of resources on the National Register of Historic Places (NRHP) was reviewed from existing documentation.

Hazardous Materials/Waste – Existing hazardous materials/waste management practices and records of compliance were reviewed to determine the capability of the facility to handle any additional hazardous materials/waste associated with Wake Island actions and any potential problems with their use, handling, storage, treatment, or disposal.

Health and Safety – Existing documents (e.g., safety manuals, SOPs) were reviewed and contractor personnel were interviewed to determine if public and occupational health and safety concerns are an issue on the island. Safety precautions regarding the use, handling, storage, and disposal of hazardous materials/waste were also reviewed.

Infrastructure and Transportation – The capacity and current demands of infrastructure elements (i.e., electricity, solid waste, sewage treatment, water supply, and transportation) were examined to determine if there were any infrastructure and transportation constraints to conducting the proposed activities.

Land Use – Facility master plans, environmental management plans, evaluations of known or suspected areas of hazardous material contamination and/or potential mitigation measures, and other documentation were reviewed to determine if there are any known conflicts between existing and future facilities and land uses and proposed activities.

Noise – Existing facility documents were reviewed and installation personnel contacted to determine if noise concerns are an issue.

Physical Resources – Existing information on topographic, geologic, and soil resources was reviewed to determine if there are any physical resource concerns.

Socioeconomics – Existing island personnel numbers were compared to the personnel requirements for proposed activities on the island.

Water Resources – Existing information on groundwater and surface water resources was reviewed to determine if there are any water resource concerns on the island. The record of wastewater discharge permits and compliance was also reviewed.

The following sections provide brief descriptions of proposed Wake Island activities and a discussion of the potentially affected environment for the facility.

2.1 AIR QUALITY

Climatological Conditions

Climate at Wake Island affects the dispersion of air pollutants and the resulting air quality. The climate of Wake Island is maritime and is chiefly controlled by the easterly trade winds, which dominate the island throughout the year (Gale Research Company, 1981). The winds blow steadily every month of the year with very little variation. The yearly

average wind speed is 22.2 km (13.8 mi) per hour (National Oceanic and Atmospheric Administration, 1993).

Temperature varies little during the day and from month to month. In February, normally the coldest month of the year, the average daily high is 27.6° Celsius (C) (81.7° Fahrenheit [F]) and the average daily low is 21.9° C (71.5° F). In August, normally the hottest month of the year, the average daily high is 31.2° C (88.1° F) and the average daily low is 25° C (77° F) (National Oceanic and Atmospheric Administration, 1993). Occasionally polar outbreaks may reach Wake Island during the late fall, winter, or early spring. The record low temperature of 17.8° C (64° F) occurred during a polar outbreak in December 1954.

Average annual precipitation is approximately 89 centimeters (cm) (35 inches [in]) (National Oceanic and Atmospheric Administration, 1993). Summer is the season with the greatest amount of rainfall. Rain showers occur most frequently between midnight and sunrise (Gale Research Company, 1981). Average annual humidity ranges from 69 to 80 percent (National Oceanic and Atmospheric Administration, 1993) and varies little from month to month. The average amount of the daytime sky obscured by clouds is 54 percent (National Oceanic and Atmospheric Administration, 1993) and varies little from month to month.

Air Quality Standards

In compliance with the Clean Air Act (CAA), the Environmental Protection Agency (EPA) has established NAAQS for six criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO₂), ozone (O₃), particulate matter with a hydrodynamic diameter less than or equal to 10 microns (PM-10), and sulfur dioxide (SO₂) (table 2-1). 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*. The CAA also seeks to "prevent significant deterioration" of air quality in areas where the air is cleaner than that required by the NAAQS.

Title III, "The Air Toxics Program," of the CAA addresses hazardous air pollutants (HAPs), which are air pollutants not covered by the NAAQS and that may reasonably be expected to cause or contribute to irreversible illness or death. Title III, from the 1990 Amendments to the CAA, replaces the old National Emissions Standards for Hazardous Air Pollutants program.

The states have *primary responsibility* to implement the CAA. The primary vehicle for implementation is the State Implementation Plan (SIP). Each state must submit its SIP to the EPA for approval.

Wake Island falls under the jurisdiction of EPA Region 9. The EPA has yet to decide which SIP, if any, Wake Island should follow (Leong, 1993). No ambient air quality monitoring data is known to be available for Wake Island; however, it is believed that there are no air pollution problems at Wake Island since the strong trade winds quickly disperse any local emissions (Leong, 1993). Furthermore, because there are no other islands within several hundred miles of Wake Island, there are no nearby sources from which Wake Island would

Table 2-1: National Ambient Air Quality Standards

Pollutants	Averaging Time	National Standards ^(a)	
		Primary ^(b,c)	Secondary ^(b,d)
Ozone	1-hour	0.12 ppm (235 $\mu\text{g}/\text{m}^3$)	Same as primary standard
Carbon monoxide	8-hour	9 ppm (10 $\mu\text{g}/\text{m}^3$)	-
	1-hour	35 ppm (40 $\mu\text{g}/\text{m}^3$)	-
Nitrogen dioxide	Annual	0.053 ppm (100 $\mu\text{g}/\text{m}^3$)	Same as primary standard
Sulfur dioxide	Annual	80 $\mu\text{g}/\text{m}^3$ (0.03 ppm)	-
	24-hour	365 $\mu\text{g}/\text{m}^3$ (0.14 ppm)	-
	3-hour	-	1,300 $\mu\text{g}/\text{m}^3$ (0.5 ppm)
PM ₁₀	Annual	50 $\mu\text{g}/\text{m}^3$ ^(e)	Same as primary standard
	24-hour	150 $\mu\text{g}/\text{m}^3$	
Lead	Quarterly	1.5 $\mu\text{g}/\text{m}^3$	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°C 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 and a reference pressure of 760 millimeters of mercury (1,013.2 millibar); ppm in this table refers to ppm by volume, or micromoles 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.

receive air pollutants, and there are no nearby communities that could be affected by air pollutants from emissions at Wake Island.

The primary toxic air containment emitted from solid rocket motor launches is hydrogen chloride (HCl). Various exposure guidelines for HCl are given in table 2-2. For HCl the two most relevant sources for guidelines are from the National Research Council (1987) and a recently published document from the EPA (1992).

In developing its guidelines the National Research Council specifically considered emissions from rocket motors, hence their applicability. However, the National Research Council's Emergency Exposure Guidance Level (EEGL) and Short-term Public Emergency Guidance Level (SPEGL) are, as their names imply, designed for application to emergency situations. In particular, the National Research Council indicates that it is inappropriate to use these guidance levels for planned exposures (such as from missile launches). Therefore, the

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

Pollutant	Exposure Duration	Guideline	Exposure Term	Application	Organization
Hydrogen chloride (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	Environmental Protection Agency (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 ₂ O ₃) as aluminum dust	8 hours	10 mg/m ³	Threshold limit value – time-weighted average	Workplace	American Conference of Governmental Industrial Hygienists ⁱ

^aConcentration that will permit continued performance of specific tasks during rare emergency conditions

^bNational Research Council, 1987

^cConcentration 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 Environmental Protection Agency, 1992

^dEnvironmental Protection Agency, 1992

^eConcentration from which one could escape within 30 minutes without a respirator and without experiencing any escape-impairing or irreversible health effects.

^fU.S. Department of Health and Human Services, 1990

^gSuitable concentration for unpredicted, single, short-term, emergency exposure of the general public

^hCeiling value which should not be exceeded at any time for the duration of the exposure

ⁱAmerican Conference of Governmental Industrial Hygienists, 1992

^jCeiling concentrations designed to avoid adverse health effects, either immediate or delayed, of more prolonged exposures and to avoid degradation of crew performance that might endanger the objectives of a particular mission as a consequence of continuous exposure up to 90 days

EEGL and SPEGL may best be applied to exposures that come from accidents, such as catastrophic failure and conflagration of a missile at the launch site. Only the National Research Council's Continuous Exposure Guidance Level may be applied to planned exposures; however, for HCl the only guidance level given is for long-term exposures (i.e., 90 days). Exposures from missile launches will be short-term, with the majority of the HCl dispersed in a fraction of an hour.

Fortunately, the EPA (1992) has recently published guidelines specifically designed to address short-term exposures of HCl. Conservative guideline values derived from the information presented in this document are given in table 2-2. These values will be used for comparison to exposure levels from normal missile launches.

Because aluminum oxide (Al_2O_3) is emitted from rocket launches as a particulate, the 8-hour work threshold limit value of 10 milligrams per cubic meter (mg/m^3) (2.41 parts per million [ppm]) for short-term nuisance dust exposures was selected as the most applicable guideline concentration (table 2-2). More generally, as a conservative guideline, the total amount of Al_2O_3 emitted may be compared to the NAAQS for PM-10.

Existing Sources of Air Pollution

The principle pollutant emission sources are the power plant, motor vehicles, aircraft operations, fuel storage tanks, open burning of trash at the base landfill, incinerator, and infrequent rocket launches (U.S. Army Strategic Defense Command, 1992b; Leong, 1993). No air emissions inventory is known to exist for Wake Island Airfield (Leong, 1993).

There have been two recent launch programs on Wake Island: the BP program and the TCMP. In the past 2 years, two TCMP missiles and one BP missile have been launched at Wake Island (Vandagriff, 1993). TCMP missiles used in the first series of flights had a Talos rocket motor first stage and an M56A-1 rocket motor second stage (U.S. Army Strategic Defense Command, 1992b).

Currently, the TCMP is the only active launch program on the island. At present, four launches are scheduled in the first quarter of CY 1995 (Bowles, 1993). This flight series is currently scheduled to use a Castor IVB first-stage motor (Bowles, 1993). Emission products for the TCMP rocket motors are presented in table 2-3. Motor emissions for the Talos and ARIES were developed from the TCMP EA (U.S. Army Strategic Defense Command, 1992b), emission products for a Castor IV rocket motor are from the USAKA EIS (U.S. Army Strategic Defense Command, 1989), and emissions products for the Castor IVB were obtained from the manufacturer and are evaluated in this EA.

Open Ocean Area

While there are no data on air quality baseline characteristics for the open ocean area surrounding Wake Island and the area between Wake 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 Wake Island itself.

Table 2-3: Combustion Products from TCMP Rocket Motors in Kilograms (Pounds)

	TALOS	ARIES	CASTOR IV	CASTOR IV B
H ₂ O ₃	- (-)	386 (850)	2,447 (5,402)	3,761 (8,292)
CO	412 (909)	1,110 (2,447)	2,597 (5,733)	2,230 (4,916)
HCl	- (-)	673 (1,483)	2,007 (4,430)	2,062 (4,545)
N ₂	150 (331)	357 (788)	806 (1,779)	822 (1,811)
H ₂ O	122 (268)	607 (1,338)	785 (1,732)	624 (1,376)
H ₂	20 (43)	1,458 (3,215)	226 (498)	235 (519)
CO ₂	416 (917)	80 (176)	380 (840)	184 (407)
Pb	20 (43)	- (-)	- (-)	- (-)
Other	- (-)	33 (73)	3 (6)	51 (112)
Total	1,140 (2,511)	4,704 (10,370)	9,251 (20,421)	9,969 (21,978)

Note: 1 kg = 2.20 lb

Sources: U.S. Army Strategic Defense Command, 1989; 1992c.

2.2 AIRSPACE

Wake Island is located in the Oakland Oceanic Control (OC)-5 Sector, in international airspace (figure 2-1). One jet route, A-450, passes directly over the island. A summary of the number of flights using this route is not maintained. During the first half of 1993 there was an average of 75 flights per month to Wake Island (Cannella, 1993).

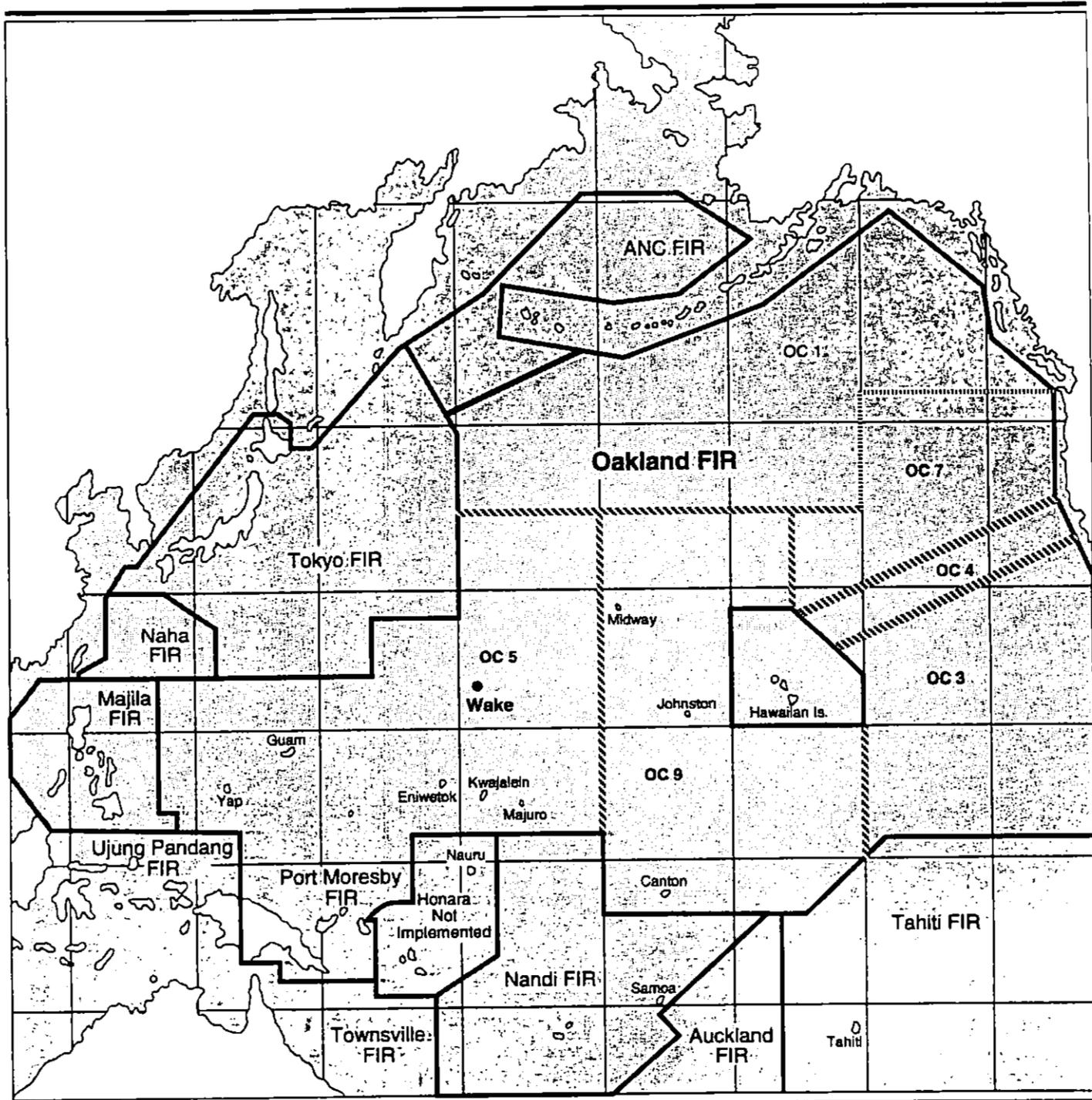
2.3 BIOLOGICAL RESOURCES

A discussion of the existing environment at Wake Island is divided into two sections. The first highlights the ornithological survey and the second highlights the botanical survey. Full reports for each survey are presented in appendices E and F, respectively. Section 2.3.3 presents a brief discussion of marine biological resources in the open ocean area.

2.3.1 ORNITHOLOGICAL SURVEY

An initial reconnaissance survey entailed searching the atoll for seabird colonies (there are no breeding land birds). All seabirds present on the island at the time of the survey, except for tropicbirds, are conspicuous nesters, i.e., they lay their eggs in the open, either on bare ground or exposed in shrubs or small trees (figures 2-2 and 2-3).

Two distinct sooty tern colonies were located, and virtually all birds in each were in the nestling stage of their current breeding cycle. The colony on Wilkes Island was in an open, grassy area, thus facilitating counting of young birds in sample plots from a distance (figure 2-3). The number of nestlings in this colony was estimated by counting the number of young in a section of the colony through binoculars and extrapolating the total for the entire colony. Photographs and videotape of the colony were also obtained for later corroboration of these initial counts. On Peale Island, all young birds encountered along the shoreline during a circuit of the point were counted, as well as all individuals that



EXPLANATION

- Oceanic Control Area Boundary
- ▨ Sector Boundary
- FIR Flight Information Region
- OC Oceanic Control

Airspace Managed by Oakland Oceanic Control Area

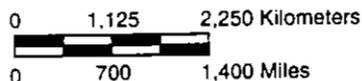
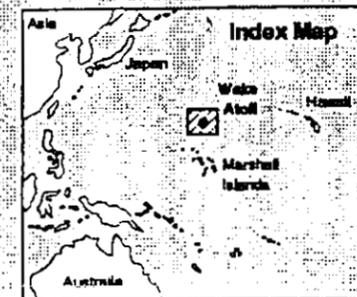
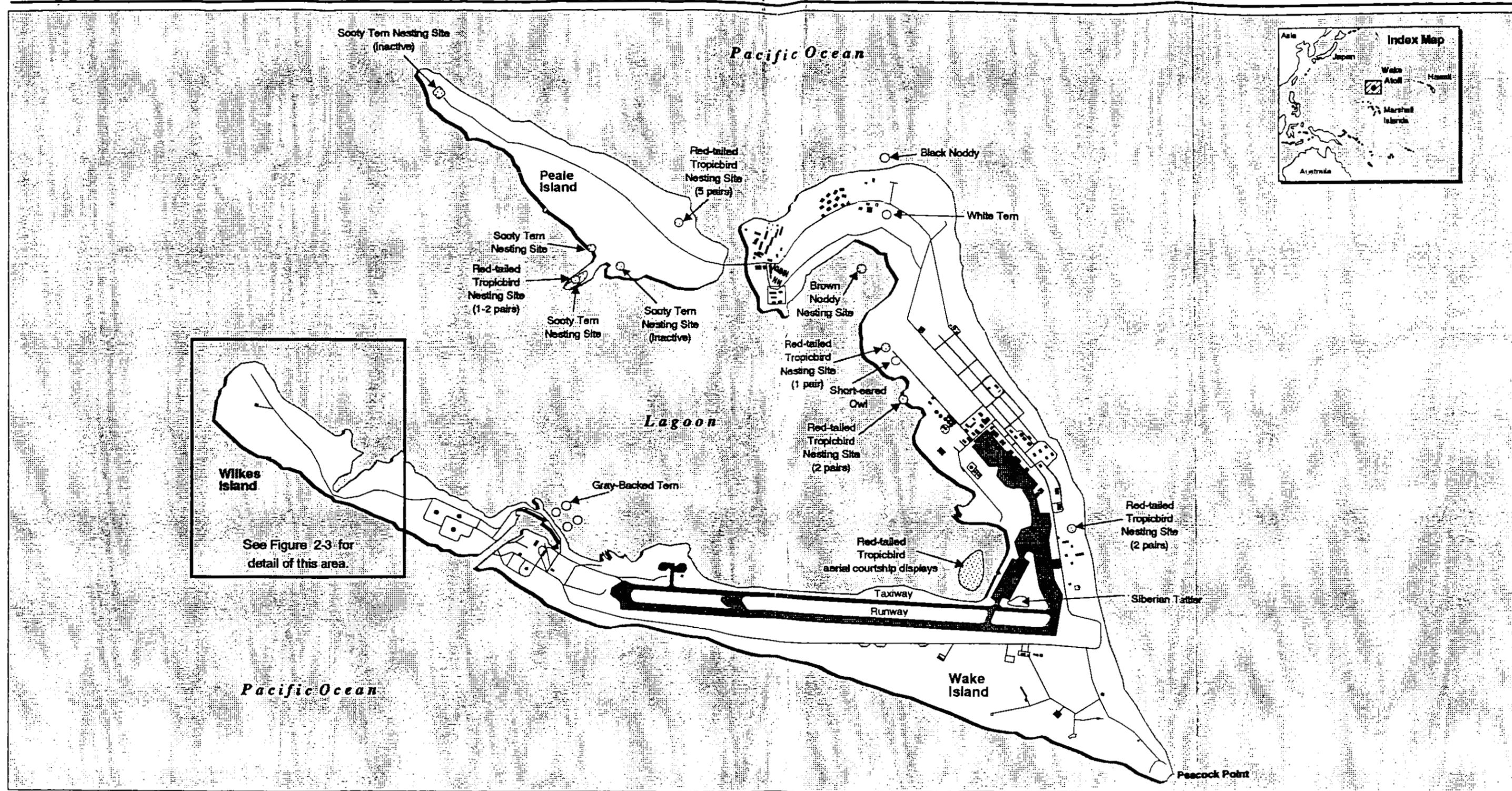


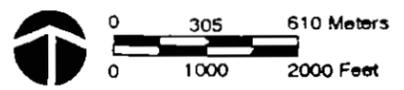
Figure 2-1



Wilkes Island
See Figure 2-3 for detail of this area.

EXPLANATION

- | | |
|--|------------------|
| Sightings of Nesting or Courtship Activity: | Other Sightings: |
| Sooty tern nesting sites | Black noddy |
| Red-tailed tropicbird nesting sites (no. of pairs) | Gray-backed tern |
| Red-tailed tropicbird, aerial courtship display | White tern |
| Brown noddy nest site | Siberian tattler |
| | Short-eared owl |

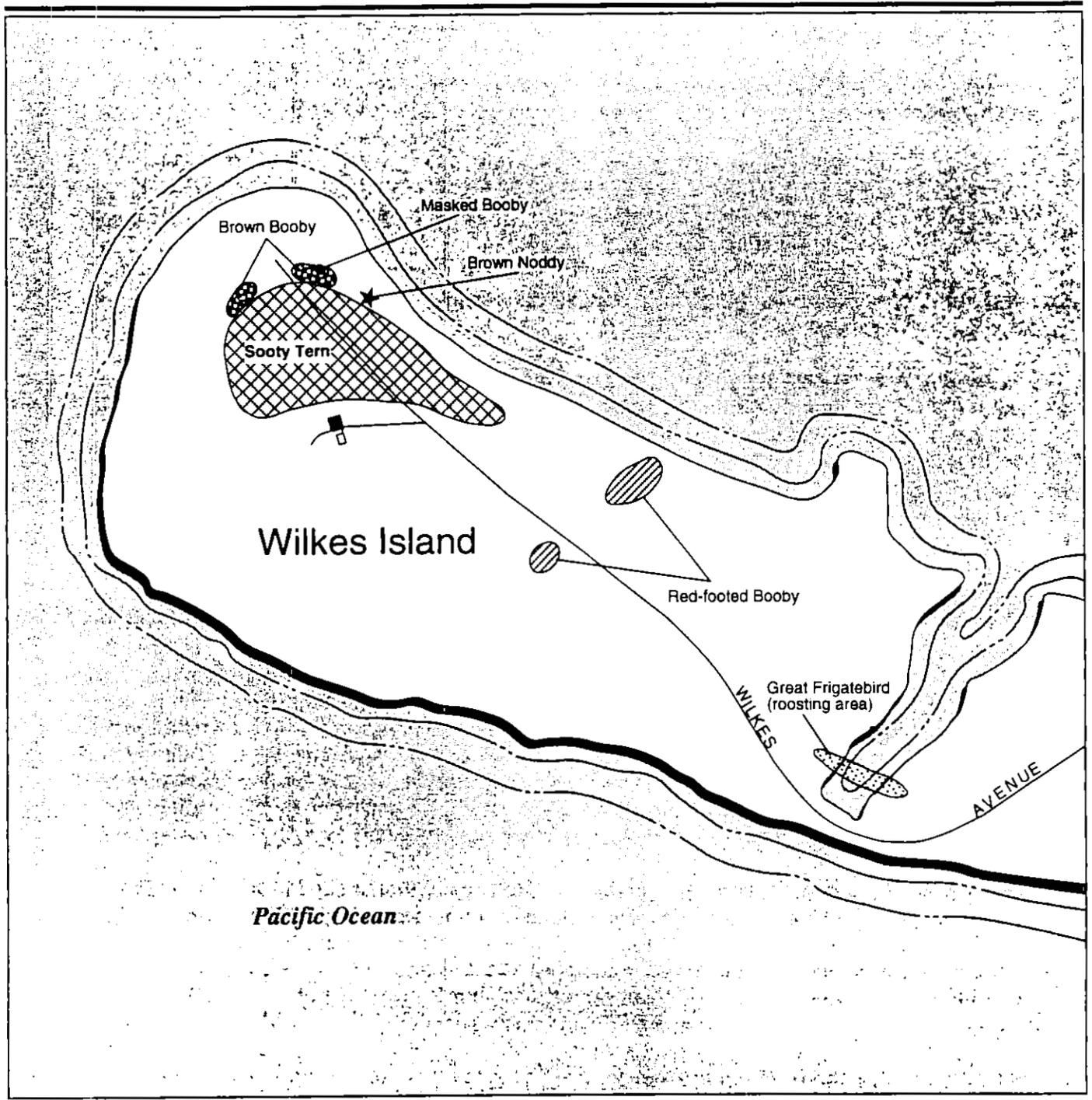


Location Map
Bird Sitings

Wake Island

Figure 2-2

THIS PAGE INTENTIONALLY LEFT BLANK



**Seabird
Nesting
Locations**

Wilkes Island

Figure 2-3



could be seen in the vegetation adjacent to the shore. The Peale Island colony was too heavily vegetated to obtain more accurate counts.

No breeding seabirds were found within any area on Wake Island proposed for facility expansion or upgrade. Several sites presented suitable nesting habitat for the red-tailed tropicbird and, perhaps, great frigatebird, black noddy, and white tern; however, the latter three species showed no sign of nesting on the island at the time of the survey and have not been documented breeding at Wake Island (except possibly for the frigatebird). All sites were heavily disturbed, although suitable habitat for these shrub-nesting species was plentiful in the general vicinity.

The results of avian surveys, conducted between March 24 and April 1, 1993, are presented below under separate headings for each species. Included in each account is a brief summary of the species' natural history, status on the island, and, where applicable, breeding biology and breeding history on the island.

Species Accounts

Laysan Albatross (*Diomedea immutabilis*) – This species was formerly more common and widespread and may have bred regularly on Wake Island. In Hawaii it nests during the winter, but it is not clear during what season this species has nested or attempted to nest on Wake Island. Typically, it arrives on its customary breeding island in early November where it lays one egg per bird, usually in early December. Chicks hatch 65 days later, and most have fledged by the end of July (Harrison 1990). A pair will typically return to the same patch of land on the same island to breed year after year, and young rarely set foot on an island other than the one on which they were fledged (Harrison 1990). This makes recolonization of islands from which they have been extirpated difficult. Harrison points out that they have failed to recolonize Wake Island nearly a half-century after colonies were destroyed during the war. This species was not observed during the present survey.

Black-footed Albatross (*Diomedea nigripes*) – This species has a similar distribution as the Laysan albatross but also breeds on Taongi Atoll (the nearest point of land to Wake Island) and a few other islands in the North Pacific (Pratt et al., 1987). However, literature references to breeding or suspected breeding on Wake Island were not found. Two black-footed albatross were seen briefly flying together about 2 km (1.2 mi) off Peacock Point on March 25, 1993, and one was seen flying low over the airstrip on March 31, 1993.

White-tailed Tropicbird (*Phaethon lepturus*) – This species breeds on many island groups throughout the tropics in the Atlantic, Pacific, and Indian oceans. It breeds primarily on high islands in shaded rock crevices along coastal headlands but may also nest in reduced numbers on low-lying atolls. One adult was seen briefly in flight near the catchment basins between the personnel housing area and the air terminal on March 25, 1993.

Red-tailed Tropicbird (*Phaethon rubricauda*) – This species has a similar distribution to the white-tailed tropicbird. It breeds primarily on atolls and other low-lying islands, generally in bunchgrass or under or adjacent to bushes that provide some cover (Harrison, 1990). The number of red-tailed tropicbirds observed during the survey period appeared to increase

noticeably, suggesting that the survey period coincided with the earliest stages of the breeding cycle.

Masked Booby (*Sula dactylatra*) – This species breeds on islands throughout the tropics and is often found breeding in association with the brown booby. It prefers the perimeter of larger islands (Harrison 1990) where it is usually much more plentiful than the brown booby. Three masked booby adults were present in the brown booby colonies, and these or other individuals were also seen on nearby offshore rocks at the west end of Wilkes Island. No nests, eggs, or young were observed.

Brown Booby (*Sula leucogaster*) – This species is pantropical, but on a worldwide basis it is much less common than the masked and red-footed boobies. The brown booby usually nests on substrates with some ground cover, often on the crest of a low ridge near the shore. Two small sub-colonies were located on the outer perimeter of the Wilkes Island sooty tern colony. From one to three adult brown boobies were frequently seen feeding from 1 to 2 km (0.6 to 1.2 mi) off Peacock Point, 7 km (4.4 mi) to the east of the breeding colonies, and occasionally elsewhere, but seldom on the north side of the island.

Red-footed Booby (*Sula sula*) – This species is also pantropical but, unlike other boobies, nests in shrubs anywhere from a few centimeters to several meters off the ground (Harrison, 1990). Two small sub-colonies were located in beach heliotrope and naupaka (*Scaevola sericea*) trees near the west end of Wilkes Island. Approximately 26 nests were visible from the open grassy field, and others were seen inside the scrub "forest" but only to a depth of about 15 m (49 ft) from the Vortac area. Approximately 35 nests were estimated to be present.

Great Frigatebird (*Fregata minor*) – This species of frigatebird is found in the Pacific and Indian oceans and in the Atlantic off the coast of Brazil. Its nesting requirements are similar to those of the red-footed booby, and the two species sometimes nest in adjacent colonies. Up to 225 birds were seen perched on powerlines that cross the man-made channel bisecting Wilkes Island about midway along its length. Other than at the powerlines, frigatebirds were only seen in the red-footed booby colony (once) and flying over Wilkes Island. They were seldom seen over either Peale or Wake islands proper.

Pacific Golden-plover (*Pluvialis fulva*) – Golden-plovers are widespread in the northern hemisphere, breeding in the arctic tundra and migrating south to the tropics in winter. This species is a fairly common and widespread winter visitor on Wilkes and Wake islands but relatively scarce on Peale Island due to the lack of open, grassy habitats.

Wandering Tattler (*Tringa incana*) – This species breeds in the arctic and sub-arctic regions of western North America and winters from the west coast of North America across the Pacific to Australia. Several individuals were seen daily in habitats including outer rocky and pebbly beaches, calm channel shorelines, fresh and brackish water ponds, and sand flats in the inner lagoon.

Siberian Tattler (*Tringa brevipes*) – This bird breeds in eastern Siberia and winters in southeast Asia, Australia, and the western Pacific. One individual was seen and heard calling at the fresh water pond located between the tarmac and taxiway at the air terminal.

This may represent the first record of this species from Wake Island; however, it is to be expected occasionally, as it is frequently seen in Micronesia and occasionally in the Marshall Islands (Pratt et al., 1987).

Ruddy Turnstone (*Arenaria interpres*) – The ruddy turnstone breeds in the arctic and migrates to the coasts of all continents except Antarctica in winter. It is a common migrant and winter visitor on most Pacific islands. One individual was observed feeding in the closely cropped grass at the west end of the runway on March 25.

Gray-backed (Spectacled) Tern (*Sterna lunata*) – This species has a somewhat limited distribution, being confined to the tropical Pacific Ocean from Hawaii south to the Tuamotu Archipelago, Tonga, and Fiji and west to the Marianas. Four to eight individuals were seen perched on and flying in the vicinity of a cluster of wooden posts just off shore on the lagoon side of the causeway between Wake and Wilkes islands. Although present in this area most mornings, no indication of breeding was observed.

Sooty Tern (*Sterna fuscata*) – The sooty tern is the most common and widespread of all tropical terns, and because it often nests in colonies numbering in the millions, some have considered it to be one of the most common birds in the world. In Hawaii, sooty terns have an annual breeding cycle, and this appears to be the case at Wake Island. This is by far the most abundant bird on Wake Island. There is a large breeding colony at the west end of Wilkes Island and a smaller active colony on Peale Island. Evidence of two recently active colonies elsewhere on Peale Island was also noted. No birds were found breeding on Wake Island proper.

Brown Noddy (*Anous stolidus*) – The brown noddy is also pantropical in its distribution but in most areas is not as abundant as the sooty tern. Eight birds and two freshly constructed nests were seen on top of a concrete bunker at the outer perimeter of the sooty tern colony on Wilkes Island. One nest with an egg was located atop a large concrete block in the lagoon near the golf course on Wake Island proper. A flock of 65 noddies was seen circling around a cluster of *Casuarina* trees on the golf course and perched on offshore coral near the golf course. The number grew to 90 individuals, plus 2 individual black noddies (*Anous minutus*). Other scattered individuals were seen throughout the island flying along shore or feeding off shore.

Black Noddy (*Anous minutus*) – The black noddy is found throughout most of the tropical Atlantic and Pacific oceans. Two individuals were seen perched together with brown noddies on a concrete structure just off shore along the outer beach opposite the golf course. This species may also breed on Wake Island on occasion; however, breeding has not been suspected by past observers, and the species has apparently been seen on the island only on a few occasions.

White Tern (*Gygis alba*) – This species breeds in the western and central Pacific Ocean, the Atlantic Ocean south of the equator, and the Indian Ocean. Three birds were seen in flight near the west end of the runway. Six birds were seen circling around and perched in the cluster of *Casuarina* trees at the golf course on the main island.

Short-eared Owl (*Asio flammeus*) – This species is nearly cosmopolitan, being found over much of North and South America, Europe, and Asia, as well as on many of the Pacific islands (Galapagos, Hawaii, and Pohnpei). An owl was flushed from beneath a small *Pemphis* bush at the southwest corner of the catchment basins in the late morning on March 28 and a few minutes later was observed flying low over the open scrubby area between the catchment basins and the golf course.

Rock Dove (Feral Pigeon) (*Columba livia*) – A flock of 11 birds on March 28 and 6 birds on March 29 were seen in the vicinity of the golf course. These birds are apparently being bred by an island resident (Rowland, 1989).

Feral cats were frequently observed on both Peale and Wilkes islands, and one feral cat was seen in the sooty tern colony on Wilkes Island. The abandoned colony on Peale Island showed evidence of cat activity that may have caused at least partial failure of that colony. Island residents said that although considerably more sooty terns have bred at Wake Island in past years (as indicated in the literature cited above), their overall decline is due to feral cats, which, according to some, can destroy hundreds of nestlings in a single night and cause others to disperse into dense vegetation where they are abandoned. One resident said that the Vortac area on Wilkes Island is graded each year prior to commencement of the sooty tern nesting season in part to destroy rats, their young, and any subsurface burrows and to make feral cats more visible to the nesting birds. Flipper Point on Peale Island may not have any resident cats because of its nearly complete isolation from the rest of Peale Island, and this may be the reason for the success of its relatively small colony.

There are no threatened or endangered bird species on Wake Island. The Wake rail (*Rallus wakensis*), a flightless species endemic to Wake Island, has not been seen since World War II and is assumed to be extinct. Japanese soldiers who occupied Wake Island during the war are reported to have resorted to capturing and eating rails to avoid starvation (Fuller, 1987). This activity either directly caused their extinction or reduced the population to a level low enough for feral cats to capture the few remaining birds.

All other naturally occurring bird species recorded at Wake Island are protected under the Migratory Bird Treaty Act of 1916 (16 U.S.C. 703-712). The act protects all non-game bird species native to the United States and its territories, including those that may be present only as migrants. Under the act, it is unlawful to "pursue, hunt, take, capture, kill, attempt to take, capture, or kill . . . any migratory bird, any part, nest, or eggs of any such bird . . ." It is generally inferred that the destruction of any habitat known to contain birds actively engaged in nesting in that habitat would be in violation of the act, as the nests, eggs, or young would almost certainly be destroyed along with the habitat.

2.3.2 BOTANICAL SURVEY

One-hundred-percent coverage botanical surveys were carried out on several sites on Wake Island. In addition, overview botanical surveys were completed on both Wilkes and Peale islands. The purpose of these surveys was to collect data on and to describe the vegetation of the sites, to prepare species lists of the naturally occurring vegetation of the

area, and to determine if any Federally listed or proposed threatened or endangered species are present on these small islands (U.S. Fish and Wildlife Service, 1992). During this study, only the naturally occurring plants of the specified sites and undeveloped areas and those plants which appear to be surviving and proliferating on their own among the abandoned buildings were recorded. Figure 2-4 shows vegetation species of special interest.

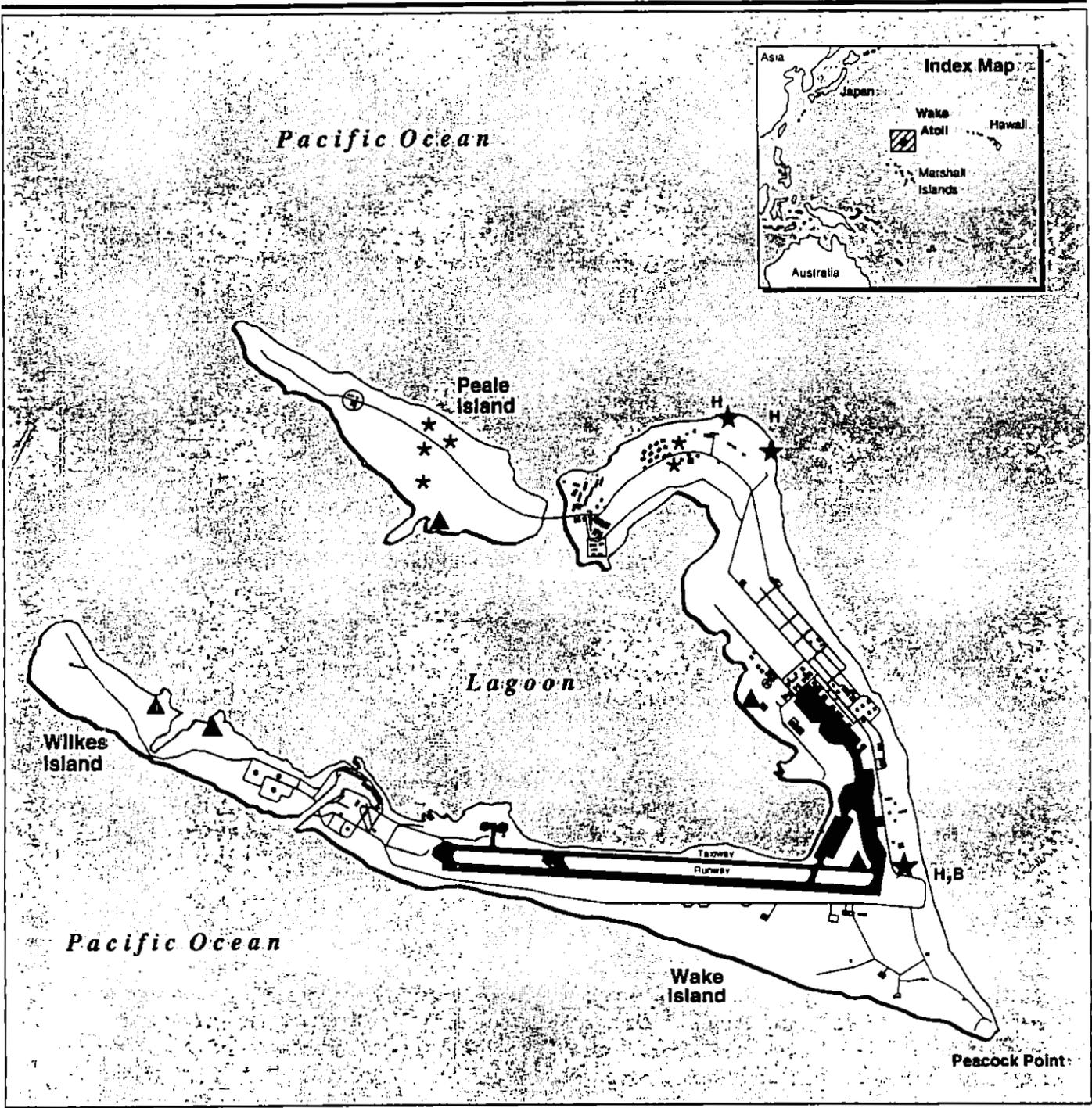
2.3.2.1 One-hundred-percent Survey Site

The Peacock Point area was the subject of a 100-percent coverage botanical survey. The site extends from the control tower eastward along Elrod Road to the ocean and from the tower south to the ocean. The vegetation of this area is a changing mosaic of scrub tree heliotrope, ironwood, and kou trees (*Cordia subcordata* L.) interspersed with dense stands of naupaka and cotton (*Abutilon albescens* Miq.). Eastward from Peacock Point Road the tree heliotrope is mostly scattered, shrubby individuals growing in coral rubble. West of Peacock Point Road, the tree heliotrope is interspersed with dense stands of naupaka and ironwood trees which become dominant at the west end of the site and in the near vicinity of the control tower. Just seaward of the tower and to the east as far as Peacock Point Road, dense stands of kou trees, 6 to 8 m (20 to 26 ft) in height, can be found. The upper branches of these trees, like all of the kou trees on the atoll, are bare and dry, a reminder of storms during the fall of 1992.

Of the 23 species of weedy plants found during this survey and not reported by Fosberg (1959), 14 were from the Peacock Point site. There are two proposed launch sites within the Peacock Point study site. These areas were revisited, and a 20-meter (66-foot) radius around each site was re-examined. The area around Launch Site 1 has been cleared, and the coral rubble has been scraped into long piles around the site. There is a scant covering of vegetation on the pushed-up rubble. The principal species are kou and tree heliotrope. At the northwest edge of the cleared area, there is one *Pisonia grandis* tree, one of the few trees native to Wake Atoll. The remainder of the vegetation is mostly low-growing weeds such as *Bidens*, pigweed, and mixed grasses.

Launch Site 2 has also been cleared and the tree heliotrope is just beginning to re-invade the area. Most of the plant cover is composed of weedy plants like *Tridax*, Jamaica vervain (*Stachytarpheta jamaicensis* (L.) Vahl), 'Uhaloa (*Waltheria indica* L.), and Nohu (*Tribulus cistoides* L.). The vegetation of the proposed launch pad sites is principally weeds, except for the few plants noted.

Also located within the Peacock Point survey area are the proposed locations for a new MSB and MAB. Vegetation at these two sites is representative of that found throughout the Peacock Point area, as already described.



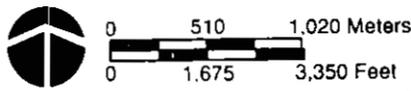
EXPLANATION

- ▲ Pemphis/Sesuvium Marshland
- ★ Undescribed Species (H = *Heliotropium* sp., B = *Boerhavia* sp.)
- ✳ *Pisonia grandis* trees (*Pisonia/Conda* forest remnants)

Vegetation Features

Wake Island

Figure 2-4



2.3.2.2 Overview Survey Sites

Wilkes Island

The western third of Wilkes Island has been set aside as a large seabird colony. The area has been cleared and is regularly mowed to protect the seabirds from the many feral cats that inhabit the island. The most conspicuous vegetation at this end of the island is a scant fringe of heliotrope trees, 4 to 6 m (13 to 20 ft) in height, and the broad mats formed by the nohu vines (*Tribulus cistoides* L.) which dominate the clipped, flattened landscape. Nohu vine was purposely introduced into the area. Because of the two, hard, stout spines that develop on its mericarps (one-half of a two-parted fruit), it was reasoned that a dense mat of these thorny vines would help keep both predators and people away from the bird colony.

From the eastern edge of the bird sanctuary clearing to the Wilkes Island channel and continuing on the south side of the road to as far as the fuel storage tanks, the vegetation cover is composed of scattered heliotrope trees from 1 to 8 m (3.2 to 26 ft) in height. The ground layer is mixed grasses, predominantly two species of bunch grass with intermittent patches of scurvy grass (*Lepidium bidentatum* Montino) and alena (*Boerhavia repens* L.).

On the south side of the dirt road, between the channel and the bird clearing, there is a long, deep tank trap. A dense colony of kou trees has grown up in this low area.

Along the lagoon shore of Wilkes Island the coastal vegetation is *Pemphis* with mats of sea purslane and a dense planting of ironwood trees near the point just north of the storage tanks. A scant scrub of tree heliotrope, naupaka, sour bush, cotton, and various weeds and grasses cover about 50 percent of the ground surface. The remainder is coral rubble and metal and wood scrap.

Peale Island

Essentially, the dominant vegetation of Peale Island is tree heliotrope, 2 to 8 m (6.6 to 26 ft) in height. The ground cover is mixed bunch grass and open coral rubble. Along the shore near the Peale Island Bridge, around to and including Flipper Point, and lining the inlets is a thriving *Pemphis* community with intermittent mats of red-stemmed sea pruslane. Upland from and intermingled with the *Pemphis* is a burgeoning community of ironwood trees. About 150 m (492 ft) from the Peale Island Bridge on the ocean side of Peale Island Road can be found a scattering of *Pisonia grandis* and kou trees, almost all that is left of what Fosberg referred to as a *Pisonia/Cordia* forest. (The only other *Pisonia* trees seen during this study were nine individuals near the golf course and a small colony of young trees coming up in the abandoned housing areas [both sites on Wake Island].)

About halfway between the Peale Island Bridge and the northwestern tip of Peale Island is a dirt road which leads to the old Pan American Seaplane Ramp. Just at the turn, there is a dense planting of *Opuntia littoralis* (Tour.) Mill., and a little further along the road is a reproducing stand of sisal. On either side of the dirt road are open areas where there are

no heliotrope trees. In these open places can be found huge enclaves of the shrubby, wild cotton which is native to this atoll.

No proposed or listed threatened or endangered plant species as set forth by the U.S. Department of the Interior Fish and Wildlife Service (*Endangered Species Act of 1973*, [16 U.S.C. 1531 - 1543] as amended) (U.S. Fish and Wildlife Service, 1992) were encountered.

2.3.3 MARINE BIOLOGICAL RESOURCES

Turtles, presumed to be green sea turtles (*Chelonia mydas*), are known to inhabit the near-shore reef surrounding Wake Atoll and have been seen entering the lagoon through the channel between Wake and Peale islands (Brown, 1993). There is no known occurrence of their having nested in the atoll.

Marine mammals that may occur in the open ocean area surrounding Wake Island and between Wake Island and the USAKA include several species of cetaceans (i.e., the blue whale [*Balaenoptera musculus*], finback whale [*Balaenoptera physalus*], humpback whale [*Megaptera novaeangliae*], and sperm whale [*Physeter catodon*]).

2.4 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 other reasons. Cultural resources have been divided for ease of discussion into three main categories: prehistoric resources, historic structures and resources, and traditional resources.

Prehistoric archaeological resources are defined as physical remnants of human activity that predate the advent of written records in a particular culture and geographic region. They include archaeological sites, structures, artifacts, and other evidence of prehistoric human behavior.

Historic resources consist of physical properties or locations postdating the advent of written records in a particular culture and geographic region. They include archaeological sites, structures, artifacts, documents, and other evidence of human behavior. Historic resources also include locations associated with events that have made a significant contribution to history or that are associated with the lives of historically significant persons.

Pre-World War II History

Wake Island was named for the British sea captain, William Wake, who passed by in 1796. In 1898 the atoll was claimed by the United States. Wilkes Island was named in 1923 for U.S. Navy Commodore Charles Wilkes, who visited the atoll in 1840, and Peale Island was named for Titian Peale, Wilkes' naturalist. In 1934 President Franklin D. Roosevelt signed

an Executive Order giving the Department of the Navy jurisdiction over the island. (National Park Service, 1984)

In 1935 Pan American Airways, Pacific Division, was established on Wake Island and was awarded the Trans-Pacific mail contract. Air service facilities were constructed on the atoll including a seaplane base and passenger facilities. (U.S. Department of Defense, 1990)

The intensifying threat of war in the Pacific in the late 1930's prompted American military planners to recognize the strategic value of Pacific outposts such as Wake Atoll. In 1938 the Hepburn Board, a group of naval officers appointed to study naval policies, recommended allocation of funds for the development of an air and submarine base at the atoll. However, it was not until January 1941 that construction began (Cohen, 1990). In December, at the outbreak of World War II, the facility was two-thirds complete (U.S. Department of Defense, 1990). Approximately 1,200 civilians supporting this effort were on the atoll at this time (Cohen, 1990). Military personnel present on the atoll at this time included:

- 1 officer and 5 enlisted men of the U.S. Army Air Corps
- 15 officers and 373 enlisted men of the 1st Marine Defense Battalion, Major James P.S. Devereux, Commander
- 10 officers and 58 enlisted men at the U.S. Naval Air Station (Commander Winfield Scott Cunningham, as senior naval officer on Wake Island, was the over-all commander of the island's military garrison.)
- 10 commissioned and 2 enlisted pilots and 49 ground crew members under the command of Major Paul A. Putnam, Marine Fighter Squadron (VMF-211)

(Cohen, 1990)

World War II

The Japanese first attack on Wake Island occurred about noon on December 8, 1941. Having heard of the attack on Pearl Harbor, the island's military and civilian personnel had made preparations. Captain Henry T. Elrod and three other pilots were aloft in their Grumman F4F Wildcat fighter planes. However, the Japanese force approached at a lower altitude and escaped their notice. The principal target of Japan's 24th Air Flotilla on this day was the Wake airfield. By the time the American pilots could come to assistance, seven of the Wildcats on the ground were destroyed and one was severely damaged. Civilian and military personnel sustained several casualties. (Cohen, 1990)

On the second day Camp Two, which was located on Wake Island near the present billeting area, and the anti-aircraft guns on Peacock Point were the targets of attack. The following day batteries on Wilkes Island were the principal targets. (Cohen, 1990)

In the early hours of December 11 a Japanese naval force was observed approaching the island. Americans fired on the ships only when they were within range of the shore batteries. American civilians assisted when and where they were able. (Cunningham and Sims, 1961)

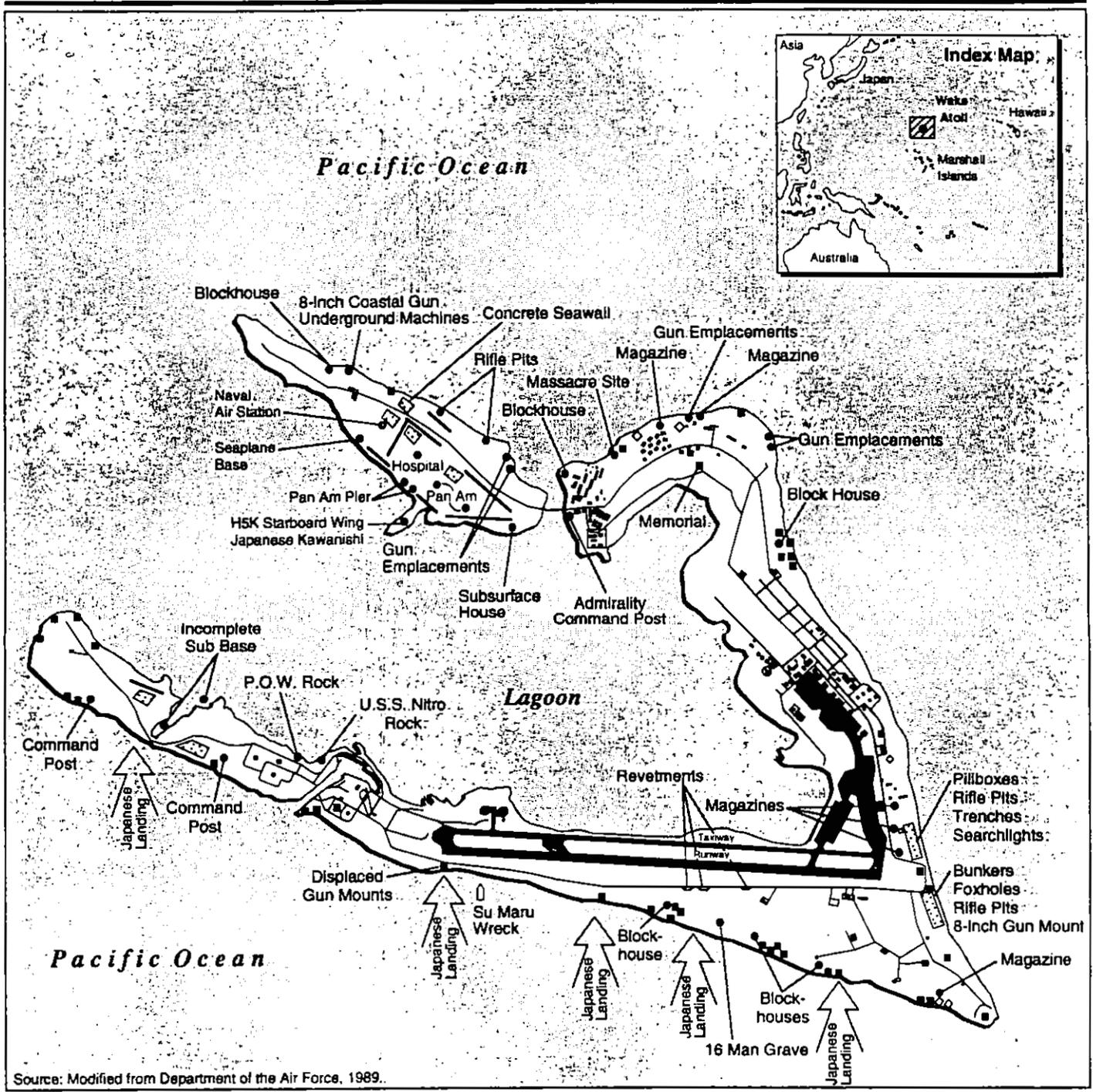
The Japanese force included three light cruisers, six destroyers, two patrol boats, two medium transports, and two submarines. Two of the destroyers were lost and five other ships were damaged as a result of American air and shore battery defensive actions. The Japanese withdrew and returned to their base on Kwajalein Island. This was considered the first authentic victory of the war for American forces. The news that the small force on Wake had turned back a Japanese invasion fleet was an incalculable boost to the morale of a nation shocked by the destruction at Pearl Harbor. (Cunningham and Sims, 1961)

In the following days the Japanese conducted sporadic attacks by air, but the various anti-aircraft batteries continued to defend the island. Several of these batteries were moved on different occasions during the night. This was an effective method of surprising returning Japanese pilots who were prepared to attack previous battery positions. (Cunningham and Sims, 1961)

On December 23 the Japanese were successful in approaching the island in the early hours under cover of the dark moonless night and disembarking troops. Shortly after 7:30 a.m. American forces surrendered and fifteen hundred American service and civilian personnel were taken into captivity (Costelle, 1981). Individual deeds of heroism were performed during this battle at the batteries on Wake Island south of the airfield and on Wilkes Island by Captain Henry T. Elrod, Second Lieutenant Robert Hanna, Major Paul Putnam, Corporal Winford McAnally, and others (Cohen, 1990). General descriptions of events and positions of Lieutenant Hanna's 3-inch gun, Battery E, Corporal McAnally's 0.50-caliber machine gun, and the 5-inch battery on Peacock Point are provided in Commander Cunningham's book (Cunningham and Sims, 1961). No documentation of investigations to determine the exact positions of these heroic deeds was discovered during the literature search.

The Japanese were in possession of the atoll until the end of the war. Rear Admiral Shigematsu Sakaibara, Imperial Japanese Navy, surrendered Wake Island to Brigadier General L.H.M. Sanderson, U.S. Marine Corps, on September 4, 1945 (Cohen, 1990). An extensive assemblage of World War II Japanese structures, earthworks, and fortifications is still present on the atoll in various stages of deterioration. Remnants of American structures of this era are also in evidence. See figure 2-5 for locations of cultural resources according to available data.

Wake Island was designated a National Historic Landmark in 1985 in order to preserve both the battlefield where important World War II events occurred and Japanese and American structures from that period (U.S. Army Strategic Defense Command, 1987). A copy of the National Register of Historic Places Inventory Nomination Form that describes the primary events during this period is included as Appendix E of the Project Starbird



EXPLANATION

- ◊ Bunker
- Pillbox
- ▨ Trenches
- Anti-tank Ditches

Locations of Recorded Surface Cultural Resources

Wake Island

Figure 2-5



Environmental Assessment (U.S. Army Strategic Defense Command, 1987). The historic boundary is defined in the nomination form as:

. . . the outer edge of the reef that surrounds Wake Island so as to include the reef, the three islands, and the lagoon. This boundary encompasses all American and Japanese structures, earthworks, fortifications, and weapons that are found over all of the three islands from the period 1941 to 1945. It includes the reef where Japanese forces landed. It also includes the land areas where Japanese enlisted men were garrisoned. All post-war developments, while within this boundary, do not contribute to the significance of Wake's World War II history and are exempted.

(National Park Service, 1984)

The Pan American facilities and the U.S. Naval submarine and aircraft base are included in the historic property (U.S. Department of Defense, 1990).

Through an agreement between Japan and the U.S. Department of State, all known Japanese remains were removed and returned to Japan (Strategic Defense Initiative Organization, 1991). In addition to war casualties, an estimated 1,500 Japanese military personnel died as a result of malnutrition by August 1945 (National Park Service, 1984). Remains of Japanese military personnel may still be present on Wake Island. Remains of American civilian and military personnel who died in early conflicts with the Japanese or as prisoners have not all been recovered. There is potential for these remains to still be present on the atoll. There has been no comprehensive subsurface investigation to determine the location of subsurface cultural material on the atoll.

No evidence of prehistoric cultural resources has been discovered on Wake Island. No traditional use areas has been identified on the island. There is little potential for prehistoric or traditional resources to be present on the island. The remoteness of the island and lack of fresh water sources other than rainfall are characteristics of the island that discouraged settlement by native Pacific populations. (Department of the Navy, 1990) No unique paleontological resources are known to exist on the island.

2.5 HAZARDOUS MATERIALS/WASTE

At the present time, operations utilizing hazardous materials at Wake Island are limited to aircraft flight and maintenance activities, base operations and infrastructure support activities, and infrequent missile launches (one in 1992 and two in 1993).

JP-5 jet fuel is the hazardous material used in the greatest quantity at Wake Island. Storage of up to 54.5 million L (14.4 million gal) of JP-5 can be accommodated in fuel storage areas. JP-5 is transported to Wake Island via cargo ship and is transferred to the on-island storage system. It is distributed through two fuel systems (the first built during the FAA's administration and the second by the Air Force) to both aircraft refueling areas and to the power plant. No waste JP-5 is produced under normal conditions. The balance is consumed by aircraft flight operations and power production. In the event of a spill

involving JP-5, the requirements in Operations Plan 355-1, *Wake Island Disaster Preparedness Plan*, and the *Oil and Hazardous Substance Pollution Contingency Plan* are observed to minimize the area of potential contamination and to maximize cleanup efforts.

In addition to JP-5, small quantities of lubricants and motor fuel (gasoline) are stored in bulk for base operations and infrastructure support. Like JP-5, these materials are delivered to Wake Island via ship and are transferred to storage facilities. Distribution of these materials is accomplished for individual users as needed. All materials are used in process, and any spills are addressed as with JP-5.

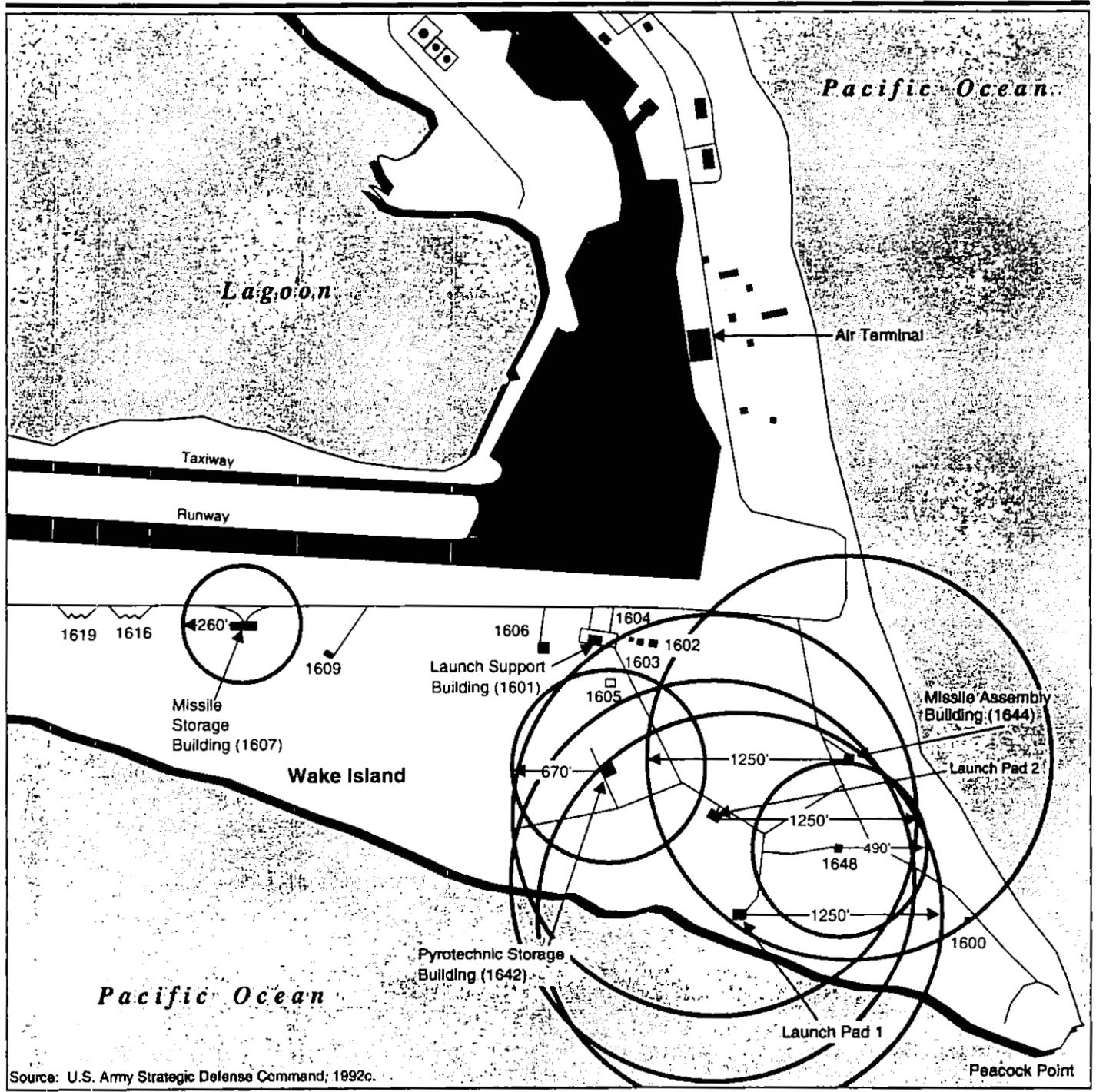
Small quantities of other hazardous materials, including some solvents, paints, cleaning fluids, pesticides, chlorine and other materials, are also used for infrastructure support and aircraft maintenance activities. These materials arrive via ship or cargo aircraft. Distribution of these materials is accomplished through the facility supply system, administered by Detachment 1 of the 15th Air Base Wing. Some of these materials are consumed in operations; the remainder are collected as hazardous waste. At the present time the infrastructure at Wake Island is just sufficient to accommodate the hazardous waste that is produced during current operations (Andel, 1993).

Small quantities of explosive materials, contained within ordnance and other equipment, are handled at Wake Island. Explosives are stored in buildings 1648 (Army operations) and 1642 (Air Force operations). Each of these facilities is sited in accordance with AFR 127-100, *Explosive Safety*. The ESQDs for these facilities as well as the launch pads and other launch support facilities established for the TCMP are shown in figure 2-6.

Management of hazardous waste is accomplished by Detachment 1, 15th Air Base Wing. Waste is initially collected at the point of generation, where it is temporarily stored. Waste is retrieved from the temporary storage areas and collected at a central accumulation area located at Building 1405. Types of waste generated include small quantities of used solvents and paints, cleaning fluids, asbestos-containing materials (generated during building maintenance activities), and some pesticides. At Building 1405 hazardous waste is placed in overpack containers (DOT-E-9618 polyethylene overpacks, approved by the DOT for waste shipment) for added security. All hazardous waste is shipped off the island to Hickam AFB, where it is disposed of by the 15th Air Base Wing through the Hickam AFB hazardous waste management system. The 15th Air Base Wing is also responsible for ensuring that hazardous waste management activities at Wake Island are properly conducted and that all personnel are properly trained in the handling of hazardous waste and in the proper response to emergency situations.

2.6 HEALTH AND SAFETY

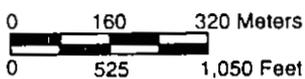
As an Air Force installation, all operational activities at Wake Island are subject to the requirements of the Air Force Occupational Safety and Health (AFOSH) Program, established in AFR 127-12, *Air Force Occupational Safety, Fire and Health*. The provisions of this program are administered through two departments: safety (which includes ground safety, flight safety, and range safety) which is responsible for all aspects of safety



Explosive Safety Quantity-Distances for Existing Facilities

Wake Island

Figure 2-6



(physical hazards) and medical which is responsible for occupational health (chemical exposure and other hazards).

At Wake Island the primary existing hazards are associated with aircraft maintenance activities and base infrastructure support. Hazards include handling and use of hazardous materials (e.g., solvents, paints, fuels, chlorine), noise exposure due to aircraft operations, and physical safety associated with the use of heavy equipment and support operations. These hazards are well controlled through ongoing evaluation and assessment of potential hazards, implementation of appropriate safety procedures, and use of safety equipment. Handling of explosives is accomplished in accordance with DOD, Air Force, and Army regulations to assure minimal hazard.

Wake Island still contains a substantial amount of buried ordnance from World War II. The U.S. Air Force always has Explosive Ordnance Disposal personnel on site during grading or trenching operations.

The missile range extending from Wake Island toward the USAKA is under the jurisdiction of the KMR. Range safety activities are managed at the USAKA. All relevant procedures in the KMR *Range Safety Manual* are applied to missile flight operations at Wake Island. This manual specifies the procedures which must be followed in order to perform a launch operation. Requirements include presentation of a complete flight performance analysis, identification of all potential hazards to range personnel and assets, and approval by the KMR Range Safety Office of all proposed operations. The intent of this system is to ensure that all safety issues receive appropriate attention in mission planning and to prevent creation of undue hazards to people, property, or the environment.

In the event of a catastrophe (e.g., natural disaster, hazardous materials spill, aircraft or missile mishap), Operations Plan 355-1, *Wake Island Disaster Preparedness Plan*, is implemented. This plan specifies the responsibilities and initial response actions to be taken in the event of a disaster and is intended to minimize both disaster recovery time and the potential hazards which could be encountered during the containment and recovery phases.

2.7 INFRASTRUCTURE AND TRANSPORTATION

Infrastructure

Infrastructure capacity at Wake Island was designed for a much larger population than is currently present. Wake Island's current permanent personnel are fewer than in the 1970s (up to 1,600 personnel).

Fire – Fire protection is provided by fire suppression systems in most operations buildings and by a continuously staffed fire station on the island.

Health – Wake Island has a medical clinic staffed by a medical technician and one full-time physician.

Police – Security on Wake Island is provided by the Base Operating Support (BOS) contractor.

Power – Electrical power for the entire island is provided by a central generating station that contains five operable 1957 vintage Worthington diesel generators, 800 kilowatts (kw) each. To sustain normal operations only three units are necessary, with the rest as backup (Andel, 1993). For logistic purposes and cost effectiveness, the generators use JP-5 jet fuel. There are several supplemental generators located on the island for emergency backup, including a 1,000-kilowatt diesel generator located on the northwest end of Wake Island proper (U.S. Army Strategic Defense Command, 1992b). The current demand at Wake Island is approximately 1,600 kw (U.S. Department of the Air Force, 1992).

Solid Waste – Solid waste generated on the island is disposed of in the island's landfill/burning pit located on Peacock Point or burned (wet waste only) in the incinerator. No trash sorting is accomplished with aluminum cans and glass burned with waste paper, foliage, leaves, and cardboard packing materials. The incinerator, an Advanced Combustion Systems Model CA-150 with a design capacity of 68 kilograms (kg) (150 pounds (lb)) per hour, actually burns approximately 27 kg (60 lb) per hour and is operated 8 hours per day, disposing of about 218 kg (480 lb) per day or about one-fifth of the island's waste (U.S. Army Strategic Defense Command, 1992b). The 300 people on the island in mid-June 1992, generated approximately 34 m³ (1,200 cubic feet [ft³]) of waste per day, at a rate of 0.1 cubic meters (m³) (4 ft³) per person per day (U.S. Army Strategic Defense Command, 1992b). Residue from the incinerator goes into the landfill (U.S. Army Strategic Defense Command, 1992b).

Two junkyards exist, one for scrap metals and other miscellaneous non-burnable trash (e.g., batteries, transformers, tires) and one for abandoned vehicles. The U.S. Air Force is currently in the process of removing hazardous materials in these junkyards from the island.

Wastewater – Along with lagoon water, the brackish wells also provide water for the sanitary sewer system. A series of wet-well lift stations is used to collect and move sewage to a treatment plant where solids are collected and waste water is discharged to the ocean off Peacock Point at the far southeast end of Wake Island. No point-source National Pollutant Discharge Elimination System permit or variance for the sewage treatment plant exists (U.S. Army Strategic Defense Command, 1992b). Although their full design capacity is not known, the sewer system and treatment plant served the 1960s' peak base population.

Water – Potable water is supplied via the capture of rainwater in two 7-hectare (17-acre) catchment basins and is augmented by a desalinization plant with a design capacity of 454,248 liters per day (Lpd) (120,000 gallons per day (gpd)). Catchment basin water is treated by filtration and disinfection through chlorine gas injection (U.S. Army Strategic Defense Command, 1992a). The desalination plant, using brackish well water, has three evaporators/boilers, only two of which are currently usable. Usually only one evaporator at a time is used, producing 136,274 to 140,060 L (36,000 to 37,000 gal) of water per day. On average 3.8 million L (1 million gal) of potable water are kept in storage (U.S.

Army Strategic Defense Command, 1992b). This desalination plant, some 30 years old, provides a backup to the rainwater catchment by treating brackish well water from nine wells.

Water quality is tested weekly for chlorine, pH, and fecal coliforms only. Currently, there are no problems with water quality on the island. A recent report stated that the water treatment, storage, and surveillance program is well managed. However, water conservation is an ongoing concern. (U.S. Army Strategic Defense Command, 1992b)

Transportation

Air – The island's runway, 3,002 by 46 m (9,850 by 150 ft), is central to the primary mission of Wake Island – the support of trans-Pacific military operations and Western Pacific military contingency operations; in-flight emergency airfield service; the provision of transient military/civilian aircraft servicing; and emergency sealift capability (U.S. Department of the Air Force, 1992). All aircraft operations and servicing activities are directed from base operations, which is manned 24 hours per day. Aircraft ramps are available for processing passengers and cargo and for refueling up to 36 aircraft in a mix of DC-8, C-130, C-141, and C-5 aircraft. There are two scheduled contract DC-8 flights per week, one cargo and one passenger (Andel, 1993). The overall condition of the runway is fair, with subsidence, raveling, and minor cracking over the entire length of the runway (U.S. Army Strategic Defense Command, 1992b).

Road – Transportation on the island is provided by Air Force or contractor vehicles and is basically dedicated to the base support functions. Transportation for aircrews and passengers is limited to two buses between the Base Operations Building and the Dining Hall/Billeting Office (U.S. Department of the Air Force, 1992).

The primary road system on Wake Island is a two-lane paved road extending from the bridge connecting Peale and Wake islands to a point on Wake Island near the fuel farm to the west end of Wake Island. The bridge connecting Peale and Wake islands has a 2-ton weight limitation (Andel, 1993). A combination of paved and coral roads serves the marina area. Paved access to Wilkes Island ends at the petroleum, oil, and lubricant tank farm where a coral road provides access to the western point of Wilkes Island. A portion of the road, near the unfinished World War II submarine channel, is flooded nearly every year by high seas. A coral road serves Peale Island. The launch sites are accessed from the main paved road on Wake Island by paved and coral roads. Generally the road network is suitable for low-speed, light-duty use only (U.S. Army Strategic Defense Command, 1992b).

Marine – The island is supplied by sea-going barges and ships. The Air Force maintains three small landing barges used to transfer material from ships to the dockyard. The barges are required because the harbor is too small for ocean-going vessels to enter. Off- and on-load fuel facilities built in the mid-1970s by the Navy have never been operated due to a reported electrical fault. The older off-load hydrants for gasoline and JP-5 fuels are operational and currently used (U.S. Army Strategic Defense Command, 1992b).

2.8 LAND USE

Wake Atoll consists of three islands (Wake, Wilkes, and Peale) formed in a "V" shape. The combined land areas are approximately 14.5 km (9 mi) in length. The islands surround a shallow lagoon.

Wake Island is the main island and contains the majority of the operations and facilities associated with the military (figure 2-7). Housing and community facilities are located toward the north end of the island. The central portion of the island contains support facilities (e.g., water catchment basins, water storage tanks, and power plant). On the south part of the island are the airfield and the missile launch facilities.

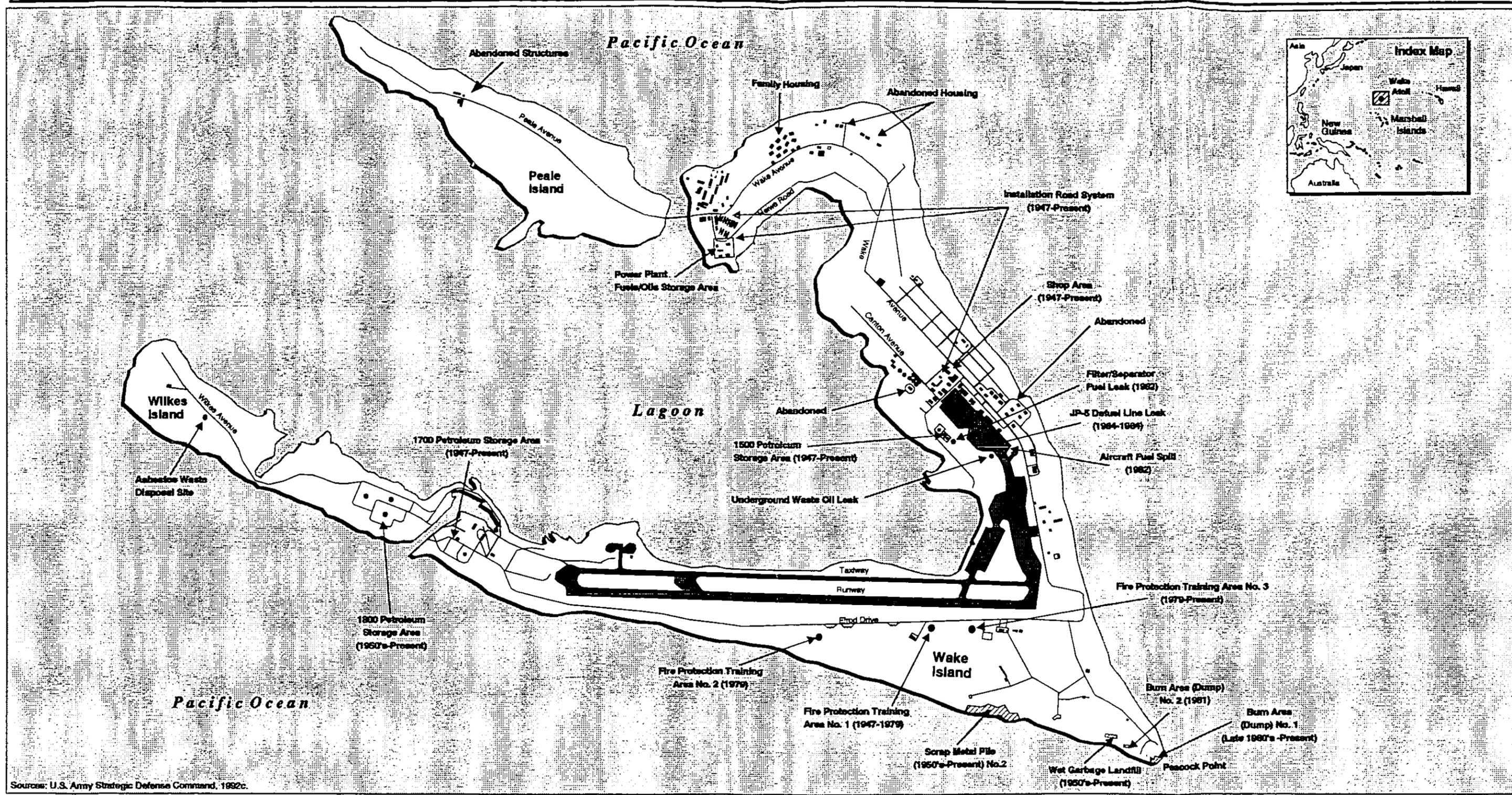
Peale Island currently contains no airfield support facilities, but the U.S. Air Force has plans to erect a high-frequency antennae field at the abandoned U.S. Coast Guard facility in late 1993. The island is largely used by migratory birds as a nesting area. There are remains of old Pan American Airways facilities, and a Thai temple is currently in use on Peale Island.

Wilkes Island is mainly an open area. The west end of the island is used as a nesting area for migratory birds. A petroleum storage area and an inactive asbestos disposal area are located on the east portion of the island. The central portion of the island contains an unfinished submarine channel that was partially developed by the Japanese during World War II.

Past hazardous waste disposal sites on Wake Island were identified and evaluated during a Phase I records search (Engineering-Science, 1984). This search was the initial phase of the DOD's Installation Restoration Program (IRP) to identify and evaluate past hazardous material disposal sites on DOD property. Waste sites associated with airfield activities and disposal of World War II debris were found on Wake and Wilkes islands but not on Peale Island. An old sanitary landfill has been covered and abandoned on Wake Island, and a new landfill was opened near Burn Area No. 2. The Phase I report (Engineering-Science, 1984) provided recommendations for land use restrictions in several categories including housing, water well development, and recreation.

In 1991, an IRP Phase II Stage 1 remedial investigation/feasibility study was conducted on Wake Island involving the evaluation of environmental contamination at 14 IRP sites (figure 2-8). Surface soil samples at each site and petroleum product samples from a waste oil storage tank were analyzed. Based on the laboratory results, indicator constituents were selected and used in a site-specific baseline risk assessment. The risk assessment evaluated potential migration pathways for, and receptors of, indicator constituents. The results of the IRP Phase II Stage 1 investigation indicated that 10 of the 14 sites could be classified as Category 1 sites. These are sites and/or operable units where no further IRP action (including remedial action) is required. Existing data for these sites are considered sufficient to find that they are a not significant impact to human health or the environment, thus making the land available for unrestricted use. Four of the sites, however, including the shop area, the installation road system, the landfill near Peacock Point, and the waste oil storage tank, were classified as Category 2 sites. These are sites and/or operable units requiring additional IRP effort to determine the mobility,

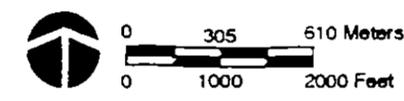
THIS PAGE INTENTIONALLY LEFT BLANK



Sites Of Potential Environmental Contamination

Wake Island

Figure 2-8



THIS PAGE INTENTIONALLY LEFT BLANK

THIS PAGE INTENTIONALLY LEFT BLANK

toxicity, and volume of detected contaminants, evaluate human health and environmental risks associated with each contaminant, and evaluate remedial alternatives in detail. Any proposed land use changes at these sites requires evaluation with respect to hazard potential and interference with further IRP activities. (U.S. Army Strategic Defense Command, 1992b)

2.9 NOISE

Natural background sound levels on Wake Island are relatively high because of wind and surf. Background levels can mask the approach of trucks on base roads, and personnel are not always aware of aircraft landings. No measurements of ambient sound levels are known to be available. (Strategic Defense Initiative Organization, 1991)

Man-made sources of noise at Wake Island are associated with airfield operations and base maintenance activities. The majority of non-military aircraft are unscheduled. The majority of military aircraft are C-141s and C-130s. (U.S. Army Strategic Defense Command, 1992b)

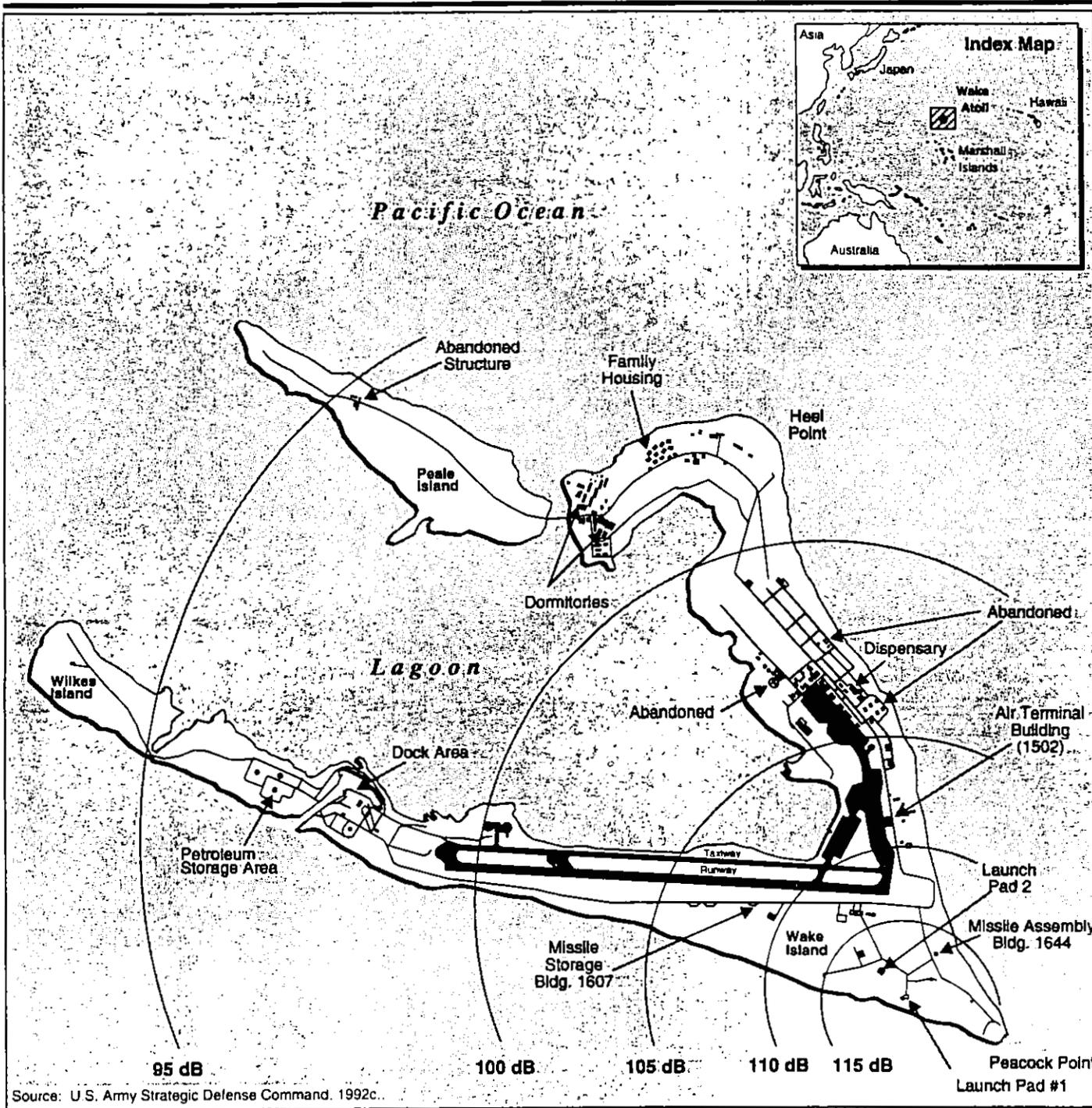
During flight operations, the noisiest aircraft that typically operates at Wake Island, an Air Force C-5, is estimated to generate A-weighted sound pressure levels of approximately 84 decibels (dB) at the base dispensary, 69 dB at base family housing, 74 dB at the base dormitories, 69 dB at the midpoint of Peale Island, and 95 dB at the midpoint of Wilkes Island. Hearing protection is required for those personnel engaged in aircraft apron operations. Estimates of aircraft noise were developed using DOD Noise Exposure Model Version 6.1. (Moulton, 1990)

Rocket launches have occurred in the past on Wake Island (Strategic Defense Initiative Organization, 1991). A map of the maximum A-weighted sound pressure level contours during flight vehicle launches for the TCMP is presented in figure 2-9. With the exception of the diesel generators, other environmental noise sources such as military training routes, small-arms ranges, or highway operations do not exist on the island (U.S. Army Strategic Defense Command, 1992b).

2.10 PHYSICAL RESOURCES

Wake Island is typical of mid-Pacific Ocean atolls formed when a volcano rises above the ocean surface and then subsides back below the surface due to deflation of the underlying magma chamber. When the volcanic island subsidence rate is relatively slow, coral reefs form around the island and continue to grow at a rate equal to that of the subsidence, forming a ring-shaped reef with a shallow central lagoon.

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 grow and die, their remains are either cemented in place to form hard reef rock



**Maximum A-Weighted
Sound Pressure Level
Contours During
TCMP Flight
Vehicle Launch**

Wake Island

Figure 2-9



or erode and wash down slopes to accumulate as sediment deposits, particularly in the lagoon or on deep terraces downslope on the ocean side of reefs. The reefs are growing actively as a result of vigorous development and populations of corals, coralline algae, and large mollusks. Only the upper thin veneer of the reef structure is alive and growing, accreting over the remains of prior generations of reef organisms. Although coral reefs are unique because they build and advance wave-resistant structures in the face of persistent and severe wave and storm attack, the organisms that form the reefs are vulnerable to sedimentation, burial, and changes in circulation caused by man's development activities (U.S. Army Strategic Defense Command, 1989).

Major reef-building organisms are marine fauna that cannot survive prolonged periods of exposure out of the water. The land masses at Wake Island have formed by one or both of two processes: accumulation of reef debris deposited on the lagoon side of the reef by large waves and the lowering of sea levels during periods of global cooling. The island's building process by large storm-generated waves is evidenced on the south side of Wake Island by the burial of pillboxes constructed during World War II under sand, gravel, and cobble-sized pieces of reef debris.

As a result of these building processes, atoll island soils are predominantly coarse-grained and almost exclusively composed of calcium carbonate. Therefore, they are of low fertility, lacking many of the nutrients required to support many plant species.

Island building by wave-deposited reef debris also limits land elevation. The maximum elevation on Wake Island is 6.4 m (21 ft) above mean sea level (Engineering-Science, 1984), and the average elevation is only about 3 m (10 ft). This makes the island very susceptible to damage from high waves generated by tropical storms as well as the high winds. In 1992 two typhoons caused extensive damage to the base infrastructure.

The only natural resources on the island are sand and gravel. This material is of low quality for construction because of its calcium carbonate composition and vesicular nature. The one known borrow area on the island for sand and gravel is located on the north shore of Wilkes Island. However, this area is no longer in use. The current procedure is to obtain all construction aggregate materials from off-island sources (Cannella, 1993).

2.11 SOCIOECONOMICS

The region of influence for Wake Island is limited to the island itself. Since the island is an isolated military installation, actions taken there have little effect on outside employment, population immigration, or local area expenditures. Therefore, key socioeconomic indicators concerned with effects on regional employment and income data were not examined.

The military or contractor personnel who work at Wake Island, including the Thai nationals brought to the island, live in billets previously constructed on the island. These billets are military controlled. There are some family housing units on Wake Island, but these are also military controlled. There are no private homes, motel/hotels, or private retail businesses on the island.

The economy on the island is dominated by the military installation. Government employment is the only contributor to the island economy.

The permanent island population is small, consisting of approximately 206 people. This number includes Air Force members, National Oceanic and Atmospheric Administration weather observers, and the BOS contractor personnel. The BOS contractor figures include approximately 170 Thai nationals and about 30 U.S. citizens. A 10-percent reduction in the contractor workforce is anticipated in December 1993 (Andel, 1993). The number of USASSDC and contractor mission-essential personnel fluctuates in relation to the duration and scope of each mission. (U.S. Army Space and Strategic Defense Command, 1992b)

There are two transient billets equipped with window-unit air conditioners ready for immediate occupancy. These billets are usually used to house transient aircrews on Wake Island in support of Air Force missions and support agreements. Building 1115 has 34 bedrooms, and Building 1116 has 29 bedrooms. There are 95 bedrooms in contingency dorms (buildings 1128, 1173, and 1174) without air conditioning that can be prepared for occupancy on short notice. Buildings 1172, 1175, and 1176 have a total of 87 bedrooms but are currently leased to the Army. Buildings 1117, 1118, 1120, and 1177 currently house contractor personnel and have a total of 178 bedrooms. (U.S. Department of the Air Force, 1992)

2.12 WATER RESOURCES

The average annual precipitation on Wake Island is 89 cm (35 in) (National Oceanic and Atmospheric Administration, 1993). Due to the relatively small area of the island and the high permeability of the soil, all precipitation rapidly runs from the land into the ocean and lagoon or filters into the soil. Other than water collected in the catchment basins, there is virtually no fresh surface water on the island.

The island contains some fresh groundwater. Rainwater that filters into the soil is less dense than the underlying saline or brackish groundwater and generally remains segregated. However, this resource is limited by the subdued topography and limited areal extent of the island. The amount of fresh groundwater that may be available for potable water consumption has not been investigated. Several deep wells are used to provide brackish groundwater to the desalination plant.

3.0

**Environmental Consequences
and Mitigation Measures**

3.0 ENVIRONMENTAL CONSEQUENCES AND MITIGATION MEASURES

The introduction to this section of the EA describes the methodological approach employed in assessing the potential environmental consequences of the proposed activities. This approach assesses potential impacts by comparing proposed program activities with potentially affected environmental components. Section 3.1 provides a discussion of the potential environmental consequences for each proposed activity. The amount of detail presented in this section is proportional to the potential for impacts. Sections 3.2 through 3.11 provide discussions of the following with regard to proposed Wake Island activities: cumulative impacts of the proposed action, mitigation measures, environmental consequences of the no-action alternative; conflicts with Federal land use plans, policies, and controls; energy requirements and conservation potential; natural or depletable resource requirements and conservation potential; adverse environmental effects that cannot be avoided; the relationship between the short-term uses of man's environment and the maintenance and enhancement of long-term productivity; irreversible or irretrievable commitment of resources; and conditions normally requiring an EIS.

This section assesses the significance of potential environmental impacts of the proposed TMD activities at Wake Island. To assess the potential for and significance of environmental impacts from the proposed activities, a list of activities necessary to accomplish the proposed action was first developed (Section 1.0). Second, the environmental setting was described, with emphasis on any special environmental sensitivities (Section 2.0). Next, the program activities were compared with the potentially affected environmental components to determine which of the identified program activities have no potential for significant environmental consequences and which, if any, present a potential for significant impact.

Federal environmental laws and regulations were reviewed to assist in determining the significance of environmental impacts (if any) in fulfillment of NEPA requirements. Appendix B provides a description of the Federal laws and regulations for each relevant environmental component. Proposed activities were evaluated to determine their potential to cause significant environmental consequences using an approach based on the interpretation of significance outlined in the Council on Environmental Quality (CEQ) regulations for implementing the procedural provisions of the NEPA (40 CFR 1500-1508) and AR 200-2, *Environmental Effects of Army Actions* (U.S. Department of the Army, 1988).

The following sections address issues of concern for each resource potentially affected. Guidelines established by the CEQ (40 CFR 1508.27) specify that significance should be determined in relationship to both context and intensity (severity). The assessment of potential impacts and the determination of their significance are based on the requirements in 40 CFR 1508.27.

"Significantly," as used in the NEPA, requires consideration of both context and intensity:

- **Context** – This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.

- **Intensity** – This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity:
 - Impacts that may be both beneficial and adverse (A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.)
 - The degree to which the proposed action affects public health and safety
 - Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas
 - The degree to which the effects on the quality of the human environment are likely to be highly controversial
 - The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks
 - The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about future a consideration
 - Whether the action is related to other actions with individually insignificant but cumulatively significant impacts (Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.)
 - The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the NRHP or may cause loss or destruction of significant scientific, cultural, or historical resources

- The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973
- Whether the action threatens a violation of Federal, state, or local law or requirements imposed for the protection of the environment

Based on the previous criteria, three levels of impact can be defined:

- No Impact – No impact is predicted.
- Not a Significant Impact – An impact is predicted, but the impact does not meet the intensity/context significance criteria for the specific resource.
- Significant Impact – An impact is predicted that meets the intensity/context significance criteria for the specific resource.

Significant impacts may be reduced to a not-significant level through implementation of appropriate mitigation measures.

3.1 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

3.1.1 GROUND-BASED SYSTEMS

3.1.1.1 Facility Modification/Construction

The following sections discuss facility modification/construction activities on Wake Island. These include activities in support of TMD target and defensive missile systems. Meteorological rockets that may be used in support of either missile system would not require any additional facilities and are not discussed in this section.

3.1.1.1.1 Theater Missile Defense Target Missile Systems

Air Quality

The hardening and interior modification of the Launch Support Building and dormitory are activities that would essentially have no potential for air emissions and thus no potential to impact air quality. However, the proposed construction activities at launch pads 1 and 2 and the Peale Island radar site, including trenching for the utility, communication, and fiber optic cables, the new incinerator pad, a new MSB and MAB, and repair of the bridge to Peale Island detailed in Section 1.3.1 would cause measurable emissions to the air environment.

Construction activities would create air pollutants in two ways. First there would be emissions from construction equipment and vehicles. Emissions from these would include CO, NO₂, SO₂, PM-10, and hydrocarbons (which are O₃ precursors) (U.S. Environmental Protection Agency, 1985b).

Construction would cause emissions of particulate matter due to soil disturbance. Earth moving, grading, and contouring have the potential to generate fugitive dust that may impact air quality. The amounts of fugitive dust would depend on several factors, including the extent of area graded as well as the soil silt and moisture content. Fugitive dust amounts would vary daily with changes in the level of preconstruction and construction activity and weather conditions. However, the impact of fugitive dust emissions is limited because the emissions are mostly large particles that settle a short distance from their source. The standard emission rate is 1.1 metric tons (1.2 tons) per 0.4 ha (1 ac) of construction per month of activity (U.S. Environmental Protection Agency, 1985a). Due to the larger-than-average diameter of the soil particles at Wake Island, emission levels would likely be less than the standard rate.

Because of the good air quality at Wake Island, as described in Section 2.1, the minor and short-term emissions caused by construction would not be expected to cause significant impact to the local air quality.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Airspace

The modification of existing facilities and construction of new facilities would have no impact on airspace use and, thus, no potential for significant impacts.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Biological Resources

The hardening and interior modification of the Launch Support Building and dormitory are activities that would occur within an existing structure and thus have no potential for biological resource impacts. However, the proposed construction activities at launch pads 1 and 2 and the Peale Island radar site, including trenching for the utility, communication, and fiber optic cables, the new incinerator pad, a new MSB and MAB, and strengthening of the bridge to Peale Island, detailed in Section 1.3.1, would have the potential to impact biological resources since some ground disturbance would be necessary.

The flora of Wake Atoll can generally be characterized as highly disturbed. Of some 71 plant species recorded in the most recent surveys (Appendix E), approximately 56 species, or 79 percent, are non-native, introduced plants. No proposed or listed threatened or endangered plant species as set forth by the U.S. Fish and Wildlife Service (Endangered Species Act of 1973 [16 U.S.C. 1531-1543, as amended]) were observed. The areas of greatest disturbance occur on Wake Island proper, with somewhat less disturbance

observed on Peale and Wilkes islands. The degree of disturbance is escalating as new weed species continue to be inadvertently introduced to the atoll via arriving aircraft or cargo (Appendix F).

Since proposed project actions will take place primarily on the main island, it is not judged that significant impacts to botanical resources will occur as a result of project implementation. However, it is recommended that precautions be taken to preserve the little remaining native vegetation on the atoll, which may have intrinsic value as a botanical resource or as potential nesting or feeding habitat for protected migratory seabirds. The *Pisonia/Cordia* forest remnants (in some cases represented by no more than a few isolated *Pisonia* trees), *Pemphis/Sesuvium* marsh areas, and isolated populations of new or previously undescribed plant species (Appendix F, Section 4.2), represent vegetational features which merit such protection.

Potential impacts of each of the separate construction sites are discussed as follows.

Launch Pad 1 – As determined during the most recent surveys (Appendix F) the area around this launch site has been cleared and scraped. With the exception of a small remnant of a *Pisonia/Cordia* vegetation assemblage, few of the plants in this area are native to the atoll. Assuming that necessary care is taken to avoid damage to the remaining *Pisonia* tree observed at the periphery of the site, according to mitigation measures recommended herein, it is anticipated that project implementation on this site will have a not-significant impact on flora.

No fauna other than occasional feral cats would be expected to occur on the site. Therefore, no significant impacts to fauna are expected to occur on this site as a result of proposed project actions.

During the recent surveys (Appendix E), no migratory birds were observed nesting or in courtship display in the Peacock Point area. While migratory bird species may occasionally pass through the area, they do not appear to utilize it for courtship or nesting. No significant impacts to migratory birds are expected to occur at Launch Pad 1 as a result of proposed project actions.

Finally, no threatened or endangered plant or terrestrial animal species are known to occur on this site; thus, no impacts to such resources would occur here.

Fiber Optic Cable Trenches – Laying fiber optic cables from Launch Pad 1 to the ocean for connection to the USAKA would necessitate trenching to the island's edge and blasting the coral reef area. The trenching would be over an area of coral rubble devoid of vegetation. Significant impacts to marine life and especially sea turtles in the vicinity could result from blasting.

Launch Pad 2 – The area around this launch site has been cleared. The most recent surveys (Appendix F) revealed that many of the plants occurring on site are weed species not native to the atoll. For this reason, and because of the nature of the actions being proposed, it is anticipated that project actions on this site will have a not-significant impact on flora.

No fauna other than occasional feral cats would be expected to occur on the site. Therefore, no impacts to fauna are expected to occur on this site as a result of proposed project actions.

During the recent surveys (Appendix E), no migratory birds were observed nesting or in courtship display in the Peacock Point area. While migratory bird species may occasionally pass through the area, they do not appear to utilize it for courtship or nesting. Impact to migratory birds at Launch Pad 2 as a result of proposed project actions is expected to be not significant.

Finally, no threatened or endangered plant or animal species are known to occur on this site; thus, no impacts to such resources would occur here.

New Missile Assembly Building and Utility Trench – The proposed new MAB site lies near the tip of Peacock Point in an area of fairly dense mixed scrub consisting largely of tree heliotrope and kou. The proposed path for the utility trench running between the new MAB and Launch Pad 1 runs along an existing road which cuts through areas of heavy scrub. The sides of the road are dominated by non-native ruderal species. Construction of a small connector road joining the new MAB to the landfill road will result in the removal of all vegetation in the footprint of the proposed road corridor. The clearing of the site for the new MAB will result in permanent removal of plants occurring on the site. However, no plant communities of high value as habitat or a natural resource will be affected. Feral cats are the only animals known to occur in this area. No threatened or endangered species are associated with this site. For these reasons, impacts resulting from implementation of construction activities associated with the new MAB site would be not significant on flora, fauna, migratory birds, or threatened or endangered species.

New Missile Storage Building and Utility Trench – The proposed site for construction of the new MSB lies in an area of heavy disturbance. Scattered around the area (which has historically been used for dumping), large and small pieces of discarded equipment, motor vehicles, etc., are found in varying abundance. The scrub vegetation is dominated by introduced species. A utility trench is proposed to run from the site of the new MSB following along the road south of the runway to the area of Building 1601. Here also the plant community is composed almost entirely of non-native species. Any clearing associated with the implementation of construction would result in removal of the plants on the site; however, as these are of low value, impacts resulting from implementation of project actions at this site would be not significant on vegetation.

Permanent Radar Site and Utility Trench – Construction at the proposed permanent radar site on Peale Island would include refurbishment of Building 1203, a concrete pad in a highly disturbed area adjacent to the building, and a trench of utility and communication lines from these sites to the billeting area along the existing unpaved road.

The proposed radar site at the abandoned U.S. Coast Guard facility on Peale Island lies in an area of substantial ground disturbance characterized by open fields on the south and west and a scant cover of tree heliotrope with a sparse ground cover of mixed bunch grass to the north. The proposed path for utility lines along the road shoulder is unvegetated although care should be taken to avoid the Puka trees located near the bridge. Little, if

any, vegetation would need to be removed for the project, and the plant community is not of high value as nesting habitat. The area also contains non-native Panini and Sisal, the removal of which would be beneficial. Feral cats are the only animals observed in this area during the survey; however a recently abandoned sooty tern colony was located between the road and Flipper Point, and five pairs of red-tailed tropicbirds were observed nesting north of the road. No threatened or endangered species are associated with the site. For these reasons, impacts resulting from construction activities would be not significant on flora or fauna. To the extent possible, construction should be planned to not occur during the seabird nesting season.

Bridge Repair – Strengthening of the bridge between Wake and Peale islands will necessitate some disturbance of the shallow channel connecting the lagoon and fringing reef. The only protected species known to use this channel is the sea turtle.

Indirect Impacts to Biological Resources – The additional personnel on Wake Island as a result of TMD activities have the potential to impact biological resources due to their presence, increased traffic, noise, and recreational activities while on the island. Although judged to be not significant, the presence of additional personnel has the potential to impact the island's flora and fauna in the following ways.

Indirect impacts on birds may result from increased human presence on the island. Human intrusion into seabird colonies could result in abandonment of the colony because of repeated or prolonged disturbance. Also, nests that are exposed when birds are flushed may be susceptible to predation by frigatebirds. Without restrictions, an increased population of humans (and accompanying increases of air and sea traffic to the island) could result in an increase of stray dogs, cats, and rats, as well as other non-native pests that may be inadvertently transported to the island. For example, the inadvertent introduction of the brown tree snake (*Boiga irregularis*) from Guam to Wake Island is a very real threat, the risk of which is likely to increase in direct proportion to the number of cargo shipments to the island, especially if unregulated or unmonitored.

Similarly, plant seeds inadvertently carried on incoming aircraft or cargo have already altered the botanical composition of the atoll. Without proper safeguards, an increased frequency of arriving aircraft associated with increased construction could exacerbate this condition.

Since program personnel would not be allowed to bring domestic cats or other pets onto the island, TMD-related personnel would not, in any way, contribute to or exacerbate the ongoing feral cat predation on the migratory bird colonies on Peale and Wilkes islands. Thus, the potential for cumulative impacts in this particular regard does not exist.

Mitigation Measures – To avoid potential impacts to nesting birds, it is recommended that, to the extent feasible, construction activities be confined to the period between August and January, as birds are least likely to be nesting during these months. Prior to any construction, a survey will be conducted one to two weeks prior to the start of construction by a trained field ornithologist to locate all seabird nests in the area. All nests will be clearly marked and not disturbed. If a nest interferes with construction plans, the plans will be altered, when feasible, to avoid the nesting area. The U.S. Fish and Wildlife

Service will be contacted to request a permit for a limited taking of a protected migratory bird species if avoidance of a nest is not possible. No construction will take place within 6 m (20 ft) of such a nest until a permit has been issued.

The potential for significant impact to sea turtles can be avoided by sending a diver into the water to ensure that the waters immediately off the reef are clear of turtles before blasting takes place. The National Marine Fisheries Service will be contacted prior to any off-shore blasting.

To avoid any impact to sea turtles, bridge modifications will be designed such that sea turtles will not be trapped or ensnared by subsurface supports. These mitigation measures would reduce the impact to a not significant level.

Cultural Resources

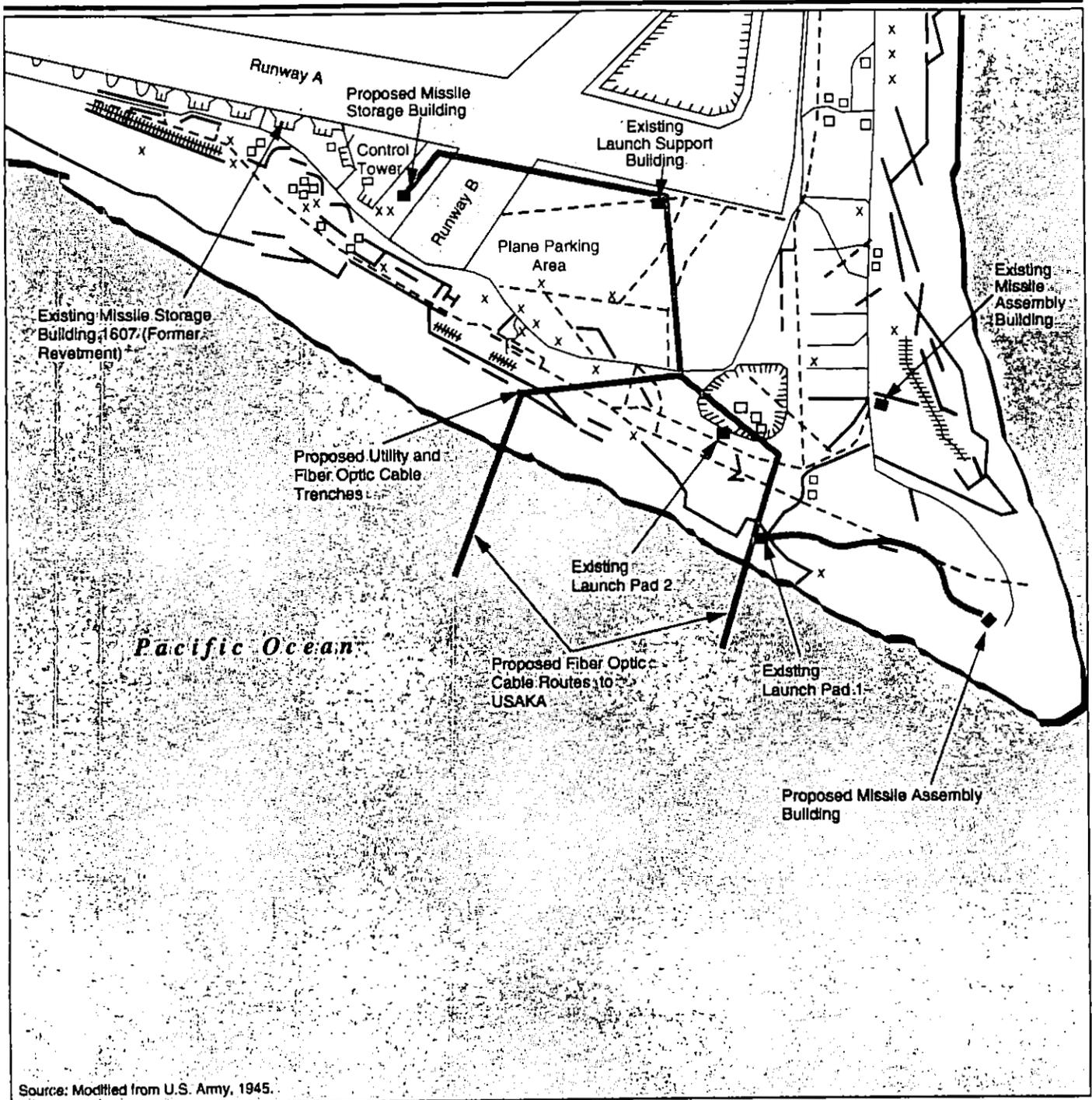
At the end of World War II there were extensive earthworks and many Japanese and American structures remaining on Wake Atoll (figures 3-1 and 3-2). Many of these features are no longer visible as a result of construction on the island and the destructive forces of nature. However, there is potential for evidence of these cultural resources to be present below the current ground surface. Therefore, there is potential for significant impact to unrecorded subsurface cultural resources to occur as a result of ground-disturbing activities associated with construction of the launch facilities and installation of the range support equipment, fiber optics cables, and requisite power and communication lines.

New construction in the proposed action area will not significantly impact the historic viewshed, thus altering the historic character of the site. This is because the island has previously been disturbed and altered by post-World War II activities to the extent that the historic character of the atoll has already diminished. The remoteness and military mission of the island also do not encourage historic interpretation of the World War II battle.

The hardening and interior modification of the Launch Support Building and dormitory are activities that would occur within an existing structure and thus would have no impact on for cultural resources. The proposed action is not expected to adversely affect the locations where heroic deeds were performed. However, the proposed construction activities at launch pads 1 and 2, including trenching for the utility, communications, and fiber optic cables, the new incinerator pad, and a new MSB and MAB have the potential for significantly impacting cultural resources since some ground disturbance would be necessary. These potential impacts are discussed as follows.

Launch Pad 1 – Located on Peacock Point, the approximately 0.04 ha (0.1 ac) of land has been previously disturbed, and the potential to impact cultural resources is expected to be not significant.

Launch Pad 2 – Located on Peacock Point, the approximately 0.1 ha (0.3 ac) of land disturbance would have no impact on recorded cultural resources. Trenches to Building 1601 for utility and communication lines would disturb approximately 0.04 ha (0.1 ac) and are expected to have a not-significant impact on recorded cultural resources.



Source: Modified from U.S. Army, 1945.

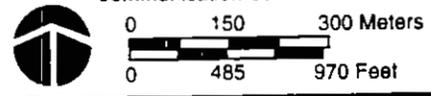
EXPLANATION

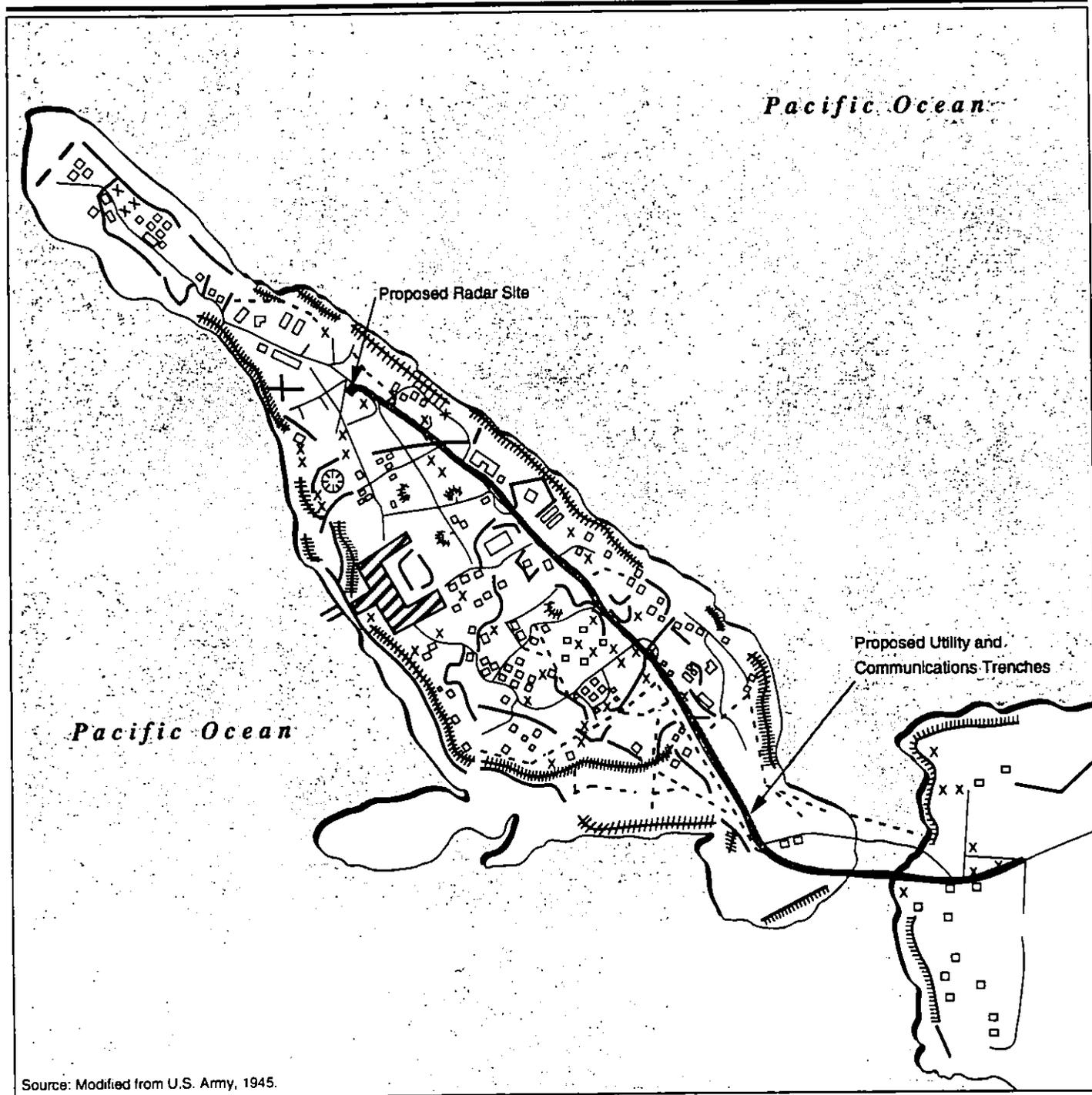
- Historic Buildings
- Embankment
- Roads
- Anti-tank Trench
- Pipeline (Oil)
- Seaplane Base
- Proposed Trenches for Utility and Communication Cables
- Excavation
- Earth Covered Structure
- Recent Structures

Proposed Actions and World War II Cultural Resources at Peacock Point (as Recorded in 1945)

Wake Island

Figure 3-1





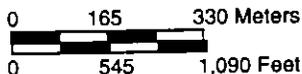
EXPLANATION

- | | | | |
|-------|--|---|-------------------------|
| | Embankment | ⊗ | Excavation |
| — | Roads | X | Earth Covered Structure |
| — | Anti-tank Trench | ■ | Recent Structures |
| - - - | Pipeline (Oil) | □ | Historic Buildings |
| ▨ | Seaplane Base | | |
| — | Proposed Trenches for Utility and Communication Cables | | |

Proposed Actions and World War II Cultural Resources on Peale Island (as Recorded in 1945)

Wake Island

Figure 3-2



Incinerator Pad – Construction activities on approximately 0.04 ha (0.1 ac) of previously disturbed land are expected to have a not-significant impact on recorded cultural resources.

Missile Assembly Building – Construction of a new MAB would disturb approximately 0.04 ha (0.1 ac) and is expected to have a not-significant impact on recorded cultural resources.

Missile Storage Building – Construction of a new MSB would disturb approximately 0.04 ha (0.1 ac) and is expected to have a not-significant impact on recorded cultural resources.

Fiber Optic Cable Trenches – Laying fiber optic cables from Launch Pad 1 to the ocean for connection to the USAKA would necessitate trenching to the island's edge and blasting of the coral reef area. Trenching would disturb 0.04 ha (0.1 ac) and is expected to have a not-significant impact on recorded cultural resources.

Peale Island Radar – Installation of utility and communications lines to the proposed radar location on Peale Island would disturb approximately 0.04 ha (0.1 ac) and is expected to have a not-significant impact on recorded cultural resources (figure 1-3).

Indirect Impacts to Cultural Resources – The presence of additional *personnel on Wake Island* as a result of TMD activities has the potential to impact cultural resources because of their *recreational activities* and incidental collecting of archaeological and historical resources while on the island.

Mitigation Measures – An archaeologist professionally qualified in accordance with the Secretary of the Interior's Professional Qualifications Standards (48 Federal Regulation 44738-9) and Appendix C, AR 420-40, will conduct a *preconstruction survey* of those areas proposed for ground-disturbing activities to determine the presence of cultural resources. This archaeologist will also be on site to monitor ground-disturbing activities during construction and installation of proposed facilities and cables. Special attention will be given to investigations near the locations of activities required for construction of the new MAB, MSB, and at Launch Pad 2 and the Launch Support Building for the purposes of determining the presence of evidence of the four previously noted deeds of heroism.

Prior to these activities, the archaeologist, who has proven familiarity with the archaeological resources of the region, will develop appropriate plans including investigative strategies and methodologies for each in coordination with the Historic Preservation Officer of Hickam Air Force Base and the ACHP. This plan will include procedures for dealing with the discovery of human remains.

The installation of the utility and communications lines and fiber optics cable from Launch Pad 1 to the Launch Support Building and to the proposed MAB will cross areas in which Japanese anti-tank trenches were constructed. The preconstruction survey will include an examination of trench routes to determine if previous disturbances have occurred or if

integrity remains intact. Those trench routes that have not been significantly disturbed by previous actions would be restored subsequent to the proposed installation activities.

The installation of utility and communications lines from the billeting area on Wake Island to the proposed radar site on Peale Island will cross areas in which Japanese anti-tank trenches were constructed. The preconstruction survey will include an examination of trench routes to determine if previous disturbances have occurred or if integrity remains intact. Those trench routes that have not been significantly disturbed by previous actions would be restored subsequent to the proposed installation activities.

Trenching for these fiber optics cables, utility and communications lines would be performed with equipment which will minimize damage to material removed from the ground so the archaeologist will be able to determine the presence of cultural resources if evidence is encountered.

In the event of the discovery of human remains, nationality will be determined, the appropriate authorities notified, and removal of the remains for reburial will be undertaken by their agents before construction activities are resumed. TMD-related personnel would be cautioned not to disturb the known existing historic structures and resources. Other mitigation measures may be employed in accordance with the final Historic Preservation Plan currently being developed by the U.S. Air Force for Wake Island.

Implementation of described mitigation measures will reduce the potential for significant cultural resource impacts to a not-significant level.

Hazardous Materials/Waste

The hardening and interior modification of the Launch Support Building and dormitory are activities that would have no hazardous materials/waste impacts since no hazardous materials usage associated with TMD target missile systems renovation/modification activities has been identified. However, although hazardous materials usage would not be expected as a result of proposed launch facility modification activities, modification of facility structures may involve the removal of small quantities of asbestos-containing material (ACM). Electrical systems upgrades may involve removal and disposal of equipment containing polychlorinated biphenyls (PCBs). These waste materials will require proper packaging and labeling in accordance with Resource Conservation and Recovery Act (RCRA) requirements (for PCBs) and requirements set forth in 40 CFR 763 Subpart G (for ACM). In each case, requirements must be met concerning packaging of the waste materials, labeling of the packages, and shipment of the waste for final disposal.

For PCBs, which are a RCRA hazardous waste, regulations specify that once equipment has been classified as waste, on-site storage cannot exceed 90 days, except at permitted facilities with a RCRA Part B Permit.

Asbestos is not classified as a RCRA hazardous waste; therefore, there are no limits concerning on-site storage. Packaging for disposal of ACM must be accomplished by "double-bagging" ACM waste and labeling each package as containing asbestos waste. Disposal can be accomplished in a sanitary landfill (Class 1 landfill), and the waste is not

classified as hazardous. In the past such disposal occurred on Wake Island; however, all such waste is now disposed of through the 15th Air Base Wing.

Handling of both of these waste types is not routinely accomplished at Wake Island; however, these materials are routinely handled at most Air Force installations. The quantities of waste generated during modification activities will be small. Proper handling, accumulation, storage, and disposal would be the responsibility of the TMD program. Where possible, the Wake Island hazardous waste management system would be used to accomplish waste storage and disposal activities, or the generator could accomplish these activities directly. In either case, applicable RCRA and other waste management regulations would be observed. Due to the small quantities of hazardous waste produced during facility construction and refurbishment activities, the impact of waste management activities will present a not-significant impact.

The proposed construction activities detailed in Section 1.3.1 would have no impact since hazardous materials associated with construction activities would be disposed of according to the RCRA and 40 CFR 763 requirements.

Mitigation Measures – The disposal of any waste materials will be in accordance with the established waste management practices, and the dumping of any hazardous material will be strictly prohibited; therefore, no impacts are expected.

Health and Safety

The hardening and interior modification of the Launch Support Building and dormitory are activities that would have no impact on the health and safety of the residents of Wake Island. Similarly, the proposed construction activities detailed in Section 1.3.1 would have no impact on the health and safety the residents of Wake Island.

Building renovation/modification and new facility construction have the potential for construction-related accidents and injuries to the construction personnel themselves. Construction activities may involve the use of heavy equipment, work on elevated platforms, electrical safety hazards, and other hazards associated with general construction. Consequently, all work would be performed in accordance with 29 CFR 1926, Construction Safety, as well as appropriate Army and Air Force safety regulations. The U.S. Air Force host command also requires that an Explosive Ordnance Disposal person be on site during any ground-disturbing activities due to the potential to uncover buried World War II ordnance. These regulations and standard operating procedures are promulgated to provide a work environment which is as safe as possible and would be employed throughout the construction phase of the TMD program.

Construction activities such as those proposed are considered to be routine renovation/construction operations, and the safety hazards associated with these operations are not considered to be not significant. Additionally, all work on Federal installations would be performed under the oversight of a qualified monitor who is empowered to stop operations in the event of unsafe working conditions. Consequently, the physical hazards associated with renovation/construction activities are considered to be not significant.

Mitigation Measures – There is no potential for significant impact, and no mitigation measures would be required.

Infrastructure and Transportation

The hardening and interior modification of the Launch Support Building and dormitory are activities that would have no or minimal potential for direct adverse impacts to infrastructure. Similarly, the proposed construction activities at launch pads 1 and 2 and the Peale Island radar site, including trenching for the utility, communications, and fiber optic cables, the new incinerator pad, a new MSB and MAB, and strengthening of the bridge to Peale Island, detailed in Section 1.3.1, would have no or minimal potential for adverse direct impacts to infrastructure. Table 3-1 shows the effects on the island infrastructure.

Both the renovation/modification and construction activities would draw on the island's power supply and generate some solid waste. However, both the power plant and Wake Island's landfill/burning pit are capable of handling any modification/construction-related requirements. Consequently, the direct impacts to infrastructure are considered to be not significant.

Construction personnel would generate indirect impacts to the island's infrastructure. However, personnel-related infrastructure demands would be constrained by the island's capacity to house program participants. Wake Island has a total of 490 beds in transient billets (U.S. Army Space and Strategic Defense Command, 1992b) and, thus, the ability to readily accommodate the maximum of 40 construction personnel to support infrastructure requirements. The actual number of personnel on Wake Island fluctuates depending on particular activities on the island, but scheduling would prevent the island's accommodations and infrastructure from being overtaxed. Program-related personnel would not be allowed on the island unless sufficient billets were available. Thus, while program personnel would impose their own fire protection, health, safety, power, solid waste, wastewater, and water demands, the island's infrastructure, capable of supporting 490 transients at any one time, would not be overburdened; thus, the impact to infrastructure would be not significant.

Wake Island's transportation infrastructure would similarly not be overburdened by the renovation/construction program or its transient personnel. The number of flights to and from the island from Hickam AFB may need to be increased, but the island has aircraft ramps for processing passengers and cargo and for refueling up to 36 aircraft in a mix of DC-8, C-130, C-141, and C-5 aircraft; therefore, no significant impacts to the air transportation infrastructure are anticipated. Road transportation on the island is provided by U.S. Air Force or contractor vehicles, and the island could readily accommodate additional traffic over the two buses that currently transport aircrews and passengers between the Base Operations Building and the Dining Hall/Billeting Office (U.S. Department of the Air Force, 1992). The island is currently supplied by sea-going barges and ships, and no marine transportation impacts are anticipated as a result of the renovation/construction program.

Table 3-1: Area Affected by Theater Missile Defense-Related Programs

TMD launch-related facility requirements	Land area required in ha (ac)	Vegetation clearing required in ha (ac)
MSB	0.04 (0.1)	0.04 (0.1)
MAB	0.04 (0.1)	0.04 (0.1)
Launch Support Building	none	none
Dormitory	none	none
Launch facilities		
Pad 1	0.04 (0.1)	none
Pad 2	0.1 (0.3)	0.1 (0.3)
Range support equipment (mobile)	0.1 (0.3) to 0.8 (2.0)	none
Range support equipment (permanent)	0.04 (0.1)	0.04 (0.1)
Incinerator	0.04 (0.1)	none
Fiber optic cable trenches	0.04 (0.1)	0.04 (0.1)
Bridge refurbishment	none	none

Mitigation Measures – There is no potential for significant impact, and no mitigation measures would be required.

Land Use

The hardening and interior modification of the Launch Support Building and dormitory are activities that would have no impact on current or planned land use since they involve only changes or modifications to a facility or structure already in place. Similarly, the proposed construction activities at launch pads 1 and 2 and the Peale Island radar site, including trenching for the utility, communications, and fiber optic cables, the new incinerator pad, a new MSB and MAB, and strengthening of the bridge to Peale Island, detailed in Section 1.3.1, would have no impact on current land use or land use plans, policies, and controls since they are all proposed for areas of the island that already are designated for these kinds of land uses. The IRP Category 2 site (the landfill near Peacock Point) would not be affected by construction. Therefore, no significant impacts to land use are anticipated.

Mitigation Measures – There would be no impact on land use, and no mitigation measures would be required.

Noise

The hardening and interior modification of the Launch Support Building and dormitory are activities that would essentially have no or minimal and short-lived impacts on the noise environment. The proposed construction activities at launch pads 1 and 2 and the Peale Island radar site, including trenching for the utility, communications, and fiber optic cables, the new incinerator pad, a new MSB and MAB, and strengthening of the bridge to Peale Island, detailed in Section 1.3.1, would have noise environment impacts outlined as follows.

Renovation/construction noise would come from the sounds produced by construction vehicles and equipment. Excluding impact equipment, such as jackhammers, rock drills, and pile drivers, the sound level at 15 m (50 ft) from construction equipment ranges from the equivalent sound level (L_{eq}) of 70 A-weighted decibels (dBA) to 90 dBA (U.S. Environmental Protection Agency, 1971). Typically, the sound level at 15 m (50 ft) from a construction site does not exceed $L_{eq} = 90$ dBA (Canter, 1977; Golden et al., 1979). Construction noise follows the inverse square law (Canter, 1977), which means there is a 6-decibel decrease in the sound level for each doubling in distance. Using this, along with an assumed maximum sound level of $L_{eq} = 90$ dBA at 15 m (50 ft), the following noise levels would be expected around a construction site: 75 dBA at approximately 76 m (250 ft); 70 dBA at approximately 136 m (446 ft); 65 dBA at approximately 241 m (792 ft); 60 dBA at approximately 430 m (1,409 ft); and 55 dBA at approximately 764 m (2,506 ft) from the edge of the construction site.

Since a sound level of less than day-night average sound level (DNL) = 65 dBA is generally considered acceptable, a significant impact from construction noise would occur only if a residence is located within 241 m (792 ft) of the edge of one of the construction areas. If impact equipment is used extensively during the construction, the noise levels would be greater, and if construction sound levels greater than the ambient noise level occur any time between 10:00 p.m. and 7:00 a.m., then the 10 dBA penalty added for the DNL measure would cause significant impact for residences up to distances of 76 m (250 ft). However, all residential areas on Wake Island are much further removed from the proposed construction sites; consequently, the impact from noise would be not significant.

Blasting of the reef area to lay fiber optic cables off shore is of greater concern. An explosive blast produces several effects: airblast, ground vibrations, and fly rock. Airblasts are the air pressure waves generated by explosions. The higher-frequency portion of the pressure wave is audible and is the sound that accompanies a blast; the lower-frequency portion is not audible but excites structures and in turn can cause a secondary and audible rattle within structures.

The noise made by blasting falls into the category of impulsive or impact noise. The term impulse (or impulsive or impact) noise generally means a discrete noise of short duration (less than a second) in which sound pressure rises very rapidly (less than 500 milliseconds) to a high peak level before decaying below the level of background noise (Environmental Protection Agency, 1974). A typical impulse noise is a sonic boom.

For impulsive or impact noise the Occupational Safety and Health Administration (OSHA) requirement is that exposure should not exceed 140 dB peak sound pressure level. Similarly, the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that no exposure in excess of 140 dB peak sound pressure level be permitted, and at this level there be no more than 100 impulses or impacts per day (American Conference of Governmental Industrial Hygienists, 1992). It should be noted that these limits were developed for work situations and are set so that workers will suffer no significant levels of permanent hearing loss.

Impulse noise, especially when unexpected, can startle, awaken, and generally annoy people. Little or no public annoyance is expected to result from one sonic boom during

daytime hours if the noise level experienced is below 35.91 Pascals, approximately 125 dB (U.S. Environmental Protection Agency, 1974). For more than one impulse noise per day, the same low probability of annoyance is expected to occur if the peak level for each noise is no more than:

$$\text{Peak Level} = \frac{35.91}{\sqrt{N}} \text{ Pa}$$

where N is the number of noises and Pa is Pascals.

The airblast caused by explosions can cause damage to the structural elements of buildings. At the relatively low overpressures of airblasts from commercial demolition, the only structural elements that may be damaged are windows. Whether or not a window is broken by an airblast depends on such factors as the peak overpressure, the area of the glass, the orientation of the window with respect to the explosion, the thickness and strength of the glass, the method of mounting the pane in the window, the presence of pre-existing stress, and the condition of the surface of the glass (Redpath, 1976). Dowding (1985) gives the probability of breakage for a single large pane (6 m² [64 ft²]) as 0.01 percent (1 in 10,000) at 130 dB and for a single small pane (0.3 m² [3.5 ft²]) as 0.01 percent at 141dB. In a sonic boom experiment a pane of glass (90 cm by 90 cm by 3 mm [3 ft by 3 ft by 1/8 in]) did not crack from sonic booms until 145 dB. Practically speaking, no significant impact from cracking of windows is expected for sound levels below 150 dB.

It is estimated that several hundred kilograms of C-4 explosive may be required for the blasting of the reef area. This amount of explosive will be used incrementally in several rounds. Furthermore, it is normal blasting procedure that the total amount of explosive in each round be separated into two or more smaller parcels. To reduce airblast and ground vibrations, these parcels are detonated with a few microsecond delays between them (Dowding, 1985). Since a standard package size of C-4 explosive is 18 kg (40 lb), all analysis in this section is based on a maximum of 18 kg (40 lb) of C-4 per delay.

In finding the relationship between weight of explosive and distance at which a given sound level occurs, the following relationship is used:

$$\frac{R}{W^{\frac{1}{3}}} = \text{dbc}$$

where R is the distance from the explosion, W is the weight per delay of trinitrotoluene (TNT) to which the amount of explosive used is equivalent, and dbc is a function of the sound level desired and is obtained from standard tables or graphs (Dowding, 1985; Kinney and Graham, 1985; Stull, 1977). This relationship assumes there are no sound barriers between the explosion and the noise receptor.

With regard to brisance (peak pressure), each pound of C-4 is equivalent to 1.16 pounds of TNT. For a sound level of 134 dB, $dbc = 1,200 \text{ ft/lb}^{1/3}$. Therefore, for an explosive blast of 18 kg (40 lb) of C-4 the sound level of 134 dB would occur at a distance of approximately 1,300 m (4,300 ft). For the OSHA requirement sound level of 140 dBA, $dbc = 600 \text{ ft/lb}^{1/3}$, and this sound level would occur at 655 m (2,150 ft). For the EPA guideline sound level of 125 dB, $dbc = 3,374 \text{ ft/lb}^{1/3}$, and this sound level would occur at approximately 3,700 m (12,000 ft).

Blasting will be carried out following procedures similar to those given for surface mining or other good operating procedures (Dowding, 1985; Foster, 1977). This will ensure that the island's residents are well informed about the blasting, are forewarned as to when the blasts will occur, and will stay reasonably far away from the blasting site.

No residences are located within 655 m (2,150 ft) of the blasting site. Given a well-informed island population, no individuals on the island are expected to incur hearing loss due to the noise of the blasts. Furthermore, the probability that any glass windows will be cracked is very low.

Mitigation Measures – Blasting can cause debris, called fly rock, to be thrown thousands of feet. This problem can be mitigated to a not-significant level by clearing nonessential personnel from the surrounding area, using blast mats, or using some combination of these two measures.

Furthermore, at times the ocean water may cover the blasting sites, and the overlying water would serve to attenuate both the loudness of the air blast and the amount of fly rock.

In general, to reduce both the loudness of the airblast and the intensity of the ground vibrations, the total quantity of explosive used can be divided into smaller and smaller amounts (Dowding, 1985). The difficulties associated with this basic strategy are that the additional activities required (e.g., drilling more holes) increase the time for the work, the cost of the work, and the likelihood of an accident.

A number of mitigating measures for construction noise are outlined by the EPA (U.S. Environmental Protection Agency, 1971). These include applying quieting technology to the construction equipment and vehicles (especially the noisier ones), keeping the noisier equipment away from the construction site boundaries, replacement of individual operations and techniques by less noisy ones (e.g., welding instead of riveting), selecting the quietest of alternative items of equipment (e.g., electric instead of diesel-powered equipment), and providing enclosures for stationary items of equipment and barriers around particularly noisy areas on the site. The most important mitigation measure is to avoid performing noisy operations between 10:00 p.m. and 7:00 a.m.

Physical Resources

The hardening and interior modification of the Launch Support Building and dormitory are activities that would have a not-significant impact on the island's geology or soil resources. The proposed construction activities detailed in Section 1.3.1 may increase soil

erosion at sites where vegetation is cleared for construction, infrastructure is excavated and replaced, or new trenches are dug to lay utility, communications, and fiber optic cables. However, topography at the proposed construction sites is essentially flat with little relief to encourage runoff, and nearly all island soils are coarse grained and porous; thus, any impacts would be not significant.

Mitigation Measures – There is no potential for significant impact, and no mitigation measures would be required.

Socioeconomics

As a result of Wake Island's mission, socioeconomic issues are essentially confined to the availability of housing. Demographic, employment, income, and fiscal impacts are not factors here. All of the renovation/construction activities detailed in Section 1.3.1 would employ approximately 40 unaccompanied transient construction workers over an 8-month period. These transient personnel would be housed in existing USASSDC-controlled billets, in which up to 170 beds are available, with additional beds available in U.S. Air Force-controlled billets (Johnson, 1993). Consequently, no socioeconomic impacts would result.

Mitigation Measures – There is no potential for impact, and no mitigation measures would be required.

Water Resources

The hardening and interior modification of the Launch Support Building and dormitory are activities that would have no impact on surface water and groundwater. Similarly, the proposed construction activities at launch pads 1 and 2 and the Peale Island radar site, including trenching for the utility, communications, and fiber optic cables, the incinerator pad, a new MSB and MAB, and repair of the bridge to Peale Island, detailed in Section 1.3.1, would have no impact on the surface water catchment basins. The increase in water use to support construction personnel would be minimal. Consequently, there would be no potential for significant impacts to water resources.

Mitigation Measures – There is no potential impact, and no mitigation measures would be required.

3.1.1.1.2 Theater Missile Defense Defensive Missile Systems

Apart from the minor modifications to the MAB (1644), the Launch Control Building (1601), and the repair of the Peale Island bridge, TMD defensive missile system activities would not require the modification of any existing facilities or structures nor the construction of new ones; consequently, no impacts to air quality, airspace use, biological or cultural resources, hazardous materials/waste, health and safety, infrastructure and transportation, land use, noise, physical resources, socioeconomics, or water resources would result from ground activities associated with this system. The minor interior modifications required to buildings 1644 and 1601 would be similar to those described for building refurbishment in Section 3.1.1.1.1. Repair of the Peale Island bridge could pose a

significant impact to sea turtles but would be reduced to a not-significant level by the mitigation measures described in Section 3.1.1.1.1 under Biological Resources.

3.1.1.2 Facility Operation and Flight Testing

The following sections discuss facility operation and flight testing activities on Wake Island. This includes activities in support of TMD target missile systems and TMD defensive missile systems. Meteorological rockets that may be used in support of either system would have no impact or less potential for a significant impact for all areas of environmental consideration evaluated than either target or defensive missile launches. Therefore, they are not addressed further in this section.

3.1.1.2.1 Theater Missile Defense Target Missile Systems

Air Quality

Operation of additional equipment in the refurbished and newly constructed facilities and the electricity demands associated with the additional personnel on the island would most likely necessitate operation of an additional generator in the island's power plant for the duration of TMD program activities on the island. This would bring the number of generators in use from three to four during periods of high activity.

Table 3-2 contains representative emission rates for oil-fired electric utility power plants based on fuel usage. These rates can be used to quantify emission rates in combination with typical monthly fuel usage for the generators at Wake Island.

Launch operations constitute the largest source of uncontrolled emissions into the atmosphere. 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).

TMD launch activities at Wake Island may include the launch of both target and defensive missiles. Potential target booster motors are given in table 1-2. The combustion products for the SR19-AJ-1, M56A-1, and M57A-1 rocket motors are given in table 3-3; the combustion products for the Castor IV and Castor IVB rocket motors are given in table 2-3.

Air quality analysis has been conducted for two representative target missile configurations: the SR19-AJ-1 first stage with M57A-1 second stage and the Castor IVB first stage with M57A-1 second stage. Details of this analysis are given in Appendix D.

The major emission products from rocket motors are CO, Al₂O₃, and HCl. CO is a criteria pollutant and will be compared to the NAAQS (table 2-1).

Table 3-2: Emission Estimates for Oil-Fired Electric Power Plants

Pollutant	Emission Rate
	kilograms of pollutant/thousand liters of oil (pounds of pollutant/thousand gallons of oil)
Nitrogen oxides	8.13 (67.8)
Hydrocarbons	0.668 (5.57)
Carbon monoxide	1.85 (15.4)
Particulates	0.60 (5.0)
Sulfur oxides	16.8 S* (140 S)

*S is the percentage of sulfur in the fuel.

Source: U.S. Environmental Protection Agency, 1985a.

Al₂O₃ has a very low toxic potential. The Al₂O₃ in the rocket exhaust is a solid dust. Thus, as the most conservative estimate, the Al₂O₃ can be assumed to be PM-10, and then compared to the NAAQS. Also, the Al₂O₃ concentrations will be compared to the 8-hour ACGIH standard given in table 2-2.

HCl 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 Environmental Protection Agency (1992), as given in table 2-2.

The analysis of potential ambient air quality impacts from proposed launch activities considers both normal launch and early flight termination scenarios. For the most part, 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 TMD missile were modeled with the TSCREEN PUFF computer model (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 D.

The results of the modeling show that for a normal launch neither the relevant NAAQS nor the HCl guidelines are exceeded for distances greater than 1.0 km (0.6 mi) from the launch site (tables D-2 and D-3). Results from the air quality modeling for the missile failure accident scenario also show, with one exception, that neither the relevant NAAQS or guideline values are exceeded for distances greater than 1.0 km (0.6 mi) from the launch site.

The one exception is that the most conservative guidance value, the SPEGL for HCl, is exceeded for distances less than 7 km (4.3 mi) for an on-pad catastrophic failure of an SR19-AJ-1/M57A-1 target missile and for distances less than 10 km (6.2 mi) for an on-pad catastrophic failure of a Castor IVB/M57A-1 target missile. To assess the impact of this potential occurrence it is necessary to note that the EEGL is that concentration of HCl in air that will permit continued performance of specific tasks during rare emergency conditions lasting for periods of 1 to 24 hours (National Research Council, 1987). The air quality modeling indicates that the EEGL for HCl, 30 mg/m³, is not expected to be

Table 3-3: Combustion Products for Selected Rocket Motors in Kilograms (Pounds)

Species	M57A-1	M56A-1	SR19-AJ-1
Al ₂ O ₃	533 (1,174)	1,472 (3,246)	1,767 (3,886)
CO	420 (927)	1,212 (2,672)	1,327 (2,919)
HCl	331 (731)	852 (1,879)	1,402 (3,084)
N ₂	135 (297)	382 (842)	545 (1,200)
H ₂ O	148 (325)	430 (947)	776 (1,708)
H ₂	39 (87)	106 (234)	117 (257)
CO ₂	48 (106)	106 (234)	288 (633)
Other	3.5 (7.7)	148 (326)	74 (164)
Total	1,658 (3,655)	4,708 (10,340)	6,296 (13,851)

Sources: Coleman Research Corporation, 1993b; Dailey, 1993.

exceeded for distances greater than or equal to 1 km (0.6 mi) downwind of the launch pad in the case of an on-pad catastrophic failure of either of the two target missile configurations modeled.

In contrast, the SPEGL is defined as a suitable concentration for unpredicted, single, short-term, emergency exposure of the general public (Nation Research Council, 1987). Because there are no people living on Wake Island, usually categorized as the "general public," the EEGL is the more appropriate standard to apply than is the SPEGL.

Furthermore, because of the conservative assumptions made and the use of the screening model (which is designed to give conservative estimates), the actual concentrations would be expected to be considerably lower than those given in Appendix D. For these reasons, no significant impact to air quality is expected to result from either a normal launch or an on-pad catastrophic failure of a TMD target missile.

This conclusion is strengthened by the fact that analyses for single launches of missiles with comparable rocket motors have been done for the TCMP EA (U.S. Army Strategic Defense Command, 1992b) and the LEAP Test Program EA (Strategic Defense Initiative Organization, 1991). In both cases no significant impact was expected to result from the combustion products from the launch of a missile.

The potential for minor impacts exists from hydrochloric acid formed from the hydration of the HCl gas (Evans, 1984; Schmalzer et al., 1986). Except during rainy or very high-humidity conditions, the HCl gas remains dry and is quickly and easily dispersed by winds. However, precipitation during or immediately after launch may lead to the rain scavenging the HCl out of the air and, thus, result in a localized near-field deposition of highly acidic rain (Pellet et al., 1983; Madsen, 1981).

In terms of cumulative impacts, the USAKA Supplemental EIS (U.S. Army Space and Strategic Defense Command, 1993a) evaluated the impacts from multiple launches of missiles per year for several years. The estimated emissions per launch used were 7,145 kg (15,753 lb) of CO; 5,178 kg (11,416 lb) of HCl; and 9,273 kg (20,444 lb) of Al₂O₃. These quantities are several times those given in table 3-1. Even for the highest

level of activity analyzed, in which a maximum of 84 missiles were launched in a single year, neither the NAAQS nor the HCl and Al₂O₃ guidelines were predicted to be exceeded (U.S. Army Space and Strategic Defense Command, 1993a).

Recalling that for the proposed action no more than 75 target missiles will be launched over a period of approximately 66 months, with a maximum launch rate of 3 to 4 per month, no significant impact to air quality would be expected to occur from cumulative impacts of missile launches.

As described in Section 1.3.1.3, meteorological rockets will be used in conjunction with the launches of TMD target and defensive missiles. The combustion products from typical sounding rockets are one-hundred to one-thousand times less than those from the TMD target missile (U.S. Army Space and Strategic Defense Command, 1993a). Therefore, no significant impacts to air quality are expected from meteorological rocket launches.

Potentially, portable generators would be used to provide electricity to range support equipment. Motor vehicle gasoline fuel would typically be used to power these generators. Emissions from these generators would include sulfur oxides, particulates, carbon monoxide, nitrogen oxides, and hydrocarbons (which are ozone precursors) (U.S. Environmental Protection Agency, 1985a). Since it is anticipated that these relatively small portable generators (one megawatt or less in total power-producing capability) would only be run for a few hours at a time prior to and during missile flights, no significant impact to air quality would be not significant from the emissions.

Mitigation Measures – No impact is anticipated from rocket motor emissions, and no mitigation measures are proposed.

Airspace

Wake Island is located in international airspace; therefore, there are no formal airspace restrictions surrounding it. The only air traffic control facility available is the control tower. However, missile launches should remain clear of air route A-450 and pose no significant impact. Such activities will be coordinated with the Central Air Reservation Center in Washington, DC.

Operation of the missile acquisition radars has the potential for some interference with airborne weather radar systems. Since this has implications for aircraft safety, rather than airspace use as such, it is discussed in some detail in the Health and Safety section below. However, airspace use would be affected by issuances of a Notice to Airmen. Aircraft within the region of the radar operating on Wake Island would be subject to an appropriate Notice to Airmen to advise avoidance of the radar area during TMD test flights. Prior permission from the commander of Wake Island is required to land on Wake Island, and the airspace is controlled by the tower or the FAA Air Traffic Control Center at Oakland, so aircraft without the knowledge and permission of an aircraft control authority are not permitted to fly within controlled airspace. Since the number of aircraft flying over or near Wake Island is small (only one jet route, A-450, passes over the island), the impacts to airspace use are considered not significant.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Biological Resources (Land)

Operation of all of the additional equipment associated with the defensive missile system should not have any direct adverse impacts on the island's flora and fauna. However, there is the potential for impacts associated with the anticipated increase in air traffic to and from Wake Island both in terms of aircraft noise and the inadvertent introduction of plant seeds carried on incoming aircraft. In addition, sonic booms associated with missile launches may have an impact. These are discussed as follows.

Large aircraft such as the C-141 Starlifter taking off and landing to the east are barely, if at all, audible from the Wilkes Island sooty tern colony which is only 1.6 km (1 mi) from the west end of the runway. Arriving and departing aircraft are not audible from Peale Island under conditions of steady trade winds of 18.5 to 37 km per hour (10 to 20 knots). These prevailing trade winds effectively mute the sound of aircraft at distances greater than a few hundred meters. Departing aircraft, which generate the most noise, take off to the east under most conditions, directly away from the seabird breeding colonies on Wilkes and Peale islands. The missile launch pads are also at the east end of the island several kilometers from any existing colonies. The constant calls of sooty terns at their nesting sites further mute any loud noises, even those originating relatively near the colony. It is not likely that future launches from launch pads 5 to 8 km (3 to 5 mi) away would have any impact on seabirds nesting on Wilkes or Peale islands.

Sonic booms would occur with each TMD target missile system launch after the vehicle exceeded the speed of sound a few seconds into flight. However, the sonic boom would be directed toward the front of the vehicle downrange of Wake Island over the ocean (U.S. Army Strategic Defense Command, 1992b). The effects of noise on birds and wildlife have been extensively reviewed (Memphis State University, 1971; Fletcher and Busnel, 1978; Brattstrom, 1982). Several studies have shown that intermittent noises (other than those at or near the threshold of pain) have little if any apparent effect on most animals, including birds (Dunnet, 1977; Kushlan, 1979; Ellis, 1981). Birds, for example, acclimate quickly to most non-constant noise in their environment, (e.g., gun shots, explosives, nearby departing aircraft). However, constant noise, even as low as 60 dB, may interfere with courtship and territorial defense in songbirds.

The potential for indirect impacts on birds may result from increased human presence on the island. Human intrusion into seabird colonies can result in abandonment of the colony from repeated or prolonged disturbance. Also, nests exposed when birds are flushed may be susceptible to predation by frigatebirds. Without restrictions, an increased population of humans (and accompanying increases of air- and sea-based traffic to the island), could result in an increase of stray dogs, cats, and rats, as well as other non-native pests that may be inadvertently transported to the island. For example, the inadvertent introduction of the brown tree snake (*Boiga irregularis*) from Guam to Wake Island is a very real threat, the risk of which is likely to increase in direct proportion to the number of cargo shipments to the island, especially if unregulated or unmonitored.

Similarly, plant seeds inadvertently carried on incoming aircraft or cargo have already altered the botanical composition of the atoll. Without proper safeguards, an increased frequency of arriving aircraft associated with increased launch activities could exacerbate this condition.

One additional possible impact would come from hazardous materials contamination in the case of an accidental spill. Generally, hazardous materials contamination would be restricted to small areas near the source of pollution. Local spills of petroleum products such as gasoline, jet fuel, and oil could be harmful if they come into contact with or are ingested by birds. Spills into the lagoon may spread over the surface of the waters and result in impacts including death of a small number of seabirds that may drink from or land on the water; however, no birds were seen doing either during recent surveys. Golden-plovers and tattlers forage along the edge of the lagoon and could be affected. However, with the standard operating procedures already in place, the potential for impact is judged to be not significant.

During nominal launch events, damage to vegetation would be minimal as vegetation is routinely cleared from the launch site to reduce the fire hazard. A catastrophic missile failure on or near the launch pad would destroy flora and fauna for some distance because of fire, flying debris, and the potential release of TEP. The extent of damage would decrease with distance from this site of the failure. The exact extent is not known, but damage from flying debris would be expected to be contained within the 381 m (1,250 ft) ESQD. Fire damage could be contained to a much smaller area. Based on the known plant toxicity of TEP (Sikora et al., 1991), in the most conservative case failure scenario where TEP would be equally dispersed radially around a catastrophic failure, all vegetation might be killed for 27 m (90 ft) or more around the event and would be damaged to a greater distance.

Biological Resources (Marine)

The open ocean area south of Wake Island and north of the USAKA is an extremely large area, and very little is known of the numbers and distribution of marine biological resources, including marine mammals and sea turtles. Of the internationally protected species, sea turtles and marine mammals would have the greatest risk, albeit extremely remote, of incidental impact from debris in the booster drop area. The taking of a protected species would be a significant impact, but the probability of such an occurrence is judged to be extremely remote; thus, no significant impacts are anticipated.

While TEP may be toxic in large concentrations, no exposure limits have been established for humans, let alone marine life. No TEP would be released to the near-shore environment during nominal launch events. Studies for a simulated missile intercept at Holloman AFB suggest that about 80 percent of the TEP in a target payload would be destroyed at intercept (U.S. Army Space and Strategic Defense Command, 1993b). It is expected that the remaining 20 percent would be quickly dispersed in the atmosphere, with no significant concentration reaching the ocean surface. In the event of a failed intercept or an on- or near-pad flight failure, the simulant could be released in high concentrations over a small area. This scenario might cause localized marine-life mortality until the TEP, which is water-soluble, is adequately diluted. In the high mixing environment of the ocean

surface and particularly along Wake Island's near-shore reef, dilution to non-toxic levels would be anticipated to take place rapidly. Because of its chemical characteristics, TEP is not expected to bioconcentrate in aquatic organisms (National Library of Medicine, 1992); therefore, any impact is expected to be direct and short-term, with no cumulative effect. For these reasons the potential for significant adverse impacts to marine life is considered highly unlikely.

Mitigation Measures – While the potential for significant impacts as a result of noise associated with TMD operations and flight testing is minimal, it is proposed that launch activities be restricted to the period between August and January, when possible, to reduce activity during the seabird nesting season.

Inadvertent or deliberate introduction of alien plant and animal species needs to be mitigated. This can be accomplished by adoption of the following measures.

- No additional cats will be brought to the island.
- Cargo-handling personnel will inspect arriving aircraft for pest species of plants and animals and will be briefed on methods for their detection. This briefing will include viewing of the video produced by the Hawaii Chapter of the Wildlife Society entitled *Oahu Snake Menace*.

The implementation of these mitigation measures would reduce impacts to a not-significant level.

Cultural Resources

Operation of the additional equipment in the refurbished and newly constructed facilities is expected to have not-significant impacts to the island's cultural resources. However, the potential for significant impacts to cultural resources could result from incidental collection of cultural resources associated with the increased human presence on the island.

There is potential for damage to an existing historical structure from the falling debris or booster from a launch abort or launch mishap. This is considered an extremely remote possibility, given (1) the unlikely possibility of a launch abort or mishap and (2) the small profile of most existing historic structures on the island and the very small probability of any one area being impacted by large debris capable of sustaining structural damage. For these reasons, significant impacts to cultural resources are not expected.

Mitigation Measures – All operations personnel would receive a brief orientation involving a definition of cultural resources and the protective Federal regulations.

In the event of damages to historic properties occurring as a result of falling missile debris or booster from a launch abort or mishap, an assessment would be conducted to determine the measures appropriate to mitigate the impacts. Mitigation measures would fall within a range of restoration of the property to demolition of non-restorable hazards after complete documentation.

Hazardous Materials/Waste

Operation of the additional equipment in the refurbished and newly constructed facilities should not require the use of any hazardous materials/waste, with the exception of small quantities of solvents and cleaning materials that may be required during launch preparation activities, and would have not-significant impacts.

Activities involved with the preparation and launch of the TMD target system from Wake Island have the potential to increase the quantities and types of hazardous materials used at Wake Island and quantities and types of hazardous waste generated. Hazardous materials associated with TMD activities fall into three categories: solvents, simulants, and explosives.

Small quantities of solvents and cleaning materials may be required during launch preparation activities. Such materials would be similar to hazardous materials already in use at Wake Island and would be transported to the facility and distributed through normal supply channels. The small quantities that would be associated with launch activities would not represent a significant increase over quantities already in use.

The only chemical simulant that would be used in target vehicle payloads is TEP. TEP ($C_6H_{15}O_4P$) is a colorless liquid with a mild odor that is very stable at ordinary temperatures. TEP is an industrial chemical, commonly used as an ethylating agent (i.e., it releases ethyl groups), as one of the raw materials used in preparation of some insecticides, and as a thermometer fluid. Assessment of potential environmental impacts is provided in the *Extended Range Intercept Technology Environmental Assessment* (U.S. Army Strategic Defense Command, 1991b) and the TMD Lethality Program EA (U.S. Army Space and Strategic Defense Command, 1993). TEP is listed and regulated in the Toxic Substances Control Act (40 CFR 702-789) and regulated as a hazardous material by the U.S. Department of Transportation which forbids transport on passenger-carrying aircraft. Handling of TEP during TMD target flight preparation activities is not expected to pose a potential for significant impact as long as the manufacturer's directions are followed.

TMD target missiles will utilize "off-the-shelf" solid-propellant rocket motors. Such systems contain large quantities of Class 1.3 explosives, which are considered safe for normal handling due to relative insensitivity to detonation initiation. Air-shipment and handling of these systems would be in accordance with AFR 127-100; safeguards would include storage in a facility approved for explosives sufficient for the quantities to be used (Building 1607). No wastes would be generated as a result of explosive-handling operations.

Minimal quantities of hazardous waste would be produced by launch activities and would consist of small quantities of used or excess solvents and cleaners. These materials are similar to waste already generated and handled at Wake Island. Management of this hazardous waste is the responsibility of the TMD program and would be accomplished in accordance with applicable RCRA and other regulatory requirements. Waste may be disposed of through agreement with the host command to use the existing waste management system or through establishment of an appropriate TMD program waste

management system. The small quantities of waste that are expected to be generated will present a not-significant impact.

All storage areas for toxic/hazardous materials and/or waste will maintain spill containment structures. Procedures found in the Wake Island Spill Prevention Plan will be implemented to further decrease the risk of accidental release of toxic/hazardous substances to the atmosphere. The disposal of waste materials will be in accordance with the island's waste management practices, and the dumping of any hazardous material will be strictly prohibited.

Mitigation Measures – No significant impacts are expected after implementation of regulatory requirements and standard handling procedures.

Health and Safety

Operation of the additional equipment in the refurbished and newly constructed facilities should not have any direct adverse health and safety impacts, with the exception of the higher potential for occurrence of a missile launch failure, explosive operations, and the potential of exposure to simulants in some of the target missile system RVs. These are discussed as follows.

The proposed launches will entail the use of TMD target systems, consisting of multi-stage solid rocket motor systems. These systems will be air-transported to Wake Island. Once at Wake Island they will be stored at Building 1607, which is sited as an explosive facility, with appropriate clearances in accordance with AFR 127-100. These explosives are identified as Class 1.3, which are considered relatively safe for normal handling due to relative insensitivity for detonation initiation. Building 1607 is also operating under a waiver from the Air Force that allows the building to be near the island's runway. Based on Building 1607 being rated a Class 1.3 building, certain motors (e.g., M57A-1) cannot be stored there because they are rated as Class 1.1. The proposed new MSB has been located and would be constructed to allow storage of Class 1.1 rocket motors. Building 1607 is also operating under a waiver from the Air Force that allows the building to be near the island's runway. Activities involving these systems are considered to be routine and have been conducted safely for many years; hence, no significant increase in hazards associated with these materials is expected.

Launch operations within the military have been conducted for many years. Safety requirements have been developed based upon the lessons learned during this time. While risks associated with launch activities will always be present, the safety systems are designed to minimize the risks to an acceptable level. Launch activities are considered to present a not-significant impact to health and safety.

TEP is an industrial chemical, commonly used as an ethylating agent (i.e., it releases ethyl groups) and as one of the raw materials used in the preparation of some insecticides. It alone is not the active ingredient in these products. It is also approved for use as an adhesive component for articles intended for packaging, holding, and/or transporting food under U.S. Food and Drug Administration regulations (21 CFR 175.105).

Available information on TEP indicates that it is a weak cholinesterase inhibitor (inhibits normal neuromuscular functioning) and can cause eye and skin irritation, although it is not absorbed through the skin. Good general room ventilation is sufficient for safe handling and use; however, the manufacturer recommends that any personnel handling this material should wear protective gloves, clothing, and safety glasses. TEP has a flash point of 99° C (210° F), is volatile, and is soluble in water.

No exposure limits have been established for TEP in part due to the low toxicity level. Previous studies reveal that it may be toxic in large concentrations; however, laboratory studies show that it is less toxic than malathion (Gumbmann, 1968). Malathion is a widely used insecticide that has been sprayed over large, densely populated areas to control fruit fly populations. For these reasons, the handling and use of TEP is expected to pose no greater health risk than commercially available insecticide when properly handled and would be a not-significant health and safety impact to workers during flight preparation activities.

During target launches, all personnel on the island would be sheltered and not directly exposed to any TEP that might be spread as a result of a catastrophic missile failure. The concentration of TEP that may enter personnel shelters from such an incident cannot be quantified but would be expected to be small because of the small volume being used and the distance of the shelters from the launch pad. Therefore, the risk of a significant health and safety impact from TEP exposure is judged to be extremely remote.

Normal launch operations will not entail any increased hazards at Wake Island, since nominal system performance is considered to be a safe operation. In the event of an accident, however, there is the potential for significant hazards associated with debris impact, explosion, and release of toxic combustion products. In accordance with the requirements of the *KMR Range Safety Manual*, a LHA will be established around the launch facility. This area represents the footprint of maximum hazard associated with debris impact and explosive overpressure. Personnel inside this area will remain within facilities rated to provide adequate blast and debris protection.

Mitigation Measures – No significant impacts to health and safety are expected because of the implementation of standard operating procedures for missile launches.

Infrastructure and Transportation

Although the program would utilize existing or newly renovated/constructed facilities, the transient personnel would be accommodated on Wake Island itself for each of the 2-week periods straddling the 15 TMD target missile system launches per year. While the precise program-related infrastructure requirements have yet to be determined, since existing facilities with the requisite supporting infrastructure in place would be utilized, no adverse impacts to the island's infrastructure are anticipated. Scheduling of the launch and launch-related activities would prevent cumulative impacts.

Personnel-related infrastructure demands would be constrained by the ability of the island's capacity to house program participants. Wake Island has a total of 490 beds in transient billets (U.S. Army Strategic Defense Command, 1992a) and, thus, the ability to

readily accommodate and support the infrastructure requirements of the maximum of 70 target missile systems operations personnel and 30 range support personnel associated with the TMD target missile systems. The actual number of personnel on Wake Island fluctuates depending on particular activities on the island, but scheduling would prevent the island's accommodations and infrastructure from being overtaxed. Program-related personnel would not be allowed on the island unless sufficient billets were available. Thus, while TMD target missile systems personnel would impose their own fire protection, health, safety, power, solid waste, wastewater, and water demands, the island's infrastructure, capable of supporting 490 transients at any one time, would not be overburdened; thus, no significant infrastructure impacts are anticipated.

Wake Island's transportation infrastructure would similarly not be overburdened by the operations and flight testing program or its transient personnel. The number of flights to and from the island from Hickam AFB may need to be increased, but the island has aircraft ramps for processing passengers and cargo and for refueling up to 36 aircraft in a mix of C-130, C-141, and C-5 aircraft; therefore, no adverse impacts to the air transportation infrastructure are anticipated. Road transportation on the island is provided by the U.S. Air Force or contractor vehicles, and the island could readily accommodate additional traffic over the two buses that currently transport aircrews and passengers between the Base Operations Building and the Dining Hall/Billeting Office (U.S. Department of the Air Force, 1992). The island is currently supplied by sea-going barges and ships, and no adverse marine transportation impacts are anticipated as a result of the TMD target missile systems operations and flight test program.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Land Use

Changes in land use were addressed for renovation/construction activities in Section 3.1.1.1.1. Operation of all of the additional equipment in the refurbished and newly constructed facilities and flight test operations would not have any direct or indirect adverse land use impacts over and above those noted for renovation and construction activities.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Noise

The launch vehicle noise predictions for TMD target and defensive missile launches were performed with a far-field predictor program based on empirical data from both solid- and liquid-fueled rocket motors (McInerny, 1989). The program was modified to allow for non-vertical launch events. Candidate rocket motor characteristics (i.e., nozzle exit diameter, nozzle exit velocity, and average thrust) were obtained to run the model. The maximum noise radiation angle was assumed to be 55° from the axis of the motor, which is typical for solid-fuel rocket motors (McInerny, 1991).

Operation of the additional equipment in the refurbished and newly constructed facilities should not have any noticeable adverse noise impacts other than the increased vehicle traffic-related noise. With the temporary increase in on-island personnel to support TMD activities, there would be an increase in the number of vehicles on the island. However, the ambient noise levels from wind and ocean waves are so high that the increased vehicle noise is expected to be unnoticeable. The flight test program would, however, increase launch vehicle noise. Noise potential was considered for the M56A-1 and SR19-AJ-1 rocket motors. Preliminary predictions showed that although the SR19-AJ-1 motor is larger and carries more fuel, the M56A-1 motor has higher acoustic power; therefore, it was chosen as the most conservative case scenario for launch noise analysis.

Predicted A-weighted sound pressure level contours for target vehicle launches using the M56A-1 motor are shown in figure 3-3. The main base buildings and the base dispensary would be subjected to maximum levels between 105 and 110 dB. Base housing, on the north end of Wake Island, would experience maximum levels between 100 and 105 dB. These maximum levels would last for several seconds and then taper off as the vehicle moved away from the launch site.

Sonic booms would occur with each TMD system launch after the vehicle exceeds the speed of sound. However, the sonic boom would be directed toward the front of the vehicle downrange of Wake Island over the ocean (U.S. Army Strategic Defense Command, 1992b).

The maximum noise levels during TMD test activities would be significantly above the maximum levels experienced during Air Force C-5 aircraft operations, except for those areas adjacent to the runway or beneath the aircraft flight path (such as Wilkes Island).

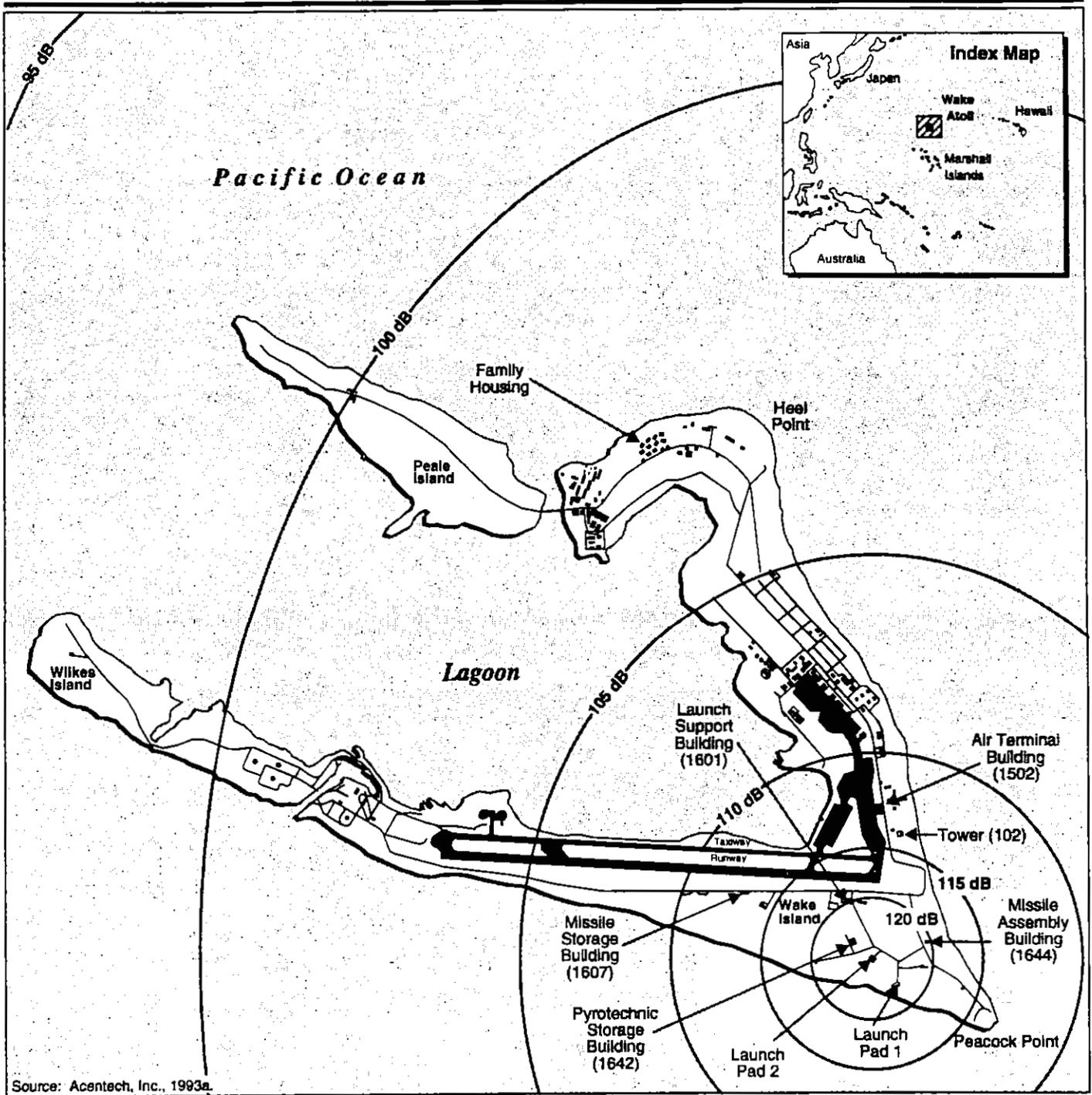
The noise level at the launch site is 120 dB for a few seconds, which is about 11 percent of the daily exposure permitted by the OSHA (U.S. Department of Labor, 1981). However, all personnel will be excluded from the launch area and thus would be protected from noise effects, therefore the impact would be not significant.

Mitigation Measures – Following standard safety procedures for health and safety, there would be a not-significant impact from noise, and no other mitigation measures would be required.

Physical Resources

Operation of the additional equipment in the refurbished and newly constructed facilities and flight test operations would not have any direct or indirect adverse physical resource impacts over and above those noted for renovation and construction activities in Section 3.1.1.1.1.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.



Predicted Maximum A-Weighted Sound Pressure Level Contours During a TMD Target System Launch

Wake Island

Figure 3-3



Socioeconomics

Because of Wake Island's mission, socioeconomic issues are essentially confined to the availability of housing. Demographic, employment, income, and fiscal impacts are not factors. All of the operational, flight preparation, and flight testing activities detailed in Section 1.3.1 would employ up to 140 unaccompanied transient personnel for each missile launch. These transient personnel would be housed in existing USASSDC-controlled billets, in which up to 170 beds are available, with additional beds available in U.S. Air Force-controlled billets (Johnson, 1993). Consequently, no impact to housing and, thus, socioeconomic resources is anticipated.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Water Resources

Surface water and groundwater are naturally occurring replenishable resources, although they are very limited at Wake Island. The only significant sources of fresh surface water on the island are the water catchment basins which provide the primary potable water supply. Groundwater use is restricted to deep brackish water wells used to supply the desalination plant during the dry season and periods of draught. No impact to the catchment basins is expected to occur as a result of nominal launch events when the wind is from the prevailing north-northeast direction. Because groundwater is obtained from deep wells located near the desalination plant and away from the launch site, the potential to impact groundwater supplies is considered very remote.

If a TMD target vehicle launch occurs when the wind direction is from the south, missile exhaust emissions might fall on the potable water catchment basins. In the most extreme case, any water in the basins at this time, or the next rainfall captured after the event, might have to be wasted to the lagoon. However, emission products could be readily flushed from the basins and any impact would be short-term and would not be cumulative. Depending on the facility's water requirement at the time and the amount of water in storage, this could require an increase in the use of the desalination plant for the production of potable water. Therefore, the proposed action is not expected to have a significant impact on water resources.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

3.1.1.2.2 Theater Missile Defense Defensive Missile Systems

Air Quality

Flight testing of the TMD defensive missile systems, in contrast to the TMD target missile systems, would involve the use of mobile and stand-alone systems rather than the existing and newly built/renovated facilities. The mobile power generator used during the defensive missile launches would have air emissions associated with its operation.

Representative emission factors for gasoline- and diesel-powered generators are given in table 3-4. Some representative portable electric power generators are the 150-kilowatt, truck-mounted electric power plant and 30-kilowatt electric power unit used as part of the PATRIOT system (Raytheon Company, 1990) and the 1-megawatt diesel-powered generator used by the TMD-GBR UOE units (U.S. Army Space and Strategic Defense Command, 1993g).

The electricity demands associated with the additional 140 personnel on the island (including the TMD-GBR) would also most likely necessitate operation of an additional generator in the island's power plant for the duration of the program and thus would have essentially the same impacts to air quality as outlined in Section 3.1.1.1.

Launch operations, as with the TMD defensive missile systems, constitute the largest sources of uncontrolled emissions. The types of combustion products for the defensive missiles are the same as those for the target missiles (table 3-3).

Each of the TMD defensive missiles produces smaller amounts of these combustion products than do the target missiles. Therefore, the impacts to air quality from the launch of defensive missiles and meteorological sounding rockets will be of the same type but of less intensity than those discussed in Section 3.1.1.2.1.

Since no significant impacts would be expected for the launch of TMD target missiles, none would be expected for the launch of TMD defensive missiles.

Mitigation Measures – There is no potential for significant impact, and no mitigation measures are proposed.

Airspace

The airspace use impacts of flight testing the TMD defensive missile systems would be essentially the same as the impacts for the target missile systems outlined in Section 3.1.1.2.1. Possible interference with airborne weather radar communication systems and electroexplosive devices are discussed in the health and safety section.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Biological Resources (Land)

Flight testing of the TMD defensive missile systems, involving the use of mobile and stand-alone systems that would be placed on existing paved or previously disturbed areas only, would not have any direct impacts to the island's flora and fauna, other than the potential for noise impacts from the missile launches and biological effects from EMR emissions from operation of the radars. One of the proposed sites for mobile GBR actions, the hot cargo pad area, is largely in a non-natural state; the vegetation survey recently completed shows it to be essentially devoid of vegetation. The closest vegetation feature of any importance is a stand of *Pemphis* edging the lagoon to the north. Similarly, no fauna, migratory birds, or threatened or endangered species were observed here. It is not felt

Table 3-4: Emission Factors for Gasoline- and Diesel-Powered Industrial Equipment

Pollutant	Engine Category	
	Gasoline	Diesel
Carbon monoxide		
g/hr	5,700.000	197.000
lb/hr	12.600	0.434
g/kwh	267.000	4.060
Exhaust hydrocarbons		
g/hr	191.000	72.800
lb/hr	0.421	0.160
g/kwh	8.950	1.500
Nitrogen oxides		
g/hr	148.000	91.000
lb/hr	0.326	2.010
g/kwh	6.920	18.800
Sulfur oxides		
g/hr	7.670	60.500
lb/hr	0.017	0.133
g/kwh	0.359	1.250
Particulates		
g/hr	9.330	65.000
lb/hr	0.021	0.143
g/kwh	0.439	1.340

Source: U.S. Environmental Protection Agency, 1985a.

that this site constitutes important habitat for any natural resources, nor is it anticipated that any vegetation, fauna, migratory bird species, or threatened or endangered plants or animals will be impacted by implementation of activities associated with portable GBRs on this site.

The second site being considered for portable GBR activities, located on the lagoon side of the baseball diamond on the northwestern tip of Wake Island proper, is a mown open field dominated almost entirely by non-native ruderal species. Some domesticated birds were observed in sheds adjacent to this site. The observation of migratory birds closest to this site involved a brown noddy nest sighted atop a concrete block within the lagoon (Appendix E, figure 1). While migratory birds may occasionally be transient on the site, none were observed here. No threatened or endangered species were observed or are known to occur on the site. Thus, no significant impacts on flora, fauna, migratory birds, or threatened or endangered species will result from implementation of activities associated with portable GBRs on this site.

Operation of the missile acquisition radars would emit EMR. Biological effects are related to incident power density, which gives rise to internal fields and power deposition (the SAR) within the exposed biological object (Polson et al., 1993). Because of the uncertain

operating frequency and power output of the particular units that may be operated at Wake Island, the following analysis, based on a typical X-band radar, is tentative since the expected power densities in the main beam are unknown.

EMR would not have any impact on wildlife on the ground since computer-operated controls and procedures are incorporated into the radar design to ensure that ground-level exposures do not exceed the relevant human general-population exposure value, which is 5 mW/cm² averaged over any 6-minute period. This power density would be in compliance with permissible exposure limits outlined in the U.S. Army Environmental Hygiene Agency's Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation (U.S. Army Environmental Hygiene Agency, 1987). These ground-level values are unlikely to cause any biological effects in birds or any other wildlife.

EMR may cause significant main-beam (airborne) exposures to birds, both in terms of thermal and non-thermal effects. Thermal effects on both the indigenous and migratory birds are a matter of concern. Much information exists on the effects of microwaves on laboratory animals, but few studies have been conducted on birds. Likewise, while there is specific information on calculating whole-body averaged SARs at different frequencies of radio frequency radiation for various polarizations for many mammalian species over a wide range of body sizes (Durney et al., 1986), there is little or no specific information for birds. It is unclear as to what additional thermal burden on any bird constitutes a problem. Birds typically expend energy at 10 to 20 times their resting metabolic rate during flight. It is not clear whether flying birds can tolerate an additional thermal burden equal to the resting metabolic rate or some multiple of this. The potential effects appear greatest for medium-sized birds. Large birds are less likely to be affected because the SARs are considerably lower, whereas small birds have much higher metabolic rates and would require a higher exposure to experience a doubling of their resting metabolic rates.

Mitigating the above concerns is the fact that the beam from the radar is narrow. To remain in the beam for any period of time would require that the bird flies directly along the beam axis or that a hovering bird does so for a significant time and that the radar beam remains stationary during this time. There is presently insufficient information to make a quantitative estimate of the joint probability of such an occurrence (beam stationary/bird flying directly on axis or hovering for several minutes), but it is expected to be low. Thus, although the potential for significant effects on birds exists, the probability that it would occur with any frequency is judged to be low.

In terms of non-thermal effects, the magnetic component of electromagnetic radiation in isolation, either as a static or very low frequency field, could influence the orientation of some birds. However, the effects of relatively strong magnetic fields appear to be transient at the very low frequencies (50 to 60 hertz) that have been studied. The birds that use magnetic cues are notable for the variety of cues they use and, consequently, exhibit rapid reorientation when they have moved beyond the area affected by the magnetic anomaly. Effects on orientation of migratory birds were reported for some but not all years in the studies of the effects of 50- to 90-hertz irradiation at the U.S. Navy's Project Sanguine (Project Seafarer) study sites in Wisconsin and Michigan. The anomalies were the strongest when the field strength was changing but even then were absent when the birds were flying straight and level. Thus the effect appears to be related to changes

in field strength due to either the operation of the equipment or the changing position of the bird with respect to the antenna. The effects, however, appear to have been minor and transitory.

In conclusion, no significant effects are expected on birds, including the navigational ability of migrants. The most plausible worst-case assumption is major thermal burden on birds flying directly in the main beam at considerable distances. The probability that birds could remain in the narrow beam, however, is judged to be small. Migratory birds use a variety of directional cues and are able to re-orient themselves following natural or artificial displacements and naturally occurring disruptions of geomagnetic cues during solar-caused electromagnetic storms. There is little evidence that the EMR from the radar would affect the navigation of migrating birds.

As with the TMD target missile systems, the potential for indirect impacts on birds from the additional 110 personnel on the island exists, along with the potential for the inadvertent introduction of plant seeds and exotic fauna such as the brown tree snake (*Boiga irregularis*) from the increased number of aircraft landing at Wake Island Airfield. As discussed in Section 3.1.1.2.1 for TMD target missile systems, these are not expected to be significant impacts, especially if the mitigation measures identified in Section 3.1.1.2.1 are implemented.

Biological Resources (Marine)

The open ocean area south of Wake Island is an extremely large area, and very little is known of the numbers and distribution of marine biological resources, including marine mammals and sea turtles. Of the internationally protected species, sea turtles and marine mammals would have the greatest risk, albeit extremely remote, of incidental impact from debris in the booster drop area. The taking of a protected species would be a significant impact, but the probability of such an occurrence is judged to be extremely remote; thus, no significant impacts are anticipated.

The potential exposure of marine biological resources to simulants is also judged to be not significant. While it may be toxic in large concentrations, no exposure limits have been established for TEP for humans, let alone marine life, and any release of TEP would be quickly dispersed in the air and diluted once it settled on the ocean surface. Although volatile, it is soluble in water, and thus the potential for significant adverse impacts to marine life is considered highly improbable.

Mitigation Measures – The mitigation measures would be the same as those identified for the TMD target missile systems in Section 3.1.1.2.1. The implementation of these mitigation measures would reduce the potential for impacts to a not-significant level.

Cultural Resources

Flight testing of the TMD defensive missile systems, involving the use of mobile and stand-alone systems that would be placed on existing paved or previously disturbed areas only, would not have significant impacts to the island's cultural resources, other than the extremely remote potential for debris impacts from a launch abort or launch mishap.

These impacts, discussed in Section 3.1.1.2.1 for TMD target missile systems, are similarly believed not to present significant impacts for the TMD defensive missiles. The potential for significant impacts resulting from the increased human presence on the island exists as discussed in Section 3.1.1.2.1.

Mitigation Measures – The mitigation measures would be the same as those identified for the TMD target missile systems in Section 3.1.1.2.1. The implementation of these mitigation measures would reduce the potential for impacts to a not-significant level.

Hazardous Materials/Waste

Flight testing of the TMD defensive missile systems would utilize much of the same hazardous materials (solvents and explosives) and generate similar minimal quantities of hazardous waste as would be utilized and generated by TMD target missile systems flight testing. These are outlined in more detail in Section 3.1.1.2.1, and, as concluded for TMD target missile systems, flight testing of the TMD defensive missiles is expected to produce not-significant hazardous materials/waste management impacts.

Mitigation Measures – The mitigation measures would be the same as those identified for the TMD target missile systems in Section 3.1.1.2.1.

Health and Safety

Flight testing of the TMD defensive missile systems, involving the use of mobile and stand-alone systems only, would have the same impacts from potential launch failure as discussed in detail for the TMD target missile systems in Section 3.1.1.2.1. Operation of the X-band phased-array TMD-GBR system and the C-band PATRIOT radar set would produce EMR discussed as follows.

*Personal exposure to the primary beam of the C-band radar represents a potential radiation hazard that can easily be avoided by controlling the direction and elevation of the main beam. Exposure to grating or side lobes of radiation can also be a hazard to personnel and island residents in the near vicinity of the radar. Grating and side lobes are predictable given a fixed set of operational conditions for a given location, but they routinely change in duration and incidence with the operation of the antenna. The presence of grating lobes when electronic beam scanning is active requires more control over possible personnel exposure to ensure that personnel are not exposed to radiation power densities exceeding 5 mW/cm² averaged over any 6-minute period. This power density is in compliance with permissible exposure levels outlined in the U.S. Army Environmental Hygiene Agency's Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation (U.S. Army Environmental Hygiene Agency, 1987) and with U.S. Air Force Regulation 161-9, *Exposure to Radiofrequency Radiation* (Payne, 1993). Consequently, grating and side lobe illumination from the radar antennae has been determined to present a not-significant impact on public health and safety based on the implementation of these operational measures.*

Although operation of the radars would be designed to preclude or restrict the generation of grating lobes and the main beam would operate at an elevation high enough to avoid

potential human contact, other health and safety EMR concerns do exist. The biological effects on birds potentially exposed to the main beams are addressed under Biological Resources. Non-biological effects include interference with communication equipment, effects on aircraft avionics equipment, and effects on electroexplosives and refueling operations. These are addressed in turn as follows.

The potential for impact on communications systems is suggested by a recent study conducted by the Electromagnetic Compatibility Analysis Center (ECAC) for the test version of the GBR known as GBR-T, X-band radar, to be located at the USAKA (Electromagnetic Compatibility Analysis Center, 1993). This study examined the potential for interference from the GBR-T with communications-electronics systems which operate both within and outside of the GBR frequency band due to so-called high-power effects and, for other radar systems, the number of undesired pulses that might be detected by the radars leading to objectionable obscuring of the visual images presented on the radar screen. The most important finding from the ECAC study of the GBR-T involved airborne and shipboard weather radars which operate within the X-band frequency range. The ECAC examined four different frequency shifts (chirps) and three pulse widths for each shift in the analysis representing a range of possible operating conditions for the radar. Using a criterion developed from experience with air traffic controllers of 100 pulses displayed on the radar screen as being obstructive to performing air controller tasks, the ECAC analyzed the number of pulses that might be observed for each operating condition. The preliminary results indicated that aircraft weather radars might be subject to wide chirp interference out to 450 to 500 km (240 to 270 nautical miles [nm]) under normal propagation conditions and out to 630 km (340 nm) under ducting conditions. They also concluded, however, that storm systems would not be obscured by interference, as defined by the 100-pulse criterion.

These preliminary findings, hereby incorporated by reference, are subject to revision as the ECAC continues to study the issue of possible interference from the GBR-T, including the possibility that the magnitude of possible impact may be significantly reduced. These findings, however, are clearly suggestive of the potential for some interference with airborne weather radar systems. At this point, it must be concluded that 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 radar operating on Wake Island would be subject to the publishing of an appropriate Notice to Airmen to advise avoidance of the radar area during TMD test flights.

Human hazard keep-out zones for the various versions of radars used in TMD testing would be established such that EMR levels outside these zones would not exceed 5 mW/cm^2 . Keep-out zones would be fenced with warning signs posted. Warning lights (beacons) may also be used when radars are operating. The TMD-GBR human safety keep-out zone is illustrated in figure 1-14. The dimensions of this keep-out zone are based on preliminary analysis of EMR levels produced by the TMD-GBR and will be validated by field measurements at low power levels prior to full-scale field testing (U.S. Space and Strategic Defense Command, 1993g). The PATRIOT radar set EMR keep-out zone extends to a distance of 120 m (394 ft) along the radar boresight and 2 m (6.6 ft) to the left and right of the radar set (Pledger, 1993).

Aircraft within the region of the radar operating on Wake Island would be subject to the publishing of an appropriate Notice to Airmen to advise avoidance of the radar area during TMD test flights. Prior permission from the commander of Wake Island is required to land on Wake Island, and the airspace is controlled by the tower or the FAA Air Route Traffic Control Center at Oakland, so aircraft are not permitted to fly within controlled airspace without the knowledge and permission of an aircraft control authority. This should eliminate the possibility of adverse effects to aircraft and military communications-electronics equipment. In addition, communication procedures would be established with the tower and the range safety organization to inhibit EMR immediately, should an unplanned penetration of a hazard zone occur. Additional safety measures to be developed in cooperation with the FAA and Wake Island flight safety personnel would consist of the designation of any aviation hazard areas needed, publication of a Notice to Airmen, and briefings to local aviators about any safety procedures that may be needed. Range operation scheduling would ensure that no ordnance would be utilized or transported near the radar during testing activities.

Effects on Aircraft Avionics Equipment – Electromagnetic fields create high-intensity radio frequency (HIRF) environments. Although many of the technical details of the proposed radars to be used in the TMD flight tests are unknown, the potential exists that the environment close to the radar installation would most likely be classified as a severe HIRF environment. For purposes of qualifying modern avionics equipment used for critical functions aboard airborne aircraft, the FAA has developed interim guidelines in the form of a so-called HIRF envelope so manufacturers have information on the types of HIRF environments in which aircraft may routinely fly. For critical avionics systems, the equipment is to be certified as capable of operating without failure when contained within aircraft flying in electromagnetic fields having electric field strengths of various magnitudes as a function of frequency.

Exposure of aircraft with avionics equipment carrying out critical functions to fields in excess of the severe HIRF values of field strength does not necessarily imply that the systems will be rendered inoperable, only that they have not been certified to function properly in such high field strengths; however, the hazard must be considered significant. Any possible impact would be reduced to a not-significant level by ensuring that aircraft activity within the region of the radar operating on Wake Island would be subject to the publishing of an appropriate Notice to Airmen to advise avoidance of the radar area during TMD test flights.

Effects on Electroexplosives and Refueling Operations – The issue of possible inadvertent fuel ignition can become a problem when RF currents, induced in metallic objects by intense RF fields, lead to possible arcing and sparks. This is a concern when refueling operations may occur in the vicinity of any high-power emitter. This phenomenon, however, is an extremely rare event and has been observed usually only under contrived test conditions. Ignition may occur if the proper mixture of fuel vapor and air exists at the point where the spark occurs, but this is considered to be extremely unlikely. Moreover, the proposed sites for the radars are both approximately 2.5 km (1.6 mi) from the refueling area on the runway on Wake Island.

Electroexplosive device detonation, for example, the inadvertent detonation during local blasting operations on the island, is also related to the electromagnetic field-induced currents that flow in the electrical leads connected to the explosive device. DOD and ANSI standards provide guidelines for maximum permissible electromagnetic field intensities to avoid these hazards. These standards will be rigorously adhered to, thus avoiding any potential problems. Use of these standard procedures for controlling possible human exposure will reduce any impact of the radar electromagnetic fields on possible fuel ignition hazards or inadvertent detonation of electroexplosive devices. Thus, no significant health and safety impacts from the radar operation are anticipated.

Mitigation Measures – No significant impacts to health and safety are anticipated due to the implementation of standard safety procedures for missile launches and radar operation.

Infrastructure and Transportation

Flight testing of the TMD defensive missile systems, involving the use of mobile and stand-alone systems that would be placed on existing paved or previously disturbed areas only, would not have any direct impacts on Wake Island's infrastructure. However, the addition of up to 140 temporary personnel would have indirect personnel-related demands similar to those expected for the TMD target system program outlined in Section 3.1.1.2.1.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Land Use

Flight testing of the TMD defensive missile systems, involving the use of mobile and stand-alone systems that would be placed on existing paved or previously disturbed areas only, would not have any direct or indirect adverse land use impacts or pose a conflict with existing or planned land use plans, policies, or controls. Operation of the X-band TMD-GBR and the C-band PATRIOT radar would require establishment of EMR hazard zone from 0.8 ha (2 ac) to 2.5 ha (6.2 ac) for TMD-GBR and extending to a distance of 120 m (394 ft) along the radar boresight and 2 m (6.6 ft) to the left and right of the radar set for the PATRIOT radar set. Operation of the radar and activation of the EMR hazard zone for one of the proposed locations south of the dormitory area on Wake Island would not impact land use since the hazard area would be almost entirely over the lagoon (figure 1-3). Operation of the radar and activation of the EMR hazard zone at the hot pad site just north of the taxiway at the western end of the runway (figure 1-3) could interfere with aircraft operations and pose a potential land use conflict. However, the radar would only be operated and the EMR hazard area activated during TMD defensive missile test flight launches, when aircraft would normally not be permitted to land or takeoff from Wake Island. This would occur for short periods of time, and all aircraft would be under the control of the Wake Island tower at the FAA Air Route Traffic Control Center in Oakland. Consequently, impacts to land use are considered not significant.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Noise

Flight testing of the TMD defensive missile systems, in contrast to the TMD target missile systems, would involve the use of mobile and stand-alone systems rather than the existing and newly built/renovated facilities. The mobile power generator, used during the defensive missile launches, would have generator noise associated with its operation.

The transportation demands associated with the addition of up to 140 temporary personnel on the island would also generate increased vehicular noise for the duration of the program and thus would have essentially the same noise impacts as outlined in Section 3.1.1.1.

Launch operations, as with the TMD target missile systems, constitute the largest sources of uncontrolled noise. However, because the TMD defensive missiles are smaller than the target missiles, the sound pressure levels they would produce during launch would be much less. This may be illustrated by using the THAAD missile as being representative of TMD defensive missiles.

For example, for the launch of the TMD target missile, the 95-decibel sound pressure level contour occurs at approximately 7,600 m (25,000 ft) from the launch pad, whereas for a typical launch of a THAAD missile, the 95-decibel contour only reaches out to approximately 1,500 m (5,000 ft) (Acentech, Inc., 1993b).

Noise impacts from launches and ground activities will be mitigated by ensuring that personnel wear hearing protection equipment which will reduce noise levels to the prescribed health and safety levels. Additionally, personnel will be moved to areas where noise levels are below OSHA-allowable short-term limits.

Mitigation Measures – No noise impacts are expected because of the implementation of standard personnel protection procedures.

Physical Resources

Flight testing of the TMD defensive missile systems, involving the use of mobile and stand-alone systems only, would not have any direct or indirect adverse physical resource impacts.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Socioeconomics

As with the flight testing of the TMD target missile systems, socioeconomic issues are confined to the availability of housing. Demographic, employment, income, and fiscal impacts are not factors because of Wake Island's unique mission. The 140 transient personnel involved with the flight testing of the TMD defensive missile systems and the TMD-GBR system could be readily housed in the existing USASSDC-controlled billets, in

which up to 170 beds are available. Consequently, no significant housing and, thus, socioeconomic impacts are anticipated.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

Water Resources

The proposed locations for TMD defensive missile systems equipment are a minimum of 610 m (2,000 ft) from the surface-water catchment basins, and the defensive missile launch site will likely be at least 1,220 m (4,000 ft) away. Because of this distance and the relatively small ground cloud produced by typical defensive missiles, it is considered unlikely that any rocket motor emissions would reach the catchment basins. However, if any emission products fall in the catchment basins they could be easily flushed. Any short-term potable water shortage caused by this action would be compensated for by increased production from the desalination plant. Due to the depth and location of the wells away from proposed TMD activity locations, the potential to impact water quality in wells used to provide brackish water to the desalination plant is considered very remote.

Mitigation Measures – Since there is no potential for significant impacts, no mitigation measures are proposed.

3.1.2 SEA-BASED SYSTEMS

3.1.2.1 Sea-Launch Preparation

The potential environmental impacts of modifying an existing surplus ship, such as an amphibious transport dock, including the installation of launch stools, erectors, missile assembly and check-out facilities, crew accommodations, and a gyroscope-controlled platform for missile launch operations, will be addressed by the Government agency responsible for obtaining the MLS.

3.1.2.2 Sea-Based Flight Testing

Among the environmental components, sea-based target missile launches from the open ocean area have the potential to impact air quality, airspace, marine biological resources, hazardous materials/waste, and the health and safety of those individuals aboard the MLS but no potential to impact cultural resources, infrastructure, land use, physical resources, socioeconomics, and water resources (defined here as groundwater and surface water resources). Sea-based launches, while limited to a maximum flight range of less than 500 km (311 mi), would create essentially the same noise as the ground-based launches, but there are no sensitive noise receptors. Accordingly, only air quality, airspace use, marine biological resources, hazardous materials/waste, and health and safety are discussed below.

Air Quality

Air emissions from sea-based launches in the open ocean area south of Wake Island would essentially be the same as the emissions from the ground-based launches discussed in Section 3.1.1.2.1 and are similarly judged to be not significant.

Airspace Use

Target missile launches from the MLS stationed in the open ocean area south of Wake Island would have no significant impacts to airspace use as long as coordination is made with the Central Air Reservation Center in Washington, DC. Aircraft operating in the area would be subject to the publishing of an appropriate Notice to Airmen to advise avoidance of the flight test area during TMD test flights. Since the number of aircraft flying over the open ocean area south of Wake Island is small, the impacts to airspace use are not considered significant.

Biological Resources (Marine)

The open ocean area south of Wake Island is an extremely large area, and very little is known of the numbers and distribution of marine biological resources, including marine mammals and sea turtles. Of the internationally protected species, sea turtles and marine mammals would have the greatest risk, albeit extremely remote, of incidental impact from debris in the booster drop area. The taking of a protected species would be a significant impact, but the probability of such an occurrence is judged to be extremely remote; thus, no significant impacts are anticipated.

The potential exposure of marine biological resources to simulants is also judged to be not significant. While it may be toxic in large concentrations, no exposure limits have been established for TEP for humans, let alone marine life, and any release of TEP would be quickly dispersed in the air and diluted once it settled on the ocean surface. Although volatile, it is soluble in water, and thus the potential for significant adverse impacts to marine life is considered highly improbable.

Hazardous Materials/Waste

Sea-based flight testing of the TMD target missiles would utilize much of the same hazardous materials (solvents and explosives) and generate similar minimal quantities of hazardous wastes as would be utilized and generated by the ground-based system flight testing outlined in Section 3.1.1.2.1. Hazardous materials would be handled in accordance with applicable regulations and guidelines, and hazardous waste generated aboard the MLS would be contained and appropriately disposed of once the MLS returned to port. As concluded for the ground-based flight testing, sea-based flight testing is expected to have a not-significant impact on hazardous materials/waste management activities.

Health and Safety

Target missile launches from the MLS stationed in the open ocean area would have the potential for health and safety impacts due to the potential of a missile launch failure and the potential of exposure to simulants in some of the target missile system payloads. Human exposure to simulants is discussed under health and safety in Section 3.1.1.2.1.

Sea launch safety criteria and mitigation would comply with USAKA requirements for missile launch activities. Flight hazard analysis would be conducted on a mission-by-mission basis. On-board personnel would be evacuated from flight hazard areas and the areas monitored before and during the flight test mission to prevent inadvertent encroachment of the hazard area by marine vessels. If deemed necessary, remote launch control would be provided by another ship, possibly an ocean tug, stationed several hundred meters from the MLS outside the LHA. Consequently, no significant impacts to health and safety are anticipated.

3.2 CUMULATIVE IMPACTS OF THE PROPOSED ACTION

The significance of the environmental consequences of the proposed TMD missile test activities was evaluated and discussed according to the approach described in Section 3.1. This section summarizes the cumulative impacts of each of the areas of environmental consideration.

Air Quality – Program activities present potential air quality impacts. Due to the increase in numbers of missile tests to be performed, construction activities, and an additional incinerator, there will be an increase in emissions on the island. However, no air quality guidelines are expected to be exceeded. Construction activities and the additional incineration of wet refuse will only represent a very small and largely transient increase in total emissions on the island, and computer simulations indicated that the short duration of flight vehicle emissions will rapidly dissipate and move away from the island during prevailing wind conditions; therefore, no significant cumulative impacts are expected.

Airspace – As Wake Island is located in an area of international airspace and only one jet route passes over the island, the cumulative effects of an increase in missile test flights is considered to be not significant.

Biological Resources – Proposed program activities present potential biological resource impacts that will require mitigation. Facility construction and trenching for utility lines will require removal of some vegetation suitable for seabird nesting habitat and could disrupt nesting seabirds. Underwater blasting could result in the accidental taking of endangered sea turtles. The increased numbers of personnel represent potential impacts due to the continuing introduction of invasive plant species that can crowd out native vegetation. Bird populations may be subjected to predation by new predator species introduced to the atoll. However, these potential impacts can be mitigated to a not-significant level. Therefore, no significant cumulative impacts from TMD-related activities would be expected.

Cultural Resources – Proposed program activities present potentially significant impacts on cultural resources that will require mitigation. The presence of additional personnel on the island has the potential to impact cultural resources because of recreational activities and incidental collecting of archaeological and historical resources while on the island. Construction activities will require ground disruption that could encounter unrecorded subsurface cultural resources. These potential effects will be mitigated to a not-significant level, and no significant cumulative impacts from test activities would be expected.

Hazardous Materials/Waste – Proposed activities present potential hazardous materials/waste impacts. Hazardous materials used during launch activities and any hazardous waste generated will be very similar to materials used and waste generated at present. All materials would be stored and handled according to appropriate health and safety procedures, and all hazardous waste generated during program activities will be shipped off the island to an approved facility. These activities can be accomplished within the existing waste management system or through establishment of a TMD program waste management system. In either case, all waste would be handled and disposed of in accordance with applicable Federal regulatory requirements, and no significant cumulative impacts are expected.

Health and Safety – Program activities would follow standard safety practices. All employees are trained in the proper use of the materials which they will be handling and will utilize required safety equipment and procedures. No significant impacts from TMD program activities are expected to occur. Construction activities on the island would be considered routine, and safety hazards associated with these operations are not considered significant. Health and safety impacts would be minimized by using established safety procedures implemented for conducting similar testing activities. While risks associated with launch activities will always be present, the safety systems are designed to minimize the risks to an acceptable level. Therefore, no cumulative impacts from TMD-related activities would be expected.

Infrastructure and Transportation – The number of personnel on the island would increase, but scheduling activities would prevent the island's accommodations and infrastructure from being overtaxed. The number of flights to and from the island from Hickam AFB may need to be increased due to mission requirements but no adverse impacts would be expected. Therefore, no cumulative impacts from test activities would be expected.

Land Use – Test activities and related activities are proposed for areas of the island that are consistent with current land uses; therefore, no cumulative impacts from test activities would be expected.

Noise – Program-related activities present potential noise impacts. Noise from construction activities would be of relatively short duration and is not expected to be substantially above background levels. Noise generated during flight vehicle launches is of short duration (about 1 minute) and will be about the same intensity as the present TCMP launches. In-place regulations would be used during test activities to provide hearing protection to workers. Therefore, no cumulative impacts from test activities would be expected.

Physical Resources – Program-related construction activities could have a cumulative impact on available seabird nesting habitat and soil erosion if the existing borrow area is used to provide aggregate for concrete. These potential effects can be mitigated by using materials brought in from off-island sources. Therefore, no cumulative impacts from test activities would be expected.

Socioeconomics – The transient personnel would be housed in existing USASSDC-controlled billets with additional beds available in U.S. Air Force-controlled billets. Scheduling would prevent the island's accommodations from being overtaxed; therefore, no cumulative impacts from test activities would be expected.

Water Resources – The surface-water catchment basins located about 1,800 m (6,000 ft) north of the target missile launch pads are the only source of fresh surface water on Wake Island and are used as the primary source of potable water. If any rocket motor emission products fall on the basins they could easily be flushed by draining the water. Increased production from the desalination plant would compensate for any short-term reduction in potable water availability. Therefore, no cumulative water resource impacts from TMD test activities would be expected.

3.3 MITIGATION MEASURES

All mitigation measures previously committed to by the USASSDC and the U.S. Air Force in the EAs for the LEAP, Starlab, BP, and TCMP launch programs at Wake Island will be adhered to during TMD construction and launch activities. The previous programs were very similar in construction requirements, test flight vehicles, and launch profiles to the proposed TMD test program. In each case, a Finding of No Significant Impact was issued for the previous programs. Previous mitigations along with those identified for the present program are as follows.

- **Biological Resources**
 - A survey for seabird nests will be conducted 1 to 2 weeks prior to construction by a trained field ornithologist.
 - If any seabird nests are found, the area will be marked and not disturbed.
 - If feasible, minor changes will be made in construction plans to avoid nesting areas.
 - If avoidance is not possible, the U.S. Fish and Wildlife Service office in Honolulu, Hawaii, will be contacted to request a permit for a limited taking of a protected migratory bird species.
 - Construction within 6 m (20 ft) of such a nest will not take place until such a permit is issued.

- No vegetation, except the minimum necessary for construction, will be cleared, trampled, or disturbed.
- No additional cats will be brought to the island.
- Cargo-handling personnel will inspect arriving aircraft for pest species of plants and animals and will be briefed on methods for their detection. This briefing will include viewing the video produced by the Hawaii Chapter of the Wildlife Society entitled *Oahu Snake Menace*.
- The National Marine Fisheries Service in Honolulu, Hawaii, will be consulted during the development of plans for any submarine blasting and will be notified prior to blast events.
- A diver will enter the water off of the coral reef to ensure that the area is clear of turtles before blasting for the fiber optic cable trenches.

■ **Cultural Resources**

- Personnel would receive an orientation involving a definition of cultural resources and the protective Federal regulations.
- An archaeologist will be on site to monitor any clearing, grading, trenching, or other ground-disturbing site-preparation activities. This archaeologist will be professionally qualified in accordance with the Secretary of the Interior's Professional Qualifications Standards (48 FR 44738-9) and Appendix C, AR 420-40.
- Cultural resources adversely affected by debris resulting from a launch mishap will be restored or demolished after complete documentation in accordance with an assessment and recommendations prepared by a cultural resource preservationist.
- Facilities will be located in such a way that historic resources will not be significantly impacted.

3.4 ENVIRONMENTAL CONSEQUENCES OF THE NO-ACTION ALTERNATIVE

The no-action alternative would be to not proceed with any new TMD launch activities on Wake Island, and no new TMD infrastructure improvements would be accomplished. The baseline activities would continue as scheduled.

3.5 CONFLICTS WITH FEDERAL LAND USE PLANS, POLICIES, AND CONTROLS

The proposed activities would occur in areas of the island already being used for similar purposes and would be limited to the DOD-operated installation. No evacuation of the ocean area between Wake Island and the USAKA is required; however, there are standard procedures for issuing warnings to airmen and mariners. Overall, proposed Wake Island activities would present no conflicts with land use plans, policies, and controls.

3.6 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

Anticipated energy requirements of each program activity would be well within the energy-supply capacity of all facilities. Energy requirements would be subject to any established energy conservation practices. No additional power generation capacity would be required from the electric power generation plant for the proposed activities. However, small portable generators may be used to provide power for the mobile radars and sensors.

3.7 NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS AND CONSERVATION POTENTIAL

Other than the small quantities of various metallic materials (e.g., aluminum, steel) required to hold agents to be tested in the proposed program activities, there are no natural or depletable resource requirements associated with the Wake Island activities.

3.8 ADVERSE ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED

There are no adverse environmental effects that cannot be avoided for any of the proposed Wake Island activities.

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

Activities at all locations would take advantage of existing facilities and infrastructure. Therefore, the proposed action does not eliminate any options for future use of the environment for any of the locations under consideration.

3.10 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

The proposed action would result in minor loss of habitat for plants or animals, no loss or impact on threatened or endangered species, and no loss of cultural resources, such as

archaeological or historic sites. Moreover, there would be no changes in land use that were not already precluded.

The amount of materials required for any program-related activities and energy use during the project would be small. Although the proposed Wake Island activities would result in some irreversible and irretrievable commitment of resources such as various metallic materials, minerals, and labor, this commitment of resources is not significantly different from that necessary for many other defense research and development programs. It is similar to that of activities that have been carried out in previous defense programs over the past several years.

3.11 CONDITIONS NORMALLY REQUIRING AN ENVIRONMENTAL IMPACT STATEMENT

The potential impacts arising from the proposed Wake Island activities were evaluated specifically in the context of the criteria for actions normally requiring an EIS described in DOD Directive 6050.1, *Environmental Effects in the United States of Department of Defense Actions* (U.S. Department of Defense, 1979), and AR 200-2, *Environmental Effects of Army Actions* (U.S. Department of the Army, 1988).

Specifically, the proposed Wake Island activities were evaluated for their potential to:

- Significantly affect environmental quality or public health or safety
- Significantly affect historic or archaeological resources, public parks and recreation areas, wildlife refuge or wilderness areas, wild and scenic rivers, or aquifers
- Adversely affect properties listed or meeting the criteria for listing on the National Register of Historic Places or the National Registry of Natural Landmarks
- Significantly affect prime and unique farm lands, wetlands, ecologically or culturally important areas, or other areas of unique or critical environmental concern
- Result in significant and uncertain environmental effects or unique or unknown environmental risks
- Significantly affect a species or habitat listed or proposed for listing on the Federal list of endangered or threatened species
- Establish a precedent for future actions
- Adversely interact with other actions so that cumulative environmental effects result

- Involve the use, transportation, storage, and disposal of hazardous or toxic materials that may have significant environmental impact

The evaluation indicated that the proposed Wake Island activities, as described in this EA, did not meet any of these criteria.

THIS PAGE INTENTIONALLY LEFT BLANK

4.0
Individuals and Agencies Contacted

4.0 INDIVIDUALS AND AGENCIES CONTACTED

U.S. DEPARTMENT OF DEFENSE AGENCIES

U.S. Air Force
15th Logistics Group, 15th Air Base Wing
Hickam Air Force Base, HI 96853-5320

U.S. Army Corps of Engineers
Pacific Ocean Division
Fort Shafter
Honolulu, HI 96858-5440

U.S. Department of Defense
Electromagnetic Compatibility Analysis
Center, ECAC-CS
120 Worthington Basin
Annapolis, MD 21402-5064

OTHER FEDERAL AGENCIES

Advisory Council on Historic Preservation
Western Office of Project Review
730 Simms Street, Room 401
Golden, CO 80401

U.S. Department of Commerce
National Marine Fisheries Service
Pacific Islands Environmental Coordinator
2570 Dole Street
Honolulu, HI 96822-2396

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

CONTRACTORS

**Piquini Management Corporation
Wake Island – Mid Pacific 96898**

**SSI Services, Inc.
Wake Island – Mid Pacific 96898**

**Teledyne Brown Engineering
Cummings Research Park
300 Sparkman Drive, NW
Huntsville, AL 35807**

5.0 References

5.0 REFERENCES

Note: Citations in the text of this document are presented in three ways. Citations presented after a period refer to the sentences preceding the citation. Citations presented before a period refer only to the information in that sentence. Citations presented within a sentence refer specifically to the fact or title which they follow. Multiple references from the same source and the same year are distinguished by a lowercase letter following the year.

Acentech, Inc., 1993a. Noise contour plot for Wake Island, 1 September.

Acentech, Inc., 1993b. Memo regarding sound pressure levels of missiles, 12 August.

American Conference of Governmental Industrial Hygienists, 1992. *1992-1993 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*, Cincinnati, Ohio.

Andel, James, 1993. Written communication between Major Andel, Detachment 1, 15th Logistics Group ICC, and The Earth Technology Corporation regarding existing conditions at Wake Island, 19 November.

Association of American Railroads, 1993. *Hazardous Materials Regulations of the Department of Transportation*, Tariff No. BOE 6000-L, Bureau of Explosives, Washington, DC.

Bowles, F., 1993a. Personal communication between Bowles, U.S. Army Space and Strategic Defense Command, and The Earth Technology Corporation regarding future TCMP program schedule, 26 August.

Bowles, F., 1993b. Personal communication between Bowles, U.S. Army Space and Strategic Defense Command, and The Earth Technology Corporation regarding TCMP rocket motors, 9 November.

Brattstrom, Bayard H., 1982. *Bibliography on the Effect of Noise on Non-Human Vertebrates*, U.S. Bureau of Land Management.

Brown, R., 1993. Personal communication between Brown, of the Piquini Management Corporation, and The Earth Technology Corporation, regarding sea turtles around Wake Atoll, 27 March.

Cannella, V., 1993. Personal communication between Cannella, Deputy to the Commander, 15th Logistics Group, and the Earth Technology Corporation regarding Wake Island activities, 28 June.

- Canter, L.W., 1977. *Environmental Impact Assessment*, McGraw-Hill, New York, New York.
- Cohen, Stan, 1990. *Enemy on Island, Issue in Doubt, The Capture of Wake Island*.
- Coleman Research Corporation, 1993. *Defense Target Program Description of Proposed Action and Alternatives (DOPAA)*, January.
- Costelle, John, 1981. *The Pacific War*, Rawson, Wade Publishers, Inc., New York.
- Cunningham, W.S., and L. Sims, 1961. *Wake Island Command*, Little, Brown & Company, Boston.
- Dailey, J., 1993. Personal communication between Dailey, Coleman Research Corporation, and The Earth Technology Corporation regarding amounts of propellant in M56A-1, M57A-1, and SR19-AJ-1 rocket motors, 6 April.
- Department of the Air Force, 1986. *Environmental Assessment for the Testing of Titan Solid Propellant Rocket Motors*, Edwards Air Force Base, California, December.
- Department of the Air Force, 1989. Pacific Air Forces Comprehensive Plan, Historic Preservation, Wake Island Airfield, 30 September.
- Department of the Army, 1990. *PATRIOT Life Cycle Environmental Assessment*, 27 December.
- Dowding, C.H., 1985. *Blast Vibration Monitoring and Control*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.
- Dunnet, G.M., 1977. "Observations on the Effects of Low-Flying Aircraft at Seabird Colonies on the Coast of Aberdeenshire, Scotland," *Biological Conservation*, 12:55-63.
- Durney, C.H., H. Massoudi, and M.F. Iskander, 1986. *Radiofrequency Radiation Dosimetry Handbook*, U.S. Air Force School of Aerospace Medicine, Brooks Air Force Base, Texas, USAFSAM-TR-85-73, October.
- Electromagnetic Compatibility Analysis Center, 1993. *Preliminary EMC Analysis of the GBR-T Demonstration/Validation Radar at the U.S. Army Kwajalein Atoll*, February.
- Ellis, D.H., 1981. *Responses of Raptorial Birds to Low Level Military Jets and Sonic Booms*, U.S. Fish and Wildlife Service, Institute for Raptor Studies.
- Engineering-Science, 1984. *Installation Restoration Program – Phase 1 – Records Search, Wake Island Airfield*, prepared by U.S. Air Force, Tyndall Air Force Base, Florida, and Hickam Air Force Base, Hawaii, September.

- Evans, L., 1984. *Acidic Precipitation Effects on Terrestrial Vegetation*, Annual Review, Phytopath. 22:397-420.
- Fletcher, J.I., and R.G. Busnel, eds., 1978. *Effects of Noise on Wildlife*, Academic Press, New York, New York.
- Fosberg, F.R., 1959. "Vegetation and flora of Wake Island," *Atoll Research Bulletin*, No. 67, Pacific Science Board, Washington, DC, 15 May.
- Foster, G.A., 1977. "Public Relations: A Practical Means to Control Blasting Complaints," Proceedings of the Third Conference on Explosives and Blasting Techniques Society of Explosives Engineers, Pittsburgh, Pennsylvania.
- Fuller, E., 1987. *Extinct Birds*.
- Gale Research Company, 1981. Weather of U.S. cities.
- Golden, J., R.P. Ouellette, S. Saari, and P.N. Cheremisinoff, 1979. *Environmental Impact Data Book*, Ann Arbor Science Publishers Inc., Ann Arbor, Michigan.
- Harrison, C.S., 1990. *Seabirds of Hawaii: Natural History and Conservation*. Cornell University Press, Ithaca, New York.
- Herman, G., 1993. Personal communication between Herman, STEWS-NR-CF, and The Earth Technology Corporation regarding Army Tactical Missile System Ground Evaluation and Airspace Requirements at Fort Wingate, New Mexico, 10 August.
- Johnson, B., 1993. Personal communication between Johnson, SSI Services, Wake Island, and The Earth Technology Corporation regarding billeting occupancy on Wake Island, 26 March.
- Jones, G., 1993. Personal communication between Jones, U.S. Army Space and Strategic Defense Command, and The Earth Technology Corporation regarding defensive missile systems, 8 April.
- Kinney, G.F., and K.J. Graham, 1985. *Explosive Shocks in Air*, Springer-Verlag, New York, New York.
- Kushlan, J.A., 1978. "Effects of Helicopter Censuses on Wading Bird Colonies," *Journal of Wildlife Management*, 43(3):756-760.
- Leong, B., 1993. Personal communication between Leong, Environmental Engineer, 15th Air Base Wing, Hickam Air Force Base, Hawaii, and The Earth Technology Corporation regarding air quality issues at Wake Airfield, 30 March.
- Madsen, B., 1981. *Acid Rain at Kennedy Space Center, Florida: Recent Observations*, *Atmospheric Environment*, 15(5): 853-862.

- McInerny, S.A., 1989. "Rocket Noise – Revisited," Proceedings of the International Conference on Noise Control Engineering, George C. Mailing Jr., ed., Institute of Noise Control Engineering, Poughkeepsie, New York, pp. 259-26.
- McInerny, S.A., 1991. "Characteristics and Predictions of Far-Field Rocket Noise," *Noise Control Engineering Journal*, 38(1) pp 5-16, January 1992.
- Memphis State University, 1971. *Effects of Noise on Wildlife and Other Animals*, U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, DC.
- Moulton, C.L., 1990. *Air Force Procedure for Predicting Aircraft Noise Around Airbases: Noise Exposure Model (NOISEMAP) User's Manual*, Report AAMRL-TR-90-011, February.
- National Aeronautics and Space Administration, 1989. *Final Environmental Impact Statement for the Space Shuttle Advanced Solid Rocket Motor Program*, March.
- National Library of Medicine, 1992. Hazardous Substances Data Bank, November.
- National Oceanic and Atmospheric Administration, 1993. Normals, Means, and Extremes for Wake Island, Pacific from National Oceanic and Atmospheric Administration Weather Service Office, Wake Island.
- National Park Service, 1984. National Register of Historic Places Nomination Form – Wake Island.
- National Research Council, 1987. *Emergency and Continuous Exposure Guidance Levels for Selected Airborne Contaminants, Volume 7, Ammonia, Hydrogen Chloride, Lithium Bromide, and Toluene*, prepared by the Committee on Toxicology for the Department of the Army.
- Nelson, S., 1993. Personal communication between Nelson, Army TACMS Project Office, and The Earth Technology Corporation, 5 April.
- Payne, S., Major, 1993. Personal communication between Payne, Bioenvironmental Engineering, Hickam Air Force Base, and The Earth Technology Corporation regarding applicable U.S. Air Force regulations for electromagnetic radiation exposure at Wake Island, 9 November.
- Pellet, G., D. Sebacher, R., Bendura, and D. Wornom, 1983. "HCl in Rocket Exhaust Clouds: Atmospheric Dispersion, Acid Aerosol Characteristics, and Acid Rain Deposition," *Journal of the Air Pollution Control Association*, 33(4): 304-311.
- Phillips, J., 1993. Personal communication between Phillips, U.S. Army Space and Strategic Defense Command, and The Earth Technology Corporation regarding range support equipment, 18 May.

- Pledger, L., 1993. Personal communication between Pledger, CAS, Inc., and The Earth Technology Corporation regarding PATRIOT launch hazard keepout zones, 14 June.
- Polson, P., L.N. Heynick, and B.R. Holt, 1993. *Analysis of the Potential for Microwave Bioeffects to Result from Operation of the Proposed U.S. Army National Missile Defense Initial Deployment (NMDID) Ground-Based Radar (GBR): General Analysis (Not System-Specific)*, Technical Report, January.
- Pratt, H.D., P.L. Bruner, and D.G. Berrett, 1987. *The Birds of Hawaii and the Tropical Pacific*, Princeton University Press.
- Raytheon, 1990. *PATRIOT Air Defense System, System Description and Equipment Summary*, March.
- Redpath, B.B., 1976. "A Review of Airblast-Induced Window Breakage," Proceedings of the Second Conference on Explosives and Blasting Techniques, Society of Explosives Engineers, Louisville, Kentucky, 28 to 30 January.
- Rowland, C.M., 1989. Trip Report – Wake Atoll (April 4-11, 1989). (Appendix B of Department of the Air Force 1990, *Environmental Impact Analysis Process Final Environmental Assessment Starlab Program*), U.S. Fish and Wildlife Service, Honolulu, Hawaii, 1 June.
- Schmalzer, P., C. Hinkle, and T. Dreschel, 1986. *Far-field Deposition from Space Shuttle Launches at John F. Kennedy Space Center, Florida*, NASA TM 83104.
- Sikora, F., S. Harper, and P. Giordano, 1991. Phototoxicity and Hydrolysis of a Chemical Weapon Simulant, Triethyl Phosphate, Final Report for Contract No. TV-N83712 between the U.S. Army Strategic Defense Command and the Tennessee Valley Authority, 2 December.
- Strategic Defense Initiative Organization, 1991. *Environmental Assessment for the Lightweight Exoatmospheric Projectile (LEAP) Test Program*, July.
- Strategic Defense Initiative Organization and U.S. Army Space and Strategic Defense Command, 1993. *Draft Theater Missile Defense Programmatic Life-Cycle Environmental Impact Statement*, January.
- Stull, D.R., 1977. *Fundamentals of Fire and Explosion*, AIChE Monograph Series, No. 10, Volume 73, American Institute of Chemical Engineers, New York, New York.
- Teledyne Brown Engineering, 1993. *Theater Missile Defense Extended Range Study*, 12 March.
- U.S. Air Force, 1987. Air Force Regulation 19-2, *Environmental Planning, Environmental Impact Analysis Process*, 30 September.
- U.S. Army, 1945. Map of Wake Island.

- U.S. Army Environmental Hygiene Agency, 1987. *U.S. Army Environmental Hygiene Agency's Guidelines for Controlling Potential Health Hazards from Radiofrequency Radiation*, TG No. 153.
- U.S. Army Kwajalein Atoll, 1991. *Range Safety Manual, Kwajalein Missile Range*, 21 June.
- U.S. Army Space and Strategic Defense Command, 1992a. *Wake Island Manday Projection of SDIO Projects and Wake Island Base Operation Support Services Cost Sharing – Fiscal Year 1993*.
- U.S. Army Space and Strategic Defense Command, 1992b. *Launch Vehicles Reference Guide*, October.
- U.S. Army Space and Strategic Defense Command, 1993a. *Draft Supplemental Environmental Impact Statement, Proposed Actions at U.S. Army Kwajalein Atoll*, March.
- U.S. Army Space and Strategic Defense Command, 1993b. *Programmatic Environmental Assessment for the Theater Missile Defense Lethality Program*, August.
- U.S. Army Space and Strategic Defense Command, 1993c. *Theater Missile Defense Target Systems Environmental Assessment*, in progress.
- U.S. Army Space and Strategic Defense Command, 1993d. *Draft Theater High Altitude Area Defense Initial Development Program Environmental Assessment*, in progress.
- U.S. Army Space and Strategic Defense Command, 1993e. *Description of Proposed Action and Alternatives for the Demonstration/Validation Phase of the Theater High Altitude Area Defense Program*, 3 March.
- U.S. Army Space and Strategic Defense Command, 1993f. *TMD Extended Test Range Environmental Impact Statement (ETRIES) Questionnaire*, May.
- U.S. Army Space and Strategic Defense Command, 1993g. *Ground-Based Radar (GBR) Family of Strategic and Theater Radars Environmental Assessment*, June.
- U.S. Army Space and Strategic Defense Command, 1993h. *Wake Atoll Real-property Master Plan*, March.
- U.S. Army Strategic Defense Command, 1987. *Project Starbird Environmental Assessment*, October.
- U.S. Army Strategic Defense Command, 1989. *Draft Environmental Impact Statement, Proposed Actions at U.S. Army Kwajalein Atoll*, June.
- U.S. Army Strategic Defense Command, 1991. *Extended Range Intercept Technology Environmental Assessment*, September.

- U.S. Army Strategic Defense Command, 1992a. *Theater Missile Defense Target Program Technical Requirements Document*, 3 February.
- U.S. Army Strategic Defense Command, 1992b. *Description of Proposed Action and Alternatives for the Demonstration/Validation Phase of the Theater High Altitude Area Defense Program*, 19 June.
- U.S. Army Strategic Defense Command, 1992c. *Environmental Assessment for the Theater Missile Defense Countermeasures Mitigation Program*, September.
- U.S. Army Strategic Defense Command, 1992d. *Sea Launch Target Delivery System Feasibility Study, SYT 92-TP-001*, March.
- U.S. Department of Defense, 1979. *Environmental Effects in the United States of Department of Defense Actions*, DOD Directive 6050.1, 30 July.
- U.S. Department of Defense, 1990. *Draft Starbird Launch Facilities Archaeological Monitoring, Wake Island Airfield, Wake Island*, September.
- U.S. Department of Health and Human Services, 1990. *NIOSH Pocket Guide to Chemical Hazards*, U.S. Government Printing Office, Washington, DC.
- U.S. Department of Labor, 1981. *Occupational Noise Exposure*, 29 Code of Federal Regulations Part 1910, Occupational Safety and Health Administration.
- U.S. Department of the Air Force, 1990. *Explosives Safety Standards*, Air Force Regulation 127-100, 3 August.
- U.S. Department of the Air Force, 1992. *DET 4 Wake Island Mission Statement*, 15th Air Base Wing.
- U.S. Department of the Army, 1985. Regulation 385-100, *Safety Manual*, 1 August.
- U.S. Department of the Army, 1987. Regulation 385-64, *Ammunition and Explosives Safety Standards*.
- U.S. Department of the Army, 1988. Army Regulation 200-2, *Environmental Effects of Army Actions*, 23 December.
- U.S. Department of the Army, 1991. *Army Tactical Missile System Site-Specific Environmental Assessment for White Sands Missile Range, New Mexico*, November.
- U.S. Environmental Protection Agency, 1971. *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances*, NTID300.1, Washington, DC.

- U.S. Environmental Protection Agency, 1974. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, 550/9-74-004, U.S. Government Printing Office, Washington, DC.
- U.S. Environmental Protection Agency, 1985a. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fourth Edition*, including supplements A, B, C, and D, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.
- U.S. Environmental Protection Agency, 1985b. *Compilation of Air Pollutant Emission Factors, Volume II: Mobile Sources, Fourth Edition*, including Supplement A, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.
- U.S. Environmental Protection Agency, 1990. *Users Guide to TSCREEN-A Model for Screening Toxic Air Pollutant Concentrations*, EPA-450/4-90-013, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.
- U.S. Environmental Protection Agency, 1992. *Health Effects and Dose-response Assessment for Hydrogen Chloride Following Short-term Exposure*, EPA-450/3-92-003, Air Risk Information Support Center, Research Triangle Park, North Carolina.
- U.S. Fish and Wildlife Service, 1992. *Endangered and Threatened Wildlife and Plants*, 50 Code of Federal Regulations 17.11 & 17.12, 29 August.
- Vandagriff, R., 1993. Personal communication between Vandagriff, U.S. Army Space and Strategic Defense Command, and The Earth Technology Corporation regarding the number of test flights from Wake Island in the last 2 years, 15 April.
- Williams, J., 1993a. Personal communication between Williams, U.S. Army Space and Strategic Defense Command, and The Earth Technology Corporation regarding target system launch requirements, 14 April.
- Williams, J., 1993b. Personal communication between Williams, U.S. Army Space and Strategic Defense Command, and the Earth Technology Corporation regarding meteorological rockets, 25 August.

6.0
List of Preparers

6.0 LIST OF PREPARERS

U.S. ARMY STRATEGIC DEFENSE COMMAND

Dennis R. Gallien, Environmental Engineer
U.S. Army Space and Strategic Defense Command
B.S., 1979, Industrial Chemistry, University of North Alabama
Years of Experience: 13

Linda Ninh, Environmental Engineer
U.S. Army Space and Strategic Defense Command
B.S., 1984, Chemical Engineering, Georgia Institute of Technology
Years of Experience: 9

CONTRACTORS

Mark Bennett, Senior Staff Environmental Specialist
The Earth Technology Corporation
B.S.E., 1982, Bioengineering, University of Pennsylvania
Ph.D., 1990, Chemical Engineering, Massachusetts Institute of Technology
Years of Experience: 4

James T. Berdach, Project Ecologist
MBA International
B.A., 1972, General Science, University of Rochester
M.S., 1976, Botany, University of Minnesota, St. Paul
Years of Experience: 9

Cheri Bogart, Staff Environmental Specialist
The Earth Technology Corporation
B.S., 1988, Biology, Shippensburg University
Years of Experience: 3

William A. Brewer, Vice President, Pacific Basin Services
MBA International
B.A., 1966, Biology, California State University, Northridge
M.S., 1970, Biology, California State University, Northridge
Years of Experience: 30

Lucia Cape, Technical Editor
The Earth Technology Corporation
B.A., 1990, Journalism, University of Georgia
Years of Experience: 3

Jon A. Ciarletta, Consultant
Acentech Incorporated
M.A., 1990, Experimental Psychology, California State University, Northridge
B.A., 1987, Psychology, California State University, Northridge
Years of Experience: 5

J.K. (Pete) Finney, Archaeologist/Senior Project Environmental Professional
The Earth Technology Corporation
B.A., 1973, Business Administration, University of Arkansas
M.A., 1989, Anthropology, University of Arkansas
Years of Experience: 15

Dave Fuller, Principal Technologist
Teledyne Brown Engineering
B.S., 1978, Biology, Missouri Southern State College
M.S., 1980, Biology, Pittsburg State College
Years of Experience: 13

Evangeline Funk, Botanical Consultant
MBA International (Associate)
B.S., 1974, Botany, University of Hawaii
M.S., 1976, Botany, University of Hawaii
Ph.D., 1988, Botany, University of Hawaii
Years of Experience: 20

Quent Gillard, Senior Environmental Specialist
The Earth Technology Corporation
B.A., 1969, Geography, University of Nottingham, United Kingdom
M.S., 1972, Geography, Southern Illinois University
Ph.D., 1975, Geography, University of Chicago
Years of Experience: 23

Donald G. Hagedorn, Project Environmental Specialist
The Earth Technology Corporation
B.A., 1989, Economics, Loyola Marymount University
Years of Experience: 4

H. Lee Jones, Ornithologist
MBA International
B.S., 1968, Zoology, North Carolina State University, Raleigh
M.S., 1970, Biology, University of California, Los Angeles
Ph.D., 1975, Biology, University of California, Los Angeles
Years of Experience: 19

Joseph Meyer, Consultant
Acentech Incorporated
B.S., 1986, Mechanical Engineering, Kansas State University
Years of Experience: 6

Ramon E. Nugent, Manager, Environmental and Industrial Acoustics
Acentech Incorporated
B.S., 1969, Engineering Science, Iowa State University
Years of Experience: 23

Michael E. Osburn, Senior Geologist
The Earth Technology Corporation
B.A., 1976, Earth Sciences, California State University, Fullerton
Years of Experience: 15

Robert M. Poll, Health and Safety Manager
The Earth Technology Corporation
B.S., 1985, Nuclear Engineering, Rensselaer Polytechnic Institute
Years of Experience: 8

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix A

LIST OF RELEVANT ENVIRONMENTAL DOCUMENTATION

- Strategic Defense Initiative Organization, 1991. *Environmental Assessment for the Lightweight Exoatmospheric Projectile (LEAP) Test Program*, July.
- Strategic Defense Initiative Organization, 1990. *Environmental Assessment for the Brilliant Pebbles Experiment Program* (Unclassified title), April, Classified document.
- Strategic Defense Initiative Organization and U.S. Army Space and Strategic Defense Command, 1993. *Draft Theater Missile Defense Programmatic Life-Cycle Environmental Impact Statement*, October.
- U.S. Army Space and Strategic Defense Command, 1993. *Environmental Assessment, Ground Based Radar (GBR) Family of Strategic and Theater Radars*, June.
- U.S. Army Space and Strategic Defense Command, 1993. *Environmental Management Plan for the Real-property Master Planning and Environmental Analysis for Wake Island*, May.
- U.S. Army Space and Strategic Defense Command, 1993. *Programmatic Environmental Assessment, Theater Missile Defense Lethality Program*, August.
- U.S. Army Strategic Defense Command, 1987. *Project Starbird Environmental Assessment*.
- U.S. Army Strategic Defense Command, 1989. *Draft Environmental Impact Statement, Proposed Actions at U.S. Army Kwajalein Atoll*, June.
- U.S. Army Strategic Defense Command, 1989. *Final Environmental Impact Statement, Proposed Actions at U.S. Army Kwajalein Atoll*, October.
- U.S. Army Strategic Defense Command, 1990. *Environmental Assessment for the Exoatmospheric Discrimination Experiment*, September.
- U.S. Army Strategic Defense Command, 1992. *Theater Missile Defense Countermeasures Mitigation Program Environmental Assessment*, September.
- U.S. Department of the Air Force, 1990. *Environmental Assessment, Starlab Program*, August.
- U.S. Department of the Army, 1991. *Army Tactical Missile System Site-Specific Environmental Assessment*, White Sands Missile Range, New Mexico, November.

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix B

ENVIRONMENTAL ATTRIBUTES, APPLICABLE LAWS AND REGULATIONS, AND COMPLIANCE REQUIREMENTS

The following Federal environmental laws and regulations were reviewed to assist in determining the significance of environmental impacts under the National Environmental Policy Act.

Air Quality – The Clean Air Act seeks to achieve and maintain air quality to protect public health and welfare (42 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 air emission standards for beryllium, mercury, asbestos, vinyl chloride, and other hazardous materials including radioactive materials.

The Clean Air Act also seeks to prevent significant deterioration 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 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 eight 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, Miscellaneous Provisions, similar to Title IV, addresses issues concerned with acid rain reduction.

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.

The 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 species or threatened species or result in the destruction or adverse modification of habitat of such species.

The Bald and Golden Eagle Protection Act establishes penalties for the unauthorized taking, possession, selling, purchase, or transportation of bald or golden eagles, their nests, or

their eggs (16 USC 668 et seq.). Any Federal activity that might disturb eagles requires consultation with the USFWS for appropriate mitigation.

In 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 to 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.

Cultural Resources – The Historic Sites Act of 1935 authorizes the Secretary of the Interior to designate areas as national natural landmarks for listing on the National Registry of Natural Landmarks (16 USC 461 et seq.). In conducting an environmental review of a proposed Department of Defense (DOD) action, the responsible official shall consider the existence and location of natural landmarks using information provided by the National Park Service pursuant to 35 Code of Federal Regulations (CFR) 62.6(d) to avoid undesirable impacts upon such landmarks.

Under Section 106 of the National Historic Preservation Act (16 USC 470 et seq.) and Executive Order 11593, if an DOD undertaking affects any property with historic, architectural, archaeological, or cultural value that is listed on or eligible for listing on the National Register of Historic Places, the responsible official shall comply with the procedures for consultation and comment promulgated by the Advisory Council on Historic Preservation in 36 CFR Part 800. The responsible official must identify properties affected by the undertaking that are potentially eligible for listing on the National Register and shall request a determination of eligibility from the Keeper of the National Register, Department of the Interior, under the procedures in 36 CFR Part 63.

Under the National Historic Preservation Act, if an DOD activity may cause irreparable loss or destruction of significant scientific, prehistoric, historic, or archaeological data, the responsible official or the Secretary of the Interior is authorized to undertake data recovery and preservation activities. Data recovery and preservation activities shall be conducted in accordance with implementing procedures promulgated by the Secretary of the Interior.

Army Regulation 420-40 – This Army regulation prescribes management responsibilities and standards for the treatment of historic properties including buildings, structures, objects, districts, sites, archaeological materials, and landmarks on land controlled or used by the Army. It describes the steps for locating, identifying, evaluating, and treating historic properties in compliance with the National Historic Preservation Act. It explains how these steps can be made through a Historic Preservation Plan and, as required, in consultation with the Advisory Council and the appropriate State Historic Preservation Officer.

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 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 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 Superfund Amendments and Reauthorization Act (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.

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.

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix C

DISTRIBUTION LIST

FEDERAL AGENCIES

Advisory Council on Historic Preservation
Western Office of Project Review
730 Simms Street, Room 401
Golden, CO 80401

Army Environmental Office
Attn: ENVR-EP, Room 1E677
The Pentagon
Washington, DC 20310

Assistant for Environmental Projects
OASA (IL&E), Room 3E613
The Pentagon
Washington, DC 20310-7100

Ballistic Missile Defense Organization
Attn: GST
The Pentagon
Washington, DC 20301-7100

Commander, 15th Air Base Wing
Attn: 15LG/CD
800 Scott Circle
Hickam Air Force Base, HI 96853-5328

Commander, 15th Air Base Wing
Detachment 1
Wake Island, Pacific

Commander, 15th Civil Engineering Squadron
Attn: 15 CES/DEV
75 H Street
Hickam Air Force Base, HI 96853-5233

Headquarters, Air Combat Command
Attn: CEVA
129 Andrews Street, Suite 102
Langley Air Force Base, VA 23665-2769

Headquarters, Pacific Air Forces/CEV
Attn: Lt. Col. Meister
25 E Street, Suite D306
Hickam AFB, HI 96853-5412

Headquarters, U.S. Air Force
Attn: AF-CEVP, Jack Bush
1260 Air Force
The Pentagon, Room 5B 269
Washington, DC 20030-1260

Office of the Army General Counsel
Room 2E725
The Pentagon
Washington, DC 20310-0104

Office of the Assistant Secretary of the Army (Research,
Development and Acquisition)
Attn: SARD-TC
The Pentagon
Washington, DC 20301-0103

Office of the Chief of Legislative Liaison
Room 2C638
The Pentagon
Washington, DC 20310-1600

Office of the Chief of Public Affairs
Attn: SAPA-PCD, Room 2E637
The Pentagon
Washington, DC 20310-1504

Office of the Deputy Chief of Staff for Operations and Plans
Attn: DAMO-FDE
The Pentagon
Washington, DC 20310-0103

Office of Federal Activities
Environmental Protection Agency
401 M Street SW
Mall Code A104
Washington, DC 20460

Office of the Judge Advocate General
Litigation Center, Environmental Law Division
901 North Stuart Street
Arlington, VA 22203-1837

Office of the Surgeon General
Attn: SGSP-PSP
5109 Leesburg Pike, Room 606
Falls Church, VA 22040-3258

Program Executive Office, Missile Defense
Attn: SFAE-MD-TMD/NMD-SS
P.O. Box 1500
Huntsville, AL 35807-3801

U.S. Army Space and Strategic Defense Command
CSSD/EN-F/IN-CS/KA-LV/LC/PA/SO/TE-O/TE-T/HO/EA
P.O. Box 1500
Huntsville, AL 35807-3801

U.S. Department of Commerce
National Marine Fisheries Service
Pacific Islands Environmental Coordinator
2570 Dole Street
Honolulu, HI 96822-2396

U.S. Department of Defense
Electromagnetic Compatibility Analysis Center, ECAC-CS
120 Worthington Basin
Annapolis, MD 21402-5064

U.S. Department of the Interior
U.S. Fish and Wildlife Service
P.O. Box 50167
Honolulu, HI 96850

U.S. Representative Office
P.O. Box 680
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

LIBRARIES

Alele Museum/Library
c/o Ministry of the Interior and Outer Island Affairs
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

Defense Technical Information Center
FDAC Division
Cameron Station
Alexandria, VA 22304-6145

Grace Sherwood Library
Kwajalein Island
U.S. Army Kwajalein Atoll 96555

Huntsville Public Library
P.O. Box 443
Huntsville, AL 35804

UAH Library
University of Alabama at Huntsville
Huntsville, AL 35899

U.S. Army Space and Strategic Defense Command
CSSD-IM-PA
Huntsville, AL 35807-3801

Appendix D

AIR QUALITY MODELING ANALYSIS

Launch operations constitute the largest source of uncontrolled emissions into the atmosphere. 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 and oxidizers.

Theater Missile Defense (TMD) activities at Wake Island may include the launch of both target and defensive missiles. Potential first-stage/second-stage target missile configurations are:

- SR19-AJ-1/M57A-1
- SR19-AJ-1/Orbis I
- Castor IVB/M57A-1
- Castor IVB/Orbis I
- Castor IV/M57A-1
- Castor IV/Orbis I
- M56A-1/M57A-1
- M56A-1/Orbis I

The combustion products for the SR19-AJ-1, M56A-1, M57A-1, and Castor IVB are given in table D-1. The chemical species listed in table D-1 are those that occur shortly after the exhaust exits the rocket motor nozzle. It is likely that, because of the high temperature of the exhaust (typically in excess of 1,650° Celsius (C) [3,000° Fahrenheit {F}]), 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.

Two configurations, the SR19-AJ-1/M57A-1 and Castor IVB/M57A-1, were chosen as the most conservative cases for the different representative configurations, and their air quality impacts are analyzed here.

The major emission products from rocket motors are carbon monoxide, aluminum oxide, and hydrogen chloride. Carbon monoxide is a criteria pollutant and will be compared to the National Ambient Air Quality Standards (NAAQS) (table 2-1).

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 particulate matter with an aerodynamic diameter less than or equal to a nominal 10 microns (PM-10) and then compared to the NAAQS. Also, the aluminum oxide concentrations were compared to the 8-hour American Conference of Governmental Industrial Hygienists (ACGIH) standard given in table 2-2. This standard is also not specific to aluminum oxide but is a standard for any dust with no asbestos and less than 1 percent crystalline silica.

Table D-1: Combustion Products for Selected Rocket Motors in Kilograms (Pounds)

<i>Species</i>	<i>M57A-1</i>	<i>M56A-1</i>	<i>SR19-AJ-1</i>	<i>Castor IVB</i>
Al_2O_3	533 (1,174)	1,472 (3,246)	1,767 (3,886)	3,761 (8,292)
CO	420 (927)	1,212 (2,672)	1,327 (2,919)	2,230 (4,916)
HCl	331 (731)	852 (1,879)	1,402 (3,084)	2,062 (4,545)
N_2	135 (297)	382 (842)	545 (1,200)	822 (1,811)
H_2O	148 (325)	430 (947)	776 (1,708)	624 (1,376)
H_2	39 (87)	106 (234)	117 (257)	235 (519)
CO ₂	48 (106)	106 (233)	288 (633)	184 (407)
Other	3.5 (7.7)	148 (326)	74 (164)	51 (112)
Total	1,658 (3,655)	4,708 (10,340)	6,296 (13,851)	9,969 (21,978)

Sources: U.S. Army Space and Strategic Defense Command, 1993; Daley, 1993; Bowles, 1993.

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

Flight Scenarios

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

During a normal launch scenario the missile accelerates while the rocket motor of the missile burns. This boost stage normally lasts only a few minutes (e.g., for a nominal M56A-1/M57A-1 TMD target flight the boost stage lasts only 117 seconds [Coleman Research Corporation, 1993a]). 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 have the potential to effect 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 occurs from ground level to an altitude of approximately 15 kilometers (km) (9.4 miles [mi]) (Seinfeld, 1986). For the nominal M56A-1/M57A-1 flight, the missile is above the troposphere in less than 60 seconds and has traveled approximately 20 km (12 mi) downrange by that time (Coleman Research Corporation, 1993a).

The combustion products' exhaust is much hotter than the ambient air (e.g., approximately 1,900° C (3,500°F) for the SR19-AJ-1 [Coleman Research Corporation, 1993a]). Because of this, buoyancy causes the cloud of rocket exhaust released near the ground to

rise until it reaches an equilibrium height. For missiles similar to the TMD target missile, the ground cloud is expected to rise to heights of 300 meters (m) (984 feet [ft]) or more (Strategic Defense Initiative Organization, 1991). This process is discussed in detail in the Space Shuttle Advanced Solid Rocket Motor Program Supplemental EIS (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 (Environmental Protection Agency, 1972). The reason that pollutants emitted above these excluding layers have little or no effect on ambient air quality is that 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 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, because of 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 possibly 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 (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* (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 (Environmental Protection Agency, 1993).

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 value discharges. TSCREEN PUFF is programmed to select the atmospheric stability class that yields the maximum ground-level pollutant concentration. (Environmental Protection Agency, 1988; 1993).

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 missiles 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 stage of the target missile: either the SR19-AJ-1 or the Castor IVB. The Castor IVB has the largest amount of emissions of any of the first-stage rocket motors under consideration.

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; Department of the Air Force, 1988). As mentioned earlier, the final altitude for ground clouds for missiles similar to the TMD target missile are expected to be 300 m (984 ft) or more (Strategic Defense Initiative Organization, 1991). Following the example of the previous analysis (Strategic Defense Initiative Organization, 1991), the conservative value of 200 m (656 ft) was chosen for the release height.

Furthermore, the TSCREEN PUFF model uses the conservative values of 320 m (1,050 ft) 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 makes the very conservative value of 1 m/s for the wind speed. Stronger wind speeds tend to more quickly disperse, and thus dilute, the emitted pollutants. Also, it should be noted that typical wind speeds are greater than 1 m/s for the proposed launch site.

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 and all emissions from the second-stage rocket motor. For a missile failure with this type of total conflagration, the final rise height of the ground cloud would be greater than that for a normal launch because of the greater amount of energy released and, thus, higher 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 value as for normal launches, 200 m (656 ft), was 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 (Turner, 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. A value of p between 0.17 and 0.20 is normally used (Turner, 1970). This method is more reliable for shorter than for longer time periods and for continuous rather 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 are given in tables D-2 and D-4. The results are clearly below the corresponding NAAQS and guideline values.

Results from the air quality modeling for the missile failure accident scenario are given in tables D-3 and D-5. Again, with only one exception, the computed values are well below the applicable NAAQS and guideline values. The one exception is that the most conservative guidance value, the SPEGL for HCl, is exceeded for distances less than 7 km (4.3 mi) for an on-pad catastrophic failure of an SR19-AJ-1/M57A-1 target missile and for distances less than 10 km (6.2 mi) for an on-pad catastrophic failure of a Castor IVB/M57A-1 target missile.

Since the results from the screening computer model do not exceed the NAAQS nor the exposure guidelines, additional modeling with a refined model, such as the Rocket Exhaust Effluent Diffusion Model: REEDM (Bjorkland, 1990), was not done. As more details become available for TMD activities, such refined modeling may be necessary.

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 that (1) emissions from the largest rocket motor were used, (2) all of the emissions from this first-stage rocket motor were assumed to be released near the ground for the normal launch scenario, (3) all of the emission from the first-stage rocket motor plus all of the emissions from the second-stage rocket motor were assumed to be released near the ground for the missile failure accident scenario, (4) all of the aluminum oxide released was assumed to be PM-10, (5) a very low wind speed of 1 m/s was used, and (6) a fairly low mixing height of 320 m (1,050 ft) was used.

Table D-2: Estimated Concentration from Normal Launch Conditions for an SR19-AJ-1 (mg/m³)^a

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)
Hydrogen	1,401.8	1 hour	6	MLE ^b	0.963	1.684	1.371	1.006	0.719	0.465
Chloride	(3,090.4)	15 minutes	20	MLE ^b	3.854	6.453	4.365	2.611	1.727	0.821
Carbon	1,327.0	8 hours	10	NAAQS ^c	0.602	1.052	0.856	0.628	0.449	0.291
Monoxide	(2,925.5)	1 hour	40	NAAQS ^c	0.912	1.594	1.298	0.952	0.681	0.441
Aluminum	1,766.6	8 hours	10	TLV-TWA ^d	0.801	1.400	1.140	0.836	0.598	0.387
Oxide	(3,894.6)	1 hour	-	-	1.214	2.122	1.727	1.267	0.906	0.587

^aValues used in TSCREEN PUFF model (Environmental Protection Agency, 1990):

release height = 200 m (656.2 ft)

wind speed = 1 m/s (3.3 ft/s)

mixing height = 320 m (1,049.7 ft)

^bMaximum Likelihood Estimate (Environmental Protection Agency, 1992)

^cNational Ambient Air Quality Standards (40 CFR 50.109)

^dThreshold Limit Value - Time-weighted Average (American Conference of Government Industrial Hygienists, 1992)

Table D-3: Estimated Concentration from Two-stage Accident Conditions for an SR19-AJ-1 and M57A-1 (mg/m³)^a

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)
Hydrogen	1,733.2	1 hour	30	EEGL ^b	1.191	2.082	1.695	1.243	0.889	0.576
Chloride	(3,821)	1 hour	1.5	SPEGL ^c						
Carbon	1,747.5	8 hours	10	NAAQS ^d	0.792	1.384	1.128	0.827	0.592	0.383
Monoxide	(3,852)	1 hour	40	NAAQS ^d	1.201	2.099	1.709	1.254	0.897	0.580
Aluminum	2,299.3	8 hours	10	TLV-TWA ^e	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

^aValues used in TSCREEN PUFF model (Environmental Protection Agency, 1990):

release height = 200 m (656.2 ft)

wind speed = 1 m/s (3.3 ft/s)

mixing height = 320 m (1,049.7 ft)

^bEmergency Exposure Guidance Level (National Research Council, 1987)

^cShort-term Public Emergency Guidance Level (National Research Council, 1987)

^dNational Ambient Air Quality Standards (40 CFR 50.109)

^eThreshold Limit Value - Time-weighted Average (American Conference of Government Industrial Hygienists, 1992)

Table D-4: Estimated Concentration from Normal Launch Conditions from a Castor IVB (mg/m³)^a

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)
Hydrogen	2,062	1 hour	6	MLE ^b	1.417	2.477	2.016	1.479	1.058	0.685
Chloride	(4,546)	15 minutes	20	MLE ^b	5.668	9.492	6.421	3.840	2.540	1.209
Carbon	2,230	8 hours	10	NAAQS ^c	1.011	1.767	1.439	1.056	0.755	0.488
Monoxide	(4,916)	1 hour	40	NAAQS ^c	1.533	2.679	2.181	1.600	1.144	0.740
Aluminum	3,761	8 hours	10	TLV-TWA ^d	1.705	2.981	2.426	1.780	1.273	0.824
Oxide	(8,292)	1 hour	-	-	2.585	4.518	3.678	2.698	1.930	1.249

^aValues used in TSCREEN PUFF model (Environmental Protection Agency, 1990):
 release height = 200 m (656.2 ft)
 wind speed = 1 m/s (3.3 ft/s)
 mixing height = 320 m (1,049.7 ft)

^bMaximum Likelihood Estimate (Environmental Protection Agency, 1992)

^cNational Ambient Air Quality Standards (40 CFR 50.109)

^dThreshold Limit Value - Time-weighted Average (American Conference of Government Industrial Hygienists, 1992)

Table D-5: Estimated Concentration from Two-stage Accident Conditions for Castor IVB and M57A-1 (mg/m³)^a

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)
Hydrogen	2,393	1 hour	30	EEGL ^b	1.645	2.875	2.340	1.717	1.228	0.795
Chloride	(5,276)	1 hour	1.5	SPEGL ^c						
Carbon	2,650	8 hours	10	NAAQS ^d	1.201	2.101	1.709	1.254	0.897	0.581
Monoxide	(5,842)	1 hour	40	NAAQS ^d	1.821	3.184	2.591	1.901	1.360	0.880
Aluminum	4,294	8 hours	10	TLV-TWA ^a	1.947	3.404	2.770	2.032	1.453	0.941
Oxide	(9,467)	1 hour	-	-	2.951	5.159	4.199	3.080	2.203	1.426

^aValues used in TSCREEN PUFF model (Environmental Protection Agency, 1990):
 release height = 200 m (656.2 ft)
 wind speed = 1 m/s (3.3 ft/s)
 mixing height = 320 m (1,049.7 ft)

^bEmergency Exposure Guidance Level (National Research Council, 1987)

^cShort-term Public Emergency Guidance Level (National Research Council, 1987)

^dNational Ambient Air Quality Standards (40 CFR 50.109)

^aThreshold Limit Value - Time-weighted Average (American Conference of Government Industrial Hygienists, 1992)

REFERENCES

- American Conference of Governmental Industrial Hygienists, 1992. *1992-1993 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*, Cincinnati, Ohio.
- Bjorkland, J., 1990. *User's Manual for the REEDM Version 7 (Rocket Exhaust Effluent Diffusion Model) Computer Program*, H. E. Cramer Company, Incorporated, 136 West Burton Avenue, Salt Lake City, Utah.
- Coleman Research Corporation, 1993a. *Theater Missile Defense (TMD) Targets Program, Preliminary Design Review (PDR) – Range B*, May.
- Coleman Research Corporation, 1993b. *Defense Target Program Description of Proposed Action and Alternatives (DOPAA)*, January.
- Dailey, J., 1993. Personal communication between Dailey, Coleman Research Corporation, and The Earth Technology Corporation regarding amounts of propellant in M56A-1, M57A-1, and SR19-AJ-1 rocket motors, 6 April.
- Environmental Protection Agency, 1972. *Mixing Heights, Winds Speeds, and the Potential for Urban Air Pollution Throughout the Contiguous United States*, EPA AP-101, Office of the Air Programs, Research Triangle Park, North Carolina.
- Environmental Protection Agency, 1993. *Supplement B to the Guideline on Air Quality Models (Revised) – 1986*, EPA-450/2-78-027R, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.
- Environmental Protection Agency, 1988. *A Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*, EPA-450/4-88-009, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.
- Environmental Protection Agency, 1990. *Users Guide to TSCREEN – A Model for Screening Toxic Air Pollutant Concentrations*, EPA-450/4-90-013, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.
- Environmental Protection Agency, 1992. *Health Effects and Dose-response Assessment for Hydrogen Chloride Following Short-term Exposure*, EPA-450/3-92-003, Air Risk Information Support Center, Research Triangle Park, North Carolina.
- National Aeronautics and Space Administration, 1990. *Supplemental Final Environmental Impact Statement for the Space Shuttle Advanced Solid Rocket Motor Program*, August.
- National Research Council, 1987. *Emergency and Continuous Exposure Guidance Levels for Selected Airborne Contaminants, Volume 7, Ammonia, Hydrogen Chloride, Lithium Bromide, and Toluene*, prepared by the Committee on Toxicology for the U.S. Department of the Army.

Seinfeld, J., 1986. *Atmospheric Chemistry and the Physics of Air Pollution*, John Wiley & Sons, New York, New York.

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

Turner, D.B., 1970. *Workbook of Atmospheric Dispersion Estimates*, Air Resources Field Office, Environmental Sciences Services Administration, U.S. Department of Health, Education, and Welfare, Public Health Service, Environmental Health Service, National Air Pollution Control Administration, Cincinnati, Ohio.

U.S. Department of the Air Force, 1988. *Environmental Assessment for the Titan IV Solid Rocket Motor Upgrade Testing at Edwards Air Force Base, California*, 10 May.

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix E

NOTICE

This Ornithological Survey assesses some specific activity locations that were part of the proposed action at the time of the survey but were later removed from consideration. However, the data have been left in the report to provide baseline information for future studies. Additionally, this survey does not discuss some new facility construction locations in the proposed action that were identified after the field investigation was completed. The environmental assessment for these additional facilities was developed from the survey report and from unpublished field notes.

THIS PAGE INTENTIONALLY LEFT BLANK

ORNITHOLOGICAL SURVEY REPORT

FOR

**ENVIRONMENTAL ASSESSMENT FOR
LONG-TERM ACTIVITIES AT WAKE ATOLL**

**Principal Investigator and Author:
H. Lee Jones, Ph.D.**

Prepared by:

**MBA INTERNATIONAL
1188 Bishop Street, Suite 3411
Honolulu, Hawaii 96813.3314**

Contacts:

**William A. Brewer
James T. Berdach**

April 1993

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
<i>ABSTRACT</i>	i
1 INTRODUCTION	1
2 METHODOLOGY	2
3 RESULTS	3
3.1 Species Accounts	3
3.2 Other Observations	15
4 DISCUSSION	16
4.1 Sensitive Species	16
4.2 Environmental Considerations	16
4.3 Mitigation Measures	18
5 REFERENCES	19

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Location Map, Bird Sitings, Wake Island	5
2. Seabird Nesting Locations, Wilkes Island	7

Abstract

Approximately 10 species of seabirds and one species of rail, now extinct, have been recorded breeding or attempting to breed on Wake Atoll (Pratt et al. 1987; Rowland 1989a, 1989b; Sutherland 1989). All but one of these species (Laysan albatross) were observed during a field survey conducted from March 24 to April 1, 1993, and breeding activity was documented for five. Sooty terns (*Sterna fuscata*) were clearly the most abundant species on the island and were in the midst of breeding during the field survey period. A second species of tern, the brown noddy (*Anous stolidus*), was present in much smaller numbers and was in the nest construction and egg-laying phase of breeding. Three species of booby were present; two, the red-footed booby (*Sula sula*) and brown booby (*Sula leucogaster*), were nesting, and a third, the masked booby (*Sula dactylatra*), although present in small numbers, was apparently not breeding. One species of tropicbird, the red-tailed tropicbird (*Phaethon rubricauda*) was nesting, but another species reported to breed on Wake Atoll, the white-tailed tropicbird (*Phaethon lepturus*), was seen only once and was believed not to be breeding. Other species present, but apparently not breeding, were black-footed albatross (*Diomedea nigripes*), great frigatebird (*Fregata minor*), gray-backed tern (*Sterna lunata*), black noddy (*Sterna minutus*), and white tern (*Gygis alba*). The latter three species are not known to breed on Wake Island, although suitable habitat and conditions are apparently present.

Six additional transient species were observed, the most common being the Asian golden-plover (*Pluvialis fulva*), a common winter visitor on the island (Pratt et al.). Others observed were ruddy turnstone (*Arenaria interpres*), wandering tattler (*Tringa incana*), Siberian (gray-tailed) tattler (*Tringa brevipes*), and short-eared owl (*Asio flammeus*).

SECTION 1 INTRODUCTION

Surveys were conducted on Wake Atoll during the period March 24 to April 1, 1993, by a professional field ornithologist. The purpose of the surveys was to delineate the avifauna present on the atoll and to identify potential seabird nesting habitats and sites. In addition, specific sites proposed for long-term activities associated with Theater Missile Defense launch programs and infrastructure improvements were surveyed to determine whether implementation of the stated activities would potentially impact bird populations or nesting habitats. Recommended mitigation measures, aimed at avoiding, minimizing, or compensating for current or future anticipated impacts on bird populations or nesting habitats, are provided.

SECTION 2 METHODOLOGY

An initial reconnaissance survey entailed searching the atoll for seabird colonies (there are no breeding land birds). All seabirds present on the island at the time of the survey, except for tropicbirds, are conspicuous nesters, i.e., they lay their eggs in the open, either on the bare ground or exposed in shrubs or small trees. Tropicbird nests were located by first finding courting or vocalizing adults in flight and observing them until one or more hovered over or landed at a potential nest site. The number of breeding pairs of all but one species, the sooty tern (*Sterna fuscata*), were ascertained on this small atoll by direct count.

Two distinct sooty tern colonies were located, and in each, virtually all birds were in the nestling stage of their current breeding cycle. The colony on Wilkes Island was in an open, grassy area, thus facilitating counting of young birds in sample plots from a distance. Strip censuses were not feasible, as they are only accurate when the terns are on eggs and can be too disruptive when young are present. Young birds will scatter at the approach of humans, making strip-census counts both inaccurate and inadvisable (Harrison 1990). The number of nestlings in this colony was estimated by counting the number of young in a section of the colony through 8 by 42 binoculars from the roof of a vacant one-story building adjacent to the colony and extrapolating the total for the entire colony. Photographs and videotape of the colony were also obtained for later corroboration of these initial counts. The colony dimensions were obtained by pacing the length and widest breadth of the colony from a reasonable distance parallel to the colony in order to minimize disturbance. To ascertain the area of the colony, the shape (and subsequently, the area) of the colony, as viewed from atop an adjacent building, was outlined on a 600-scale (1 inch = 600 feet) map. One transect was walked through the colony to obtain a count of eggs. Additional transects were not deemed necessary, as none of the eggs examined while conducting this transect were viable.

On Peale Island, all young birds encountered along the shoreline during a circuit of the point were counted, as well as all individuals that could be seen in the vegetation adjacent to the shore. The Peale Island colony was too heavily vegetated to obtain more accurate counts.

SECTION 3 RESULTS

The following project sites were examined during the survey: the proposed new power plant site behind the softball field in the housing area; the water catchment basin area; the proposed new incinerator site between the catchment basins and the airfield; both launch complexes near Peacock Point; the proposed batch plant and lay-down areas behind the revetment area on the south side of the runway; and the borrow pit area on Wilkes Island. Several sites (batch plant and lay-down areas, borrow area, and general vicinity of launch pads and incinerator) presented suitable nesting habitat for the red-tailed tropicbird and, perhaps great frigatebird, black noddy, and white tern; however, the latter three species showed no sign of nesting on the island at the time of the survey, and have not been documented breeding at Wake Atoll.¹ All sites were heavily disturbed, although suitable habitat for these shrub-nesting species was plentiful in the general vicinity.

The results of avian surveys, conducted between March 24 and April 1, 1993, are presented below under separate headings for each species. Included in each account is a brief summary of the species' natural history, status on the island, and, where applicable, its breeding biology and breeding history on the island. The locations of bird nesting colonies as well as the sites of other ornithological observations, are noted on figures 1 and 2.

3.1 SPECIES ACCOUNTS

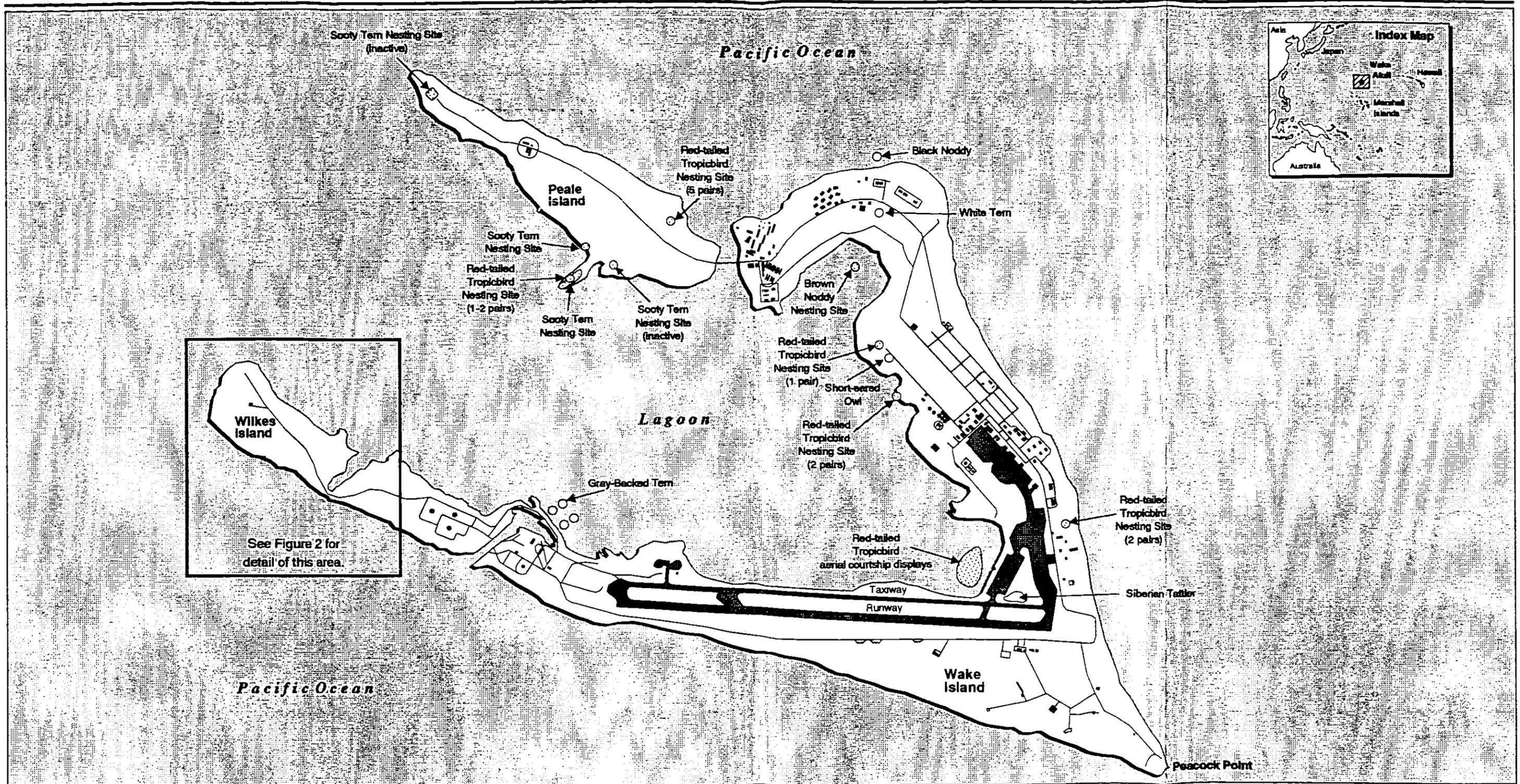
Laysan Albatross *Diomedea immutabilis*. This species breeds in the leeward Hawaiian Islands and in the Bonin Islands south of Japan, and ranges at sea throughout the northern Pacific Ocean (Harrison 1985). It was formerly more common and widespread and may have bred regularly on Wake Island. Laysan albatrosses prefer to nest on open ground close to vegetation, generally away from the shore or sandy areas (Harrison 1990). Like most seabirds, they lay one egg. In Hawaii, they nest during the winter, but it is not clear during what season this species has nested or attempted to nest on Wake Atoll. Typically, they arrive on their breeding island in early November where they lay one egg, usually in early December. Chicks hatch 65 days later and most have fledged by the end of July (Harrison 1990).

Exhibiting strong site fidelity, a pair will typically return to the same patch of land on the same island to breed year after year, and young rarely set foot on an island other than the one on which they were fledged (Harrison 1990). This makes recolonization of islands from which they have been extirpated difficult. Harrison points out that they have failed to recolonize Wake Island nearly a half-century after colonies were destroyed during the war.

Mr. Titian Peale, artist and naturalist on the United States Exploring Expedition in 1841, found "short-tailed albatrosses" here (Bryan 1959), which may have been this species. Rowland (1989b) mentions a 1936 photograph of the old Pan American Airways hotel in the Wake Island Museum that shows an adult Laysan albatross and several downy chicks on the lawn. Bailey (1951) suggests that some species of albatross bred on the island during the period of Japanese occupation in World War II.

¹ Except possibly for the frigatebird.

THIS PAGE INTENTIONALLY LEFT BLANK



EXPLANATION

Sightings of Nesting or Courtship Activity:

Other Sightings:

- Sooty tern nesting sites
- Red-tailed tropicbird nesting sites (no. of pairs)
- Red-tailed tropicbird, aerial courtship display
- Brown noddy nest site

- Black noddy
- Gray-backed tern
- White tern
- Siberian tattler
- Short-eared owl

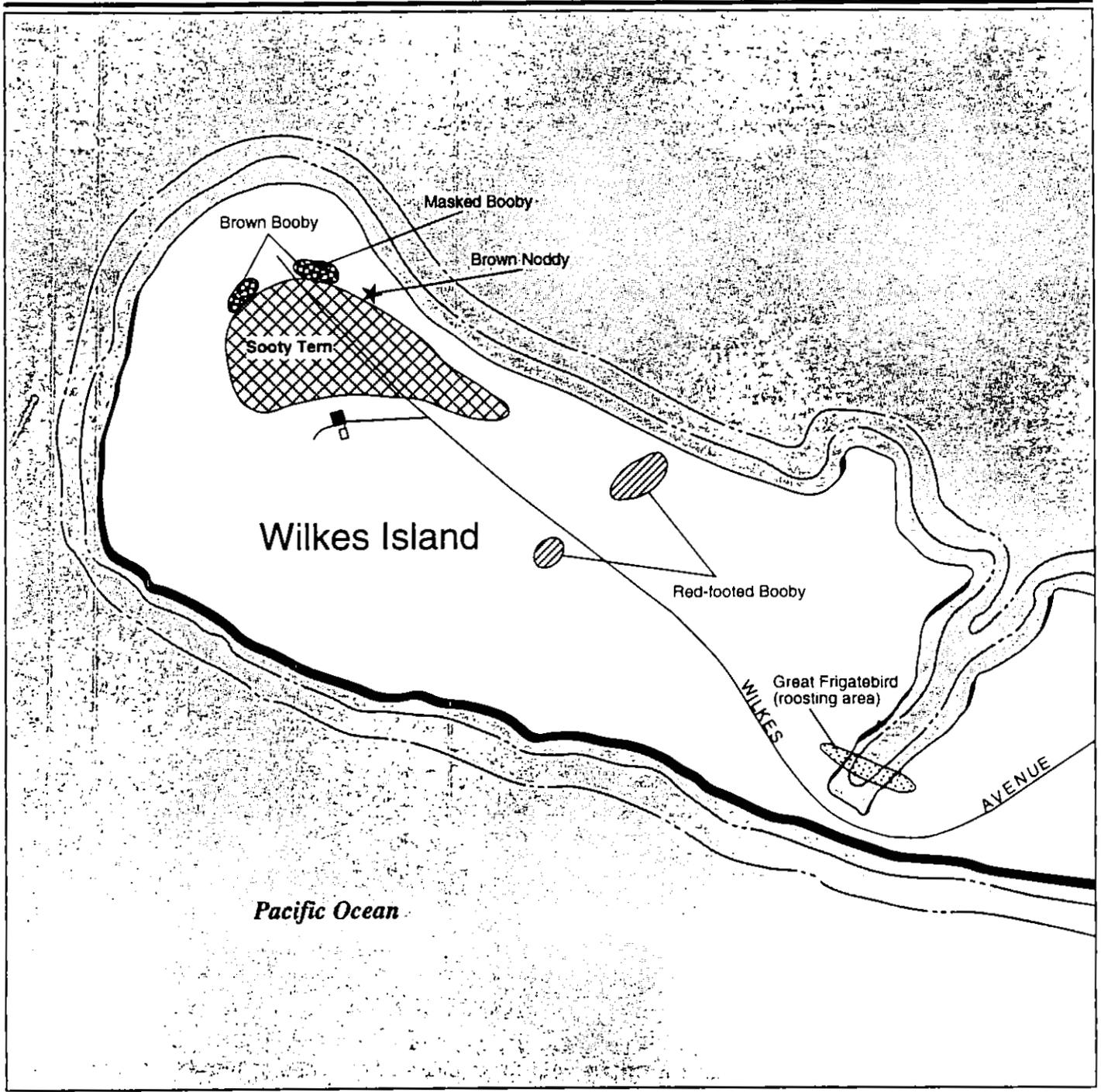


Location Map
Bird Sitings

Wake Island

Figure 1

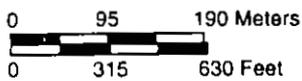
THIS PAGE INTENTIONALLY LEFT BLANK



**Seabird
Nesting
Locations**

Wilkes Island

Figure 2



An American blockade of the island had all but cut off the Japanese from their supply lines, resulting in the starvation of many of the troops during the last few months of their occupation. He quotes from the diary of a Japanese officer stationed on the island at that time: "An order has just come out forbidding us to catch gooney birds [albatrosses] lest they be wiped out." Rowland (1989b) also mentions a possible Laysan albatross nest observed in 1988 and reported to him by island residents.

This species was not observed during the present survey.²

Black-footed Albatross *Diomedea nigripes*. This species has a similar distribution as the Laysan albatross, but also breeds on Taongi Atoll (the nearest point of land to Wake Island) and a few other islands in the North Pacific (Pratt et al. 1987). However, literature references to breeding or suspected breeding on Wake Island were not found. Although it has a similar geographical breeding range as the Laysan, it is much less common, with a world breeding population only one-tenth the size of the Laysan albatross population (Harrison 1990). Unlike Laysan albatrosses, black-footed albatrosses prefer to nest in areas that are exposed to wind-blown sand. They are also winter breeders and have a similar breeding cycle; however, chicks mature faster and fledge about three weeks earlier than Laysans.

Two black-footed albatrosses were seen briefly flying together about 2 kilometers (km) off Peacock Point on March 25, and one was seen flying low over the airstrip on March 31.³

White-tailed Tropicbird *Phaethon lepturus*. This species breeds on many island groups throughout the tropics in the Atlantic, Pacific, and Indian oceans. It breeds primarily on high islands in shaded rock crevices along coastal headlands, but may also nest in reduced numbers on low-lying atolls. White-tails nest in early spring; their incubation period is 41 days and the young fledge 10 to 12 weeks after hatching (Harrison 1990).

² Lou Hitchcock, a civilian employee who has resided on the island for 20 years, has seen this species frequently on the island and showed the writer a number of excellent photographs of pairs in apparent courtship. He said they generally can be found in the closely cropped grassy areas adjacent to the runway where they apparently lay their eggs. However, he has never seen young and believes the feral cats, and possibly rats, prevent them from nesting successfully.

³ Gary Lumia, an Air Force maintenance technician, described up to six large, all-dark "gooney birds" he had seen regularly at Peacock Point for a period of time until about four weeks prior to this survey. He thought they might be nesting because of their courtship activities, but never saw eggs or young. Mr. Hitchcock, however, was not familiar with this species and does not recall seeing any all-dark albatrosses here.

One adult was seen briefly in flight near catchment basins between the personnel housing area and the air terminal on March 25.⁴

Red-tailed Tropicbird *Phaethon rubricauda*. This species has a similar distribution to the white-tailed tropicbird, but is absent from the Atlantic Ocean. Unlike the white-tailed tropicbird, it breeds primarily on atolls and other low-lying islands, generally in bunchgrass, under bushes, or adjacent to bushes that provide some cover (Harrison 1990). When nesting under bushes, they generally require an adjacent clearing or beach devoid of dense vegetation that may impede their access or ability to take flight easily. Pairs nest in spring and lay one egg. The incubation period is 41 days, and young usually hatch in April and fledge 12 to 13 weeks later (Harrison 1990).

The number of red-tailed tropicbirds observed during the eight-day survey period appeared to increase noticeably, suggesting that the survey period coincided with the earliest stages of the breeding cycle. Invariably, nests were found near the shoreline, or under shrubs or small trees with ground-hugging branches. In all, 10 incubating birds were located, and courtship activity was observed in other areas, suggesting additional unseen or not-yet-established nest sites. Nesting or courtship were observed in six more or less distinct areas on Peale Island and on Wake Island proper northwest of the air terminal (figure 1). Each nesting locality consisted of from one to five pairs; all nests were under large bushes or small trees with dense, protective branches and foliage down to ground level. Two or three individuals (probably representing one to two pairs) were seen repeatedly on Flipper Point, but no nests were found. Five more pairs were found nesting under two adjacent *Pemphis acidula* bushes at the upper edge of the shoreline north of the bridge connecting Peale with the main island (figure 1). One nest, although being attended, was empty; the contents of the other four were not determined. On Wake Island, one pair was nesting under a *Pemphis* bush just west of the catchment basin, on a nest containing one egg; two pairs were apparently nesting under a *Pemphis* bush along the lagoon shoreline adjacent to the catchment basins, although their nests were not actually observed (one bird was seen landing beside, and two were heard calling from beneath these two bushes); two pairs were nesting under two adjacent ironwoods (*Casuarina equisetifolia*) on the upper edge of the ocean shoreline just northwest of the air terminal, but the contents of the nests were not determined. All nests observed were nothing more than slight depressions in the leaf litter reasonably well hidden by the overhanging vegetation.

Masked Booby *Sula dactylatra*. This species breeds on islands throughout the tropics and is often found breeding in association with brown boobies. It prefers the perimeter of larger islands (Harrison 1990) where it is usually much more plentiful than the brown booby. On low-lying sandy atolls like Wake, it often nests in sand on the upper beach (Harrison 1990). Masked boobies usually begin nesting in spring. Incubation is 43 to 44 days. Young masked boobies in Hawaii take up to one month longer to fledge than do brown or red-footed boobies (Harrison 1990).

Three masked booby adults were present in the brown booby colonies, and these or other individuals were also seen on nearby offshore rocks at the west end of Wilkes Island (figure 2). No nests, eggs, or young were observed. These birds may have been in the early (pre-egg laying) stages of breeding.

⁴ Mr. Hitchcock sees this species every year and believes that a few breed each year. However, no references could be found in the literature to document breeding on the island, even though most investigators reported seeing 2 or 3 birds during their visits.

Apparently, this species never breeds on Wake in large numbers. Other accounts of this species all refer to less than six pairs. Bryan (1959) mentions that Fosberg saw only a very few on Peale Island in 1953. Rowland (1989b) saw only two active nests, both with chicks, on Wilkes Island in 1989. Sutterfield (1989) saw two masked boobies on eggs in late October 1989.

Brown Booby *Sula leucogaster*. Like the masked booby, this species is pantropical, but on a worldwide basis it is much less common than the masked and red-footed boobies. Most boobies (masked, brown, and red-footed) nest during spring and summer. The brown booby usually nests on substrates with some ground cover, often on the crest of a low ridge near the shore. Brown and masked boobies usually lay two eggs, but sometimes three or only one. The incubation period is the same as for masked boobies, but time to fledging is only three months, one month less than for masked boobies, at least in Hawaii. In both brown and masked boobies, generally only one egg hatches; when both eggs hatch, only one chick survives to fledge.

Two small sub-colonies were located on the outer perimeter of the Wilkes Island sooty tern colony (Exhibit 2). Nests were located just above the upper reaches of the non-vegetated sand/coral beach in grassy vegetation or, in a few cases, adjacent to small tree heliotrope (*Tournefortia argentea*) bushes. This narrow interface between beach and grassy plain was slightly raised in elevation and contained scattered large coral "rocks", giving the area at least some topographic relief. Approximately 56 nests were observed, 30 and 26 respectively, in each colony. No eggs were observed; however, several incubating birds may have been on eggs. Young were observed in all stages of growth from recently hatched to nearly full size downy young with moderate flight feather development. No nest contained more than two young and all nests with well developed young contained only one offspring.

From one to three adult brown boobies were frequently seen feeding from 1 to 2 km off Peacock Point 7 km to the east of the breeding colonies, and occasionally elsewhere, but seldom on the north side of the atoll (off Peale and adjacent portions of Wake).

Rowland (1989b) counted 106 nests on Wilkes Island in April 1989, most with young. Sutterfield (1989) found 148 brown boobies beginning nest construction and two on eggs in late October 1989.

Red-footed Booby *Sula sula*. This species is also pantropical, but unlike other boobies, nests in shrubs anywhere from a few centimeters (cm) to several meters (m) off the ground (Harrison 1990). These boobies build platforms of sticks in which they lay a single egg.

Two small sub-colonies were located in beach heliotrope and naupaka (*Scaevola sericea*) trees near the west end of Wilkes Island (figure 2). These two colonies were approximately 100 m apart at the interface between heliotrope scrub forest and the large grassy field (the Vortac area) at the island's west end, and between 1.5 and 4 m off the ground. Nestlings were observed in approximately one-third of the nests; the other nests may have contained eggs or recently hatched young. No young were more than two thirds grown. Approximately 26 nests were visible from the open grassy field and others were seen inside the scrub "forest", but only to a depth of about 15 m from the Vortac area. Approximately 35 nests in all were estimated to be present.

Frigatebirds were frequently seen perched in the nesting trees and flying in the vicinity of the red-footed booby colony. On one occasion (afternoon of March 25), about 15 frigatebirds had taken up temporary residence in the colony, but no birds were observed taking contents from any of the nests. On one occasion a frigatebird may have attempted to take either the eggs or young from one nest, but it was

fended off by a booby. A feral cat was seen walking beneath the nesting trees on 25 March, perhaps searching for eggs or young that had fallen from the nests.

Most red-footed boobies on Wake Island are light-morph birds; however, at least two white-tailed brown morph individuals were observed. One of these was attending a nest with a white morph individual (the other one may have been as well). A few other birds with dusky, mottled backs, wings, and (in some cases) tails were presumed to be immatures of the light morph. No red-footed boobies were seen away from the immediate vicinity of the colony other than one seen flying in toward the colony from the ocean south of Wilkes Island on March 31, 1993.

Bailey (1951) saw no boobies of any species nesting on the island when he visited in May 1949; however, he attributed this to the near devastation of the island during the war which had ended only four years prior to his visit.

Rowland (1989b) counted 41 red-footed booby nests on Wilkes Island in April 1989. The eight nests in which he was able to determine the contents all had young.

Great Frigatebird *Fregata minor*. This species of frigatebird is found in the Pacific and Indian oceans and in the Atlantic off the coast of Brazil. Its nesting requirements are similar to those of the red-footed booby, and the two species sometimes nest in adjacent colonies. Frigatebirds build their crude platform nests in bushes from 0.5 to 4 m off the ground. Their breeding season in Hawaii is in spring and summer; egg laying takes place in March and April and the young have fledged by October.

Up to 225 birds were seen perched on power lines that cross the manmade channel bisecting Wilkes Island about midway along its length (figure 2). Frigatebirds use these power lines for roosting; although a few were frequently seen there well into the morning and well before dusk. Most of the frigatebirds observed at the atoll (70 percent) were immatures. Other than at the power lines, frigatebirds were only seen in the red-footed booby colony (once) and flying over Wilkes Island. They were seldom seen over either Peale or Wake proper.

Frigatebirds showed no indication of breeding during the survey period. None of the references examined (Bailey 1951; Bryan 1959; Rowland 1989a, 1989b; Sutterfield 1989) indicated that frigatebirds nested on the island, although most found a number of birds present (Sutterfield counted 274 on the power lines across the Wilkes Island channel).

Pacific Golden-Plover *Pluvialis fulva*. Golden-plovers are widespread in the northern hemisphere, breeding in the arctic tundra and migrating south to the tropics in winter (see Hayman et al. 1986 for worldwide distributions of shorebirds). Most authorities (Hayman, et al. 1986; American Ornithologists' Union, in press) now recognize *P. fulva* as a separate species distinct from other golden-plovers in plumage characters, body size, and proportions. The Pacific (or lesser) golden-plover breeds in northern Siberia and western Alaska and winters in southern Asia, Australia, New Zealand, and the Pacific islands. Two other species, *P. apricaria* and *P. dominica* breed in Europe and North America, respectively.

This species is a fairly common and widespread winter visitor on Wilkes and Wake islands, but is relatively scarce on Peale Island due to the lack of open, grassy habitats. It was observed primarily in short-cropped grassy areas (especially along the runway, taxiway, and golf course, but also on both outer and inner beaches).

Wandering Tattler *Tringa incana*. This species breeds in the arctic and sub-arctic regions of western North America and winters from the west coast of North America across the Pacific to Australia.

Several individuals were seen daily in habitats including outer rocky and pebbly beaches, calm channel shorelines, fresh and brackish water ponds, and sand flats in the inner lagoon.

Siberian Tattler *Tringa brevipes*. This bird breeds in eastern Siberia and winters in southeast Asia, Australia, and the western Pacific.

One individual was seen and heard calling at the fresh water pond located between the tarmac and taxiway at the air terminal (figure 1). This may represent the first record of this species from Wake Atoll; however, it is to be expected occasionally, as it is frequently seen in Micronesia and occasionally in the Marshall Islands (Pratt et al. 1987). Nearly identical in plumage to the wandering tattler, the Siberian tattler (also called gray-tailed tattler and Polynesian tattler in the literature) is undoubtedly often overlooked. If heard calling, however, the two species can be readily distinguished.

Ruddy Turnstone *Arenaria interpres*. The ruddy turnstone breeds in the arctic and migrates to the coasts of all continents but Antarctica in winter. It is a common migrant and winter visitor on most Pacific islands.

One individual was observed feeding in the closely cropped grass at west end of runway on 25 March. This species was abundant at Kwajalein Island on March 23 and 31 (March 24 and April 1, Wake Island time) so it is somewhat surprising that only one was seen on Wake.

Gray-backed (Spectacled) Tern *Sterna lunata*. This species has a somewhat limited distribution, being confined to the tropical Pacific Ocean from Hawaii south to the Tuamotu Archipelago, Tonga, and Fiji, and west to the Marianas. It often nests on the same islands and even in the same colonies with sooty terns, but because it is usually much less common than the sooty tern, it may be forced to nest at the perimeter of the colony, often in more exposed areas (Harrison 1990). Its breeding cycle is usually slightly ahead of the sooty tern, with eggs sometimes laid as early as February.

Four to eight individuals were seen perched on and flying in the vicinity of a cluster of wooden posts (possibly part of an old fish trap) just offshore on the lagoon side of the causeway between Wake and Wilkes islands (figure 1). Although present in this area most mornings, no indication of breeding was observed. It is possible that a few pairs of this species, which can easily be overlooked in a large mass of sooty terns, may breed at Wake Atoll occasionally, although breeding has not been documented. Harrison (1990) lists Wake as one of the islands where it breeds but gives no specific information.

Sooty Tern *Sterna fuscata*. The sooty tern is the most common and widespread of all tropical terns, and because it often nests in colonies numbering in the millions, some have considered it to be one of the most common birds in the world. However, like all highly gregarious species, it is vulnerable to mass extirpation by introduced predators such as feral cats and from habitat destruction in major breeding areas. In Hawaii, sooty terns have an annual breeding cycle, and this appears to be the case at Wake Atoll. Clearly, most, if not virtually all sooty terns at Wake nest in the spring, as on Hawaii.

The breeding cycle may vary according to oceanographic conditions which affect food supplies, but in general, sooty terns lay their single egg sometime between March and July. Observations on Wake, at least in 1989 and 1993, suggest an earlier breeding season, with the incubation period having ended by late March and early April; however, Bailey (1951) found sooty terns still on eggs in May. Sooty terns have an incubation period of 29 days. Young require eight weeks to fledge.

This is by far the most abundant bird on Wake Atoll. There is a large breeding colony at the west end of Wilkes Island (Exhibit 2) and a smaller active colony on Peale Island (figure 1). Evidence of two recently active colonies elsewhere on Peale was also noted. No birds were found breeding on Wake Island proper. The Wilkes colony occupied an area of 18,000 m² at the west end of an expansive grassy area just above the shoreline. The number of adults counted in this colony varied between approximately 10,000 and 25,000, with higher counts obtained at dawn and dusk. The number of young was estimated to be approximately 3,000 to 3,500 based on extrapolation from counts made in various sections of the colony. There were an estimated 9,800 eggs in the colony, but none examined were viable as most were cracked or broken. Young birds varied in age from only a few days old to nearly full grown. No flying young were seen in this colony during the first two days, but one newly-fledged bird was seen on March 26 and 27 flying over the shoreline just west of the colony (perhaps the same individual on both occasions). No predation on sooty tern eggs or young was observed; however, a feral cat was observed running through the colony on March 27. The cat did not attempt to capture any young but rather seemed harassed by the birds.

On Peale Island, the only breeding birds were found on and immediately adjacent to Flipper Point. Flipper Point is actually a separate island except at low tide when it is connected to Peale by a narrow sand spit. Young birds were seen in groups along the shoreline, and a few were seen in the vegetation just above the shoreline. An estimated 400 young were present in this colony; however, a direct count was not possible because of the dense vegetation over most of its area. Interestingly, in contrast with the Wilkes colony, many young in this colony had fledged and were seen flying about the colony on March 24 and afterward. On average, unfledged birds were about 1.5 to 2 weeks older than on Wilkes.⁵ Evidence of recent nesting was present near Flipper Point and at the west end of Peale where a number of dead chicks and non-viable eggs were found. Most of these were in the colony near Flipper Point. Approximately 500 eggs and an undetermined number of dead chicks of all ages were found, as well as about 10 dead adults. The deterioration of the carcasses prevented any determination of cause of death. At the extreme west end of Peale, fewer than 20 hatchling-aged chick carcasses were found in a small clearing at the end of the road. No remains of eggs, adults, or older chicks were found. There was no evidence of nesting anywhere else on Peale. Much of Peale Island is heavily vegetated with *Tournefortia argentea*, *Scaevola sericea*, and *Pemphis acidula* shrubs, and does not appear to be suitable nesting habitat for sooty terns.

Rowland (1989a, 1989b) visited the atoll in early-April 1989 and found approximately 250,000 nestling sooty terns in a 48,000 m² colony at the west end of Wilkes Island. This stands in stark contrast to the 3,000 to 3,500 chicks found in a colony only three-eighths this size during the present visit at virtually the same time of year when birds were in about the same stage of their breeding cycle. Rowland also found considerably more birds on Peale Island. He estimated about 100,000 chicks on Flipper Point alone and 43,000 more in the general vicinity of Flipper Point. In contrast, a total of about 300 chicks

⁵ Island residents mentioned that there were considerably more adult birds on Peale (they used the term "millions") a few weeks prior to the survey.

and recently fledged birds were found on Peale during the present survey.⁶ Sutterfield (1989) found no nesting evidence on Wilkes Island in late October 1989, but did find "a few eggs" on the northwest point of Peale Island. He did not indicate if they were being incubated.

It should be noted that Bailey (1951) described the sooty tern colony on Peale Island as "...the largest I had ever seen", suggesting that the colony was much larger than the one encountered during this survey; however, he did not give estimates of size other than to say that he saw "thousands of birds on their eggs" on May 15.

Brown Noddy *Anous stolidus*. The brown noddy is also pantropical in its distribution, but in most areas is not as abundant as the sooty tern. It breeds on the ground, on cliffs and offshore rocks, and in trees, often well within the interior of larger islands. This species is much less colonial than the sooty tern and black noddy. Brown noddies in Hawaii have a protracted nesting season with two egg-laying peaks, one in spring, the other in summer (Harrison (1990). Consequently, the brown noddy may be seen on eggs any time between March and August. Its incubation period is about 35 days and the young remain dependent on their parents for up to three months.

Eight birds and two freshly constructed nests were seen on top a concrete bunker at the outer perimeter of the sooty tern colony on Wilkes on March 26 (figure 2), and four birds were seen perched, one with vegetation in its beak, atop a relatively large offshore coral "rock" covered with whitewash off the west end of Wilkes. On March 28, one nest with an egg was located atop a large concrete block in the lagoon near the golf course on Wake Island proper (figure 1). Also on this date, a flock of 65 noddies were seen throughout much of the day circling around a cluster of *Casuarina* trees on the golf course and perched on offshore coral near the golf course. By March 29 the number had grown to 90 individuals, plus two individual black noddies (*Anous minutus*). Other scattered individuals were seen throughout the atoll flying along shore or feeding offshore, with overall numbers on the atoll increasing noticeably over the duration of the survey period.

Bailey (1951) found brown noddies nesting in *Pisonia grandis* trees in May 1949. Bryan (1959) makes two additional references to brown noddies nesting at Wake Atoll: one nest of unknown contents seen by Fosberg in April 1952, and one nest with a half-grown young seen in October 1953.

Black Noddy *Anous minutus*. The black noddy is found throughout most of the tropical Atlantic and Pacific oceans. It breeds primarily in trees and bushes such as *Tournefortia*, *Casuarina*, and *Scaevola*, but also in bunchgrass and other plants (Harrison 1990). Black noddies in Hawaii may lay as early as November. Egg laying peaks in December and January, but can continue until June (Harrison 1990). Their incubation period is the same as for brown noddies, but black noddy young grow much faster, averaging 38 days from hatching to first flight.

Two individuals were seen perched together with brown noddies on a concrete structure just offshore along the outer beach opposite the golf course on March 29 (figure 1). This species may also breed on Wake Atoll on occasion; however, breeding has not been suspected by past observers and the species has apparently been seen on the atoll only on a few occasions.

⁶ Island residents described a much larger colony a few weeks prior to this visit.

White Tern *Gygis alba*. This species breeds in the western and central Pacific Ocean, the Atlantic Ocean south of the equator, and the Indian Ocean. It does not build a nest, but lays its egg on exposed rocks, tree crotches, ledges, and even fenceposts, window ledges, and bare branches (Harrison 1990). Birds generally breed during spring and summer in Hawaii. Their incubation period is 34 to 36 days and the young generally fledge in eight to nine weeks.

Three birds were seen in flight near the west end of the runway on March 24. This species was not seen again until March 28 when six birds were seen circling around and perched in the cluster of *Casuarina* trees at the golf course on the main island (figure 1). These birds were seen there every day subsequently until the end of the survey period on April 1. They were not seen exhibiting any courtship behavior.

Short-eared Owl *Asio flammeus*. Nearly cosmopolitan, being found over much of North and South America, Europe, and Asia, as well as many of the Pacific Islands (Galapagos, Hawaii, and Pohnpei). Migrants have been found in the Marshall Islands and elsewhere in the Pacific.

An owl was flushed from beneath a small *Pemphis* bush at the southwest corner of the catchment basins in the late morning on March 28 (figure 1), and a few minutes later was observed flying low over the open scrubby area between the catchment basins and the golf course.⁷

Rock Dove (Feral Pigeon) *Columba livia*. A flock of 11 birds on March 28 and six birds on March 29 were seen in the vicinity of the golf course. These birds are apparently being bred by an island resident (Rowland 1989b).

3.2 OTHER OBSERVATIONS

Feral cats were frequently observed on both Peale and Wilkes islands, and one feral cat was seen in the sooty tern colony on Wilkes on March 26. The abandoned colony on Peale Island showed evidence of cat activity that may have caused at least partial failure of that colony. Island residents said that considerably more sooty terns have bred at Wake Atoll in past years (as indicated in the literature cited above), and attribute their decline to feral cats, which, according to some, can destroy hundreds of nestlings in a single night and cause others to disperse into dense vegetation where they are abandoned. One resident said that the Vortac area on Wilkes is graded each year prior to commencement of the sooty tern nesting season, in part, to destroy rats, their young, and any subsurface burrows, and to make feral cats more visible to the nesting birds.

Flipper Point on Peale Island may not have any resident cats because of its nearly complete isolation from the rest of Peale, and this may be the reason for the success of its relatively small colony.

⁷ Although unrecorded in the literature from Wake Island, Mr. Hitchcock has seen owls (presumably this species) at Wake on several occasions. They are usually seen in vehicle headlights when flushed from the roadside at night.

SECTION 4 DISCUSSION

4.1 SENSITIVE SPECIES

There are no threatened or endangered bird species on Wake Atoll. The Wake rail (*Rallus wakensis*), a flightless species endemic to Wake, has not been seen since World War II and is assumed to be extinct. Japanese soldiers who occupied Wake Atoll during the war are reported to have resorted to capturing and eating rails to avoid starvation (Fuller 1988). This activity either directly caused their extinction or reduced the population to a level low enough for feral cats to capture the few remaining birds.

All other naturally occurring bird species recorded from Wake Atoll are protected under the Migratory Bird Treaty Act of 1916 (16 U.S.C. 703-712). The act protects all non-game bird species native to the United States and its territories, including those that may be present only as migrants. Under the Act, it is unlawful to "pursue, hunt, take, capture, kill, attempt to take, capture, or kill...any migratory bird, any part, nest, or eggs of any such bird...". It is generally inferred that the destruction of any habitat known to contain birds actively engaged in nesting in that habitat would be in violation of the Act, as the nests, eggs, or young would almost certainly be destroyed along with the habitat.

4.2 ENVIRONMENTAL CONSIDERATIONS

Most colonial nesting seabirds found on Wake Atoll (sooty terns, boobies, frigatebirds) do not breed on Wake Island proper, presumably as a result of past and present human activities on the island. Non-colonial or semi-colonial nesters such as the red-tailed tropicbird, however, do nest on the main island. Colonial nesters are more vulnerable to direct disturbance by human intrusion and by feral cats, both of whom can cause abandonment of an entire colony through repeated disturbance. While feral cats are a problem on both Wilkes and Peale islands, humans and their activities generally are not. There are no regularly inhabited structures on Peale or the western half of Wilkes islands.

Most proposed project activities addressed in this document are restricted to Wake Island proper. Those that are not, are an extension of a water pipeline along an existing roadway on Peale Island and a borrow site in a small, disturbed area of Wilkes Island well away from any breeding colonies. The only seabirds with the potential for being impacted directly from project activities are the red-tailed tropicbird, brown noddy, and, perhaps, great frigatebird, black noddy, and white tern which nest in shrub vegetation and may nest on the main island (if they nest on Wake Atoll at all).

Most proposed construction activities should not have a direct impact on nesting seabirds at Wake Atoll. Colonial nesting species at Wake (sooty tern, boobies) are confined to Wilkes and Peale islands where little construction activity is proposed. The proposed potable water distribution pipeline, which will extend to Peale Island, will be confined to an existing road alignment. The proposed borrow area on Wilkes Island is in an already highly disturbed area where no seabirds currently nest. Construction activity could disrupt nearby breeding birds such as black noddies, white terns, and great frigatebirds; however, they apparently do not presently nest in any of the areas proposed for construction.

Nesting of red-tailed tropicbirds was observed on Wake Island; suitable tropicbird nesting habitat is present. However, it should be noted that all observed breeding activity for this species during the survey was in the northern arm of the atoll. The batch plant and lay-down areas are in the southern arm of the atoll.

The literature is not clear as to whether white-tailed tropicbirds nest on the island, but this species could potentially be affected by construction. Even if it nests on the island, it would never be common, as this species typically nests on high islands, not atolls. Black noddies and white terns are two tree-nesting species that could potentially breed on the main island. However, as there is no direct evidence of these species nesting on Wake Island, it is assumed that they will not be affected by construction. Great frigatebirds appear to be permanent residents at the atoll, and most observers have assumed that they breed here (despite apparent absence of breeding records in the literature).

As the areas of proposed construction are small and confined to populated areas of Wake Island proper, a small forested area of Wilkes Island (borrow site), and along an existing road alignment on Peale, any construction-related impacts to seabirds would not be considered significant. All of the seabirds breeding at Wake Island are widespread and common in the Pacific and would be minimally impacted (if at all) on Wake Atoll as a direct result of these activities.

Large aircraft such as the C-141 StarLifter taking off and landing are barely if at all audible from the Wilkes Island sooty tern colony which is only one mile from the end of the runway. Arriving and departing aircraft were not audible from Peale Island under conditions encountered during the survey (steady trade winds of 10 to 20 knots). These prevailing trade winds effectively mute the sound of aircraft at distances greater than a few hundred meters. Departing aircraft, which generate the most noise, take off to the east under most conditions, directly away from the seabird breeding colonies on Wilkes and Peale islands. The missile launch pads are also at the east end of the island several miles from any existing colonies. The constant calls of sooty terns at their nesting sites further mute any loud noises, even those emanating from relatively near the colony. It is not likely that future launches from launch pads three to four miles away would have any impact on seabirds nesting on Wilkes or Peale islands.

Effects of noise on birds and other wildlife have been extensively reviewed (Fletcher and Busnell 1978; Brattstrom 1982; Memphis State University 1971). Several studies have shown that intermittent noises (other than those at or near the threshold of pain) have little if any apparent effect on most animals, including birds (Dunnet 1977; Ellis 1981; Kushlan 1979). Birds, for example, accommodate quickly to most non-constant noise in their environment, even gun shots, explosives, nearby departing aircraft, and the like.⁸ However, constant noise (such as the drone of freeway traffic), even as low as 60 decibels, may interfere with courtship and territorial defense in songbirds.

Persistent and relatively brisk trade winds should minimize any contamination of the air in the vicinity of Wake Atoll to levels below that which should have any impacts on birds or other wildlife.

Generally, hazardous materials contamination would be restricted to small areas near the source of pollution. Local spills of petroleum products such as gasoline, jet fuel, and oil could be harmful if they come into contact with or were ingested by birds. Spills into the lagoon may spread over the water

⁸ H. Lee Jones, personal observations.

surface and result in impacts, including death of a small number of seabirds that may drink from or land on the water; however, no birds were seen doing either during the survey period. Golden-plovers and tattlers forage along the edge of the lagoon and could be affected. However, none of the proposed activities is likely to result in petroleum contamination.

Indirect impacts on birds may result from increasing human presence on the atoll. Human intrusion into seabird colonies can result in abandonment of the colony from repeated or prolonged disturbance. Also, nests exposed when birds are flushed may be susceptible to predation by frigatebirds. Without restrictions, an increased population of humans (and accompanying increases of air- and sea-based traffic to the atoll), could result in an increase in stray dogs, cats, and rats, as well as non-native pests that may be inadvertently transported to the island. For example, the inadvertent introduction of the brown tree snake (*Boiga irregularis*) from Guam to Wake is a very real threat, the risk of which is likely to increase in direct proportion to the number of cargo shipments to the island, especially if unregulated or unmonitored.

4.3 MITIGATION MEASURES

All island residents, including visitors, should be briefed on the importance of protecting the nesting seabirds at Wake Island from human disturbance. Access to certain areas is currently restricted or denied during periods when the sooty terns are nesting, and this policy should be continued, but enforced more rigorously. During the survey period (on March 25), seven island residents were observed parked within 20 m of the red-footed booby colony on Wilkes Island. Earlier in the day, about 25 frigatebirds were perched in these nesting trees. Although they had left by sunset, frigatebirds are well known for raiding the exposed eggs and chicks of booby nests left unattended, as when nesting birds are flushed by human intruders.

All shipments to Wake Island should be carefully checked for pest species such as the brown tree snake, rats, mice, and insects and insect larvae, both prior to shipment and at arrival on the island. Any such pest found should be promptly destroyed.

To avoid potential impacts to nesting birds, it is recommended that, to the extent feasible, construction activities be confined to the period between August and January, as birds are least likely to be nesting during these months.

SECTION 5 REFERENCES

- American Ornithologists' Union. In press. *Check-list of North American Birds*, 7th edition.
- Bailey, A.M. 1951. Notes on the Birds of Midway and Wake Islands. *Wilson Bull.* 63(1): 35-37.
- Brattstrom, Bayard H. 1982. *Bibliography on the Effect of Noise on Non-Human Vertebrates*. U.S. Bureau of Land Management.
- Bryan, E.H., Jr. 1959. Notes on the Geography and Natural History of Wake Island. *Atoll Res. Bull.* No. 66.
- Dunnet, G.M. 1977. Observations on the Effects of Low-Flying Aircraft at Seabird Colonies on the Coast of Aberdeenshire, Scotland. *Biol. Conserv.* 12:55-63.
- Ellis, David H. 1981. *Responses of Raptorial Birds to Low Level Military Jets and Sonic Booms*. U.S. Fish and Wildlife Service, Institute for Raptor Studies. 59pp.
- Fletcher, John I. and T.G. Busnell, eds. 1978. *Effects of Noise on Wildlife*. Academic Press. New York, New York. 305pp.
- Fuller, Errol 1987. *Extinct Birds*.
- Harrison, C.S. 1990. *Seabirds of Hawaii: Natural History and Conservation*. Cornell University Press, Ithaca, New York.
- Harrison, Peter 1985. *Seabirds: An Identification Guide* (revised edition). Houghton Mifflin Company, Boston.
- Hayman, P., J. Marchant, and T. Prater 1986. *Shorebirds: An Identification Guide to the Waders of the World*. Houghton Mifflin Company, Boston.
- Kushlan, James A. 1978. Effects of Helicopter Censuses on Wading Bird Colonies. *J. Wildl. Manage.* 43(3):756-760.
- Memphis State University 1971. *Effects of Noise on Wildlife and Other Animals*. U.S. Environmental Protection Agency. Office of Noise Abatement and Control, Washington, D.C. 74pp.
- Pratt, H.D., P.L. Bruner, and D.G. Berrett 1987. *The Birds of Hawaii and the Tropical Pacific*. Princeton University Press.

- Rowland, Craig M. 1989a. Biological Survey Wake Island Starlab Sites (Appendix A of Department of the Air Force 1990, *Environmental Impact Analysis Process Final Environmental Assessment Starlab Program*). U. S. Fish and Wildlife Service, Honolulu, Hawaii. 1 June 1989.
- Rowland, Craig M. 1989b. Trip Report - Wake Atoll (April 4-11, 1989). (Appendix B of Department of the Air Force 1990, *Environmental Impact Analysis Process Final Environmental Assessment Starlab Program*). U. S. Fish and Wildlife Service, Honolulu, Hawaii. 1 June 1989.
- Sutterfield, T. 1989. Seabird Survey of Project Starbird Construction Sites on Wake Atoll. (Appendix D of Department of the Air Force 1990, *Environmental Impact Analysis Process Final Environmental Assessment Starlab Program*). U. S. Fish and Wildlife Service, Honolulu, Hawaii. 1 June 1989.

Appendix F

NOTICE

This Botanical Survey assesses some specific activity locations that were part of the proposed action at the time of the survey but were later removed from consideration. However, the data have been left in the report to provide baseline information for future studies. Additionally, this survey does not discuss some new facility construction locations in the proposed action that were identified after the field investigation was completed. The environmental assessment for these additional facilities was developed from the survey report and from unpublished field notes.

THIS PAGE INTENTIONALLY LEFT BLANK

BOTANICAL SURVEY REPORT

FOR

**ENVIRONMENTAL ASSESSMENT FOR
LONG-TERM ACTIVITIES AT WAKE ATOLL**

**Principal Investigator and Author:
Evangeline J. Funk, Ph.D.**

Prepared by:

**MBA INTERNATIONAL
1188 Bishop Street, Suite 3411
Honolulu, Hawaii 96813.3314**

Contacts:

**William A. Brewer
James T. Berdach**

April 1993

TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
1	INTRODUCTION	1
2	METHODS	2
3	RESULTS	4
3.1	One Hundred Percent Survey Sites	4
3.1.1	Proposed New Generator Site	4
3.1.2	Proposed Incinerator Site 2	4
3.1.3	Proposed Wilkes Island Borrow Pit Site	4
3.1.4	Proposed Batch Plant Site	5
3.1.5	Peacock Point Area	5
3.1.6	Proposed Water Distribution Project	6
3.2	Overview Survey Sites	6
3.2.1	Wilkes Island	6
3.2.2	Peale Island	8
4	DISCUSSION	23
4.1	Observations and Recommendations	23
4.2	New Weed Species, Undescribed Species, and Endangered Species	24
5	COMPREHENSIVE SPECIES LIST	25
6	REFERENCES	31

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1.	Botanical Survey Sites, Wake Island	3
2.	Vegetation Map, Wake Island	7

LIST OF TABLES¹

<u>Table</u>		
1.	Plants at Proposed New Generator Site, Wake Island	9
2.	Plants at Proposed Incinerator Site, Wake Island	11
3.	Plants at Proposed Borrow Pit Site, Wilkes Island	13
4.	Plants at Proposed Batch Plant Site, Wake Island	15
5.	Plants of Peacock Point Area, Wake Island	17
6.	Plants along Proposed Water Supply Alignment, Wake Island	20
7.	Plants of Wake Atoll, Survey of March 1993	26

¹Tables 1 through 6 appear at the end of Section 3; Table 7 appears at the end of Section 5.

SECTION 1 INTRODUCTION

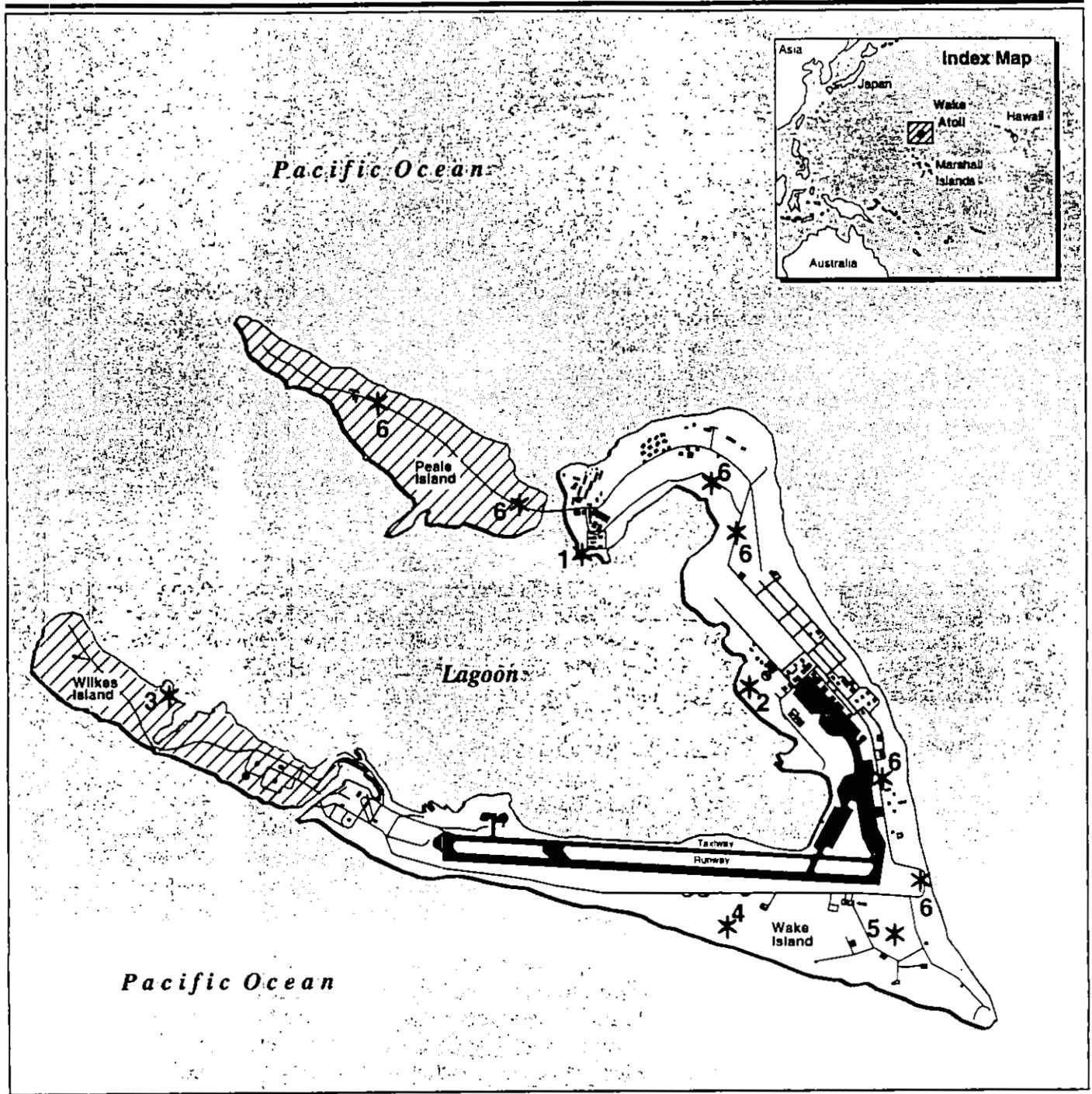
One hundred percent coverage botanical surveys were carried out on several selected sites on Wake Island during the last week of March 1993. In addition, overview botanical surveys were completed on both Wilkes and Peale islands. The purpose of these surveys was to collect data on and to describe the vegetation of the sites, to prepare species lists of the naturally occurring vegetation of the area, and to determine if any federally listed or proposed threatened or endangered species are present on these small islands (USFWS 1992).

The botanical history of Wake Island has been more than adequately reviewed by both Bryan (1959) and Fosberg (1959). Since Fosberg's publication, Rowland (1989) has reported the results of biological surveys on several project sites on Wake Island. While Fosberg recognized 93 species of vascular plants on the atoll, it should be noted that all plant taxa present on the island were recorded including plants in private gardens and those which were used in the landscaping of developed areas. Fosberg identified 19 species in 11 plant families which were indigenous to these islets.

During this study, only naturally occurring plants of the specified sites, of the undeveloped areas, and those plants which appear to be surviving and proliferating on their own among abandoned buildings were recorded.

SECTION 2 METHODS

Two botanists walking 6 to 10 meters (m) apart covered those sites on which 100 percent coverage surveys were requested (figure 1). On Wilkes and Peale islands circular transects were walked and cross island transects were carried out where the vegetation warranted. The vegetation of each 100 percent coverage survey site is described and a species list for each of these sites is included. General descriptions of the vegetation of Wilkes and Peale islands are also provided.



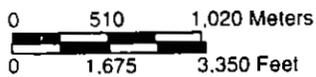
EXPLANATION

* 100% Coverage Surveys

▨ Overview Surveys

Numbers 1 Through 6 Are Site Survey Points

Botanical Survey Sites



Wake Island

Figure 1

SECTION 3 RESULTS

3.1 100 PERCENT SURVEY SITES

3.1.1 PROPOSED NEW GENERATOR SITE

This small site, less than 1 hectare in size, is located on the lagoon side of the baseball field (Site 1, figure 1). The area is planted in mixed grasses which are regularly mowed. Species diversity is low and consists mostly of introduced grasses and weeds. Only along the shore of the lagoon is it evident that some woody vegetation was beginning to develop. Here are found some ironwood trees (*Casuarina equisetifolia* L.), a tropical almond tree (*Terminalia catappa* L.), and some shrubby individuals of *Leucaena leucocephala* (Lam.) deWit.

The plant species found on this site are listed in table 1.

3.1.2 PROPOSED INCINERATOR SITE NUMBER 2

The proposed site of Incinerator No. 2 is located on the lagoon (Site 2, figure 1). It is an open, mowed area consisting of approximately 0.5 hectares in size. The area is flat and presently two unpaved roads cross this small space. It is fringed with planted trees such as ironwoods, tropical almond, and sea grape (*Coccoloba uvifera* [L.] L.). The ground cover is composed of mixed, introduced grasses and weeds. Plants found on this site are listed in table 2.

3.1.3 PROPOSED WILKES ISLAND BORROW PIT SITE

The proposed Wilkes Island borrow pit site is located on the lagoon side (Site 3, figure 1) of the island near the manmade channel which was created by earlier borrowings from the area. Immediately upland from the shore, the vegetation is *Pemphis acidula* Forst. f. scrub which is between 3 to 4 m in height. In the old digging sites, which are below sea level, there is standing sea water and around these low places, dense mats of red-stemmed sea purslane (*Sesuvium portulacastrum* L.) have become established.

On higher ground there is a scattering of tree heliotrope (*Tournefortia argentea* L. fil.), 3 to 4 m in height. The ground cover in the most disturbed portion of the site is composed of several weedy herb and grass species, but much of the space is strewn with coral rubble and sand. The relatively undisturbed portion of this site is vegetated with tree heliotrope and common bunch grass (*Lepturus repens* [G. Forster] R. Br.) with small enclaves of native scurvy grass (*Lepidium bidentatum* Montin) found under the trees.

Like most of the rest of this atoll, the interior of this site displays the scars left from World War II. There are deep trenches which were dug to slow the movement of tanks, there are gun emplacement sites, and other types of protective excavations and pits, most of which are covered by dry, brown bunch grass (*Lepturus gasparricensis* Fosb. and *L. repens*).

Only the taxa listed in table 3 were found on this site.

3.1.4 PROPOSED BATCH PLANT SITE

The proposed batch plant site lies between the revetments and seaward from Elrod Road and the Pacific Ocean (Site 5, figure 1). This is a very disturbed site, some of which (the area closest to the ocean) appears to have been inundated by the large storms which raked the atoll in late 1992. The emergent vegetation is scattered, introduced ironwood trees, 8 to 15 m in height with tree heliotrope forming a canopy layer 3 to 4 m in height. Derelict bunkers and other fortifications are interspersed with discarded vehicles, metal, and concrete rubble. There are widely dispersed enclaves of *Pemphis*, naupaka (*Scaevola sericea* Vahl.), and sourbush (*Pluchea symphytifolia* [Mill.] Gillis). The ground layer, near the highway, is composed of introduced grasses and adventives while nearer the ocean, the ground layer is coral rubble and sand.

This is a somewhat larger site and the species diversity is correspondingly greater. The taxa found on the site are included in the listing shown in table 4.

3.1.5 PEACOCK POINT AREA

The Peacock Point site extends from the control tower eastward along Elrod Drive to the ocean and from the tower to the Pacific Ocean (Site 6, figure 1). The vegetation of this area is a changing mosaic of scrub tree heliotrope, ironwood, and kou trees (*Cordia subcordata* L.) interspersed with dense stands of naupaka and cotton (*Abutilon albescens* Miq.). Eastward from Peacock Point Road the tree heliotrope is mostly scattered, shrubby individuals growing in coral rubble. West of this road, the tree heliotrope is interspersed with dense stands of naupaka and ironwood trees which become dominant at the west end of the site and in the near vicinity of the control tower. Just seaward of the tower, and to the east as far as Peacock Point Road, dense stands of kou trees, 6 to 8 m in height, can be found. The upper branches of these trees, like all of the kou trees on the atoll, are bare and dry, a reminder of the storms of last fall.

Of the 23 species of weedy plants found during this survey and not reported by Fosberg (1959), 14 were from the Peacock Point site.

There are two proposed launch sites within the Peacock Point study site. These areas were revisited and a 20 m radius around each site was re-examined. The area around Launch Site 1 has been cleared and the coral rubble has been scraped into long piles around the site. There is a scant covering of vegetation on the pushed up rubble. The principal species are kou and tree heliotrope. At the northwest edge of the cleared area, there is one *Pisonia grandis* tree, one of the few trees native to Wake Atoll. The remainder of the vegetation is mostly low growing weeds such as *Bidens*, pigweed, and mixed grasses.

Launch Site 2 has also been cleared and the tree heliotrope is just beginning to re-invade the area. Most of the plant cover is composed of weedy plants like *Tridax*, Jamaica vervain (*Stachytarpheta jamaicensis* [L.] Vahl), 'Uhaloa (*Waltheria indica* L.), and Nohu (*Tribulus cistoides* L.). The vegetation of the proposed launch pad sites is principally weeds, except for the few plants noted.

The taxa found on Peacock Point are recorded in table 5.

3.1.6 PROPOSED WATER DISTRIBUTION PROJECT

The proposed water distribution project study area included both sides of the main road from the control tower, through the developed areas, the principal side streets, and on to the ruins located on Peale Island (figure 1). The existing system is to be pressure tested and repaired or replaced to restore it to the original specifications. The botanical survey covered an area on either side of the road, 7 m from the centerline.

It was found that the road shoulders are, for the most part, kept mowed and the fringing vegetation is mostly composed of grasses and prostrate herbs. On Peale Island some shrubs such as *Pemphis*, sourbush, and sea grape infringe on the road shoulders. On the lagoon side of the road (near the ruins) some ironwood trees and a large enclave of thorny cactus (*Opuntia littoralis* [Tour.] Mill) will have to be removed.

These and other plants found along this alignment are listed in table 6.

3.2 OVERVIEW SURVEY SITES

3.2.1 WILKES ISLAND

Wilkes Island is connected to Wake Island by a narrow causeway. At the present time only a liquid fuel storage facility, a small building belonging to the University of Hawaii, and a small boat harbor are located on this small islet consisting of more than 100 hectares.

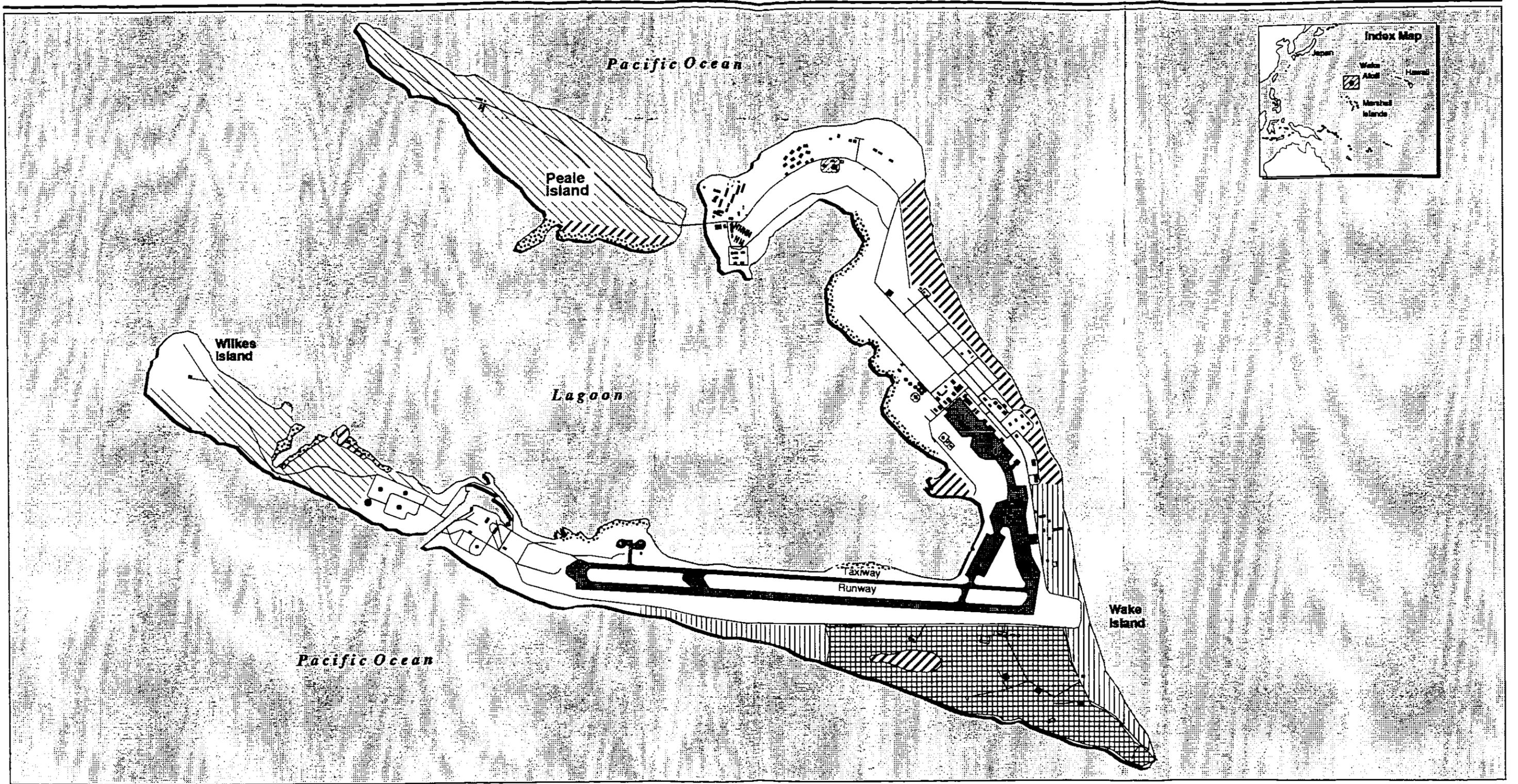
The western one-third of Wilkes Island has been set aside for a large sea bird colony (figure 2). The area has been cleared and is regularly mowed to protect the sea birds from the many feral cats which inhabit the island. The most conspicuous vegetation at this end of the island is a scant fringe of heliotrope trees, 4 to 6 m in height, and the broad mats formed by the nohu vines (*Tribulus cistoides* L.) which dominate the clipped, flattened landscape. Nohu vine was introduced into the area to help keep both predators and people away from the colony.²

From the eastern edge of the bird sanctuary clearing to the Wilkes Island channel and continuing on the south side of the road to as far as the fuel storage tanks, the vegetation cover is composed of scattered heliotrope trees from 1 to 8 m in height. The ground layer is mixed grasses, predominantly two species of bunch grass with intermittent patches of scurvy grass (*Lepidium bidentatum* Montin) and alena (*Boerhavia repens* L.).

On the south side of the dirt road, between the channel and the bird clearing, there is a long, deep tank trap. A dense colony of kou trees has grown up in this low area.

Along the lagoon shore of Wilkes Island, from the causeway to the proposed borrow pit site, the coastal vegetation is *Pemphis* with mats of sea purslane and a dense planting of ironwood trees near the point just north of the storage tanks. Between the coastal vegetation and the dirt road, many, many truck loads

² Because of the two hard, stout spines (5 to 6 mm-long) which develop on its mericarps (one-half of a two-parted fruit), it was reasoned that a dense mat of these thorny vines would discourage entry into the area.



EXPLANATION

Primary Vegetation Type

- | | |
|---|--|
|  Tree Heliotrope/Mixed Grass Scrub |  Ironwood |
|  Tree Heliotrope/Coral Rubble |  Pemphis |
|  Mixed Scrub | |



Vegetation Map

Wake Island

Figure 2

THIS PAGE INTENTIONALLY LEFT BLANK

of coral rubble have been stored. A scant scrub of tree heliotrope, naupaka, sour bush, cotton, and various weeds and grasses cover about 50 percent of the ground surface. The remainder is coral rubble and metal and wood scrap.

All plants encountered on Wilkes Island are included in the comprehensive species list (Section 5).

3.2.2 PEALE ISLAND

A wooden bridge connects Peale Island to Wake Island at its northwestern tip (figure 2). Although Peale Island is uninhabited, a number of beach huts have been built along the shore as well as Thai Buddhist temple near the Wake Island Bridge.

Essentially, the dominant vegetation of Peale Island is tree heliotrope 2 to 8 m in height. The ground cover is mixed bunch grass and open coral rubble. Along the shore near the Wake Island Bridge, around to and including Flipper Point, and lining the inlets is a thriving *Pemphis* community with intermittent mats of red-stemmed sea purslane. Upland from, and intermingled with the *Pemphis*, is a burgeoning community of ironwood trees. About 150 m from the Wake Island Bridge on the ocean side of Peale Island Road can be found a scattering of *Pisonia grandis* and kou trees, almost all that is left of what Fosberg referred to as a *Pisonia/Cordia* forest (the only other *Pisonia* trees seen during this study were nine individuals near the golf course and a small colony of young trees coming up in the abandoned housing [both sites on Wake Island]).

About halfway between the Wake Island Bridge and the northwestern tip of Peale Island is a dirt road which leads to the old Pan American Seaplane Ramp. Just at the turn, there is a dense planting of *Opuntia littoralis* (Tour.) Mill. and a little further along the road is a reproducing stand of sisal (*Agave sisalana* Perrine). On either side of the dirt road are open areas where there are no heliotrope trees. In these open places can be found huge enclaves of the shrubby, wild cotton which is native to this atoll.

All plants found on Peale Island are reported in the comprehensive species list (Section 5).

TABLE 1
PLANTS AT PROPOSED NEW GENERATOR SITE, WAKE ISLAND¹

FAMILY NAME	
<i>Scientific Name</i>	Common Name
AGAVACEAE - Agave Family	
* <i>Agave sisalana</i> Perrine	Sisal
POACEAE - Grass Family	
* <i>Cenchrus echinatus</i> L.	Common sandbur
* <i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass
* <i>Dactyloctenium aegyptium</i> (L.) Willd.	Beach wiregrass
* <i>Eleusine indica</i> (L.) Gaertn.	Wiregrass
* <i>Eragrostis cilianensis</i> (All.) Link	Stinkgrass
* <i>Eragrostis tenella</i> (L.) P. Beauv. ex Roem. & Schult	Lovegrass
<i>Lepturus gasparricensis</i> Fosb.	Broad-leaf bunchgrass
<i>Paspalum vaginatum</i> Sw.	Seashore paspalum
ARECACEAE - Palm Family	
* <i>Cocos nucifera</i> L.	Coconut
ASTERACEAE - Sunflower Family	
* <i>Bidens alba</i> (L.) DC	
* <i>Tridax procumbens</i> L.	Coat buttons
BORAGINACEAE - Borage Family	
<i>Cordia subcordata</i> Lam.	Kou
* <i>Heliotropium anomalum</i> Hook. & Arnott	Hinahina
* <i>Tournefortia argentea</i> L. fil.	Tree heliotrope
CASUARINACEAE - She-oak Family	
* <i>Casuarina equisetifolia</i> L.	Ironwood tree
COMBRETACEAE - Indian almond Family	
<i>Terminalia catappa</i> L.	Tropical almond

TABLE 1 (CONTINUED)

FAMILY NAME <i>Scientific Name</i>	Common Name
CONVOLVULACEAE - Morning-glory Family	
* <i>Ipomoea pes-caprae</i> (L.) R. Br. <i>Ipomoea violacea</i> L.	Beach morning-glory
CUCURBITACEAE - Gourd Family	
* <i>Coccinia grandis</i> Ehrenb. ex Spach	Hedge hog
EUPHORBIACEAE - Spurge Family	
* <i>Chamaesyce hirta</i> (L.) Millsp.	Hairy spurge
MALVACEAE - Hibiscus Family	
* <i>Abutilon albescens</i> Miq. <i>Sida fallax</i> Walp.	'Ilima
PORTULACACEAE - Purslane Family	
* <i>Portulaca oleracea</i> L.	Pigweed
VERBENACEAE - Verbena Family	
* <i>Stachytarpheta jamaicensis</i> (L.) Vahl	Jamaica vervain
ZYGOPHYLLACEAE - Creosote Family	
* <i>Tribulus cistoides</i> L.	Nohu

1. * = Non-native species introduced to Wake Atoll.

TABLE 2
PLANTS AT PROPOSED INCINERATOR SITE, WAKE ISLAND¹

FAMILY NAME	
<i>Scientific Name</i>	Common Name
POACEAE - Grass Family	
* <i>Cenchrus echinatus</i> L.	Common sandbur
* <i>Chloris divaricata</i> R. Br.	Stargrass
* <i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass
* <i>Dactyloctenium aegyptium</i> (L.) Willd.	Beach wiregrass
* <i>Eleusine indica</i> (L.) Gaertn.	Wiregrass
* <i>Eragrostis ciliaris</i> (All.) Link	Stinkgrass
* <i>Eragrostis tenella</i> (L.) P. Beauv. ex Roem. & Schult	Lovegrass
<i>Lepturus gasparricensis</i> Fosb.	Broad-leaf bunchgrass
<i>Paspalum vaginatum</i> Sw.	Seashore paspalum
CYPERACEAE - Sedge Family	
* <i>Cyperus rotundus</i> L.	Nut grass
* <i>Fimbristylis cymosa</i> R. Br.	
ASTERACEAE - Sunflower Family	
* <i>Bidens alba</i> (L.) DC	
* <i>Tridax procumbens</i> L.	Coat buttons
BORAGINACEAE - Borage Family	
* <i>Heliotropium anomalum</i> Hook. & Arnott	Hinahina
CASUARINACEAE - She-oak Family	
* <i>Casuarina equisetifolia</i> L.	Ironwood tree
COMBRETACEAE - Indian almond Family	
<i>Terminalia catappa</i> L.	Tropical almond
CONVOLVULACEAE - Morningglory Family	
<i>Ipomoea violacea</i> L.	

TABLE 2 (CONTINUED)

FAMILY NAME <i>Scientific Name</i>	Common Name
POLYGONACEAE - Buckwheat Family	
* <i>Coccoloba uvifera</i> (L.) L.	Sea grape
PORTULACACEAE - Purslane Family	
* <i>Portulaca oleracea</i> L.	Pigweed
ZYGOPHYLLACEAE - Creosote Family	
* <i>Tribulus cistoides</i> L.	Nohu

1. * = Non-native species introduced to Wake Atoll.

TABLE 3
PLANTS AT PROPOSED BORROW PIT SITE, WILKES ISLAND¹

FAMILY NAME <i>Scientific Name</i>	Common Name
CYPERACEAE - Sedge Family	
* <i>Fimbristylis cymosa</i> R. Br.	
POACEAE - Grass Family	
* <i>Chloris divaricata</i> R. Br.	Stargrass
<i>Lepturus gasparricensis</i> Fosb.	Broad-leaf bunchgrass
<i>Lepturus repens</i> (G. Forster) R. Br.	Bunch grass
AIZOACEAE - Fig-marigold Family	
<i>Sesuvium portulacastrum</i> (L.) L.	Akulikuli
ASTERACEAE - Sunflower Family	
* <i>Conyza bonariensis</i> (L.) Cronq.	Hairy horseweed
* <i>Pluchea symphytifolia</i> (Mill.) Gillis	Sourbush
* <i>Tridax procumbens</i> L.	Coat buttons
BORAGINACEAE - Borage Family	
* <i>Heliotropium anomalum</i> Hook. & Arnott	Hinahina
* <i>Tournefortia argentea</i> L. fil.	Tree heliotrope
BRASSICACEAE - Mustard Family	
<i>Lepidium bidentatum</i> Montin	Scurvy grass
CASUARINACEAE - She-oak Family	
* <i>Casuarina equisetifolia</i> L.	Ironwood tree
CONVOLVULACEAE - Morning-glory Family	
<i>Ipomoea violacea</i> L.	

TABLE 3 (CONTINUED)

FAMILY NAME <i>Scientific Name</i>	Common Name
EUPHORBIACEAE - Spurge Family	
* <i>Chamaesyce hypericifolia</i> (L.) Millsp.	Graceful spurge
* <i>Euphorbia cyathophora</i> J. A. Murray	Mexican fire plant
LYTHRACEAE - Loosestrife Family	
<i>Pemphis acidula</i> Forst. f.	
MALVACEAE - Hibiscus Family	
<i>Sida fallax</i> Walp.	'Ilima
NYCTAGINACEAE - Four o'clock Family	
* <i>Boerhavia repens</i> L.	Alena
PORTULACAEAE - Purslane Family	
<i>Portulaca lutea</i> Sol. ex G. Forster	'Ihi

1. * = Non-native species introduced to Wake Atoll.

TABLE 4
PLANTS AT PROPOSED BATCH PLANT SITE, WAKE ISLAND¹

FAMILY NAME	
<i>Scientific Name</i>	Common Name
POACEAE - Grass Family	
* <i>Cenchrus echinatus</i> L.	Common sandbur
* <i>Chloris divaricata</i> R. Br.	Stargrass
* <i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass
* <i>Dactyloctenium aegyptium</i> (L.) Willd.	Beach wiregrass
* <i>Eleusine indica</i> (L.) Gaertn.	Wiregrass
* <i>Eragrostis cilianensis</i> (All.) Link	Stinkgrass
* <i>Eragrostis tenella</i> (L.) P. Beauv. ex Roem. & Schult	Lovegrass
<i>Lepturus gasparricensis</i> Fosb.	Broad-leaf bunchgrass
<i>Paspalum vaginatum</i> Sw.	Seashore paspalum
CYPERACEAE - Sedge Family	
* <i>Cyperus rotundus</i> L.	Nut grass
* <i>Fimbristylis cymosa</i> R. Br.	
ASTERACEAE - Sunflower Family	
* <i>Bidens alba</i> (L.) DC	
* <i>Conyza bonariensis</i> (L.) Cronq.	Hairy horseweed
* <i>Pluchea symphytifolia</i> (Mill.) Gillis	Sourbush
* <i>Tridax procumbens</i> L.	Coat buttons
BORAGINACEAE - Borage Family	
* <i>Heliotropium anomalum</i> Hook. & Arnott	Hinahina
* <i>Tournefortia argentea</i> L. fil.	Tree heliotrope
CASUARINACEAE - She-oak Family	
* <i>Casuarina equisetifolia</i> L.	Ironwood tree
CONVOLVULACEAE - Morning-glory Family	
* <i>Ipomoea pes-caprae</i> (L.) Rb.	Beach morning-glory
<i>Ipomoea violacea</i> L.	

TABLE 4 (CONTINUED)

FAMILY NAME <i>Scientific Name</i>	Common Name
EUPHORBIACEAE - Spurge Family	
* <i>Chamaesyce hirta</i> (L.) Millsp.	Hairy spurge
* <i>Chamaesyce hypericifolia</i> (L.) Millsp.	Graceful spurge
* <i>Euphorbia cyathophora</i> J. A. Murray	Mexican fire plant
GOODENIACEAE - Goodenia Family	
* <i>Scaevola sericea</i> Vahl	Naupaka
LYTHRACEAE - Loosestrife Family	
<i>Pemphis acidula</i> Forst. f.	
MALVACEAE - Hibiscus Family	
* <i>Abutilon albescens</i> Miq.	
* <i>Gossypium religiosum</i> L.	Wild cotton
<i>Sida fallax</i> Walp.	'Ilima
PORTULACACEAE - Purslane Family	
<i>Portulaca lutea</i> Sol ex G. Forster	
* <i>Portulaca oleracea</i> L.	Pigweed
STERCULIACEAE - Cacao Family	
<i>Waltheria indica</i> L.	'Uhaloa
VERBENACEAE - Verbena Family	
* <i>Stachytarpheta jamaicensis</i> (L.) Vahl	Jamaica vervain

1. * = Non-native species introduced to Wake Atoll.

TABLE 5
PLANTS OF PEACOCK POINT AREA, WAKE ISLAND¹

FAMILY NAME	
<i>Scientific Name</i>	Common Name
ARECACEAE - Palm Family	
* <i>Cocos nucifera</i> L.	Coconut
CYPERACEAE - Sedge Family	
* <i>Cyperus rotundus</i> L.	Nut grass
* <i>Fimbristylis cymosa</i> R. Br.	
* <i>Fimbristylis dichotoma</i> (L.) Vahl	Fringe rush
POACEAE - Grass Family	
* <i>Cenchrus echinatus</i> L.	Common sandbur
* <i>Chloris barbata</i> (L.) Sw.	Swollen fingergrass
* <i>Chloris divaricata</i> R. Br.	Stargrass
* <i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass
* <i>Dactyloctenium aegyptium</i> (L.) Willd.	Beach wiregrass
* <i>Digitaria insularis</i> (L.) Mez ex Ekman	Sourgrass
* <i>Eleusine indica</i> (L.) Gaertn.	Wiregrass
* <i>Eragrostis cilianensis</i> (All.) Link	Stinkgrass
* <i>Eragrostis tenella</i> (L.) P. Beauv. ex Roem. & Schult	Lovegrass
<i>Lepturus gasparricensis</i> Fosb.	Broad-leaf bunchgrass
<i>Lepturus repens</i> (G. Forster) R. Br.	Bunch grass
<i>Paspalum vaginatum</i> Sw.	Seashore paspalum
* <i>Zoysia japonica</i> Steud.	Temple grass
AIZOACEAE - Fig-marigold Family	
<i>Sesuvium portulacastrum</i> (L.) L.	Akulikuli
APOCYNACEAE - Dogbane Family	
* <i>Catharanthus roseus</i> (L.) G. Don	Madagascar Perwinkle
ASTERACEAE - Sunflower Family	
* <i>Bidens alba</i> (L.) DC	
<i>Conyza bonariensis</i> (L.) Cronq.	Hairy horseweed
* <i>Pluchea symphytifolia</i> (Mill.) Gillis	Sourbush
* <i>Tridax procumbens</i> L.	Coat buttons

TABLE 5 (CONTINUED)

FAMILY NAME <i>Scientific Name</i>	Common Name
BORAGINACEAE - Borage Family	
* <i>Cordia subcordata</i> Lam.	Kou
<i>Heliotropium</i> sp.	
* <i>Heliotropium anomalum</i> Hook. & Arnott	Hinahina
* <i>Tournefortia argentea</i> L. fil.	Tree heliotrope
CASUARINACEAE - She-oak Family	
* <i>Casuarina equisetifolia</i> L.	Ironwood tree
CONVOLVULACEAE - Morning-glory Family	
* <i>Ipomoea pes-caprae</i> (L.) R. Br.	Beach morning-glory
<i>Ipomoea violacea</i> L.	
EUPHORBIACEAE - Spurge Family	
* <i>Chamaesyce hirta</i> (L.) Millsp.	Hairy spurge
* <i>Chamaesyce hypericifolia</i> (L.) Millsp.	Graceful spurge
* <i>Chamaesyce prostrata</i> (Aiton) Sma.	Prostrate spurge
* <i>Euphorbia cyathophora</i> J. A. Murray	Mexican fire plant
FABACEAE - Bean Family	
* <i>Leucaena leucocephala</i> (Lam). deWit	Koa haole
GOODENIACEAE - Goodenia Family	
* <i>Scaevola sericea</i> Vahl	Naupaka
LYTHRACEAE - Loosestrife Family	
<i>Pemphis acidula</i> Forst. f.	
MALVACEAE - Hibiscus Family	
* <i>Abutilon albescens</i> Miq.	
* <i>Gossypium religiosum</i> L.	Wild cotton
<i>Sida fallax</i> Walp.	'Ilima
* <i>Thespesia populnea</i> (L.) Sol ex. Correa	Milo

TABLE 5 (CONTINUED)

FAMILY NAME <i>Scientific Name</i>	Common Name
NYCTAGINACEAE - Four o'clock Family	
* <i>Boerhavia repens</i> L.	Alena
<i>Pisonia grandis</i> R. Br.	Puka
PASSIFLORACEAE - Passion flower Family	
* <i>Passiflora foetida</i> L.	Love-in-a-mist
POLYGONACEAE - Buckwheat Family	
* <i>Coccoloba uvifera</i> (L.) L.	Sea grape
PORTULACAEAE - Purslane Family	
<i>Portulaca lutea</i> Sol. ex G. Forster	'Ihi
* <i>Portulaca oleracea</i> L.	Pigweed
* <i>Portulaca pilosa</i> L.	Akulikuli
<i>Portulaca samoensis</i> L.	
STERCULIACEAE - Cacao Family	
<i>Waltheria indica</i> L.	'Uhaloa
VERBENACEAE - Verbena Family	
* <i>Stachytarpheta jamaicensis</i> (L.) Vahl	Jamaica vervain
ZYGOPHYLLACEAE - Creosote Family	
* <i>Tribulus cistoides</i> L.	Nohu

1. * = Non-native species introduced to Wake Atoll.

TABLE 6
PLANTS ALONG PROPOSED WATER SUPPLY ALIGNMENT,
WAKE ISLAND¹

FAMILY NAME <i>Scientific Name</i>	Common Name
AGAVACEAE - Agave Family	
* <i>Agave sisalana</i> Perrine	Sisal
ARECACEAE - Palm Family	
* <i>Cocos nucifera</i> L.	Coconut
CYPERACEAE - Sedge Family	
* <i>Cyperus rotundus</i> L.	Nut grass
* <i>Fimbristylis cymosa</i> R. Br.	
* <i>Fimbristylis dichotoma</i> (L.) Vahl	Fringe rush
POACEAE - Grass Family	
* <i>Bothriochloa pertusa</i> (L.) A Camus	Pitted beardgrass
* <i>Cenchrus echinatus</i> L.	Common sandbur
* <i>Chloris divaricata</i> R. Br.	Stargrass
* <i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass
* <i>Dactyloctenium aegyptium</i> (L.) Willd.	Beach wiregrass
* <i>Eleusine indica</i> (L.) Gaertn.	Wiregrass
* <i>Eragrostis cilianensis</i> (All.) Link	Stinkgrass
* <i>Eragrostis tenella</i> (L.) P. Beauv. ex Roem. & Schult	Lovegrass
<i>Lepturus gasparricensis</i> Fosb.	Broad-leaf bunchgrass
<i>Lepturus repens</i> (G. Forster) R. Br.	Bunch grass
<i>Paspalum vaginatum</i> Sw.	Seashore paspalum
AIZOACEAE - Fig-marigold Family	
<i>Sesuvium portulacastrum</i> (L.) L.	Akulikuli
APOCYNACEAE - Dogbane Family	
* <i>Catharanthus roseus</i> (L.) G. Don	Madagascar Perwinkle
ASTERACEAE - Sunflower Family	
* <i>Bidens alba</i> (L.) DC	
* <i>Conyza bonariensis</i> (L.) Cronq.	Hairy horseweed

TABLE 6 (CONTINUED)

FAMILY NAME	
<i>Scientific Name</i>	Common Name
* <i>Pluchea symphytifolia</i> (Mill.) Gillis	Sourbush
* <i>Tridax procumbens</i> L.	Coat buttons
BORAGINACEAE - Borage Family	
* <i>Cordia subcordata</i> Lam.	Kou
* <i>Heliotropium anomalum</i> Hook. & Arnott	Hinahina
* <i>Tournefortia argentea</i> L. fil.	Tree heliotrope
CACTACEAE - Cactus Family	
* <i>Opuntia littoralis</i> (Tour.) Mill.	Panini
CASUARINACEAE - She-oak Family	
* <i>Casuarina equisetifolia</i> L.	Ironwood tree
CONVOLVULACEAE - Morning-glory Family	
* <i>Ipomoea pes-caprae</i> (L.) R. Br.	Beach morning-glory
<i>Ipomoea violacea</i> L.	
EUPHORBIACEAE - Spurge Family	
* <i>Chamaesyce hirta</i> (L.) Millsp.	Hairy spurge
* <i>Chamaesyce prostrata</i> (Aiton) Sma.	Prostrate spurge
* <i>Euphorbia cyathophora</i> J. A. Murray	Mexican fire plant
FABACEAE - Bean Family	
* <i>Leucaena leucocephala</i> (Lam). deWit	Koa haole
GOODENIACEAE - Goodenia Family	
* <i>Scaevola sericea</i> Vahl	Naupaka
LYTHRACEAE - Loosestrife Family	
<i>Pemphis acidula</i> Forst. f.	

TABLE 6 (CONTINUED)

FAMILY NAME <i>Scientific Name</i>	Common Name
MALVACEAE - Hibiscus Family	
* <i>Abutilon albescens</i> Miq.	Wild cotton 'Ilima Milo
* <i>Gossypium religiosum</i> L.	
<i>Sida fallax</i> Walp.	
* <i>Thespesia populnea</i> (L.) Sol ex. Correa	
NYCTAGINACEAE - Four o'clock Family	
* <i>Boerhavia repens</i> L.	Alena Puka
<i>Pisonia grandis</i> R. Br.	
POLYGONACEAE - Buckwheat Family	
* <i>Coccoloba uvifera</i> (L.) L.	Sea grape
PORTULACAEAE - Purslane Family	
<i>Portulaca lutea</i> Sol. ex G. Forster	'Ihi
* <i>Portulaca oleracea</i> L.	Pigweed
STERCULIACEAE - Cacao Family	
<i>Waltheria indica</i> L.	'Uhaloa
VERBENACEAE - Verbena Family	
* <i>Stachytarpheta jamaicensis</i> (L.) Vahl	Jamaica vervain
ZYGOPHYLLACEAE - Creosote Family	
* <i>Tribulus cistoides</i> L.	Nohu

1. * = Non-native species introduced to Wake Atoll.

SECTION 4 DISCUSSION

4.1 OBSERVATIONS AND RECOMMENDATIONS

Several plant species, many of which were intentionally introduced to Wake Atoll, have proliferated uncontrollably. Following is a discussion of several specific plants and recommended actions regarding their control.

Ironwoods. In 1959, Fosberg reported that ironwood trees "were growing behind shelters and in wind breaks". During the 1970s "family tree planting days" were held on the atoll to set out young ironwood trees.³ These early efforts have been extremely successful for today, ironwood trees 15 m or more in height are common and young trees are beginning to take over in all parts of the atoll. Young plants are common around buildings and are beginning to crowd out the native vegetation. If the abandoned housing area is to be put to any useful purpose, the young ironwood trees should be bulldozed now while it is relatively easy to do.

Ivory Gourd. Two ivory gourd (*Coccinia grandis* Ehrenb. ex Spach) vines are now growing on the atoll. One is near the baseball field and the other one is north of the water catchment. This robust vine with grape-like leaves, white flowers, and bright red fruits and can develop a stem 10 to 12 centimeters (cm) across. Unfortunately, while this plant is quite attractive and provides vegetative cover on fences and unsightly structures, in less than 10 years, it has become a major pest in Hawaii. Left uncurbed, its spread on Wake may occur as quickly.

Nohu. As mentioned earlier, Nohu or *Tribulus cistoides* L. is a vine which was purposely introduced to the atoll. Unfortunately, it is now well established on all three islets. In addition, a second species, puncture vine (*Tribulus terrestris* L.), is now becoming part of the atoll flora. Several vines were seen near the men's dormitory. Nohu is quite attractive with its downy leaves and bright yellow flowers; however, it is the thorny seed coat which is injurious to animals and people. As for the second species, puncture vine, it has been declared a noxious weed because its spiny burrs can penetrate automobile tires, shoes, and animal feet.

Prickly Pear Cactus. A large colony of this cactus (*Opuntia littoralis* [Tour.] Mill.) growing near the turn-off from Peale Island Road to the track leading to the old seaplane ramp should be carefully examined. The pads of this cactus are bright green, the flowers are large and pure yellow, and the fruit is bright red, altogether a fairly attractive colony of plants. However, the plant is easily propagated by seed or detached pads and the pads are covered with long and short, sharp, spiny thorns. In its present form, the colony is controllable by bulldozing; left unattended this cactus could conceivably take over large parts of this islet.

Opiuma. Among the ruins, near the cactus patch on Peale Island, were found three individuals of Opiuma or Manila tamarind (*Pithecellobium dulce* [Roxb.] Benth). One of these plants is a sapling which indicates that the tree is viable and could spread. This is a tree which thrives in dry, hot places and

³Personal Communication from Robert Watanabe, National Oceanic and Atmospheric Administration, and former resident of Wake Atoll.

produces masses of greenish white to pale yellow mimosaceous flowers which are very attractive to bees. It also produces sharp spines along its stems and branches. Because of these spines it may not be desirable to keep these trees.

4.2 NEW WEED SPECIES, UNDESCRIBED SPECIES, AND ENDANGERED SPECIES

New Weed Species. Fosberg (1959) recorded 96 species of vascular plants on Wake Atoll. This included cultivars such as broccoli, radishes, and cucumbers which were being grown in private gardens. It also included such landscape plants as banyan trees. Fifty-seven of Fosberg's recorded taxa can be said to have been self-perpetuating at the time of his study. In addition, nine of the weed species recorded by Fosberg were not found during this survey. In other words, 63 species which were present in 1959 are still thriving on the atoll.

As stated earlier, plants which were being grown in garden situations or plants which had been planted and were being cared for as a part of landscaping were not included in the present survey. A total of 72 taxa were found, 23 of which do not appear on Fosberg's species list.

Most of the newly found taxa can be classed as weeds and were found in the Peacock Point area and in the glide path of the runways indicating that original propagules were hitchhikers on either airplanes or cargo.

Undescribed Species. Fosberg noted and collected what is probably an indigenous (native to the atoll) and unnamed species of *Boerhavia*. This plant was found growing on the dunes near the weather station. It was collected during this survey and has been placed in the herbarium of the Bernice P. Bishop Museum, Honolulu, Hawaii for future identification.

An undescribed species of beach heliotrope (*Heliotropium* sp.) was found in four places on the atoll. A colony of approximately 100 individuals is growing in front of the weather station. A large colony of about 500 plants is to be found at the high water line just east of the old Wake Island School site. A small group of 5 plants was found on the lagoon side of Wilkes Island near the manmade channel and a single plant is located on Peacock Point. A sample of this taxon has also been placed in the Bernice P. Bishop Museum herbarium for future identification.

E. H. Bryan reported "some kind of water lemon" on Wake Atoll in the 1940s. Today, the water lemon known as Love-in-a-mist (*Passiflora foetida* L.) is extremely common in the Peacock Point area where the vines form large, tangled mats on the sand and coral dunes.

Endangered Species. No proposed or listed threatened or endangered plant species as set forth in the Endangered Species Act of 1973 (16 U.S.C. 1531-1543), were encountered (U.S. Department of the Interior Fish and Wildlife Service [USFWS] 1992).

SECTION 5 COMPREHENSIVE SPECIES LIST

In the following species list (table 7) the plant families have been arranged alphabetically within three groups: Ferns, Monocotyledones, and Dicotyledones. The genera and species have been arranged alphabetically within the families. The taxonomy and nomenclature follow that of Fosberg 1959, with taxonomic updating using Wagner, Herbst, and Sohmer (1990), St. John (1973), and Neal (1965). For each taxon the following information is provided:

- An asterisk before the plant name indicates a plant introduced to Wake Atoll since the arrival of the Wilkes Expedition (Pickering 1876).
- The scientific name.
- The mostly widely used common name.
- Abundance ratings: These are for this site only and have the following meanings:
 - Uncommon = a plant that was found less than five times.
 - Occasional = a plant that was found between five to ten times.
 - Frequent = a plant that was found in widely scattered parts of the site in low numbers.
 - Common = a plant considered an important part of the vegetation
 - Locally abundant = plants found in large numbers over a limited area. For example, the plants found in grassy patches.

This species list is the result of extensive surveys of these sites completed well past the end of the rainy season (late fall according to Fosberg 1959), and it reflects the vegetative composition of the flora during a single dry season. Changes in the vegetation will occur due to introductions and losses, and a slightly different species list would result from a survey conducted during a different growing season. In addition, there may be environmental factors such as fire which will lead to species composition alteration.

Only plants that appeared to be surviving on their own were recorded. Plants in private gardens or plants which were tended as part of the landscaping are not included on this list.

TABLE 7
PLANTS OF WAKE ATOLL, SURVEY OF MARCH 1993¹

FAMILY NAME <i>Scientific Name</i>	Common Name	Abundance
1. FERNS AND FERN ALLIES		
POLYPODIACEAE - Fern Family		
* <i>Polypodium scolopendrium</i> Burm. f.	Rabbit-foot fern	Uncommon
2. MONOCOTYLEDONES		
AGAVACEAE - Agave Family		
* <i>Agave sisalana</i> Perrine	Sisal	Locally abundant
* <i>Cordyline fruticosa</i> (L.) A. Chev.	Ti	Uncommon
ARECACEAE - Palm Family		
* <i>Cocos nucifera</i> L.	Coconut	Occasional
CYPERACEAE - Sedge Family		
* <i>Cyperus rotundus</i> L.	Nut grass	Locally abundant
* <i>Fimbristylis cymosa</i> R. Br.		Locally abundant
* <i>Fimbristylis dichotoma</i> (L.) Vahl	Fringe rush	Occasional
LILIACEAE - Lily Family		
* <i>Aloe vera</i> L.	Aloe	Locally abundant
PANDANACEAE - Screwpine Family		
* <i>Pandanus tectorius</i> S. Parkinson ex Z	Screw pine	Uncommon
POACEAE - Grass Family		
* <i>Bothriochloa pertusa</i> (L.) A Camus	Pitted beardgrass	Locally abundant
* <i>Cenchrus echinatus</i> L.	Common sandbur	Common
* <i>Chloris barbata</i> (L.) Sw.	Swollen fingergrass	Occasional
* <i>Chloris divaricata</i> R. Br.	Stargrass	Common

TABLE 7 (CONTINUED)

FAMILY NAME Scientific Name	Common Name	Abundance
* <i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass	Locally abundant
* <i>Dactyloctenium aegyptium</i> (L.) Willd.	Beach wiregrass	Common
POACEAE - Grass Family (continued)		
* <i>Digitaria insularis</i> (L.) Mez ex Ekman	Sourgrass	Uncommon
* <i>Eleusine indica</i> (L.) Gaertn.	Wiregrass	Locally abundant
* <i>Eragrostis cilianensis</i> (All.) Link	Stinkgrass	Common
* <i>Eragrostis tenella</i> (L.) P. Beauv. ex Roem. & Schult	Lovegrass	Common
<i>Lepturus gasparricensis</i> Fosb.	Broad-leaf bunchgrass	Common
<i>Lepturus repens</i> (G. Forster) R. Br.	Bunch grass	Common
<i>Paspalum vaginatum</i> Sw.	Seashore paspalum	Common
* <i>Zoysia japonica</i> Steud.	Temple grass	Rare
3. DICOTYLEDONES		
AIZOACEAE - Fig-marigold Family		
<i>Sesuvium portulacastrum</i> (L.) L.	Red-stemmed sea purslane	Locally abundant
APOCYNACEAE - Dogbane Family		
* <i>Catharanthus roseus</i> (L.) G. Don	Madagascar Perwinkle	Common
ASTERACEAE - Sunflower Family		
* <i>Bidens alba</i> (L.) DC		Common
* <i>Conyza bonariensis</i> (L.) Cronq.	Hairy horseweed	Frequent
* <i>Pluchea symphytifolia</i> (Mill.) Gillis	Sourbush	Common
* <i>Tridax procumbens</i> L.	Coat buttons	Common
BORAGINACEAE - Borage Family		
* <i>Cordia subcordata</i> Lam.	Kou	Common
* <i>Heliotropium anomalum</i> Hook. & Arnott	Hinahina	Occasional
<i>Heliotropium</i> sp.		Occasional
* <i>Tournefortia argentea</i> L. fil.	Tree heliotrope	Common

TABLE 7 (CONTINUED)

FAMILY NAME <i>Scientific Name</i>	Common Name	Abundance
BRASSICACEAE - Mustard Family		
<i>Lepidium bidentatum</i> Montin	Scurvy grass	Locally abundant
CACTACEAE - Cactus Family		
* <i>Opuntia littoralis</i> (Tour.) Mill.		Locally abundant
* <i>Opuntia ficus-indica</i> (L.) Mill.	Panini	Locally abundant
CASUARINACEAE - She-oak Family		
* <i>Casuarina equisetifolia</i> L.	Ironwood tree	Common
COMBRETACEAE - Indian almond Family		
<i>Terminalia catappa</i> L.	Tropical almond	Uncommon
CONVOLVULACEAE - Morning-glory Family		
* <i>Ipomoea pes-caprae</i> (L.) R. Br.	Beach morning glory	Common
<i>Ipomoea violacea</i> L.		Common
CRASSULACEAE - Orpine Family		
* <i>Kalanchoe pinnata</i> (Lam.) Pers	Mother-of-thousands	Locally abundant
CUCURBITACEAE - Gourd Family		
* <i>Coccinia grandis</i> Ehrenb. ex Spach	Hedge hog	Uncommon
EUPHORBIACEAE - Spurge Family		
* <i>Chamaesyce hirta</i> (L.) Millsp.	Hairy spurge	Common
* <i>Chamaesyce hypericifolia</i> (L.) Millsp.	Graceful spurge	Locally abundant
* <i>Chamaesyce prostrata</i> (Aiton) Sma.	Prostrate spurge	Uncommon
* <i>Euphorbia cyathophora</i> J.A. Murray	Mexican fire plant	Locally abundant
* <i>Euphorbia tirucalli</i> L.	Pencil tree	Uncommon
* <i>Phyllanthus debilis</i> Kleen ex Willd.	Niruri	Uncommon

TABLE 7 (CONTINUED)

FAMILY NAME <i>Scientific Name</i>	Common Name	Abundance
FABACEAE - Bean Family		
* <i>Desmanthus virgatus</i> (L.) Willd.	Slender mimosa	Occasional
* <i>Leucaena leucocephala</i> (Lam). deWit	Koa haole	Occasional
* <i>Pithecellobium dulce</i> (Roxb.) Benth	Manila tamarind	Uncommon
GOODENIACEAE - Goodenia Family		
* <i>Scaevola sericea</i> Vahl	Naupaka	Locally abundant
LYTHRACEAE - Loosestrife Family		
<i>Pemphis acidula</i> Forst. f.		Common
MALVACEAE - Hibiscus Family		
* <i>Abutilon albescens</i> Miq.		Occasional
* <i>Gossypium religiosum</i> L.	Wild cotton	Common
<i>Sida fallax</i> Walp.	'Ilima	Common
* <i>Thespesia populnea</i> (L.) Sol ex. Correa	Milo	Uncommon
NYCTAGINACEAE - Four o'clock Family		
<i>Boerhavia</i> sp.		Uncommon
* <i>Boerhavia repens</i> L.	Alena	Locally abundant
* <i>Bougainvillea</i> sp. Commerson ex Juss.	Bougainvillea	Occasional
<i>Pisonia grandis</i> R. Br.	Puka	Locally abundant
PASSIFLORACEAE - Passion flower Family		
* <i>Passiflora foetida</i> L.	Love-in-a-mist	Locally abundant
POLYGONACEAE - Buckwheat Family		
* <i>Coccoloba uvifera</i> (L.) L.	Sea grape	Occasional
PORTULACAEAE - Purslane Family		
<i>Portulaca lutea</i> Sol. ex G. Forster	'Ihi	Common

TABLE 7 (CONTINUED)

FAMILY NAME <i>Scientific Name</i>	Common Name	Abundance
* <i>Portulaca oleracea</i> L.	Pigweed	Occasional
* <i>Portulaca pilosa</i> L.	Akulikuli	Uncommon
<i>Portulaca samoensis</i> L.		Occasional
STERCULIACEAE - Cacao Family		
<i>Waltheria indica</i> L.	'Uhaloa	Common
VERBENACEAE - Verbena Family		
* <i>Stachytarpheta jamaicensis</i> (L.) Vahl	Jamaica vervain	Common
ZYGOPHYLLACEAE - Creosote Family		
* <i>Tribulus cistoides</i> L.	Nohu	Common
* <i>Tribulus terrestris</i> L.	Puncture vine	Occasional

1. * = Non-native species introduced to Wake Atoll.

SECTION 6
REFERENCES

- Bryan Jr., E.H. 1959. Notes on the geography and natural history of Wake Island. *Atoll Res. Bull.* 66. Pacific Science Board. National Academy of Sciences, Washington D.C.
- Fosberg, F.R. 1959. Vegetation and flora of Wake Island. *Atoll Res. Bull.* 66. Pacific Science Board. National Academy of Sciences, Washington D.C.
- Neal, M.C. 1965. In *Gardens of Hawaii*. Special Publication 65. Bernice P. Bishop Museum, Honolulu, Hawaii.
- Pickering, C. 1876. Geographical distribution of animals and plants. *U.S. Exploring Expedition* 19(2): pp.1-524.
- Rowland, C.M. 1989. Biological Survey Wake Island Starlab Project Sites. (Appendix A of Department of the Air Force [USAF] 1990. *Environmental Impact Analysis Process Final Environmental Assessment Starlab Program*). U.S. Fish and Wildlife Service, Honolulu, Hawaii.
- St. John, H. 1973. *List and Summary of the Flowering Plants of the Hawaiian Islands*. Pacific Tropical Botanical Garden, Lawai, Kauai, Hawaii.
- USFWS. 1992. *Endangered and Threatened Wildlife and Plants*. 50 CFR 17.11 & 17.12
- Wagner, W.L., D.R. Herbst and S.H. Sohmer. 1990. *Manual of the Flowering Plants of Hawaii*. Bishop Museum Special Publication #83. University of Hawaii Press. Vols. 1 & 2.

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix G



REPLY TO
ATTENTION OF

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

November 17, 1993

Environmental and
Engineering Office

Mr. Robert P. Smith
U.S. Department of the Interior
Fish and Wildlife Service
P.O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Smith:

First I would like to take the opportunity to thank you and your staff for the timely response to our Coordinating Draft Environmental Assessment for Wake Island. You should be aware that the proposed action has changed in several respects since that draft was issued. It is our intent to publish the preliminary final environmental assessment that will address these changes and review comments received from the coordinating draft on October 1, 1993. A copy of this document will be provided to the Fish and Wildlife Service.

In regard to the response received from your office on August 12, 1993, the U.S. Army Space and Strategic Defense Command (USASSDC) has the following comments:

While Code of Federal Regulations (CFR) 1508.7 defines "cumulative impact" as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such actions," we believe that the operative word in this case is "added." While the USASSDC acknowledges, and has addressed in the coordinating draft environmental assessment, the potential for the introduction of alien plant and animal species and the minor loss of vegetation, the actions leading to the extinction of the Wake Rail ceased with the recapture of Wake Island by Allied Forces in 1945. Unfortunately, it came too late to save the rail. However, ongoing activities, and those of the past 48 years, cannot be linked in any way to the rail's extinction and certainly should not be considered ongoing cumulative impacts in this regard.

The proposed action would not, in fact, directly or indirectly impact nesting seabirds by adding to the feral cat population. Theater Missile Defense related personnel would not be allowed to bring cats or other pets to the island or to feed

feral cats; therefore, there is no significant potential for incremental impacts from the proposed action. The Wake Island Environmental Assessment has satisfied the intent of the National Environmental Policy Act in that it fully addresses the potential cumulative impacts of the proposed action in this regard. Nevertheless, the USASSDC and the Ballistic Missile Defense Organization are committed to work with Hickam Air Force Base, the islands administrator, and the U.S. Fish and Wildlife Service to develop a long term program to enhance the Wake Island environment for seabirds nesting.

A reasonable baseline for discussion of past impacts to the island's vegetation is very difficult to identify. As you know, vegetation on the island was completely devastated during World War II. The few records available for the period since that time indicate that there has been a general pattern of increasing areal distribution and density of vegetation and, therefore, increased nesting habitat for some seabird species. During the period when the island was operated by the Federal Aviation Administration, there were about 1,600 residents on Wake Island and substantially more activity on Wilkes and Peale Islands. Air Force activities and new construction since its acquisition of the island have been very minimal relative to the previous user. Currently, there are only about 206 island residents, and many of the structures constructed by the Federal Aviation Administration have been demolished, allowing vegetation to grow freely in these areas. Therefore, while many non-indigenous species of vegetation have been introduced, there has been a net beneficial effect on the amount of potential seabird nesting habitat on the atoll over the last 20 years. The presently proposed programs would require the removal of less than 1 percent of the mixed scrub vegetation in the Peacock Point area and considerably less than 1 percent of the other vegetation associations on other parts of Wake Island. As no active nests or signs of past nesting activity were identified in the Peacock Point area during the ornithological survey, and there is no record of significant numbers of seabirds nesting anywhere on Wake Island proper, we believe there will be no substantive effect on the amount of available nesting habitat. In addition, since the small amount of vegetation to be impacted directly through project actions is neither rare, threatened, or endangered, no mitigation for its loss is being proposed.

As far as restricting access to seabird nesting areas is concerned, permanent and visiting personnel are already being briefed on the protected status of the island's seabirds. Additionally, visiting personnel are restricted from Peale and Wilkes islands without a permit issued by the base commanding officer's office or without being escorted by an island resident. These actions minimize human disturbance of the seabird nesting colonies on these islands. While there are no controlled access

areas on Wake Island, tropicbirds, the only birds found to be nesting on Wake Island during the field survey, typically nest away from human activity.

Regarding the comment on the methodology used to detect tropicbird nests, it was not intended that the ornithological survey locate all tropicbird nests on Wake Island. However, we believe that the method employed enabled us to locate the great majority of active nests for the following reasons: the prevalence of courtship activity observed during the survey period, coupled with the daily increase in number of tropicbirds observed at the island over the 7 days of observation, suggest that the breeding season was in its early stages; also, no nestlings or tropicbirds carrying food to nestlings were observed. It is only during a relatively brief period when birds would still be incubating subsequent to all courtship activity and prior to hatching of young that nests may be difficult to locate. It should be noted that the entire island was searched daily for tropicbird activity, and any activity observed, other than "flybys," was investigated. Several areas were investigated numerous times during the week. Only areas where no tropicbird activity was observed during the entire survey period and where no project activity is proposed were not investigated. However, we recognize that the possibility certainly exists that a few incubating birds were overlooked.

The purpose of the quick transect through the Sooty Tern colony was to determine the number and condition of what appeared to be an unusually large number of addled eggs. This decision was made only after 3 days of observing the colony from a distance and obtaining counts of adults and young in selected portions of the colony from the roof of a nearby building through binoculars and a telescope and extrapolating the colony size from those counts. As no birds appeared to be incubating and most young were a week or more old at this time, disturbance to the colony from walking a brief transect was determined to be minimal. Care was taken to see that young did not continue dispersing ahead of the observer but to the side. The transect was conducted at a fast pace that took only 2 minutes, and eggs were counted in blocks of five and ten rather than through more time-consuming direct counts. A few whole eggs were picked up "on the move" for closer examination. All proved to be addled. No predators were observed in the area prior to conducting the transect, and no predation was observed after completion of the transect. It should be noted that the original suggestion to walk selected transects through the tern colonies, discussed with Fish and Wildlife Service personnel prior to the study, met with no objections at the time. Only after arriving on the island and assessing the situation was it decided that transects, other than the one described above, were neither necessary or advisable.

The following modifications and corrections will be made in the assessment:

a. Reference to a feral cat management program will be changed in the text and the appendices to read as follows: "Efforts will be made to protect populations of native plants and wildlife from introduced species."

b. The Tim Sutterfield report citation will be corrected to accurately reflect that the report was generated by the U.S. Navy.

c. In reference to frigatebird nest-raiding behavior, the words "the exposed eggs and chicks of" will be deleted so that the sentence reads "...frigatebirds are well known for raiding unattended booby nests..."

The USASSDC plans to include the following additional mitigation measures for the proposed actions in the preliminary final environmental assessment:

a. No additional cats or other pets will be brought to the island by the U.S. Army program personnel.

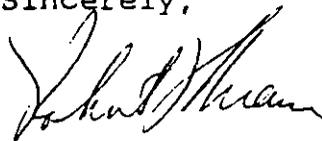
b. The preconstruction site survey for seabird nests will be conducted by a trained field ornithologist 1 to 2 weeks prior to the start of construction.

c. Cargo-handling personnel will inspect arriving aircraft for pest species of plants and animals and will be briefed on methods for their detection.

d. Facility construction and launch activities will be restricted when possible to the period between August and January to reduce activity during the seabird nesting season. However, it is recognized that this measure may not always be possible.

Your assistance in this matter is greatly appreciated. Should you need additional information, please contact Ms. Linda Ninh at (205) 955-1154.

Sincerely,



Robert F. Shearer
Chief, Environmental
and Engineering Office



REPLY TO
ATTENTION OF

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

November 17, 1993

Environmental and
Engineering Office

Mr. John Naughton
Pacific Islands Environmental Coordinator
National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii 96822-2396

Dear Mr. Naughton:

The Ballistic Missile Defense program is an extensive research program designed to determine the feasibility of developing an effective ballistic missile defense system. The program includes research of theater missile defense (TMD) technologies necessary for the protection of deployed U.S. forces, as well as U.S. friends and allies throughout the world, from future missile threats.

Congress has called for the development of what could be a stand-alone TMD system. The Ballistic Missile Defense Organization (BMDO), previously known as the Strategic Defense Initiative Organization, has been designated as the management office, with various elements of the TMD program being delegated to the Army, Air Force, Navy, and Marine Corps. The BMDO will be the principal architect for this system. The U.S. Army Space and Strategic Defense Command (USASSDC) proposes to conduct long-distance missile flight tests to support the developmental requirements needed to validate system design and operational effectiveness of Army ground-based TMD missile and sensor systems.

The purpose of the program is to provide a realistic TMD quantification of intercept lethality against chemical, biological, and nuclear/conventional weapons and to collect data from liquid-fuel motors for plume signature recognition. The target system would be designed to deliver single or multiple reentry vehicles toward the U.S. Army Kwajalein Atoll (USAKA). For target launches from Wake Island, the defensive missile would be launched from the USAKA. If defensive missiles are launched from Wake Island, the targets could be launched from the USAKA or from a Missile Launch Ship located south of Wake Island. In either case, target and defensive missile flight azimuths and test profiles will be designed so that no lethal debris would fall on Wake Island or any other land mass as a result of nominal flight tests.

Wake Island has been proposed as one of the potential sites for conducting the TMD flight experiments for the following reasons:

a. Existing infrastructure on the island will minimize the necessity for new construction or major modifications that would be required elsewhere which could potentially impact natural resources.

b. Remote location, relative to inhabited land areas.

c. Geographic location and distance of U.S. Army Kwajalein Atoll as an existing downrange sensor facility.

To support the proposed action, construction of several new facilities and modifications to some existing facilities will be required. The locations of these proposed actions are shown on Figure 1-3 in the Preliminary Final Environmental Assessment provided under separate cover. As shown on the map, two of the proposed activities are located in the marine or near-shore environment. These are the placement of a fiber optic cable on the south side of Wake Island and refurbishment of the bridge between Wake and Peale Islands.

A fiber optics cable has been proposed that would link Wake Island and Kwajalein Island. The route of the cable has not been determined. The cable could be trenched and laid along the south side of Wake Island and brought on shore near Launch Pad 1 or near the proposed location for liquid fuel storage. From there a likely route would be along the access road to one of these sites to the Range Support Building (1601) in existing utility trenches. The reef that surrounds the island is very narrow along the southern shore and this location would require the minimum of potential off-shore blasting and trenching for cable placement.

It is expected that the bridge strengthening would include additional pier supports into the lagoon and additional or replacement of cross members above the high tide line. Replacement would be designed to minimize disruption of water flow between the lagoon and the open ocean area.

Based on existing information gathered through past field surveys, these are the only ground activities in the proposed action that could adversely affect the green sea turtle (*Chelonia mydas*), the only federal listed species known to occur near the site with any frequency. To mitigate the potential for accidental taking of these animals, the U.S. Army is proposing to use underwater divers to survey the area immediately prior to any explosive detonation. Explosives will not be detonated until all sensitive species are clear of the area. Additionally, bridge

modifications would be designed such that sea turtles would not be trapped or ensnared by the structure.

There is also a potential for the accidental taking of sea turtles or federally listed marine mammals during flight testing. Whole booster motors and missile debris will impact in the open ocean area between Wake and Kwajalein islands. Although the taking of protected species would be significant, the probability of such an occurrence is extremely remote, thus no significant impacts are anticipated.

In accordance with the National Environmental Policy Act, the Council on Environmental Quality regulations implementing the Act, Department of Defense Directive 6050.1, Environmental Effects in the United States Department Actions, and Army Regulation 200-2, Environmental Effects of Army Actions, the USASSDC is conducting an Environmental Assessment to determine potential impacts to the natural resources by the proposed actions. We would appreciate any comments or concerns you may wish to express regarding this proposed action.

Your assistance in this matter is greatly appreciated. Should you need additional information, please contact Ms. Linda Ninh at (205) 955-1154.

Sincerely,



Robert F. Shearer
Chief, Environmental
and Engineering Office



REPLY TO
ATTENTION OF

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

November 17, 1993

Environmental and
Engineering Office

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

Dear Ms. Nissley:

The Ballistic Missile Defense program is an extensive research program designed to determine the feasibility of developing an effective ballistic missile defense system. The program includes research of theater missile defense (TMD) technologies necessary for the protection of deployed U.S. forces, as well as U.S. friends and allies throughout the world, from future missile threats.

Congress has called for the development of what could be a stand-alone TMD system. The Ballistic Missile Defense Organization (BMDO), previously known as the Strategic Defense Initiative Organization, has been designated as the management office, with various elements of the TMD program being delegated to the Army, Air Force, Navy, and Marine Corps. The BMDO will be the principal architect for this system. The U.S. Army Space and Strategic Defense Command (USASSDC) proposes to conduct long-distance missile flight tests to support the developmental requirements needed to validate system design and operational effectiveness of Army ground-based TMD missile and sensor systems.

The purpose of the program is to provide a realistic TMD quantification of intercept lethality against chemical, biological, and nuclear/conventional weapons and to collect data from liquid-fuel motors for plume signature recognition. The target system would be designed to deliver single or multiple re-entry vehicles toward the U.S. Army Kwajalein Atoll (USAKA). For target launches from Wake Island, the defensive missile would be launched from the USAKA. If defensive missiles are launched from Wake Island, the targets could be launched from the USAKA or from a Missile Launch Ship located south of Wake Island. In either case, target and defensive missile flight azimuths and test profiles will be designed so that no lethal debris would fall on Wake Island or any other land mass as a result of nominal flight tests.

Wake Island has been proposed as one potential site for conducting the TMD flight experiments for the following reasons:

a. Existing infrastructure on the island will minimize the necessity for new construction or major modifications that would be required elsewhere which could potentially impact natural and cultural resources.

b. Remote location, relative to inhabited land areas.

c. Geographic location and distance of U.S. Army Kwajalein Atoll as an existing downrange sensor facility.

To support the proposed action, construction of several new facilities and modifications to some existing facilities will be required. The location of these proposed actions are shown on Figure 1-3 in the Preliminary Final Environmental Assessment provided under separate cover. A general description of the proposed facility activities is provided below:

a. The construction of a new missile storage and a new missile assembly building has been proposed. Ground disruption at each site would consist of a shallow excavation for a concrete pad, road clearing and grading to each building, and trenching for the placement of utility and communication lines. The total area affected by the construction of each facility would be about 0.25 acres.

b. A launch equipment building may be required at Launch Pad 1 and Launch Pad 2 on Wake Island. Each building would be about 500 square feet and require concrete foundation of slightly larger dimensions. The area of land disturbance required will depend on the exact site location. Final building locations will be selected to minimize or avoid land disturbance, but in no case will more than 0.1 acres be required for each structure.

c. Launch Pad 2 will be used for target missile launches and may be used for defense missile launches. Additional new construction at this site could include a vertical launch stool and trenches to building 1601 for utility and communication lines. The total area potentially disturbed by this construction would be up to 0.3 acres including the launch equipment building site and clearing for fire safety.

d. A fiber optics cable has been proposed that would link Wake Island and Kwajalein Island. The route of the cable has not been determined. The cable could be trenched and laid along the south side of Wake Island and brought on shore near Launch Pad 1 or near the proposed location for liquid fuel storage. From there a likely route would be along the access road to one of

these sites to the Range Support Building (1601) in existing utility trenches. The reef that surrounds the island is very narrow along the southern shore and this location would provide the shortest overland route to the Range Support Building and the least ground disturbance if previously trenched areas for utilities were used.

e. An additional refuse incinerator may be required to support the influx of project-related personnel. The unit would be similar to the existing unit in size and would be located adjacent to the existing incinerator on an approximately 0.1 acres of previously disturbed land.

f. The proposed site for the location of permanent range support sensors is the abandoned U.S. Coast Guard facility on Peale Island. Site preparation would include the refurbishment of building 1203 for electronic equipment, construction of a concrete foundation approximately 30 feet by 30 feet for a MPS-36 or similar radar, trenching along the existing road to the billeting area for utility and communication lines, and strengthening of the bridge between Wake and Peale Islands. The total area expected to be disturbed for this option is about 0.25 acres.

g. A New mobile, TMD ground-based radar system would be used in some testing. This radar is currently being developed as an integral part of the TMD system and would provide surveillance, target missile detection, fire control support, and kill assessment for TMD defensive missile systems. This radar and the supporting power plant and antenna mast group will be road and aircraft transportable systems of modular design. This system would require dedicated areas ranging from 0.8 hectare (2 acres) to 2.53 hectares (6.25 acre) for the electromagnetic radiation hazard zone and mobile unit parking areas. The system would be located adjacent to the power plant or on the old hot cargo pad on the northwest end of the runway. Ground disturbance would not be required at either site.

In accordance with the National Environmental Policy Act, the Council on Environmental Quality regulations implementing the Act, Department of Defense Directive 6050.1, Environmental Effects in the United States Department Actions, and Army Regulation 200-2, Environmental Effects of Army Actions, the USASSDC is conducting an Environmental Assessment to determine potential impacts to the natural and cultural resources by the proposed actions.

In fulfilling its responsibilities for complying with Sections 106 and 110 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's regulations

implementing Section 106 (36 Code of Federal Regulations 800), the USASSDC is taking into account the effect of this undertaking on historic properties. We would appreciate any comments or concerns you may wish to express regarding this proposed action and the cultural resources of the area.

Your assistance in this matter is greatly appreciated. Should you need additional information, please contact Linda Ninh at (205) 955-1154.

Sincerely,



Robert F. Shearer
Chief, Environmental
and Engineering Office